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# **The effects of focus of attention when imitating a professional darts player**

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## **Abstract**

This current study investigates the effects of imitating a video of a professional darts player. Participants were asked to focus on, and then replicate either internal or external factors of a professional darts player's throw. Contrary to previous research, it was found that participants performed best in the control condition, followed by the internal condition, with the external condition provoking the worst score in study 1. However, when instructions were changed in study 2, the control condition performed better than the external condition, followed by the internal condition: the differences in scores were shown to be significant by a one-way ANOVA  $F(2,48) = 3.95$ ,  $p < 0.05$ , showing that participants' performance was significantly inhibited by both the video and instructions.

## **Introduction**

For competitive athletes, sport is more than a game (Jones, 1995), there are few athletes in the world that would argue against the significance of being mentally prepared before, or during, any form of competition, with extra impetus being put on their mind-set during competitive situations (Gee, 2010). Therefore it is important that athletes utilise the best strategies for performance, one strategy that has been extensively researched is the performer's focus of attention.

What an athlete focuses on when performing can have a large impact on the results of their performance. An external focus of attention refers to the performer's attention being away from their body movements when performing an action, for example focusing on the way a football spins during its flight. In contrast, an internal focus of attention refers to the performer focusing on their own body movements, for example, focusing on the way that their leg moves when kicking the ball followed by where their foot needs to connect with the ball to make it spin in the desired manner (Wulf, Höß & Prinz, 1998).

The best focus of attention to use has been a source of much research within the realm of sport psychology and sport science, trying to identify suitable attentional states in order to have more efficient execution of movements (Marchant, Clough & Crawshaw, 2007), the effect of external and internal factors has been of interest to many researchers, one of whom is Gabriele Wulf (Wulf, 2007). In a review of her work on focus of attention and motor learning, the main focus was on how the effects of external and internal focus can affect a person's performance in a task. The main findings from Wulf's (2007) research was that the focus of attention plays an important role in a person's performance in a variety of situations, whether it is darts, golf or how high you can jump, with research showing an external focus of attention be more beneficial compared to an internal focus of attention almost immediately. However, more interestingly it was shown that where a person focuses their attention affects their learning process; the skill learned is retained more effectively when using external focus of attention. These benefits have been shown to be applicable to many skills, whether it is at an amateur level, or at an elite level the effects can still be seen.

The differences between the performance when using external and internal focusing strategies have been widely investigated in many sports, one of which is darts. Radlo, Steinberg, Singer, Barba and Melnikov (2002) investigated the influence of attentional strategies on brain activity, heart rate and dart throwing performance in novice dart throwers. The participants' brain activity was measured using an electroencephalogram (EEG) whilst their heart rate was measured using electrodes placed on the sternum; they also measured muscle activity in the arm using electromyography (EMG). The dartboard used was painted white with 10 concentric circles for scoring, each circle being 5cm apart and numbered 0-9 with the aim of performing a perfect shot into the centre of the target. The throws were scored by where the dart landed within the 10 circles, the centre scoring 0 and the outer most circle scoring 9, a score of 9 was also given if a dart landed outside of the last circle, or missed the board completely.

The participants listened to verbal instructions corresponding to their strategy group, either external or internal; these instructions were repeated before every throw, with participants being asked to practice these instructions before and during their throw.

Those in the internal focus of attention group were instructed to; (1) feel the weight of the dart in their hand; (2) think about drawing the dart back to the ear; (3) feel the bend in the elbow; and (4) feel the dart as it left the finger tips. Whilst participants in the external focus groups were directed to focus on the outcome of the task and use following instructions given to achieve this: (1) focus on the centre of the dart board; (2) slowly begin to expand upon perspectives of the dart board; (3) then refocus to the centre of the dart board, expanding the centre and making it as large as possible; and (4) toss the dart when so focused. Once the participants had completed the instruction phase, they were asked to perform 10 practice throws using the strategy they were assigned to, this was followed by 40 test throws split into 10 blocks of 4 throws each.

It was found that participants using an external focusing strategy recorded less error than their counterparts using an internal focusing strategy. The external group had a mean score of 2.25 compared to the internal groups mean score of 2.94 providing evidence that an external focus of attention leads to greater accuracy.

As for the cognitive aspect of these behaviour changes, the EEG recordings indicated that variations in alpha brain wave power corresponded to the behavioural output, it was shown that lower levels of left and right hemispheric alpha occurred immediately before the release of the dart was shown in participants using an external focus of attention. This finding led Radlo et al (2002) to the conclusion that the participants in the external condition are in fact less conscious of their actions than those in the internal condition.

The heart rate measurements also proved the external condition to be the most beneficial. It was found that those applying an external focusing strategy displayed a steady decrease in heart rate immediately before the dart throw, whilst those using an internal focusing strategy showed a decrease in heart rate up until the point of initiating the dart throw, from this point a significant increase in heart rate was recorded, Radlo et al (2002) argue that, due to the fact that muscle tension was the same in both attentional focus groups it is apparent that heart rate is influenced by the direction of attentional focus.

Radlo et al's (2002) findings were investigated further by Marchant, Clough and Crawshaw (2007) who randomly assigned participants to one of three conditions, either a control, external or internal condition. Participants' were given an anxiety state questionnaire, once completed they were given written instructions as well as verbal instructions consistent with their assigned group. The instructions were adapted from those used by Radlo et al (2002) as they were found to induce appropriate attentional states. Participants were asked to throw as accurately as possible using the instructions given with each participant throwing 10 practice throws using their respective strategy; they then threw 40 test throws divided into 10 blocks of 4 throws each, they then completed a post-task experience questionnaire.

It was found that the throwing accuracy of the novice dart players was significantly affected by the strategy they used to focus, a result which is concordant with the majority of focus of attention research. Utilising an external focus of attention produced greater accuracy than applying an internal focus of attention, supporting the findings of Radlo et al (2002) as well as the findings shown above. It was also shown that the control group had significantly better performance than the internal

group; however no significant difference could be found between the control groups and the external focus of attention group's performance. The performance of the control group is contradictory to previous research as participants in control conditions usually perform at a similar level to those who are using an internal focus of attention. These results provide support for the 'constrained action hypothesis' (Wulf et al, 2001) as they suggest that an internal focus of attention has a negative impact on the accuracy of participants due to interference with the execution of the movement compared to the control condition.

The constrained action hypothesis argues that focusing attention in the movement effect can promote an automatic mode of control. Thus, adopting an external focus allows the movement to be controlled by unconscious, fast and reflexive processes. In contrast, implementing an internal focus by consciously controlling their own movements tends to constrain the motor system as it intervenes in the processes that would usually regulate the coordination of their movements; therefore the automatic processes which have the power to create effective and efficient control of movements are disrupted (Wulf et al, 2001).

The effect that conscious or controlled processing has on performance in a dart throwing task has been investigated by Weiss (2011) who utilised the reinvestment scale first created by Masters, Polman and Hammond (1993). It was proposed that the reinvestment of controlled or conscious processing may be a dimension of personality, suggesting that particular individuals may in fact have a disposition towards the reinvestment of controlled processing. Thus the reinvestment scale was created in order to measure the susceptibility of a person to both public and private self-consciousness.

Weiss (2011) found evidence in support of the constrained action hypothesis in that participants instructed to use a non-preferred internal focus of attention strategy whilst also scoring highly on the reinvestment scale, displayed the lowest overall performance. This factor has been explained as an effect of the instructions causing participants to experience excessive thinking, causing a breakdown in their skill. Of the three other groups, external-high and external-low all showed improvement from the baseline task whilst the internal-low group maintained a decline. The retentions phase showed that all four groups maintained a stable score; showing that when high level of conscious reinvestment is placed into a task, it negatively affects participants when using an internal focus of attention, whilst if the same person was to utilise an external focus their performance would improve.

The current study is going to use a video of a professional darts player, Phil Taylor. The participants will be required to watch and reproduce internal and external aspects of the throw. In order to reproduce Phil Taylor's technique and dart flight it will be required that participants use mechanisms of imitation.

One such mechanism is the goal guided theory of imitative performance proposed by Bird, Brindley, Leighton and Heyes (2007). It has been claimed that the replication of the outcome of an action is more important than the imitation of the body movements through which they were achieved. This goal guided theory of imitative performance can be explained using the following example; more importance will be placed on the fact that a darts player hits the bullseye than the technique employed in the throwing process. The theory of goal-directed imitation provides perhaps the most explicit and

comprehensive view that goals guide imitative performance, neatly tapping into the focus of attention research. Internal focus of attention focuses on technique, which according to the goal directed theory of imitation is viewed as less important than the end goal, an external attention of focus.

The processes of imitation have also been investigated by Wohlschlagel, Gattis and Bekkering (2003) who propose that the imitator doesn't imitate the observed movement as a whole. Instead the movement is decomposed into different aspects, which are in turn hierarchically ordered with the imitator's main goal being given highest priority. When this motor programme is then activated, the model's movement is sometimes matched, whilst the main goal extracted from the model movement is almost always imitated correctly.

It has also been suggested that the goal directed theory of imitation may in fact relate to mirror neurons. Oztop, Kawato and Arbib (2006) postulate that the main goal activates the motor schema that is most strongly associated with the end product of that goal. However, they acknowledge that there is no magic related to the complex imitation which will inevitably select the correct hierarchy when decomposing a movement. They argue that it in fact rests on a 'high level approximation' of the action that is observed, leading the attention to crucial sub goals which may not have been seen initially and thus, the process then leads to successful imitation.

In order to extend the research into focus of attention the research to be carried out will follow on from the research highlighted above by investigating the effect of focus of attention when imitating an expert throwing a dart. As mentioned previously a video of a professional darts player will be shown to participants who will be asked to focus on different aspects of the technique used. By instructing the participants they will be guided as to their goals in each condition, whilst the instructions will also help the participants to decompose the task into different aspects. This should cause the participants to reproduce the skills shown

It is predicted that participants will exhibit better performance when in the external condition, in concordance with the research of Radlo et al (2002), Marchant et al (2007) as well as the extensive findings from Wulf (2007). The hypothesis that will be tested is; an external focus of attention when focusing on an expert's technique demonstrated on a video recording will lead to better performance than when focusing on internal factors. The null hypothesis being tested is that the control condition will perform better in the task, due to the video constraining the participant's focus.

## **Study 1**

### **Method**

#### *Aim*

To investigate the effect of external and internal focus of attention when trying to imitate aspects of an expert throwing a dart.

### *Participants*

The participants were 20 psychology students from the University of Plymouth comprising of 15 females and 5 males. All of whom were completing the experiment in order to gain participation points as a requirement of their course.

### *Materials*

A dartboard was set up according to the official regulations, the centre of the bullseye was 5' 8" above the floor, with the 'hockey' or throw line being 7' 9 ¼" away from the front of the dartboard, this distance was indicated using a line of tape which the participants were instructed to stand behind when throwing. A standard dartboard was used, with a diameter of 19" however in order to make the task easier to non-darts players, the dartboard was changed to a target of 5 rings (Figure 1), the innermost ring had a radius of 2.5cm, the second rings radius was 5.5cm, the third ring had a radius 9.5cm, the fourth ring had a radius of 13.5cm and the fifth ring had a radius of 17.5cm. The darts used in the experiment were regulation, 22g, 90% Tungsten Steel Tip Darts made by Harrows. A laptop was also used in order to show the videos.



**Figure 1:** The dartboard used in the task.

### *Design and Procedure*

The research used a within subjects design consisting of one level, and three factors, the instructions given, the three sets of instructions were external, internal and control this was chosen so that when comparing participant's performance, individual differences would not have as much influence as each participant would have partaken in each condition.

Participants entered the room, and were greeted by the researcher, they were then asked to sit down and read the information sheet (Appendix A) which told them the procedure they were about to follow, the amount of time the study would take, and what would be gained from the study. Participants were asked to sign the consent form. Once the participants had read through the information sheet they were given the opportunity to ask any questions about the study. Once all the questions had been answered the experimenter briefly told the participant what was going to happen and explained the scoring system; that the main goal with each throw was to score the highest score possible (5). It was important that participants were very clear about the aim of the experiment.

Once the participants were fully aware of the task they were asked to throw a set of 12 darts as close to the centre of the dartboard (bullseye) as possible in order to allow them to get used to the weight of the dart and the weight of the throw needed. After the warm up throws were completed they were read the instructions for the corresponding condition. The instructions for the external focus of attention condition were *'In this block of trials, I want you to ignore the movement of the arm. Instead, focus on the flight of the dart as it travels towards the board. I want you to try and reproduce this in your next six throws, in order to achieve the best possible score.'* The instructions for the internal focus of attention were *'In this block of trials, I want you to ignore the flight of the dart. Instead, focus on the sequence of movements that make up the throw. I want you to try and reproduce this in your next six throws, in order to achieve the best possible score.'* Finally, the instructions for the control condition were, *'In this block of trials, I want you to ignore all previous instructions given. Instead, throw the dart as you did at the start of the experiment. I want you to try and reproduce this in your next six throws, in order to achieve the best possible score.'* The instructions were worded as similarly as possible to one another in order to remove any confounding effect.

Once the instructions had been read out to the participant, they were shown the video corresponding to the condition; each video lasted for the same amount of time, seventeen seconds, so that the participants' performance could not be affected by the amount of time they were exposed to the video. The videos were either focused on the expert's arm movement, internal focus of attention, or the flight of the dart thrown by the expert, external focus of attention. Each video is filmed from the same angle, and shows the same throw however, it has been edited so that both the initial arm movement and release is shown during the internal condition. The external condition shows the flight of the dart, and the dart entering the board. When exposed to the control condition no video was shown.

After watching the video, the participants threw 6 darts in the desired manner. The researcher then scored the participant's throws in sets of 3 darts; the scoring system scored the centre ring as 5 points, the fourth ring as 4 points, third ring as 3 points, second ring as 2 points and the outer ring as 1 point. If the participants missed the board a score of 0 was given. To remove the effect of 'knowledge of performance' on the effect of subsequent shot the participants were not told that the scores were being taken. For example, if the participant had performed badly on the first 2 throws in a set of three, they may not focus fully on the final throw of the set. Once the participants had thrown 6 darts, they were reminded of the instructions and shown the video once more.

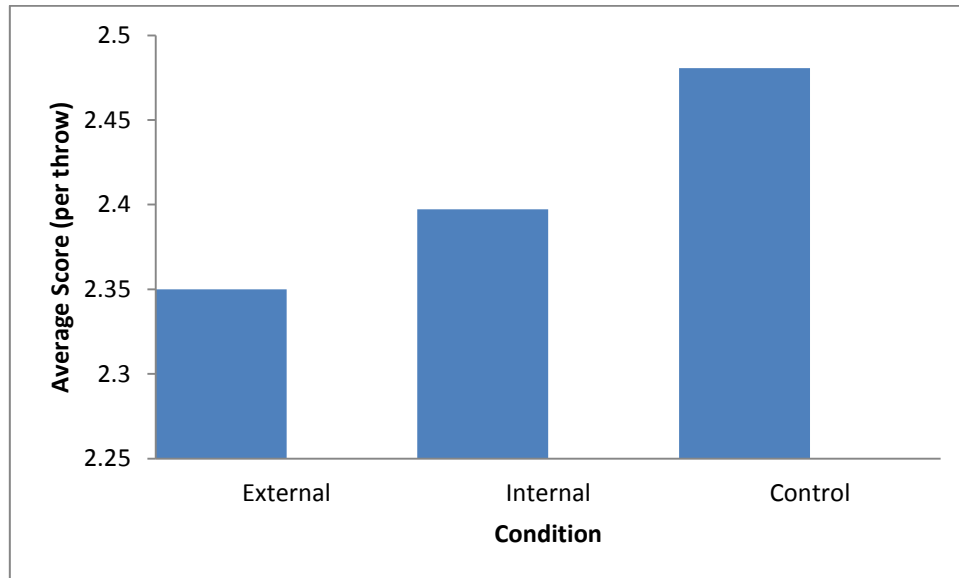
Once the participants had thrown the block of 12 darts in their first condition the same procedure was carried out for the next condition, in order to prevent order of exposure having an effect on the results, the exposure was counterbalanced; there were 6 different orders of exposure in total (Appendix B).

Whilst participants were throwing the darts, their score on each throw was noted by the researcher on the results sheet (Appendix C). At the end of the experiment participants were presented with the debrief form, available in Appendix D, and asked if they had any questions about the research.



## Results

The average scores in each condition, as shown in Figure 2, show participants to have performed better in the control condition than both the external, and the internal condition. However, a one-way analysis of variance (ANOVA) showed the differences in these means to be not significant ( $F(2,38) = 1.05$ ,  $p = .361$ ).

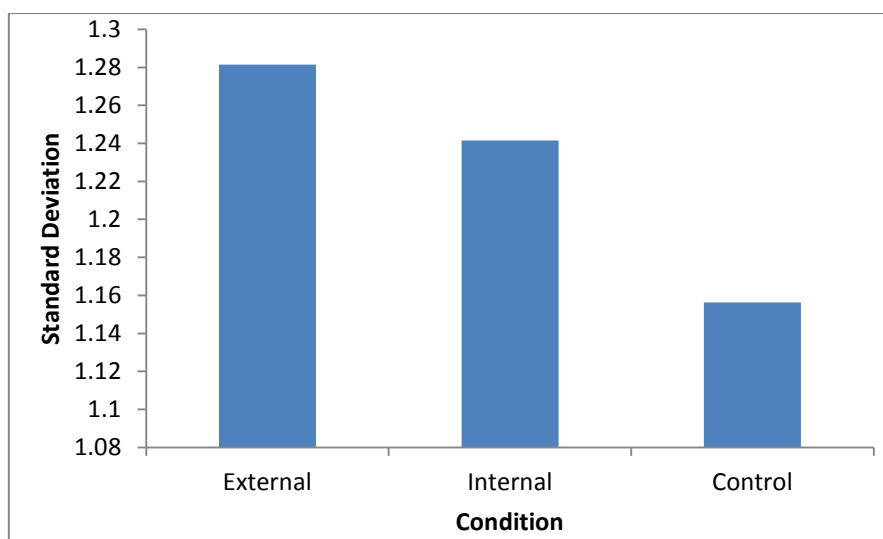


**Figure 2:** Bar Chart showing the average scores per dart thrown for each condition.  $N=20$

The standard deviations, as shown in Figure 3, indicate that the when in the control condition participants achieved more consistent performance during the task whilst the external and internal conditions provoked more erratic scoring.

To elucidate whether these differences in consistency were significant, we ran a one way repeated measurements ANOVA on the participant's standard deviations in each condition. The result showed the differences to be significant  $F(2,38) = 7.64$   $p=0.002$ . This result, however, does not indicate where the significant differences in these effects lie; therefore an LSD post-hoc test was carried out.

The post-hoc test showed that significant differences ( $p<0.05$ ) were found in the interactions between the control condition and the external condition ( $p<0.001$ ) as well as between the control condition and the internal condition ( $p<0.04$ ), however no significant differences were found between the external and internal conditions.



**Figure 3:** Bar chart showing standard deviations of the average score in each condition. N=20

## Discussion

The results from this study show that when watching the video and trying to reproduce behaviours of a professional darts player, participants' performance was inhibited, as shown by both of the experimental conditions scoring worse than the control condition. The standard deviations also show that the control condition performed more consistently throughout the task. This result provides support for the constrained action hypothesis (Wulf et al, 2001). It could also however, be due to the fact that the instructions used were too vague. In order to investigate this factor further, a second study was conducted, this time using stronger instructions.

## Study 2

### Method

#### *Aim*

To investigate the effect of extrinsic and intrinsic attention of focus when trying to imitate an expert.

#### *Participants*

The participants were 20 psychology students from the University of Plymouth comprising of 15 males and 5 females. All of whom were completing the experiment in order to gain participation points as a requirement of their course.

#### *Materials*

The materials used in this study were identical to Study 1.

#### *Design and procedure*

The design and procedure for this study was identical to that of study 1, however this time the instructions used were more specific as to what the participants should be focusing on. The instructions were as follows, in the extrinsic condition the participants' were read the following instructions *'In this block of trials, I want you to ignore the movement of the arm. Instead, focus on the flight of the dart as it travels towards the board. Focus specifically on the trajectory and angle of the dart. I want you to try and reproduce this in your next six throws, in order to achieve the best*

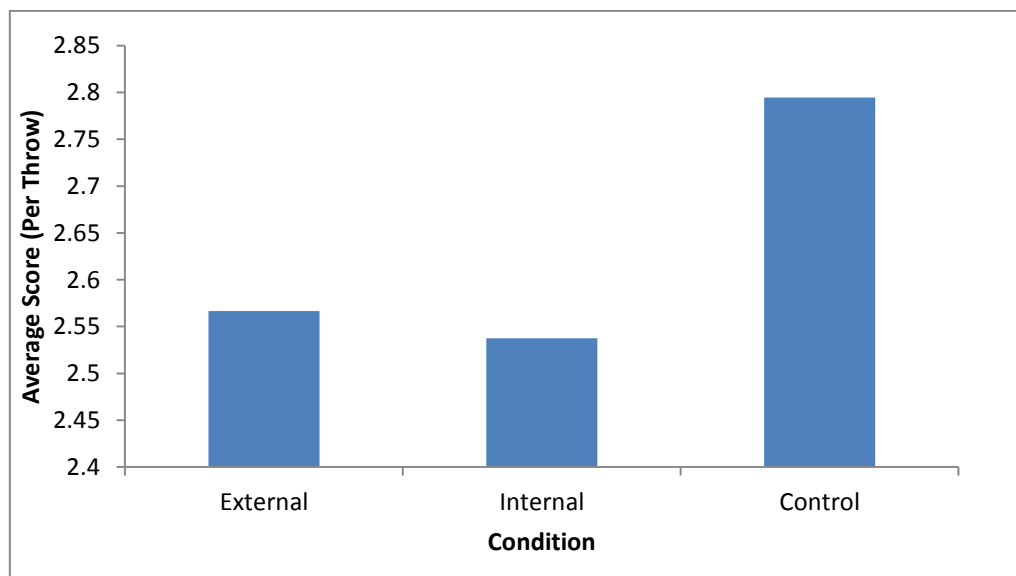
*possible score.* Whilst in the intrinsic condition participants were read these instructions, *'In this block of trials, I want you to ignore the flight of the dart. Instead, focus on the sequence of movements that make up the throw. Focus specifically on the position of the elbow and the extension of the arm. I want you to try and reproduce this in your next six throws, in order to achieve the best possible score.'* The instructions for the control condition remained the same as in Study 1, with participants being read *'In this block of trials, I want you to ignore all previous instructions given. Instead, throw the dart as you did at the start of the experiment. I want you to try and reproduce this in your next 6 throws, in order to achieve the best possible score.'*

## Results

The results from the second study, as shown in figure 4, show that with each throw, on average, participants performed better when in the control condition, followed by exposure to the external and the internal conditions.

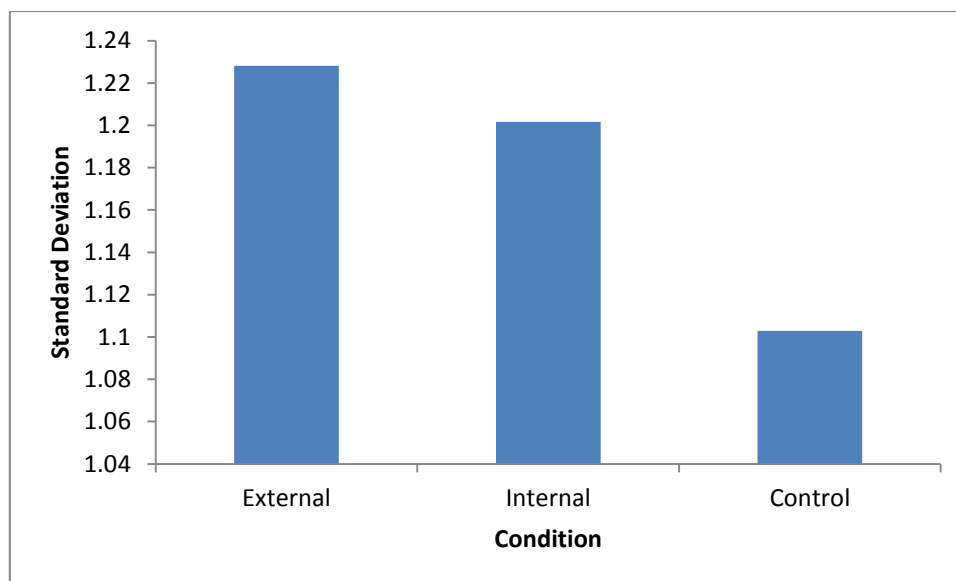
A one way ANOVA showed the differences in these means to be significant  $F(2,48)=3.95$ ,  $p<0.05$ . This result, however, does not indicate where the significant differences in these effects lie; therefore an LSD post-hoc test was carried out.

The post-hoc test showed that significant differences ( $p<0.05$ ) were found in the interactions between the control condition and the external condition ( $p<0.049$ ) as well as between the control condition and the internal condition ( $p<0.040$ ), however no significant differences were found between the external and internal conditions.



**Figure 4:** Bar Chart showing average scores for each condition when new instructions were used (n=20).

The standard deviations of each condition, as seen in figure 5, also show that participants performed most consistently in the control whilst in the internal and external conditions they proved to be less consistent.



**Figure 5:** Bar chart showing standard deviations for the average score in each condition with new instructions (n=20).

When comparing the effect of the instructions used in both studies, a 3 by 2 between subjects ANOVA was conducted with the instructions as a within subjects factor, and the experiment as a between subjects factor. The ANOVA showed no significant differences  $F(1, 38) = 1.899, p = 0.176$ .

### Discussion

The results of study 2 show that the instructions did make a difference to the performance, as shown by the increased average scores. It was also shown that the differences in the scores between external and control, and internal and control conditions were significant, showing that the videos and improved instructions significantly inhibited the performance of participants in the task. The standard deviations in each condition also indicates that participants performed more consistently than participants in study 1, this may be due to the more explicit instruction as it makes the participants more aware of their goal in the task, which according to the goal directed theory of imitation would mean that they perfect this goal perfectly almost all of the time (Wohlschlager et al, 2003).

### General Discussion

Overall, it has been shown from the two studies that participants' performance was inhibited when attempting to imitate aspects of a professional darts players throw. The results from both study one and study two show similar patterns. In study one, it was found that the control condition provoked the highest average score, as well as providing the most consistent scoring; this was followed by the internal condition and lastly the external condition.

Study two found a similar pattern of results, however, compared to study one the average scores across all conditions were higher, as well as the standard deviations being lower. The order of performance however was different, with the control condition performing better than the external condition, followed lastly by the internal

condition. The results of both studies are can be explained by the constrained action hypothesis (Wulf, McNevin and Shea, 2001) and can also tap into the goal directed theory of imitation as to why participants were better in the control condition in both studies.

The results of this study have produced extremely contrasting results compared to previous research conducted. Research into the best focus of attention to apply has consistently shown an extrinsic focus of attention to be the most beneficial. (Wulf, 2007; Radlo et al, 2002; Marchant et al, 2007). The results do however; provide support for Wulf et al's (2001) constrained action hypothesis.

The constrained action hypothesis argues that focusing attention in the movement effect can promote an automatic mode of control. Thus, when adopting an external focus allows the movement to be controlled by unconscious, fast and reflexive processes. In contrast, implementing an internal focus by consciously controlling their own movements tends to constrain the motor system as it intervenes in the processes that would usually regulate the coordination of their movements (Wulf et al, 2001). The results suggest that watching the video caused constraint to the motor system of the participants in both the internal and external conditions, as they had to pay attention to several factors before throwing the dart. It may be possible that participants were disrupted by the video and were unable to throw the dart as accurately in the experimental conditions as their motor system was inhibited by the amount of information that they needed to process, whereas the control condition allowed their movement to be controlled by more unconscious, fast and reflexive processes.

An alternative explanation may be that there was in fact no 'external' condition. Whilst the video that the participants watch in this condition shows the effect of the professionals' movements on the environment, once the participants step up to throw the dart in the manner instructed, the onus is then on them to focus on their own movements so that they are able to work out how the professional achieved that end goal. Therefore, it could be possible that the participants then utilise an internal attention of focus in order to achieve a similar flight to the participants, rather than focusing on how the effects of their movements on the environment. Thus highlighting a problem with the validity of the study as the external condition may not measure what it was intended to measure. This would also offer an explanation as to why both the internal and external conditions had similar average scores, despite the improved instructions enhancing the external scores in study 2, there were no significant differences between the internal and external conditions, this could possibly be due to the fact that both conditions were activating and measuring similar mechanisms.

In order to test this statement when conducting future research, it may be suitable to ask the participants what they were focusing on in each condition, this could be done either via a questionnaire, or by the researcher asking participants after being exposed to each condition, and then noting it next to the block of trials just completed on the score sheet. This would allow the researcher to gain an understanding as to what each participant had been focusing on in each block of trials. Further research could also utilise the use of EEG recordings, similar to Radlo et al (2002). This would make it possible for the researcher to investigate the cognitive aspects of the experiment, and be able to find out if there was more

cognitive 'noise' in the experimental conditions when compared to the control condition.

The problem with validity could also stem from the instructions given, it could be possible that the instructions for the external condition, despite asking participants to '*focus on the flight of the dart as it travels towards the board*' which puts emphasis on the external factors of the throw, the next sentence '*I want you to reproduce this in your next 6 throws, in order to achieve the highest score possible.*' may then cause the participants to think about their movements as opposed to thinking about the effect of their movements on the environment; therefore, the instructions may also need to be changed in future research so that the external instructions put participants focus purely on external factors. If, when the instructions have been changed, participants perform better in the external condition it can be concluded that the instructions used acted as a confounding variable in the external condition, thus inhibiting performance.

A further explanation for the results can come from the goal directed theory of imitation. Wohlschlager et al (2003) propose that the imitator doesn't imitate the observed movement as a whole but in fact decomposes it into different aspects. These aspects are then hierarchically ordered with the imitator's main goal being given highest priority. When this motor programme is then activated, the model's movement is sometimes matched, whilst the main goal extracted from the model movement is almost always imitated correctly. They suggest that the hierarchy is created in the following way; the imitator doesn't imitate the observed movement as a whole, instead the movement is decomposed into several separate aspects by the imitator and then hierarchically ordered with the most important aspect being the main goal, the other aspects then becoming sub-goals. When the movement is imitated, the main goal extracted is almost always imitated in the correct manner.

According to this postulation it would make sense that when the participant's goal is to reproduce the flight of the dart, they will almost always replicate it perfectly; however the aim of scoring as highly as possible will take a back seat, and will only be achieved occasionally. Similarly the internal condition will see the participants reproducing the sequence of movements perfectly, whilst the scoring will also be less of a concern and thus not replicated as often. In contrast, the control condition requires the participants to have the main goal of replicating their warm-up throws, which participants will have easier access to as they are trying to imitate themselves as opposed to someone else.

This also offers an explanation for the difference in standard deviations in each condition. The external and internal deviations could be explained as high because participants did not place as much emphasis on the achievement of a high score, whilst the control conditions low standard deviation could be explained as the participants' main goal was to replicate their performance in the warm-up, and as Wohlschlager et al (2003) suggest, this is achieved almost always.

One flaw in the research conducted was that the participants were not filmed throwing the darts which would have made it possible to analyse the throws, and discover whether participants did in fact replicate the professional's movements correctly. In order to investigate this further, future research could use video cameras, to analyse the flight of the dart and the participants' movements in the

external and internal conditions respectively. This would allow researchers to find out whether participants do in fact replicate the professionals movements correctly.

As for real life implications, the current research has highlighted than when trying to teach or learn to play darts, learning from different aspects of a video of a professional may not lead to the best results .However, it is unknown how participants would have performed if they had watched the whole video and were merely asked to imitate the throw. If participants do in fact perform better it can be concluded that they need to see the complete movement, this may be so that, as Wohlschlager et al (2003) proposed, they can decompose the whole movement into their own hierarchy and then imitate.

Another problem with the research is that the participants, who are novices at darts, were trying to imitate an expert therefore the task of imitating a professional darts player may have been too difficult. Darts players have perfected their throwing technique through regular and dedicated practise over a number of years, whereas the task in the study required participants to learn the skills within minutes, as the activity only lasted 30 minutes consequently, it may be that the participants performed worse in the experimental conditions because they could not grasp the same skill in such a short space of time. In order to test the effect that viewing an expert has on novice participants', further tests could use a video of a novice throwing a dart, as opposed to the video used in this study. If the participants performed better in the experimental conditions when viewing a novice dart thrower, it can be concluded that it was too hard for participants to imitate a professional.

During the research several problems occurred, for example, on one occasion a participant threw a dart and the flight came off, at the time it wasn't possible to fix the dart, meaning 3 participants had to complete the study throwing six sets of two darts per condition, as opposed to four sets of three darts as shown in the method. The three participants' data was not removed as their scoring patterns were consistent with the other participants.

A second problem that occurred was that some participants complained of fatigue, with one participant asking 'are there many more?' when in the last block of trials. Another two participants told the researcher when the study had been completed that their arm ached. These participants however showed no deviation in results, and thus their results were not removed.

The final problem that emerged during research was a small number of participants who asked if they were meant to aim their dart to land at the corresponding place on the study board to match that of video in the external condition. In the video the dart is seen landing in the treble 20 zone but participants are instructed to achieve the highest score possible which, with the scoring system used, meant them aiming to score 50, situated in the bullseye. Those who asked were told by the researcher that their aim is to achieve the highest score. However it isn't possible to know the effect of this problem as it may be that in fact that some participants aimed to throw the dart where it lands in the video, rather than aiming to achieve the highest score possible. This problem would be easily overcome by using a video that shows the dart landing in the bull's-eye.

Overall it has been shown from the two studies that participants' performance was inhibited when attempting to imitate aspects of a professional darts player's throw. However, the research has opened up many new avenues for future research in order to find out what it was that inhibited performance. It may be that the external instructions, conversely, caused participants to focus on internal factors. Alternatively, it could be that the instructions in both experimental conditions caused participants to put emphasis on the goal of imitation as opposed to the goal of achieving the highest score. This current study has found interesting results, however there were also many confounding variables highlighted, that need to be investigated further. Until these different suggestions have been investigated further it is unknown how much the videos inhibited performance, and therefore a true conclusion cannot be drawn as there is insufficient evidence.

## References

- Bird, G., Brindley, R., Leighton, J., & Heyes, C.** (2007). General Processes, Rather Than "Goals," Explain Imitation Errors. *Journal of Experimental Psychology: Human Perception and Performance*, 33, 1158-1169.
- Gee, C.** (2010). How Does Sport Psychology Actually Improve Athletic Performance? A Framework to Facilitate Athletes' and Coaches' Understanding. *Behaviour Modification*, 34, 386-402.
- Jones, G.** (1995). More than just a game: research developments and issues in competitive anxiety in sport. *British Journal of Psychology*, 86, 449-478.
- Marchant, D., Clough, P., & Crawshaw, M.** (2007). The effects of attentional focusing strategies on novice dart throwing performance and their task experiences. *International Journal of Sport and Exercise Psychology*, 5, 291-303.
- Masters, R. S. W., Polman, R. C. J., & Hammond, N. V.** (1993). Reinvestment: A dimension of personality implicated in skill breakdown under pressure. *Personality and Individual Differences*, 14, 655-666.
- Oztop, E., Kawato, M., & Arbib, M.** (2006). Mirror neurons and imitation: A computationally guided review. *Neural Networks*, 19, 254-271.
- Radlo, S., Steinberg, G., Singer, R., Barba, D., & Melnikov** (2002). The influence of an Attentional Focus Strategy on Alpha Brain Wave Activity, Heart Rate, and Dart-throwing Performance. *International Journal of Sport Psychology*, 33, 205-217.
- Weiss, S.** (2011). The Effects of Reinvestment of Conscious Processing on Switching Focus of Attention. *Research Quarterly for Exercise and Sport*, 82, 28-36.
- Wohlschläger, A., Gattis, M., & Bekkering, H.** (2003). Action generation and action perception in imitation: An instantiation of the ideomotor principle. *Philosophical Transactions of the Royal Society of London: Biological Sciences*, 358, 501-515.
- Wulf, G.** (2007). Attentional Focus and Motor Learning: A Review of 10 Years of Research. *Bewegung und Training*, 1, 4-14.



- Wulf, G., Höß, M., & Prinz, W.** (1998). Instructions for motor learning: Differential effects of internal versus external focus of attention. *Journal of Motor Behaviour*, 30, 169-179.
- Wulf, G., McNevin, N., & Shea, C.** (2001). The automacity of complex motor skill learning as a function of attentional focus. *The Quarterly Journal of Experimental Psychology*, 54, 1143-1154.
- Wulf, G., & Prinz, W. (2001).** Directing attention to movement effects enhances learning: A review. *Psychonomic Bulletin & Review*, 8, 648-660.