The Effect of Theoretically-based Imagery Scripts on Field Hockey Performance

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This study examined the application of a Langian imagery perspective (Lang, 1979, 1985) to a real-life sporting task, namely field hockey penalty flick performance. Twenty-seven novice hockey players were randomly assigned to either one of two imagery groups, or a control group. Participants in one of the imagery groups received stimulus and response proposition-laden imagery scripts, while the other received stimulus proposition-only scripts. All imagery participants imagined performing twenty penalty flicks three times per week for seven weeks, and control participants performed no imagery or physical practice during this period. Pre- and post-tests consisted of ten penalty flicks, with performances recorded for all groups. The response proposition group improved to a significantly ($p < .05$) greater degree than the stimulus proposition-only group, which in turn showed greater improvement ($p < .05$) than the controls. Results support the application of bio-informational theory to sport and indicate that imagery scripts should be laden with response propositions to maximize their effectiveness.

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During the past century, over a hundred studies have examined the effects of imagery on motor skill performance (Murphy, 1990), and most have shown imagery to be an effective *performance enhancement* technique (see meta-analyses by Driskell, Copper & Moran, 1994, and Feltz & Landers, 1983). The typical method in such investigations has been to perform a pre-test on the relevant skill, then split participants into three groups that perform equal amounts of either physical practice or imagery, or do nothing at all. Generally, the physical practice group performs significantly better on a post-test than the imagery group which, in turn, performs significantly better than the control group.

These studies have provided extremely valuable information as to the usefulness of imagery in enhancing the performance of many different motor skills. However, few sport psychology studies have attempted to examine either the mechanism(s) through which imagery enhances performance, or the relative effectiveness of different types of theoretically-based imagery interventions. Thus, the sport psychology literature to date has offered limited help to sport psychologists, coaches and athletes who wish to know not only whether imagery can enhance performance of a particular motor skill, but also how best to implement an imagery intervention to produce optimal results (Keil, Holmes, Bennett, Davids & Smith, 2000; Murphy, 1990).

One theoretical position from mainstream psychology, which has received increasing attention from sport psychologists (Bakker, Boschker & Chung, 1996; Collins & Hale, 1997; Hecker & Kaczor, 1988; Keil et al., 2000), is bio-informational theory (Lang, 1979, 1985). According to this theory, all knowledge is represented in memory as processed, abstract units of information regarding objects, relationships and events. These units of information are termed propositions, of which there are three fundamental categories: stimulus, response and meaning propositions. Stimulus propositions are the descriptive referents relating to the external environment. For example, taking a penalty flick in the final minute of a close field hockey match would involve the stimulus propositions of the sight of the goal and the noise made by the crowd. Response propositions describe the responses of the individual to the stimuli in the scene. These responses can include motor activity, such as limb and eye movements, and autonomic changes such as sweating and alterations in heart rate. For example, responses in the above situation might include muscle contractions, dry mouth, sweaty palms and increased heart rate. Meaning propositions are analytical and interpretative, adding components of information not available from the stimuli in the situation. They define the significance of events and the consequences of action. For example, meaning propositions in the above situation might include the knowledge that the scores are even, that there is only one minute left in the match and that the match is a major championship final, and thus the outcome is important for the individual's goal achievement.

According to Lang (1985), the processing of response propositions initiates the motor program for the imagined action, and can lead to physiological responses, termed 'efferent leakage', in relevant muscles and organs. Furthermore, the use of response and meaning propositions in imagery manipulations serves more effectively to access, and subsequently strengthen, the associated motor program than the use of stimulus propositions alone. Thus, under this theoretical perspective, the processing of all categories of propositional information is crucial since it is the accessing, and subsequent strengthening, of the motor program that is hypothesized to enhance performance.

Recent work (Decety, 1996; Jeannerod, 1997) has suggested that the motor program may be part of a biological representational structure associated with both the physical and imaginary execution of a skill. It is well recognized that experience can modify the structure and function of the brain due to its plastic nature (Kolb & Whishaw, 1998). If cortical reorganization can occur through physical practice of a motor task, imagery of the same behavior, accessing the same motor representation, should also be able to re-model cortical structures. This is supported by a large amount of research showing common neuronal mechanisms in imagery and like-modality perception (Kosslyn, 1988), and more specifically the functional equivalence research which shows similar cortical neuronal activity during imaginary and actual motor performance (for a review, see Jeannerod, 1997). Considering these findings in conjunction with bio-informational theory provides a strong, integrated model for motor imagery.

Lang's theory was developed to explain the therapeutic effects of imagery upon individuals suffering from anxiety disorders, but it has been postulated (Hale, 1994) that the theory could be applied equally to the use of imagery in sport. The first researchers to test this hypothesis were Hecker and Kaczor (1988), who instructed college athletes to imagine four scenes: A neutral scene (sitting outside on a summer afternoon), an unfamiliar fear scene (being in an out-of-control jet plane), a familiar action scene (bench pressing), and a familiar athletic anxiety scene (walking to the batter's box at a crucial point in a baseball game). The scene descriptions all contained response propositions except for the neutral scene. Heart rate was significantly greater during the action scene compared to the neutral scene, and there was a non-significant trend for heart rate to be greater during the athletic scene compared to the neutral scene. Therefore, these results appear to provide some support for bio-informational theory in a sport-related context.

More recently, Bakker, Boschker and Chung (1996) examined changes in muscle activity when participants imagined lifting weights using either stimulus or response proposition-laden imagery scripts. Electromyographic (EMG) activity was monitored during the lifting, and significantly greater EMG activity was found during the response proposition condition compared to the stimulus proposition condition, as predicted by bio-informational theory.

Therefore, there is some evidence that bio-informational theory may indeed be generalizable to the imagery of motor skills. However, the above-mentioned studies have concentrated only on the psychophysiological aspects of bio-informational theory. Although this research is clearly interesting and valuable, it does not answer the question of whether imagery interventions based on bio-informational theory are more effective in enhancing motor skill performance than those based solely on stimulus proposition-based scripts. In fact, this issue has not yet been addressed in any published sport psychology studies. This is a very important issue, as research in clinical psychology has shown bio-informationally-based imagery interventions to be significantly more effective than stimulus proposition-only interventions (see Cuthbert, Vrana & Bradley, 1991, for a review). Given the almost ubiquitous use of imagery in sport, the degree to which these findings generalize to the imagery of motor skills is clearly an issue that merits investigation. Therefore, the aim of this study was to examine this question using an intact real life skill, namely field hockey penalty flick performance, as the dependent variable. It was hypothesized that penalty flick performance would be enhanced to a significantly greater degree by the administration of a stimulus and response proposition-laden imagery intervention, than by the administration of a stimulus proposition-only intervention.

Method

Participants

Twenty-seven undergraduates, seven male and twenty female (mean age = 20.0 years, *S.D.* = (3.43) participated in the study. Although we recognize that sex differences exist with regard to hemispheric lateralization, for example on spatial abilities (see Kolb & Whishaw, 1996), it was felt acceptable to use mixed-sex groups as participants were randomly allocated to groups and no between-group differences in imagery ability were identified (see Results). None of the participants had previously performed the field hockey penalty flick, or had any previous imagery training, as identified through pre-experimental interviews. All participants provided informed consent prior to participating.

Instruments

Movement Imagery Questionnaire - Revised (MIQ-R; Hall & Martin, 1997). The MIQ-R is a revised version of the Movement Imagery Questionnaire (MIQ; Hall & Pongrac, 1983). The scale consists of eight items, four visual and four kinesthetic. The higher the score, the easier a movement is to imagine for that individual. It has acceptable concurrent validity when correlated with the original MIQ, with r values of -.77, -.77 and -.87 for the visual subscale, kinesthetic subscale and overall score respectively (Hall & Martin, 1997). The negative correlation is due to a reversal in the scale since, in the original MIQ, the higher the rating, the harder a movement was to imagine for the respondent.

Procedures

The participants completed the MIQ-R and were randomly assigned to one of three groups, each consisting of nine participants: A stimulus proposition group, a stimulus and response proposition group, and a control group.

Prior to the administration of the intervention, a pre-test was carried out. Each participant was allowed five practice shots prior to the pre-test, which consisted of twenty penalty flicks into a field hockey goal. Each flick was taken from the penalty spot, which was 6.5 meters in front of the center of the goal line. Two flags, which signified the boundaries of designated scoring areas, were placed on the goal line, 40 centimeters from either post. If the ball was flicked between the goal post and flag, the participant scored two points. If the ball was flicked in between the flags in the center of the goal, the participant scored one point. No points were awarded if the ball did not enter the goal or if the ball did not leave the ground at any point. Thus, each participant was awarded a total score out of a maximum of forty. Participants were instructed to attempt to flick the ball between the goal post and flag at each attempt. This scoring system was used to increase the face validity of the task, as normally in a match situation the goalkeeper would be in the center of the goal. Thus, a goal would be more likely to be scored if the ball was shot into the corner of the goal. No goalkeeper was used because the responses of a goalkeeper may have confounded the results, but as noted the scoring system took account of the goalkeeper's neutral position.

Following the pre-test, the imagery interventions were introduced to the participants. The intervention introduced to the stimulus and response group participants, which was based upon the tenets of Lang's (1979, 1985) bio-informational theory, commenced with a procedure known as response training (Lang, Kozak, Miller, Levin & McLean, 1980). This involved focusing the participants upon actual responses, by eliciting and reinforcing verbal reports of physiological and behavioral involvement in the scene, thus emphasizing a response orientation toward the imagery. The information gained from each individual participant was then used to create that participant's individualized imagery script, which was loaded with stimulus and response propositions reported by the participant. Not surprisingly, there was considerable inter-individual variation in the participants' reported responses. Typical response propositions included references to feelings of tension in the hands and forearm as they gripped the hockey stick, and the stinging sensation of the cold air blowing against the face. All members of this group were instructed to perform their imagery, in real time, after reading the script. Participants were issued with an imagery diary which they were instructed to sign when they had completed each imagery session, and to note down any difficulties they experienced while performing their imagery.

In accordance with previous research in clinical psychology (Lang et al., 1980), participants in the stimulus group were given stimulus training, in which the stimulus details in the participants' images were solicited and reinforced. As the stimulus details reported by the stimulus participants were all very similar to each other, stimulus participants were provided with the same, stimulus proposition-laden imagery script, matched in length to the response proposition-laden scripts provided for the stimulus and response group. No response propositions were included in this script. Therefore, the script simply described the imagined scene, without reference to the physiological responses of the participant. The stimulus elements included the sight of the hockey stick, the ball and the goal, and the sound of other people on the hockey pitches around them. As with the stimulus and response group, the stimulus group participants were issued with an imagery diary, and were instructed to perform their imagery after reading the script.

Each participant in the experimental groups performed his or her imagery three times per week for seven weeks, with each imagery session consisting of twenty imagined penalty flicks. Control group participants were instructed not to perform, or to imagine performing, the penalty flick during this period. A post-test, once again consisting of twenty penalty flicks, was then carried out. It was decided not to have control participants perform a 'placebo' task between the pre- and post-tests, as the results of previous research (see Driskell, Copper & Moran, 1994) indicate that the use of 'placebo' tasks has no significant effect on the performance of control groups in imagery experiments. However, to ensure consistency, all groups received equal attention, in terms of time, from the experimental team to reduce Hawthorne effects. In place of the stimulus or response training, general information regarding hockey was discussed.

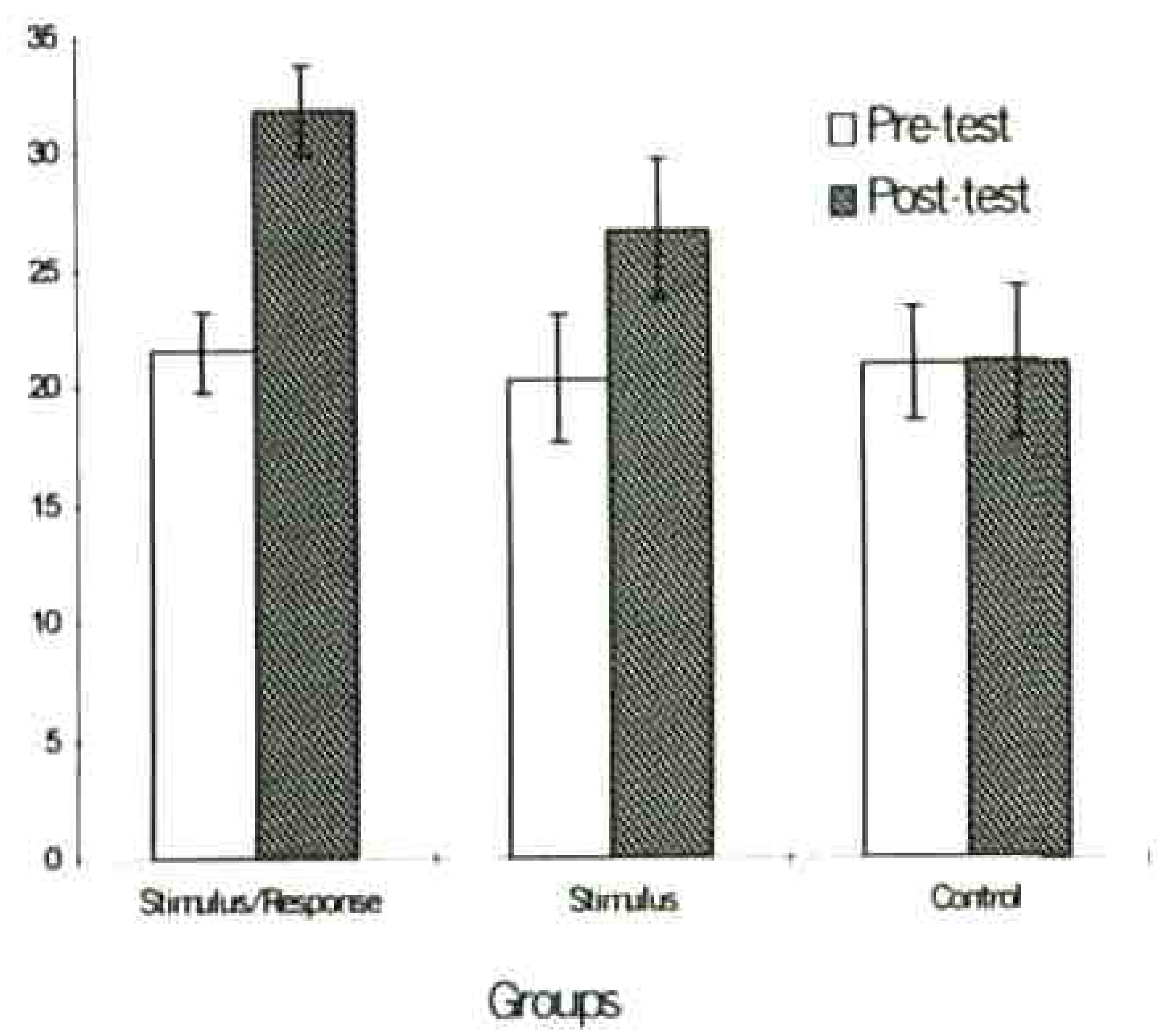
Post-experimental manipulation checks, in the form of brief interviews, were conducted to ensure that the imagery instructions were being followed correctly, as per the recommendations of Goginsky and Collins (1996). The interviews with the stimulus group participants revealed that none of them imagined or experienced the kinesthesis associated with performing the task, but instead 'pictured themselves' performing the task. This indicated that the stimulus training and instructions had been successful in producing a stimulus orientation in the stimulus participants with regard to their imagery. This is because simply 'visualizing' a scene, i.e. using the external visual perspective which is the subject of ongoing research (Hardy & Callow, 1999; Smith, Collins & Hale, 1998), would presumably mostly involve the processing of stimulus propositions. In contrast, however, as well as imagining these stimulus elements, the stimulus and response group participants reported vividly imagining the physiological sensations associated with performing the task. Therefore, the manipulation check provided a strong indication that the response training and instructions given had been effective in producing a response orientation in the stimulus and response group participants with regard to their imagery. Thus, it appears that the manipulations performed with both imagery groups were effective. Self-reports showed that the participants perceived their imagery to be effective in enhancing performance. In addition, the imagery diaries of the participants, which were examined following the post-test by the first and third authors, revealed that all scheduled imagery sessions had been completed. No difficulties had been noted by any of the participants, again indicating the effectiveness of the imagery training performed following the pre-test.

Results

A MANOVA was performed to examine differences in MIQ-R scores between the two imagery groups. No significant overall effect was found (Wilks' Lambda = .92, $F[2, 15] = .66$, $p > .05$).

Figure 1 shows that the mean scores in the post-test were greater than in the pre-test for all three experimental groups. The mean scores of the stimulus and response group increased by 47.4% in the post-test compared to the pre-test. The mean scores of the stimulus and control groups increased by 31.1% and .5% respectively. All participants in the imagery groups improved their performance in the post-test compared to the pre-test, whereas only three of the control participants showed slight improvements. To examine between-group differences in performance, a group x test ANOVA was performed. This revealed a significant interaction effect ($F[2, 24] = 25.52$, $p < .001$). Follow-up Tukey HSD tests revealed no significant between-group differences in pre-test scores ($p > .05$ in all cases). However, the post-test scores of the stimulus and response group were significantly ($p < .05$) greater than the post-test scores of the stimulus group. In turn, the post-test scores of the stimulus group were significantly ($p < .05$) greater than those of the control group. Effect size calculations (Cohen, 1988) revealed that the effect of both the imagery interventions were large (*ES* for stimulus and response, stimulus and control groups = 5.21, 2.24 and .04 respectively).

Figure 1.
Group Means and Standard Deviations for Penalty Flick Performance Scores.



Discussion

These results provide strong support for the effectiveness of imagery as a means of enhancing the hockey penalty flick performance of beginners, as both imagery groups improved to a significantly greater degree than the control group. Also (and more importantly, for the purposes of this study), the stimulus and response proposition-based intervention produced significantly greater improvements than the stimulus proposition-only intervention, providing clear support for this prediction of bio-informational theory.

According to bio-informational theory, these results can be explained by the accessing and strengthening of the motor program, which occurs due to the processing of response propositions. The processing of stimulus propositions is hypothesized to be insufficient to allow this process to take place. Of course, this does not mean that stimulus proposition-only scripts are of no value in enhancing motor performance, as processes other than the strengthening of the motor program may explain at least some of the positive effects of imagery upon performance (for example, self-efficacy and motivational effects; see Feltz, 1984, and Martin & Hall, 1995). However, the theory does suggest that personalized, response proposition-laden interventions should be the most effective, and this was clearly the case in the present study.

Similar results have been shown in the clinical psychology literature, with regard to the use of emotional imagery (for a review, see Cuthbert, Vrana & Bradley, 1991). However, this is the first time that this aspect of the theory has been tested in relation to the imagery of motor skills, and the result has interesting practical implications for the administration of imagery interventions in sport. For example, although the importance of including response propositions in motor imagery scripts has been emphasized by several authors (Bakker, Boschker & Chung, 1996; Collins & Hale, 1997; Hale, 1994; Hecker & Kaczor, 1988), some sport psychologists (e.g., Tenenbaum et al., 1995) still refer to the process as 'visualization', conceptualizing it as a purely visual experience, rather than a multi-sensory one. Such interventions may be less effective, for the reasons outlined above. In addition, generic (i.e., non-personalized) imagery scripts have been made available for use by sport psychologists (Cabral & Crisfield, 1996). However, according to bio-informational theory, more effective results may be achieved if the imagery intervention is personalized, as the individual is unlikely to relate fully to an intervention which is not specifically based on his or her own experiences (Cuthbert, Vrana & Bradley, 1991; Lang, 1985).

The need to personalize imagery scripts was indicated not only by the relative performances of the two experimental groups, but also by the responses given by the participants when interviewed following the pre-test. All the participants reported differing physiological responses when performing the hockey flick. No two answers were identical, indicating that, if sport psychologists use generic scripts rather than personalized ones, some athletes may have difficulty relating to them, and therefore the imagery is likely to be less effective. However, it is important to note that such inter-individual differences in responses were not apparent with regard to the stimulus propositions reported by participants. Indeed, as noted in the Method, the stimulus propositions reported were so similar that identical stimulus proposition-only scripts had to be given to participants in the stimulus group. This does not mean that the interventions performed with the stimulus group participants were not personally relevant: after all, each participant's script included the stimulus propositions that he or she had reported, in the same way as the scripts read by the participants in the response group included the stimulus and response propositions that they had reported. However, it does indicate that sport psychologists need to pay particular attention to individual differences in perceived physiological responses when administering imagery interventions.

Finally, it should be emphasized that the current study has shown the above-noted effects in respect of novice performers. Previous research (see meta-analysis by Driskell, Copper & Moran, 1994) has found that more experienced performers tend to benefit more from imagery than do novices. This being the case, perhaps expert hockey players would have improved to an even greater degree than the participants in the present study. More research examining the effects of different types of imagery scripts on performers of varying skill levels would be a valuable addition to the literature on this important topic.

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