A BEHAVIOURAL ANALYSIS OF "CHOKING" IN SELF-PACED SKILLS

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I, Robin Jackson, hereby certify that this thesis, which is approximately 60,000 words in length, has been written by me, that it is a record of my own work and that it has not been submitted in any previous application for a higher degree.

Date..28/2/98..... Signature of candidate [redacted]..............

I was admitted as a candidate for the degree of Ph. D. in October, 1993; the higher study for which this is a record was carried out in the University of St. Andrews between 1993 and 1997.

Date...28/2/98... Signature of candidate [redacted]...........

I hereby certify that the candidate has fulfilled the conditions of the Resolution and Regulations appropriate for the degree of Ph. D. in the University of St. Andrews and that the candidate is qualified to submit this thesis in application for that degree.

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ABSTRACT

This thesis is about "choking" in self-paced skills. Choking refers to "the occurrence of inferior performance despite striving and incentives for superior performance" (Baumeister and Steinhilber, 1986, p. 361). Self-paced skills are skills in which performance is initiated by the athlete. This research set out to investigate the cause of choking in self-paced skills within the theoretical framework of behaviour analysis. The main focus of the research relates to the distinction between behaviour under the control of verbal antecedents (rule-governed behaviour) and behaviour that is shaped by its consequences (contingency-shaped behaviour).

It was originally hypothesised that the insensitivity of rule-governed behaviour to changes in the contingencies of reinforcement could be beneficial in situations where these changes led to greater performance pressure. Specifically, it was predicted that performance under the control of verbal antecedents would be less susceptible to choking. In the first experiment, no support was found for the hypothesis and, furthermore, rule-governed performance appeared to be inferior to contingency-shaped performance in the early stages of acquisition.

In light of these results, and after a detailed examination of the behaviour analysis distinction between these two forms of behaviour, evidence was presented which suggested that verbal control of the topography, or form, of behaviour would be likely to disrupt performance in self-paced skills. In subsequent experiments, it was found that using simple verbal cues was an effective means of preventing choking under pressure. It was hypothesised that the function of these cues was in preventing reinvestment of too many technical instructions in the moments before performance initiation. The assumptions upon which the reinvestment theory of choking is based were also examined with results providing general support for the theory but also suggesting that it needs to be refined to account for verbal antecedents that do not disrupt performance.

TABLE OF CONTENTS

FIGURES

TABLES

Chapter 1- Introduction to the Study of Stress and Performance in Sport

1.1. Introduction

> "Human beings under pressure are wonderfully unpredictable; their nature is a puzzle to us all, and psychology has only scratched the surface. When human beings are placed in an arena, and their hopes and fears exposed in front of thousands of observers, they are likely to do extraordinary things."
>
> (Patmore, 1986, p. 7)

In 1997, sportsmen and women still do "extraordinary things" in competitive situations. Sometimes, they achieve extremely high levels of performance: athletes break world records, golfers shoot course records and rugby goal kickers are successful with all their kicks. At other times, these extraordinary things are associated with inexplicably poor performance. In 1996, Greg Norman played exceptional golf over the first three rounds of the U.S. Masters (one of the four "major" championships in mens' golf) to build up a six shot lead entering the last round. It was considered a formality that he would go on to win the tournament. Unfortunately for Norman, he took 78 shots in the final round to finish runner-up to Nick Faldo by five strokes. In 1993, Jana Novotna led 4-1, 40-30 in the final set of the Wimbledon ladies' final against Steffi Graf. Suddenly she started to serve double faults, missed routine volleys and went on to lose the match. In 1995, Novotna was the subject of an even more spectacular collapse at the French Open, where she lost a match against Chanda Rubin having led 5-0, 40-0 in the final set.

It is the latter type of performance, colloquially referred to as "choking", that is the subject of the current thesis. In particular, why such poor performance occurs and what can be done to prevent choking form the central foci of the research. As the title states, this thesis is a behavioural analysis of choking. Adoption of this framework does not, however, imply a combative position with respect to other, more mainstream approaches to the study of behaviour. Indeed, after the original experiments, presented in Chapter 2, the position throughout the thesis, is one of attempting to bridge the schism between cognitive and behavioural analyses (Slocum and Butterfield, 1994). In particular, similarities in the behaviour analysis distinction between rule-governed and contingency-shaped behaviour and the cognitive distinction between explicit and implicit learning forms a common theme.

This introduction begins with a section examining the definition of choking. This is followed by a section which summarises the traditional approaches used to study the relationship between stress and performance in sport. Having provided this background a summary of the basic tenets of behaviour analysis and a description of the distinction between rule-governed and contingency-shaped behaviour is presented. Finally, possible implications of this distinction for the performance of two types of motor skill are described.

1.2. Defining Choking

When talking about "choking" it is important to make a distinction between the colloquial and scientific use of the term. In the media, for example, choking has been used in verb form ("she choked"), noun form ("that was a choke") or as an adjective ("he is a choker") to describe just about any sub-optimal sports performance. Such use fits with a rather vague early definition of choking as "the inability to perform up to previously exhibited standards" (Daniel, 1981). To be useful as a scientific term, however, a definition of choking must distinguish between performance that can and cannot be explained by random variation. An example of the problem with the colloquial use of the term concerns a golf putt that Bernhard Langer had to hole for Europe to retain the 1991 Ryder Cup. To briefly summarise the situation, the Ryder Cup is the most prestigious team event in mens' golf and is contested every two years by the top twelve professional golfers from Europe and the United States of America. In 1991, the outcome of the contest rested on the result of the final match. More specifically, Bernhard Langer needed to hole a putt of approximately six feet on the final hole for Europe to retain the Cup. In the event he missed the putt by a fraction. This has been interpreted by many in the popular press as being an example of choking (e.g. Roberts, 1993), despite the fact that many putts of this length are missed in golf tournaments without choking being inferred. Indeed, Bernhard Langer himself describes this putt as an example of how he managed to make a good smooth putting stroke in a pressure situation (Fine, 1993).

Related to the problem of making inferences based on small sample sizes, Gilden and Wilson (1995) have looked at "streaks" in skilled performance. They found that people are poor judges of what a random sequence looks like and are "not competent to discriminate chance occurrence from truly remarkable performance" (p. 260). A similar conclusion was reached by Gilovich, Vallone and Tversky (1985) who argued that observers' detection of hot streaks could be attributed to a misconception of chance. The implications for choking are clear: not all sub-optimal performances are instances of choking and the use of statistical analyses are required for a valid scientific use of the term.

As a scientific term "choking" has been defined as "performance decrements under circumstances that increase the importance of good or improved performance" (Baumeister, 1984, p. 610). Similarly, Baumeister and Showers (1986) used the term "paradoxical performance effects" which they defined as "the occurrence of inferior performance despite striving and incentives for superior performance" (p. 361). Both of these definitions encapsulate two elements that are necessary for correct use of the term: poor performance and situational incentives for good performance. These are not sufficient for a technical definition, however, because poor performance in such situations could result from other factors such as injury, or adverse weather conditions. Choking is, therefore, the occurrence of inferior performance despite striving and incentives for a high level of performance, in the absence of another explanation for that performance, such as occurrence of injury or adverse weather conditions.

The above definition remains flexible with regard to the specific comparisons that can be made to determine choking. For example, Leith (1988) described three different types of performance to which the term choking could be applied:

i) "when an athlete performs flawlessly in practice but not in a game situation"
ii) "when an athlete plays well in every game except the big one, or the one that really counts"
iii) "where the athlete plays well throughout the game but folds in clutch situations"

(Leith, 1988, p. 59)

Thus choking may be inferred by comparing practice and competition data as well as by comparing data from different situations within a game, match or event. For example, in analysing the percentage of successful first serves in tennis, a number of different comparisons could be made. Firstly, figures in practice and competition could be compared. Secondly, to analyse performance associated with different match situations, figures early in a set could be compared with figures late in a set, or figures associated with critical points (e.g. break points) could be compared with non-critical points. This degree of flexibility is important to allow choking to be identified for both the competitor who performs worse in competition than in practice, and in the competitor who performs worse in specific competitive situations.

1.3. The Study of the Relationship Between Stress and Performance

The question of which factors determine performance in stressful situations has been a long standing one in psychology. Accordingly, it is not surprising to find that some of the main theories from other areas of psychology have been tested in the context of stress and performance in sport. Thus, "drive theory" (Hull, 1943; Spence and Spence, 1966) and "the Inverted-U hypothesis" (Yerkes and Dodson, 1908) formed the basis of much of the early research in this area. More recently, research into the relationship between anxiety and performance has become the dominant approach for investigating the relationship between stress and performance (Martens, Vealey and Burton, 1990). A review of the vast literature pertaining to each of these areas is beyond the scope of this thesis, but a summary of each approach is outlined below.

1.3.1. Drive Theory

Based on the work of Hull (1943) and Spence and Spence (1966) and conceptualised within an early behavioural "stimulus-response" approach to the study of behaviour (Watson, 1925), drive theory predicts that the likelihood of a particular behaviour will be a function of the organism's "drive state" and "habit strength". Drive state is considered to be a hypothetical construct defined as "the sum of all of the energetic components affecting an individual at the time of the behaviour" (Hackfort and Schwenkmezger, 1993, p. 343). Habit strength refers to the probability that a particular response will follow a particular stimulus. For well learned skills, therefore, drive theory predicts that an individual's level of performance (represented by the probability of the dominant response) will be positively related to his or her drive state.

Data supporting a drive theory explanation of choking is conspicuous by its absence (Neiss, 1988). Thus, although limited support for the theory exists in the context of social facilitation theory (Zajonc, 1965; Singer, 1970), a great deal of anecdotal and empirical evidence has been gathered indicating that high levels of physiological arousal often have a detrimental effect on the performance of skills, particularly complex skills. For example, Kimble and Rezabek (1992) found that, contrary to the predictions of social facilitation theory, good players performed worse in the presence of an audience on both simple and complex games (pinball and tetris).

The practical implication of drive theory for the performers of motor skills is that when the dominant response is the correct one, it should be more likely to be performed correctly under pressure than in a situation associated with low drive state. This prediction reveals an obvious limitation of drive theory, which is that it cannot easily account for poor performance of well-learned skills under pressure. For example, consider a basketball player who, although successful with 70% of free-throw attempts in practice is only successful with 30% in match situations. If one assumes that the game situation is accompanied by an increased drive state then drive theory cannot account for such performance. In effect, drive theory predicts that choking should not occur in skills that are well-learned.

1.3.2. The Inverted-U Hypothesis

Partly due to its failure to adequately account for the poor performance of highly skilled individuals in situations considered likely to invoke high drive states, the "inverted-U hypothesis" (Oxendine, 1970) superceeded drive theory as the dominant theory in stress-related sport research during the 1970's and early 1980's.

Based on research carried out at the beginning of the century into the rate of habit formation in mice (Yerkes and Dodson, 1908), the inverted-U hypothesis predicts a curvilinear relationship between arousal and performance (Oxendine, 1970). Specifically, it predicts that there is an optimal level of arousal, above and below which performance becomes progressively worse in proportion to the deviation from this level. Two advantages the inverted-U hypothesis has over drive theory are, firstly, it is able to account for debilitative effects of high levels of arousal. Secondly, it is more flexible than drive theory. For example, in accordance with animal research, Oxendine (1970) proposed that the optimum level of arousal for performing complex motor skills would be lower, with a narrower bandwidth than for performing simpler skills. More recently, it has been proposed that task complexity should be further broken down into different factors relating to the decision making, perceptual and muscular requirements of the task in order to determine the likely optimum level of arousal (Landers and Boutcher, 1993).

Despite these advantages, as well as its intuitive appeal, the inverted-U hypothesis has recently been criticised on several fronts. Some of these criticisms reflect dissatisfaction with the inverted-U hypothesis in particular, but others reflect a more general dissatisfaction with the construct of arousal and how it is measured.

1.3.2.1. Use of the Term 'Arousal'

Arousal was recently defined as "general physiological and psychological activation of the organism that varies on a continuum from deep sleep to intense excitement" (Gould and Krane, 1992, p. 121). This definition is indicative of the evolution of the term which now includes reference to psychological as well as physiological responses to stressors. This change is reflected in the range of measures used to record arousal. For example, in addition to traditional physiological and biochemical indicators such as heart rate or galvanic skin response, Wrisberg (1994) that some of the predictions of the inverted-U hypothesis are effectively irrefutable. For example, it could be argued that any experiment failing to reveal poor performance at high levels of physiological arousal simply did not increase arousal to a sufficiently high level to induce performance decrements for that task.

Further evidence against a general relationship between arousal and performance comes from a recent experiment by Molander and Backman (1994). On a golf putting task, they found a dissociation between the effects of increased physiological arousal on performance in older and younger skilled performers. Specifically, it was found that increased heart rate was associated with decreased putting accuracy in two older groups (aged 50-57 and 58-73 years), whilst similar increases in heart rate were associated with higher accuracy in the two younger groups (aged 15-19 and 25-35 years). Such results cannot be easily accommodated within the inverted-U hypothesis.

1.3.3. Anxiety and Performance

Since the late 1970's there has been a large increase in the amount of research examining the role of anxiety in the relationship between stress and sports performance. Recently, anxiety was defined as:

> "the cognitive/emotional reaction that occurs when a perceived imbalance between environmental demand and individual capability to meet the demand is interpreted as threatening"
>
> (Wrisberg, 1994, p. 61)

A number of self-report measures have been developed to measure anxiety in sport. The first sport-specific test, the Sport Competition Anxiety Test (Martens, 1977), was designed to measure trait anxiety in competitive situations. Following validation research for this test, the Competitive State Anxiety Inventory (CSAI) was designed by modifying Spielberger's State Anxiety Inventory (Martens, 1990). This test was then further modified to reflect the multidimensional nature of anxiety, taking into account the distinction between the cognitive and somatic components of anxiety. The resulting CSAI-2 inventory consisted of 27 items, 9 in each of the cognitive and somatic components and 9 which measured self-confidence, a sub-scale that emerged during earlier work on development of the modified version.

Given that anxiety based research using this and other tests is the most widely used approach to investigating fluctuations in competitive performance, it is useful to consider reasons why this theoretical framework was not adopted as the basis for the present research. To this end there are two factors in particular that are worth considering.

1.3.3.1. Measuring Anxiety

From a purely practical point of view, the main problem with anxiety based research is that the tests themselves cannot usually be administered during performance. This means that they cannot account for performance variations that occur after completion of the test. This is particularly important when considering that choking often occurs during specific situations within a game, match or event. For example, in the 1993 Wimbledon Ladies' final between Jana Novotna and Steffi Graf, Novotna is credited with playing extremely good tennis for the majority of the match before performing extremely poorly from midway through the final set. Clearly, a pre-performance measure of state anxiety is unable to explain such fluctuations in performance. To use a research-based example, Davis and Harvey (1992) analysed the batting averages of 300 US major league baseball players in the 1989 season. They used different game situations to compare performance in pressure and no pressure situations. The authors found that performance was poorer for 80% of 156 comparisons made using the team data (26 clubs, compared in 6 pressure/no pressure situations). Again, while this data demonstrates the extent of choking in sport, it is difficult to see how pre-game measures of anxiety could explain these differences. Related to this point one could also question the validity of an assumption that pre-performance anxiety is predictive of anxiety during the performance itself (Jones, Mace and Stockbridge, 1997).

In the one study that has attempted to assess anxiety during game situations, a complicated picture of the relationship between anxiety and performance has been found. In their research Krane, Joyce and Rafeld (1994) administered a modified version of the "Mental Readiness Form" to members of a womens' softball team just before they went to bat. The form required performers to rate how they felt on two 11-point Likert type scales from "calm" to "worried" and from "tense" to "relaxed". This scale was designed to give a measure that was quick to complete and which corresponded to the cognitive and somatic anxiety components of the CSAI-2 scale. Over the course of five games during a tournament, each player used the two scales to rate how they felt just before going to bat. A number of pressure situations were defined and given a "situation criticality" value ranging from '1' to '5'. Each performance was then rated by six independent observers.

The results of the experiment suggested an extremely complex relationship between anxiety and performance. To summarise, it was found, firstly, that high situation criticality was associated with higher scores on the cognitive but not the somatic anxiety scale. Secondly, it was found that the relationship between somatic anxiety and performance was dependent on the source of the game pressure. When the score was the source of pressure a curvilinear relationship was found between somatic anxiety and performance in high pressure situations but not in low pressure situations. By contrast, when using base pressure (runner on third base or not) a curvilinear relationship between somatic anxiety and performance was evident in the low pressure situation, but not in the high pressure situation. The authors did not conduct similar tests using cognitive anxiety but the somatic anxiety data, at least, suggest that the relationship between anxiety and performance during actual performance might be extremely complex.

A second limitation with anxiety based research concerns the reliance on self-report measures. This leads to potential problems associated with response biases and questions concerning the reliability and validity of the tests. For example, Williams and Krane (1989) found that the scores of 58 female collegiate golfers on the CSAI-2 sub-scales were significantly correlated with their scores on a social desirability scale. Response distortions such as these previously led Rushall (1975) to comment that "on the hierarchy of preferred methods for assessing personality and behaviour, questionnaires are at the very bottom" (p. 79). More than twenty years later, the use of self-report measures is more prevalent than ever in sport psychology leading Fogarty (1995) to caution that "we must acknowledge that testing has serious limitations, particularly when we are forced to rely upon self-report instruments" (p. 168).

1.3.3.2. The Relationship Between Anxiety and Performance

Even if tests are demonstrated to be reliable and valid and the problem of response biases is taken into account, and even if the practical problems of administering the tests can be overcome, two related questions remain. First, what is the relationship between anxiety and performance, and, second, what does any relationship indicate about how to prevent choking in pressure situations?

Regarding the first of these questions the results are somewhat equivocal. No straightforward relationship between CSAI-2 sub-scales and performance has been demonstrated and many researchers have argued that none exists. For example, Imlay et al., (1995) proposed that rather than there being a general optimal level of state anxiety, each individual has a "zone of optimal functioning". They proposed that intraindividual state anxiety scores should be used for the purpose of comparison, rather than assessing the relationship between gross scores and performance. Adopting this methodology, Burton (1988) used intraindividual measures of both CSAI-2 sub-scale scores (cognitive anxiety, somatic anxiety, and self-confidence) and performance to test the relationship between anxiety and swimming performance. The results indicated a negative linear relationship between cognitive anxiety and performance, a positive linear relationship between self-confidence and performance, and an inverted-U shape relationship between somatic anxiety and performance.

Despite this progress, it has been argued that even when using intraindividual scores "multidimensional anxiety theory" is flawed because it does not explain how the different components interact to influence performance (Hardy, 1990). To this end, Hardy (1990) outlined a "cusp catastrophe model" of the relationship between physiological arousal, cognitive anxiety and performance. In this model, the interaction between these three factors is considered in terms of a three-dimensional performance surface. Specific predictions are made regarding how performance will be affected by changes in each factor or combination of factors. In particular, it is predicted that at low levels of cognitive anxiety, changes in physiological arousal will have small effects on performance, although it is suggested that any effects might take the form of an inverted-U shape. For high levels of cognitive anxiety, however, it is predicted that increases in physiological arousal will follow an inverted-U shape up to a point whereupon a "sudden and dramatic decline in performance" will occur (Hardy, Jones and Gould, 1996, p. 152). To regain a high level of performance, catastrophe theory predicts that physiological arousal must first be significantly reduced.

Other developments in anxiety research paint an increasingly complicated picture regarding its relationship with performance (Burton, 1993). In fact, it has been suggested that measures of anxiety need to be further modified to take into account its "direction". The argument for doing this is that the same level of cognitive anxiety could be perceived as being either facilitative or debilitative (Jones, Swain and Hardy, 1993; Jones and Swain, 1995). The implications for choking interventions are that it is unclear what to recommend. If a causal relationship does exist between components of anxiety and performance then it appears to be highly complex. This might help to explain why some applied studies that have successfully decreased pre-performance anxiety have failed to reveal any differences in performance measures (Murphy and Woolfolk, 1987; Maynard, Hemmings and Warwick-Evans, 1995). Even using individual zones of optimal functioning, formed by assessing cognitive anxiety in the moments before season best performances, Imlay et al. (1995) found that 37% of second best performances occurred outside of these zones, whilst 31% of worst performances occurred within these zones. At the present time, assessing pre-performance anxiety does not seem to offer a viable explanation of why choking occurs.

1.4. Behaviour Analysis

An alternative approach to studying choking that has yet to be explored in any detail is the use of the theoretical framework of behaviour analysis. In the following section the basic tenets of this approach are described and some of the main terms are defined. The historical reason for the distinction between rule-governed and contingency-shaped behaviour is then described along with possible implications for the performance of different types of skill.

1.4.1. Operant Behaviour and the Three-Term Contingency

The basic tenets of behaviour analysis are that behaviour is analysed in terms of the antecedents, or the circumstances that set the occasion for behaviour, the behaviour itself, and the consequences of that behaviour. This is sometimes referred to as the three-term contingency or the A-B-C of behaviour. Contingency-shaped, or operant behaviour is the term used for behaviour that can be modified by its consequences and because of this relationship with consequences is described as being emitted rather than elicited (Catania, 1992). Reinforcement is used to refer to the process whereby responding increases as a result of the delivery of consequences following a response. Conversely, punishment is used to refer to the process whereby responding decreases as a result of the delivery of consequences following a response (Catania, 1992).

Discrimination refers to a difference in responding "resulting from differential consequences of responding in the presence of different stimuli" (Catania, 1992, p. 372). For example, if the lever pressing behaviour of a rat is reinforced when a light is on but not when it is off, the behaviour will, over time, increase when the light is on and decrease when the light is off. The controlling stimulus is referred to as the discriminative stimulus and is said to occasion the response (Michael, 1980).

Shaping refers to the process of "gradually modifying some property of responding by differentially reinforcing successive approximations to a target operant class" (Catania, 1992, p. 395). Of particular relevance to choking is the distinction that is made in behaviour analysis between operant, or contingency-shaped behaviour, and behaviour that is under the control of verbal antecedents, or prior contingency-specifying stimuli (Skinner, 1966). This second form of behaviour has become known as rule-governed behaviour, a class of behaviour distinguished from contingency-shaped behaviour by its apparent insensitivity to any changes in the programmed contingencies of reinforcement (Catania, Matthews and Shimoff, 1990).

1.4.2. Rule-Governed and Contingency-Shaped Behaviour

The original distinction between rule-governed and contingency-shaped behaviour was made because of differences in the patterns of behaviour that were observed in human and infrahuman subjects on various schedules of reinforcement. This finding was important because the applicability of the principles of behaviour analysis to human behaviour relied on the continuity assumption, which simply stated that the principles of behaviour, established using infrahuman subjects, would prove equally applicable to human behaviour (Hayes and Wilson, 1993).

Many of the findings from research using non-human organisms were indeed also found in studies of human behaviour. For example, using a simple button pressing apparatus in which the subject earned points for pressing in accordance with various programmed contingencies, human subjects were found to emit high inter-reinforcement response rates under variable interval (VI) schedules of reinforcement (where the first target response after a variable period of time with a pre-programmed mean value is reinforced). For other schedules of reinforcement, however, the pattern of human responding was found to differ from infrahuman performance. In particular, it was firstly found that on fixed-interval (FI) schedules, where only the first response after a fixed period of time is reinforced, human performance did not usually display the temporal patterning of responses displayed by non-humans (Weiner, 1964, 1969; Leander, Lippman and Meyer, 1968; Matthews, Shimoff, Catania and Sagvolden, 1977; Lowe, Harzem and Hughes, 1978). Secondly, the response rates of human subjects on FI schedules were found to be a function of their conditioning history. For example, Weiner (1964) found that subjects trained on a fixed ratio (FR) schedule exhibited high rates of continuous inter-reinforcement button pressing when an FI schedule was programmed for the test session whilst subjects trained on a differential reinforcement of low rate responding (DRL) schedule continued to exhibit low rates of pressing.

A third finding of this early research was that the instructions that subjects received concerning how to maximise reinforcement during the experiment exerted powerful control over subsequent responding to the extent that behaviour became insensitive to the programmed contingencies of reinforcement. In what effectively constituted the first experiments on rule-governed behaviour, Kaufman, Baron and Kopp (1966) conducted three studies investigating the effects of instructions on human operant behaviour.

The main finding came from the first two experiments, in which 31 subjects were presented either minimal instructions (M), minimal + response instructions (MR), or minimal + response + contingency instructions (MRC). The M group were simply shown the apparatus and asked to obtain as high a reading as possible on the scoring counter. The MR group received additional information on how the apparatus worked.

Specifically, they were told that pressing the response key would sometimes turn on a green light and that this light was a signal to press one of the choice keys. A correct choice would then turn on the light above the chosen key and a point would be registered on the counter. The MRC group received additional information regarding the contingency that was allegedly programmed for their session (either variable ratio, variable interval or fixed interval). In fact in all cases a variable interval one-minute schedule was in effect.

Kaufman et al. (1966) found that subjects in the MR and MRC groups emitted response rates that were consistent with the instructions they had been given. The responding of subjects in these groups was found to be "insensitive" to the actual programmed contingencies, so that even subjects given false contingency instructions continued to emit behaviour appropriate for such instructions.

Finally, Leander, Lippman and Meyer (1968) found that subjects' own verbalisations concerning the contingencies could have powerful control over responding. In their experiment subjects ranked four possible descriptions of the contingencies for reinforcement and it was found that subsequent response rates on an FI schedule of reinforcement could be predicted from their "verbalisation" of the contingencies.

Skinner (1966) made a formal distinction between operant behaviour and behaviour under the control of instructions in the chapter entitled "An operant analysis of problem solving", later reprinted in Skinner's (1969) book entitled "Contingencies of reinforcement: A theoretical analysis". Thus, the term rule-governed behaviour was introduced in the context of human problem solving behaviour:

> "Behaviour which solves a problem may result from direct shaping by contingencies or from rules constructed either by the problem solver or by others. Because different controlling variables are involved, contingency-shaped behaviour is never exactly like rule-governed behaviour."
>
> (Skinner, 1966, reprinted in Catania and Harnad, 1988, p. 218)

He went on to say:

> "We refer to contingency-shaped behaviour alone when we say that an organism behaves in a given way with a given probability because the *behaviour has been followed by a given kind of consequence in the past.* We refer to behaviour under the control of prior contingency-specifying stimuli when we say that an organism

behaves in a given way because *it expects a similar consequence to follow in the future.*"

(Skinner, 1966, reprinted in Catania and Harnad, 1988, p. 227, italics in original)

In other words, human behaviour could be gradually shaped by its consequences or it could be controlled by verbal statements of the contingencies believed to be in effect in that environment, as when an individual receives instructions on the best way to do something. For example, in learning how to swing a golf club, a golfer might be given a series of technical instructions designed to facilitate acquisition. Alternatively, the behaviour might be shaped by its consequences, with the differential reinforcement associated with different qualities of shot leading to an increase in the behaviour associated with good strikes and a corresponding decrease in behaviour resulting in poor strikes. The importance of this distinction with respect to choking concerns the implications for skilled performance on tasks with different requirements regarding the sensitivity of performance.

1.4.2.1. Implications for Skilled Performance

By definition, contingency-shaped behaviour must be sensitive to any change in the contingencies. This sensitivity, and the corresponding insensitivity of rule-governed behaviour, has important implications for the performance of much skilled behaviour. In particular, a defining feature of most skilled performance is its moment by moment sensitivity to continuously changing contingencies. In behaviour analysis this has been studied in social skills, where skilled behaviour is said to be characterised by a "social sensitivity" to the context in which it occurs (Azrin and Hayes, 1984).

Azrin and Hayes argued that because of the insensitivity of rule-governed behaviour more skilled social behaviour (characterised by improved sensitivity to changes in the contingencies) would result from a contingency-shaped approach to teaching the skills as opposed to the more traditional rule-governed, or instructional approach. To test their hypothesis, an experiment was set up in which 89 males, approximately half of whom responded to an advert offering a program for improving social interaction, observed twenty, one-minute videos of a female interacting with an unseen male. After each video the subjects rated the level of interest shown by the female towards the male. In the training stage, a further twenty-four videos were shown during which time half of the subjects received feedback about the woman's true degree of interest, which she had previously recorded. A control group also watched the videos but received no feedback concerning the woman's true level of interest. In the final, post-assessment phase, subjects performed the same task as in the pre-assessment stage, using a new set of videos.

The results indicated that, over the course of the experiment, subjects who received feedback became increasingly successful at discriminating the true level of interest being shown by the woman on the tape. Secondly, it was found that this ability generalised to videos of previously unviewed females. Finally, subjects from the feedback group also displayed improved actual social skills in subsequent role-playing situations, indicating that the sensitivity of their behaviour to changes in context had been enhanced.

In skilled motor behaviour moment by moment sensitivity to changes in context, particularly visual context is found to be a characteristic of the performance of many skills, an observation which Bartlett (1932) made:

> "When I make the stroke I do not, as a matter of fact, produce something absolutely new, and I never merely repeat something old. The stroke is literally manufactured out of the living visual and postural "schemata" of the moment and their interrelations"
>
> (Bartlett, 1932, p. 89)

More recently, Catania (1992) went so far as to suggest that because of the insensitivity of rule-governed behaviour, skilled performance "must be contingency-shaped instead" (p. 249). To illustrate his point Catania included the examples of the behaviour of an American Football quarterback in which sensitivity allows him to anticipate the movements of an opposing player, and the behaviour of a ballet dancer which accommodates slight deviations in a partner's movements. There are numerous other examples from different sports in which moment by moment sensitivity to changing contingencies is a defining characteristic of skilled performance, including open play in team sports such as basketball, football and korfball, and individual sports such as squash and badminton.

1.4.2.2. Open and Closed Skills

It is tempting to assert, as Catania does, that sensitivity might be a defining characteristic of all skilled behaviour, however, not all skills are performed in an environment of continuously changing contingencies. In the motor skill learning literature, skills that take place in an unpredictable or changing environment are classified as open skills (Gentile, 1972). By contrast, the term closed skill refers to skills that take place under fixed, unchanging environmental conditions (Gentile, 1972). With respect to the requirements for sensitivity to moment by moment changes in the contingencies, open skills require such sensitivity but closed skills do not. An example of a closed skill would be taking a "free-throw" in basketball. Thus, the hoop is at a specified height and a set distance from the free-throw line, and the task is to throw a regulation size basketball through the stationary hoop. For closed skills the behaviour does not *need* to be contingency-shaped in terms of the sensitivity requirements outlined above. Furthermore, the level of performance that an individual attains may benefit from an insensitivity to other changes in the contingencies of reinforcement, particularly changes that increase the "pressure" associated with performance.

1.4.3. Pressure as a Change in the Contingencies of Reinforcement

Baumeister and Showers (1986) defined pressure as "the presence of situational incentives for optimal, maximal or superior performance" (p. 362). Using the locution of behaviour analysis, pressure in sport can be defined as the presence of additional contingencies that increase the perceived importance of optimal performance at any given time. To use the example of a golf putt, in a practice situation no contingencies are present other than the naturally occurring consequences associated with different quality shots. When putting in a competitive situation, however, additional consequences are made contingent upon successful performance. These may be financial, as when a golfer has a putt to win a certain amount of prize money, or may simply relate to intrinsic motivation as in the case of "friendly" matches. In terms of the present discussion, choking can be viewed as behavioural sensitivity to the addition of pressure related contingencies. In such cases, insensitivity would be beneficial in that performance would be unaffected by these additional contingencies.

Recently, Martin (1992) and Martin and Pear (1992) have argued that an intervention to eliminate differences between performance in practice and competition could be conceptualised within the behaviour analysis framework of rule-governed behaviour. Specifically, Martin (1992) suggested that performers could capitalise on the insensitivity of rule-governed behaviour by bringing their behaviour under the control of verbal stimuli during practice. By doing so it was argued that performance would generalise to the competitive environment by a process referred to as "program common stimuli" (Kirby and Bickel, 1988). In the next chapter the possibility that the insensitivity of rule-governed behaviour might extend to contingencies associated with performance pressure is explored.

1.5. Summary

Previous research examining the relationship between stress and performance has focussed on anxiety and physiological arousal. No simple relationship has been found and the implications for preventing choking are unclear. A previously unexplored possibility is that the insensitivity associated with verbally controlled human behaviour could prove beneficial when performing closed skills under pressure.

<u>Chapter 2</u>- The Sensitivity of Rule-governed and Contingency-shaped Behaviour to a Pressure Manipulation.

> "Rarely does a player... produce his best performance on the day. On the day, he finds himself suddenly a stranger in his own sport. He comes believing it to be a game, and finds it is something else. What happens? For a start, he finds his whole identity is involved in a sort of side-bet, and that everyone is looking at him in a meaningful way. His arms turn to sausages. His knees sag. His hands swell up like soft crabs. He can't hear properly, or see straight. His skill deserts him. His mouth goes dry. He loses".
>
> (Patmore, 1986, p. 23)

2.1. Introduction

In the previous chapter, it was suggested that the conceptual framework of behaviour analysis provides an alternative approach to investigating choking. In the present chapter, the history of applying the principles of behaviour analysis to the study of sport behaviour is outlined. This leads in to a description of the hypothesis to be tested in the first experiment. After considering the results of this experiment a follow up experiment is then described followed by a general discussion of the implications of the two experiments.

2.2. Behaviour Analysis in Sport

The principles of behaviour analysis have been applied in a variety of settings, most notably in the treatment of people with learning difficulties and in clinical psychology in general (Zettle and Hayes, 1982). The focus of interventions employing these principles is extremely variable, ranging from attempts to decrease self-injurious behaviour to devising methods for individual performance management (Ackley and Bailey, 1995). Several excellent papers have also been written which demonstrate the effectiveness of applying operant techniques in the modification of sport and exercise behaviour. Lee (1993) recently reviewed many of these studies which can be divided into two main areas. The first concerns interventions that relate to behaviour in the clinical sense of the word. As Rushall (1975) notes, "unfortunately most critics believe that this is the only application" (p. 76), but there is a second group of studies that relate to particular aspects of sports performance.

With respect to the first group of studies, Rushall (1975) described an intervention in which the behaviour of a swimming coach was changed over a period of several months from being predominantly negative and critical to being more positive and rewarding of desirable behaviours. In the intervention, the coach developed an appropriate vocabulary that enabled him to reinforce desirable behaviours and provide positive feedback to his swimmers. Rushall also notes that the coach's more positive, less critical approach generalised to his day-to-day social interactions. The topic of coaching behaviour, particularly in youth sports, has been the area of sport that has received most attention from researchers using the principles of applied behaviour analysis, most notably in the work of Smith and Smoll (e.g. Smith, 1993; Smoll and Smith, 1993). The "positive approach" to coaching (Smith, 1993) has been demonstrated to be effective in a range of different sports, including football (Rush and Ayllon, 1984), tennis (Buzas and Ayllon, 1981), gymnastics (Allison and Ayllon, 1980), and swimming (Koop and Martin, 1983).

Considering research relating to sports performance, the number of studies using a behaviour analysis framework is more limited. Rushall (1975) was the first scholar to outline the potential benefits of applying the principles of behaviour analysis in this area. His paper described a number of studies, including the use of a punishment procedure to decrease the frequency of the incorrect "trudgeon" kick in a young swimmer. This procedure involved shining a light in the swimmer's eyes each time he performed an incorrect kick and recording only the lengths that were performed to a criterion level on the swimmer's progress chart. From a baseline level of fifteen incorrect kicks per length the criterion level was set at four incorrect kicks per length on day two, two per length on day three and no incorrect kicks on day four. By the 35th length of the intervention the trudgeon kick had been eliminated and the punishment procedure "completely and permanently changed the swimmer's form of kicking" (Rushall, 1975, p. 77).

Also related to sports performance, Rushall (1975) discussed a device designed to facilitate the shaping of an aspect of rowing behaviour that was normally dependent on direct instruction from a coach over a period of approximately two months. The device involved an alarm that sounded whenever the boat tilted beyond a pre-set angle. Over the course of several weeks the critical angle was reduced, so that at each point the sculler's rowing behaviour would be shaped towards an increasingly stable form.

In a very different environment, the range of applications of behaviour analysis is demonstrated by Komaki and Barnett (1977) who used a behavioural intervention to improve three backfield plays of a youth American Football team. Each play was divided into five distinct behaviours from which check-lists were drawn up to provide a basis for giving feedback to the players involved in the execution of each skill. The intervention consisted of the coach telling the players how they had done after each play, pointing out both what had been done incorrectly and reinforcing correct behaviours. Using a multiple baseline design across the three plays, the percentage of correct behaviours increased from 61.7% to 81.5% for Play A, 54.4% to 82.0% for Play B and 65.5% to 79.8% for Play C.

All of the above studies are examples of the application of operant strategies to the study of sport behaviours (Lee, 1993). As outlined in chapter one, however, the characteristic patterns of responding found when using non-human subjects are not always found in humans (e.g. Weiner, 1964, 1969; Leander, Lippman and Meyer, 1968, Matthews, Shimoff, Catania and Sagvolden, 1977; Lowe, Harzem and Hughes, 1978). For example, whereas interval and ratio schedules maintain different rates of responding in animal subjects, the same is not true of human subjects, who often display continued high rates of responding during extinction on these schedules (e.g. Kaufman, Baron and Kopp, 1966; Shimoff, Matthews and Catania, 1986). As mentioned in the previous chapter, this led to Skinner (1966, 1969) making a distinction between operant behaviour and behaviour under the control of verbal antecedents. Rule-governed behaviour was the name given to the latter and was distinguished from contingency-shaped behaviour by its insensitivity to changes in the contingencies of reinforcement (Catania, Matthews and Shimoff, 1990).

With respect to sports behaviour, very few studies have made reference to this distinction. Thus, although Martin (1992) notes that some "sport psyching" interventions have involved verbal behaviour conceptualised within the applied behaviour analysis framework, these papers have not made any reference to rule-governed behaviour. For example, Rushall (1984), and Rushall, Hall, Roux, Sasseville and Rushall (1988) looked at the effects of different self-talk instructions on rowing and skiing performance respectively. Similarly, Zieglar (1987) studied the effect of using verbal cues on the acquisition of tennis service returns in novice players. Despite not making reference to rule-governed behaviour, Martin (1992) notes that a common thread in these studies is that athletes are taught to bring their behaviour under the control of cue words or self-talk during practice, with the aim being to cue the same level of performance in competitive situations. This approach, Martin argues, "capitalises on rule-governed control of behaviour and uses a generalisation programming strategy referred to as "program common stimuli"" (p. 238). Recently, Ming and Martin (1996) conducted a study in which they used a "self-talk package" to help pre-novice and novice competitive figure skaters improve particular figures. The results of the experiment were interpreted in terms of the behaviour analysis distinction between rule-governed and contingency-shaped behaviour. One problem with this interpretation, however, is that the verbal component was only part of a more extensive intervention program in which subjects also observed elite skaters on videotape and visualised the required movements.

As Martin (1992) noted, another limitation of these studies is that they have taken place in practice situations and not under the pressure associated with competitive performance. One exception is the study by Kendall, Hrycaiko, Martin and Kendall (1990) who examined the effectiveness of a self-talk package on the defensive performance of basketball players during actual match situations. Although the results indicated that the overall intervention was effective, this study again cannot be interpreted solely in terms of rule-governed behaviour because the package also included imagery, rehearsal and relaxation components, all of which have previously been demonstrated to be effective means of improving competitive performance (e.g. Suinn, 1976).

Clearly, conceptualising sports performance interventions within the behaviour analysis framework of rule-governed and contingency-shaped behaviour is in its infancy. Martin and Pear's (1992) proposal that the insensitivity of rule-governed behaviour can be used to help athletes maintain high levels of performance under pressure has important implications for choking interventions, but has yet to be tested experimentally.

The main aim of the following experiment, therefore, is to assess the sensitivity of rule-governed and contingency-shaped behaviour to a change in the contingencies of reinforcement that constitutes an increase in the pressure associated with performance. The hypothesis is that rule-governed behaviour will be superior to contingency-shaped behaviour when the pressure manipulation is in effect. Specifically, it is predicted that the behaviour of the rule-governed group will be insensitive to the pressure manipulation, so that performance will remain at the same level, whilst the behaviour of the contingency-shaped group will be sensitive to the manipulation, resulting in poorer performance in this stage of the experiment.

Experiment 1

2.3. Method

2.3.1. Subjects

Thirty-eight students aged between 17 and 30 years (mean = 20.47 years, SD = 2.72) from the University of St. Andrews were each paid £3.50 to take part in the experiment. Subjects were required to be novices in the skill being tested (dart throwing), and to this end it was stipulated that only individuals who had thrown darts on fewer than five previous occasions were suitable for the experiment. Prior to taking part in the experiment, subjects were required to indicate how many times they had previously played darts. The mean number of times reported was 2.47 (SD = 1.50).

2.3.2. Task/Apparatus

The apparatus for the present experiment consisted of a cork dartboard mounted on a wall. In line with the regulations of the British Darts Organisation, the centre of the target was positioned 1.7m above the floor and subjects stood at a mark located 2.37m from the base of the wall on which the board was mounted (see Figure 2.1). Three 22g nickel darts were used.

The target consisted of a standard size dartboard modified to create a target in which the aim of the task was to try to throw each dart into the centre of the board. The target itself was drawn onto a white sheet of cotton which was taped to the board. The target contained six distinct scoring areas, separated by five concentric circles with diameters of 0.08m, 0.16m, 0.24m, 0.32m, and 0.40m. Five points were awarded for a dart finishing in the "bull's eye" of diameter 0.08m and four, three, two and one points were awarded for darts landing in subsequent regions (see Figure 2.1). Any dart in which the radial error was greater than 0.20m was given zero points.

Where appropriate, the throw action instructions were posted on the wall, to the right of the dartboard, in full view of the subject at all times. The throwing action of each subject was recorded using a Canon E600 camcorder mounted on a tripod.

2.3.3. Design

The experiment was divided into three distinct stages: the acquisition stage, the retention stage and the competition stage. During the acquisition stage, each subject threw 40 sets of 3 darts. Approximately one week later, subjects threw a further 30 sets of 3 darts, the first 20 sets of which served as a measure of retention and the last 10 of which constituted the competition stage of the experiment. The dependent variable was the number of points scored on each set of three darts.

Subjects were randomly assigned to one of four groups, two which received instructions on the technique of dart throwing and two which did not. Subjects receiving instructions were divided into a rule-governed (RG) and a rule-governed control (RGC) group. Similarly, subjects not receiving these instructions were divided into a contingency-shaped (CS) and a contingency-shaped control (CSC) group.

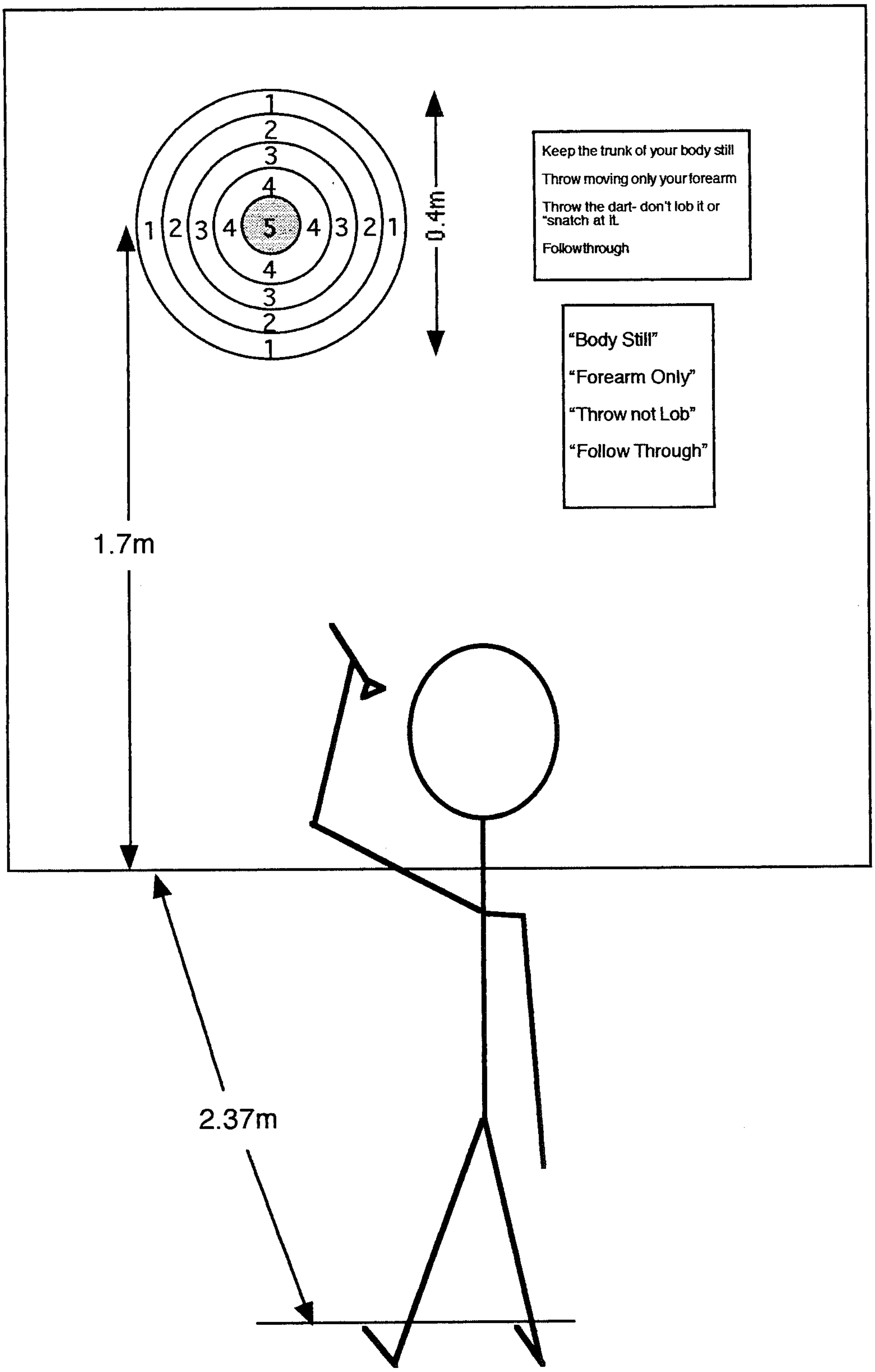

Figure 2.1. Diagram of the set-up for the dart throwing task used in Experiments 1 and 2 (not to scale).

2.3.4. Procedure

2.3.4.1. All Groups

On entering the laboratory the subject filled out the front page of a questionnaire which simply asked for some general information such as their age and how many times they had played darts in the past (see Appendix 1). On completion of the form, the apparatus and task were explained to the subject who was told that the purpose of the experiment was to look at aspects of skill acquisition. All four groups were told that their task was simply to try to score as many points as possible with each set of darts for the duration of the experiment. It was stressed that it did not matter how many or how few points were scored at the beginning of the experiment but that it was important to continue to try and improve at all times.

2.3.4.2. Rule-governed and Rule-governed Control Groups

Subjects in the RG and RGC groups received instructions adapted from a British Darts Organisation booklet concerning how to grip the dart, how to stand, and then on the actual throwing action. Specifically these instructions were:

Grip

Grip the dart between your first finger and thumb, with your second finger alongside the dart.

Your thumb should be at the centre of gravity of the dart.

Stance

Stand with your right foot pointing towards the "bulls-eye" and your other foot resting behind you in a position of maximum balance and comfort.

Throw Action

Keep the trunk of your body still.

Throw moving only your forearm.

Throw the dart- don't lob it or "snatch" at it.

Follow through.

The throw-action instructions were placed to the right of the dartboard and were visible at all times. To ensure that the instructions were being attended to for the duration of the experiment subjects in the RG and RGC groups were required to say out loud shortened versions of the "throw action" instructions prior to each set of 3 darts that were thrown. These were as follows:

"Body still"
"Forearm only"
"Throw not lob"
"Follow through"

The CS and CSC groups did not receive any technical instructions at any stage of the experiment.

2.3.4.3. Competition Stage

In the final, competition stage of the experiment, the non-control groups (RG and CS) were informed that they had a chance of winning £20. Specifically, subjects were told that their score in the last 10 sets of darts would be compared to their previous performance in the experiment, and that £20 would be awarded to the subject who had the greatest increase in mean score for each set of three darts. After the experiment, the percentage difference between each subject's mean block score in the competition and retention stages was calculated and the subject with the largest percentage improvement was given the £20. In order to control for any effects on performance caused by having a break between the retention and competition stages, the RGC and CSC groups were also given a break of approximately one minute before throwing their final 10 sets of darts.

2.3.4.4. Post-experimental Questionnaire

After throwing their final dart in the competition stage of the experiment, all subjects completed a short questionnaire (Appendix 1). Subjects in the CS and CSC groups were asked to describe any strategy that they felt helped them to throw their better darts, either in the previous session or the present session. Subjects in the RG and RGC groups were asked to write down any strategies, other than following the instructions, that they felt helped them to throw well. In addition, they were asked to indicate which, if any, instructions they found to be the most helpful. Subjects who threw under the pressure contingency (RG and CS groups) were also asked to describe any strategy which they felt helped them to throw well in the competition stage of the experiment.

Table 2.1. Block score means and standard errors for all four groups in the acquisition, retention and competition stages of Experiment 1.

Group	*Acquisition Score (Pts)*							
	Block 1		*Block 2*		*Block 3*		*Block 4*	
	Mean	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*
RG	39.30	3.49	36.70	2.29	39.10	2.51	43.20	2.63
RG (Control)	34.67	4.71	41.22	3.97	39.11	3.60	42.67	3.50
CS	39.10	2.49	40.60	2.33	44.20	3.77	46.10	2.76
CS (Control)	39.89	2.40	44.67	2.17	45.78	2.49	47.56	2.09
All Subjects	38.29	1.65	40.68	1.40	42.03	1.59	44.87	1.37

Group	*Acquisition Score (Pts)*							
	Block 5		*Block 6*		*Block 7*		*Block 8*	
	Mean	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*
RG	41.90	1.93	45.10	1.44	42.40	1.28	43.70	2.58
RG (Control)	42.67	3.49	41.33	3.14	42.67	2.81	45.78	1.60
CS	46.00	2.48	45.10	2.43	46.70	2.49	47.00	2.61
CS (Control)	49.78	2.45	51.00	2.05	48.22	2.30	48.56	2.71
All Subjects	45.03	1.35	45.61	1.24	44.97	1.16	46.21	1.21

Group	*Retention Score (Pts)*							
	Block 1		*Block 2*		*Block 3*		*Block 4*	
	Mean	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*
RG	40.20	2.19	42.30	2.63	45.50	2.28	48.60	1.73
RG (Control)	41.89	3.55	43.22	3.76	47.44	2.56	43.78	3.00
CS	43.50	3.85	43.30	3.82	45.40	2.40	45.80	3.12
CS (Control)	43.67	2.78	50.44	1.91	47.11	2.14	49.22	2.37
All Subjects	42.29	1.53	44.71	1.60	46.32	1.14	46.87	1.30

Group	*Competition Score (Pts)*			
	Block 1		*Block 2*	
	Mean	*S. Err.*	*Mean*	*S. Err.*
RG	51.70	2.40	49.00	3.76
RG (Control)	45.78	2.12	44.00	2.38
CS	46.90	3.70	45.10	2.50
CS (Control)	47.89	2.46	49.33	2.80
All Subjects	48.13	1.39	46.87	1.46

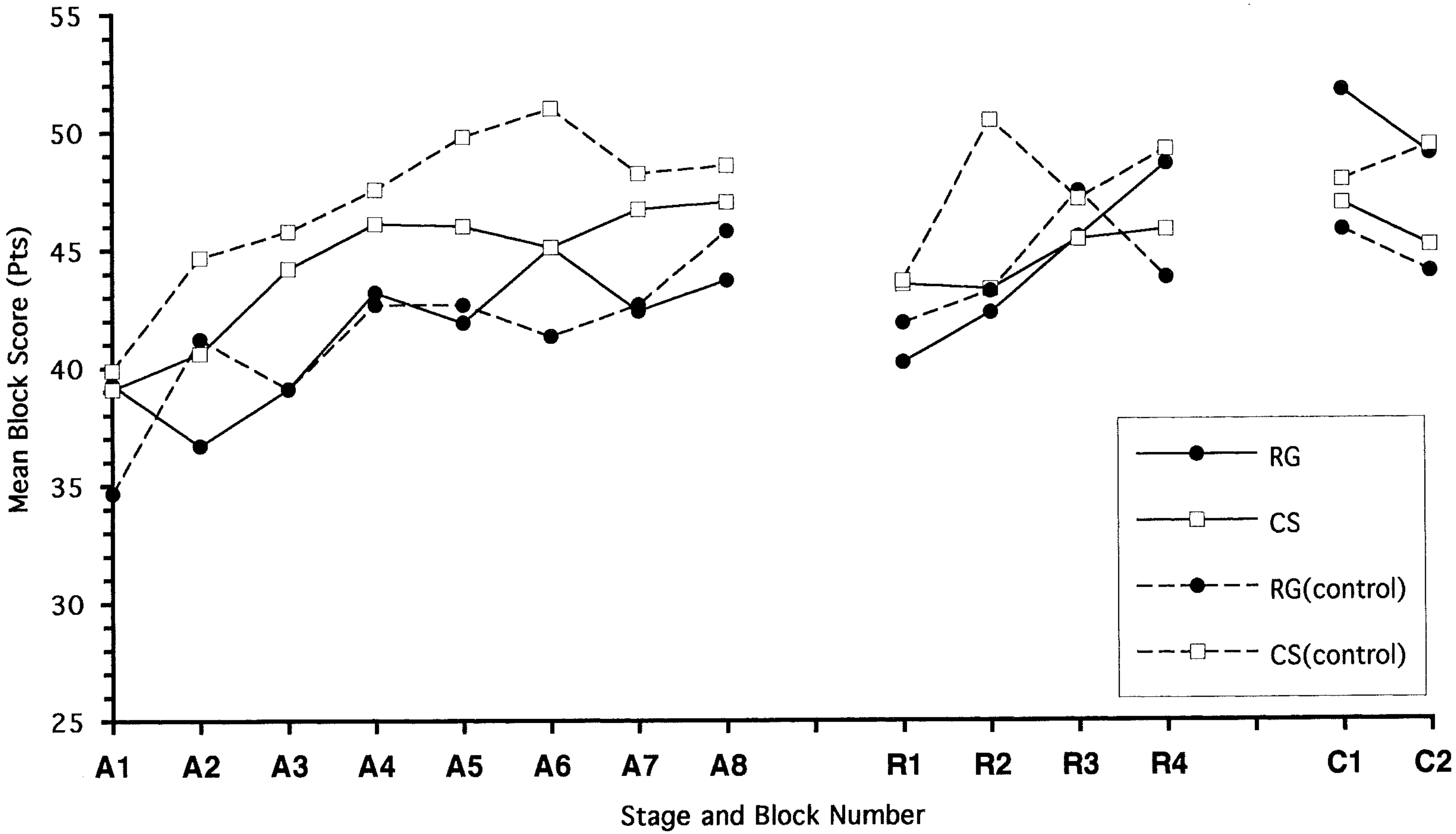

Figure 2.2. Graph of scores in consecutive blocks of 15 darts (maximum possible score = 75pts) for each group in Experiment 1. The letters on the x-axis denote the stage of the experiment ('A' for acquisition, 'R' for retention and 'C' for competition) and the number denotes the block.

2.4. Results

Subject scores for each set of three darts were recorded, and trial block scores were calculated by adding together scores from consecutive blocks of five sets of darts. Thus, it was possible to score a maximum of 75 points in each block.

A second dependent variable, the variable error, was calculated to give a measure of the variability, and hence consistency of each subject's performance about their individual mean block score. This figure was simply the standard deviation of each subject's block scores. Both the mean and variable error data were analysed separately for the acquisition (8 blocks), retention (4 blocks) and competition (2 blocks) stages of the experiment.

2.4.1. Acquisition stage

2.4.1.1. Points Scored

The point score data were analysed using a 8 x 4 (block x group) ANOVA with repeated measures on the block factor. For tests involving the block within subjects factor, the conservative Greenhouse-Geisser estimate of epsilon was used to correct for the correlation between observations. The analysis revealed a significant main effect for trial block ($F(7,238) = 9.10$, $p<.001$), but not for group ($F(3,34) = 1.60$, n.s.) or for the interaction between block and group ($F(21,238) = 0.70$, n.s.). Planned contrasts indicated a significant difference in scores between the groups that did and did not receive instructions ($F(1,34) = 4.16$, $p<.05$), but not between the control and non-control groups, ($F(1,34) = 0.33$, n.s.).

From the graph in Figure 2.2, it can be seen that the block main effect was the result of an increase in scores across the eight blocks of fifteen throws. The mean trial block scores for each group are shown in Table 2.1. The absence of an interaction between block and group indicates that this improvement in scores was similar across the four groups.

From Table 2.1 as well as inspection of the graph in Figure 2.2, it can be seen that the significant difference between the rule-governed and contingency-shaped groups was the result of subjects in the two rule-governed groups (RG and RGC) averaging fewer points than subjects in the two contingency-shaped groups (CS and CSC) during this stage of the experiment.

2.4.1.2. Variable Error

The variable error data were also analysed using a 8 x 4 (block x group) ANOVA with repeated measures on the block factor, and again the Greenhouse-Geisser adjustment to epsilon was made where appropriate. The analysis indicated no significant main effect for either group (F(3,34) = 1.36, n.s.) or block (F(7,238) = 1.10, n.s.) and no interaction between these factors (F(21,238) = 1.23, n.s.). From the variable error data for each group, (see Appendix 2), it can be seen that the mean values for the two rule-governed groups were greater than for the two contingency-shaped groups, however, planned contrasts indicated no significant difference between the rule-governed and contingency-shaped groups (F(1,34) = 4.02, n.s.), or between the control and non-control groups (F(1,34) = 0.01, n.s.).

2.4.2. Retention stage

The 20 sets of darts thrown in the retention stage were analysed using a 4 x 4 (group x block) ANOVA with repeated measures on the block factor. Again, the Greenhouse-Geisser estimate of epsilon was used where appropriate.

2.4.2.1. Points Scored

A significant main effect was found for block (F(3,102) = 7.12, p<.001) but not for group (F(3,34) = 0.44, n.s.). Planned contrasts between the rule-governed and contingency-shaped groups (F(1,34) = 0.59, n.s.), and between the control and non-control groups F(1,34) = 0.37, n.s.) both failed to reach significance. The interaction between block and group was also non-significant (F(9,102) = 1.83, n.s.).

As can be seen from the graph in Figure 2.2 the block main effect was the result of a general increase in scores across blocks.

2.4.2.2. Variable Error

There were no main effects for either group (F(3,34) = 1.14, n.s.) or block (F(3,102) = 1.31, n.s.) and the interaction between the two was also non-significant (F(9,102) = 1.18, n.s.). Planned contrasts between the rule-governed and contingency-shaped groups (F(1,34) = 1.54, n.s.), and between the control and non-control groups F(1,34) = 0.01, n.s.) both failed to reach significance.

2.4.3. Competition Stage

The 10 sets of darts thrown in the competition stage were analysed by a 2 x 4 (block x group) ANCOVA with repeated measures on the block factor, and "late retention" point or variable error score as covariate. The late retention covariate was used to take into account individual differences in point scores or consistency that were present before the competition stage. This method, rather than comparing change scores directly, was used following the recommendation of Cronbach and Furby (1970) who state that this method is advantageous when the correlation between the covariate and the dependent variable is greater than 0.4.

For both the point and variable error data, late retention score was calculated by taking the average of the scores in the third and fourth blocks of the retention stage of the experiment. As in previous analyses, the Greenhouse-Geisser adjustment was made where appropriate.

2.4.3.1. Points Scored

The interaction between the covariate and the group factor was non-significant and was, therefore, removed from the ANCOVA model. The resulting table indicated that late retention score was a highly significant predictor of performance in the competition stage of the experiment ($F(1,33) = 31.48$, $p<.001$), but the group main effect was non-significant ($F(3,33) = 0.94$, n.s.).

Planned contrasts between the RG and RGC groups ($F(1,33) = 2.56$, n.s.) and the CS and CSC groups ($F(1,33) = 0.04$, n.s.) both indicated no significant differences between the control/non-control group pairs.

2.4.3.2. Variable Error

As with the point scores, the interaction between the covariate and the group factor was non-significant and so was removed from the model. The final table revealed no significant main effect for group ($F(3,33) = 0.75$, n.s.). In addition, the covariate was not a significant predictor of variable error in the competition stage of the experiment.

Planned contrasts between the RG and RGC groups ($F(1,33) = 0.62$, n.s.) and the CS and CSC groups ($F(1,33) = 0.04$, n.s.) were both non-significant.

Table 2.2. Mean ratings of 28 independent observers for how well a sample of subjects performed the four "throw action" instructions in Experiment 1. Observers rated video clips of ten subjects (five from the rule-governed groups and five from the contingency-shaped groups) throwing six darts in the acquisition stage of the experiment, using a five point Likert-type scale from 1 ("very poor") to 5 ("very good").

	Behaviour							
	Body Still		*Forearm Only*		*Throw not Lob*		*Follow Through*	
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
RG/RGC	3.18	0.48	2.46	0.63	3.25	0.53	3.66	0.52
CS/CSC	2.52	0.52	1.99	0.57	2.23	0.58	2.54	0.64
Difference	0.66		0.47		1.02		1.12	

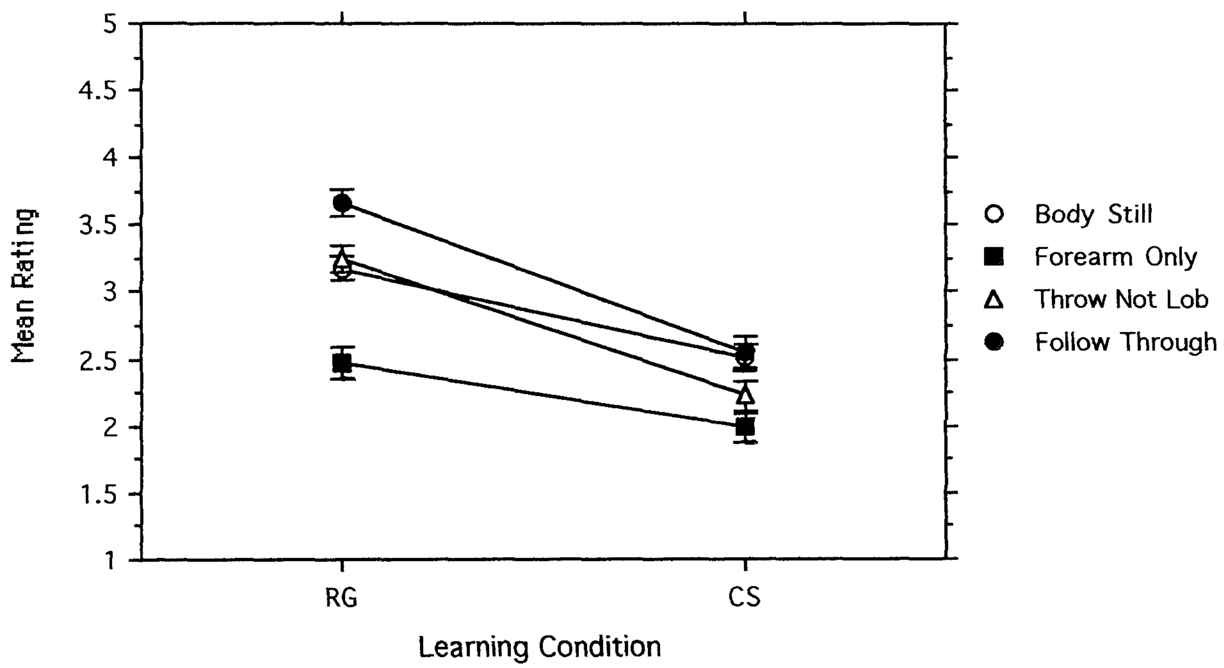

Figure 2.3. Graph of mean ratings of 28 independent observers for how well a sample of subjects from the two rule-governed and two contingency-shaped groups performed the four "throw action" instructions in Experiment 1.

2.4.4. Analysis of Instruction Following

In order to analyse the degree to which subjects' throwing action conformed with the behaviour specified by the throw action instructions, video clips of ten of the subjects (five from rule-governed and five from contingency-shaped groups) throwing darts in the acquisition stage of the experiment were shown to 28 independent observers. Each clip showed a subject throwing a dart six times after which the observers were asked to rate the throwing action of each subject according to how well they performed the actions specified by the four throw-action instructions. They did this using a 5-point Likert type scale from 1 ("very poor") to 5 ("very good"). The raters were not given any information regarding the nature or purpose of the experiment, and were unaware of any grouping procedure. All first darts (in each set of three) were excluded to ensure that no verbalising of instructions was evident in any of the video clips.

The mean ratings are shown in Table 2.2 and are illustrated in Figure 2.3. The data were analysed by a 2 x 4 (group x instruction) ANOVA with repeated measures on both factors. The results indicated significant main effects for both group ($F(1,27) = 111.85$, $p<.001$) and instruction ($F(3,81) = 35.49$, $p<.001$) as well as a significant interaction between the two ($F(3,81) = 8.47$, $p<.001$).

As can be seen in Table 2.2 the ratings for subjects who were given the instructions (RG/RGC groups) were higher than for those who were not given instructions (CS/CSC groups). It can also be seen that the significant main effect for instruction was the result of subjects achieving a higher mean rating on the "follow through" instruction and lower mean rating on the "forearm only" instruction than on the "body still" and "throw not lob" instructions. The presence of a significant interaction between the group and instruction factors indicates that the difference between the ratings for the RG/RGC and CS/CSC groups was not uniform across the four instructions. As Table 2.2 shows, the difference was larger in the "throw not lob" and "follow through" instructions than in the "body still" and "forearm only" instructions.

2.4.5. Post-experimental Questionnaire

2.4.5.1. Additional Strategies

Out of 38 subjects, 30 reported using at least one additional strategy to help them to throw better darts. Of the eight subjects who did not report using an additional strategy, four were from the RGC group, two were from the RG group, one was from the CS group and one was from the CSC group. In all, a total of 51 strategies were reported, with 18 reported by subjects in the two rule-governed groups and 33 reported by subjects in the two contingency-shaped groups.

2.5. Discussion

The main hypothesis of the present experiment was that the rule-governed (RG) group would perform better than the contingency-shaped (CS) group in the competition stage of the experiment. An analysis of covariance of the competition data, using mean scores from the last two blocks of the retention stage as covariate, failed to reveal a significant difference between groups.

This hypothesis involved separate predictions for the RG/RGC and CS/CSC groups regarding their sensitivity to the pressure contingency manipulation. As predicted, there was no significant difference between the scores of the RG and RGC groups during the competition, however, there was also no significant difference between the CS and CSC groups in this stage of the experiment.

This result is problematic because a central assumption is that the performance of the CS group will be worse under pressure. The fact that this did not occur suggests that the pressure manipulation may not have been effective. There are a number of possible reasons for this including the possibility that the sum of money on offer was not sufficient to affect performance. Alternatively, Rushall and Sherman (1987) and Baumeister (1984) identified a number of additional sources of performance-related pressure that were not manipulated in this experiment, including the expectations of others and presence of an audience. Undoubtedly, the pressure manipulation lacked ecological validity in this respect, which is an area that needs to be addressed in future experiments.

Another possibility is that the validity of the pressure manipulation was compromised because subjects simply did not believe they stood a chance of winning the money. A large proportion of the subjects who took part in the experiment were recruited from psychology undergraduate classes and it is possible that their knowledge of previous psychology experiments led them to suspect some form of deception.

A fourth possibility is that subjects did not feel under pressure to perform to any particular level because the £20 prize was not made contingent upon attaining a specific level of performance. As a consequence, the subject could not specify a score that would guarantee them the money. In future experiments, it might be preferable to use a similar approach to Baumeister (1984), who manipulated pressure by making the monetary reward contingent upon the individual beating their previous score. Anecdotal evidence from golfers suggests that knowing their position in relation to others is an important factor in determining the level of performance they attain under the pressure of actual tournament play. For example, some golfers report that they deliberately avoid looking at the leader boards when in contention towards the end of a tournament in an attempt to alleviate the performance-related pressure (Patmore, 1986).

An unexpected finding was that the RG and RGC groups scored significantly fewer points during the acquisition stage of the experiment than the CS and CSC groups. This finding is the focus of Experiment 2 and is discussed in detail at the end of that experiment.

Possibly the most important issue raised by the present experiment concerns the definitions of rule-governed and contingency-shaped behaviour. In the post-experimental questionnaire, subjects reported using a large number of additional strategies to help them throw well. In fact, a total of 51 strategies were reported, the majority being general strategies but others relating to the actual throwing technique. This finding is in line with previous work by Shimoff, Matthews and Catania (1986) who found that human subjects often formulate their own rules concerning the relationship between behaviour and consequences. This observation has important implications for the "purity" of the contingency-shaped groups. In fact, it can be questioned whether the CS and CSC groups were indeed contingency-shaped. For example, if these additional strategies, in the form of verbal antecedents, led to differential responding then it could be argued that the dart throwing behaviour of these subjects was under the control of verbal antecedents and hence, by definition, rule-governed.

In summary, the present experiment did not support the hypothesis that rule-governed behaviour would be superior to contingency-shaped behaviour under an additional pressure contingency. Although the RG group appeared to be insensitive to the pressure manipulation, so did the CS group. This might have been caused by the poor ecological validity of the pressure manipulation, but the additional problem of self-rule formulation was highlighted. The most notable finding was that the performance of the rule-governed groups was significantly poorer than that of the contingency-shaped groups in the acquisition stage of the experiment. This was in spite of the fact that the throwing action of a sample of subjects from the rule-governed groups was rated as superior to that of a sample of subjects from the contingency-shaped groups.

<u>Experiment 2</u>- Testing the Disruptive Effect of Verbalising Throw-action Instructions Using a Within-subjects Design

2.6. Introduction

In Experiment 1 verbalising technical instructions was found to result in poorer performance during the acquisition stage of the experiment compared to a group of subjects who received no instructions. This finding was unexpected and only just reached the .05 level of significance ($F(1,37) = 4.16$, $p=.049$), therefore, it was decided that a within-subject design should be used to test whether performance disruption would occur in a group for whom acquisition initially took place without instructions. The hypothesis was that performance disruption would occur when the instructions were introduced.

2.7. Method

2.7.1. Subjects

The participants were 10 female undergraduate students aged between 18 and 21 years (mean = 19.20, SD = 1.03). As in Experiment 1 all subjects had played darts on fewer than five previous occasions (mean = 2.30, SD = 1.57).

2.7.2. Apparatus/Task/Design

The apparatus was identical to that used in the previous experiment. The task was, therefore, a dart-throwing task in which the dependent variable was the number of points scored in each set of three darts. In this experiment the instruction condition served as the independent variable and subjects were required to throw 40 sets of 3 darts, the first 20 sets without instructions, followed by 20 sets with instructions.

2.7.3. Procedure

The initial procedure was exactly the same as the procedure for the CS and CSC groups in Experiment 1. After throwing 20 sets of darts the subjects were then given the same instructions that the RG and RGC groups received in Experiment 1. As in the previous experiment, subjects then verbalised shortened versions of the four throw-action instructions prior to throwing each of the remaining 20 sets of darts.

After throwing all 40 sets of darts, subjects were paid £2.50 for participating in the experiment and any questions they had were answered.

2.8. Results

As in the previous experiment, the score for each set of three darts was recorded. Trial block scores were again calculated by adding together the number of points scored in each consecutive block of 15 darts.

A 2 x 4 (instruction condition x block) ANOVA, with repeated measures on both factors and using the Greenhouse-Geisser adjustment where appropriate, indicated a significant main effect for block ($F(3,27) = 3.86$, $p<.05$) but not condition ($F(1,9) = 1.80$, n.s.). The interaction was non-significant ($F(3,27) = 0.61$, n.s.). Planned contrasts between the final block in the CS condition and the subsequent RG blocks indicated that performance was significantly worse in the first, second and third RG blocks than the final CS block ($F(1,9) = 13.18$, $p<.01$; $F(1,9) = 5.30$, $p<.05$; $F(1,9) = 5.13$, $p<.05$ respectively). Performance in the final RG block was not significantly different from the final CS block ($F(1,9) = 1.56$, n.s.).

To enable a visual comparison between the data in this and the previous experiment, the data from the present experiment are plotted in Figure 2.4 together with the mean acquisition data of the RG/RGC and the CS/CSC groups from Experiment 1. Although it is invalid to make direct statistical comparisons, it can be seen that the mean scores of subjects in the present experiment (CS-RG) were similar to the scores of the two contingency-shaped groups of Experiment 1 (CS-CS) for the first four blocks and similar to the two rule-governed groups of Experiment 1 (RG-RG) for the second four blocks.

2.9. General Discussion

The results of Experiment 2 provide support for the hypothesis that verbalising the throw-action instructions has a detrimental effect on performance. The question that arises concerns why such disruption occurs.

In behaviour analysis it has been argued that instructions are likely to be beneficial when the direct acting consequences are either too weak, too unlikely, or too temporally remote to enter into an effective contingency (Malott, 1989). In motor skill learning, rules can also be beneficial in terms of increasing the probability that a subject will emit an approximation of the desired behaviour which is sufficiently close to make effective contact with the contingencies of reinforcement. There may be short term

Table 2.3. Block score means and standard errors for Experiment 2 presented with the mean acquisition scores of the CS/CSC and RG/RGC groups from Experiment 1. Data for Experiment 2 are under the CS-RG group label to indicate that the first four blocks of darts were thrown without instructions and the second four blocks were thrown with instructions.

	Total Score (Pts)							
	Block 1		*Block 2*		*Block 3*		*Block 4*	
Group	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*
CS-RG	41.00	4.13	41.90	3.96	46.90	3.55	47.40	2.73
CS-CS	39.47	1.69	42.53	1.63	44.95	2.25	46.79	1.72
RG-RG	37.11	2.86	38.84	2.23	39.11	2.09	42.95	2.10

	Total Score (Pts)							
	Block 5		*Block 6*		*Block 7*		*Block 8*	
Group	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*
CS-RG	38.10	3.87	41.50	3.68	41.60	2.99	44.20	3.14
CS-CS	47.79	1.75	47.90	1.71	47.42	1.67	47.74	1.84
RG-RG	42.26	1.89	43.32	1.68	42.53	1.45	44.68	1.53

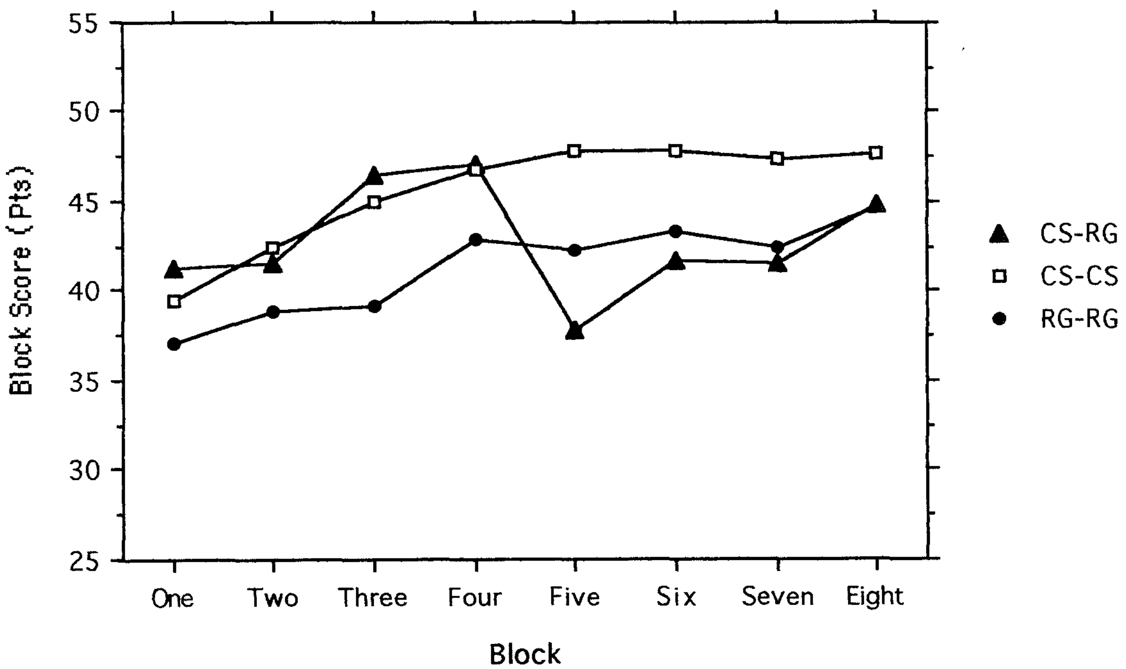

Figure 2.4. Mean block scores in Experiment 2 (CS-RG data points), presented with the mean acquisition stage scores of the RG/RGC and CS/CSC groups from Experiment 1. Subjects in Experiment 2 threw the first four blocks of darts without instructions, followed by four blocks with instructions.

"costs" in following these instructions however, as Catania (1992) outlined using the example of learning to type using a "hunt and peck" method as opposed to touch typing. He noted that when following instructions for using the touch typing method, performance is typically slower with more mistakes than typing using the hunt and peck method. Over time, however, people using the touch typing method are able to type much faster and more accurately than individuals using the hunt and peck style.

One interpretation of the results in Experiment 2 together with those in the acquisition stage of Experiment 1 is that, as with instructions to adopt a touch typing method, the dart throwing instructions led to behaviour with short term performance costs, even though the behaviour under their control was a closer approximation to the desired throwing action than that of the CS and CSC groups. Support for this interpretation comes from the videotape analysis, in which the rule-governed subjects received higher ratings for performing the behaviours specified by the instructions than those who did not receive instructions. Together with analysis of the retention data, which revealed no significant differences between the rule-governed and contingency-shaped groups, this suggests that the performance costs were transient.

A second point to be made about the poor performance associated with following the instructions concerns the number of instructions to which subjects were asked to attend. It has been argued in the motor learning and sport psychology fields that attending to too many technical instructions may be detrimental to performance. For example, Bunker, Williams and Zinsser (1993) suggest that "Even on the beginning level, self-talk should be kept as brief and minimal as possible. Oververbalization, by the coach or athlete, can cause paralysis by analysis" (p. 227). This view has theoretical backing from the cognitive distinction between controlled and automatic processing, where the central executive component of working memory is viewed as having limited capacity (Schneider and Shiffrin, 1977). It is possible that the attentional demands of thinking about four aspects of the throw action had an adverse effect on performance which overshadowed any benefits resulting from following the instructions. Support for this position comes from the general comments of subjects on the post-experimental questionnaire, a number of whom drew attention to the difficulty of concentrating on all four instructions.

The detrimental effect of technical instructions on the acquisition of motor behaviour has also been documented by applied sport practitioners. For example, Fine (1993) described a case from his tennis coaching experience:

> "I had been teaching a 9-year-old girl for about six weeks. In that time her best back-and-forth rally with me on the practice court was just six consecutive strokes... Sensing my normal method of coaching was proving difficult for her to follow... I asked her to forget everything I had told her, and instead simply say

'bounce' out loud every time the ball bounced on the court and, and 'hit' every time the ball hit her racket. The results were astonishing. She did 53 consecutive shots in her first rally".

(Fine, 1993, p. 25)

This suggests that, far from being beneficial in pressure situations, rule-governed behaviour might actually be a cause of performance disruption. It seems that the facilitative rule-governed behaviour described by Martin (1992) and Ming and Martin (1996) cannot be the same as the disruptive rule-governed behaviour found in the present experiments.

2.10. Conclusion

The two experiments presented in this chapter have raised some important issues regarding the definitions of rule-governed and contingency-shaped behaviour. This distinction lies at the very heart of a behaviour analysis of human behaviour yet the relatively simplistic use of the rule-governed behaviour term (e.g. Ming and Martin, 1996) does not seem sufficient when analysing the control of human motor skills. Clearly, any theory based on this distinction must be precise in defining what constitutes rule-governed and contingency-shaped behaviour. Therefore, in the next chapter these terms are considered in more detail, particularly in terms of how they relate to the control of human motor behaviour.

Chapter 3- A Critique of the Behaviour Analysis Distinction Between Rule-governed and Contingency-shaped Behaviour

3.1. Introduction

The simplest definition of rule-governed behaviour is that it is "behaviour, either verbal or nonverbal, under the control of verbal antecedents" (Catania, 1992, p. 393). In using this definition, rule-governed behaviour is contrasted with contingency-shaped behaviour which is defined as behaviour that can be modified by its consequences (Catania, 1992). Although on the face of it this distinction appears a clear one there has been much debate amongst behaviour analysts about issues such as what constitutes a rule and exactly how rule-governed behaviour differs from contingency-shaped behaviour (Reese, 1989; Cerutti, 1989). For example, some researchers have defined rules as contingency-specifying stimuli (e.g. Skinner, 1969; Reese, 1989) whilst others have argued that rules need not be descriptions of the whole contingency (Cerutti, 1989; Schlinger, 1993) or that they simply refer to "verbal behaviour that controls other behaviour" (Slocum and Butterfield, 1994).

In this chapter the use of the term rule-governed behaviour in behaviour analysis is examined. From here, the implications of the distinction between rule-governed and contingency-shaped behaviour for the study of motor behaviour in sport are explored. It is argued that the clinical nature of much of the applied work in behaviour analysis has had two important consequences. Firstly, it has resulted in researchers failing to make a clear distinction between rule-following and rule-governed behaviour. Secondly, the focus on the function of behaviour (i.e. the effect the behaviour has on the environment) has resulted in a relative neglect of a topographical level of analysis (i.e. relating to the form of the behaviour). It is suggested that to be usefully applied to the study of sports skills a distinction must be made between three different levels of verbal control. With this in mind a three level analysis of the distinction between rule-governed and contingency-shaped behaviour is presented that incorporates both the functional and topographical levels of analysis.

3.2. The Distinction Between Rule-governed and Contingency-shaped Behaviour

The distinction between rule-governed and contingency-shaped behaviour has traditionally been described in the context of instructional control, as the following passage illustrates:

> "Sometimes what people do depends on what they are told to do; people often follow instructions. Such behaviour, mainly determined by verbal antecedents, has been called *rule-governed* behaviour; its properties differ from those of *contingency-governed* behaviour, behaviour that has been shaped by its consequences"
>
> (Catania, 1992, p. 248, italics in original)

In examining the precise nature of this distinction there are three main areas that are usually discussed: the benefits of instructional control, an analysis of the contingencies that maintain rule-following, and an outline of what has been described as a defining feature of rule-governed behaviour: its insensitivity to changes in the contingencies associated with the behaviour (Shimoff, Catania and Matthews, 1981). A summary of these three areas follows.

3.2.1. The Benefits of Instructional Control

A functional level of analysis is concerned with the effect the behaviour has on the environment independent of the precise movements, or topography, of the behaviour. For example, in golf we speak of the behaviour of putting even though the precise movements will change according to the requirements of each putt. On the other hand, the topography of a response is defined by its form. This distinction is important when one considers research into the benefits of instructional control. By the nature of the question, a functional level of analysis is implied. Thus, when one talks about behaving in the social sense of the word, functional classes of behaviour are implied, such as "cleaning the dishes" or "tidying the room". For these behaviours, the precise form of the tidying or cleaning behaviour is of little interest. This is in contrast to most behaviour in sport, where the interest is primarily at the topographical level due to the different consequences associated with slight changes in the form of behaviour. For example, in golf it is usually of less interest to analyse why a particular individual is conforming or failing to conform with the rules of the game than it is to analyse the different outcomes of each shot due to the slight differences in the form of the swing.

Unfortunately, research in this area fails to make a clear distinction between these different levels of analysis. The terms rule-following behaviour and rule-governed behaviour are often used interchangeably even though each implies analysis by a different set of contingencies. Specifically, an analysis of behaviour in terms of rule-following involves a higher-order set of contingencies. To illustrate, consider two approaches to explaining the advantages of instructional control. The first approach examines situations in which it is beneficial to have behaviour under the control of higher-order contingencies. In other words, situations in which it is beneficial to follow instructions. This is the approach taken by Malott (1989) who described three general situations where control by direct-acting contingencies would be ineffective or inappropriate. These are when the direct-acting consequences following a behaviour are either too delayed, too improbable or too small to change behaviour.

Malott suggests that health-related behaviours such as dental flossing are examples of behaviour in which the direct-acting contingencies are ineffective because the health benefits for flossing on a given day are too small to be effective reinforcers of the behaviour. Other examples of this level of analysis concern situations where failure to follow instructions would have highly aversive or potentially fatal consequences, as in the case of the child who is told "Don't touch the stove or you will burn yourself" (Catania, 1992). Clearly, it would be of little benefit if behaviours such as these could only be learned through direct contact with the contingencies.

This level of analysis is most relevant to situations in which the aim is to increase compliance with instructions, that is, increase rule-following behaviour. The implications of this level of research are that contingencies can be arranged to increase the likelihood that rule-following will occur.

A second, different approach is taken by Skinner (1974) who outlined three particular benefits of following instructions in the context of problem solving:

"1. Rules can be learned more quickly than the behaviour shaped by the contingencies that the rules describe.
2. Rules make it easier to profit from similarities between contingencies.
3. Rules are particularly valuable when contingencies are complex or unclear."

(Skinner, 1974, p. 125)

This analysis considers the potential benefits of following rules in terms of the direct-acting contingencies. In other words, rather than assessing why people follow rules (higher-order contingencies) this approach assesses the immediate benefits as well as the limitations associated with rule-governed behaviour itself. The focus of this level of analysis is, therefore, on the characteristics of rule-governed behaviour and how they differ from contingency-shaped behaviour in a problem solving situation. For example, Skinner noted that when attempting to solve a problem subjects may not make effective contact with the contingencies that would shape their behaviour and that instructions can speed up the process by eliminating a great deal of irrelevant behaviour. In the third of his points Skinner (1974) notes that instructions can be particularly beneficial in instances where the contingencies are highly complex. In such situations, presumably, it is less likely that the subject will behave in a way that makes effective contact with the appropriate contingencies of reinforcement. This is particularly relevant to the learning of motor skills, a point that will be discussed later in the chapter.

From the above, it can be seen that the distinction between rule-governed and contingency-shaped behaviour is made at two levels. One level is concerned with rule-following, a higher-order class of behaviour most closely associated with instructional control in the social or clinical sense of the word. The second level is concerned with an analysis of the potential benefits of rule-governed behaviour in the context of problem solving. This distinction is important because many laboratory experiments involve problem solving (e.g. how to get the greatest number of points on a particular apparatus) whereas much of the applied work of behaviour analysts involves analysing behaviour according to contingencies associated with rule-following. Although the term rule-governed behaviour has been used in both these situations, it only seems appropriate when analysing behaviour in terms of direct-acting contingencies. The question of why the instructions are followed in the first place is associated with the higher-order contingencies that maintain rule-following.

3.2.2. Contingencies that Maintain Instruction Following

The finding that so much human problem solving behaviour could be so dramatically affected by verbal antecedents posed a serious threat to the study of human behaviour using the principles of behaviour analysis (Hayes and Wilson, 1993). That is, how could human behaviour be understood in terms of the discriminated operant if so much of this behaviour was apparently the subject of verbal control?

It seems that there were two responses to this quandary. The first was to argue that the rules that control behaviour are simply verbal discriminative stimuli that can be studied and understood within the traditional three-term contingency (e.g. Skinner, 1966, 1969; Brownstein and Shull, 1985; Cerutti, 1989). This position has the obvious problem that discriminative stimuli gain their properties through a history of the behaviour being differentially reinforced in their presence (Michael, 1980, 1982). No such history is necessary when following a particular instruction and, as Malott (1989) noted, this is one of the advantages of control by instructions. What is more, Schlinger (1990) poses the question of why a special term is required if rules are simply discriminative stimuli. A further problem is that discriminative stimuli evoke behaviour immediately, whereas verbal statements such as "leave when the bell sounds" may not change behaviour for minutes or even hours (Blakely and Schlinger, 1987; Schlinger and Blakely, 1987; Schlinger, 1993).

The second response was to argue that the verbal behaviour and rule-following of each individual was itself shaped over their lifetime. This led to the analysis of behaviour at the higher-order level with the argument being that, ultimately, behaviour under the control of instructions could also be explained by the operant. In other words, instruction following is controlled by its consequences (Galizio, 1979).

When analysing the distinction between rule-governed and contingency-shaped behaviour, a consideration of these higher-order contingencies is clearly important in establishing the validity of an operant analysis of human behaviour. Probably because of the direct relevance to many behavioural problems faced in the clinical setting this area of discussion has received a great deal of attention. For example, consider the behaviour of a boy with learning difficulties who responds to staff instructions to do something with violent outbursts. The implications of a rule-following level of analysis are that an intervention could take place in two ways. Firstly, an attempt might be made to change the frequency, intensity or duration of a behaviour by manipulating the direct-acting contingencies that appear to maintain the behaviour. A second approach would involve analysing the contingencies that affect rule-following in general. In this case the subsequent intervention would involve arranging contingencies for the generalised behaviour of rule-following, rather than trying to change the direct-acting contingencies associated with specific instances of the target behaviour.

Discussion of rule-following, therefore, examines the contingencies which establish and/or maintain it as a higher-order response class. The main thrust of the argument is that there are higher-order contingencies that do not operate on the behaviour directly, but instead operate on the correspondence between the verbal antecedents (saying) and the behaviour which follows (doing) (Catania, Matthews and Shimoff, 1982). In this way, the higher order behaviour of rule-following is reinforced rather than the behaviour specified by the rule.

3.2.2.1. Pliance and Tracking

A central feature of the analysis of rule-following behaviour is that a distinction is made between rule-following maintained by social contingencies, and rule-following that is maintained by a correspondence between the natural contingencies and the instructions which describe them (Cerutti, 1989). In the case of the former, the contingencies contain verbal descriptions of consequences for either complying or, more usually, failing to comply with instructions. This type of rule following has been called pliance where "a rule is followed because of a past history of socially mediated reinforcement for a correspondence between similar rules and relevant behaviour" (Hayes, Brownstein, Zettle, Rosenfarb and Korn, 1986, p. 253). Numerous examples exist in which this type of contingency is in effect, including the rules which constitute the justice system and the rules in military establishments.

The second kind of rule-following is when a rule is followed "because of a past history of a correspondence between the rule and natural (i.e. nonarbitrary) contingencies" (Hayes et al., 1986, p. 253, brackets in original). This is referred to as tracking and in this case rule-following is more likely because an individual has been reinforced for following similar rules in the past. The nature of the track itself also differs from the ply in that it specifies "the way in which the world is arranged" (Zettle and Hayes, 1982) rather than any socially constructed contingencies. An example of tracking would be a golfer following the advice of a coach because similar instructions have, in the past, resulted in improved performance.

In distinguishing between pliance and tracking it is important to note that the contingencies associated with tracking do not implicate an instructor. Thus, an instruction could be presented in spoken or written form and is subject to variables such as the listener's previous experience of similar rules. In contrast, instances of pliance directly implicate the speaker-mediated consequences associated with following the instruction and are subject to a separate set of variables including the importance of the consequences and the ability of the speaker to enforce the consequences (Zettle and Hayes, 1982).

3.2.3. Theories for the Insensitivity of Rule-governed Behaviour

As noted in Chapter 1, it has been said that a defining feature of rule-governed behaviour is that it is insensitive to changes in the programmed contingencies (e.g. Catania, Matthews and Shimoff, 1982). For example, under different schedules of reinforcement, human button pressing has been found to be insensitive to changes in the programmed contingencies so that the rate of responding does not change in a manner consistent with contingency-shaped behaviour. This was initially demonstrated for contingencies associated with high rates of responding (Harzem, Lowe and Bagshaw, 1978; Matthews, Shimoff, Catania and Sagvolden, 1977) but has also been found for low rates of responding. For example, Shimoff, Catania and Matthews (1981) found that human low rate responding was insensitive to a change in the contingencies when it was instructed, but was sensitive to changes when it was shaped. In analysing rule-governed and contingency-shaped behaviour, theories concerning why insensitivity occurs is a third area of discussion.

3.2.3.1. The Preclusion Hypothesis

One of the first theories presented will be referred to as the "preclusion hypothesis". This was described by Galizio (1979) who argued that on human schedule experiments, instructions generated patterns of responding that precluded effective contact with the programmed contingencies. To test his theory Galizio carried out an experiment in which subjects were given either accurate or inaccurate instructions for how to respond to score the most points. It was found that presenting subjects with accurate instructions led to rapid control of responding. More importantly it was found that the inaccurate instructions also controlled the button pressing behaviour of the subjects but only until contact with aversive consequences occurred whereupon rapid cessation of rule-following took place.

The preclusion hypothesis was examined further by Hayes et al., (1986) who looked at the performance of human subjects on a button pressing task under four instructional conditions. Subjects were either given no instructions about the programmed schedule of reinforcement, accurate instructions (to press rapidly when one light was lit and slowly when the other was lit) or one of two "minimal instructions" conditions, where subjects were either told to leave several seconds between pushes, or to push the button rapidly. The actual programmed contingency involved a multiple schedule which alternated between a schedule programmed to give increased reinforcement for higher rates of pressing and a schedule programmed to give increased reinforcement for lower rates of pressing. Thus, the two minimal instruction conditions represented accurate descriptions of the programmed contingencies for half of the duration of the experiment.

Partial support for the preclusion hypothesis was found in that the "go fast" and "go slow" instructions did affect the range of behaviour emitted. However, it was also found that when the behaviour of some of the subjects made contact with consequences which contradicted the instructions they were given, they nevertheless continued to follow the instructions. From this, Hayes et al. (1986) concluded that there were at least two sets of contingencies in operation, those programmed for the button pressing and a second set that maintained the rule-following behaviour.

3.2.3.2. Discrimination Theory

Based to a large extent on the points made by Hayes et al. (1986), Cerutti (1989) presented a "discrimination theory" of rule-governed behaviour. He suggested that, in problem solving, instructed behaviour enters two contingencies, one associated with the consequences for following the instruction and a second associated with the problem itself, which he called collateral consequences. Cerutti argues that the insensitivity of rule-governed behaviour should be viewed, not as a property of instructed responding but as an outcome of its interaction with these collateral contingencies. In other words, insensitivity is likely when collateral reinforcement is programmed for following the instruction.

3.2.3.3. Variability of Responding Hypothesis

A refinement of the preclusion hypothesis was proposed by Joyce and Chase (1990) who argued that the variability of responding at the moment of the contingency change was the critical factor in determining whether a change in responding would occur. They predicted that behaviour would only be insensitive to the change when there was a low variability of responding irrespective of whether this low variability was established by instructions or shaping of the behaviour. This is indeed what they found and furthermore, rule-governed performance was found to show sensitivity when the subjects were instructed to perform in a way which resulted in increased response variability.

3.3. Applying the Traditional Distinction to Sports Behaviour

From the above it can be seen that discussions about the behaviour analysis distinction between rule-governed and contingency-shaped behaviour have mainly focussed on higher-order rule-following behaviour. Mainly because of the prevalence of rule-governed behaviour in humans, together with the direct clinical application, theory and research into rule-governed behaviour has also tended to emphasise the function rather than the topography of behaviour.

This has left the topographical distinction between rule-governed and contingency-shaped behaviour comparatively underdeveloped. Whilst not a problem in the study of clinical behaviour, this means that the current behaviour analysis framework has limited scope for studying skilled motor behaviour. In the following section, this problem is highlighted by considering the present scope and limitations of focusing on the functional distinction between rule-governed and contingency-shaped behaviour when applied to sports behaviour. As a first step in providing an integrated model that is relevant to the study of sports behaviour, three levels at which verbal antecedents can control sports behaviour are outlined and the importance of this for an analysis of performance disruption is discussed.

3.3.1. Rule-following Behaviour in Sport

When the higher-order contingencies associated with rule following are considered it is readily apparent that this level of analysis, including the distinction between pliance and tracking, also applies to the study of motor behaviour. For example, athletes are often given explicit instructions concerning what to wear and how to behave by an organisation which also arranges aversive consequences for failing to comply with "team policy". Conforming with such instructions is an example of pliance. Similarly, all sports are bound by rules concerning what is and is not considered to be appropriate behaviour for the participants and there are officials, referees or umpires on hand to try to ensure compliance with these rules.

With respect to tracking, many athletes follow the instructions of their coach because of a history of high correspondence between the rules stated by the coach and the natural contingencies. For example, if a tennis player who follows the instruction, "to beat this player you must serve and volley", is subsequently successful then the player will be more likely to follow similar instructions (tracks) in the future.

In sport, as with other human behaviour, the distinction between pliance and tracking can be subtle. For example, a golfer may change his grip on the advice of a coach which takes the form, "if you turn your hands slightly anti-clockwise you will be less likely to hook the ball". This advice takes the form of a track because it specifies a natural contingency associated with golf but subsequent rule-following may be an instance of pliance if the individual follows the advice because of past reinforcement from the coach for complying with his or her instructions. Rule-following on the part of the athlete is clearly a complex interaction between the contingencies associated with both pliance and tracking as can be seen in situations where athletes continue to follow the instructions of a coach in spite of a series of poor results.

An analysis of the contingencies that maintain rule-following is, therefore, an important area of study in sport just as in other walks of life. When considering how athletes learn and perform complex motor skills, however, the more important question is how behaviour under the control of rules differs from behaviour that is under the control of the environment.

3.3.2. Human Contingency-shaped Behaviour

Perhaps the main reason that researchers have directed most of their attention towards analysing the contingencies associated with rule-following is that it has proved difficult to specify instances of human behaviour that are unquestionably contingency-shaped (Hayes, Kohlenberg and Melancon, 1989). The difficulty arises because of the tendency for human subjects to engage in self-instruction during problem solving situations, as has been shown in experiments that test human performance on different schedules of reinforcement (Rosenfarb, Newland, Brannon and Howey, 1992). This problem is exacerbated by the definition of operant behaviour as "behaviour that can be modified by its consequences" (Catania, 1992, p. 385). This definition does not explicitly exclude the behaviour of a child who, on receiving a reward for tidying his room, makes a conscious decision to tidy his room the next day in the hope of being rewarded again. As a consequence, many examples of "human operant behaviour" might, strictly speaking, be examples of rule-governed behaviour in which the consequences merely modify the verbal antecedents (Shimoff et al., 1986). It is easy to see why this occurs when one considers the task used in such experiments.

3.3.2.1. Human "Schedule Performance" Task

The task used to study human performance on different schedules of reinforcement typically requires the subject to press a button in order to try to gain as many points as possible (to be later exchanged for money). Usually, the only information the subject has is that (s)he has to press the button "in some way" in order to gain points (Weiner, 1964). The design of the apparatus restricts the range of behaviour that the subject is likely to emit. For example, it seems highly unlikely that subjects will attempt to vary precisely how they press the button (i.e. the topography of their behaviour) on a button pressing task. Realistically, the only dimension along which subjects might do so (aside from the intended temporal patterning of responses) is in the amount of force used when pressing the button. Even this seems unlikely given a history in which this dimension has no functional significance.

In order to classify such problem solving behaviour as contingency-shaped it must be demonstrated that it is not subject to verbal control, whether the verbal behaviour originates from others or from the subject in the form of self-instructions. Given such a situation, it seems implausible that any subject would fail to engage in some kind of verbal problem solving behaviour, whether covert or overt, to try to work out the solution to the point scoring problem. Not surprisingly, subjects have been found to formulate and test verbal hypotheses concerning the programmed contingencies (Rosenfarb et al., 1992; Lippman, 1994). For this reason it cannot be said with any degree of certainty that human performance in such experiments is contingency-shaped. This is true even when apparent sensitivity to a change in contingencies is displayed because this may simply reflect the fact that the subject has verbally "solved the problem". The term "pseudosensitivity" has been used to distinguish this verbally mediated sensitivity, of the type "if green button lit then press fast, if red button lit then press slow", from genuine contingency-shaped sensitivity which occurs in the absence of verbal control (Shimoff, Matthews and Catania, 1986).

This has important applied implications. For example, Catania et al. (1982) suggested that from a clinical point of view "it makes sense to work on a client's verbal behaviour rather than directly on the client's non-verbal behaviour" (p. 246). This conclusion was supported by their findings from human schedule experiments in which shaping subjects' written descriptions of the contingencies they believed to be in effect was found to result in greater sensitivity to the programmed contingencies than when subjects were simply given instructions about how to respond (Catania et al., 1982). Zettle and Hayes (1982) made a similar point when arguing that an expansion of the concept of rule-governed behaviour could be helpful in enhancing the understanding and treatment of common clinical problems such as anxiety and depression, in which maladaptive self-verbalisations play such a prominent role.

Given that verbal behaviour is implicated in the control of so much human behaviour, it is tempting to question whether any human behaviour is contingency-shaped. For example, after extensive research into human schedule performance Catania, Matthews and Shimoff, (1990) concluded that:

> "...apart from the area of motor skills, it is difficult to find instances of adult human behaviour that are unequivocally contingency-shaped"
>
> (Catania, Matthews and Shimoff, 1990, p. 223)

Considering that contingency-shaped or operant behaviour is the cornerstone upon which the basic tenets of behaviour analysis are built, it is somewhat surprising to find that very little theoretical development of the distinction between rule-governed and contingency-shaped behaviour has taken place in the context of motor skill learning. In the following section, therefore, an attempt is made to do this by considering three levels of skilled behaviour at which verbal control may be in effect.

3.4. A Three Level Distinction Between Rule-governed and Contingency-shaped Behaviour

Consider the following examples:

1) A skilled football player arrives at a new club and is given instructions by his new coach concerning how to play the new, unfamiliar system.

2) A child decides to take up golf and has a lesson with a teaching professional. The pro' gives the child instructions on how to grip the club and the correct stance to adopt when addressing the ball.

3) Just before an important tennis match against a player of whom she has no previous experience, a skilled tennis player is instructed by her coach to look for weaknesses in her opponent's game.

The above examples relate to three distinct levels at which instructions may control motor behaviour in the context of sport. They are associated with three different types of instructions: instructions specifying strategies, instructions about technique, and more general instructions referring to metastrategies.

3.4.1. Strategic Level

The strategic level of analysis refers to "the planning and decision making aspects of sport performance" (Alderson, 1996, p. 25). The importance of this level is that it is the level of analysis associated with most human and animal problem solving experiments where the focus is on the what, when and where of behaviour rather than the how. In these experiments, the solution to the problem, as expressed in a statement of the contingency, does not specify the topography of the required behaviour. For example, the statement "leave a gap of five seconds before pressing the button" does not specify how the button should be pressed at the end of five seconds and unless specifically programmed, any method of pressing the button will be reinforced.

Performing almost all sports skills is an instance of problem-solving in so far as the skill involves a strategic element. Each different sport is characterised by its own unique set of problems which the participants attempt to solve, either individually or collectively as part of a team. Indeed, almost all sports require participants to learn strategies which may take the form of numerous descriptions of what to do in different situations in order to increase the probability of success. The above example of a skilled footballer playing for a new club illustrates these points. A coach who gives a player strategic instructions assumes that the individual has the technical ability to carry them out. Thus a footballer may be told to make runs off the ball, to take a defender wide or to time his runs in a particular way but it is unlikely that the coach would make any reference to the topography of the running action. Similarly, a tennis player might be instructed to serve and volley on the first serve but not on the second without describing the mechanics of how the player should come to the net. These instructions qualify as rules, and the behaviour under their control is, therefore, rule-governed.

At this level behaviour can also be contingency-shaped. For example, the behaviour of playing to an opponent's backhand in tennis may be differentially reinforced (either by wining more points with such shots or forcing weaker return shots) resulting in an increased tendency for the player to favour that side, without having formulated a strategic rule (made a conscious decision) to do so. Contingency-shaped behaviour at this level is most apparent in situations where the contingencies are highly complex. In such instances, the contingencies are difficult or may even be impossible to describe. For example, a skilled football player may be unable to describe the factors that control his decisions regarding where, when and to whom to pass the ball, yet be able to perform extremely effectively.

3.4.2. Topographical Level

In marked contrast to high-strategy games or skills, such as playing chess or engaging in complex problem solving tasks, the majority of motor behaviour in sport has contingencies associated with the topography of performance. For example, a slight change in the form of a golf swing may cause a significant change in the flight characteristics of the ball. For this reason, learning most sports skills also involves instructions relating to the topography of the behaviour. These are usually described as instructions about technique and are contrasted with strategic instructions which do not specify the form of behaviour. The distinction is made clear if one considers a strategic skill, such as playing chess. In chess it is difficult to imagine any useful instructions which could be given concerning the technique for moving the pieces. By contrast, it is equally difficult to imagine learning to play golf without receiving technical instructions about how to swing the club. Similarly, learning almost all sports skills usually involves individuals investing a great deal of time learning the "fundamentals of good technique".

As mentioned earlier, the technical, or topographical level has been left virtually untouched in behaviour analysis accounts of the distinction between rule-governed and contingency-shaped behaviour. This is because, firstly, the function of a response class, rather than the topography of a particular response, is usually of greater importance in the clinical setting and, secondly, many behaviours are believed to operate independent of the environment at the technical level (Catania, 1992). In other words, the contingencies that are usually arranged in the applied setting do not generally affect the muscular coordination associated with the movement.

The distinction between rule-governed and contingency-shaped behaviour at this level is particularly important because a central characteristic of verbal instructions at the technical level is that the behaviour controlled by them becomes less reliant on the instructions over time. However although technical instructions are particularly evident during the early stages of learning a new skill they are by no means confined to this period. Even at the highest level, coaches give technical instructions to participants in many sports, particularly in sports such as golf which require a high degree of precision. Nevertheless, a characteristic of well-learned actions, is that they require little or nothing by way of verbal control (Adams, 1971; Miller, Galanter and Pribram, 1970).

For example, a footballer may be given instructions about how to kick the ball to put a curl on it. Over time and after much practice this skill will become "automatic" in the sense that it is no longer subject to control by the original verbal instructions. To the extent that skilled performance is not subject to control by technical instructions it is contingency-shaped at this level. This is best revealed when questioning individuals how they perform their skilled behaviour. For example, Bakker, Whiting and van der Brug (1995) consider the behaviour of catching a ball:

> "Not only do such typical sport actions involve both spatial and temporal constraints, but they would also appear to involve a series of sequential decisions. However, some caution must be exercised in relation to the latter since questioning, of expert catchers at least, will indicate that introspection on their part will provide very little insight into how they are able to do what they do! They are aware that they have caught the ball but not of consciously making decisions. The catch is, as it were, the decision!"
>
> (Bakker, Whiting and van der Brug, 1995, p.190)

3.4.3. Metastrategic level

The above two levels of analysis account for the majority of instructions relating to the performance of motor skills in sport. Broadly speaking they encompass instructions concerning "what to do" (strategic) and "how to do it" (technical). However, there is a third level of analysis associated with instructions that do not fit into either of these categories. These instructions are metastrategies, or higher-order strategic instructions that do not specify a particular behaviour:

> "Many rules which help in solving the problem of solving problems are familiar. "Ask yourself 'What is the unknown?'" is a useful bit of advice which leads not to a solution but to a modified statement to which a first-order rule may then be applied... Second-order "heuristic" rules are often thought to specify more creative or less mechanical activities than the rules in first-order (possibly algorithmic)

problem solving, but once a heuristic rule has been formulated, it can be followed as mechanically as any first-order rule."

(Skinner, 1969, p. 145)

In sport, "less mechanical" activities are specified by instructions such as "look for the weakness in your opponent's game". This level of instruction does not specify a first-order strategy in the way that "serve to his backhand" does but may lead to a first-order strategic rule of this type which can then control behaviour at the strategic level.

3.4.4. Summary of the Three-level Distinction

The above three levels have important implications for the distinction between rule-governed and contingency-shaped behaviour in that they generate the possibility for a multiple classification system for a given behaviour. For example, a football player may be following the highly verbal (and vocal) strategic instructions of a coach which would be an example of rule-governed behaviour at that level. However, the precise form of the movements of the player during compliance with the instructions is unlikely to be subject to verbal control. The behaviour of the player would, therefore, be defined as contingency-shaped at the technical level. The importance of being able to distinguish between these levels with respect to choking is that the effect of verbally controlling behaviour at each of the three levels might be quite different. Particularly relevant to choking is that there is evidence suggesting that verbally controlling behaviour at the topographical level can be disruptive to performance.

3.5. Limitations of the traditional distinction

Some researchers in behaviour analysis have hinted at limitations associated with the traditional, general distinction between rule-governed and contingency-shaped behaviour when considering skilled behaviour in general. In particular, Catania (1992) uses the performance of chess grandmasters as an example of behaviour which appears to fit the definitions of both rule-governed and contingency-shaped behaviour and is, therefore, not easily defined as one or the other:

"Grandmaster chess play is called intuitive, which is another way of saying that it is contingency-shaped rather than rule-governed. This kind of expert performance is not independent of verbal behaviour, however, and it therefore suggests that there may be more than one variety of contingency-shaped behaviour."

(Catania, 1992; p. 345)

Catania proposed that the taxonomy of behaviour analysis be expanded to include three classes of skilled behaviour. Two of the three classes refer to types of contingency-shaped behaviour, one which has never depended on verbal rules, and a second in which control by verbal antecedents has attenuated following continued contact with the environment. The third class refers to a type of rule-governed behaviour in which verbal antecedents "override" the nonverbal contingencies.

Whilst the distinction between different classes of skilled behaviour is a significant step forward in a behavioural analysis of the control of skilled behaviour, the three classes proposed by Catania do not appear to provide an answer to the original problem that he described. If an assumption is made that the skilled performance of the chess grandmaster did "depend on verbal rules" at one point in time this eliminates the first class of skilled behaviour. On the basis that the behaviour of the grandmaster is also described as being dependent to some extent on verbal behaviour, the second of the two contingency-shaped classes of skilled behaviour is also eliminated. This leaves Catania's rule-governed class of skilled behaviour, in which the verbal behaviour of the grandmaster overrides the effects of the nonverbal contingencies. Yet a defining feature of skilled chess playing is that the grandmasters cannot describe all of their play in rule-governed terms. They assess situations without calculating moves in rule-governed ways (Avni, Bar-Eli and Tenenbaum, 1990), hence the use of the term intuitive. The original problem still remains, which is how to classify skilled behaviour which shares many of the characteristics associated with contingency-shaped behaviour but at the same time is controlled to some extent by verbal antecedents.

One possibility with respect to chess, is that the verbal behaviour specifies generalised strategies or metastrategies of the sort "look for the weaknesses in the defence". Because such verbal control relates to the metastrategic level, it would not interfere with the "intuitive" decision making processes that are said to occur at the strategic level (Avni et al., 1990). The three level distinction allows for the integration of verbalisable knowledge that an individual can use to influence performance, and the relatively automatic and self-organising contingency-shaped behaviour that is necessary for performance sensitivity and the fine tuning of motor skills. For example, Shiffrin, Dumais and Schneider (1981) suggested that:

> "...it must be realised that automatism and controlled processing are theoretical states and that performance in almost all tasks will be carried out with a contribution from both types of processes"
>
> (Shiffrin, Dumais and Schneider, 1981, p. 224)

One way in which the respective contributions might be better understood is by considering the topographical, strategic and metastrategic levels outlined above.

3.6. Advantages of a Three Level Analysis

3.6.1. Simultaneous Classification of Behaviour

The main advantage of considering three separate levels of analysis is that it allows a given behaviour to be simultaneously classified as both rule-governed and contingency-shaped. For example, instances of skilled motor behaviour could be described as strategically rule-governed but technically contingency-shaped. If the distinction between different levels is not made the classification of sport behaviour becomes extremely problematic, as the following passage illustrates:

> "Although those who play games begin by following the rules, they may discover ways of playing that are not explicitly covered- new strategies in baseball and basketball, for example, or new openings and replies in go and chess. Advanced players sometimes describe these strategies in additional rules. When they do not, we call them intuitive."
>
> (Skinner, 1989a, p. 91)

At the beginning of this quote, it is unclear whether Skinner is referring to rules regarding technique or strategy. He does not actually specify one or the other and it is fair to say that "those who play games" usually begin by following both strategic and technical rules, certainly in the case of sports such as baseball. Skinner then goes on to use the word strategy, and in the remainder of the quote he talks of the "intuitive" strategic play of advanced players. The word "intuitive" does not just apply to the strategic level however- it can also be applied at the technical level, where it may be described in terms such as "feel" which Skinner himself also referred to:

"We may play billiards intuitively as a result of long experience, or we may determine masses, angles, distances, frictions, and so on, and calculate each shot... In the first case we *feel* the rightness of the force and direction with which the ball is struck: in the second we feel the rightness of the calculations but not of the shot itself"

(Skinner, 1989b, p. 235, italics in original)

Without distinguishing between different levels of control the classification becomes yet more complicated by considering additional contingencies which affect the higher-order behaviour of rule-following. For example, there are contingencies in place which are intended to ensure that participants behave in accordance with the rules of the game or sport being played:

"Games like baseball or basketball are played according to rules. The play is nonverbal, but the rules are maintained by umpires and referees whose behaviour is decidedly verbal."

(Skinner, 1989a, p. 91)

Here Skinner hints at the problem faced in classifying sport behaviour as either rule-governed or contingency-shaped. Thus, the play itself is non-verbal and, therefore, not rule-governed (presumably Skinner is referring to a well-learned skill in which the strategies are performed intuitively), but at the same time is under the control of the "decidedly verbal" instructions of the umpires or referees, which by definition implies that the behaviour *is* rule-governed! Clearly it is not possible for behaviour to be simultaneously rule-governed and contingency-shaped unless the behaviour is analysed at different levels.

3.6.2. Cross-interpretation of Cognitive and Behaviour Analytic Concepts

A second advantage of a three level analysis is that it allows for the interpretation of cognitive concepts in behavioural terms and vice versa, such as the distinction between "knowing that" and "knowing how" (Ryle, 1949).

3.6.2.1. "Knowing that" and "Knowing how"

Cognitive psychologists make a distinction between "explicit, controlled, conscious processing" which is seen as "slow, effortful, capacity limited, easily stopped and propositional (focusing on 'knowing that')" and "implicit, automatic, unconscious processing" which is described as "parallel, fast, effortless, capacity unlimited, ballistic (once triggered) and procedural (focusing on 'knowing how')" (Reese, 1989, p. 31, brackets in original). Although expressed in different language styles, the above distinction parallels the behaviour analysis distinction between rule-governed and contingency-shaped behaviour. For example, Hineline (1983) argued that using the terminology of behaviour analysis, the key distinction between "knowing that" and "knowing how" is the presence or absence of a verbal repertoire, and furthermore that the origin of the terms "awareness" and "consciousness" are the same as for "knowing that". He states:

> "...in ordinary language, 'being aware' is tantamount to being able to describe. To this native speaker at least, 'acting unconsciously' implies the absence of such a repertory of self-description- no more, no less."
>
> (Hineline, 1983, p. 184)

Hineline (1983) goes on to argue that the term "consciously" denotes an available descriptive repertoire whilst "knowing how" implies the absence of a verbal repertoire. In the terminology of behaviour analysis Hineline states that "knowing how" simply implies behavioural sensitivity to changes along various dimensions of the environment, such as temporal, spatial or probabilistic dimensions. In addition, Catania (1992) defines implicit learning in humans as contingency-shaped learning. An example from Slobin, cited in Reese (1989) clearly illustrates this distinction:

> "I can describe how to drive a golf ball, in the sense that I can describe the component movements... and how they are coordinated. However, the outcomes of my actual attempts to drive the ball are unpredictable."
>
> (Reese, 1989, p. 32)

This quote refers to a limitation of rule-governed behaviour at the topographical level which is that for skilled behaviour rules cannot completely describe the contingencies they are designed to replace (Skinner, 1969). Unfortunately, research in behaviour analysis has been primarily concerned with why rules or instructions are followed (Zettle and Hayes, 1982) where terms like "knowing that" and "knowing how" do not readily translate into rule-governed and contingency-shaped behaviour. By making the distinction between the three levels described in this chapter along with the higher order rule-following behaviour, sharing of parallel concepts should be facilitated.

3.6.2.2. Procedural and Declarative Knowledge in Sports Performance

Using a three level distinction between rule-governed and contingency-shaped behaviour could also help to simplify the application of the concepts of procedural and declarative knowledge to the study of expertise in sport. For example, Eysenck and Keane (1995) state that "procedural knowledge corresponds to knowing how, and refers to the ability to perform skilled actions (e.g. how to ride a bicycle; how to play the piano) without the involvement of conscious recollection" (p. 171, brackets in original). When considering sports performance, however, the terms have not always been considered to be synonymous with the terms 'knowing that' and 'knowing how'. For example, Thomas and Thomas (1994) state that "*procedural knowledge* is used to generate action, that is how to do something" and go on to suggest that it may vary depending on the situation. Specifically, they suggest that in "high strategy sports", such as baseball, procedural knowledge refers to "a series of '*if* X occurs, *then* I do Y' statements", whereas in "low strategy sports", such as swimming, procedural knowledge "focuses on how to execute the skill rather than what skill to execute" (p. 299, itallics in original). Thomas and Thomas' (1994) use of the term does not distinguish between performance that is in accordance with if-then statements and performance that is consciously controlled by such statements. This is evident when they suggest that "procedural knowledge can be measured with interviews, game play, and paper and pencil tests" (p. 299). By using the distinction between rule-governed and contingency-shaped behaviour, which is based on the presence or absence of verbal control, the distinction between different types of knowledge being used can be made at each of the three levels described.

3.6.3. More Detailed Understanding of the Relationship Between Verbal Behaviour and Motor Performance

A third advantage of the three level distinction is that it provides a behaviour analysis framework for understanding how different types of verbal instructions can influence the performance of motor skills. Sports participants are given a wide range of different instructions relating to many different aspects of their performance. In addition they may engage in a large amount of covert verbal behaviour, or self-talk, that may also affect different aspects of their behaviour (Rushall, 1984). In particular, the attempt to control a well-learned skill by reverting to technical instructions that were present during the early stages of skill acquisition may result in disruption of that behaviour (Masters, 1992). Skinner (1985) hinted at this facet of rule-governed behaviour by recalling a poem which illustrates the problem a centipede might have had it required instructions on how to coordinate its legs when learning to walk:

> "An unnecessary return to rules may be troublesome. Mrs E. Craster (d. 1874) suggested that when the toad asked the centipede, 'Pray, which leg goes after which?' the centipede 'worked her mind to such a pitch/ She lay distracted in the ditch/ Considering how to run'."
>
> (Skinner, 1985, p. 294)

The centipede does not appear to have such problems because its behaviour is "unconscious" in the same way that a great deal of skilled motor behaviour is also unconscious at the technical level. As Zettle (1990) states:

> "Contingency-shaped behaviour is "unconscious" in that the behaving organism may have no awareness of the behaviour itself and the variables of which it is a function. It thus characterises the actions of all non-verbal organisms and undoubtedly a substantial portion of human behaviour as well."
>
> (Zettle, 1990, p. 43)

Despite the extent of "unconscious control" in motor skills, almost all skills are taught with the aid of a significant number of technical instructions concerning how best to perform the required action. In the next chapter, evidence is reviewed which suggests that when a well-learned skill is reinvested with control by rules relating to the topography of behaviour, performance is disrupted.

3.7. Summary

One of the original criticisms that Adams (1971) made of attempts to apply behavioural theories of learning to motor skills was that they failed to take into account the observation that humans could covertly guide their behaviour with verbal responses. Adams' criticism did not take into account what was then a relatively new distinction between contingency-shaped and rule-governed behaviour. Nevertheless, it was well-founded in the sense that there was little development of this distinction at the topographical level, a level critical to the performance of sports skills. Consequently, while there has recently been some interest in the study of motor skills in behaviour analysis (Martin, 1992, Ming and Martin, 1996) there has been no attempt to develop the conceptual framework within which these studies are conducted. The traditional distinction between rule-governed and contingency-shaped behaviour does not provide an adequate framework for discriminating between different levels at which instructions can control motor behaviour. In order to achieve this it is suggested that a distinction should be made between rule-governed and contingency-shaped behaviour at the technical, strategic and metastrategic levels. These three levels of control, in addition to the higher-order level associated with rule-following, provide a framework in which the terms rule-governed and contingency-shaped behaviour can be usefully applied to the study of motor behaviour in sport.

Chapter 4- Does Using Verbal Cues Prevent Choking?

4.1. Introduction

In the previous chapter it became clear that the behaviour analysis distinction between rule-governed and contingency-shaped behaviour is a complex one when applied to motor behaviour in sport. An attempt was made to clarify the distinction by describing three different levels at which motor behaviour could be either rule-governed or contingency-shaped: the topographical, strategic and metastrategic levels. This distinction, when considered alongside the distinction between rule-governed and rule-following behaviour, has important implications for the original hypothesis. In Chapter 2, the potential benefits of rule-governed behaviour in terms of choking were described in the context of research into the sensitivity of rule-governed behaviour. In Chapter 3 it was apparent that the insensitivity of rule-governed behaviour relates to higher-order contingencies associated with rule-following and the related research into pliance and tracking. Therefore, insensitivity is due to a set of variables that do not directly affect the three lower-order levels. In crude terms, behaviour is insensitive because the subject is told to behave in a given way (to use the example of pliance).

By making a clear distinction between rule-following and rule-governed behaviour it becomes apparent that there is no sound theoretical basis for predicting that rule-governed behaviour will prove insensitive at these lower-order levels during a pressure manipulation. Furthermore, by examining the characteristics of rule-governed behaviour at these three levels it is apparent that high level performance in many skills requires sensitivity to moment by moment changes in the contingencies at the strategic level. Due to the complexity that this generates, the contingencies of skilled performance cannot be completely verbalised which implies that the behaviour must be contingency-shaped. Similarly, at the topographical level, a precise description of the movements involved in skilled performance would involve an infinite number of rules for even the simplest of actions.

In the present chapter, evidence is presented which supports the view that skilled motor performance must be contingency-shaped at the topographical level. Following on from this, research is evaluated which suggests that when the behaviour of skilled performers reverts to being rule-governed at this level performance is disrupted. After considering the implications of related research and in particular the reinvestment theory of Masters (1992, 1993), it is hypothesised that, to maintain a high level of performance in pressure situations, reinvestment of technical rules must be prevented. Two experiments are then presented which test the hypothesis that using verbal cues can prevent reinvestment and hence choking in a well-learned, self-paced skill.

4.2. Evidence that Skilled Motor Behaviour Must be Contingency-shaped

There is a growing body of evidence which suggests that contingency-shaped behaviour at the technical level is necessary for skilled motor performance. The first source of support comes from traditional cognitive accounts of the different stages or phases of motor skill learning. In particular, the description of the changing characteristics of motor control associated with progression from beginner to skilled performer lends support to the notion that skilled motor behaviour must be contingency-shaped at the technical level. Related to this, there is support from the sport psychology literature concerning the characteristics of optimal performance states that has come under various headings including trust, flow, and peak performance.

4.2.1. Stages of Motor Skill Learning

In cognitive descriptions of characteristics associated with different stages of motor skill learning, an individual is said to pass through three stages on the way to becoming proficient at performing a skill. These are most commonly referred to as the cognitive, associative and autonomous stages (Fitts, 1964).

Fischman and Oxendine (1993) described the cognitive phase as the "beginning phase of learning" in which the individual gains an understanding of how the skill is to be performed. It is described as a relatively short period that "may last only a few minutes" and is associated with "much conscious attention to the details of movement" and "much verbal activity" (Fischman and Oxendine, 1993, p. 12). Adams (1971) used the term "verbal-motor stage" to describe this early stage of motor skill learning, in which he suggested that conscious adjustments to behaviour are made based on the outcome (or knowledge of results) of each trial.

The associative phase is described as being a longer phase "ranging from perhaps a few hours to learn simple skills to several years for mastering complex ones" (Fischman and Oxendine, 1993, p. 13). It is said to include all aspects involved in progressing from beginner to the advanced level. This phase is said to be characterised by a decreasing reliance on attention to the specific mechanics of the action and an increased ability to self-monitor performance. Finally, Fischman and Oxendine (1993) described the autonomous phase as being characterised by performance in which the performer requires "very little conscious thought or attention to the details of movement" (p. 13).

The process of becoming proficient in performing motor skills is, therefore, characterised by increasing automaticity or decreasing awareness of the precise mechanics of the performance (Kimble and Perlmuter, 1970). In behavioural terms it can be described as a change from rule-governed to contingency-shaped behaviour (Skinner, 1969), or a change from verbal control to control by the direct-acting contingencies associated with the behaviour.

Although these descriptions of different stages provide some evidence to support the contention that skilled performance *is* contingency-shaped at the topographical level, it is important from a behaviour analytic perspective to establish reasons why skilled performance *must* be contingency-shaped at this level. To this end there are two key issues which relate to the requirements of skilled motor performance. The first concerns the requirements for skilled performance at the strategic level. This leads into the second issue which concerns the requirements for topographical precision that are present in almost all sports skills.

4.2.2. Sensitivity Requirements of Skilled Performance at the Strategic Level

The first source of evidence that skilled motor behaviour must be contingency-shaped comes from analysing the sensitivity requirements associated with the performance of skills at the strategic level. Many skills require moment by moment sensitivity to contingencies that are constantly changing, as in the case of a rugby player trying to avoid being tackled by the opposition. The skills that require this type of sensitivity are referred to as open skills, defined as skills that take place in a temporally and/or spatially changing environment (Gentile, 1972).

As Catania (1992) suggested, the sensitivity requirements of open skills appear to dictate that they be contingency-shaped at the strategic level. In information processing terms, the demand placed on a supposedly limited capacity central executive in working memory would be impossibly large for verbal control of open skills. This problem can be appreciated by considering skills which require complex decision making to take place over a more extended period of time. For example, when attempting to write computer programs for self-paced skills such as chess playing, the number of different board positions means that, to compete with a grandmaster, an extremely powerful computer is required in order to calculate the probable outcome of hundreds of thousands of sequences of moves per second (Eysenck and Keane, 1990).

This distinction between self-paced and externally-paced skills is important in the context of sensitivity requirements because, by definition, self-paced skills do not place such high demands on the brain in terms of speed of information processing. Therefore, in self-paced skills such as golf or chess, the decision making process (e.g.

shot selection in golf or deciding on a move in chess) does not *have* to be contingency-shaped. As noted in the above chess example, however, when the decision to be made involves a number of factors, each associated with more than one possible response, even fairly liberal time constraints can dictate that these skills must be contingency-shaped for effective performance at the strategic level. For open, externally-paced skills, the combination of the infinite variability of the environment in which they are performed, and the speed with which responses must be made, mean that performance must be contingency-shaped at this level.

As mentioned earlier, closed skills, have no sensitivity requirements at this level. For example, taking a free-throw in basketball does not require strategic decision making in that the player is simply trying to throw the ball through the hoop. This type of skill does not, therefore, have to be contingency-shaped at the strategic level.

4.2.3. Sensitivity Requirements of Skilled Performance at the Topographical Level

A defining feature of much skilled behaviour is that it is extremely difficult to describe the contingencies of reinforcement associated with these behaviours at the topographical as well as strategic levels. For example, at the strategic level, Hayes, Kohlenberg and Melancon (1989) considered the implications of trying to teach social skills:

> "Even if it would be possible to name every component of social skill and relate each one to every conceivable context, the resulting rule-book would seemingly contain many thousands of rules and would be virtually impossible to teach"
>
> (Hayes, Kohlenberg and Melancon, 1989, pp. 363-364)

Similarly, at the topographical level, attempting to describe the precise characteristics of even a relatively simple movement such as a basketball free-throw would be an equally daunting task. The problem is that a complete description of the contingencies would require detailed biomechanical descriptions, specifying information about the precise force and spatiotemporal characteristics associated with the movement (Loland, 1992). The level of precision that such instructions would specify is beyond what can be consciously attained. If it was not then a basketball player could become an expert free-throw shooter simply by reading the relevant instructions. For this reason, the emergence of skilled motor behaviour must involve shaping at the topographical level.

This is not to say that learning motor skills must only involve shaping. Technical instructions can be extremely beneficial, particularly in generating behaviour that closely approximates the required performance during the early stages of motor skill learning (Whiting, 1969). However, as Skinner (1989a) noted "rules never fully describe the contingencies they are designed to replace" (p. 93). This is particularly true at the topographical level and implies that the fine tuning that is necessary to develop the level of precision characteristic of much skilled performance must be contingency-shaped.

4.2.4. Optimal Performance States

Further support for the importance of contingency-shaped behaviour at the topographical level comes from research into features of optimal performance states and introspective accounts of peak performance.

4.2.4.1. Peak Performance and Flow

Indirect evidence for the importance of suppressing verbal control comes from introspective reports of peak performance experiences in sport and recent literature on "flow". Unfortunately, the subjective nature of these experiences together with the reliance on self-report data means that there are many methodological and definitional problems (McInman and Grove, 1991) which make direct comparison with rule-governed and contingency-shaped behaviour difficult. Nevertheless, insofar as the key distinction between rule-governed and contingency-shaped behaviour is the presence or absence of verbal control then it is useful to consider the nature of these states with respect to this factor. For example, Ravizza (1977) interviewed twenty athletes from twelve different sports concerning their greatest moment in sport. Of these subjects, nineteen reported that their experience was associated with "no thinking of performance" (p. 37). Similarly, Privette and Landsman (1983), using a questionnaire design, found that one of the most common experiences of peak performance was a feeling that the "action just came out of me" (p. 198). This characteristic is illustrated in the following quote from a musician in their study:

> "All of a sudden nothing seemed to matter except the music... The things I practiced seemed to just come out. I never thought about which fingering I would use or when I would breathe. It just came out naturally."
>
> (Privette and Landsman, 1983, pp. 195-196)

The absence of thinking during performance is also found to be one of the characteristics associated with "flowlike states" (Grove and Lewis, 1996). In

Csikszentmihalyi's (1990) book on flow, this is described as a loss of self-consciousness and has close parallels with descriptions of automatic performance, as the following quote from a climber illustrates:

> "...when things become automatic, it's like an egoless thing, in a way. Somehow the right thing is done without you ever thinking about it or doing anything at all... It just happens. And yet you're more concentrated."
>
> (Csikszentmihalyi, 1990, pp. 62-63)

More recently, Jackson and Marsh (1996) have referred to this characteristic of flow as "action-awareness merging", distinguishing it from the "loss of self-consciousness" factor in their development of an inventory to measure flowlike states.

4.2.4.2. Inner Game Theory

More closely related to the conceptual approach of considering skilled performance within a learning paradigm are the principles upon which "inner game" theory is based (Gallwey, 1974, 1979). In his "Inner Game" books, Gallwey describes two different modes of consciousness which he calls Self 1 and Self 2. Self 1 is the verbal, instructional self whereas Self 2 is the one who actually executes the actions. Gallwey sees Self 1 as interfering with the ability of Self 2 to perform so that the main aim of the inner game approach is to minimise the interference of Self 1. As Gallwey puts it:

> "I observed that the one doing the talking, whom I named Self 1, thought he knew all about how to play and was supervising Self 2, the one who had to hit the ball... I began looking for ways to decrease the interference of Self 1, and to see what happened if I trusted the potential of Self 2. I found that when I could quiet Self 1 and let Self 2 learn and play without interference, my performance and learning rate improved significantly... Likewise, I found that when, as a teacher, I didn't feed the instruction-hungry Self 1 of a student with a lot of technical information but, instead, trusted in the capacity of *his* Self 2 to learn, the progress of my students was three or four times faster than average"
>
> (Gallwey, 1979, pp. 32-33)

Although Gallwey based his ideas primarily on his coaching experience rather than any particular psychological theory, his distinction between the two selves has close parallels with the behaviour analysis distinction between rule-governed and contingency-shaped behaviour, and the related cognitive distinction between explicit and implicit learning. In effect, his approach can be considered to be an attempt to promote contingency-shaped or implicit learning, and his methods have proved to be extremely popular even achieving "an almost cult-like following" according to some (Hardy and Ringland, 1984, p. 203).

4.2.4.3. Trust

More recently, inner-game theory, as it relates to the performance of well-learned skills, has been studied under the title of "trust". Again, the absence of conscious control is found to be a central component of trust, which is defined as "letting go of conscious controlling tendencies and allowing automatic processes, which have been developed through training, to execute the motor skill" (Moore and Stevenson, 1991, p. 282). Moore and Stevenson (1994) propose a number of drills for helping athletes to train for trust, all of which are either identical to, or slight variants of, drills proposed in the inner game books. Most relevant to the present research are the "quiet drills" which involve subjects verbalising non-instructional stimuli during performance. For example, in tennis the drill involves the player saying "bounce" as the ball bounces and "hit" as the racquet makes contact with the ball. Similarly, in golf the drill involves saying "back" at the top of the backswing and "hit" as the club strikes the ball. As mentioned above the aim of these drills is to suppress attempts to verbally control the behaviour during performance.

4.3. Choking: Rule-governed Behaviour at the Topographical Level?

A summary of the above is that the learning of many skills starts with an emphasis being placed on instructions about technique so that in the early stages of skill acquisition performance may be largely rule-governed at the topographical level. One of the characteristics of skilled performance, however, is that it occurs in the absence of conscious attention to technical instructions (e.g. Kimble and Perlmuter, 1970). By analysing the requirements associated with much skilled performance it was argued that this was necessary in order for skilled performance to emerge. In the following section, evidence is presented from "self-consciousness", "reinvestment", and "attention" theories of choking which suggests that returning to rule-governed control at this level disrupts performance.

4.3.1. Self-consciousness

Baumeister (1984) proposed a "self-consciousness" theory of choking in which he suggested that:

> "Under pressure, a person realises consciously that it is important to execute the behaviour correctly. Consciousness attempts to ensure the correctness of this execution by monitoring the process of performance (e.g., the coordination and precision of muscle movements); but consciousness does not contain the knowledge of these skills, so that it ironically reduces the reliability and success of the performance when it attempts to control it."
>
> (Baumeister, 1984, pp. 610-611)

Baumeister predicted that subjects who were high in dispositional self-consciousness would be used to performing in this way so that any situation which induced a state of self-attention, such as a pressure situation, would affect them less than their unselfconscious counterparts. To test this theory, Baumeister (1984) conducted a series of experiments using the Self-consciousness Scale (Fenigstein, Scheier and Buss, 1975). He found that, firstly, subjects who were high in trait self-consciousness, determined by their scores on the "private self-consciousness" dimension of this scale, performed worse than low self-conscious subjects on a skill task in the absence of any pressure manipulation. Baumeister then used rivalry, coaction, and the presence of an audience to induce performance pressure. In this condition a significant interaction was found between pressure and trait self-consciousness, with low self-conscious subjects again performing better than their high self-conscious counterparts in the control condition, but suffering a significant decrease in performance under pressure. By contrast, there was no difference in the performance of the high self-conscious subjects under the control and pressure conditions.

In two further experiments, Baumeister found, firstly, that using a financial incentive to induce pressure, low self-conscious subjects again showed a tendency to choke but only in the first of two identical pressure manipulations. Finally, in an attempt to demonstrate choking in a field setting, it was found that players of one of two arcade games suffered a 25% mean decrease in performance following a "self-presentational" manipulation of pressure. This manipulation involved recording of the player's name and age and close observation of performance whilst pretending to record time using a stop-watch (Baumeister, 1984). In an extension of this last experiment, Tice, Buder and Baumeister (1985) found that the age of the subject was critical in determining the effect of pressure on performance, with males under thirteen years, and females under twelve years showing an improvement in performance, while subjects between the ages of thirteen and nineteen showed the largest decrease in performance. Subjects who were twenty years or above also showed decreases in performance but not to the same degree as those found in the thirteen to nineteen years age group.

A summary of the above experiments is that 1) high self-attention appears to result in comparatively poor levels of performance and 2) high self-attention may result from either high dispositional self-consciousness, or a pressure manipulation.

4.3.1.1. The Home Field Disadvantage

Baumeister and Steinhilber (1984) sought to gain support for the self-consciousness theory of choking by analysing naturally occurring pressure situations, specifically high pressure matches in the U.S. basketball and baseball "world series". They hypothesised that the pressure associated with performing in front of their home crowd (high expectation of success) when one game away from overall victory would be likely to lead to a state of self-attention in the home players and hence poorer performance. In short, they predicted that the "home field advantage" would become a disadvantage in such games. The archival data supported this prediction in both baseball and basketball, with home teams winning just 38.5% of decisive seventh games in baseball, and 37.5% of basketball games in which the home team had a chance to clinch the championship. Furthermore, analysis of player errors in baseball and free-thow percentages in basketball offered support for the position that these results were mostly due to poorer home team performance rather than improved away team performance.

Recently the existence of the home field disadvantage as a general phenomenon has been criticised by Benjafield, Liddell and Benjafield (1989) who presented data supporting the view that the phenomenon is specific to particular clubs (e.g., the New York Yankees in baseball). Furthermore, there has been recent debate over the validity of the home-field disadvantage in light of a re-analysis of the data, taking into account results from 1983 to 1993, a period in which home teams won all of the decisive seventh games in the baseball world series, dropping the overall statistic below the 0.05 level of significance (Schlenker, Phillips, Boniecki and Schlenker, 1995a, 1995b; Baumeister, 1995).

Other variables that have been proposed to engender a state of self-consciousness include praise (Baumeister, Hutton and Cairns, 1990), presence of an audience, and performance feedback (Heaton and Sigall, 1991). Specifically, Baumeister et al. (1990) found that praise resulted in poorer performance on a "skill task" (video game) but improved performance on an "effort task" (card sorting).

4.3.2. Attention Research

A second line of evidence for rule-governed behaviour at the technical level being disruptive to performance comes from research into attentional processes during the performance of self-paced skills. This research relates to the attention based choking theory of Nideffer (1986, 1990); who argues that:

> "... 'choking' ... occurs as physiological arousal continues to increase to the point of causing an involuntary narrowing of an athlete's concentration and to the point of causing attention to become more internally focussed."
>
> (Nideffer, 1986, p. 258)

The "attention narrowing" part of this theory has its roots in research conducted during the 1950's when it was found that an increase in "emotional arousal" led to a reduction in the range of cues that could be used from peripheral vision using a dual-task paradigm (Easterbrook, 1959). Support for this position comes from Bahrick, Fitts and Ranklin (1954) (cited in Easterbrook, 1959) who, using a dual-task paradigm, found that making reward contingent on performance of both central and peripheral tasks led to improved performance on the central task and poorer performance on the peripheral task. Bursill (1958) described this effect as a "funnelling" of attention and found that subjects were also poorer at detecting targets in the periphery when under heat induced stress.

Easterbrook (1959) subsequently described the "cue utilisation theory" in which he proposed that the range of cues used by an organism reduced as emotional arousal increased. More particularly, Easterbrook proposed that as emotional arousal increased, task-irrelevant cues would initially be excluded, followed by task-relevant ones. This theory has great relevance to the performance of externally-paced, open skills, which require successful discrimination between relevant and irrelevant cues, as well as sensitivity to a changing visual environment. For closed skills such as golf, however, the player has minutes rather than milliseconds in which to make decisions about the most appropriate course of action to take. In addition, the player only has to focus on the stationary golf ball during the swing, so that funnelling or narrowing of attention should not disrupt performance. Therefore, any narrowing effect that physiological arousal might have on the breadth of attention should not affect the performance of self-paced skills. Indeed, according to Nideffer, the execution of a golf shot requires a narrow-external focus of attention, so that an increase in physiological arousal might even be predicted to improve performance of this skill.

This leads to the second part of Nideffer's theory of choking, the internalising of attention, which has been operationally defined as individuals attending to their own thoughts or feelings (Weinberg, 1982). Unfortunately, internal attention has been largely neglected as an area of research in both mainstream and sport psychology research (Summers and Ford, 1995; Moran, 1996) not least because of the methodological problems associated with controlling internal stimuli, or manipulating it in a consistent way (Eysenck and Keane, 1995). Nevertheless some indirect evidence has been gathered from psychophysiological studies which supports the view that the direction of attention in the few seconds before skill execution is an important determinant of performance in self-paced skills.

A number of studies have used the assessment of electrocortical activity in the moments prior to movement initiation to examine attentional processes in the performance of sports such as golf putting (Crews and Landers, 1993), archery (Wang and Landers, 1986, Landers et al., 1994) and shooting (Hatfield, Landers and Ray, 1984; Konttinen and Lyytinen, 1992). In the study of Hatfield et al. (1984) electrocortical activity was recorded in fifteen international level rifle shooters. In particular, they recorded the alpha activity of the right (T4) and left (T3) temporal sites over three, 2.5 second epochs prior to four blocks of ten shots. They then used this data to generate a T4:T3 "laterality index". They found a significant interaction between block of shots and epoch, with the index decreasing across the three blocks. Separate analysis of the left and right sites revealed a significant increase in alpha activity across blocks for the left temporal (T3) site, but no significant change for the right temporal (T4) site. Bearing in mind that increases in alpha activity are associated with decreases in electrocortical arousal, Hatfield et al. (1984) suggested that the changing ratios may be indicative of a reduction in "excessive self-instruction and covert verbalisations" just prior to performance (p. 56).

4.3.3. Reinvestment

As suggested in the previous chapter, when considering problem solving behaviour, the behaviour analysis distinction between rule-governed and contingency-shaped behaviour is closely related to the distinction made in cognitive psychology between implicit and explicit learning (Reese, 1989). Recently, choking research has been conducted within this conceptual framework. In particular, Masters (1992) proposed that choking involves "reinvesting" explicit knowledge about how to perform a skill. This led him to predict that:

> "if... explicit learning can be minimized, the performer will have less conscious knowledge of the rules for execution of the skill, and will be less able to reinvest his or her knowledge in time of stress. This should result in a lower incidence of skill breakdown under stress. In practical terms, the performer will be less likely to choke."
>
> (Masters, 1992, p. 345)

In the terminology of behaviour analysis, Masters' proposal is that if skills are acquired primarily by shaping (at the technical level), they will be less susceptible to choking.

To test the hypothesis, Masters used a golf putting experiment, in which forty novice golfers were randomly assigned to one of five groups, three of which were exposed to the pressure situation at the end of the experiment and two which acted as control groups. The three non-control groups used different learning conditions: "explicit learning" (EL) in which subjects were given a set of specific instructions concerning how to putt, "implicit learning" (IL) in which subjects were not given any putting instructions but engaged in a random letter generation task whilst putting, and a "stressed control" (SC) condition in which subjects were not given any putting instructions and did not engage in a secondary task. The two groups not subjected to the pressure manipulation were the "non-stressed control" (N-SC) group who acted as control for the SC group, and an "implicit control" (IC) group who did likewise for the IL group.

The experiment involved subjects putting one hundred times on five consecutive days. The task consisted of putting up a 1:4 incline towards a hole 10.8cm in diameter from a distance of 1.5m and the dependent variable was the number of putts holed. After four acquisition sessions, the final session involved a pressure manipulation for the appropriate groups. Specifically, subjects were told that their performance was to be evaluated by a golf professional and that the £12 payment for participation could either increase to £15 or decrease to £1 depending on this evaluation.

To test his hypothesis, Masters calculated the difference between the number of putts holed in Session 4 (the final acquisition session) and Session 5 (the pressure session) for each group. In accordance with his main prediction, Masters found that there was a significant difference between the performance decrement shown by the EL and SC groups and the performance increment of the IL, ILC and N-SC groups. Thus, while the EL and SC groups holed slightly fewer putts in the pressure session, the IL, ILC and N-SC groups continued to improve in this final session.

4.3.2.1. Evaluation of Masters' Experiment

It should be noted that the comparison of 'difference' scores between Sessions 4 and 5, which Masters used to test his hypothesis, is potentially confounded by the fact that the two implicit learning groups did not carry out the secondary task in Session 5. Thus, the difference scores for these groups may have been exaggerated because of improved performance resulting from the removal of the secondary task. This point was recently noted by Hardy, Mullen and Jones (1996) who conducted a partial replication of Masters' experiment, whilst adding an implicit learning group that continued to engage in articulatory suppression during the pressure stage of the experiment. They found that both implicit learning groups had an almost identical increase in performance from Session 4 to Session 5 suggesting that the removal of the secondary task was not a significant source of improvement. Nevertheless, another problem with using the difference score of the implicit learning group is that it is not clear how much of the improvement in Session 5 is the result of decreased attentional demands of the suppression task. If any of the difference can be attributed to this variable then it confounds the comparison with groups that did not engage in a secondary task by creating a more positive difference score against which to compare the other groups.

For the above reason, the change in performance of the SC group, which closely resembled that of the EL group, is of particular interest in Masters' (1992) experiment. Thus, although subjects in the SC group were given no technical instructions they nevertheless appeared to "choke" in a similar manner to the EL group. The problem is that simply not giving subjects instructions does not prevent them from formulating their own. In fact, the SC group reported a mean of approximately three rules about how to putt when writing down "technical and mechanical" factors which they felt were important to hitting perfect putts. This compares to approximately six rules for the EL group and less than one rule for the IL and ILC groups. It seems that even having knowledge of just three rules is sufficient to induce choking. This point is considered in more detail in the following section.

4.3.2.2. Implications for the Relationship Between Learning and Performance

Masters (1992) did not discuss the practical implications of his experiment in detail, although he did suggest that "prolonged explicit instruction" may be detrimental to the performance of élite athletes when under pressure. In addition, both Masters (1992) and Hardy et al. (1996) have suggested that coaching practices which employ a great deal of explicit instruction might increase the chance of choking. The practical implications for coaches are unclear, however, because the results of Masters' experiment suggest that simply decreasing or eliminating explicit instruction would not be effective in reducing the tendency to choke due to self-rule formulation. Thus the SC group showed a similar pattern of performance to the EL group even though they were not given any putting instructions. In fact, the results of Masters' experiment imply that to prevent choking golfers must avoid formulating any more than two rules, perhaps by engaging in various secondary tasks when practicing or playing golf. Even given an extremely conscientious individual, the feasibility of such an approach is questionable. One obvious problem is that subjects might develop an explicit knowledge base when not physically playing golf. Preventing individuals from formulating just three rules in the time that it would take to progress to the élite level, seems a futile quest. In addition, such an approach would neglect the possible benefits which may accrue from being taught with the aid of verbal instructions, some of which were described in the previous chapter.

Accepting that preventing subjects from formulating rules is an unrealistic approach to preventing choking, the logical alternative is to try to prevent reinvestment from occurring in pressure situations. To take golf, for example, it is probably safe to assume that all professional golfers can verbalise three or more rules concerning how to swing the golf club. According to reinvestment theory all of these golfers have a sufficient knowledge base for choking to occur. The fact that some golfers seem susceptible to choking whilst others, such as Nick Faldo, have a reputation for maintaining a high level of performance under pressure suggests that certain individuals are better able to prevent reinvestment from occurring than others.

One possibility is that reinvesting rules is a dimension of personality. As noted earlier, trait self-consciousness has been shown to predict choking (e.g., Baumeister, 1984). Recently, Masters (1993), constructed a "reinvestment scale" using items from the Self-Consciousness Scale (Fenigstein et al., 1975), the Cognitive Failures Questionnaire (Broadbent et al., 1982) and the rehearsal factor of the Emotional Control Questionnaire (Roger and Nesshoever, 1987). There is some evidence to suggest that this test has predictive utility. For example, Masters (1993) found that the Reinvestment Scale explained almost 35% of the variance ($r=0.59$) in the "difference" scores of 14 golfers from two of the groups in the Masters (1992) experiment. In addition, a significant positive correlation was found between the reinvestment scores of 24 university athletes (12 squash players and 12 tennis players) and ratings from their respective captains and presidents concerning their tendency to choke under pressure ($r=0.63$ and $r=0.70$ for squash and tennis respectively). Although these figures are quite high, the individual differences approach does not help in explaining why, for example, only the putting performance of a golfer is disrupted.

4.4. Verbal Cues and the Prevention Hypothesis

An alternative explanation of the individual differences in the tendency to choke is that performers who are better in pressure situations use a concentration technique that prevents reinvestment from occurring. One method for doing this might include the use of verbal cues, or the equivalent of "swing thoughts" in golf (Boutcher and Rotella, 1987). In other words, by attending to a simple cue associated with the well-learned action, the tendency to reinvest too many technical rules about how to swing the club would be suppressed in the pressure situation. According to the results of Masters (1992), 'too many' appears to be three or more rules. Nick Faldo provides some anecdotal support for this view. Thus, although recognised as being a "mechanical" player who has a detailed understanding of the golf swing at the technical level, he concentrates on an individual swing thought when playing each shot during a tournament (Lewis, 1997). This line of thought reflects the present position which maintains that it is not the rules (explicit knowledge) themselves but rather the process of reinvesting these rules that disrupts performance.

This suggestion is in line with a recent analysis of the function of verbal cues by Landin (1994) who suggested that they could be used, firstly, to help direct novices' attention to appropriate visual stimuli, secondly, to facilitate decision making and, thirdly, to initiate movement sequences. For the performance of well-learned, self-paced skills such as golf putting, the need for the first two of these functions is minimal. Regarding the initiation of movement sequences, Landin notes that very little research has actually been conducted using well-learned skills in the sporting arena.

In an experimental setting, Singer (1988) described a "Five-Step Strategy" which he proposed would be useful for learning and performing all types of self-paced skills. The strategy consisted of going through the sequence of "readying, imaging, focusing, executing, and evaluating" (Singer, 1988, p. 49). The important part of this procedure in terms of the present discussion concerns the focusing and executing steps. The focusing step is described as helping the athlete to "cope with and block out internal and external distractions" (Singer, 1988, p. 57) whilst the executing step requires the subject to "let the movements flow and to perform the task as if in a state of automaticity" (Singer, Lidor and Cauraugh, 1993, p. 23). In the focusing stage Singer (1988) suggests that the individual should "concentrate with effort... on a cue" (p. 57). The cues described in the five-step strategy are visual cues, such as concentrating on the seams of a tennis ball. Singer et al. (1993) found that subjects using this strategy had significantly less radial error when throwing a ball at a target compared to a control group. Evidence that this effect was primarily the result of the focusing and executing parts of the five-step strategy comes from the finding that a group using just these two steps, referred to as a "non-awareness" strategy, performed as well as the five-step strategy group. Although the experiment of Singer et al. (1993) makes use of visual cues during the focusing stage, the same line of thinking concerns the use of verbal cues in pressure situations.

To summarise, the evidence outlined above is representative of a growing body of literature supporting the view that skilled performance must be contingency-shaped at the topographical level and further that reinvestment of three or more rules at this level might be a cause of self-paced performance disruption in pressure situations. The present hypothesis is that using verbal cues will prevent reinvestment of too many technical rules from occurring meaning that choking will not occur in a pressure manipulation.

Experiment 3- A Test of the Prevention Hypothesis in Rugby Goal-Kicking

4.5. Introduction

The following experiment is being included because it represents an important stage in the theoretical development of the research, particularly as it represents the first attempt to test the hypothesis that using verbal cues will prevent choking. Although I had considerable input in many aspects of the experiment, in particular in explaining the theoretical rationale and providing the basic framework for the study, the data were collected by two undergraduate students. What follows, therefore, is a summary of the experiment but the main focus is on, first, a re-analysis of the results and, second, consideration of some methodological problems that were encountered, both of which had important implications for the design of subsequent experiments.

4.6. Method

4.6.1. Subjects

Four male rugby union players from the University of St. Andrews Rugby Club took part in the study. The players were aged between 20 and 22 years (mean age = 21.0 years) and had between 12 and 15 years rugby playing experience (mean = 12.8 years). All four players had previously kicked goals for University teams.

4.6.2. Task/Apparatus

The aim of the task was to kick a Rugby Football Union regulation size five rugby ball between the goal posts from a location directly in front of the posts at a distance of approximately 31 metres (see Figure 4.1).

4.6.3. Design

A within-subjects design was used and performance was assessed by two dependent variables: whether or not the kick was successful and the accuracy of the kick. The independent variables were the level of pressure (baseline or competition) and the stage of the experiment (pre- or post-intervention).

4.6.3.1. Accuracy Score

Each kick was scored on a scale of 0 to 5, with successful kicks receiving either 3, 4, or 5 points and unsuccessful kicks gaining 0, 1, or 2 points. A diagram of the scoring system and the set up for the experiment is shown in Figure 4.1.

4.6.3.2. Pressure Manipulation

In order to manipulate pressure a series of five competitions between the four subjects were arranged. For each competition prize money was made contingent upon performance with £10 being awarded for first place, £5 for second place, £3 for third place and £0 for fourth.

4.6.4. Procedure

There were five distinct stages of the experiment, each consisting of two baseline sessions followed by a competition. An additional baseline session was used prior to the first competition to ensure that the subjects were of a similar kicking standard. Overall, there were eleven baseline and five competition sessions. In each baseline session, subjects took 20 kicks, whilst in each competition subjects took 10 kicks.

The kicking order for the first competition was decided by drawing lots. The order was then rotated in each subsequent competition to ensure that all four subjects kicked in the four possible positions (i.e., first, second, third and last) at least once. During each competition, all subjects took one kick after which all four subjects were informed of the scores of each player. The process was then repeated, with subjects

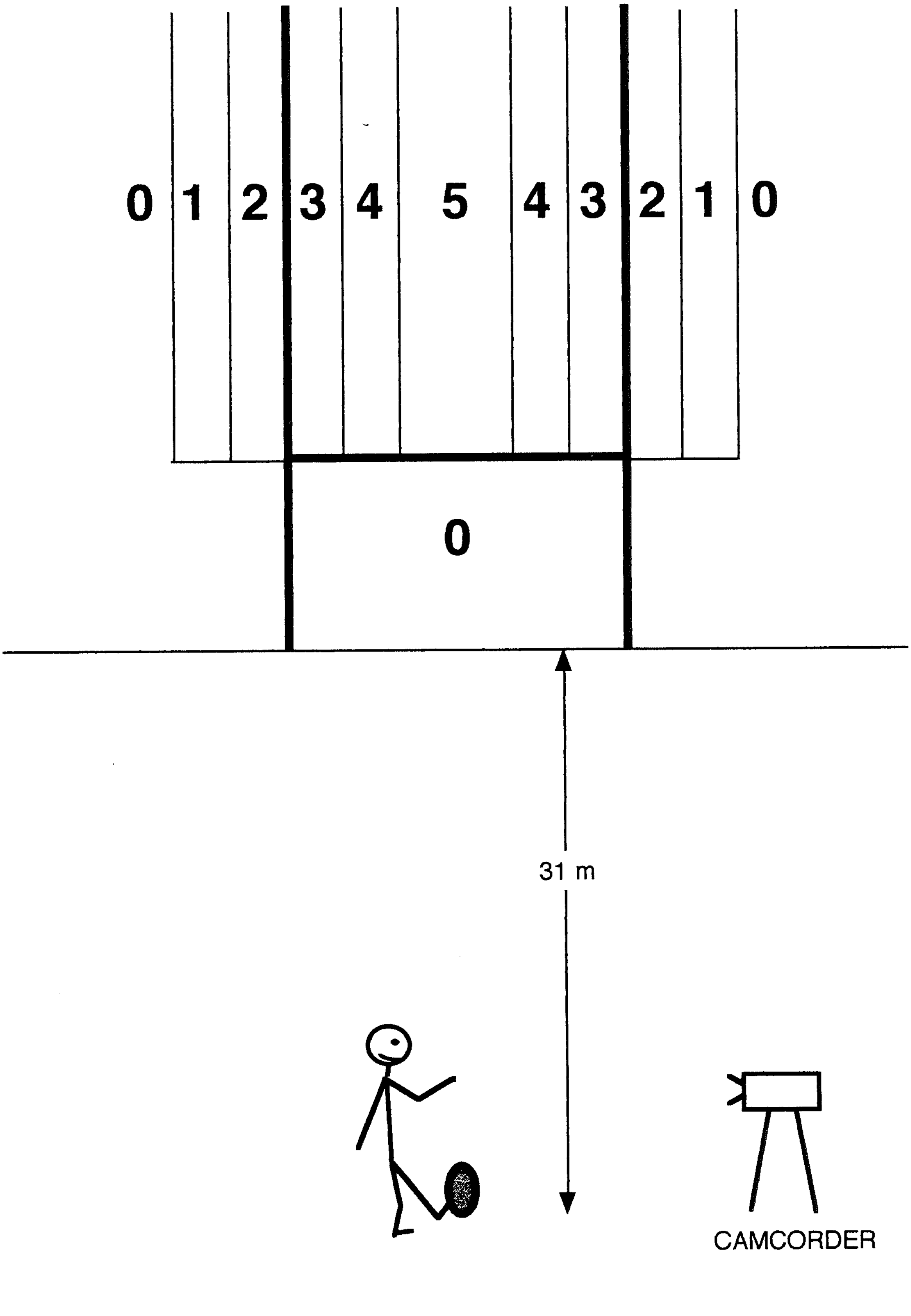

Figure 4.1. Diagram of the set-up and point scoring system for Experiment 3. All kicks which failed to clear the horizontal bar were awarded no points.

being updated on all four participants' running totals after each set of four kicks, until all ten kicks had been taken. The prize money was then awarded to subjects with the first, second and third place scores.

4.6.4.1. Intervention

The intervention took place for subjects DB, MA, AA and LR after the first, second, third and fourth competitions respectively. To begin with, the subject was read the following standardised set of instructions:

> "The aim of this intervention is to improve your performance so that you can perform equally well in both practice and competition stages. We are not trying to change your actual kicking technique but are aiming to add a verbal aspect to your routine so that every kick effectively becomes the same.
>
> Specifically, we would like you to introduce a verbal "kick thought" into your pre-kick routine (example of a golfer concentrating on the verbal stimulus "solid legs" before each full swing given at this point). After deciding on your verbal stimulus, we would like you to incorporate it into your routine during the next baseline session. You may adjust the stimulus during this session if you wish but aim to be settled on a precise stimulus by the end of this session. We would then like you to verbalise this "kick thought" just prior to each kick in all subsequent baseline and competition stages until the end of the experiment.
>
> In order to help you decide on your particular verbal stimulus we would like you to view some of the videotape of your kicking whilst observing the set of kicking rules provided. Try to choose a verbal stimulus based on a rule which you feel helps you on your better kicks".

The subject had an opportunity to ask questions, and clarification was given for any parts of the passage which were not fully understood. An example of how the concept of a swing thought might be applied to rugby was then given and it was again emphasised that the subject should formulate his kick thought from no more than two of the instructions.

The subject then read a set of instructions selected from coaching manuals on the basis that they were considered to be central elements of a sound kicking technique. Specifically these were:

1. The non-kicking foot should be level with the ball when the ball is struck.
2. Keep your "eye on the ball" as the ball is struck.
3. Your kicking foot should have a high follow through.

4. Your head should be level with the ball at impact.
5. You should maintain a balanced position as the ball is struck, with your shoulders parallel to the ground.

To help the subject decide on a "kick thought" a video of the subject taking several kicks was shown.

4.7. Results

4.7.1. Percentage Success and Mean Point Scores

The successful kick percentages and mean number of points scored on each kick are shown for each subject in all four stages of the experiment in Table 4.1. It can be seen that prior to the intervention three of the four subjects had lower success percentages in competition than in baseline. After the intervention, three of the four subjects had a higher success percentage in competition than in practice, with the other subject (DB) achieving the same level of success in both sessions.

For the points data, Table 4.1 shows that before the intervention subjects AA and LR had poorer scores under competition conditions, subject DB had identical scores in baseline and competition conditions, whilst subject MA scored better under competition conditions. After the intervention, subjects MA, AA and LR scored better under competition conditions whilst subject DB did better under baseline conditions. Graphs of the percentage and point data are shown in Figures 4.2 and 4.3 respectively.

Both sets of data were analysed using a 2 x 2 (intervention stage x pressure) ANOVA, with repeated measures on both factors. The analysis for the percentage data indicated a significant interaction between the two factors ($F(1,3) = 15.97$, $p<0.05$). The main effects for stage ($F(1,3) = 2.05$, n.s.) and pressure ($F(1,3) = 0.02$, n.s.) were both non-significant. Analysis of the points data revealed no significant interaction between the stage and pressure factors ($F(1,3) = 1.67$, n.s.). Again there were no significant main effects either for stage ($F(1,3) = 2.05$, n.s.) or pressure ($F(1,3) = 0.02$, n.s.).

4.7.2. Comparison of Point and Percentage Data

In order to determine the source of the discrepancy between the percentage and points data, the actual percentage success scores were compared with those predicted by expressing the mean point scores (out of 5) as a percentage. This value was then compared to the actual percentage success. The differences that were

Table 4.1. Mean point scores (per kick) for each subject in the four stages of Experiment 3. Also shown are the overall successful kick percentages for each subject in each stage. Finally, the group means and standard deviations are shown for both the percentage and point data in each stage of the experiment.

	Mean Point Scores				***Percent Success***			
	Pre-Intervention		*Post-Intervention*		*Pre-Intervention*		*Post-Intervention*	
Subject	*Baseline*	*Comp*	*Baseline*	*Comp*	*Baseline*	*Comp*	*Baseline*	*Comp*
DB	2.80	2.80	3.15	3.00	58.33	40.00	65.00	65.00
MA	3.33	3.60	3.33	3.73	72.00	75.00	73.33	80.00
AA	3.00	2.72	2.71	3.28	62.14	56.67	52.50	65.00
LR	3.08	3.04	2.73	2.95	65.00	57.50	60.00	70.00
Group Data								
Mean	3.05	3.04	2.98	3.24	64.37	57.92	62.71	70.00
S.D.	0.22	0.40	0.31	0.36	5.78	14.36	8.75	7.07

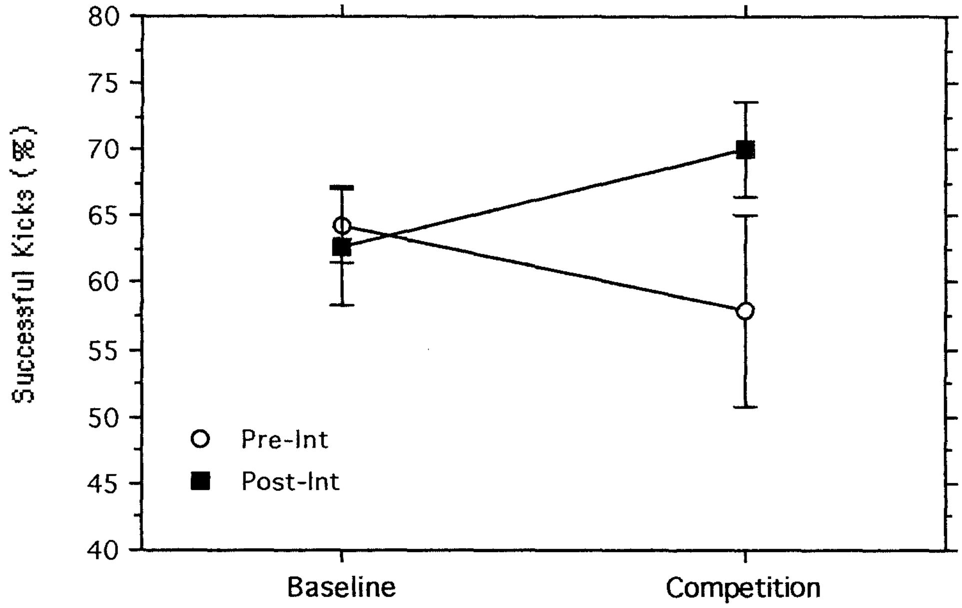

Figure 4.2. Mean percentage of successful kicks under no pressure (baseline) and pressure (competition) conditions before and after the intervention, with standard error error bars.

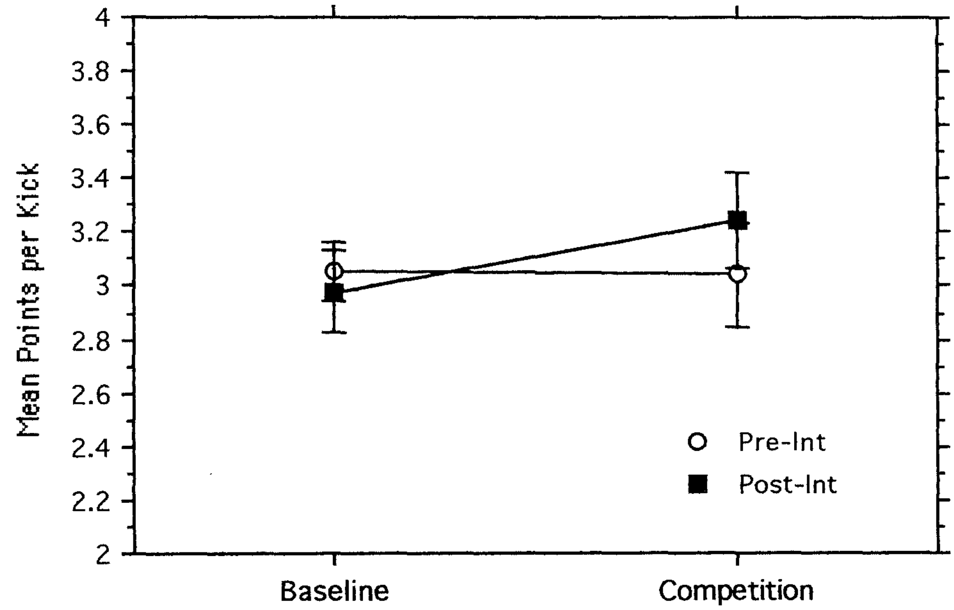

Figure 4.3. Mean number of points scored on each kick under no pressure (baseline) and pressure (competition) conditions before and after the intervention, with standard error error bars.

Table 4.2. The difference between the actual percentage success scores and those predicted from the mean point scores expressed as a percentage of the maximum possible score (i.e. (mean score ÷ 5) * 100). To make the sum of the differences equal to zero, 2.03 was subtracted from each cell total. Positive scores indicate a higher recorded percentage score than was predicted by the points data.

	Pre-Intervention		*Post-Intervention*	
Subject	*Baseline*	*Comp*	*Baseline*	*Comp*
DB	0.30	-18.03	-0.03	2.97
MA	3.37	0.97	4.70	3.37
AA	0.11	0.24	-3.73	-2.63
LR	1.37	-5.33	3.37	8.97
Means	1.29	-5.54	1.08	3.17

obtained using this calculation are presented in Table 4.2. The gross scores were adjusted to ensure that the sum of all the figures was zero. This meant subtracting 2.03 from each difference score. In the table, positive values represent higher percentage success than was predicted from the mean point score, while negative values indicate lower percentages than were predicted from the mean point score.

From Table 4.2 it can be seen that the largest discrepancies occurred in the pre-intervention competition score of subject DB, which was approximately 18% lower than predicted by his mean points score, and the post-intervention percentage success of subject LR, which was approximately 9% higher than predicted by his mean points score on each kick.

4.8. Discussion

In terms of the kicking percentages, the intervention was successful in eliminating the difference between performance under no pressure (baseline) and pressure (competition) conditions that was present in three of the four subjects prior to the intervention. Indeed post-intervention success percentages were more than seven per cent higher during competition than in baseline sessions. These results offer some support for the hypothesis that using verbal cues can help to prevent choking under pressure. There are, however, a number of factors that are important to consider.

4.8.1. Sensitivity of the Dependent Variable

First of all, one problem with using a dependent variable based on a simple hit-miss criterion is that some of the calculations were based on a small number of attempts. For example, the pre-intervention competition score of subject DB was based on only ten kicks. This can give a false impression of how well or how poorly a subject is kicking. This appears to have been the case for subject DB who was successful with only four out of ten pre-intervention competition kicks yet scored a mean of 2.80 points out of a possible 5 over the same ten kicks. Closer analysis of his performance in this competition reveals that five of his six unsuccessful kicks were awarded two points, which translate to "near misses". Similarly, the post-intervention performance of LR revealed discrepancies in the percentage and points data. Given the small sample size, these discrepancies between the actual and predicted percentage scores appear to have been largely responsible for the significant interaction found in the percentage data.

Analysis of the data using the five-point scale, which is less subject to large fluctuations, failed to produce a significant interaction between stage and pressure.

Indeed, from Table 4.1 it can be seen that, prior to the intervention, there was almost no difference between the mean kick scores in the baseline and competition conditions.

4.8.2. Subject and Kick Sample Size

One possible solution to the above problem would have been to increase the number of kicks taken by each subject in the competitions. The difficulty with this is that a compromise had to be made between attempting to increase the pressure associated with each kick and obtaining an accurate measure of performance. In some ways the ideal experiment would involve a single performance of a particular skill, and this is indeed the situation in "clutch situations" in sport. However, this approach would require very large sample sizes, which has significant logistical implications for an experiment using rugby goal-kicking. In the present experiment, the main criterion by which subjects were deemed suitable for participation was that they either had been, or were presently taking place-kicks for one of the University teams, which limits the number of suitable subjects. A second possible solution would have been to increase the number of competitions both before the first and after the last intervention. This would have been more appropriate for a single-subject design because it would have allowed a stable pre- and post-intervention level of performance to be established for all subjects. A potential problem with this approach, however, is that subjects might habituate to the pressure manipulation so that any choking effects quickly disappear.

4.8.3. The Pressure Manipulation

A third problem relates to the pressure manipulation, which did not clearly lead to poorer pre-intervention performance. There are a number of possible explanations for this. Firstly, baseline scores may not have given an accurate reflection of subjects' ability, perhaps due to poor motivation and/or lack of effort. This possibility has some support from the post-experimental questionnaire (Appendix 3) in which subject MA reported that, during the baseline sessions, concentration was sometimes good whilst at other times "it seemed we were just going through the motions". Alternatively, players could feel under pressure to perform well during baseline sessions. Again this has some support from the questionnaire responses, with subject LR reporting that he felt under pressure during the baseline sessions "because I wasn't kicking consistently in matches". In addition, the prize money was only mentioned by one of the subjects as being a source of pressure. The rivalry and competition amongst the four kickers was cited as being a source of pressure for three of the subjects, and the sole reported source of pressure for two of them.

A final problem with the pressure manipulation is that it did not take into account differences in kicking ability. Instead an attempt was made to match subjects for kicking ability. Nevertheless, the 13% difference between the mean point scores of subjects DB and MA prior to the first competition was the equivalent of a seven point advantage over ten kicks. This could have been reflected in different expectations of success for these subjects during the competition.

4.8.4. Verbalising of the Kick Thought

Although the subjects were instructed to verbalise their kick thought before every kick, responses on the questionnaire indicated that they did so on approximately 75% of kicks. Monitoring of the use of the kick thought was not possible because of the need to prevent subjects who were still in the pre-intervention stage of the experiment from finding out what the intervention entailed. The subjects were, therefore, instructed to use covert as opposed to overt verbalisation.

4.9. Conclusion

Overall, the support for the original hypothesis proved to be very weak when considering the data using the mean number of points scored on each kick. Several problems were encountered which clearly needed to be addressed in future experiments. These included the choice of task, the pressure manipulation, and the choice between using either a single-subject or group design.

<u>Experiment 4</u>- Testing the Prevention Hypothesis Using a Golf Putting Task

4.10. Introduction

The aim of Experiment 4 was to test the prevention hypothesis using a larger sample size under controlled conditions. In addition, a number of changes were made to take into account the problems encountered in Experiment 3. For example, it was decided to test the hypothesis using the skill of golf putting in order to ensure that there would be a suitably large pool of potential subjects. Using this skill had the additional advantage that it was possible to design a task that could be set up inside, under more controlled conditions. The rugby goal-kicking task, whilst having quite high ecological validity, was subject to variations in weather conditions, in particular in the strength of the wind which could affect task difficulty and other variations in climate that could affect the quality of the kicking surface (e.g. rain or freezing temperatures).

4.10.1. A New Pressure Manipulation

Another change that was implemented concerned the design of the pressure manipulation. Clearly, any experiment that is concerned with how different interventions affect performance in pressure situations initially needs to establish a valid pressure manipulation. In Experiment 1 performance contingent reward formed the basis for the manipulation. On its own, this did not appear to be sufficient to induce choking under pressure. In Experiment 3, as well as prize money, competition between co-actors was also used to induce pressure. There was some evidence that this had a deleterious effect on the performance of subjects prior to the intervention in that mean competition scores increased post-intervention in both the point score and percentage data. Nevertheless, a weakness of this design is that simply having a competition amongst individuals fails to take into account differences in their ability levels. Although an attempt was made to ensure that subjects in Experiment 3 were of a similar ability level, the range in handicaps and hence putting abilities that were expected in the present experiment meant that this would not be possible. Previously, others have used standard pressure manipulations for all subjects that do not make explicit reference to a level of performance to be achieved. For example, Masters (1992) used performance evaluation by a supposed professional golfer in combination with a financial contingency to manipulate pressure. However, subjects did not know how well or how poorly they had to perform to increase or decrease their payment.

A characteristic of most situations in which choking occurs is that the individual has performed at a level that puts him or her in a position to win or achieve some other subjectively important goal (e.g. making the halfway cut in a golf tournament or finishing high enough in the order of merit to play in the Ryder Cup). The implication is that the individual must at least maintain the same level of performance to achieve the desired outcome. The aim of the present pressure manipulation was to try to reflect this facet of performance pressure for each individual. To this end, an implicit competition, in which each subject competed against the scores of five other individuals, formed the basis of the pressure manipulation. The scores were said to have been achieved by other individuals "in the same handicap bracket" as the subject. In fact, unknown to the subject, a number of different score sheets had previously been formulated and the scores of the five "opponents" were yoked to each subject's baseline score achieved earlier in the experiment. This enabled the experimenter to ensure that the baseline score of each subject was below 3rd place but no worse than equal 4th place on the posted scores. A list of the different scores posted for each range of baseline scores is presented in Appendix 4. The pressure manipulation was completed by the performance contingent prize money, described in the methods section that follows.

Again, the hypothesis being tested was that preventing reinvestment of too many rules relating to the topography of the behaviour during a pressure manipulation would prevent choking. As in Experiment 3, it was predicted that using a verbal cue in the moments before movement initiation would be effective in this respect and would, therefore, prevent choking. In addition, in accordance with previous work on the use of visual cues (e.g. Singer and Suwanthada, 1986; Singer, Lidor and Cauraugh, 1994; Singer et al., 1991) it was hypothesised that attending to a visual stimulus during this time would also prevent choking. It was also predicted that the content of the verbal cue would not be a factor in determining its effectiveness in preventing reinvestment. Specifically, it was predicted that verbalising task-irrelevant words would also be effective in preventing reinvestment and hence choking.

4.11. Method

4.11.1. Subjects

Forty male golfers aged between 18 and 25 years (mean = 19.68, SD = 1.40) took part in the experiment. All subjects were students and had a mean handicap of 9.60 (SD = 5.40) and a mean of 7.63 years (SD = 3.30) golfing experience.

4.11.2. Apparatus/Task

A diagram of the apparatus used for the putting task is shown in Figure 4.4. It consisted of a 4m x 1.5m white cotton sheet taped to the floor to create a flat, slick surface on which to putt. The target consisted of five concentric circles, the smallest of which had a diameter of 0.2m. The four surrounding circles had diameters of 0.4m, 0.6m, 0.8m and 1.0m. This created six different scoring zones, from five points for a ball ending up in the central "red five" zone, to zero points for a ball which failed to finish inside the largest (1.0m diameter) circle. The aim of the task was to putt a standard size (1.68" diameter) golf ball from a distance of 3m so that it came to rest as near to the centre of the target as possible. To enable precise recording of the final position of each ball in the competition, a 2.3m x 1.2m numbered grid of 0.1m squares was drawn onto the sheet.

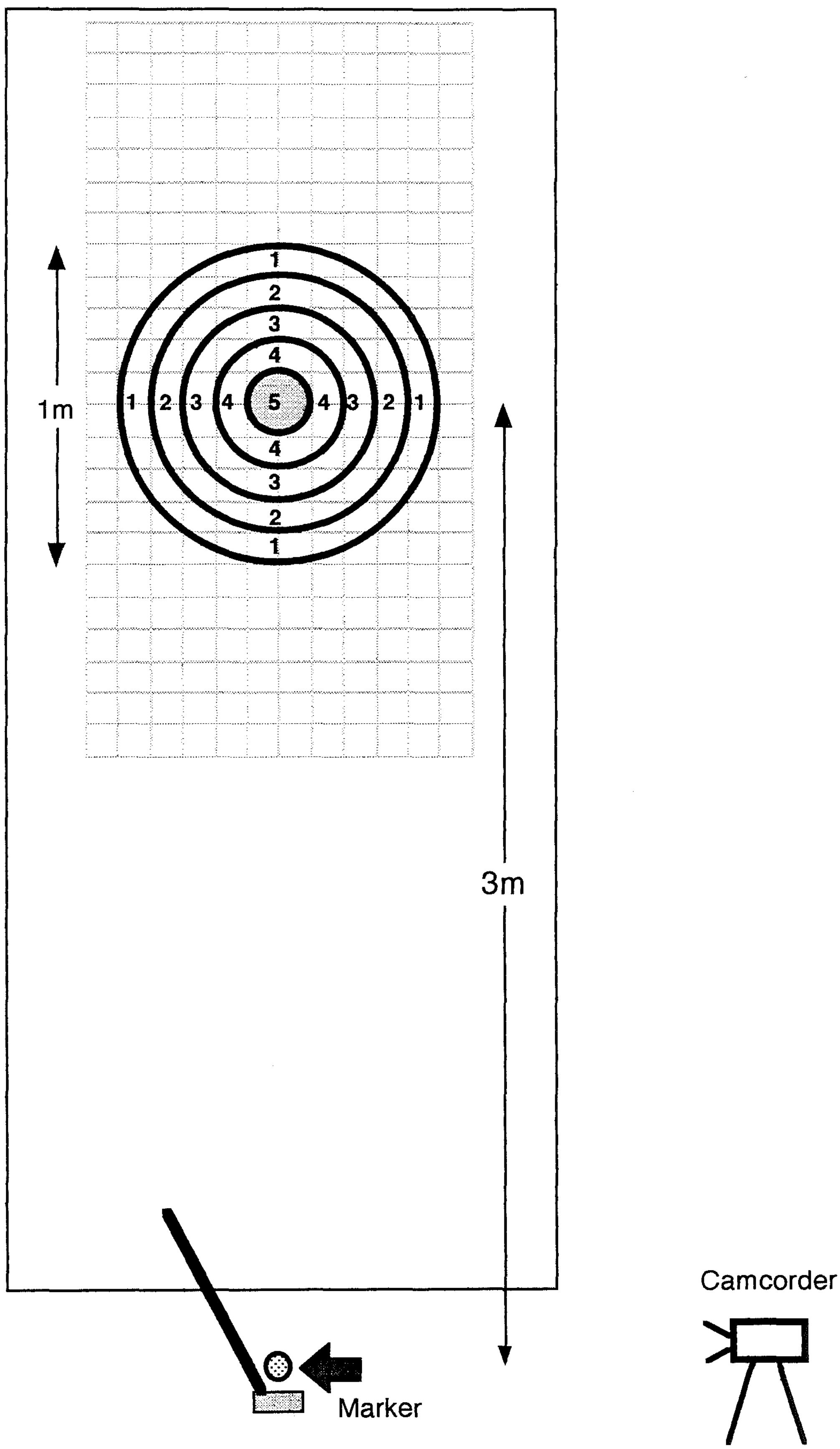

Figure 4.4. An illustration (approximately to scale) of the set-up and scoring system for the golf putting task used in Experiment 4.

With respect to the putter, each subject had the choice of either using their own or a "Ping Anser" putter provided by the experimenter. The putting action of each subject was recorded using a Canon E600 camcorder.

4.11.3. Design

The experiment consisted of four separate stages: a "warm-up" stage in which subjects familiarised themselves with the task; a stage to determine baseline performance; an intervention stage; and finally a competition stage, in which the pressure manipulation took place.

The main dependent variable used to assess performance was the number of points scored on each putt. By recording the grid reference of each putt five additional dependent variables were used to assess performance in the competition stage of the experiment. These were the radial error, horizontal error (signed and unsigned) and vertical error (signed and unsigned). The main independent variables were the group and the stage of the experiment.

4.11.4. Procedure

On entering the room the subject was shown the apparatus and the nature of the task was explained. Specifically the subject was told that the aim of the task was to putt the ball so that it came to rest as near to the centre of the "red five target zone" as possible. It was mentioned to the subject that this was slightly different from the majority of putts taken in golf, where the aim is to putt the ball with sufficient force to run past the hole, thereby having a chance of holing the putt. This point was emphasised by placing the ball in the "two zone" in front of, and then beyond, the "five zone" while pointing out that these putts would receive the same number of points. After describing the task subjects in the non-control groups were then read the following:

> "In the experiment today you will take approximately 80 putts in all. These will be split into four blocks of 20 and you will be able to rest for a few minutes between each block of 20 putts.
>
> For the first two blocks of 20 putts you will simply putt using your normal routine. In the third block you will practise putting using a concentration strategy. Finally, in the last block of 20 putts you will have the chance to putt for some money."

For subjects in the control group, the instructions were the same with the exception that "two blocks" was replaced with "three blocks", and the sentence beginning "In the third block..." was omitted.

4.11.4.1. Stage 1- Warm-up

After explaining the task, the experimenter turned on the video camera. The subject was then asked to take 20 putts to get used to the set-up and pace of the putt. After the 20th putt the subject was given the option of taking additional putts to become fully accustomed to the pace of the putt. If requested, the subject was allowed up to 20 additional putts in which to practice. (A graph showing the warm-up scores of each group over consecutive blocks of 5 putts is shown in Appendix 8. A Helmhert post-hoc analysis indicated that performance improved up to the third block, which was not significantly different from block 4.)

4.11.4.2. Stage 2- Baseline

After the warm-up stage of the experiment, the subject took 20 putts in order to allow a baseline score to be calculated. The following standardised set of instructions were read to each subject:

> "For the next 20 putts the aim is simply to try to score as many points as possible, using your normal putting routine. This is not a competition and there are no expectations about performance so simply try to score as many points as possible. While it is theoretically possible to score 100 points this is obviously extremely unlikely, so simply try to do the best you can. I will continue to return the ball to you each time and let you know every so often how many putts you have taken, and how many points you have scored."

The subject was told how many putts had been taken and how many points had been scored after putts five, ten, fifteen and twenty, in addition to any other times that the subject requested the information.

4.11.4.3. Stage 3- Intervention

Subjects were randomly assigned to one of four groups, with the proviso that they did not report using any particular concentration strategy for putting. It was considered important that subjects in the control group did not routinely use one of the concentration strategies associated with the different groups in the experiment. In the event, two golfers reported verbalising swing thoughts and one golfer reported focusing on the letters of the manufacturer's name printed on the ball. These subjects were therefore allocated to the verbal cue and visual cue groups respectively. Subjects who were not in the control group were then read the following passage:

> "As you are probably aware, golfers use a number of different techniques to help them concentrate when putting. In the next stage of the experiment, I want you to use one of these techniques to help you concentrate for the remainder of the experiment."

Verbal Cue Group

Subjects in the Verbal Cue group were asked to indicate an aspect of their technique that they considered to be important to their putting well. To facilitate the process, examples of swing thoughts that might be appropriate for the full swing were given, such as "head down" and "left arm straight". The experimenter then helped the subject to formulate an easily verbalised swing cue from the rule(s) of putting technique that was/were mentioned (e.g. "slow back, follow through"). Subjects were then instructed to say this verbal cue out loud before each putt for the remainder of the experiment. All of the verbal cues that were used are listed in Appendix 5.

Verbal Task-Irrelevant Cue Group

Subjects in the verbal task-irrelevant group (RGYB) were told that one of the techniques used by golfers involved verbalising task-irrelevant words before each putt. It was then explained to subjects that while a wide range of words could be used, the words "red, green, yellow, blue" were to be used for the purposes of the present experiment. Subjects were then instructed to say these words out loud just before initiating the putting action for the remainder of the experiment.

Visual Cue Group

Subjects in the Visual Cue group were firstly asked whether they usually looked at the ball or the ground just behind the ball when they putted. Subjects who indicated that they usually looked just behind the ball were asked to focus on the texture of the floor surface just before each putt for the remainder of the experiment. Subjects who reported that they usually looked at the ball were asked to focus on the actual dimple pattern on the surface of the golf ball just before each putt for the remainder of the experiment.

Control Group

Subjects in the Control group were told that they now had an opportunity to take twenty additional practice putts before the final stage of the experiment. The experimenter returned each ball to the subject and engaged in trivial golfing conversation during this time.

During the intervention stage, subjects in the three non-control groups were given a minimum of 20 putts in which to familiarise themselves with the intervention. At the end of 20 putts the subject was asked whether he would like any additional putts to become used to the "concentration strategy" and, if requested, was allowed up to 20 further putts. It was important that the intervention did not have a lasting detrimental effect on the performance of the subject because this might result in poorer performance during the competition stage of the experiment which was unrelated to the pressure manipulation. Therefore, if the experimenter judged that performance had not returned to a level equivalent to what was achieved during baseline, the subject was asked to take additional putts. With the variability in performance associated with any skill and the time constraints involved, there were no strict criteria for judging whether a subject required additional putts. If the experimenter was in any doubt, however, the subject was asked to take additional putts. A graph of the scores of the non-control groups in consecutive blocks of 5 putts in this stage of the experiment is shown in Appendix 9. In addition, the performance of the Verbal Cue group in all stages of the experiment is shown in Appendix 10.

When the subject declared himself happy with putting using the new concentration strategy and the experimenter was satisfied that performance had returned to the level achieved in baseline subjects moved on to the final stage of the experiment.

4.11.4.4. Stage 4- Pressure Manipulation

In the final stage of the experiment, subjects were given a chance to putt for extra money, in addition to the £3.50 which they received for taking part in the experiment. Two A-4 size sheets of paper were posted at the far end of the apparatus. On the first sheet were printed the fictitious scores of five other golfers. To increase authenticity, the scores for the first ten and second ten putts were also noted alongside the total score (for an example of a typical display, see Appendix 6). To the right of this sheet, a second sheet of paper was posted, indicating the additional amounts of money the subject could receive for beating these scores. Specifically, it was noted that the subject could win an additional £6, £4, £2, £1, and £0 for beating the 1st, 2nd, 3rd, 4th and 5th place scores respectively. The following standard protocol was then read to the subject:

"What I have here are the scores of five other people in your handicap bracket who have putted on this apparatus. The four brackets are zero to five, six to ten, eleven to fifteen and sixteen to twenty, so these are the scores of the golfers in the ___ handicap bracket.

Depending on how you do compared to these other people over the next 20 putts, you will receive extra money, in addition to the £3.50 which you will get for taking part in the experiment. Specifically, if you beat the first place score you will receive an additional £6, £4 for beating the second place score, £2 for beating third, £1 for beating fourth, and £0 for beating the fifth place score. So, for example, [repeating/scoring just one more point than] your score of ___ from the set of putts you took after the warm-up would mean that you would beat the fourth place score and you would receive an extra £1 pound. Scoring ___ points would mean that you would beat the first place score and would receive an extra £6.

The reason I am doing this is to see how you perform when putting under a bit of pressure. As you probably know from playing with friends on the course, some people tend to perform slightly better when putting for money, and some people do slightly worse. I'm just interested to see how you do."

If appropriate, the subject was then instructed to continue using the concentration technique which had been introduced during the previous session, and was finally advised that "every so often" he would be informed of how many putts he had taken together with what his score was. This information was then given after the 5th, 10th, 15th, 18th and 20th putts, and on any other occasions that the subject requested it. At the end of the competition session, the subject filled out a questionnaire (see Appendix 7), after which any questions were answered and payment of £3.50 was made, plus any money won during the competition.

4.12. Results

4.12.1. Points Scored

The total number of points scored by each subject was calculated for the baseline and competition stages of the experiment. The group means for these stages of the experiment, together with the least square means (baseline score as covariate) for the competition stage, are shown in Table 4.3. It can be seen from this table that the performance of the Verbal Cue and Visual Cue groups is similar in the baseline and competition stages whereas the performance of the Control group and, to a lesser extent, the verbal task-irrelevant (RGYB) group, appears to be worse in the competition stage.

The data were analysed by a one-factor analysis of covariance (ANCOVA), with competition score serving as the dependent variable, baseline score the covariate and group the independent variable. In testing for homogeneity of slopes, the interaction between baseline score and group was found to be non-significant and was, therefore, removed from the analysis. In the remaining table, significant main effects were found for both group ($F(3,35) = 4.47$, $p<.01$) and baseline ($F(1,35) = 42.27$, $p<.001$).

A Tukey HSD post-hoc test on the group factor indicated that both the Verbal Cue and Visual Cue groups scored significantly more points than the Control group in the competition stage. The scores of the RGYB group were not significantly different from any of the other three groups. The scores for each group in the baseline and competition stages of the experiment are illustrated in Figure 4.5.

4.12.2. Block Effect

To see whether there were any differences in the patterns of performance over the 20 putts, trial block scores for each subject were calculated for four consecutive blocks of five putts in the baseline and competition stages. The mean block scores for each group are presented in Table 4.4 where it can be seen that the overall means were greater in Blocks 3 and 4 than in the first two blocks. The data were analysed by a 4 x 4 x 2 (group x block x stage) ANOVA with repeated measures on the stage and block factors. The main effect for block was found to be significant ($F(3,108) = 3.63$, $p<.05$) but no other significant effects were found.

4.12.3. Error Scores

During the competition, the final position of each ball was recorded by the experimenter on a scaled down diagram of the scoring grid printed on graph paper. Specifically, the vertical and horizontal distance of each putt from the centre of the target was recorded to the nearest centimetre. From these coordinates five error variables were calculated. These were:

Radial Error- the distance from the centre of the target.

Table 4.3. Group means and standard deviations for point and radial error scores in the baseline and competition stages of Experiment 4. Baseline point scores were used as the covariate in calculation of least square means for both point and radial error data.

Group	*Total Score (pts)*					
	Baseline		*Competition*			
	Mean	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	66.00	8.18	57.30	11.13	58.27	6.26
Verbal Cue	65.40	5.60	66.20	8.09	67.66	6.28
RGYB	66.70	7.89	62.10	7.74	62.39	6.24
Visual Cue	69.80	5.67	68.80	9.24	66.07	6.38
All Groups	67.00	6.88	63.60	9.83		

Group	*Radial Error (cm)*			
	Competition			
	Mean	*S.D.*	*L.S. Mean*	*S.D.*
Control	27.37	6.66	26.89	3.50
Verbal Cue	22.37	3.94	21.61	3.51
RGYB	24.38	4.64	24.05	3.49
Visual Cue	20.81	4.42	22.36	3.58
All Groups	23.73	5.43		

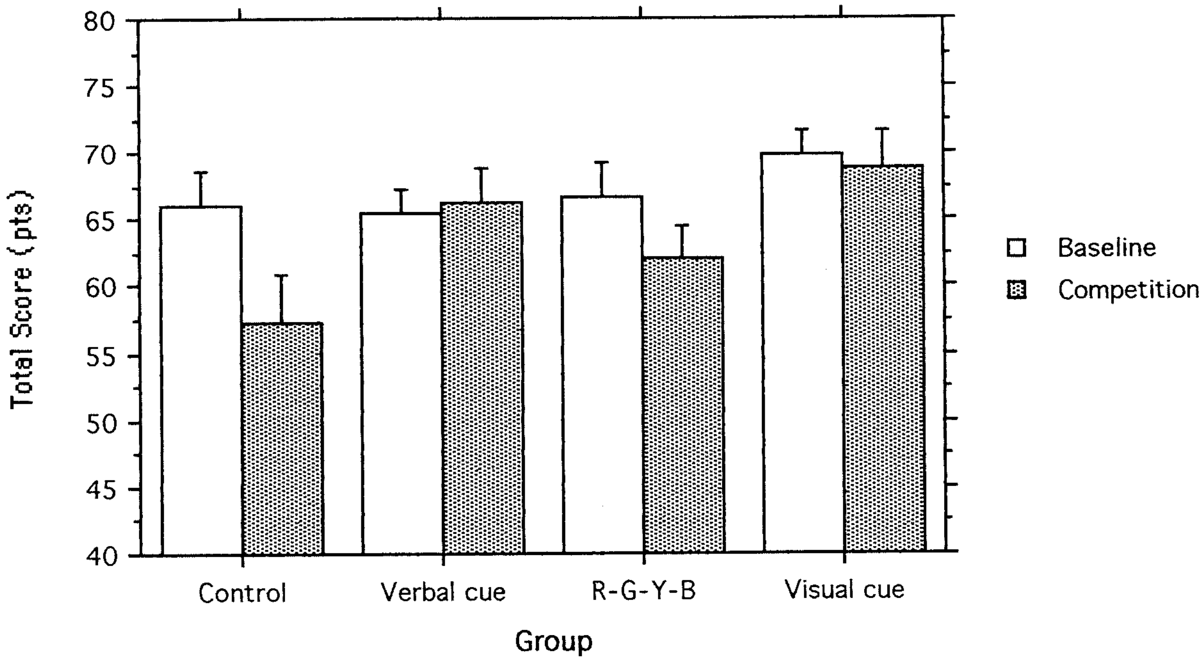

Figure 4.5. Mean total point scores (maximum = 100 pts) for each group in the baseline and competition stages of Experiment 4, with standard error error bars.

Table 4.4. Group means and standard deviations for point scores on consecutive blocks of five putts in the baseline and competition stages of Experiment 4 (maximum score in each block = 25 pts).

	Block 1 (Putts 1-5)				Block 2 (Putts 6-10)			
	Baseline		Competition		Baseline		Competition	
Group	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Control	16.80	3.08	14.00	3.53	14.70	3.92	13.10	4.61
Verbal Cue	16.40	2.32	15.60	2.72	16.10	2.38	18.70	3.23
RGYB	14.70	3.20	14.40	2.95	16.40	3.24	14.30	4.16
Visual Cue	16.90	3.51	16.00	3.62	17.30	2.58	16.90	4.15
All Groups	16.20	3.07	15.00	3.21	16.13	3.11	15.75	4.49

	Block 3 (Putts 11-15)				Block 4 (Putts 16-20)			
	Baseline		Competition		Baseline		Competition	
Group	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Control	17.60	3.66	15.50	3.92	16.90	2.38	14.70	3.06
Verbal Cue	15.60	2.72	16.50	3.06	17.30	3.47	15.40	3.44
RGYB	18.00	3.16	15.90	3.75	17.60	3.72	17.50	1.65
Visual Cue	17.30	3.16	17.60	3.06	18.30	2.41	18.30	2.58
All Groups	17.13	3.20	16.38	3.43	17.53	2.98	16.48	3.05

Vertical Unsigned Error- the unsigned y-axis component of the radial error.

Vertical Signed Error- the signed y-axis component of the radial error (i.e. negative scores for putts finishing short of the target).

Horizontal Unsigned Error- the unsigned x-axis component of the radial error.

Horizontal Signed Error- the signed x-axis component of the radial error (i.e. negative scores for putts finishing left of the target).

An illustration of how the outcome of each putt is broken down into its error components is shown in Figure 4.6.

4.12.3.1. Radial Error

The mean radial error scores for each group, a more precise indicator of the accuracy of each putt, are presented in Table 4.3. The data were analysed using a one-way ANCOVA, with baseline points score as covariate. In line with the points data, the analysis revealed a significant group main effect ($F(3,35) = 4.59$, $p<.01$), with a Tukey HSD post-hoc test revealing the same group differences that were found when analysing the points data.

4.12.3.2. Vertical and Horizontal Unsigned Error

The mean vertical and horizontal unsigned error scores for each group are presented in Table 4.5. The data were analysed using Wilks' Lambda multivariate analysis of covariance (MANCOVA), with baseline point score as the covariate. This analysis indicated no significant interaction between group and the covariate ($F(6,62) = 1.19$, n.s.) which was, therefore, removed from the analysis. The resulting MANCOVA table indicated a significant main effect for the covariate ($F(2,34) = 18.94$, $p<.001$) and a marginally significant effect for the group main effect ($F(6,68) = 2.18$, $p=.055$). Analysis of the univariate ANCOVAs indicated that the group main effect was significant for the vertical unsigned error, ($F(3,35) = 3.63$, $p<.05$), but not for horizontal unsigned error, ($F(3,35) = 0.74$, n.s.). A Tukey HSD post-hoc test for vertical unsigned error indicated that, as with the points scored, the Verbal Cue and Visual Cue groups had significantly less vertical error than the Control group. Similarly, reflecting the analysis of the points data, the vertical unsigned error of the RGYB group did not differ significantly from any of the other groups. These results

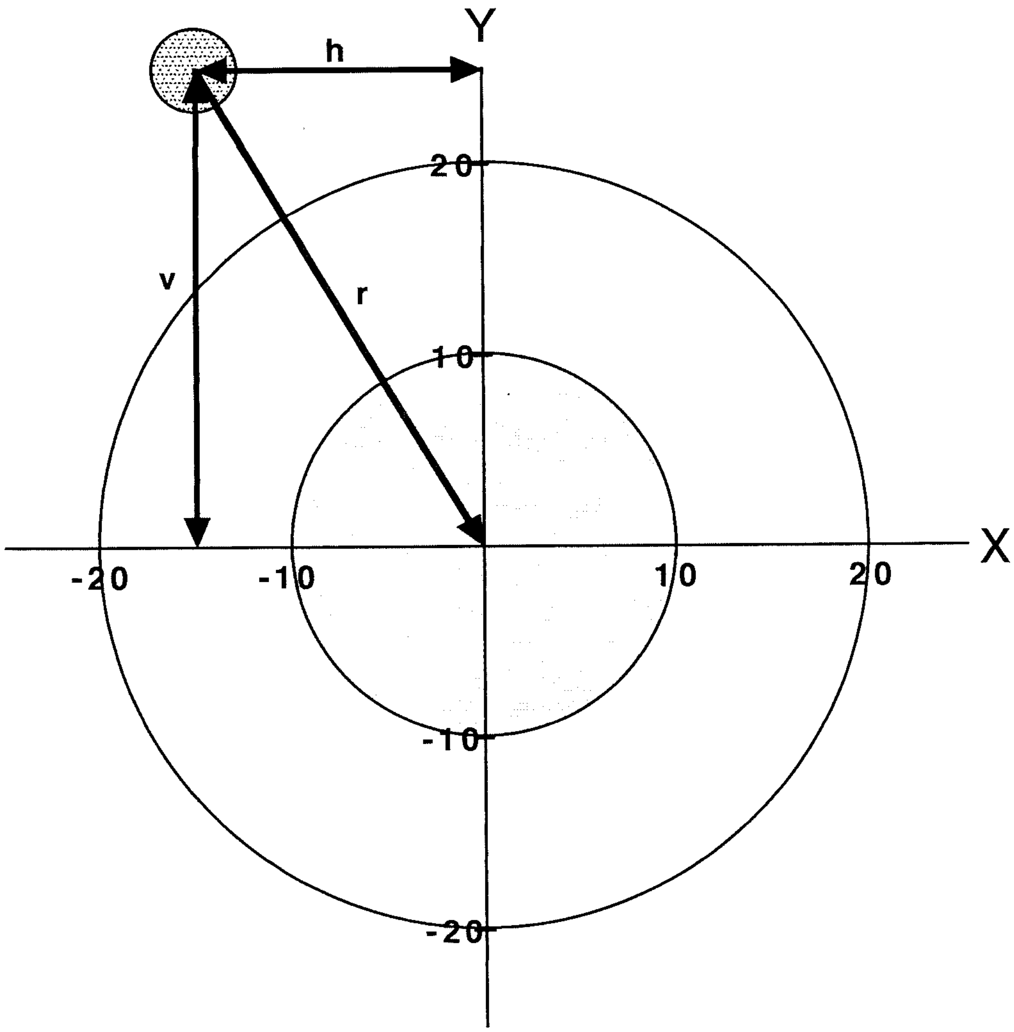

Figure 4.6. An illustration of the error scores used in the competition stage of Experiment 4. "Radial Error" is denoted by the letter 'r' and represents the total distance from the centre of the target (i.e. the origin) to the middle of the ball. "Horizontal Error" is denoted by the letter 'h', and represents the x-component of the radial error. "Vertical Error" is denoted by the letter 'v', and represents the y-component of the radial error. In the example shown, both vertical signed and unsigned error = 25. Horizontal signed error = –15, and unsigned error = 15. From these values, radial error can be calculated to be 29.15 (to 2 d.p.).

Table 4.5. Group means and standard deviations for vertical and horizontal error scores in the competition stage of Experiment 4. Negative scores on the signed error data indicate putts finishing short and/or left of the centre of the target.

Group	*Vert.Error (signed)*		*Horiz.Error (signed)*	
	Mean	*S.D.*	*Mean*	*S.D.*
Control	4.85	6.77	2.15	3.89
Verbal Cue	1.31	6.09	3.56	2.95
RGYB	0.65	9.11	3.37	2.76
Visual Cue	-0.43	4.40	2.54	2.27
All Groups	1.60	6.84	2.91	2.97

Group	*Vert.Error (unsigned)*		*Horiz.Error (unsigned)*	
	Mean	*S.D.*	*Mean*	*S.D.*
Control	25.07	6.88	7.80	1.31
Verbal Cue	20.23	4.07	7.08	0.95
RGYB	22.07	4.73	7.28	1.53
Visual Cue	18.47	4.77	6.94	1.18
All Groups	21.46	5.59	7.27	1.26

indicate that the differences in radial error found during the competition stage were the result of poorer distance rather than direction control.

4.12.3.3. Vertical and Horizontal Signed Error

The mean vertical and horizontal signed error scores for each group are presented in Table 4.5. The data were analysed by a one-way MANOVA. The results of this analysis indicated no group main effect (Wilks' Lambda = 0.87, $F(6,70) = 0.81$, n.s.).

4.12.4. Consistency of Performance

The consistency of performance for each group during the competition was assessed by calculating the standard deviation of each subject's radial error scores. This data set was analysed by means of a one-way ANCOVA, using the standard deviation of each subject's point scores in baseline as the covariate. The results of the analysis revealed no significant differences in consistency of performance between groups ($F(3,35) = 1.59$, n.s.). The consistency of baseline performance was a highly significant predictor of the consistency of performance during the competition ($F(1,35) = 17.40$, $p<.001$).

4.12.5. Routine Analysis

From the videotape recordings, the total routine time was calculated for each subject by recording the amount of time that was taken from the placement of the ball to the initiation of the putting stroke. In addition, the number of times each subject glanced at the target and the number of practice swings that were taken before each putt were recorded. This data is presented in Table 4.6.

4.12.5.1. Routine Times

To take account of possible changes in routine times following the interventions, competition routine times were compared with routine times during the intervention stage for non-control groups and with baseline routine times for the Control group. The mean times in the two stages of the experiment are shown in Table 4.6 where it can be seen that the mean routine times were longer for all four groups in the competition stage of the experiment.

The routine time data were analysed by a 4 x 2 (group x stage) ANOVA, with repeated measures on the stage factor. This revealed a significant main effect for stage

Table 4.6. Group means and standard deviations for routine times, routine time variable error and routine behaviours (glances towards the target and practice swings) in the competition and "comparison" stages of Experiment 4. Baseline times were used for comparison in the control group and intervention times were used for comparison in the non-control groups. Also shown are each group's mean ratings for the consistency of their pre-shot routine in the baseline and competition stages of the experiment.

	Routine Time				***Routine Time Variable Error***			
	Comparison		*Competition*		*Comparison*		*Competition*	
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
Control	5.56	1.84	7.06	1.88	0.75	0.81	1.08	0.42
Verbal Cue	5.13	2.07	6.77	2.77	0.89	0.56	1.06	0.49
RGYB	5.51	1.08	7.14	1.55	0.57	0.20	0.55	0.26
Visual Cue	6.46	1.86	8.45	1.44	0.90	0.43	1.07	0.37
All Groups	5.67	1.74	7.36	1.78	0.78	0.59	0.94	0.36

	Glances				***Practice Swings***			
	Comparison		*Competition*		*Comparison*		*Competition*	
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
Control	1.58	0.64	1.98	0.85	0.31	0.46	0.48	0.61
Verbal Cue	1.16	0.53	2.13	1.92	0.07	0.09	0.22	0.41
RGYB	1.39	0.56	1.65	0.76	0.05	0.05	0.13	0.15
Visual Cue	1.45	0.74	1.91	0.85	0.15	0.26	0.34	0.67
All Groups	1.40	0.61	1.92	1.27	0.15	0.30	0.29	0.44

	Consistency Ratings			
	Baseline		*Competition*	
Group	*Mean*	*S.D.*	*Mean*	*S.D.*
Control	4.40	0.84	4.30	1.16
Verbal Cue	4.60	1.58	5.00	1.41
RGYB	4.50	1.27	4.70	1.64
Visual Cue	4.10	1.52	5.00	1.33
All Groups	4.40	1.30	4.75	1.37

($F(1,36) = 73.75$, $p<.001$). Neither the group main effect ($F(3,36) = 1.33$, n.s.) nor the group by stage interaction ($F(3,36) = 0.37$, n.s.) were significant, indicating that similar increases occurred across all four groups.

To examine the consistency of routine times the standard deviation of each subject's routine times across the 20 putts was calculated in the competition and appropriate comparison stage of the experiment. The means for each group are shown in Table 4.6 where it can be seen that the mean variability in the RGYB group was less than in the other three groups. Analysis of the data, using a 4 x 2 (group x stage) ANOVA revealed a significant main effect for group ($F(3,36) = 2.96$, $p<.05$), however, a Tukey HSD post-hoc test failed to reveal any significant group differences. The main effect for stage ($F(1,36) = 2.88$, n.s.) and the interaction between stage and group ($F(3,36) = 0.56$, n.s.) were both non-significant.

4.12.5.2. Routine Behaviour

The mean number of practice swings and glances towards the target for each group in the baseline and competition stages of the experiment are shown in Table 4.6. The data were analysed by a 4 x 2 x 2 (group x behaviour x stage) MANOVA, with repeated measures on the stage factor. The only significant difference revealed was a significant main effect for stage (Wilks' Lambda = 0.90, $F(2,71) = 3.83$, $p<.05$). Separate ANOVAs for the two behaviours indicated that the significant stage effect was only present for the glances towards the target ($F(1,72) = 6.02$, $p<.05$) which were more frequent in the competition stage of the experiment.

4.12.6. Post-Experimental Questionnaire

4.12.6.1. Pressure Ratings in Baseline and Competition Stages

Subjects were asked whether they felt under pressure to do well in the baseline and competition stages of the experiment. Using a simple "yes" or "no" forced choice response 12 out of 40 subjects reported feeling under pressure in the baseline condition, while 37 out of 40 subjects did so in the competition condition. Using the sign test for related samples it was found that this difference was highly significant ($p<.0001$).

4.12.6.2. Routine Consistency Ratings

Subjects were asked to rate the consistency of their pre-shot routines during the baseline and competition stages, using a 7-point Likert-type scale, from 1 (not at all consistent) to 7 (highly consistent). The means of these ratings are presented in Table 4.6 where it can be seen that the mean consistency ratings were higher for the competition stage of the experiment for every group except the Control group. Analysis of the ratings by a 4 x 2 (group x stage) ANOVA, with repeated measures on the stage factor, indicated that the main effects for both group ($F(3,36) = 0.23$, n.s.) and stage ($F(1,36) = 3.16$, n.s.) were non-significant, as was the interaction between these factors ($F(3,36) = 1.14$, n.s.).

4.12.6.3. Correlations of Background Information with Performance Measures

The post-experimental questionnaire obtained information concerning subjects' age, golf handicap and number of years of golf experience. It also asked subjects to write down as many "rules" of good putting technique as they could. The group means for each of these variables are shown in Table 4.5. Analysis of the data using a 4 x 4 (variable x group) MANOVA revealed no significant differences between groups on these measures (Wilks' Lambda = 0.71, $F(12,82.31) = 0.95$, n.s.).

In order to see whether any of these variables were predictive of the tendency to choke in the competition Pearson product-moment correlation coefficients were calculated between age, handicap, years of experience, number of known rules and the difference between baseline and competition scores. The r-values for these correlations are displayed in Table 4.7, and indicate no significant predictors of the difference variable.

Table 4.7 also shows correlations involving the five dependent variables measuring performance in the competition stage. Of these variables, radial error was, not surprisingly, predicted by handicap, which in turn was a strong predictor of vertical, but not horizontal, unsigned error. There were two slightly odd results relating to horizontal signed error. Firstly, the number of rules of good putting technique reported by subjects was negatively correlated with horizontal signed error, indicating that subjects who reported more rules had a tendency to putt the ball further to the left of the target. Secondly, the difference between baseline and competition scores was found to be positively correlated with horizontal signed error, indicating that subjects who did better in the competition compared to baseline had a tendency to push the ball to the right of the target.

4.13. Discussion

The main purpose of the present experiment was to test the hypothesis that using verbal cues would prevent poor performance of a well-learned skill in a pressure

Table 4.7. Correlation matrix for background information, point scores in the baseline and competition stages (and the difference between these scores) and error scores in the competition. (Note that n=38 for values involving age due to two missing values, otherwise n=40). Two-tailed critical r-values for n=40 are r=0.312, p<.05 and r=.403, p<.01. Correlations significant at the .05 level are typed in bold print.

	Age	*H'cap*	*Exp*	*Rules*	*Base*	*Comp*	*Diff*	*Radial*	*V(sign)*	*H(sign)*	*V(unsign)*
Age	1.00										
Handicap	-0.07	1.00									
Experience	**0.40**	-0.29	1.00								
Rules	-0.10	-0.18	0.00	1.00							
Baseline	0.02	**-0.60**	0.15	-0.08	1.00						
Competition	0.07	**-0.51**	-0.05	-0.20	**0.71**	1.00					
Difference	0.08	-0.13	-0.22	-0.21	-0.01	**0.71**	1.00				
Radial Error	-0.05	**0.46**	0.06	0.25	**-0.70**	**-0.98**	**-0.70**	1.00			
Vert(signed)	-0.14	-0.05	0.20	-0.20	-0.06	-0.11	-0.09	0.05	1.00		
Horiz(signed)	0.11	0.21	-0.17	**-0.44**	-0.07	0.24	**0.41**	-0.23	0.05	1.00	
Vert(unsigned)	-0.05	**0.45**	0.10	0.23	**-0.68**	**-0.97**	**-0.70**	**0.99**	0.06	-0.21	1.00
Horiz(unsigned)	-0.06	**0.32**	-0.16	0.01	-0.27	**-0.34**	-0.22	**0.33**	0.06	0.00	0.19

situation. Both the points data and the more sensitive radial error data supported the hypothesis. Thus, mean competition scores for the Verbal Cue group were significantly higher than for the Control group.

In terms of the function of the verbal cue, it was predicted that verbalising task-irrelevant words as well as using a visual cue would prove equally effective in preventing reinvestment of technical rules, and hence choking under pressure. This hypothesis was only partially supported, with the Visual Cue group also showing no sign of choking, but the RGYB group scoring no differently from the other three groups in the competition stage.

4.13.1. Performance of the RGYB Group

Looking at the difference in scores between the baseline and competition stages for the ten subjects in the RGYB group, the group seemed to be divided, with four of the subjects performing at a similar level to baseline and the remaining six subjects scoring at least six points fewer in the competition than baseline stage of the experiment. Although complicated by the variability of performance in both stages, one possibility is that the subjects who performed poorly had a significant pause between verbalising of the words and initiation of the putting stroke, thus leaving a period in which reinvestment could occur. To examine this possibility, the time from the end of the verbalisation to the initiation of the putting stroke was determined for these two sub-groups. It was found that the mean delay for the good (0.22sec) and poor (0.20secs) performers was almost identical, suggesting that this was not a likely explanation for the poorer performances in this group.

Another possible explanation for the performance of the RGYB group is that the task-relevance of the Verbal Cue and Visual Cue group tasks helped subjects establish a consistent pre-performance routine of actions whereas verbalising task-irrelevant words did not. Several authors have argued that establishing a consistent pre-shot routine in self-paced skills such as golf can help facilitate performance (e.g. Boutcher, 1990). The analysis of routine time variable error scores and self-report ratings of routine consistency in both baseline and competition stages provided no evidence of any group differences in the consistency of routines. In fact, the RGYB group had the least variable routine times in both baseline and competition, suggesting that this was an unlikely cause of the performance.

One further point, which became apparent from examination of the videotape of the RGYB subjects, was the degree of variability in the precise moment the words were verbalised, both within and across subjects. Of the ten subjects in the group, four initiated their putting stroke before they had finished saying all four words, although only consistently so in the case of one individual, who did this on 19 out of 20 putts. A second subject verbalised during his swing on 13 out of 20 putts, mainly during the first half of the competition. Despite the fact that both subjects performed poorly in the competition, it is not clear whether verbalising during the task was responsible. This is because, firstly, the same subjects performed well during the intervention, when also verbalising during the putt, and secondly, previous applied research has found that simultaneous verbalisation can facilitate performance, for example by saying "back-hit" during a putting stroke (Gallwey, 1979; Fairweather and Sidaway, 1994).

4.13.2. Vertical and Horizontal Unsigned Error

The error data revealed that the differences in performance in the competition stage of the experiment were only present on the vertical component. This was possibly due to the nature of the task which involved what is, in golfing terms, a short putt, thus decreasing the magnitude of horizontal error scores. Also, the cotton surface meant that the putt was highly sensitive to any variations in the amount of force used to strike the ball. In short, achieving accuracy was more difficult for the length of the putt than for the direction. A different task, in particular one involving a longer putt or sloped surface, may well have led to different results. For example, Backman and Molander (1991) used an 8.90m putting track of the type used in miniature golf, and found significant horizontal error differences following various experimental manipulations. It would, therefore, be inappropriate to make any generalisations concerning which part of the putting skill breaks down under pressure.

4.13.3. Ecological Validity of Task

An alternative to using the accuracy task would have been to have subjects putt towards an actual hole, with the dependent variable being the number of putts holed. This type of task has previously been employed by other researchers (e.g. Masters, 1992; MacMahon, Masters and Chamberlain, 1997; Crews and Landers, 1993), and clearly has a higher degree of ecological validity. One of the disadvantages of this type of task, however, is that the dependent variable does not discriminate between different types of missed putt. Therefore, a ball which "yips out" is scored the same as one that misses by a considerable distance. It was felt that, in using this type of task, there would be a danger that the dependent variable would not be sensitive enough to reveal slight disruptions in performance. Previously, researchers have used large numbers of putts in each session to get round this problem (Masters, 1992; MacMahon et al., 1997) but the design of this study meant that this was not a realistic option. For example, using the number of putts holed out of 100 as the dependent variable (as was used in the Masters (1992) and MacMahon et al. (1997) studies) would have meant that at least 240 putts would have been required creating potential problems associated with fatigue or boredom. In addition, it would not have been possible to objectively assess how the intervention affected performance making the judgement of whether or not each subject's putting had returned to baseline levels a harder one. A final problem relates to the pressure manipulation in which it could be argued that having subjects putt 100 times effectively dilutes the importance of each individual putt.

4.13.1. Pressure Manipulation

One problem with attempting to create a pressure situation is that it cannot recreate all the elements present in "the real thing". Other researchers have attempted to establish that stress increased by means of self-report measures of, for example, state anxiety or by using physiological indicators such as heart rate (e.g. Masters, 1992). In the present experiment, it was felt that the validity of the pressure manipulation should primarily be determined by whether or not differences were evident, either between the performance of the Control group under baseline and pressure conditions or between the experimental and Control groups in the competition stage. As a simple additional measure, subjects were also asked whether or not they felt under pressure to perform well in the competition and baseline stages of the experiment, with significantly more reporting that they did so in the competition (37) than in the baseline stage (12).

As well as the self-report data, analysis of pre-shot routine times indicated that there was an equivalent increase in times across the four groups in the competition condition. Previously, response time has been used to index "effort" in cognitive tasks such as anagram solving (Foley, Foley, Wilder and Rusch, 1989). An effective pressure manipulation would be expected to lead to increased effort in participants and should, therefore, also lead to increased pre-performance routine times. Previously, this has been found to be the case in golf putting, with Masters (1992) finding an increase in total time taken by subjects in the stressful condition. The increase in routine times during the present pressure manipulation provides further support for its validity.

4.14. Conclusion

The present experiment provided support for the hypothesis that using task-relevant verbal cues just before initiating a putting stroke can prevent choking in self-paced skills. Concerning the reinvestment theory of choking, support for the prevention hypothesis was equivocal. The theory proposed that engaging in any non-disruptive activity that prevented reinvestment in the moments before initiation of the swing would prevent choking. Although the performance of the Verbal Cue and Visual Cue groups was consistent with this view a group verbalising task-irrelevant words, though not performing significantly worse than the Verbal Cue and Visual Cue groups, also failed to perform significantly better than the Control group.

Chapter 5- An Examination of the Underlying Assumptions of the Reinvestment Theory of Choking.

Experiment 5- The Effect of Attending to Technical Instructions Relating to the Set-up and Putting Stroke

5.1. Introduction

In Experiment 4, it was found that verbalising task-relevant cues prevented choking under pressure in a golf putting task. The finding that attending to a visual stimulus also prevented choking was consistent with the theory that, under pressure, an important function of stimulus cueing is to prevent subjects from reinvesting rules about correct technique prior to initiation of the action (Singer et al., 1993). There are two assumptions implicit in this theory with respect to golf putting. The first is that the process of reinvesting rules about correct technique *before* initiation of the swing, leads to disruption *during* the swing. The second assumption is that, in a pressure situation, the player will reinvest technical rules about the putting stroke itself and not other features of putting, such as rules about the correct set-up. Thus far, it has not been demonstrated that, for a self-paced skill, thinking about rules concerning the topography of the required movement in the moments before movement initiation leads to poorer performance. Most research into the effect of trying to consciously control motor behaviour has involved subjects consciously attending to the individual components of a task during performance (e.g. Carver and Scheier, 1978; Baumeister, 1984).

Regarding the second assumption, the main evidence for verbal activity in the few seconds before performance being disruptive comes from psychophysiological studies of electrocortical activity in the few seconds before skill execution (e.g. Crews and Landers, 1993; Boutcher and Zinsser, 1990; Hatfield et al., 1984). One obvious limitation of these studies is that they cannot establish the precise content of any conscious activity. It is quite possible, therefore, that golfers under pressure think, not about technical aspects of the swing but about rules concerning the correct set-up position, and that it is reinvesting these rules which leads to the disruption of performance. Support for this possibility comes from consideration of the skills that have been assessed in EEG studies, such as archery and rifle shooting, which require very little technical knowledge relating to the execution phase of performance- i.e. how to release the bow or pull the trigger. The majority of technical rules in these sports relate to the "set-up" position which the individual should aim to adopt to maximise his or her chance of success.

While golf is a skill in which an abundance of technical instructions exist concerning how to actually swing the club, adopting the correct set-up position or "address" is considered by many teaching professionals to be at least as important as the swing itself in determining the outcome of a shot. For example, the late Harvey Penick, regarded as one of the best teachers in the game stated:

> "Mistakes in grip and ball position are mistakes made before the swing that may ruin any grand plans you have for the shot."
>
> (Penick, 1992, p. 83)

Although no previous research has looked at the effect of separately attending to rules concerning either the set-up or putting stroke, Backman and Molander (1991) conducted an experiment which looked at the effect of attending to nine instructions, relating to both the set-up and swing aspects of golf putting. The subjects in the experiment were twelve highly skilled, male miniature golf players from Sweden. (In Sweden, miniature golf is highly competitive with regular, national level competitions and refers to the nature of the task, not the stature of the competitors!). The experimental task consisted of putting a standard golf ball along an 8.90m by 0.90m flat putting "fairway", aiming for the middle of a wooden bar from a distance of 8.15m. Each subject took 25 putts under four experimental conditions.

In the normal (N) condition the subject received no technical instructions and was instructed to "strike the ball as felt natural to him". In the self-generated (SG) condition the experimenter read aloud any points (technical or non-technical) that the subject had reported normally thinking about "during preparation and play". These points were repeated during preparation after every fifth putt. In the cognitive-motoric (CM) condition, the subject was instructed to "think of and carry out" nine technical points concerning the golf putt. These were as follows: to stand with the feet in parallel; not to stand too far or too close from the tee; to stand in balance and with slightly bent knees; to have a steady hand grip; to concentrate on fixating the ball; to hit the ball with the centre of the club head; not to have a too short or long backswing and follow-through; not to turn the head or the body before the execution of the shot; and not to strike the ball too easy or too hard. In the cognitive (C) condition the subject was told to attend to the same points as in the CM condition, but there were no requirements to "carry out" the instructions.

The results of Backman and Molander's (1991) experiment indicated that performance, defined by mean distance from the centre of the target, was worse under the CM- and C-conditions than under the N- and SG-conditions. This supports the view that verbalising technical rules prior to the golf putt disrupts performance, but does not allow for assessment of whether the poor performance was the result of the set-up instructions or those relating to the putting stroke. Thus, of the nine instructions, the first three clearly refer to aspects of the set-up, the next two are relevant to both the set-up and swing, and the final four relate to the putting action.

An additional problem with interpreting the results of Backman and Molander's (1991) experiment is that some of the instructions used are not universal rules for good putting. For example, the instruction to "stand with the feet in parallel" (to the target line) seems to be eminently sensible, however, many players prefer to stand with an "open" stance (i.e. with an imaginary line between the feet pointing to the left of the target for a right handed golfer), whilst others prefer to adopt a "closed" stance. For this reason, as Backman and Molander noted, disruption to performance could simply be due to the fact that the instructions interfered with the players' normal motor behaviour. To try to overcome this problem, Backman and Molander included a "cognitive" condition, in which subjects did not have to carry out the instructions in question. A problem with this is that it is difficult to imagine that subjects would find it easy to distinguish between attending to and carrying out these instructions. At the very least the distinction is subtle, and it could be argued that there is none if one accepts that "an organism is said to attend to a stimulus or stimulus property when variation of that stimulus or stimulus property changes behaviour" (Catania, 1992).

An alternative approach to using "cognitive motoric" and "cognitive" conditions is to use instructions that are key elements of *any* putting stroke. This eliminates the problem of interference with the normal motor behaviour of the individual because the behaviour specified by the instructions would already be part of each individual's putting repertoire. Any disruption to performance which subsequently occurs could then be more reliably attributed to the process of consciously attending to the behaviours specified by the instructions. Essentially, the aim is to distinguish between disruption of a motor skill which occurs because of being instructed to do something differently (i.e. changing technique) and disruption which occurs through consciously trying to ensure that behaviours that are already performed correctly, continue to be so. The results of Backman and Molander (1991), although interpreted in terms of "cognitive interference", could still be explained by disruption occurring because of interference with the subjects' normal putting technique.

The main aim of the present experiment is to assess the effect of separately attending to instructions concerning the set-up and swing components of golf putting. In accordance with the reinvestment theory of choking, it is hypothesised that attending to several instructions regarding the swing, in the few seconds before performance, will have a disruptive effect. In addition, performance of self-paced skills usually involves adopting the correct set-up position and it is hypothesised that attending to several instructions concerning this aspect of putting will also be disruptive to performance. This prediction is in line with the behavioural interpretation of reinvestment theory, which does not make a distinction between the content of instructions at the topographical level.

5.2. Method

5.2.1. Subjects

Twenty male golfers, aged between 18 and 24 years (mean = 20.25 years, SD = 1.86) took part in the experiment. The golf handicaps of subjects ranged from 1 to 19 (mean = 7.5, SD = 5.54), and they had a mean of 8.65 years (SD = 4.30) golf playing experience.

5.2.2. Task / Apparatus

The apparatus for the present experiment was identical to that used in Experiment 4, a diagram of which is shown in Figure 4.4 of the previous chapter. Thus, the dimensions of the different scoring zones remained the same and the task involved putting golf balls from a distance of 3.0 metres so that they came to rest as close to the centre of the target as possible. Again, subjects were filmed using a Canon E-600 camcorder.

5.2.3. Design

The experiment used a repeated measures design with all subjects putting under five different conditions. These consisted of a control condition (no instructions), two conditions involving set-up instructions, and two conditions involving instructions about the putting stroke, or swing. In the baseline condition subjects simply putted using their normal technique. In the two "set-up" conditions, subjects verbalised shortened versions of four instructions concerning the correct set-up position to adopt. In the two "swing" conditions, subjects verbalised shortened versions of four instructions relating to correct putting technique. The dependent variable used to assess performance was the number of points scored on each putt.

To control for possible position and order effects, incomplete counter-balancing was used so that, over the 20 subjects, every condition appeared four times in each of the five possible positions and was followed by each of the other four conditions four times.

5.2.3.1. Selection of Instructions

The instructions were selected from several golf instruction books and magazine articles. In addition, a PGA-qualified golf teaching professional was consulted. His experience of teaching many different people at all levels, including beginners and tour professionals, was considered necessary to ensure that only instructions that were important rules for all good putting styles were selected. To this end, it was decided that the following set of instructions were common to all good putting styles:

Set-up
Place the putter face square to the target line
Position your eyes directly over the ball
Position your shoulders parallel to the target line
Line up the ball with the centre/sweet spot of the putter

Putting Stroke
Keep your head absolutely still throughout the stroke
Ensure the swing pivots from the centre of your shoulders
Keep the back of the left wrist fixed throughout the swing
Ensure the putter blade is square at the point of impact

*5.2.4. **Procedure***

On entering the room the subject was asked to fill out the front page of a questionnaire designed specifically for the present experiment. This contained questions about general background information (i.e., age, handicap, years golfing experience) and also asked the subject to write down as many rules of good putting technique as they could, both in relation to the set-up and the putting stroke (the full questionnaire is shown in Appendix 11). After completing these questions, the subject was then shown the putting apparatus and the task was explained. Specifically, the following passage was read to the subject:

"In the experiment today you will take approximately 120 putts in all- these will be split into 6 blocks of 20 and you will be able to rest for a minute or so between each block of 20 putts.

The experiment itself is straightforward- for 2 of the 6 blocks you will simply putt using your normal routine. For the other 4 blocks of 20 putts you will verbalise some instructions before each putt. I will tell you more about these at the appropriate stage of the experiment."

5.2.4.1. Warm-up

Before putting under the five experimental conditions, each subject was given 20 warm-up putts in which to practice and become accustomed to the pace of the putt. Specifically, the following instructions were given:

"For the first block of 20 putts, simply practice so that you become completely comfortable with the pace of the putt. As you will discover, the sheet creates quite a slick surface.

As opposed to a normal putt, in which you generally want to run the ball past the hole, there is no difference in this experiment between a putt which finishes short and a putt which finishes past the target. The putt is therefore a 'lag putt' in which the aim is to have the ball come to rest as near as possible to the centre of the 'red 5' target circle.

Go ahead now and take 20 putts. I will return the ball to you each time and will let you know every so often how many putts you have had."

The subject then took 20 putts, after which he was asked if he was completely comfortable with the pace of the putt, or whether he would like some additional putts. If further putts were requested then the subject was allowed up to 20 additional putts to become fully accustomed to the task. If no additional putts were required, the subject moved on to the next stage of the experiment.

In the four subsequent conditions requiring instructions, two A4 size sheets of paper were placed on the floor "above" the ball. Written on the sheet closest to the ball were the exact words that the subject had to verbalise in that stage of the experiment. Above this, a second sheet displayed each of the full instructions.

5.2.4.2. Baseline

In the baseline condition, subjects putted using their normal putting style and were not required to engage in any task prior to initiation of the putting action. The following instructions were read to each subject:

> "For the next 20 putts the aim is simply to try to score as many points as possible, using your normal putting routine. This is not a competition and there are no expectations about performance so simply try to score as many points as you can. Every so often I will let you know how many putts you have had and how many points you have scored."

5.2.4.3. Set-up 8

In the Set-up 8 condition, the subject was asked to concentrate on the four set-up instructions specified above. The verbal stimulus that the subject was required to say before each putt was eight syllables long, hence the name of the condition. Each subject was read the following instructions:

> "Before the next 20 putts I would like you to read 4 instructions concerning the set-up for a putting stroke. These are taken from several golf instruction books and are selected because the consensus of opinion suggests that each instruction is a key component of a good set-up. They have also been verified by a PGA qualified teaching professional as being key components in a sound set-up. You may well have written down similar instructions to these in the questionnaire at the start of the experiment."

The subject was then asked whether he understood all the instructions and clarification was given for any that the subject was unclear about. The experimenter then continued:

> "Over the next 20 putts I would like you to really concentrate on the instructions, attempting to ensure that the actions specified by each one are being performed correctly. To help you do this, and to ensure that you attend to all 4 of the instructions, I would like you to say out loud shortened versions of these instructions just before each of the 20 putts in this block.
>
> The shortened versions of the instructions are as follows:
>
> "BLADE SQUARE"

"EYES BALL"
"IN LINE"
"CENTRE"

Say each of these as you attend to them during your set-up. Once you have done this go ahead and putt the ball in your normal way. Continue to try to score as many points as possible. As in the previous block every so often I will let you know how many putts you have taken and how many points you have scored."

5.2.4.4. Set-up 16

In the Set-up 16 condition, the instructions were the same as for the Set-up 8 condition, except for the stimulus to be verbalised which was sixteen syllables long. The precise words were as follows:

"PUTTER FACE SQUARE"
"EYES OVER BALL"
"SHOULDERS IN LINE"
"BALL AT CENTRE"

5.2.4.5. Swing 8

In the Swing 8 condition, the subject was asked to concentrate on the four instructions relating to the putting stroke. The instructions that were read to the subject were similar to the Set-up 8 condition, except that no explicit instruction was given about ensuring that the actions specified by each instruction were being performed correctly. Instead, the specific instruction was as follows:

"Over the next 20 putts I would like you to really concentrate on the instructions in the few seconds before putting. To help you do this, and to ensure that you attend to all 4 of the instructions, I would like you to say out loud shortened versions of these instructions just before each of the 20 putts in this block".

The words that made up the verbal stimulus were:

"HEAD STILL"
"PIVOT"
"WRIST FIXED"
"SQUARE STRIKE"

Reference to saying the instructions "as you attend to them during your set-up" was also omitted.

5.2.4.6. Swing 16

In the Swing 16 condition, the instructions were the same as for the Swing 8 condition, except for the words that made up the verbal stimulus, which were as follows:

"KEEP MY HEAD STILL"
"CENTRAL PIVOT"
"KEEP LEFT WRIST FIXED"
"SQUARE AT IMPACT"

The subject was allowed to take a break of approximately one minute between each of the five conditions. After putting under all five instructional conditions, the subject then completed the remainder of the questionnaire. When this had been done the subject received payment of £3.50 for taking part in the experiment and any questions concerning the nature of the experiment were answered.

5.3. Results

5.3.1. Point Scores in each Condition

The mean number of points scored in each condition are shown in Table 5.1. It can be seen that the mean scores in the Set-up 8 and Set-up 16 conditions were approximately the same as the mean scores in the baseline condition. The mean scores in the Swing 8 and Swing 16 conditions were similar to each other but were less than the mean scores in the other three conditions. The scores in each of the five conditions are illustrated in Figure 5.1.

The data were analysed by a one-way, repeated measures ANOVA which revealed a significant main effect for condition ($F(4,76) = 8.09$, $p<.001$). Planned contrasts indicated a significant difference in the number of points scored in the set-up and swing conditions ($F(1,19) = 24.05$, $p<.001$) but no significant difference between the eight and sixteen syllable conditions ($F(1,19) = 0.58$, n.s.). The contrast between the number of points scored in the Baseline and two set-up conditions was non-significant ($F(1,19) = 0.06$, n.s.) but that between the Baseline and two swing instruction conditions was significant ($F(1,19) = 18.01$, $p<.001$).

5.3.2. Block Scores

In order to see whether any differences in performance were consistent over the course of the 20 putts in each condition, trial block scores were calculated for consecutive blocks of five putts. Thus, Block 1 corresponded to the total score for putts 1 to 5, Block 2 corresponded to the total score for putts 6 to 10, Block 3 to putts 11 to 15 and Block 4 to putts 16 to 20. Since no significant difference was found between the 8 and 16 syllable conditions, the scores in the two set-up and two swing instruction conditions were combined for analysis of the block data. The mean trial block scores for all five conditions are shown in Table 5.1 and are illustrated in Figure 5.2. It can be seen from the graph in Figure 5.2 that scores tended to increase over the four blocks of putts and that the difference between the swing conditions and both the set-up and Baseline conditions remained at a similar level over the four blocks of putts.

The block data were analysed by a 3 x 4 (condition x block) ANOVA, with repeated measures on both factors. Using the Greenhouse-Geisser adjustment where appropriate, significant main effects were found for both block ($F(3,57) = 7.49$, $p<.001$) and condition ($F(2,38) = 15.69$, $p<.001$) but the interaction between block and condition was non-significant ($F(6,114) = 0.83$, n.s.).

5.3.3. Pre-shot Routine Analysis

5.3.3.1. Concentration Times

From the video recordings, concentration times for each subject were calculated by recording the time from the moment the subject grounded the putter head behind the ball to the moment the putting stroke was initiated. To generate mean times for each subject, ten putts were randomly selected in each condition. The times were recorded using a hand held Casio digital stop-watch. It should be noted that the recorded times will be slightly longer than the actual times due to the fact that pressing the stop button at the initiation of the putting stroke is effectively a simple reaction time task. No attempt was made to correct the times, however, because this source of error should remain constant in which case it would not affect the statistical analysis.

The mean concentration times in each condition are presented in Table 5.2 and are displayed in Figure 5.3. From the graph it can be seen that the mean times were longer in the non-baseline conditions but were very similar in the two set-up and two swing instruction conditions. In addition, times appear to be slightly longer in the two 16 syllable conditions than the two 8 syllable conditions.

The concentration times were analysed by a one-way, repeated measures ANOVA which revealed a significant main effect for condition ($F(4,76) = 56.45$,

Table 5.1. Mean number of points scored in each condition for all subjects in Experiment 5. Total scores over the 20 putts (maximum = 100) and scores in four consecutive blocks of five putts (maximum = 25) are shown.

Condition	*Total Score*	
	Mean	*S.D.*
Baseline	68.95	7.61
Set-up 8	67.25	8.53
Set-up 16	69.90	8.06
Swing 8	62.65	8.86
Swing 16	61.95	9.59

Condition	*Block 1 (Putts 1-5)*		*Block 2 (Putts 6-10)*	
	Mean	*S.D.*	*Mean*	*S.D.*
Baseline	16.15	3.35	17.10	2.57
Set-up 8	15.55	2.69	17.10	3.61
Set-up 16	17.10	2.83	17.35	4.17
Swing 8	13.65	4.18	17.55	2.98
Swing 16	14.60	3.17	15.75	4.17
All Conditions	15.41	3.44	16.97	3.54

Condition	*Block 3 (Putts 11-15)*		*Block 4 (Putts 16-20)*	
	Mean	*S.D.*	*Mean*	*S.D.*
Baseline	17.75	3.09	17.95	2.61
Set-up 8	16.75	3.39	17.75	2.47
Set-up 16	17.20	4.19	18.15	2.72
Swing 8	16.00	3.60	16.00	4.00
Swing 16	15.90	3.14	15.70	3.70
All Conditions	16.72	3.50	17.11	3.27

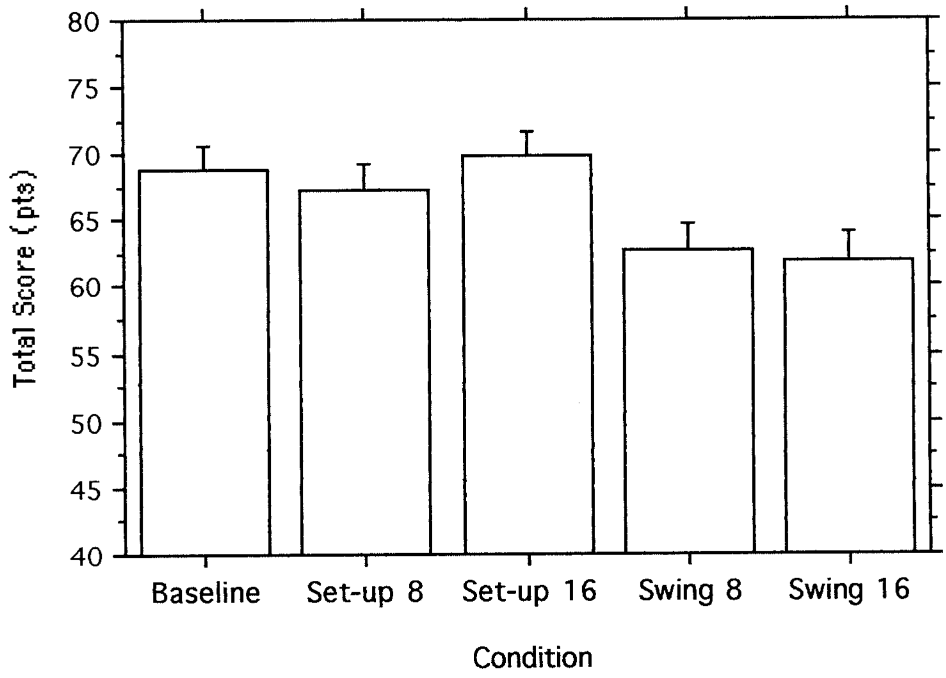

Figure 5.1. Mean total point scores in the five conditions of Experiment 5, with standard error error bars.

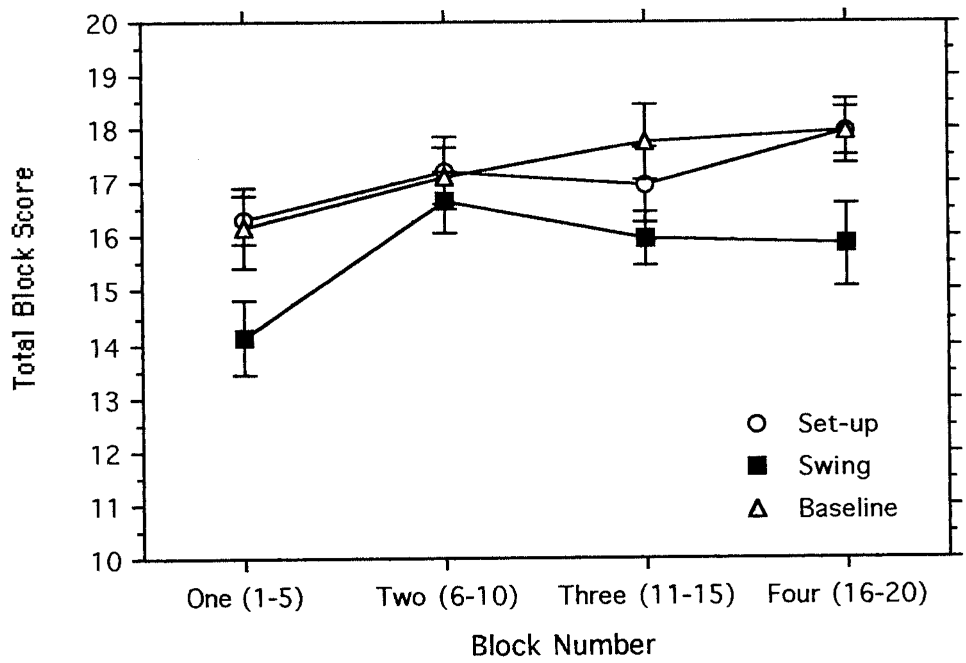

Figure 5.2. Interaction plot showing total scores over four consecutive blocks of five putts in Experiment 5, with standard error error bars. Scores for the 8 and 16 syllable conditions have been collapsed so that both the Set-up and Swing scores represent the mean values of their respective 8 and 16 syllable conditions.

Table 5.2. Mean concentration times (secs) in each condition of Experiment 5. Numbers for the concentration time variable error represent the mean intra-subject standard deviations over the 20 putts in each condition. Adjusted concentration times were calculated by subtracting the time taken to verbalise the stimuli. Additional concentration times were calculated by subtracting the baseline concentration times from the adjusted concentration times.

	Concentration Time		***Conc. Time (Var. Error)***	
Condition	*Mean*	*S.D.*	*Mean*	*S.D.*
Baseline	4.43	1.27	0.63	0.40
Set-up 8	8.61	2.22	0.98	0.50
Set-up 16	9.85	2.38	1.12	0.64
Swing 8	8.47	2.88	1.11	0.46
Swing 16	9.48	2.81	1.08	0.43

	Conc. Time (Adjusted)		***Additional Conc. Time***	
Condition	*Mean*	*S.D.*	*Mean*	*S.D.*
Baseline	4.43	1.27	n/a	n/a
Set-up	7.37	2.88	2.93	2.63
Swing	7.45	3.35	3.02	2.92

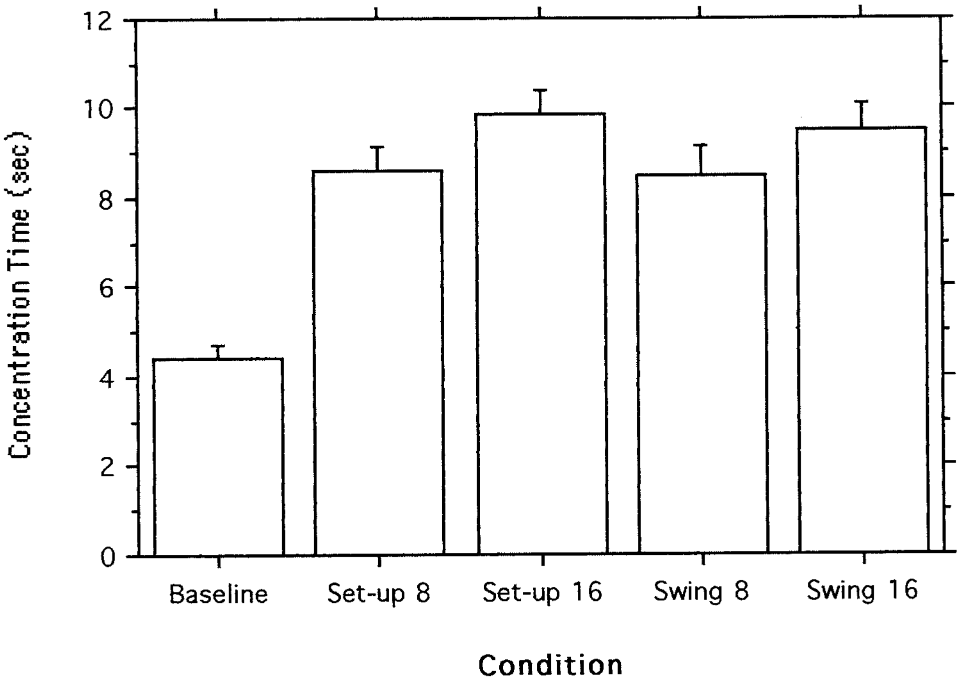

Figure 5.3. Mean concentration times (secs) for Experiment 5 in all conditions, with standard error error bars.

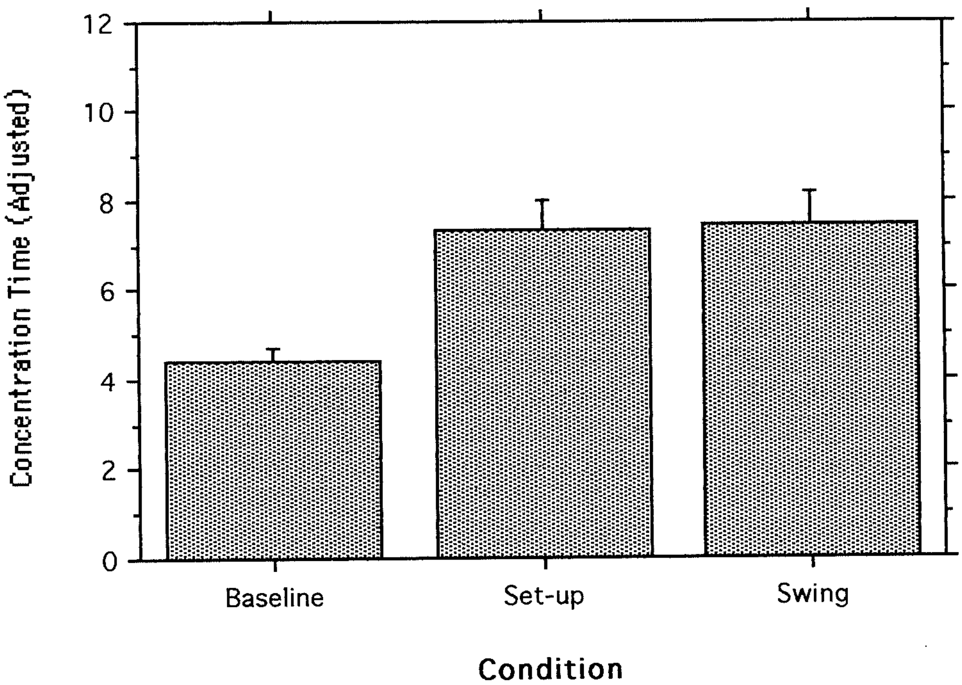

Figure 5.4. Mean adjusted concentration times (secs) for Experiment 5, calculated by subtracting the estimated time spent verbalising the instructions from total concentration time, with standard error error bars. [Note that times in the set-up and swing conditions are the same for both the 8 and 16 syllable conditions, due to the formula used].

p<.001). Planned contrasts indicated a significant difference between concentration times in the 8 and 16 syllable conditions ($F(1,19) = 15.34$, $p<.01$) but no difference in times between the set-up and swing conditions ($F(1,19) = 0.78$, n.s.).

5.3.3.2. Concentration Time Consistency

As a measure of the consistency of each subject's concentration times, standard deviations of intra-subject concentration time data were calculated in each condition. This variable is referred to as the concentration time variable error and mean values for subjects in each condition are shown in Table 5.2. Analysis of the data using a one-way, repeated measures ANOVA indicated a significant main effect for condition ($F(4,76) = 5.57$, $p<.01$), with inspection of the means revealing that variable error was similar in the four conditions requiring verbalising of instructions, but smallest in the baseline condition.

5.3.3.3. "Additional Thinking Time"

To obtain an indication of the amount of time subjects spent thinking about the instructions being verbalised, the differences between routine times in the 8 and 16 syllable conditions were calculated for each subject in both the Set-up and Swing conditions. This figure was used to estimate the time each subject took to verbalise 8 syllables. It was then subtracted from each subject's 8 syllable concentration times to give Set-up and Swing concentration times that were adjusted for time spent verbalising the words. The "additional thinking time" was then calculated by subtracting concentration times in the baseline condition from the adjusted Set-up and Swing concentration times. A summary of the steps involved in the calculation is as follows:

CTBaseline
Concentration Time (Baseline) = Time from placement of club-head behind ball to initiation of putting action in Baseline condition.

CTSet-up
Concentration Time (Set-up) = Time from placement of club-head behind ball to initiation of putting action in Set-up instruction conditions.

CTSwing
Concentration Time (Swing) = Time from placement of club-head behind ball to initiation of putting action in Swing instruction conditions.

VSet-up

Time to verbalise 8 syllables (Set-up) = CTSet-up (16) – CTSet-up (8)

VSwing

Time to verbalise 8 syllables (Swing) = CTSwing (16) – CTSwing (8)

CTSet-up (adj)

Adjusted Concentration Time (Set-up) = CTSet-up – VSet-up

CTSwing (adj)

Adjusted Concentration Time (Swing) = CTSwing – VSwing

Additional Thinking Time (Set-up)

Additional Thinking Time (Set-up) = CTSet-up (adj) – CTBaseline

Additional Thinking Time (Swing)

Additional Thinking Time (Swing) = CTSwing (adj) – CTBaseline

The mean adjusted concentration times for baseline, Set-up and Swing conditions, as well as the mean additional thinking times in the Set-up and Swing conditions, are presented in Table 5.2 and are illustrated in Figure 5.4. It can be seen from the graph that the mean adjusted concentration times were longer in the Set-up and Swing conditions than in the baseline condition.

The data were analysed using a one-way, repeated measures ANOVA. The condition main effect was found to be significant ($F(2,38) = 11.26$, $p<.001$) with planned contrasts indicating significantly longer adjusted concentration times in both the Set-up ($F(1,19) = 16.40$, $p<.001$) and Swing ($F(1,19) = 17.37$, $p<.001$) instruction conditions than in the baseline condition, but no significant difference between the Set-up and Swing conditions ($F(1,19) = 0.01$, n.s.).

5.3.4. Questionnaire Analysis

5.3.4.1. Difficulty of Carrying Out Instructions

Subjects were asked to rate how difficult they found it to carry out each of the eight instructions, on a scale from 1 ("very easy") to 7 ("very difficult"). The mean values for the four set-up and four swing instructions are shown in Table 5.3. The data for the Set-up ratings of the 19 subjects who completed this question was analysed using a one-way, within subjects ANOVA which revealed a significant main effect for

Table 5.3. Mean ratings in Experiment 5 for i) how difficult it was to carry out each of the four set-up and swing instructions, on a scale from 1 ("very easy") to 7 ("very hard") and ii) how well subjects thought they usually performed each of the behaviours specified by the instructions when using their usual putting method, on a scale from 1 ("very poorly") to 7 ("very well").

Set-up Rule	*Difficulty Rating*		*Performance Rating*	
	Mean	*S.D.*	*Mean*	*S.D.*
Putter Square	1.68	0.89	4.35	1.95
Eyes Over Ball	2.26	1.24	4.70	1.75
Shoulders in Line	3.90	1.66	3.85	1.39
Ball Centred	1.68	0.89	5.00	2.00

Swing Rule	*Difficulty Rating*		*Performance Rating*	
	Mean	*S.D.*	*Mean*	*S.D.*
Head Still	2.63	1.26	4.25	2.02
Central Pivot	3.68	1.53	4.15	1.57
Wrist Fixed	2.63	1.42	4.63	1.64
Blade Square	3.47	1.68	4.70	1.75

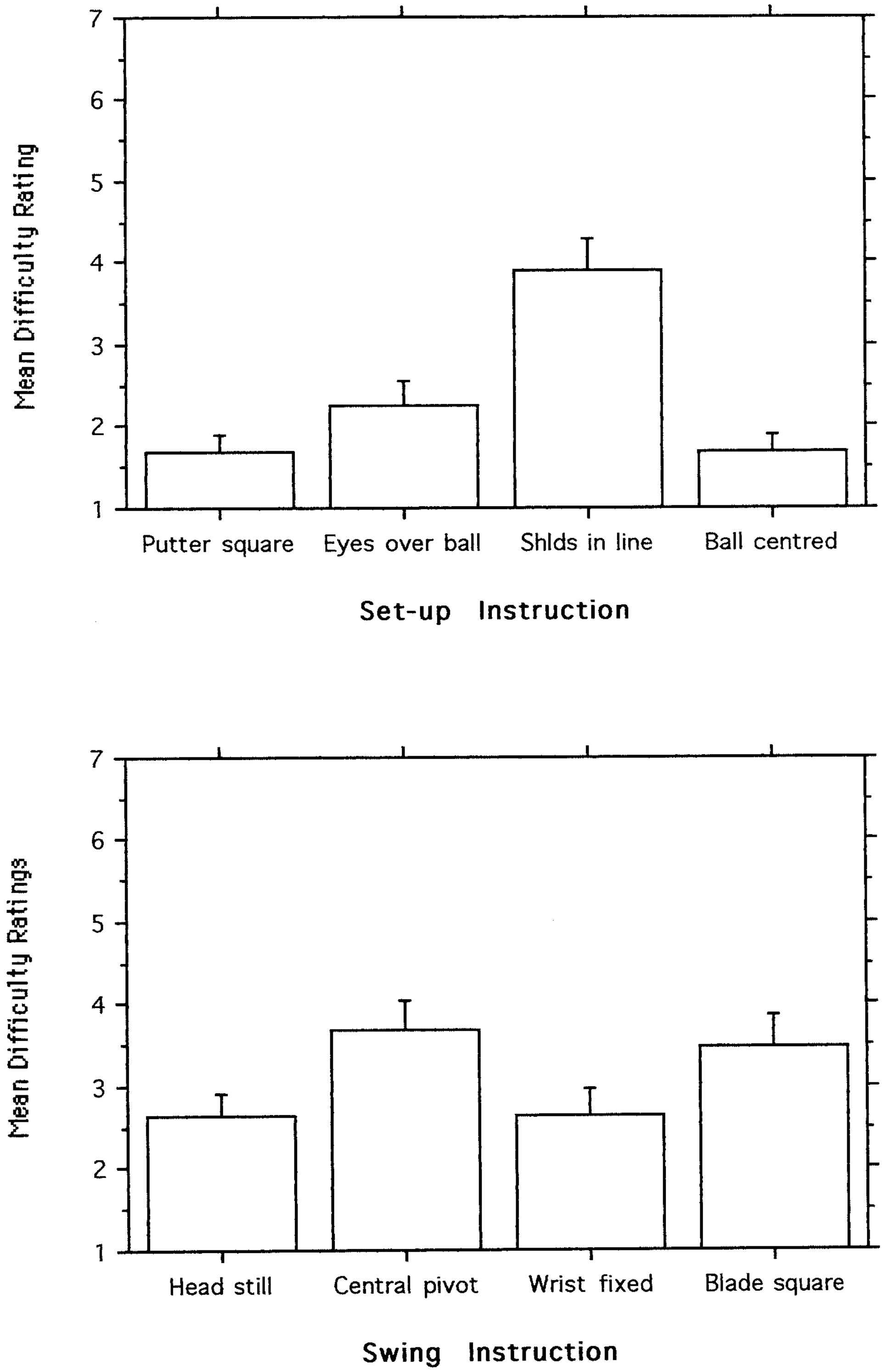

Figure 5.5. Mean subject ratings for how difficult it was to carry out each of the "set-up" and "swing" instructions used in Experiment 5, with standard error error bars. Ratings were on a scale from 1 ("very easy") to 7 ("very difficult").

instruction ($F(3,54) = 17.24$, $p<.001$). From the top graph in Figure 5.5 it can be seen that the instruction concerning the alignment of the shoulders was reported as being the hardest to carry out with a mean value approximately mid-way between the very easy and very difficult ends of the scale.

The same analysis on the swing instruction difficulty ratings again revealed a significant main effect for instruction ($F(3,54) = 4.19$, $p<.05$). As can be seen in the bottom graph in Figure 5.5, the instructions to pivot from the centre of the shoulders and keep the putter blade square at impact were reported as being less easy to follow than those to keep the head still and the left wrist in a fixed position.

To compare the difficulty ratings of the set-up and swing instructions, the mean values for each set of four instructions were analysed by a one-way, within subjects ANOVA. This revealed a significant main effect for instruction type ($F(1,18) = 11.38$, $p<.01$), with the mean scores indicating that the swing instructions (mean = 3.11) were reported as less easy to carry out than the set-up instructions (mean = 2.38).

5.3.4.2. Performance Ratings for Instructions

Subjects were asked to rate how well they thought they usually performed each of the instructions when using their normal putting method, on a scale from 1 ("very poorly") to 7 ("very well"). The mean values for the eight instructions are shown in Table 5.3. Separate analyses of the set-up and swing instructions, using one-way, within subjects ANOVAs indicated no significant effect for instruction content in either the set-up or the swing instructions ($F(3, 54) = 2.63$, n.s. and $F(3,54) = 1.22$, n.s. respectively). In addition, comparison of the mean overall performance ratings for the set-up and swing instructions revealed no significant differences between the two types of instructions ($F(1,18) = 0.03$, n.s.).

5.4. Discussion

The main purpose of the present experiment was to examine the underlying assumption of the reinvestment theory of choking. This was that thinking about several technical aspects of the swing during the preparatory phase of the golf putt would result in poorer performance. The second purpose of the experiment was to test the hypothesis that thinking about technical aspects of the set-up would also lead to poorer performance. The results revealed that attending to the "swing" instructions led to significantly poorer performance than achieved in baseline, but attending to the "set-up" instructions had no effect on performance. The overall length of the verbal stimulus had no effect on performance, with no difference between the 8 and 16 syllable conditions.

These results extend the previous research of Backman and Molander (1991), who found that having subjects think about nine instructions relating to both the set-up and swing aspects of putting led to poorer performance. The present experiment provides support for their interpretation that poor performance was the result of "conscious cognitive activity", rather than reflecting attempts to change their normal putting technique. However, the results of the present experiment suggest that it is only conscious cognitive activity relating to the putting stroke that is disruptive to performance and not thinking about the set-up aspect of putting.

Analysis of the scores in the set-up, swing, and baseline conditions over four consecutive blocks of five putts revealed no interaction between block and condition. Therefore, the disruptive effect of attending to the swing instructions was consistent over the four blocks of putts. Of concern was that subjects would habituate to the instructions, thus any effects on performance would decrease over the course of the 20 putts.

5.4.1. Implications for the Reinvestment Theory of Choking

The first implication for a general reinvestment theory of choking is that one must be careful not to assume that reinvesting rules relating to all technical aspects of a skill will be disruptive to performance. The results of the present experiment suggest that if a golfer, under pressure, only reinvests rules about the set-up then performance will not be disrupted. This finding also has implications for the use of routine times as an indicator of the likelihood of choking. For example, it has been widely noted that the pre-shot routine times of Greg Norman during his final round at the 1996 U.S. Masters golf tournament were "double or treble his normal time" (Wheatley, 1997, p. 2). Similarly, it has been noted that Doug Sanders took far longer than normal before missing a putt to win the 1970 Open Championship here in St. Andrews. It is tempting to suggest that these increased times are associated with increased thinking about how to perform the skill and that they should, therefore, be a good indicator of choking. Despite this, previous research has found that total pre-shot routine times are a poor indicator of performance in self-paced skills, such as basketball free-throws, whether or not the performer is in a pressure situation (Predabon and Docker, 1992). Based on the results of the present experiment, a possible explanation for this is that the routine time variable is too general, failing to discriminate between conscious cognitive activity that will facilitate, have no effect, or disrupt performance. Thus, in the present experiment, while there was no difference between the "additional thinking time" in the set-up and swing conditions, only the swing instruction conditions were associated with a decline in performance. Anecdotally, it is interesting to note that during his final round at the 1996 U.S. Masters Norman's driving accuracy appeared to remain at a high level, despite similar increases in pre-shot routine times. Although purely speculative, it is possible that, when putting, Norman reinvested technical rules concerning the swing but, when driving, he reinvested rules concerning the set-up.

5.4.2. Why did Reinvestment of Set-up Instructions not Disrupt Performance?

One possible explanation for the different effects of attending to the set-up and swing instructions is that disruption occurred in the swing instructions because they were harder to carry out than the set-up instructions. Thus, subjects reported that following the swing instructions was more difficult than following the set-up instructions. Instructions were not matched for difficulty before the experiment due to the limited number of instructions that were considered to be important aspects of all putting strokes. Nevertheless, rather than trying to find easier swing instructions or more difficult set-up instructions, a simpler interpretation of the difficulty ratings is that they reflect the different cognitive demands associated with the two tasks, particularly with respect to the different time constraints and opportunity for using feedback in each task.

Considering the set-up instructions first of all, subjects had unlimited time in which to ensure that their behaviour was consistent with the instructions. This means that adopting the correct set-up position could be thought of as a "closed loop" task (Adams, 1971) in which the subject was able to make use of moment by moment feedback to assess the level of agreement between the actual and required behaviour. For example, the subject was able to see whether or not the ball was lined up with the sweet spot of the putter, and whether or not the putter face was square to the target line, and was able to make adjustments accordingly. This is consistent with the finding that the set-up instruction rated most difficult to carry out was the one requiring subjects to ensure that their shoulders were parallel to the target line. For this instruction, it was more difficult for subjects to make use of visual feedback, so that they had to rely primarily on kinesthetic information to "feel" the correct position. This is more difficult because of the lack of a visual frame of reference against which an objective judgement could be made. What felt correct might, in fact, have been incorrect, a problem familiar to any golfer who has been shocked to see what their set-up position *actually* looks like on video tape.

Considering the two swing instruction conditions, the task differed in two important ways from the set-up conditions. First, the subject could not actually monitor the correctness of the swing instructions until commencement of the putting action. This is different from the two set-up conditions, in which there were no additional cognitive demands associated with the putting stroke itself. Secondly, whereas the set-up component of putting is not associated with time-constraints, the putting stroke only lasts for approximately one second. In addition, all but one of the swing instructions referred to behaviours that needed to be performed over the duration of the putt (the exception being the "square strike" instruction, although it could be argued that even this instruction implies the need for a specific swing path). The easier ratings of the set-up instructions were probably, therefore, reflecting the different cognitive demands associated with the two sets of instructions which, in turn, could explain why attending to set-up instructions did not disrupt performance.

5.5. Conclusion

In the present experiment, support was found for the hypothesis that attending to instructions concerning the putting action in the few seconds before movement initiation would be disruptive to performance. No evidence was found to support the hypothesis that attending to instructions relating to the topography of the set-up would be disruptive to performance. The results suggest that the reinvestment theory of choking needs to be refined, at least in the case of self-paced skills, to specify the type of reinvestment that is most likely to be disruptive. The present experiment suggests that reinvestment of rules concerning the set-up will have no effect on performance.

Experiment 6- The Effect of Attending to Two Swing Instructions

5.6. Introduction

The prevention hypothesis that was tested in Experiments 3 and 4, proposed that using verbal cues would prevent reinvestment of rules at the topographical level in pressure situations. It could be argued that behaviour under the control of verbal cues also fits the definition of rule-governed behaviour as behaviour under the control of verbal antecedents (Catania, 1992). That is, by basing verbal cues on instructions at the topographical level, it seems as though this is promoting the very behaviour said to cause choking. At this point it is useful to make a distinction between the different function of each of these verbal antecedents. In the case of the simple verbal cue, it is proposed that, as with visual stimulus cueing, the cue has the function of evoking the entire sequence of actions involved in the response, performed without attention to the component parts of the movement (Zieglar, 1987; Hill and Borden, 1995, Landin, 1994). In the case of choking, the verbal antecedents are proposed to evoke controlled processing, associated with attention to the component parts of the movement. In effect, it is proposed that a verbal cue evokes contingency-shaped behaviour at the topographical level whilst the verbal antecedents associated with choking evoke controlled processing during the performance.

A question which arises from this position concerns the point at which verbal "cues" become disruptive. More specifically, at what point does a verbal cue cease to cue automatic processing and instead lead to the controlled processing associated with reinvestment. In Experiment 5, it was found that attending to four swing instructions relating to the putting action resulted in poorer performance. Masters (1992) found that having knowledge of approximately three rules of putting was also sufficient to cause choking in a group of novice putters. In Experiment 4, subjects in the Verbal Cue group verbalised shortened versions of instructions relating to the putting stroke. In this case, the "swing thought" usually only referred to a single instruction. Inspection of the graph showing the points scored by the Verbal Cue group in the four blocks of five putts during the baseline and intervention stages of Experiment 4 indicated little sign of disruption to performance, with only the first block of putts showing any deviation in performance from that observed during baseline (see Appendix 10).

From an applied perspective, it is important to know whether using verbal cues based on two aspects of the putting stroke will disrupt performance, as in the swing instruction conditions of Experiment 5, or will have no effect on performance, as in the Verbal Cue group during the intervention stage of Experiment 4.

5.7. Method

5.7.1. Subjects

Twenty male golfers, aged between 18 and 23 years (mean = 19.85 years, SD = 1.53) took part in the experiment. The golf handicaps of subjects ranged from "plus one" to 18 (mean = 5.95, SD = 5.65), and they had a mean of 9.35 years (SD = 3.95) golf playing experience.

5.7.2. Task / Apparatus

The task and apparatus were identical to those used in Experiment 5.

5.7.3. Design

As in Experiment 5, a within-subjects design was used, with subjects putting under five different conditions. These consisted of a baseline condition, two conditions in which subjects verbalised shortened versions of two instructions about the putting stroke, and two conditions in which shortened versions of four instructions about the putting stroke were verbalised.

5.7.3.1. Instructions / Verbal Stimuli

The instructions used in the present experiment were the same instructions that were used in the Swing 8 and Swing 16 conditions in Experiment 5. In the "two instruction" conditions, two pairs of instructions were used:

Keep your head absolutely still throughout the stroke
Ensure the swing pivots from the centre of your shoulders

Keep the back of the left wrist fixed throughout the swing
Ensure the putter blade is square at the point of impact

The pairings were chosen to control for differences in perceived difficulty associated with carrying out each of the instructions. Thus, each pair of instructions incorporated one of the two instructions rated as the easiest to carry out in Experiment 5, together with one of the two instructions rated as most difficult to carry out. These were formed into phrases of 8 and 16 syllables, with the pair of instructions used in the 8 and 16 syllable conditions being alternated so that all subjects verbalised both pairs during the course of the experiment. Thus, for half of the subjects, the first two instructions were used for the 8 syllable condition and the second two instructions for the 16 syllable condition, while for the remaining subjects, the first pair of instructions were used for the 16 syllable condition and the second pair for the 8 syllable condition. Incomplete counterbalancing was used to control for any position or order effects that might occur. In the two conditions in which subjects were required to verbalise all four instructions, the phrases that were used in Experiment 5 were again used in the present experiment.

As in Experiment 5, the dependent variable used to assess performance was the number of points scored on each putt.

5.7.4. Procedure

The procedure followed the same format as Experiment 5. Subjects filled out the first page of an experimental questionnaire (Appendix 12) and were then read the same general instructions. The verbal stimuli for each condition were as follows:

Baseline: None

Swing (2 components, 8 syllables):

"KEEP MY HEAD STILL"
"CENTRAL PIVOT"
or
"KEEP LEFT WRIST FIXED"
"SQUARE AT IMPACT"

Swing (2 components, 16 syllables):

"KEEP MY HEAD STILL DURING THE STROKE"
"PIVOT FROM CENTRE OF SHOULDERS"
or
"KEEP POSITION OF LEFT WRIST FIXED"
"KEEP PUTTER BLADE SQUARE AT IMPACT"

Swing (4 components, 8 syllables):

"HEAD STILL"
"PIVOT"
"WRIST FIXED"
"SQUARE STRIKE"

Swing (4 components, 16 syllables):

"KEEP MY HEAD STILL"
"CENTRAL PIVOT"
"KEEP LEFT WRIST FIXED"
"SQUARE AT IMPACT"

As in Experiment 5 the subject was allowed to take a break of approximately one minute between each of the five conditions. After putting under all five instructional conditions, the subject completed the remainder of the questionnaire after which any questions were answered and the subject was paid £3.50 for taking part in the experiment.

5.8. Results

5.8.1. Point Scores in each Condition

The mean number of points scored in each condition are shown in Table 5.4. These data are illustrated in Figure 5.6. where it can be seen that the lowest mean scores were found when attending to four instructions, i.e., in the Swing 4-8 and Swing 4-16 conditions. Mean scores in both of the two component conditions (Swing 2-8 and Swing 2-16) were also lower than in the baseline condition. Analysis of the data using a one-way, repeated measures ANOVA revealed a significant main effect for condition ($F(4,76) = 3.58$, $p<.05$). Planned contrasts indicated no difference between scores in the 8 and 16 syllable conditions ($F(1,19) = 0.01$, n.s.) but a significant difference between the Swing 2 and Swing 4 conditions ($F(1,19) = 7.11$, $p<.05$). A significant difference was found in the contrast between scores in the baseline and Swing 4 conditions ($F(1,19) = 11.89$, $p<.01$) but not between scores in the baseline and Swing 2 conditions ($F(1,19) = 1.62$, n.s.).

5.8.2. Block Scores

As in Experiment 5, performance over the course of the 20 putts in each condition was again divided into four consecutive blocks of five putts. In the absence of a difference between performance in the 8 and 16 syllable versions of the two sets of instructions these conditions were combined for the purpose of analysis. The mean trial block scores for all five conditions are shown in Table 5.4 and are illustrated in Figure 5.7 where it can be seen that the mean scores tended to increase over the four blocks.

The data were analysed by means of a 3 x 4 (condition x block) ANOVA, with repeated measures on both factors. The results indicated a significant main effect for both block ($F(3,57) = 3.65$, $p<.05$) and condition ($F(2,38) = 6.07$, $p<.01$), as well as a significant interaction between the two ($F(6,114) = 2.57$, $p<.05$). The presence of an interaction appears to have been caused, firstly, by performance in the Swing 4 conditions. In these conditions, the mean number of points scored was below baseline performance in all but the second block of five putts, where the number of points scored was greater than in either the baseline or Swing 2 conditions. In addition, performance in the Swing 2 conditions was slightly below baseline performance in the first block of putts, but almost exactly the same thereafter.

Table 5.4. Mean number of points scored in each condition of Experiment 6. Both total scores for all 20 putts (maximum = 100) and scores in four consecutive blocks of five putts (maximum = 25 in each block) are shown.

	Total Score	
Condition	*Mean*	*S.D.*
Baseline	68.95	7.61
Set-up 8	67.25	8.53
Set-up 16	69.90	8.06
Swing 8	62.65	8.86
Swing 16	61.95	9.59

	Block 1 (Putts 1-5)		*Block 2 (Putts 6-10)*	
Condition	*Mean*	*S.D.*	*Mean*	*S.D.*
Baseline	16.15	3.35	17.10	2.57
Set-up 8	15.55	2.69	17.10	3.61
Set-up 16	17.10	2.83	17.35	4.17
Swing 8	13.65	4.18	17.55	2.98
Swing 16	14.60	3.17	15.75	4.17
All Conditions	15.41	3.44	16.97	3.54

	Block 3 (Putts 11-15)		*Block 4 (Putts 16-20)*	
Condition	*Mean*	*S.D.*	*Mean*	*S.D.*
Baseline	17.75	3.09	17.95	2.61
Set-up 8	16.75	3.39	17.75	2.47
Set-up 16	17.20	4.19	18.15	2.72
Swing 8	16.00	3.60	16.00	4.00
Swing 16	15.90	3.14	15.70	3.70
All Conditions	16.72	3.50	17.11	3.27

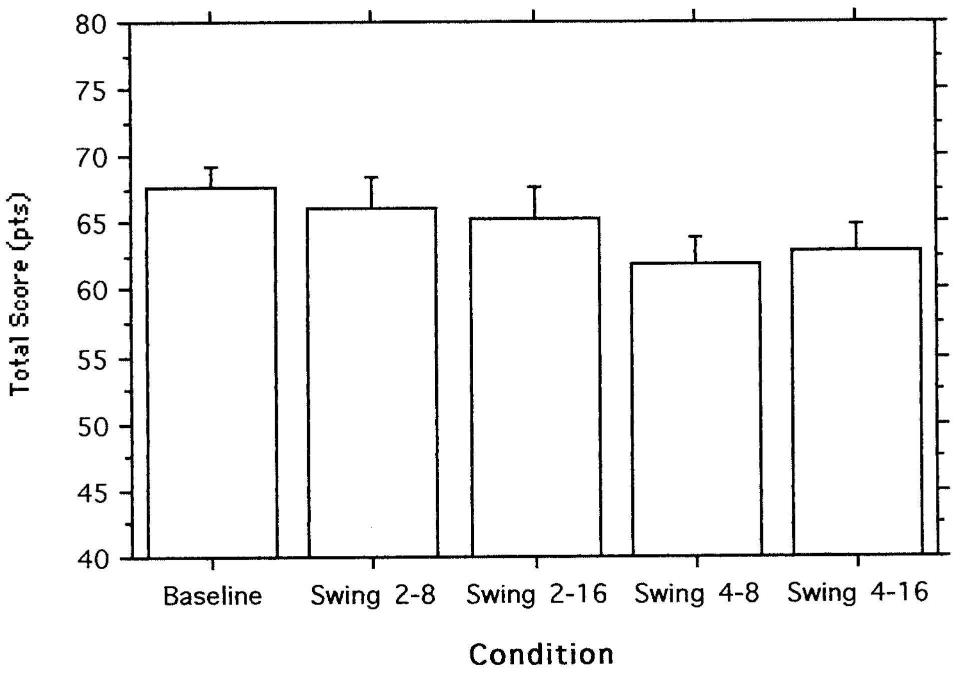

Figure 5.6. Total number of points scored in all five conditions of Experiment 6, with standard error error bars.

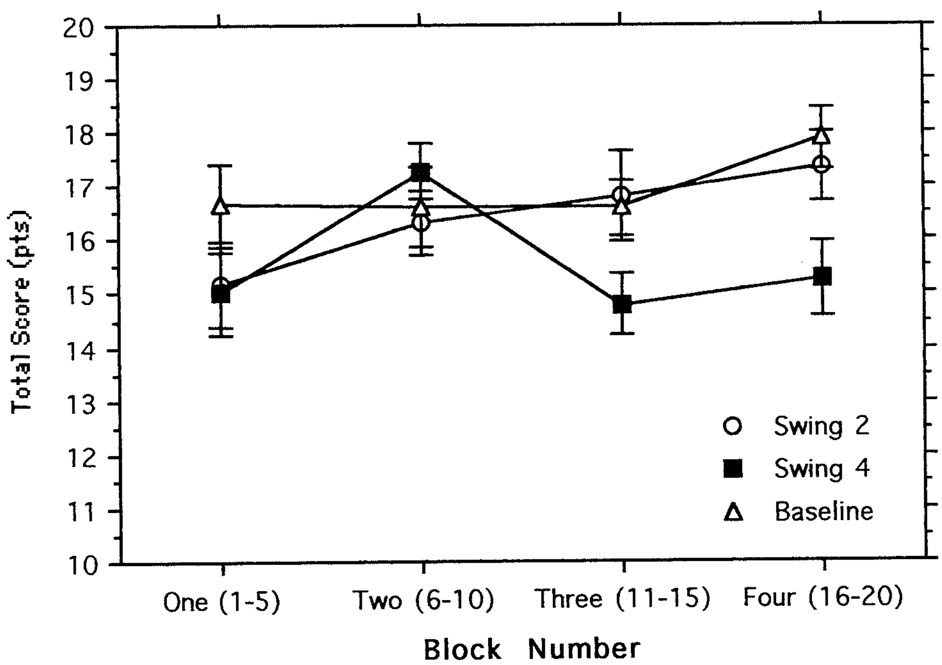

Figure 5.7. Interaction plot showing mean scores in consecutive blocks of five putts in Experiment 6, with standard error error bars. Scores for the 8 and 16 syllable conditions have been collapsed so that the "Swing 2" and "Swing 4" scores represent the mean values of their respective 8 and 16 syllable conditions.

5.8.3. Concentration Times

Concentration times were calculated in the same way as Experiment 5 and the mean times in each condition are presented in Table 5.5. It can be seen that mean times were longer in the Swing 4 conditions than the Swing 2 conditions and in the 16 than 8 syllable conditions. In addition, the mean times in all of these conditions were longer than in the baseline condition. Analysis of the data using a one-way, repeated measures ANOVA revealed a significant main effect for condition ($F(4,76) = 51.59$, $p<.001$). Planned contrasts indicated a significant difference between times in the two 8 and 16 syllable conditions ($F(1,19) = 30.95$, $p<.001$) and also in the two and four component conditions ($F(1,19) = 40.02$, $p<.001$). These results are illustrated in Figure 5.8.

5.8.4. Adjusted Concentration Time

Adjusted concentration times were calculated in the same way as Experiment 5, with "Set-up" times being replaced by "Swing 2" times. From this "additional thinking times" were calculated by subtracting mean baseline concentration times. Mean times for both additional thinking time and adjusted concentration time are presented in Table 5.5 where it can be seen that mean adjusted concentration times were longer in the Swing 4 than the Swing 2 and Baseline conditions.

Analysis of the data, using a one-way, repeated measures ANOVA revealed this to be the case. Thus, a significant main effect was found for condition ($F(2,38) = 20.60$, $p<.001$) with planned contrasts indicating, firstly, longer adjusted concentration times in the Swing 4 than the Swing 2 conditions ($F(1,19) = 29.44$, $p<.001$). Secondly, a significant difference was found between adjusted concentration times in the Swing 4 and Baseline conditions ($F(1,19) = 32.30$, $p<.001$), and finally no difference was found between the Swing 2 and baseline conditions ($F(1,19) = 0.07$, n.s.). These results are illustrated in Figure 5.9.

5.8.5. Concentration Time Consistency

The mean consistency of concentration times in each condition was again calculated using intra-subject standard deviations. The mean variable error scores for each condition are shown in Table 5.5 where it can be seen that the variability of routine times was smallest in the baseline condition and equivalent in the remaining conditions. Analysis of the data using a one-way, repeated measures ANOVA indicated a significant main effect for condition ($F(4,76) = 3.22$, $p<.05$).

Table 5.5. Mean concentration times (secs) in each condition in Experiment 6. Concentration time variable error represents the mean of intra-subject standard deviations over the 20 putts in each condition. Adjusted concentration times were calculated by subtracting the time taken to verbalise the stimuli. Additional concentration times were calculated by subtracting the baseline concentration times from the adjusted concentration times.

	Concentration Time		*Conc. Time (Var. Error)*	
Condition	*Mean*	*S.D.*	*Mean*	*S.D.*
Baseline	3.86	1.45	0.54	0.25
Swing 2-8	5.20	1.94	0.86	0.50
Swing 2-16	6.47	2.22	0.98	0.64
Swing 4-8	6.62	1.87	0.85	0.63
Swing 4-16	7.60	2.06	0.79	0.37

	Conc. Time (Adjusted)		*Additional Conc. Time*	
Condition	*Mean*	*S.D.*	*Mean*	*S.D.*
Baseline	3.86	1.45	n/a	n/a
Swing (2)	3.94	2.11	0.08	1.55
Swing (4)	5.65	1.96	1.79	1.29

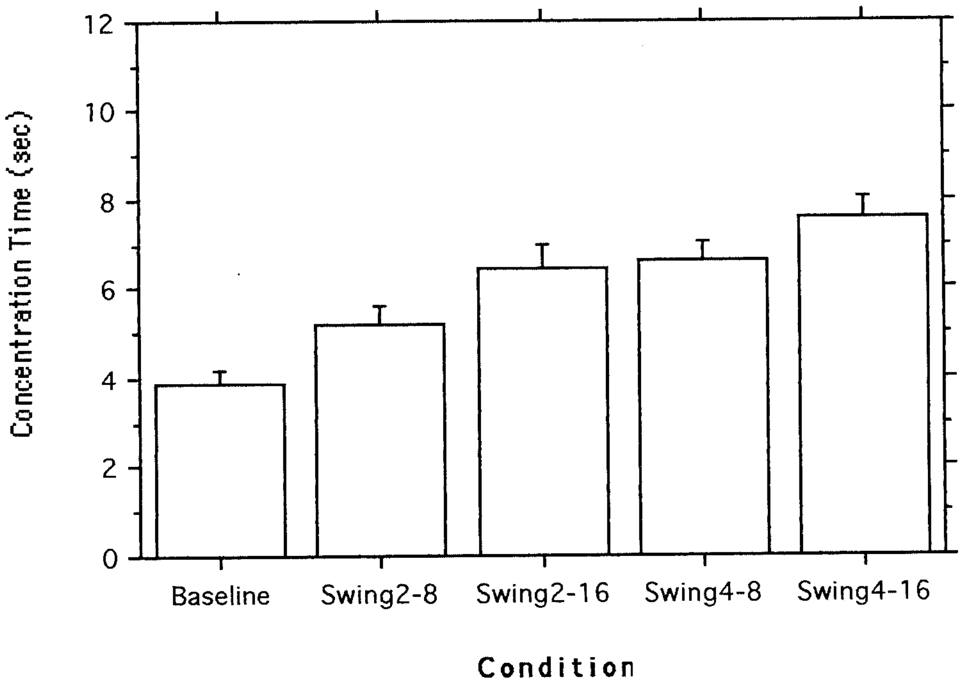

Figure 5.8. Mean concentration times (secs) in the five conditions of Experiment 6, with standard error error bars.

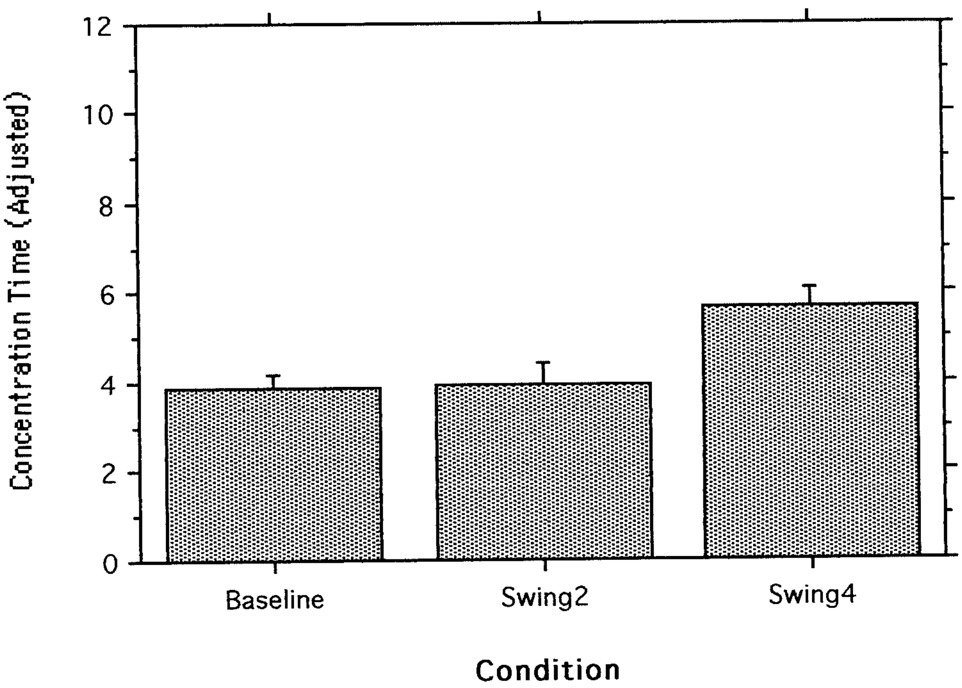

Figure 5.9. Mean adjusted concentration times (secs) for Experiment 6, calculated by subtracting the estimated time spent verbalising, with standard error error bars.

Table 5.6. Mean ratings in Experiment 6 for i) how difficult it was to carry out each of the four swing instructions, on a scale from 1 ("very easy") to 7 ("very hard") and ii) how well subjects thought they usually performed each of the instructions when using their usual putting method, on a scale from 1 ("very poorly") to 7 ("very well").

	Difficulty Rating		Performance Rating	
Swing Instruction	Mean	S.D.	Mean	S.D.
Head Still	1.75	0.72	5.00	1.60
Central Pivot	3.60	1.73	4.26	1.70
Wrist Fixed	3.25	1.45	4.58	1.47
Blade Square	3.55	1.61	4.58	1.47

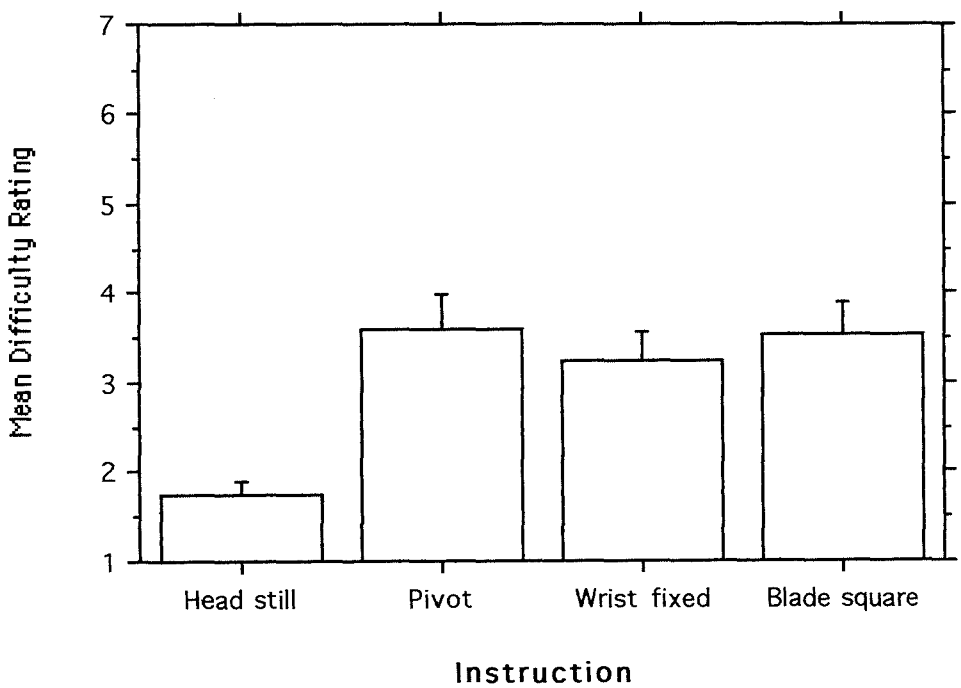

Figure 5.10. Mean ratings for how difficult it was to carry out each of the four swing instructions used in Experiment 6, on a scale from 1 ("very easy") to 7 ("very difficult"), with standard error error bars.

5.8.6. Questionnaires

5.8.6.1. Difficulty of Carrying Out Instructions

Subjects rated the difficulty associated with ensuring that each instruction was being carried out correctly on the same 7 point scale used in Experiment 5, from 1 ("very easy") to 7 ("very difficult"). The mean ratings for each instruction are shown in Table 5.6 and are presented in Figure 5.10. From the graph it can be seen that the instructions to keep the left wrist fixed and the putter blade square at impact were reported as being less easy to carry out than the instructions to keep the head still and to pivot from the centre of the shoulders.

A one-way, within-subjects ANOVA indicated a significant effect for instruction content ($F(3,57) = 8.71$, $p<.001$) with the planned comparison between the two pairs of instructions used in the two component conditions unexpectedly revealing a significant difference ($F(1,19) = 6.02$, $p<.05$). Looking at the mean values in Table 5.6 it can be seen that the "central pivot" instruction was actually rated as more difficult to follow than the "wrist fixed" and "square strike" instructions from the other pairing, meaning that the significant difference was due to how easy subjects found it to carry out the "head still" instruction.

5.8.6.2. Competence Ratings

As in Experiment 5, subjects were asked to rate how well they usually performed each of the instructions when using their normal putting method, on a scale from 1 ("very poorly") to 7 ("very well"). The mean values for the four instructions are shown in Table 5.6 and analysis of the data revealed no significant differences between the different instructions ($F(3,54) = 1.26$, n.s.).

5.9. Discussion

The main aim of the present experiment was to examine the effect of attending to two aspects of the putting stroke to see whether this would lead to disruption in performance, or whether, as with the use of simple verbal cues, no disruption would occur. Analysis of the results indicated no significant difference between the number of points scored in the two component and baseline conditions.

This result suggests that the reinvestment theory of choking must be refined to take into account the possibility that, under pressure, a performer could reinvest rules concerning one or two aspects of technique without disruption to performance. In support of reinvestment theory, attending to four instructions relating to the putting stroke was again shown to disrupt performance, with significantly fewer points scored in the four component conditions than in either the baseline or two component conditions.

5.9.1. Block Scores

Analysis of the block scores indicated a significant interaction between block and condition. The graph in Figure 5.7 suggests that the main reason for the interaction was the performance of subjects in the Swing 4 conditions compared to the other conditions and, in particular, the fact that performance was not consistently suppressed over the four blocks. In addition, the mean performance in the Swing 2 conditions was slightly below baseline performance in the first block of five putts, although examination of the error bars in Figure 5.7 indicate that this was not significantly so. It is unclear why performance in the Swing 4 condition seemed to improve in the second block of putts before falling back below the level of the Swing 2 and Baseline conditions for the remaining putts. It is interesting to note that a similar effect occurred in Experiment 5 (see Figure 5.2) although the interaction did not reach significance in that case. It is possible that a contingency was in effect, in which the behaviour of consciously monitoring performance, evoked by the verbal stimulus, was punished by the subsequent poor performance. This explanation does not account for the fact that performance again became disrupted later in the series of putts. At the present time it is unclear why this pattern of results emerged.

5.9.2. Additional Concentration Times

As in Experiment 5, additional concentration times associated with the Swing 2 and Swing 4 conditions were calculated. It was found that the additional concentration time was approximately zero in the Swing 2 conditions, as indicated by the fact that the adjusted concentration times in these conditions were almost identical to baseline concentration times (see Table 5.5). Together with the point score data, this finding is consistent with the view that subjects were able to use a stimulus relating to two aspects of technique to cue contingency-shaped behaviour. That is, no additional time was required in which to elaborate on the instructions. A note of caution, however, concerns the fact that cognitive elaboration could displace other cognitive activity that normally takes place in the concentration period prior to initiation of the putting stroke. In this case, no increase in additional concentration times would be apparent.

In Experiment 5, the additional concentration times associated with the set-up and swing instructions were 2.93 and 3.02 seconds respectively. In Experiment 6, the additional concentration times in the Swing 2 and Swing 4 conditions were 0.08 and 1.79 seconds respectively. Despite the fact that the conditions were identical, the mean additional concentration times in the Swing 4 conditions of Experiments 5 and 6 differed by more than one second. In the absence of any differences in the demographic data for these groups, it seems most logical to explain this result in terms of the difference in the other two instruction conditions associated with each experiment. In the present experiment, these conditions involved attempting to ensure that two aspects of the swing were correctly performed. These two aspects were drawn from the same four instructions used in the Swing 4 conditions. Thus half of the subjects had already experienced at least two of the instructions before putting in either of the Swing 4 conditions. In Experiment 5, the other conditions involved instructions relating to the set-up, meaning that no subject had prior experience of any of the swing instructions. Insofar as the additional concentration time reflects the effort involved in attending to the instructions (Foley et al., 1989) one interpretation is that this previous experience resulted in less effort being required during the Swing 4 conditions. To examine this possibility, the additional Swing 4 concentration times of subjects who had and had not first putted in one of the Swing 2 conditions were compared. Contrary to the prediction, there was no significant difference between the two sub-groups. In fact, the mean time for the subjects with prior experience of a two instruction condition was actually higher (mean = 2.10 secs) than that for subjects with no prior experience of a two instruction condition (mean = 1.48 secs). The reason for the discrepancy in times remains unclear.

5.9.3. Difficulty of Carrying Out Instructions

Unexpectedly, it was found that one of the pairs of instructions was rated as being easier to follow than the other. This result was caused by the very low (i.e. easy) rating associated with the "head still" instruction. Also, the ratings associated with the "wrist fixed" instruction were higher (harder) than in Experiment 5. These differences were not reflected in performance, however, as comparison of the scores associated with each instruction pair in the Swing 2 conditions revealed no significant differences.

5.10 Overall Summary

The reinvestment theory of choking suggests that when under pressure, an individual "begins thinking about how he or she is executing the skill, and endeavours to operate it with his or her explicit knowledge of its mechanics" (Masters, 1992, p. 345). This theory, together with other theories which postulate similar mechanisms for the breakdown of performance under pressure (e.g. Baumeister, 1985; Langer and Imber, 1979), does not distinguish between different types of skill. Consequently, one possibility not previously addressed is that, for skills in which the adoption of a specific set-up position is an important factor, performance disruption occurs because of reinvestment of technical rules relating to the set-up rather than the movement itself. In addition, reinvestment theory does not specify the number of rules that need to be reinvested before performance disruption will occur.

The results of Experiment 5 did not support the hypothesis that reinvesting rules about set-up would disrupt performance. Attending to four set-up instructions did not lead to a different level of performance than was observed in the baseline condition. By contrast, verbalising four instructions relating to the putting stroke did disrupt performance, thereby demonstrating that verbal reinvestment of rules before movement initiation leads to disruption of that movement.

The two studies presented in this chapter did not make any attempt to manipulate pressure. The finding that certain things disrupt performance whilst others do not in a non-pressure situation does not, of course, necessarily imply that the same processes are responsible for performance disruption in pressure situations. Nevertheless, the above experiments do provide support for the central assumptions upon which the reinvestment theory of choking is based. It is also encouraging to note that the level of disruption found in the Swing 4 conditions of Experiments 5 and 6 was similar to that found in the control group when putting under the pressure manipulation in Experiment 4.

In terms of rule-governed behaviour, the present results suggest that at least two qualifiers must be added to the statement that rule-governed behaviour at the topographical level will disrupt the performance of a well-learned skill. First, the nature of the skill must be taken into account. Many self-paced, discrete skills require that the person adopt a precise position from which to execute the skill. This is true of skills such as snooker, archery, and rifle shooting as well as golf. The results of Experiment 5 suggest that if a performer reinvests rules at the technical level that only relate to the topography of the set-up position, then disruption of performance will not occur. Secondly, the results of Experiment 6 suggest that if the pressure situation leads the performer to reinvest only one or two rules relating to the topography of the swing then, again, performance will not be disrupted.

Chapter 6- Using Verbal Cues to Prevent Choking: Testing the Effect of the Source and Focus of the Cue

Experiment 7

6.1. Introduction

In Experiment 5 it was found that golfers could verbalise four instructions about the correct set-up position to adopt for putting, without this disrupting subsequent performance. A key question arising from this finding is whether using verbal cues relating to the set-up will prevent choking. Similarly, in Experiment 6 it was found that verbalising instructions that specified just two components of the putting stroke did not affect the level of performance attained. Again, a question which arises is whether this type of verbal cue will be effective in preventing choking.

A second important consideration relates to the origin of the verbal stimulus. In particular, whether the stimulus is self-generated or has an external origin, such as a coach, or instruction book. This is particularly important from an applied perspective because of the prevalence of coaches or teaching professionals, who can often be seen giving players advice on the practice ground just before the start of a round. Again, the prevention hypothesis predicts that both types of verbal stimulus will be effective in preventing performance disruption in a pressure situation.

The reinvestment theory of choking, updated to take into account the results of Experiments 5 and 6, predicts that reinvesting rules relating to more than two technical aspects of the putting action will be disruptive to performance. Consequently, the refined "prevention hypothesis" predicts that any activity that prevents subjects from engaging in this form of rule-governed behaviour will be effective in preventing performance disruption under pressure. Thus, it is hypothesised that if subjects use verbal cues that specify aspects of the set-up or just two aspects of the swing, their performance will remain at a high level in a pressure situation.

The performance of subjects verbalising set-up stimuli is of particular interest because this type of instruction does not require the subject to monitor or control any aspect of their behaviour during the actual putting stroke. In this sense the task demands are the same as those for the group that verbalised task-irrelevant words ("red-green-yellow-blue") in Experiment 4. The results of that experiment with respect to the prevention hypothesis were inconclusive because the performance of the RGYB group was not significantly different from either the control group (that choked) or the verbal and visual cue groups (that did not choke).

The main aims of the present experiment are, firstly, to replicate the choking effect shown by the control group in Experiment 4 and, secondly, to test the refined prevention hypothesis by examining two factors that are important considerations for the competitive golfer, the source and the focus of the verbal cue.

6.2. Method

6.2.1. Subjects

50 male golfers from the University of St. Andrews took part in the experiment. All but one of the subjects were aged between 18 and 25 years and one subject was aged 50 years (overall mean = 21.52, SD = 5.79). Handicaps ranged from "plus one" to 18 (mean = 7.02, SD = 4.44) and golfers had a mean of 10.20 years golfing experience (SD = 4.60).

6.2.2. Apparatus/Task

The same apparatus and task that was used for the previous putting experiments was again used in the present experiment (see section 4.11.2). As in Experiment 4, each subject had the choice of either using their own putter or a "Ping Anser" putter, provided by the experimenter. The putting action of each subject was recorded using a Panasonic VHS video camera.

6.2.3. Design

The four phases of the experiment were the same as in Experiment 4. Thus, there was a "warm-up" stage of at least 20 putts in which subjects familiarised themselves with the task, and pace of the putt. This was followed by 20 putts to determine baseline performance, an intervention phase of at least 20 putts, and finally a competition phase of 20 putts, in which the pressure manipulation took place.

To assess putting performance, the same dependent variables that were used in Experiment 4 were used in the present experiment. These included the number of points scored on each putt and, from the grid references, the radial error, vertical error (signed and unsigned), and horizontal error (signed and unsigned) associated with each putt. One change from Experiment 4 was that the precise finishing position of each ball was recorded in all four stages of the present experiment, rather than just the competition stage.

6.2.4. Procedure

On entering the room subjects completed the front page of the experimental questionnaire (see Appendix 13) which was designed to obtain some general background information (i.e. age, handicap and number of years golfing experience). Subjects were also asked to write down as many rules as they could concerning the putting stroke and the correct set-up for putting. In addition, there were two questions asking the subject to describe any "swing thoughts" or other concentration strategies that he routinely used when putting. After these questions, the subject was shown the apparatus and the task was explained to them. Specifically the following instructions were read to subjects in the non-control groups.

> "In the experiment today you will take approximately 80 putts in all. These will be split into four blocks of 20 and you will be able to rest for a few minutes between each block of 20 putts.
>
> For the first two blocks of 20 putts you will simply putt using your normal routine. In the third block you will practise putting using a concentration strategy. Finally, in the last block of 20 putts you will have the chance to putt for some money."

For subjects in the control group, the instructions were the same with the exception that reference to "two blocks" was replaced with "three blocks", and the sentence beginning "In the third block you will...." was omitted.

6.2.4.1. Stage 1- Warm-up

The instructions continued with the following information regarding the warm-up stage of the experiment:

> "For the first block of 20 putts then, I simply want you to practice so that you become completely comfortable with the pace of the putt. As you will discover, the sheet creates quite a slick surface.
>
> Regarding the putt itself, as opposed to a normal putt, in which you generally want to run the ball past the hole, there is no difference in this experiment between a putt which finishes short and one which finishes past the target. For example, a ball finishing in the 2-zone here (ball placed in the 2-zone short of the target) will receive the same number of points as a ball finishing in the 2-zone here (ball placed

in the 2-zone beyond target). The putt is therefore a 'lag putt' in which the aim is to have the ball come to rest as near as possible to the central 'red 5' target circle.

Go ahead now and take your 20 putts. I will return the ball to you each time and will let you know every so often how many putts you have had."

As with Experiment 4, after 20 warm-up putts the subject was asked whether or not he required any further putts in order to become fully accustomed to the pace of the putt. If requested, the subject was allowed to take up to 20 additional putts.

6.2.4.2. Stage 2- Baseline

As in Experiment 4, subjects were given 20 putts from which their baseline score was calculated. The following standardised instructions were read to each subject:

"For the next 20 putts the aim is simply to try to score as many points as possible, using your normal putting routine. This is not a competition and there are no expectations about performance so simply try to score as many points as possible. While it is theoretically possible to score 100 points this is obviously extremely unlikely, so simply try to do the best you can. I will continue to return the ball to you each time and let you know every so often how many putts you have taken, and how many points you have scored."

Specifically, subjects were told how many putts they had taken and how many points they had scored after the fifth, tenth, fifteenth and twentieth putts.

6.2.4.3. Stage 3- Intervention

Subjects were assigned to one of five groups, taking into account their answers to the questions at the beginning of the experiment. In particular, it was considered important that subjects in the Control group did not report routinely using any of the same types of swing thought that were being used in the present experiment. In cases where subjects did report using swing thoughts (relating to either the set-up or putting action) they were randomly allocated to one of the two groups incorporating the relevant swing thought. In total, nine out of fifty subjects reported using swing thoughts, with eight of these relating to the putting action and one relating to the set-up.

Subjects in the non-control groups were then read the following passage:

> "As you are probably aware, golfers use a number of different techniques to help them concentrate when putting. One of these is to use "swing thoughts". In the next stage of the experiment, I want you to use a swing thought before each of the 20 putts."

Set-up (given) Group

In the Set-up (given) group, subjects were given two instructions concerning the set-up that were used in Experiment 5. The specific instructions were as follows:

> "In particular, I would like you to read 2 instructions concerning the set-up for a putting stroke [at this point a sheet of paper showing full versions of the two instructions was placed on the floor]. These are taken from several golf instruction books and are selected because the consensus of opinion suggests that each instruction is a key component of a good set-up. They have also been verified by a PGA qualified teaching professional as being key components in a sound set-up. You may well have written down similar instructions to these in the questionnaire at the start of the experiment. Do you understand what these instructions mean?
>
> Over the next 20 putts I would like you to really concentrate on these instructions, attempting to ensure that the actions specified by each one are being performed correctly. To help you do this, and to ensure that you attend to both of the instructions, I would like you to use the following swing thought:
>
> "EYES OVER BALL, IN LINE"
>
> This should be verbalised just before each putt. Once you have done this go ahead and putt the ball in your normal way, continuing to try to score as many points as possible. As in the previous block, every so often I will let you know how many putts you have taken."

Swing (given) Group

Subjects in the Swing (given) group were given two instructions concerning the swing that were used in Experiments 6 and 7. The instructions were identical to those for the Set-up (given) group, except for replacement of the word "set-up" with the word "swing", and the actual swing thought to be verbalised before each putt which was:

"HEAD STILL, WRIST FIXED"

Set-up (self) Group

Subjects in the Set-up (self) group were read the following instructions:

"In particular, I would like you to formulate a swing thought from 2 instructions that you think are key components of a sound set-up. So, for example, on your questionnaire you mentioned....." [at this point the "rules" that the subject listed in the questionnaire were read back to him].

The rules that had been noted were then discussed, and two that the subject felt were most important were chosen to be the focus of the swing thought. The experimenter then continued:

"Over the next 20 putts I would like you to really concentrate on these instructions in the few seconds before putting. To help you do this, and to ensure that you attend to both of the instructions, I would like you to turn them into an easily verbalised swing thought. Let's do that now".

When the swing thought had been decided upon, the final instructions were read out:

"This swing thought should be verbalised before each putt. Once you have done this go ahead and putt the ball in your normal way, continuing to try to score as many points as possible. As in the previous block, every so often I will let you know how many putts you have taken".

The verbal cues used by the Set-up (self) group in the present experiment are listed in Appendix 14.

Swing (self) Group

The instructions for the Swing (self) group were the same as for the Set-up (self) group except for the word "set-up" which was replaced by the words "putting stroke". The verbal cues used by the Swing (self) group in the present experiment are listed in Appendix 14.

Control Group

Subjects in the control group simply took an additional 20 putts using their usual putting technique during the intervention stage of the experiment.

As in Experiment 4, subjects in the four experimental groups were given a minimum of 20 putts in which to become accustomed to incorporating the verbal cue into their putting routine. Again, it was not possible to have an explicit rule or formula for deciding whether a subject required additional putts. The decision was, therefore, a subjective one based on visual inspection of the data over the course of the 20 putts. It should be noted, however, that similar verbal stimuli had been found to have no effect on performance in previous experiments so that no disruption to performance was expected.

6.2.4.4. Stage 4- Pressure Manipulation

The pressure manipulation was identical to the one used in Experiment 4 (see section 4.11.4.4). Thus, subjects were again given a chance to putt for extra money by competing with the scores of five other fictitious golfers purported to be in the same handicap bracket as the subject.

After reading the standard set of instructions, subjects in the non-control groups were instructed to continue using the swing thought that had been introduced during the previous session. All subjects were then advised that, as in previous stages, every so often they would be told how many putts they had taken and how many points they had scored. As in Experiment 4 this information was given after the 5th, 10th, 15th, 18th and 20th putts, as well as any other occasions that the subject requested it.

At the end of the competition session, the subject filled out the remainder of the questionnaire (Appendix 13) after which any questions that the subject had about the experiment were answered. Finally, the subject was paid £3.50, plus any money won during the competition, for participating in the experiment.

6.3. Results

6.3.1. Points Scored

The total number of points scored by each group in the baseline and competition stages of the experiment are shown in Table 6.1 and are illustrated in Figure 6.1. From the graph in Figure 6.1, it can be seen that the mean scores of the Control and Swing (given) groups were lower in the competition than baseline stage of the experiment while the remaining groups scored approximately the same number of points in these stages.

The data were analysed by a one-factor analysis of covariance (ANCOVA), with the dependent variable being the number of points scored in the competition, and baseline score the covariate. The interaction between baseline score and group was non-significant and was, therefore, removed from the analysis. The resulting table indicated a significant main effect for group ($F(4,44) = 4.58$, $p<.01$), with baseline score also being a significant predictor of competition score ($F(1,44) = 31.79$, $p<.001$).

Post-hoc analysis of the competition scores, using the Tukey HSD test, indicated that the Swing (self) group scored significantly more points than the Control and Swing (given) groups. No other differences reached significance.

6.3.2. Radial Error

The radial error group means in the baseline and competition stage are presented in Table 6.1 and are illustrated in Figure 6.2. In line with the points data, it can be seen that mean radial error is greatest in the Control and Swing (given) groups, and least in the Swing (self) group.

The radial error data during the competition stage were analysed by a one-factor ANCOVA with baseline radial error as covariate. The test for homogeneity of slopes revealed no significant interaction between group and the covariate which was, therefore, removed from the analysis. The resulting table indicated a significant group main effect ($F(4,44) = 4.13$, $p<.01$). A Tukey HSD post-hoc test revealed a significant difference between radial error scores in the Set-up (self) and Swing (given) groups in addition to the same differences that were found using the points data (i.e. a significant difference between radial error scores in the Swing (self) group and both the control and Swing (given) groups).

6.3.3. Block Effect

The pattern of performance over the course of the 20 putts was analysed in the baseline and competition stages by dividing subject scores into four consecutive blocks of five putts. Mean scores are shown in Table 6.2.

The data were analysed using a 5 x 4 x 2 (group x block x stage) ANOVA, with repeated measures on the stage and block factors, using the Greenhouse-Geisser adjustment where appropriate. The analysis revealed no significant interaction between group and block ($F(12,135) = 0.58$, n.s.) but a significant interaction between stage and block ($F(3,135) = 2.85$, $p<.05$). The graph of this interaction is shown in Figure 6.3, in which it can be seen that the difference between baseline and competition scores was approximately the same in blocks one, three and four but that, in block

Table 6.1. Group means and standard deviations for point and radial error scores in the baseline and competition stages of Experiment 7. Least square mean scores represent competition scores adjusted to take into account the respective baseline covariates.

	Total Score (pts)					
	Baseline		*Competition*			
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	72.00	4.71	66.70	4.35	66.47	4.74
Swing (self)	71.80	7.33	73.50	7.53	73.40	4.73
Set-up (self)	72.60	4.62	72.40	5.13	71.76	4.75
Swing (given)	72.00	6.15	67.00	7.36	66.77	4.74
Set-up (given)	69.90	5.99	70.70	5.72	71.90	4.78
All Groups	71.66	5.68	70.06	6.52		

	Radial Error (cm)					
	Baseline		*Competition*			
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	19.61	2.97	21.84	2.42	21.76	2.58
Swing (self)	19.58	4.34	18.26	4.01	18.19	2.58
Set-up (self)	18.76	3.26	18.73	3.28	19.15	2.59
Swing (given)	19.35	3.61	21.78	3.88	21.85	2.58
Set-up (given)	20.08	3.52	19.67	2.68	19.31	2.59
All Groups	19.48	3.45	20.06	3.52		

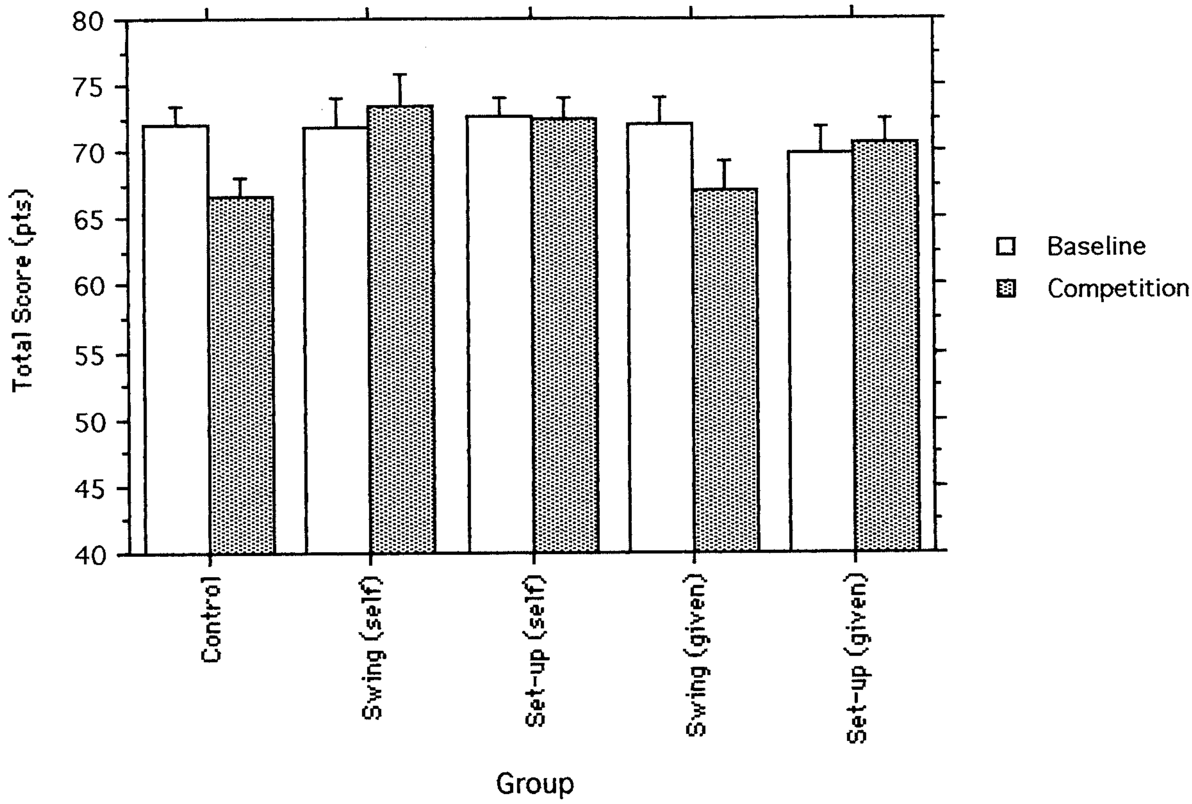

Figure 6.1. Mean total point scores for each group in the baseline and competition stages of Experiment 7, with standard error error bars.

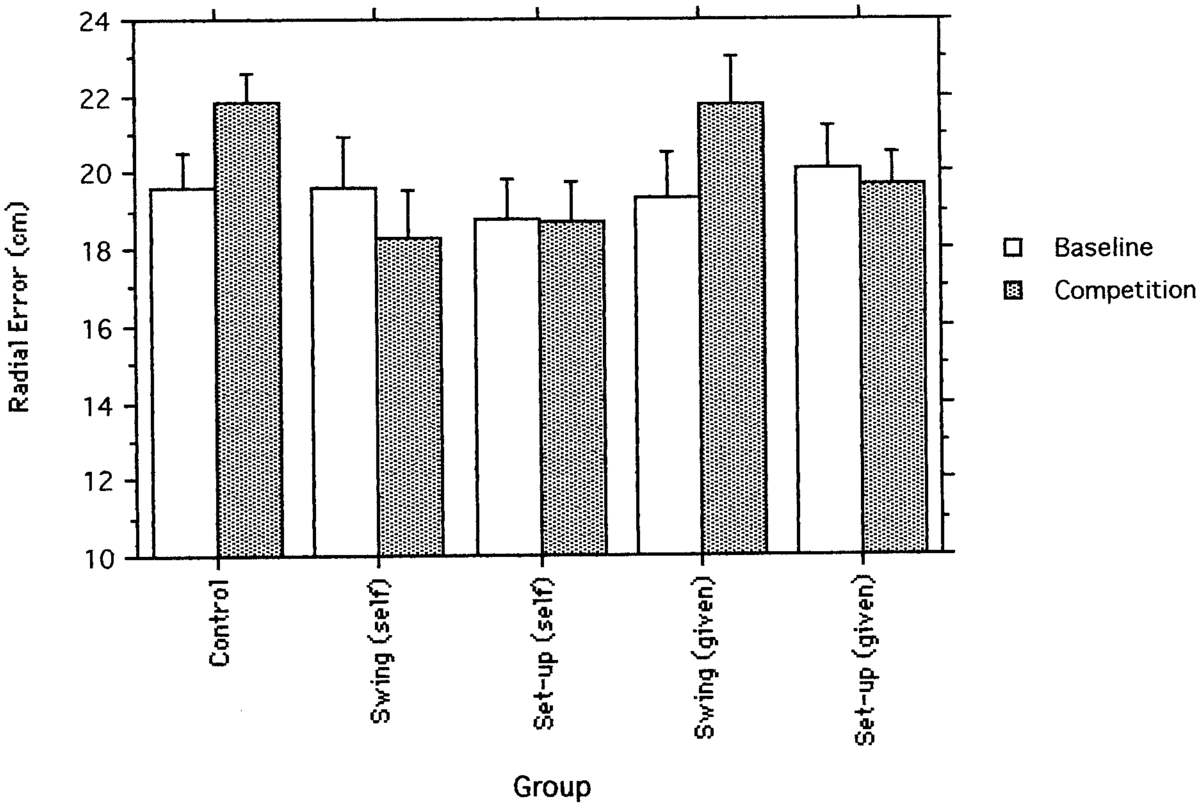

Figure 6.2. Mean radial error scores for each group in the baseline and competition stages of Experiment 7, with standard error error bars.

Table 6.2. Group means and standard deviations for point scores in consecutive blocks of five putts in the baseline and competition stages of Experiment 7 (maximum score in each block = 25 pts).

Group	***Block 1 (Putts 1-5)***				***Block 2 (Putts 6-10)***			
	Baseline		*Competition*		*Baseline*		*Competition*	
	Mean	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
Control	18.50	3.54	16.70	2.26	16.40	2.55	16.80	2.30
Swing (self)	18.10	2.88	16.00	3.80	16.90	3.03	18.70	1.70
Set-up (self)	18.70	2.41	17.90	2.13	16.30	3.53	17.70	3.47
Swing (given)	17.10	3.11	17.10	2.38	16.80	3.85	16.30	3.92
Set-up (given)	16.30	3.37	18.10	2.88	17.10	2.69	18.40	2.55
All Groups	17.74	3.10	17.16	2.76	16.70	3.05	17.58	2.93

Group	***Block 3 (Putts 11-15)***				***Block 4 (Putts 16-20)***			
	Baseline		*Competition*		*Baseline*		*Competition*	
	Mean	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
Control	18.70	1.95	17.10	3.75	18.40	1.84	16.10	2.77
Swing (self)	17.80	1.93	20.30	1.95	17.30	5.38	17.30	4.45
Set-up (self)	19.20	2.82	18.20	1.99	18.40	1.51	18.60	2.76
Swing (given)	18.90	2.02	16.40	3.06	19.20	2.15	17.10	2.92
Set-up (given)	18.20	2.30	17.60	2.84	18.30	2.91	16.60	3.24
All Groups	18.56	2.20	17.92	3.00	18.32	3.02	17.14	3.26

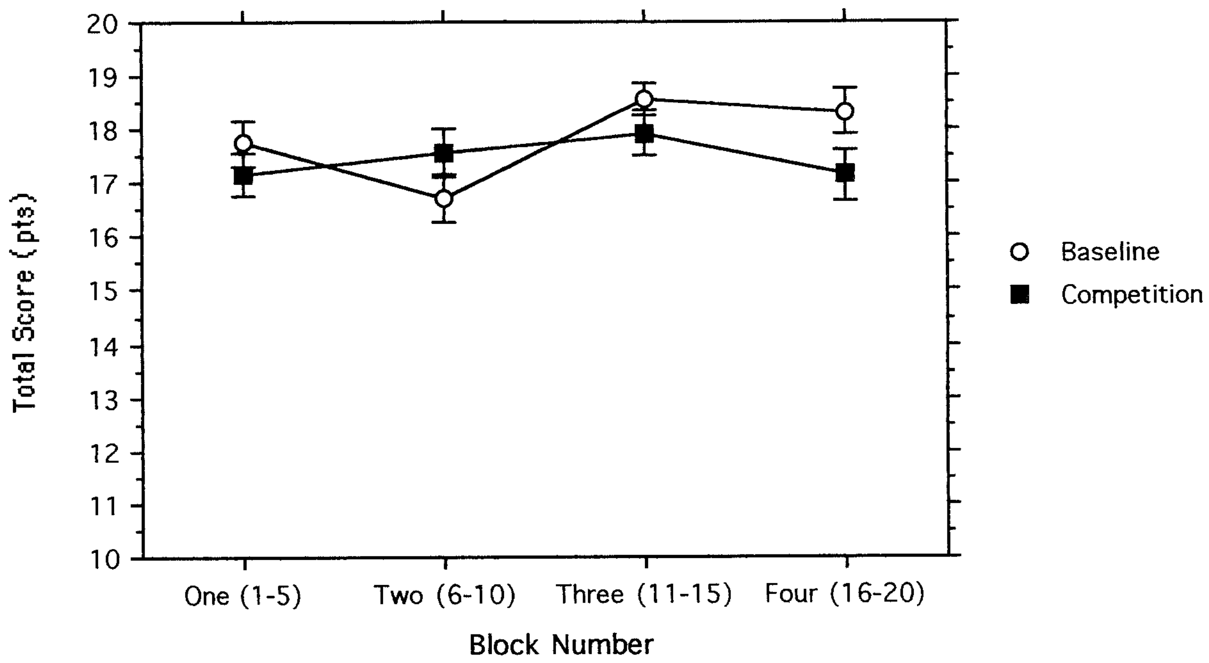

Figure 6.3. Graph showing the interaction between stage (baseline/ competition) and trial block in Experiment 7, with standard error error bars. Each block consists of five putts, giving a maximum possible score of 25 points.

two, baseline performance dropped below that achieved in competition. The three-way interaction between stage, block and group was non-significant ($F(12,135) = 1.30$, n.s.), indicating that the different patterns of performance across blocks observed in the baseline and competition stages were similar for all five groups.

6.3.4. Vertical and Horizontal Error Scores

The precise final position of each putt, represented by a grid reference, was used to calculate the mean radial error, vertical error (signed and unsigned) and horizontal error (signed and unsigned) for each putt. The group means for the two horizontal and two vertical error variables in the baseline and competition stages of the experiment are shown in Table 6.3. In the analysis of the vertical and horizontal error scores, a Bonferroni adjustment was made to the critical levels of significance to take into account the increased probability of a Type I error associated with conducting separate ANCOVAs for each of the dependent variables.

6.3.4.1. Vertical and Horizontal Error (unsigned)

The vertical and horizontal unsigned error variables were analysed by separate one-way ANCOVAs, using baseline unsigned vertical and horizontal error scores as respective covariates. For the vertical error (unsigned), the group by baseline interaction was non-significant and was, therefore, removed from the analysis. The resulting analysis revealed a significant group main effect ($F(4,44) = 4.13$, $p<.025$) with the Tukey HSD post-hoc test indicating the same differences between groups that were found with the radial error data.

For the horizontal error (unsigned), the group by baseline interaction was again non-significant and was, therefore, removed from the analysis. There was no evidence of a group main effect in the resulting table ($F(4,44) = 1.09$, n.s.). The vertical and horizontal unsigned error scores are illustrated in Figures 6.4 and 6.5 respectively.

6.3.4.2. Vertical and Horizontal Error (signed)

The vertical and horizontal (signed) error variables were also analysed by two separate one-way ANCOVAs, using their respective baseline vertical and horizontal error (signed) scores as covariates. In both cases the interaction between the respective baseline error score and group was non-significant and was, therefore, removed from the analysis. The resulting analysis indicated no significant group main effect for either vertical ($F(4,44) = 1.27$, n.s.) or horizontal ($F(4,44) = 0.58$, n.s.) signed error scores.

Table 6.3. Group means and standard deviations for vertical and horizontal error scores in the baseline and competition stages of Experiment 7. Signed data takes into account the directional component of errors, with negative scores indicating putts finishing short and/or left of the "origin" of the target. Competition least square means represent mean scores adjusted to take into account the effect of the relevant baseline covariates.

Group	*Vertical Error (signed)*						*Horizontal Error (signed)*					
	Baseline		*Competition*				*Baseline*		*Competition*			
	Mean	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	1.64	4.92	-0.81	4.11	-1.14	4.70	-3.17	2.92	-2.16	3.61	-1.40	2.41
Swing (self)	0.67	2.41	0.54	3.22	0.57	4.69	-2.28	2.76	-2.51	4.55	-2.60	2.38
Set-up (self)	-0.19	5.52	2.67	5.77	3.02	4.71	-1.65	1.93	-0.48	2.65	-1.17	2.41
Swing (given)	2.50	5.18	1.84	6.30	1.18	4.75	-2.70	2.31	-1.94	2.76	-1.62	2.39
Set-up (given)	-0.83	5.68	-1.37	4.88	-0.78	4.74	-2.07	2.20	-1.02	2.62	-1.32	2.39
All Groups	0.76	4.84	0.57	5.02			-2.37	2.41	-1.62	3.28		

Group	*Vertical Error (unsigned)*						*Horizontal Error (unsigned)*					
	Baseline		*Competition*				*Baseline*		*Competition*			
	Mean	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	18.03	3.97	20.22	3.52	19.78	2.94	5.11	1.67	5.05	1.69	5.37	1.18
Swing (self)	16.56	5.35	14.93	4.74	15.36	2.94	5.45	1.96	5.86	2.92	5.91	1.15
Set-up (self)	16.38	3.25	16.44	3.51	16.99	2.95	5.32	0.62	5.31	1.02	5.25	1.19
Swing (given)	17.24	3.93	19.67	4.09	19.70	2.93	5.76	1.29	6.31	1.19	6.19	1.17
Set-up (given)	18.26	3.91	17.86	2.93	17.29	2.95	5.78	0.82	5.29	1.67	4.83	1.23
All Groups	17.29	4.04	17.82	4.16			5.48	1.34	5.56	1.81		

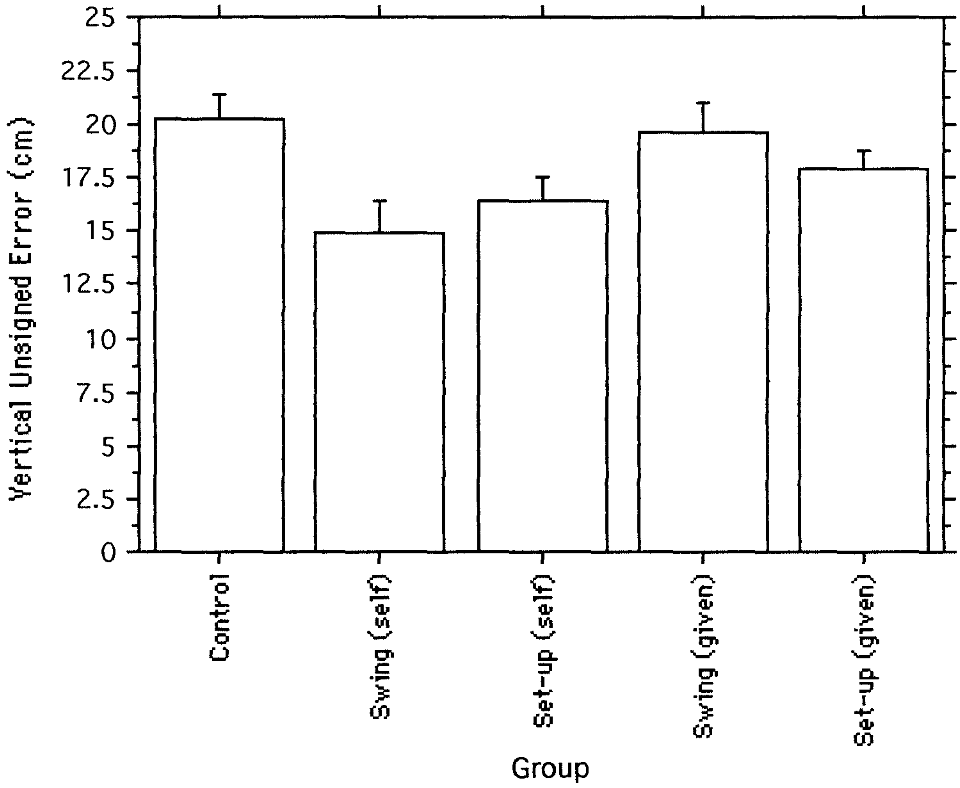

Figure 6.4. Mean vertical unsigned error scores for each group during the competition stage of Experiment 7, with standard error error bars.

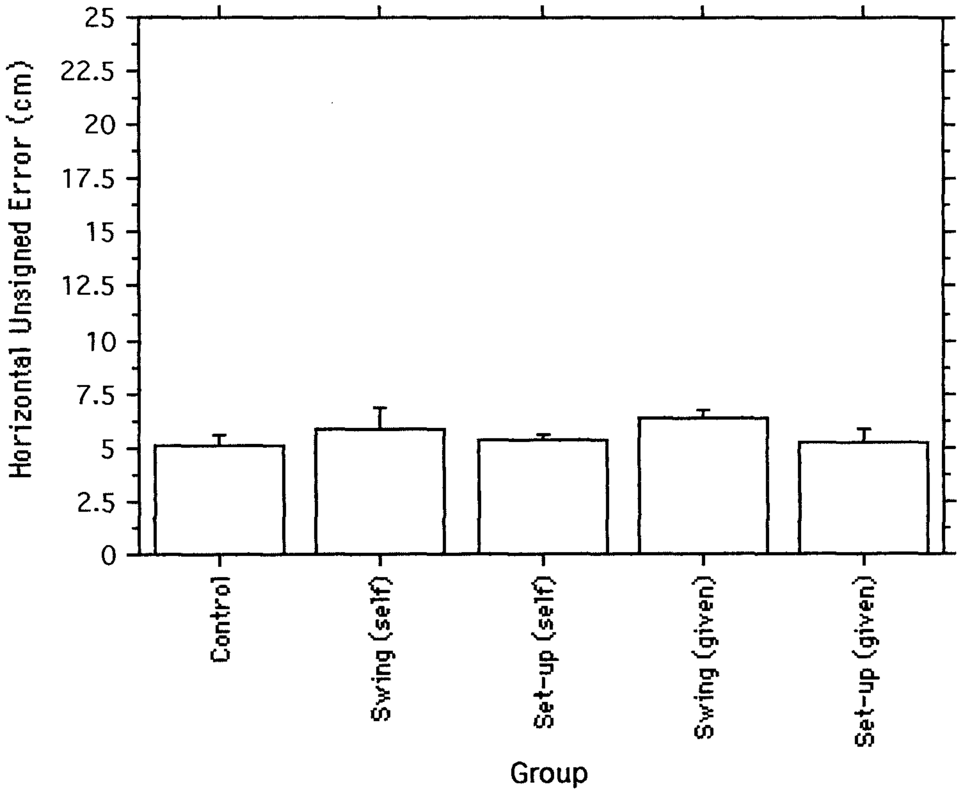

Figure 6.5. Mean horizontal unsigned error scores for each group during the competition stage of Experiment 7, with standard error error bars.

6.3.5. Consistency of Performance

To measure consistency of performance, standard deviations of each subject's radial error scores were calculated for the 20 putts in both the baseline and competition stages of the experiment. This will be referred to as VE Rad (variable error of radial error). The mean values for each group in the baseline and competition stages of the experiment are shown in Table 6.4.

The data were analysed by means of a one-way ANCOVA using the baseline VE Rad scores as covariate. Analysis of the data indicated that the interaction between group and the covariate was non-significant, therefore it was removed from the analysis. The resulting table revealed a significant main effect for group ($F(4,44) = 4.24, p<0.05$), however, a Tukey HSD post-hoc test indicated no significant group differences. Visual inspection of the means and least square means in Table 6.4 indicates that subjects in the Set-up (self) and Swing (self) groups had the most consistent performance of the five groups, with the Control and Swing (given) groups being least consistent.

6.3.6. Routine Analysis

In the present experiment, both routine and concentration times were calculated from the video recordings. Routine time was defined as the time from placement of the ball to initiation of the putting stroke. Concentration time was defined as the time from the moment the putter face was grounded behind the ball to the moment the putting stroke was initiated. Two pre-shot routine behaviours were also noted from analysis of the videos: the number of times each subject glanced at the target and the number of practice swings that were taken.

6.3.6.1. Mean Routine and Concentration Times

For the purpose of statistical analysis, routine and concentration times in the competition stage were compared with baseline times for the control group and intervention stage times for the non-control groups. As in Experiment 4, this was done to take into account any effect that the intervention might have on the length of these times. The "comparison" and competition routine and concentration times for each group are shown in Table 6.5. A Bonferroni adjustment was made to the critical levels of significance to account for the increased probability of a Type I error associated with conducting separate ANCOVAs for each of the dependent variables.

The routine time data were analysed, firstly, by a one-way ANCOVA, with the appropriate comparison routine time as covariate. The interaction between the

Table 6.4. Group means and standard deviations for variable error associated with both point and radial error data in Experiment 7. Variable error represents intra-subject standard deviations measured accross each set of 20 putts. Least square means represent competition scores adjusted to take into account the effect of the respective baseline covariates.

	Variable Error (Pts)					
	Baseline		*Competition*			
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	1.18	0.26	1.34	0.28	1.37	0.26
Swing (self)	1.27	0.29	1.09	0.36	1.07	0.26
Set-up (self)	1.25	0.20	1.08	0.30	1.07	0.26
Swing (given)	1.26	0.21	1.32	0.27	1.31	0.26
Set-up (given)	1.20	0.30	1.21	0.23	1.23	0.26
All Groups	1.23	0.25	1.21	0.30		

	Variable Error (Radial Error)					
	Baseline		*Competition*			
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	12.61	4.00	14.14	3.16	14.17	3.20
Swing (self)	13.52	5.60	10.71	3.73	10.33	3.22
Set-up (self)	12.72	4.50	11.07	4.47	11.05	3.20
Swing (given)	12.49	3.12	14.37	4.12	14.45	3.20
Set-up (given)	12.02	3.67	12.27	2.63	12.56	3.21
All Groups	12.67	4.12	12.51	3.85		

covariate and group was non-significant and so was removed from the analysis. In the resulting table, there was no evidence of a group main effect (F(4,44) = 0.79, n.s.). Secondly, to investigate changes in times from the comparison to the competition stages, a 5 x 2 (group x stage) ANOVA was calculated, with repeated measures on the stage factor. This revealed a significant main effect for stage (F(1,45) = 17.18, p<.0005), but no interaction between stage and group (F(4,45) = 1.05, n.s.). As can be seen from Figure 6.6 all groups had longer pre-shot routine times in the competition stage of the experiment.

The concentration time data was analysed in the same way. After removal of the non-significant interaction between group and the comparison covariate, the ANCOVA again failed to indicate a significant group main effect (F(4.44) = 0.56, n.s.). The 5 x 2 ANOVA revealed similar results to the above, with a significant main effect for stage (F(1,45) = 10.00, p<.005) and no interaction between stage and group (F(4,45) = 0.56, n.s.). As with the routine time data, all groups had longer concentration times in the competition stage of the experiment.

6.3.6.2. Consistency of Routine and Concentration Times

Consistency of routine and concentration times was also assessed by analysing the standard deviations of each subject's times over the 20 putts in each stage. The mean group data is shown in Table 6.5 where it can be seen that both routine and concentration times were more variable in the competition stage of the experiment for four of the groups, the exception being the Set-up (Given) group. A 5 x 2 (group x stage) ANOVA on the routine time variable error data revealed a significant main effect for stage (F(1,45) = 4.88, p<.05), but not group (F(4,45) = 1.81, n.s.), and no interaction between the two (F(4,45) = 1.50, n.s.). The same pattern of results emerged using the concentration time variable error data. Again there was a significant main effect for stage (F(1,45) = 6.17, p<.05) but not group (F(4,45) = 1.17, n.s.) and no significant interaction between the two (F(4,45) = 1.74, n.s.).

6.3.6.3. Routine Behaviour

The mean number of glances towards the target and practice swings taken before each putt in the competition and appropriate comparison stage of the experiment are presented in Table 6.6. As with the analysis of pre-shot routine and concentration times, comparison data are represented by intervention data for non-control groups and baseline data for the control group. Analysis of the glance data by a 5 x 2 (group x stage) ANOVA with repeated measures on the stage factor, revealed a significant main effect for stage (F(1,45) = 10.51, p<.01), but not for group (F(4,45)

Table 6.5. Group means and standard deviations for routine and concentration times in the competition and "comparison" stages of Experiment 7. Baseline times were used for comparison in the control group and intervention times were used for comparison in the non-control groups. Variable error data gives an indication of the consistency of times in each group with smaller numbers indicating greater consistency.

	Routine Time						**Concentration Time**					
	Comparison		*Competition*				*Comparison*		*Competition*			
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	4.31	1.89	5.16	2.23	6.17	1.03	3.62	1.16	3.85	1.24	5.03	0.86
Swing (self)	4.42	1.35	4.92	1.35	5.81	1.02	4.13	1.26	4.51	1.32	5.21	0.82
Set-up (self)	5.26	1.11	6.22	1.37	6.31	0.99	4.92	1.32	5.57	1.59	5.52	0.80
Swing (given)	6.21	2.05	6.54	2.10	5.73	1.02	6.08	1.89	6.24	1.87	5.08	0.86
Set-up (given)	6.58	1.81	6.81	2.14	5.64	1.05	5.58	2.01	5.96	2.23	5.28	0.82
All Groups	5.36	1.86	5.93	1.96			4.87	1.76	5.23	1.86		

	Routine Time Variable Error						**Concentration Time Variable Error**					
	Comparison		*Competition*				*Comparison*		*Competition*			
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	0.69	0.36	1.06	0.59	1.07	0.54	0.62	0.37	0.94	0.73	0.97	0.47
Swing (self)	0.45	0.18	0.68	0.34	0.75	0.57	0.46	0.18	0.58	0.35	0.71	0.49
Set-up (self)	0.79	0.25	1.16	0.75	1.14	0.54	0.61	0.33	1.04	0.56	1.08	0.47
Swing (given)	0.71	0.47	0.88	0.44	0.89	0.54	0.76	0.49	0.85	0.48	0.79	0.47
Set-up (given)	0.97	0.55	0.78	0.51	0.71	0.56	0.92	0.54	0.83	0.47	0.67	0.49
All Groups	0.72	0.41	0.91	0.55			0.67	0.42	0.85	0.53		

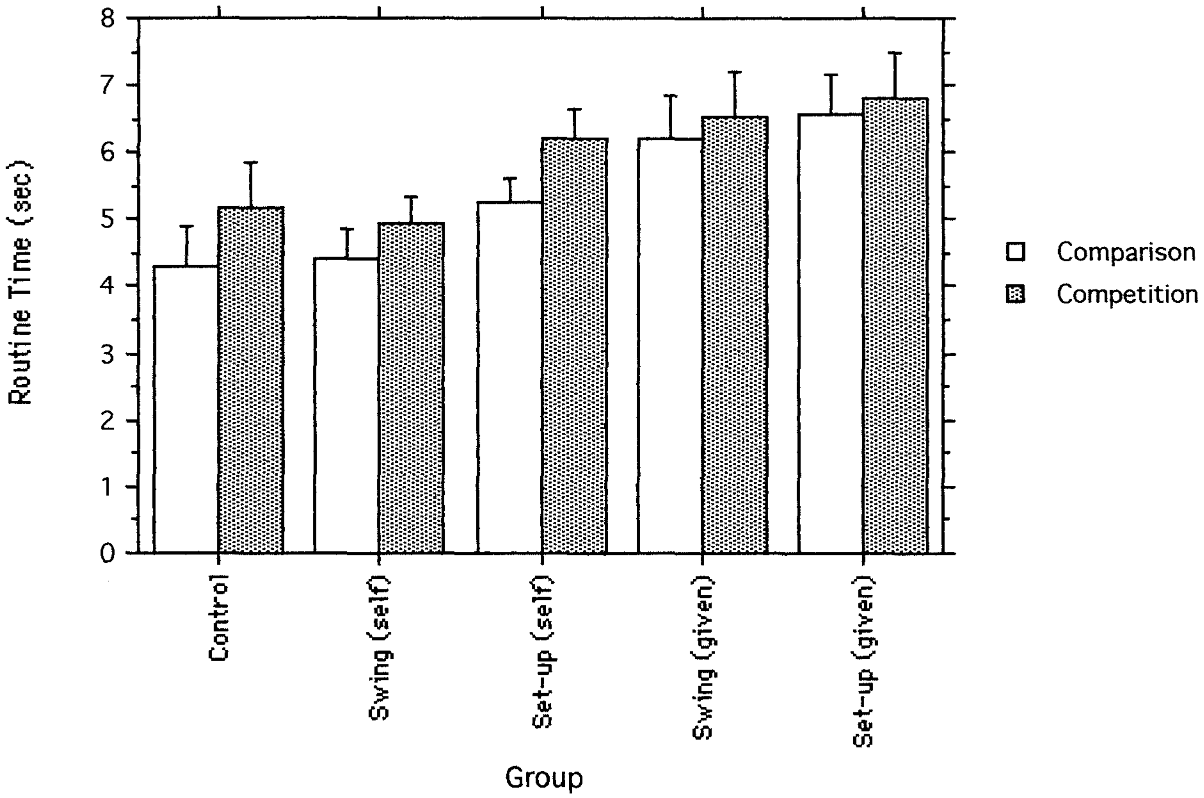

Figure 6.6. Mean routine times for each group in the "comparison" and competition stages of Experiment 7, with standard error error bars.

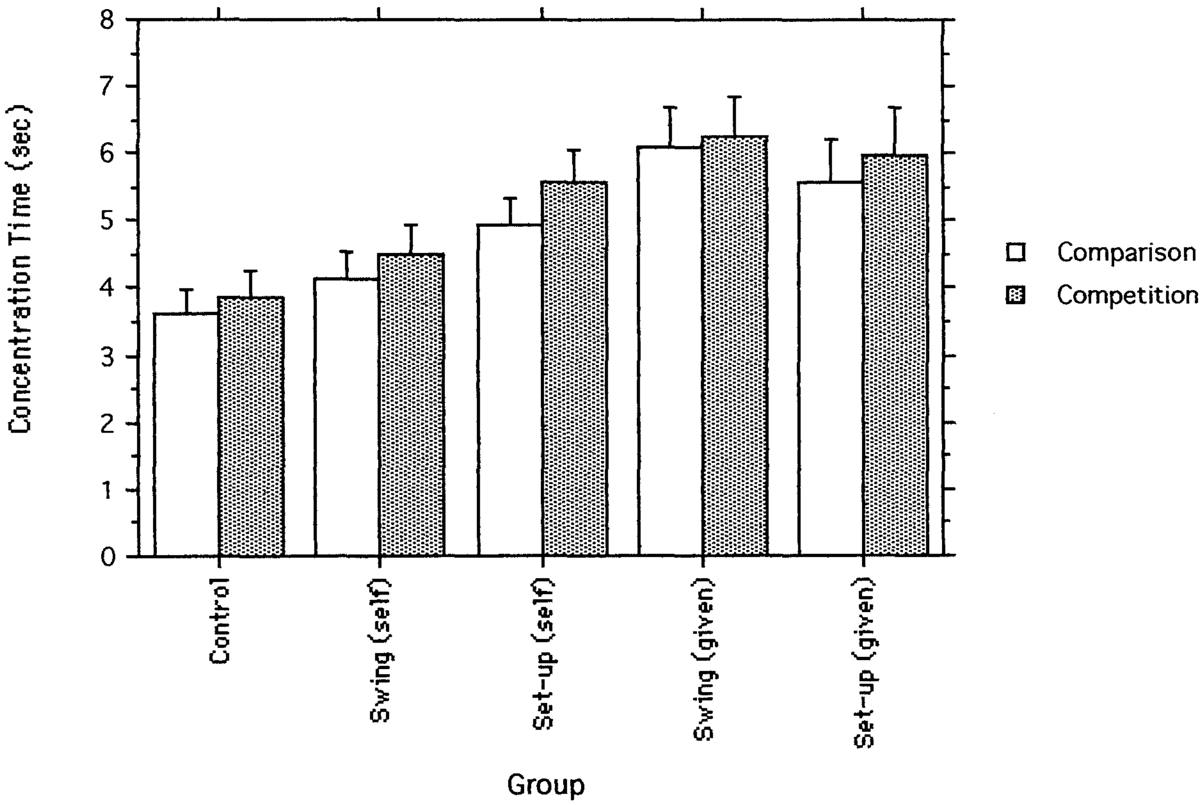

Figure 6.7. Mean concentration times for each group in the "comparison" and competition stages of Experiment 7, with standard error error bars.

Table 6.6. Group means and standard deviations for mean number of glances towards the target and practice swings taken before each putt in the competition and appropriate comparison stage of Experiment 7. The comparison stage is the baseline stage for the control group and intervention stage for non-control groups.

	Glances					
	Comparison		*Competition*			
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	1.24	1.00	1.46	0.69	1.41	0.43
Swing (self)	1.22	0.82	1.16	0.82	1.13	0.43
Set-up (self)	1.41	1.04	1.74	0.89	1.54	0.43
Swing (given)	0.84	0.56	1.06	0.81	1.35	0.44
Set-up (given)	1.20	0.41	1.52	0.74	1.51	0.43
All Groups	1.18	0.79	1.39	0.80		

	Practice Swings					
	Comparison		*Competition*			
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*L.S. Mean*	*S.D.*
Control	0.24	0.76	0.14	0.33	0.06	0.15
Swing (self)	0.00	0.00	0.08	0.19	0.11	0.14
Set-up (self)	0.03	0.06	0.02	0.06	0.04	0.14
Swing (given)	0.00	0.00	0.08	0.14	0.11	0.14
Set-up (given)	0.08	0.25	0.07	0.25	0.07	0.14
All Groups	0.07	0.41	0.08	0.55		

= 0.92, n.s.) and no interaction between the two factors ($F(4,45) = 1.23$, n.s.). From Table 6.6 it can be seen that the mean number of glances towards the target were greater in the competition stage of the experiment.

Analysis of the number of practice swings, again using data from the appropriate comparison stages, revealed no significant main effects for either group ($F(4,45) = 0.64$, n.s.) or stage ($F(1,45) = 0.12$, n.s.) and no significant interaction between the two ($F(4,45) = 0.95$, n.s.). As can be seen from Table 6.6, very few practice swings were taken before each putt in either stage of the experiment.

6.3.7. Experimental Questionnaire

6.3.7.1. Number of Rules

Subjects reported a mean of 6.12 rules (SD = 2.16) regarding correct putting technique of which a mean of 3.18 (SD = 1.38) related to the set-up and 2.94 (SD = 1.13) related to the putting stroke. To test for group differences on these variables, the data were analysed by a MANOVA which proved to be non-significant (Wilks' Lambda = 0.85, $F(12,114.06) = 0.6$, n.s.) indicating that a similar number of rules were reported by each group prior to the experiment.

6.3.7.2. Routine Consistency Ratings

Subjects were asked to rate the consistency of their pre-shot routines on a scale from 1 ("not at all") to 7 ("highly consistent"). The mean ratings for each group are presented in Table 6.7, where it can be seen that those of the control and Swing (given) groups were lower than for the other three groups in both the baseline and competition stages.

A 5 x 2 (group x stage) ANOVA, with repeated measures on the stage factor, indicated a significant main effect for group ($F(4,45) = 5.54$, $p<.01$) but not stage ($F(1,45) = 2.85$, n.s.) and no significant interaction between the two factors ($F(4,45) = 2.12$, n.s.). Post-hoc analysis of the group main effect using Tukey's HSD test revealed that there was a significant difference between the ratings of the control group and those of the Set-up (self), Swing (self) and Set-up (given) groups.

6.3.7.3. Pressure Ratings

Subjects were asked to rate how much pressure they felt under in the competition stage of the experiment compared to the baseline stage, using a 7-point Likert type scale from 1 ("much less") to 7 ("much more"). The mean ratings for each

Table 6.7. Summary of background information for each group in Experiment 7. Also shown are subject ratings for both the consistency of their pre-shot routine, on a scale from 1 ("not at all") to 7 ("highly consistent"), and how much pressure subjects felt under in the competition compared to the baseline stage, on a scale from 1 ("much less") to 7 ("much more").

	Age		**Handicap**		**Experience**	
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
Control	21.10	2.51	7.20	4.42	9.90	3.18
Swing (self)	19.50	0.97	6.40	6.10	9.80	3.19
Set-up (self)	20.80	1.03	6.90	4.36	9.55	4.74
Swing (given)	21.40	2.91	7.30	3.43	9.30	4.40
Set-up (given)	24.80	12.17	7.30	4.37	12.60	6.88
All Groups	21.52	5.79	7.02	4.44	10.20	4.60

	Consistency Rating				**Pressure Rating**	
	Baseline		*Competition*		*Competition*	
Group	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
Control	3.20	1.55	3.00	1.15	5.30	0.95
Swing (self)	5.10	1.10	4.80	1.69	5.40	0.70
Set-up (self)	4.30	1.06	5.40	0.84	5.50	0.71
Swing (given)	3.70	1.34	4.30	1.16	4.90	0.74
Set-up (given)	4.80	1.03	5.10	1.45	5.20	0.79
All Groups	4.22	1.37	4.52	1.50	5.26	0.78

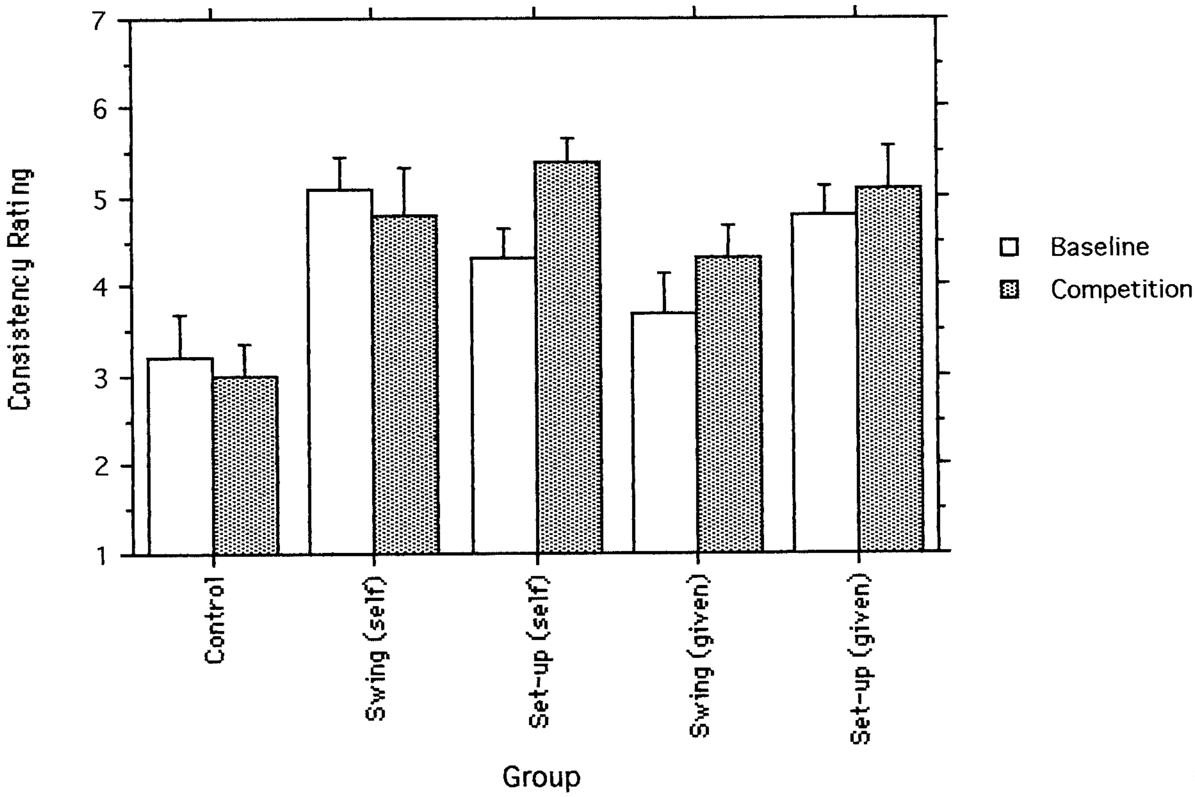

Figure 6.8. Mean pre-putt routine consistency ratings for all groups in the baseline and competition stages of Experiment 7, with standard error error bars. Ratings were scored on a 7-point scale from 1 ("not at all") to 7 ("highly consistent").

Table 6.8. Correlation matrices showing relationships between background information and putting performance. Two-tailed critical r-values for n=50 are r=.279, p<.05 and r=.361, p<.01. Correlations that are significant at least at the .05 level are typed in bold print.

	Age	*H'cap*	*Exp*	*Rules (set-up)*	*Rules (swing)*	*Rules (total)*
Rules (set-up)	*-0.17*	*-0.10*	*-0.14*	*1.00*		
Rules (swing)	***-0.28***	*-0.02*	***-0.28***	***0.48***	*1.00*	
Rules (total)	***-0.26***	*-0.07*	*-0.24*	***0.89***	***0.83***	*1.00*

	Baseline	*Comp*	*Diff*	*Radial Error*	*V. Error (signed)*	*H. Error (signed)*	*V. Error (unsigned)*	*H. Error (unsigned)*
Age	*-0.09*	*0.03*	*0.13*	*-0.03*	*-0.07*	*0.18*	*-0.03*	*0.07*
Handicap	***-0.44***	***-0.52***	*-0.16*	***0.53***	*-0.14*	*-0.05*	***0.43***	*0.14*
Experience	*-0.06*	*0.07*	*0.14*	*-0.06*	*-0.15*	*0.11*	*-0.16*	*0.07*
Rules (set-up)	***0.30***	*0.08*	*-0.20*	*-0.05*	*0.03*	*0.04*	*0.03*	*-0.08*
Rules (swing)	*0.17*	*0.10*	*-0.06*	*-0.15*	*-0.02*	*-0.14*	*-0.20*	*0.11*
Rules (total)	***0.28***	*0.11*	*-0.16*	*-0.11*	*0.01*	*-0.05*	*-0.09*	*0.01*

group are shown in Table 6.7. A one-factor ANOVA indicated no significant differences between groups ($F(4,45) = 0.87$, n.s.).

6.3.7.4. Correlations

As in Experiment 4, Pearson product-moment correlation coefficients were calculated to examine the relationships between the background data for each subject and their subsequent putting performance. These correlations are shown in Table 6.8.

From this table it can be seen that age, years of golfing experience, and the number of reported rules of correct putting technique were not significantly correlated with either the performance measures during the competition stage, or the difference between subjects' scores in the baseline and competition stages.

Interestingly, there were significant negative correlations between the number of swing rules stated and both age ($r=-.28$, $p<.05$) and years experience ($r=-.28$, $p<.05$), indicating that older, more experienced golfers tended to report fewer rules about the putting stroke. This relationship was not apparent for the set-up rules.

6.4. Discussion

One of the aims of the present experiment was to test the effectiveness of the pressure manipulation. As in Experiment 4, support was found for its effectiveness, with the control group again scoring fewer points in the competition compared to the baseline stage. Thus, although not a perfect replication of the pressure golfers may experience when in the position to win a tournament, the individualised pressure manipulation, was successful in creating the potential for performance disruption.

The present experiment represented a third test of the hypothesis that using verbal cues or "swing thoughts" just before movement initiation would prevent performance disruption of a self-paced skill in a pressure situation. It was predicted that all forms of swing thought would be effective in preventing choking and that all non-control groups would, therefore, perform better than the control group in the competition stage of the experiment. Analysis of the radial error data did not provide conclusive support for the hypothesis. More specifically, the Swing (given) group appeared to choke, so that the Swing (self) and Set-up (self) groups both had significantly less radial error in the competition stage of the experiment. More difficult to assess is the performance of the Set-up (given) group, for which the competition radial error did not differ significantly from any of the other groups. Although this group did not score a significantly different number of points to the Control group in the competition, it can be seen in Figure 6.2 that the mean radial error of this group was actually lower in the competition than baseline stage. The present interpretation, therefore, is that the Set-up (given) verbal stimulus was successful in preventing choking.

The main question that arises from these results concerns why the verbal cues used by the Swing (given) group did not appear to prevent choking. This result contradicts the prediction of the prevention hypothesis and suggests that the origin of each stimulus might be an important determinant of its effectiveness. An explanation in terms of this factor alone, however, does not account for the finding that the Set-up (given) group actually performed better in the competition than baseline stage although, as previously noted, the mean radial error data of this group was not significantly different from the Control group. If an assumption is made that the reinvestment theory of choking is correct then there are two main lines of explanation for this result.

The first possibility is that in the case of the Swing (given) group, the verbal cue did not suppress reinvestment of at least three rules relating to the putting action in the period before initiation of the putting stroke. Thus, it is possible that disruptive reinvestment occurred either before or after verbalising of the cue. This might occur if, for example, the subject perceived that he performed better whilst not verbalising the cue so that he saw its use as an obstacle to wining money in the competition stage. A subject might then attempt to verbalise the cue early on so as not to have it affect his performance in this stage. Unfortunately, the video-recording equipment available for use in the present experiment did not record sound so it was not possible to establish the precise moment at which the stimulus was verbalised.

A second possibility is that the interaction between the cue, the origin of the instructions and the pressure manipulation led to the same verbal cue having a different function. This line of explanation reflects the earlier distinction that was made between reinvestment of verbal rules before performance and reinvestment of conscious controlling processes in the brain during the performance itself. It is possible that the same verbal cue could have the function of cueing a sequence of actions in a no pressure situation whilst initiating conscious control processes when under pressure. Similarly, it is possible that, under pressure, the source of the verbal cue becomes critical in determining its function. The concept of trust (Moore and Stevenson, 1991, 1994) is a useful way of thinking about this point. Moore and Stevenson (1994) listed a number of factors that are likely to influence the likelihood that an individual can release conscious control of their actions (at the technical level) during performance, including confidence and composure. In self-paced skills, it may be the case that subjects also have to have confidence in the swing thought or concentration strategy that they are using. If this is the case, additional interpersonal factors concerning the relationship between the instruction giver and receiver would become important. For example, a critical factor might prove to be the confidence the subject has in the instruction giver, in which case the present result would have little practical implication for competitive golfers beyond ensuring that a swing thought is not based on a tip or "quick fix" suggestion from an unspecified source. Evaluating the complex interaction between the instruction giver, the instruction and the performer could be an area for extensive future research if the present finding proves robust.

6.4.1. Routine and Concentration Times

Concentration time was used in the present experiment to gain an indication of the "thinking time" component of routine time in the comparison and competition stages. In the event, the analysis of both variables revealed similar results, with equivalent increases in both routine and concentration times being found for all groups. In addition, both the routine and concentration times were found to be more variable in the competition stage. These results again provide support for the validity of the pressure manipulation and were similar to those found in Experiment 4. There was no evidence of any difference between the concentration or routine times of the different groups in the competition stage (taking appropriate comparison times into account). This suggests that the times were reflecting the increased importance of the situation and were not causally related to performance.

6.4.2. Block Scores

The finding of a significant interaction between stage and block was unexpected, and appeared to be caused by poor subject scores in the second block of five putts during the baseline stage rather than an increase in scores in this block during the competition. It is not readily apparent why this pattern was observed. It is out of line with the baseline performance observed in subjects during Experiments 4, 5 and 6 and cannot be associated with a grouping procedure because none was present in this stage of the experiment. One possibility is that concentration was high during the early part of the baseline stage but then temporarily decreased as the subject became more familiar with the task. The problem with any explanation of this sort is that it does not account for the fact that, using the same apparatus, a similar effect was not found in previous experiments. Given that the result was only significant at the .05 level and in the absence of an apparent alternative, it is concluded that the result was caused by random variation in block scores.

6.4.3. Vertical and Horizontal Error Scores

The vertical and horizontal signed error scores were similar for all groups in the competition stage of the experiment. Group differences between point and radial error scores that were found in the competition were not, therefore, associated with an increased tendency to hit the ball to the left or right, or short or long.

The unsigned vertical and horizontal error scores provided a means for separately assessing how judgement of the length (or "weight") and direction of putt were affected in the pressure manipulation. It was found that, as with Experiment 4, the results of the vertical (unsigned) error mirrored those of the radial error analysis. Similarly, the horizontal error (unsigned) results failed to reveal a significant group main effect, so that the overall difference in performance between groups in the competition stage was not reflected in the directional component of putting. In fact, inspection of the means indicates that the control group actually had the lowest horizontal (unsigned) error in the competition stage, whilst the Swing (given) group had the largest. These two groups performed most poorly in the competition stage which seems to suggest that the direction component of performance was not affected by the pressure manipulation. It should be reiterated, however, that the combination of the target used and the speed of the putting surface meant that the present task was more a test of the ability to judge distance than direction.

6.5. Conclusion

In conclusion, the results of the present experiment again provide qualified support for the hypothesis that using "swing thoughts" can help to prevent choking in a self-paced skill. When considered alongside the results of Experiment 4, however, the finding of a significant difference between groups that verbalised experimenter-given and self-formulated swing thoughts suggests that the prevention hypothesis might need to take account of other factors. In particular, it is possible that other factors mediate the extent to which a verbal cue is effective in preventing choking, perhaps by altering the probability that it will have the function of cueing automatic or controlled processing in a pressure situation. If this is the case then future research could aim to specify which factors, both external and internal, are important in this respect.

Chapter 7- General Discussion

7.1. Introduction

This discussion is in three parts. The first part summarises the main findings of the experiments presented in the preceding chapters. The second part considers the implications of the present research. This part is divided into, firstly, implications of the present three level distinction between rule-governed and contingency-shaped behaviour for the study of the "sensitivity" of behaviour. Secondly, the implications of the main results for research into choking and, in particular, for the reinvestment theory are discussed. The final part of the discussion considers some limitations of the present research and possibilities for future experimentation in this area.

7.2. Summary of Findings from Experiments

The original idea for the present research came from a desire to find out what determined the level of performance attained by individuals in "pressure situations", when the successful performance, or otherwise, of a well-learned skill was likely to have a large influence on the outcome of a competitive event. In particular, why did some people seem to be able to maintain a high level of performance in these situations while others "choked" and, secondly, what could be done to help prevent choking?

The first hypothesis stemmed from research in applied behaviour analysis which showed that a central (some argued defining) characteristic of rule-governed behaviour was its insensitivity to the programmed contingencies associated with that behaviour (Ribes and Martinez, 1990). By viewing a pressure situation as a change in the contingencies associated with performance, it was hypothesised that the insensitivity of rule-governed behaviour would prove advantageous for certain skills. In fact, the prediction made was that, for closed skills, rule-governed behaviour would not be susceptible to choking and would, therefore, be superior to contingency-shaped behaviour in pressure situations. Open skills were excluded from this prediction because performance of these skills required moment by moment sensitivity to continually changing contingencies of reinforcement.

Experiment 1 was designed to test this hypothesis using the skill of dart throwing and using a learning paradigm in which subjects acquired the skill with or without the aid of instructions. The results provided no support for this hypothesis with the most notable finding being the poorer performance of the rule-governed group during the acquisition stage of the experiment. This finding appeared to be due to verbalising and/or attending to several instructions because introduction of the instructions after a period of contingency-shaped learning was shown to disrupt performance in Experiment 2. These experiments raised a number of theoretical and conceptual issues, the most important of which concerned the behaviour analysis definition of rule-governed behaviour. This was examined in some detail in Chapter 3 where it was concluded that, to be applicable to the study of motor behaviour, the distinction between rule-governed and contingency-shaped behaviour needed to be made at three different levels. These were referred to as the topographical, strategic and metastrategic levels. Evidence was then presented which supported a choking theory for self-paced skills based on rule-governed control at the topographical level. By comparing contingency-shaped learning with implicit learning similarities between the rule-governed theory of choking and the cognitively based reinvestment theory proposed by Masters (1992, 1993) were described.

The use of a learning paradigm, the choice of paradigm for Experiments 1 and 2, as well as for choking research related to reinvestment theory (Masters, 1992; Hardy et al., 1996), was then critically evaluated. It was decided to discard this approach in favour of experiments involving the performance of well-learned skills. This decision was based on a number of factors, the most critical being the problem of contamination of contingency-shaped learning by self-rule formulation. For this reason it was felt that, while Masters (1992) and Hardy et al. (1996) provided some evidence that learning a skill implicitly could prevent choking, it was not clear how this could lead to a practical "choking intervention". Furthermore, it was noted that some top performers could perform well under pressure, despite possessing extensive knowledge of the "mechanics" of what they do (Ripoll, 1991; Russell and Salmela, 1992; Thomas and Thomas, 1994; Williams and Davids, 1995).

Based on these observations, it was argued that, rather than trying to decrease or eliminate the explicit knowledge base of an individual, techniques should be developed to prevent the process of reinvestment from occurring. This was referred to as the prevention hypothesis. For self-paced skills, the critical period was considered to be the few seconds before initiation of the movement. It was proposed that one effective means for preventing reinvestment of rules in this period would be for individuals to use the equivalent of "swing thoughts" in golf. In Experiment 3, the hypothesis was tested using the skill of rugby goal-kicking. By comparing the successful kick percentages and mean point scores of subjects during practice and competition both before and after the intervention limited support was found for the prevention hypothesis. However, a number of methodological problems were described that reduced the power of the results.

In Experiment 4, the prevention hypothesis was tested using a golf putting task and a new pressure manipulation. The main differences from most previous manipulations were, firstly, that the new manipulation was sensitive to the putting ability of each individual. This was achieved by yoking the scores required for each monetary prize to the subject's baseline score. Support for the effectiveness of this manipulation was provided by the poor performance of a control group compared to their baseline performance. In addition, the performance of the Verbal and Visual Cue groups, both provided support for the prevention hypothesis. Specifically, these groups scored a similar number of points in the baseline and competition stages of the experiment and scored significantly more points than the Control group during the competition. Support for the hypothesis was equivocal, however, due to the point scores of the task-irrelevant verbal cue group (RGYB), which were no different from either the lower scores achieved by the Control group or the higher scores achieved by the Verbal and Visual Cue groups.

Experiment 5 was designed, firstly, to test the underlying assumption of the reinvestment theory of choking, which was that attending to technical rules in the moments before movement initiation would result in performance disruption. Secondly, the content of the verbal stimulus was varied to take into account a key component of self-paced skills: the adoption of a correct set-up position. It was predicted that reinvesting rules concerning the set-up for putting would be equally disruptive to performance. The results indicated that verbalising a stimulus relating to four aspects of the swing disrupted performance, however, the stimulus relating to four aspects of the set-up did not. In addition, the results of Experiment 6 suggested that an individual could verbalise a stimulus specifying two aspects of the swing without any detrimental effect on performance. Together, these findings suggested that the reinvestment theory needed to be refined in order to be more specific about the number and type of rules that would lead to performance disruption in closed skills.

The purpose of Experiment 7 was to incorporate the results of Experiments 5 and 6 into a third test of the prevention hypothesis. Using the same putting task, the results again provided support for the effectiveness of the pressure manipulation with the control group performing more poorly in the competition than baseline stage of the experiment. The Swing (self), Set-up (self) and Set-up (given) groups provided support for the refined version of the prevention hypothesis, in that they had a similar mean radial error in the baseline and competition stages of the experiment. Contrary to the prediction, however, the Swing (given) group also choked in the competition which led to the suggestion that there might be mediating factors which determine the effectiveness of a swing thought.

7.3. Implications for Behaviour Analysis

It was mentioned above that the learning paradigm used in the first two experiments was subsequently discarded in favour of using well-learned skills. Although the theoretical framework of behaviour analysis was maintained, it was argued that the distinction between rule-governed and contingency-shaped behaviour should be made at three levels, in addition to the higher-order level associated with rule-following. This three level distinction has important implications for researchers studying motor behaviour within the behaviour analysis framework of rule-governed and contingency-shaped behaviour particularly where claims are made based on the apparent insensitivity of rule-governed behaviour (Martin, 1992).

7.3.1. The Distinction Between Rule-governed and Rule-following Behaviour: Implications for Applying "Sensitivity" Research to Sport

As a direct consequence of the lack of a clear distinction between rule-following and rule-governed behaviour, discussion regarding the insensitivity of rule-governed behaviour suffered from a general failure to fully appreciate different types of insensitivity. That is, the same instructed behaviour can be analysed either in terms of the contingencies that establish and maintain rule-following or in terms of how the characteristics of the resulting behaviour differ as a result of the method by which it was learned. Although Skinner's (1966, 1969) original analysis of rule-governed behaviour addressed both of these, he did not make the distinction clear and subsequent theories have almost all been described at the rule-following level. For example, Cerutti (1989) suggested that rule-governed behaviour is best understood by a "discrimination theory" in which the behaviour enters into two sets of contingencies. The important part of Cerutti's theory is the collateral consequences associated with following the rule itself as when, for example, socially mediated reinforcement maintains behaviour that is said to be the result of "peer group pressure". Taking the higher order rule-following a stage further, Baum (1995) argued that rule-governed behaviour requires an evolutionary perspective for a full understanding. In his analysis Baum makes a distinction between the short term, socially mediated contingencies that maintain rule-following and the long-term fitness enhancing contingencies related to health, resources, relationships and reproduction. Clearly, both of these analyses relate to rule-following behaviour which, whilst important, has little relevance to the problem solving context in which rule-governed behaviour was originally discussed (Skinner, 1969).

From the rule-following perspective, the insensitivity shown by rule-governed behaviour to changes in the contingencies is explained in terms of the collateral contingencies that maintain rule-following (Cerutti, 1989; Hayes, Zettle and Rosenfarb, 1989). In sport, this level of analysis might be of interest in understanding why players appear unable to adapt to unanticipated strategies used by opponents. For example, this level of analysis would investigate the higher-order contingencies associated with following the coach's instructions, contingencies that might lead to compliance no matter how bad the resulting performance. In other words, the performance would be insensitive to its consequences. There is, however, nothing in the insensitivity literature to support Catania's (1992) assertion that skilled performance *must* be contingency-shaped. The assertion appears correct, as described in Chapter 4, but the reason lies with the limitations of the central nervous system. In particular, the lack of precision attainable by conscious control and the small amount of information that can be "processed" in working memory restrict the level of performance attainable on many tasks. When both the decision making and precision requirements of the response are low, rule-governed behaviour can be as sensitive to changes in the contingencies as contingency-shaped behaviour, simply by formulating a series of "if—then" statements (e.g. Shimoff et al., 1986). When the number of statements becomes too large to decide on the correct course of action in the time available, behaviour must be contingency-shaped. Similarly, when the level of precision required in the response is greater than can be consciously controlled, behaviour must be contingency-shaped.

7.3.2. Implications of the Three Level Distinction Between Rule-governed and Contingency-shaped Behaviour

The main implication of the three level distinction is that whether or not a behaviour must be contingency-shaped depends on the level at which the contingencies are operating. If the topographical contingencies are simple, as in lever pressing experiments, then the behaviour need not be contingency-shaped. Similarly, if it is possible to formulate a simple rule that accurately describes the contingencies that are in effect at the strategic level, such as, "red light on- money is in the red box, green light on- money is in the green box" then again, behaviour need not be contingency-shaped at this level. For the performance of many sports skills, however, complex contingencies are operating at the topographical level so that slight changes in the form of behaviour result in different consequences. In fact, these contingencies are a defining feature of all sports because it is through them that comparisons can be made between opponents. For example, these contingencies allow observers to distinguish between good and poor shots in golf and tennis. Similarly slight changes in movement characteristics result in different scores in gymnastics, different distances flown in the ski-jump and different speeds in swimming. The reasons for arranging these contingencies are simple: if everybody could perform at an equal level simply by following instructions then sporting encounters would be decidedly boring affairs! The result of this is that the disparity between the level of precision attainable through following verbal instructions and the precision required for high level performance, dictate that such behaviour must be contingency-shaped at the topographical level.

In many sports, complex contingencies are also operating at the strategic level. As described earlier, these are particularly evident in team sports such as football or basketball, which require participants to perform open, externally-paced skills. In these sports the visual environment is constantly changing as the ball and players move both in relation to each other and the pitch or court. For this reason, these sports require decision making sensitivity at the strategic level, again beyond a level that can be attained simply by following instructions. For example, even the most advanced computer football games do not create very realistic simulations of the real thing and frequently appear to show strategic, or tactical naivety. Even if humans were able to compute all the procedural commands built into a program of this sort, their behaviour would similarly not display the decision making sensitivity that is a defining feature of many open skills. Therefore, skilled performance in such skills must also be contingency-shaped at the strategic level.

7.3.3. ***Fluency***

In behaviour analysis, the term fluency has been used to refer to "that combination of accuracy plus speed of responding that enables competent individuals to function efficiently and effectively in their natural environment" (Binder, 1996). It is interesting to note that the sort of tasks that are considered most likely to benefit from "fluency-building" are tasks in which the discriminative stimuli are constantly changing (Johnson and Layng, 1996), that is, open skills. Indeed, Johnson and Layng (1996) make the point that the typical experimental contingencies set up in behaviour analysis laboratory based investigations only apply to a "small number of real world contingencies". The aim of fluency-based instruction is to build up the fast, effortless, accurate and sensitive characteristics of performance by making frequency of the component sequences the dependent variable, rather than accuracy of performance. Thus a large number and variety of problems are presented to the subject who's aim is to respond as quickly as possible. For example, one of the component sequences for being a striker in football involves seeing, controlling then shooting footballs. A fluency-based training program would involve rapid presentation of footballs to the learner from a variety of positions, followed by the player rapidly shooting towards the goal.

In terms of motor behaviour, fluency-based instruction can be interpreted as aiming to facilitate the emergence of the topographical sensitivity required for high level open skill performance. Although not stated as such, it is possible that the process of rapidly presenting variable visual stimuli acts to suppress verbal mediation of responses, therefore facilitating contingency-shaping of the skill. Whether or not this proves to be the case, there are close parallels between the concepts of behavioural fluency and automaticity (Dougherty and Johnston, 1996), with the characteristic of performing "without thinking" being implicated in both. In short, the characteristics said to be associated with fluent or automatic performance of many skills are indicative of contingency-shaped rather than rule-governed behaviour at both the topographical and strategic levels.

7.4. Implications for Choking Research

7.4.1. Reinvestment Theory

The present rule-governed theory of choking is directly linked with the reinvestment theory proposed by Masters (1992, 1993). The results of the present experiments provide some further support for reinvestment theory, whilst also indicating that some refinement might be required to take into account rules that would not be predicted to disrupt performance if reinvested. Specifically, for the golf putt at least, attempting to consciously ensure that four rules concerning the set-up were correctly adhered to did not disrupt performance. Likewise, attending to just two rules of correct putting technique did not disrupt performance. The main implication of these results for reinvestment theory concerns the distinction between, firstly, the verbal reinvestment that occurs in the moments before initiation of movement and, secondly, reinvestment that occurs during the action itself.

7.4.1.1. Verbal Reinvestment and Reinvestment of Controlled Processing

This distinction is essentially between two different levels of explanation. The first involves observable behaviour, whether by the performer, observers or both. The second refers to an analysis of the cognitive processes or underlying brain activity that are proposed to occur during instances of choking and which are addressed in information processing accounts of behaviour (e.g. Shiffrin and Schneider, 1977) and neuropsychological studies of brain activity (Posner and Rothbart, 1992). Previously this distinction has not been explicitly stated. For example, Masters (1992) refers to "reinvestment of controlled processing" as well as to a performer being less able to "reinvest his or her knowledge in time of stress" (p. 345). In many skills it might be difficult to dissociate the two aspects of reinvestment. For example, in continuous skills such as rowing or running, both verbal reinvestment and reinvestment of controlled processing would, presumably, occur simultaneously. Nevertheless, the results of Experiment 6 suggest that, for self-paced skills, it might be useful to make the distinction because behaviour under the control of a verbal antecedent relating to two aspects of the swing did not appear to be reinvested with conscious control of the component parts of the swing. Perhaps the distinction could be clarified by using the terms verbal reinvestment and reinvestment of controlled processing. The implication for choking in self-paced skills is that an individual who reinvests verbal rules in the moments before performance will not necessarily reinvest controlled processing during the performance itself.

This distinction has potential implications for the design of choking interventions. The preceding experiments focused on the behaviour before performance, in line with the rule-governed framework which focuses on verbal antecedents. The aim of the interventions has been to suppress verbal reinvestment in the moments before performance. If one accepts that, ultimately, choking in self-paced skills occurs by the neural activity associated with reinvestment of controlled processing then an alternative method of preventing choking would be to design interventions that specify activity to be performed during performance.

7.4.1.2. Reinvestment in Open, Externally-paced Skills

The present experiments have involved performing self-paced, closed skills. However, the three-level model predicts that the potential for performance disruption through reinvestment is related to the precision requirements and temporal restrictions associated with each particular level. This has important implications for the performance of skills in high strategy sports requiring rapid decision making. In particular, open, externally-paced skills such as those required during open play in football would be predicted to be vulnerable to disruption by reinvestment of strategic as well as technical rules. For example, in football decisions must be made according to a number of variables such as the relative location of team-mates, the opposition and the ball. In the same way that the topography of a tennis shot requires sensitivity to the different way in which the ball approaches on each occasion, so the decision making process involved in football requires sensitivity to the constantly changing relative positions of team-mates, opponents and the ball.

According to the three level distinction, the prediction is that excessive instructions regarding the strategic elements of the game (e.g. where and when to move, who to pass to etc.) would, paradoxically, lead to performance disruption for the same reasons that excessive technical instructions would disrupt performance at the topographical level. It is interesting to speculate how strategic reinvestment might occur. For example, in football, strategic choking might be mediated by a coach who, in trying to ensure that his of her team maintains a narrow lead, gives increasingly frequent and more detailed strategic instructions to the players. Based on the behavioural account of reinvestment theory, it would be predicted that the potential for disruption would be greatest for players in positions requiring the highest degree of strategic sensitivity (tactical awareness) and/or in positions requiring rapid decision making.

One way in which such disruption to performance might become evident is in a reduced ability to anticipate the movements of others. There is evidence that skilled performers in externally-paced, reactive skills make use of advanced visual cues in order to perform optimally in such situations (Tenenbaum and Bar-Eli, 1993). This has been shown in skills requiring fast reactions to unpredictable events, including ice hockey goal-keeping (Salmela and Fiorito (1979) and batting in cricket (McLeod and Jenkins, 1991). The finding is in line with what would be expected from exposure to a three-term contingency. Thus, as certain behaviours are differentially reinforced according to the dimensions of a visual stimulus, increasingly fine discrimination along that dimension will occur. Eventually a high level of discrimination to subtle differences between stimulus characteristics emerges and the behaviour comes under stimulus control. The use of advanced visual cues is, therefore, a characteristic of contingency-shaped behaviour at the strategic level. Because skilled performance in fast reaction sports requires use of these cues reinvestment of rule-governed behaviour at this level would be predicted to disrupt performance.

The applied implication of extending reinvestment theory to the strategic level is that coaches who give a large number of detailed strategic instructions to players prior to an important game or match could do more harm than good. As with analysis at the topographical level, the irony is that it is precisely because one wants to ensure optimum performance that excessive instruction is likely to be given. An interesting area for future research would involve exploring reinvestment at this level because the nature of the disruption might take a different form from that at the topographical level. For example, disruption in the performance of a tennis player who is given a plethora of strategic instructions from a coach would be predicted to manifest itself in the form of an apparent lack of "court awareness", positional errors and poor shot selection. At the topographical level, the coordination of all the relevant muscle movements involved in moving about the court and executing the shots would not be affected, however, because the behaviour would remain contingency-shaped.

7.4.1.3. Decision Making in Self-paced Skills

The distinction between the different forms of performance disruption is clearest when considering self-paced skills which involve complex decision making processes. For example, the selection of a golf shot must take into account a number of infinitely variable factors such as the lie of the ball, the direction and speed of the wind and the characteristics of the ground on which the ball lands. Similarly, when putting on a real green the variability in the texture of the surface, the undulations on the green and the distance of the putt all contribute to the unique nature of each putt (Moran, 1996). The comparatively unrestricted time available for selection of the appropriate shot means that professional golfers usually discuss these factors with their caddies before deciding on which club to use and what type of shot to play. The use of a particular swing thought does not, therefore, prevent conscious decision making from taking place and considerable thought at this level should not disrupt performance at the topographical level. In effect, selecting the most appropriate shot in this way leads to behaviour that is equivalent to the pseudosensitive behaviour observed in human performance under different schedules of reinforcement (Shimoff et al., 1986).

If, instead, a golfer relies on "feel" to select the most appropriate shot, this is another way of saying that the selecting behaviour is contingency-shaped rather than rule-governed (Skinner, 1989). The point is that, although these skills require strategic sensitivity, it is not the moment by moment sensitivity required for skilled performance in open skills. Therefore, while poor performance could occur, it would be due to the fact that the the rules used in the decision making process did not fully describe the contingencies at this level. The execution of the shot itself would not be expected to be disrupted, however, since this is associated with contingencies at the topographical level. To illustrate with an example, Boreham (1994) refers to "the dangerous practice of thinking" (p. 172) in making medical diagnoses because of the limitations of the explicit memory system. This level is equivalent to the strategic level in sports performance. In the same way that making an incorrect diagnosis would not be expected to disrupt the behaviour of handing the patient the prescription, so making an incorrect choice of shot would not be expected to interfere with the mechanics of executing the shot itself.

Decision making is an unfortunate term in this respect because it implies a conscious process based on verbal reasoning. The present argument is that skilled decision making in open, externally-paced skills is primarily contingency-shaped, thus creating the possibility that choking in such skills can occur through reinvestment of strategic rather than technical rules.

7.4.2. Support for the Importance of a Pre-shot Routine

Although the present research did not investigate the function of pre-performance routines as a whole, it has been suggested that one function of such routines might be to "prevent athletes from thinking about the details or mechanics of well-learned skills that are better performed automatically" (Boutcher, 1990, p. 235). Previously, although intuitively appealing, there had been little empirical support for this claim. For example, while it was shown that taking away an individual's pre-shot routine led to significantly poorer basketball free-throw performance (Lobmeyer and Waserman, 1986) no relationship was found between total routine time and performance in actual basketball games (Wrisberg and Pein, 1992). The present research suggests that what the individual does to prevent reinvestment from occurring in the moments before movement initiation, might be more important in determining performance in pressure situations, than either the length or consistency of the entire pre-shot routine. Thus, Experiments 4 and 7 found no relationship between the consistency of routine times in a group and its performance in the competition stage of the experiments.

7.5. Limitations of Present Research

The ultimate goal of this line of research is to be able to recommend an intervention that will prevent choking in golf in particular and self-paced skills in general. The most obvious limitation of the present research in this respect is that no experiments have yet been conducted to assess how well the results generalise to other skills. In addition, several further questions have arisen during the present research which need to be addressed in order to make progress towards this goal.

7.5.1. Generalisation of Results

There are two main areas in which generalisation needs to be demonstrated. Firstly it needs to be demonstrated that the results generalise to a real golf putting task. Related to this, there is a need, secondly, to assess the effectiveness of any choking intervention in actual pressure situations.

7.5.1.1. Generalisation to Real Golf Putting

Unlike putting on the golf course, the task used in all of the golf putting experiments did not require the subject to "hole" a putt. In fact, the speed and length of the putt, in combination with the criteria used for scoring, meant that the task was primarily an assessment of the ability to judge the "weight" or distance of a putt rather than the direction. To illustrate this point, consider that the width of a standard golf cup is 10.8 cm whereas the width of the 5-zone in each of the putting experiments was 20cm. As such the target allowed considerably greater lateral error than an actual golf putt. While this meant that a putt which would miss the hole in a real putting situation might end up in the 5-zone in the experimental task a more common occurrence was that putts which would normally have been "holed" in a real putting situation rolled well beyond the 5-zone in the experimental task. It could be argued, therefore, that the present task was not a true test of putting ability.

A more ecologically valid task would, of course, involve putting towards a hole. The reader is referred to chapter 4 (section 4.13.3) for an explanation of the reasoning behind the choice of task. Nevertheless, it is accepted that the results of the experiment would be strengthened by replication using the more ecologically valid task. To this end it is encouraging to note that Weavers (1997) recently replicated the main findings of Experiment 4, using a putting task in which the dependent variable was the number of putts holed in 20 attempts from a distance of 2.75m.

7.5.1.2. Generalisation to Elite Golfers in Real Pressure Situations

Despite the fact that the golf putting experiments used subjects for whom the skill was already well-learned, there is a need to find out whether the results generalise to top level amateur and professional golfers. More specifically, there is a need to find out whether using self-formulated swing thoughts is effective in preventing choking in real pressure situations, involving élite golfers. Clearly this type of experiment is fraught with methodological and practical difficulties, but using a choking index based on the difference between performance of a skill in practice and game situations, of the sort used by Hamilton and Fremouw (1985) for basketball, might offer a way forward in this respect. In their study, Hamilton and Fremouw (1985) compared the free-throw success percentages of members of a basketball team in practice sessions and game situations. By using an appropriate measure of performance, a similar technique could be adopted to assess the benefits of any intervention in other sports including golf.

Regarding the validity of the pressure manipulation, it was intended to reflect the situation that might occur in a real tournament or competition. That is, the subject found himself in a position to win some money, only needing to perform at the same level as had previously been achieved (or one point better) to win extra money. Nevertheless, as Rushall and Sherman (1987) noted, there are many factors which can increase the perceived importance of performance. It is, therefore, extremely unlikely that the pressure associated with putting in Experiments 4 and 7 was comparable to that experienced by professional golfers when in the position to either win a tournament, or when trying to make a par score to retain their tour card. As Jack Nicklaus once said: "90 per cent of the rounds I play in major championships, I play with a bit of shake" (Patmore, 1986, p. 75). As with any performance intervention, the ultimate test is whether it proves effective in actual competitive situations.

7.6. Suggestions for Future Choking Research

As well as the possibility of extending reinvestment theory to the strategic level, one area that has the potential for extensive future research concerns investigating factors which might influence the effectiveness of a particular swing thought. This stems from the finding in Experiment 7, concerning the performance of the Swing (given) group, who choked in the competition stage. It was suggested in the previous chapter that one such factor might be the confidence the performer has in the source of the instruction. To explore this possibility, an experiment could be designed in which "confidence in the instruction giver" is manipulated by making overt reference to the source of the instruction(s) on which the verbal cue is based. For example, the instructions might be said to come from a book of a well-respected and well-known golf coach for one group and from a little known golf coach for another group.

Another possibility for future research concerns the timing of the verbal cue. In the present experiments, the instructions concerning when the subject should verbalise the swing thought have simply stated that it should be "just before you putt". Theoretically, it is possible that a subject might verbalise the cue early in their pre-performance routine and then engage in disruptive reinvestment. This possibility was recently addressed by Weavers (1997) who found that when subjects were made to pause for at least five seconds after verbalising task-irrelevant words ("red-green-yellow-blue") they performed worse in a pressure situation than when verbalising the same words just before putting. The present suggestion that verbalising of the cue should take place just before execution of the required movement comes from studies which have recorded electrocortical activity in self-paced performance in the few seconds before movement initiation. Nevertheless, a question of interest is whether there is a critical period in which the swing thoughts must be used to be effective in preventing choking.

Another area that has not been explored in detail relates to the level of detail specified in the swing thought. Some verbal swing thoughts that are used by golfers are very general. For example, one of the swing thoughts used in the past by Nick Faldo for playing "pitch shots" was "stomach and buttons". The idea behind the thought was to have Faldo focus on turning his stomach away from the target on the backswing and then on finishing with his shirt buttons facing the target. The important question is whether this type of swing thought, which focuses on a more general overall image of the swing rather than on a particular aspect of technique, proves equally effective in preventing choking.

Somewhat related to this is the question of whether swing thoughts involving visual imagery could prevent choking. Athletes have reported using visual imagery in a number of ways (Feltz and Landers, 1983). For example, visual imagery has been reported to have a motivational function (Hall, Rodgers and Barr, 1990) as well as having a more direct effect on performance when used in combination with relaxation procedures (Suinn, 1976; Hall and Erffmeyer, 1983). It is possible that using imagery in the moments before performance could also have the function of preventing reinvestment in pressure situations. To date, although visual imagery is a component of many "package" interventions (e.g. Anshel, 1990; 1994; Ming and Martin, 1996), it has yet to be demonstrated that this is an effective means of improving performance in pressure situations.

7.7. Conclusion

The present research has examined the distinction between rule-governed and contingency-shaped behaviour as it relates to the performance of motor skills. It was argued that the distinction needs to be made to take into account at least three levels at which verbal control can operate. By analysing the task demands at the three levels evidence was presented which suggested that reverting to rule-governed behaviour at the topographical level would be disruptive to the performance of sports skills. Overall, the experimental evidence supported the hypothesis that using verbal cues would prevent reinvestment and hence choking in self-paced skills. Reinvestment research is in its infancy and there are a number of possible future directions that research in this area might take. As well as raising some questions regarding the performance of self-paced skills, one particularly interesting possibility is that reinvestment might lead to a different type of choking at the strategic level, associated with a reduced ability to make use of advanced visual cues. For self-paced skills, however, the most pressing need is to test whether interventions that prevented choking in the present experiments prove equally beneficial under the stress associated with real competitive situations.

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—Appendix 1—

Name: ....

Sex: M / F

Age: ....

I have played darts .... times before.

[Of the following questions, subjects in the CS and CSC groups were only asked Question 5, with the part in brackets omitted]

The following questions concern the experiment you took part in today and last week.

1) Do you feel that you consistently managed to follow the technique instructions today?

   YES / NO

2) Were you making a conscious effort to follow these instructions in both parts of today's session?

   YES / NO

   Other: ....

3) Were you making a conscious effort to follow these instructions in last week's session?

   YES / NO

   Other: ....

4) During the experiment did you find any of the instructions to be more helpful than others?

   YES / NO

   If yes, then which of the following was the most helpful? (please tick)

   GRIP
   STANCE
   THROW ACTION- "BODY STILL"
   THROW ACTION- "FOREARM ONLY"
   THROW ACTION- "THROW NOT LOB"
   THROW ACTION- "FOLLOW THROUGH"

5) Do you feel that any strategy (other than following these instructions) helped you to throw better darts

a) last week?

....

....

b) in the first 20 sets today?

....

....

c) in the last 10 sets today?

....

....

Additional comments:

....

....

....

....

....

....

—Appendix 2—

Variable error scores in each block of the acquisition, retention and competition stages of Experiment 1.

	Acquisition Variable Error							
	Block 1		*Block 2*		*Block 3*		*Block 4*	
Group	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*
RG	2.26	0.25	1.98	0.23	2.46	2.51	2.09	2.63
RG (Control)	2.44	0.35	2.14	0.17	2.44	3.60	2.20	3.50
CS	2.10	0.33	1.80	0.19	1.85	3.77	2.30	2.76
CS (Control)	2.03	0.31	1.78	0.20	1.80	2.49	1.70	2.09
All Subjects	2.21	0.15	1.92	0.10	2.14	0.13	2.08	0.12

	Acquisition Variable Error							
	Block 5		*Block 6*		*Block 7*		*Block 8*	
Group	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*
RG	2.32	1.93	1.44	1.44	2.11	1.28	2.24	2.58
RG (Control)	1.90	3.49	2.00	3.14	2.29	2.81	1.65	1.60
CS	1.85	2.48	2.08	2.43	1.52	2.49	1.95	2.61
CS (Control)	2.40	2.45	1.79	2.05	1.51	2.30	2.06	2.71
All Subjects	2.12	0.11	1.82	0.14	1.86	0.13	1.98	0.13

	Retention Variable Error							
	Block 1		*Block 2*		*Block 3*		*Block 4*	
Group	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*	*Mean*	*S. Err.*
RG	2.23	0.20	2.05	0.17	1.89	0.18	1.62	0.22
RG (Control)	2.14	0.26	2.14	0.20	1.91	0.25	2.24	0.42
CS	1.62	0.22	2.30	0.26	2.05	0.21	1.91	0.21
CS (Control)	2.17	0.21	1.90	0.18	1.48	0.24	1.64	0.20
All Subjects	2.04	0.12	2.10	0.10	1.84	0.11	1.85	0.14

	Competition Variable Error			
	Block 1		*Block 2*	
Group	*Mean*	*S. Err.*	*Mean*	*S. Err.*
RG	1.57	0.32	1.96	0.35
RG (Control)	2.04	0.21	1.86	0.22
CS	1.60	0.24	1.67	0.16
CS (Control)	1.78	0.18	1.44	0.09
All Subjects	1.74	0.12	1.74	0.12

—Appendix 3—

Rugby Goal-Kicking Questionnaire

Name: ....

Date of birth: ....

How many years have you been playing rugby? ....

Which team(s) do you currently represent? ....

....

How often do you currently kick for your team(s)? (please tick)

primary kicker (i.e. first choice) ....
occasionally ....
never ....
other (specify) ....

Questions 1 to 3 apply to your behaviour BEFORE the intervention

1) How consistent do you feel your routine before each kick was?

1	2	3	4	5	6	7
not at all consistent						highly consistent

2) Did you concentrate on any particular verbal stimulus prior to each kick?

Yes / No

If yes, what was it? ....

....

3) How do you feel you performed **IN COMPETITION** compared to your performance in practice?

1	2	3	4	5
much worse	slightly worse	same	slightly better	much better

Questions 4 to 7 apply to your behaviour <u>AFTER</u> the intervention

4) What verbal stimulus / "kick thought" did you concentrate on before each kick?

....

5) Did this change at any time over the course of the experiment?

Yes / No

If yes:

a) what did you change it to?

....

b) why did you change it?

....

....

6) How do you feel you performed **<u>IN COMPETITION</u>** compared to your performance in practice?

1	2	3	4	5
much worse	slightly worse	same	slightly better	much better

7) How consistent do you feel your routine before each kick was?

1	2	3	4	5	6	7
not at all consistent						highly consistent

<u>General Questions</u>

<u>Competitions</u>

8) Did you feel under pressure to do well in the competitions?

Yes / No

If yes, in what way? ....

....

Practice

9) Did you feel under pressure to do well in practice? Yes / No

If yes, in what way? ....

....

....

Intervention:

10) For approximately what percentage of your kicks (after the intervention) did you focus on the chosen verbal stimulus / "kick thought"? (mark an "x" on the line)

0 10 20 30 40 50 60 70 80 90 100

----

11) How do you think focussing on the verbal stimulus / "kick thought" affected your kicking performance:

a) in practice sessions?

1	2	3	4	5
made it a lot worse	made it slightly worse	no change	improved it slightly	improved it a lot

b) in competitions?

1	2	3	4	5
made it a lot worse	made it slightly worse	no change	improved it slightly	improved it a lot

Please Turn Over

General comments/additions:

....

....

....

....

....

....

....

....

....

....

THANK YOU FOR TAKING PART IN THE EXPERIMENT

Baseline Score	*Posted Scores (Pts)*				
	1st	*2nd*	*3rd*	*4th*	*5th*
84-85	89	88	86	84	82
81-83	88	86	84	81	78
77-80	86	84	81	77	74
72-76	84	81	77	72	69
67-71	81	77	72	67	64
62-66	77	72	67	62	59
57-61	72	67	62	57	54
52-56	67	62	57	52	49
50-52	62	57	52	47	44

—Appendix 5—

A list of the "swing thoughts" used by subjects in the Verbal Cue group during Experiment 4.

"one, two, through"
"steady stroke"
"pendulum"
"square stroke"
"rock shoulders"
"eyes over ball"
"straight back, follow through"
"length and follow through"
"straight back"
"left hand forward"

1st	£6
2nd	£4
3rd	£2
4th	£1
5th	£0

1st	41-36	77
2nd	34-38	72
3rd	36-31	67
4th	29-33	62
5th	32-27	59

Name:

Sex: M / F

Date of birth:

Current Handicap:

How many years have you been playing golf? ....

Name as many "rules" of good putting technique as you can:

....
....
....
....
....
....

THE FOLLOWING QUESTIONS CONCERN THE EXPERIMENT YOU TOOK PART IN TODAY

1 a) How consistent do you feel your routine before each putt was in the practice session?

1	2	3	4	5	6	7
not at all						highly consistent

b) How consistent do you feel your routine before each putt was in the competition?

1	2	3	4	5	6	7
not at all						highly consistent

2 a) Did you routinely use any particular **<u>CONCENTRATION STRATEGY</u>** prior to each putt **<u>IN PRACTICE</u>**?

Yes / No

If yes, what was it? ....
....

b) Did you routinely concentrate on any particular **VERBAL STIMULUS** (i.e. a "swing thought") prior to each putt **IN PRACTICE**?

Yes / No

If yes, what was it? ....

....

(non-control groups only)

c) How do you think the strategy that you used for the **COMPETITION** stage affected your performance **COMPARED TO PRACTICE**?

1	2	3	4	5
made it a lot worse				improved it a lot

3) Did you feel under pressure to do well in the competition?

Yes/No

If yes, in what way? ....

....

4) Did you feel under pressure to do well in the practice session?

Yes/No

If yes, in what way? ....

....

5) How do you feel you performed in the **COMPETITION** stage compared to your performance in the **PRACTICE** stage?

1	2	3	4	5
much worse	slightly worse	same	slightly better	much better

6) What do you think is the key to performing well in pressure situations in golf?

....

....

....

....

7) Why do you think some sportspeople (in golf and other sports) tend to "choke" in high pressure situations?

....
....
....
....

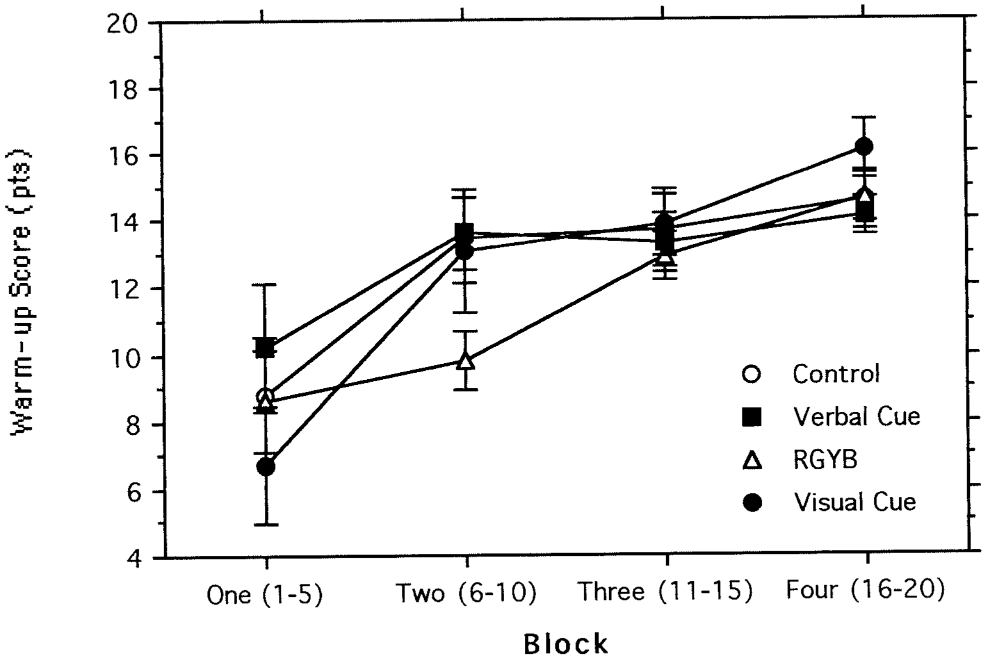
General comments/additions:

....
....
....
....
....
....
....
....
....
....

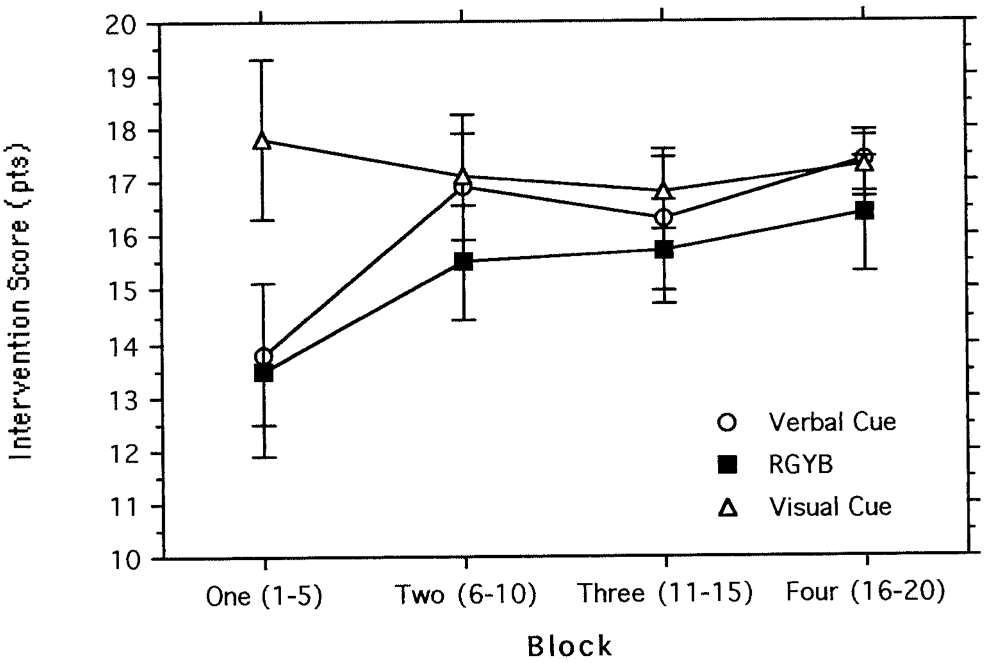
THANK YOU FOR TAKING PART IN THE EXPERIMENT

—Appendix 8—

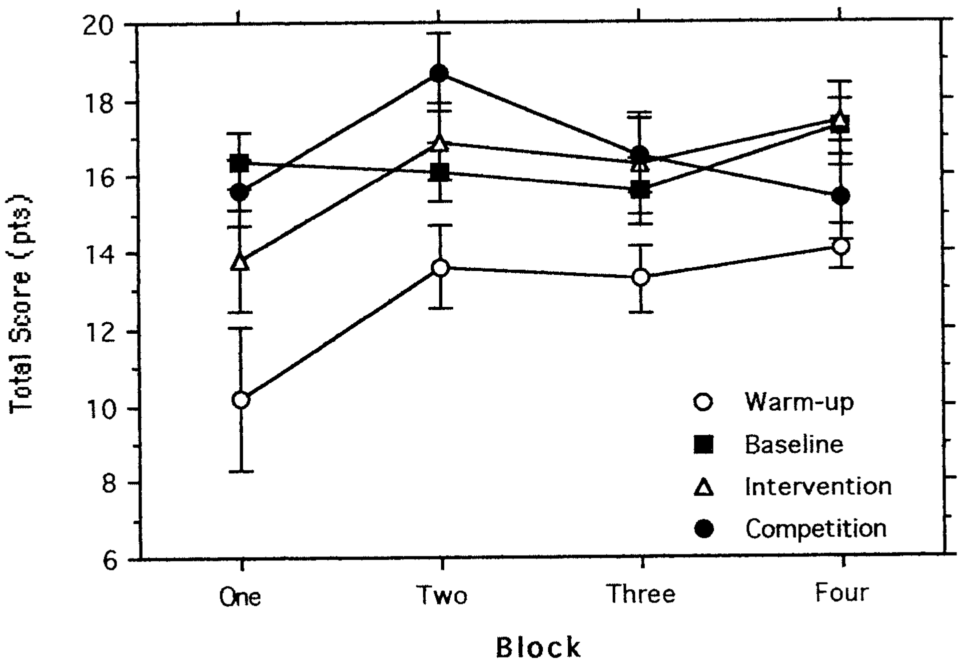
Warm-up scores for the four groups in Experiment 4 across the four blocks of five putts.



Intervention scores for the non-control groups across the four blocks of five putts in Experiment 4.



Block scores for the Verbal Cue group in all stages of Experiment 4.



—Appendix 11—

The information you provide below will remain completely confidential and will be used solely for the purposes of the current experiment.

Name: ....

Date of birth: ....

Current Handicap: ....

How many years have you been playing golf? ....

Name as many 'rules' of good putting technique as you can:

a) concerning the set-up

....
....
....
....
....

b) concerning the putting stroke

....
....
....
....
....

The following questions concern the experiment you took part in today.

1 a) When using your **NORMAL** putting method, do you routinely concentrate on any **VERBAL** stimulus (ie a "swing thought") before each putt?

Yes / No

If yes, what is it? ....
....

b) Do you routinely use **any other** concentration strategy in your normal putting method?

Yes / No

If yes, what is it? ....
....

2) Did you feel under pressure to do well at any stage of the experiment?

Yes/No

If yes, when and in what way? ....
....
....

Verbal Instruction conditions:

3 a) How do you think you performed when verbalising the **SET-UP** instructions **COMPARED WITH** when using your normal putting method?

1	2	3	4	5
a lot worse	slightly worse	same	slightly better	a lot better

b) How do you think you performed when verbalising the **PUTTING ACTION** instructions **COMPARED WITH** when using your normal putting method?

1	2	3	4	5
a lot worse	slightly worse	same	slightly better	a lot better

4 a) On a scale of 1 to 7 how difficult did you find each of the **SET-UP** instructions to follow?

(circle **one** number for each of the instructions)

1= VERY EASY **7= VERY DIFFICULT**

a) putter face square	1	2	3	4	5	6	7
b) eyes over the ball	1	2	3	4	5	6	7
c) shoulders parallel to target line	1	2	3	4	5	6	7
d) line up ball on the sweet spot	1	2	3	4	5	6	7

4 b) On a scale of 1 to 7 how difficult did you find each of the **PUTTING ACTION** instructions to follow?

(circle **one** number for each of the instructions)

1= VERY EASY **7= VERY DIFFICULT**

a) keep your head still	1	2	3	4	5	6	7
b) pivot from centre of shoulders	1	2	3	4	5	6	7
c) keep back of the left wrist fixed	1	2	3	4	5	6	7
d) putter blade square at impact	1	2	3	4	5	6	7

5 a) When using your **NORMAL** putting method, how well do you think you perform each of the **SET-UP** instructions that were specified in today's experiment?

(circle **one** number for each of the instructions)

1= VERY POORLY **7= VERY WELL**

a) putter face square	1	2	3	4	5	6	7
b) eyes over the ball	1	2	3	4	5	6	7
c) shoulders parallel to target line	1	2	3	4	5	6	7
d) line up ball on the sweet spot	1	2	3	4	5	6	7

5 b) When using your **NORMAL** putting method, how well do you think you perform each of the **PUTTING ACTION** instructions that were specified in today's experiment?

(circle **one** number for each of the instructions)

1= VERY POORLY **7= VERY WELL**

a) keep your head still	1	2	3	4	5	6	7
b) pivot from centre of shoulders	1	2	3	4	5	6	7
c) keep back of the left wrist fixed	1	2	3	4	5	6	7
d) putter blade square at impact	1	2	3	4	5	6	7

Please write any general comments you may have in the space below:

....

....

....

....

....

....

....

....

....

....

Thank you very much for taking part in the experiment

—Appendix 12—

The information you provide below will remain completely confidential and will be used solely for the purposes of the current experiment.

Name: ....

Date of birth: ....

Current Handicap: ....

How many years have you been playing golf? ....

Name as many 'rules' of good putting technique as you can:

a) concerning the set-up

....
....
....
....
....

b) concerning the putting stroke

....
....
....
....
....

The following questions concern the experiment you took part in today.

1 a) When using your **NORMAL** putting method, do you routinely concentrate on any **VERBAL** stimulus (ie a "swing thought") before each putt?

Yes / No

If yes, what is it? ....
....

b) Do you routinely use **any other** concentration strategy in your normal putting method?

Yes / No

If yes, what is it? ....
....

2) Did you feel under pressure to do well at any stage of the experiment?

Yes/No

If yes, when and in what way? ....
....
....

<u>Verbal Instruction condition</u>:

3) How do you think you performed when verbalising the putt action instructions **COMPAREDTO** when using your normal putting method:

a) when verbalising **TWO** instructions?

i) "head still" and "pivot from centre"

1	2	3	4	5
a lot worse	slightly worse	same	slightly better	a lot better

ii) "left wrist fixed" and "putter blade square"

1	2	3	4	5
a lot worse	slightly worse	same	slightly better	a lot better

b) when verbalising **FOUR** instructions?

1	2	3	4	5
a lot worse	slightly worse	same	slightly better	a lot better

4) On a scale of 1 to 7 how difficult did you find each of the instructions to follow?

(circle **one** number for each of the instructions)

1= VERY EASY 7= VERY DIFFICULT

a) keep your head still	1	2	3	4	5	6	7
b) pivot from centre of shoulders	1	2	3	4	5	6	7
c) keep back of the left wrist fixed	1	2	3	4	5	6	7
d) putter blade square at impact	1	2	3	4	5	6	7

5) When using your **NORMAL** putting method, how well do you think you perform each of the putting action instructions that were specified in today's experiment?

(circle **one** number for each of the instructions)

1= VERY POORLY 7= VERY WELL

a) keep your head still	1	2	3	4	5	6	7
b) pivot from centre of shoulders	1	2	3	4	5	6	7
c) keep back of the left wrist fixed	1	2	3	4	5	6	7
d) putter blade square at impact	1	2	3	4	5	6	7

Please write any general comments you may have in the space below:

....
....
....
....
....
....
....
....

Thank you very much for taking part in the experiment

The information you provide will remain completely confidential and will be used solely for the purposes of the current experiment.

Name: ....

Date of birth: ....

Current Handicap: ....

How many years have you been playing golf? ....

Name as many 'rules' of good putting technique as you can:

a) concerning the set-up

....
....
....
....
....

b) concerning the putting stroke

....
....
....
....
....

When putting on the golf course, do you use a particular "swing thought" which you verbalise just before each putt?

Yes / No

If yes, what is it? ....
....

Do you routinely use any other concentration strategy prior to each putt on the golf course?

Yes / No

If yes, what is it? ....
....

—Appendix 13—

The following questions concern the experiment you have just taken part in.

1) How consistent do you feel your routine before each putt was in the baseline session (2nd block of 20 putts)?

1	2	3	4	5	6	7
not at all						highly consistent

2) How consistent do you feel your routine before each putt was in the competition?

1	2	3	4	5	6	7
not at all						highly consistent

3) Compared to the baseline condition how much pressure did you feel under in the **COMPETITION** stage of the experiment?

1	2	3	4	5	6	7
much less			same			much more

4) Did you feel under pressure to do well in any other stage of the experiment?

Yes/No

If yes, in what way? ....

....

....

5) [This question asked to the non-control groups only]
Apart from the "key thought" you used in the last two blocks of putts, did you use any **ADDITIONAL** strategy to help you putt well in the competition stage?

Yes / No

If yes, what was it? ....

....

5) [This question asked to the control group only]
Apart from any strategy you may have mentioned in the questions you completed before the experiment, did you use any **ADDITIONAL** strategy to help you putt well in the competition stage?

Yes / No

If yes, what was it? ....

....

6) How do you feel you performed in the <u>COMPETITION</u> stage compared to your performance in the <u>PRACTICE</u> stage?

1	2	3	4	5
much worse	slightly worse	same	slightly better	much better

7) What do you think is the key to performing well in pressure situations in golf?

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8) Why do you think some sportspeople (in golf and other sports) tend to "choke" in high pressure situations?

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Please write any general comments you may have in the space below:

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Thank you very much for taking part in the experiment

—Appendix 14—

Self-formulated swing thoughts used in Experiment 7

Set-up (self) group

"eyes over ball, relaxed"
"head over ball, left foot"
"feet square, arms relaxed"
"head over ball, blade square"
"pendulum set-up, hands forward"
"eyes over ball, left instep"
"solid weight, head on"
"eyes over ball, soft grip"
"eyes over ball, shoulders parallel"
"head over ball, in line"

Swing (self) group

"straight back, hands forward"
"swing from shoulders, follow through"
"left wrist, square strike"
"back square, accelerate through"
"wrists fixed, pendulum"
"smooth away, accelerate through"
"wrists firm, shoulder rock"
"slow back, accelerate smoothly"
"relaxed grip, pivot shoulders"
"slow back and pendulum"