

The Effect of Altering Focus of Attention on Throwing Accuracy in Highly Skilled Baseball Pitchers

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ABSTRACT

Previous research has consistently demonstrated that using an external focus of attention rather than an internal focus of attention enhances motor skill learning and performance. The purpose of this study was to examine whether using different focus of attention (i.e. internal or external) influenced pitching accuracy. It was hypothesized that highly skilled baseball pitchers utilizing an external focus of attention would display greater pitching accuracy when compared to trials performed following instructions that were designed to direct attention internally. Participants (N=11) completed 60 trials under internal and external conditions, 20 trials per day over a six day period for a total of 120 trials of practice. A univariate analysis of variance (ANOVA) was conducted for absolute error and constant error. Results of this study indicated that throwing accuracy was not differentially effected by instructing the pitchers to focus attention internally or externally.

Keywords: motor behavior, practice, bullpen, instructions

INTRODUCTION

Over the years, pitchers have “thrown bullpens” in order to practice throwing mechanics and to work on pitching accuracy. A bullpen is a session used by pitchers to throw off a mound in order to practice throwing various pitches with the goal of improving accuracy. While athletes throw these bullpens, coaches provide verbal instructions and feedback to pitchers in an attempt to improve their overall performance. Although mechanical issues associated with pitching have been researched to give pitchers the most efficient way to deliver the ball (House, 2000), little has been done to investigate the influence verbal instructions have on pitching. It is critical for pitching coaches to identify the differential effects various types of verbal instructions have on pitching accuracy.

Numerous studies have demonstrated how individuals focuses her or his conscious attention impacts motor skill performance (Shea & Wulf, 1999; Wulf, Hoess, & Prinz, 1998; Wulf, Lauterbach, & Toole, 1999). Specifically, performance benefits have been greatest when participants use an external focus of attention (e.g., attention directed to the movement effect on the environment) compared to an internal focus of attention (e.g., focusing on body

movement) (Wulf, et al., 1999). An example of an internal focus while completing a bench press would be to have the mover focus on extending the elbows when executing the lift; while an example of an external focus would be to have the participant focus on pushing the bar away from the chest.

One of the first studies to empirically investigate the efficacy of attentional focus was conducted by Wulf and colleagues in 1998. Sixteen volunteers were randomly assigned to either the internal focus or the external focus of attention group for a balance task using a stabilometer. Participants were instructed to place their feet on a platform so that the tip of each foot touched one of the red markers located on the platform. Both groups practiced the task for two consecutive days, learning was assessed in a retention test on the third day. The internal focus group participants were instructed to focus on their feet and to try and keep them at the same height, whereas participants in the external focus condition were instructed to focus on the red markers and to keep the markers at the same height. Results revealed no advantage for the external focus condition during practice; however, during the retention test the external focus condition was found to be more effective for learning than the internal focus condition. A reason for this is

their attempts to consciously control the movement while in the internal focus condition actually interfered with automatic control processes. Wulf et al. (1998) suggested that instructions given to learners while they are practicing a motor skill can have a decisive influence on learning. Instructions related to the performer's body movements (i.e., internal focus) are not always optimal and can degrade performance. Giving instructions that cause the performers to focus on the effects the movements have on the environment (i.e., external focus) can be much more effective for motor learning.

Advantages for learning a skill where attention is focused on the movement's effect rather than on the movement itself has been shown to be beneficial in many tasks such as golf (Bell & Hardy, 2009; Wulf, & Su, 2007), balancing (Wulf, 2008; Wulf, Mc Nevin, & Shea, 2001; Wulf, Shea, & Park, 2001), basketball (Weiss, Reber, & Owen, 2008), dart throwing (Marchant, Clough, & Crawshaw, 2007; Weiss et al., 2008), juggling (Zentgraf & Munzert, 2009), standing long-jump (Porter, Ostrowski, Nolan, & Wu, 2010), and weight lifting (Vance, Wulf, Tollner, Mc Nevin, & Mercer, 2004). The benefits of adopting an external focus of attention are explained by the constrained action hypothesis (Wulf et al., 2001). This hypothesis states that participants trying to consciously control one's movements constrain the motor system by interfering with automatic motor control processes that would "normally" regulate the movement. Focusing on the movement effect, on the other hand, allows the motor system to more naturally self-organize, unconstrained by the interference caused by conscious control. This lack of interference results in more effective motor performance and learning (Wulf et al., 2001). For example, in a study by Wulf et al. (2001), participants balanced on a stabilometer, while probe reaction times (RTs) were taken to measure the cognitive demands required under external and internal attentional focus conditions. External focus participants demonstrated faster probe RTs compared to participants utilizing an internal focus of attention. These results suggest using an external focus of attention is less cognitively demanding, thus allowing the neurological system to process information more rapidly.

If an external focus does lead to improved performance, why do most coaches typically give instructions about what the performer's bodies are doing during the performance of a skill (Porter, Wu, & Partridge, 2010)? Novices

are guided to be aware of movement cues and what the body parts are doing while performing, while motor skills performed by highly skilled athletes appear to be performed automatically (Singer, Lidor, & Cauraugh, 1994). In other words, the benefits of this automaticity may depend on the skill level of the athlete. It was suggested by Bernstein (1996) that focusing on the desired outcome of the action might be more beneficial for skilled athletes than less skilled athletes because the levels of automatization is different. Bernstein (1996) stated that motor skills are more highly automatized in expert athletes than in non-experts; and focusing on the performance of the action may revert a skilled athlete to think like a low-skilled athlete. A study by Perkins-Ceccato et al. (2003) examined the effects of attentional focus in highly skilled golfers (average handicap of 4) compared to low-skilled golfers (average handicap of 26) under external focus (i.e., focus on hitting the ball as close to the target as possible) and internal focus conditions (i.e., focus on the the swing). Results revealed that highly skilled golfers performed more effectively with external focus instructions, whereas the less-skilled golfers benefited more from internal focus instructions (Perkins-Ceccato et al., 2003).

One question that remained following the Perkins-Ceccato et al. (2003) study was whether the effectiveness of different focus conditions varied with higher levels of expertise? Wulf and Su (2007) sought to answer this question by using expert golfers in a pitch shot task. Six expert golfers with average handicaps of 1.3 participated in this study. They were instructed to hit golf balls using their own clubs at a target 15 m away using an internal focus, external focus, and control conditions, performing 20 trials under each condition. In the internal focus condition, participants were instructed to focus on their arm motion. In the external focus condition, participants were instructed to focus on the club motion, and in the control condition participants were encouraged to use their normal focus of attention. Wulf and Su (2007) found that expert golfers' performance benefited from instructions that induced an external focus of attention.

As previously mentioned, there are numerous studies showing the benefits of using an external focus of attention for a variety of sport skills. One consideration that has not been established is whether or not benefits of an external focus of attention are observed in pitching a baseball. If the manipulation of verbal instructions can lead

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to increased accuracy for pitchers, then it is of great importance for pitching coaches to understand how to deliver instructions so they can enhance the pitcher's performance.

Thus, the purpose of this study was to examine if using verbal instructions to elicit different attentional focus (i.e., internal or external) influenced pitching accuracy. This is important for practical reasons so that pitching coaches are able to utilize external focus techniques in practice and in games to help their pitchers throw with better accuracy. It was hypothesized that participants would be more accurate when they used an external focus of attention rather than an internal focus of attention.

METHOD

Participants

Eleven male college baseball players (M age= 19.55 years, SD=1.63; M height= 187.96 cm, SD=4.40; M weight= 83.91 kg, SD= 12.04) participated in this experiment. Three of the participants were left-handed throwers and eight were right-handed throwers. Originally there were thirteen pitchers, but two were unable to participate due to injuries. All participants signed an informed consent and completed a medical history questionnaire; both of these documents as well as the experimental methods

were approved by the University's Institutional Review Board.

Apparatus and Task

Participants were instructed to throw a bullpen off a regulation National Collegiate Athletic Association (NCAA) approved pitching mound located 18.44 m from home plate. The pitching mound had a height of 25.40 cm. Participants used a regulation baseball made by Rawlings (22.86cm in circumference and 141.75 g in weight) (NCAA, 2011). This experiment was designed to take place outside on a dirt mound at a university baseball stadium. Due to inclement weather only two bullpen sessions were thrown outside off of a dirt mound. The other four bullpen sessions were thrown inside off of a turf covered mound with the same dimensions as the one described above. For this study the participants were asked to throw only fastballs. In order to ensure precise measurement, every bullpen session was recorded using a camcorder set approximately five meters in front and to the left side of the target. The target was set up at the back edge of home plate. The target was the size of the strike zone, 43.18 cm wide and approximately 101.60 cm in height. The strike zone was divided into 11 sections (approximately every 10.16 cm apart) that were given point totals from 5 to -5 (see Figure 1 below).

Data Collection Chart

Date: _____

Practice #: _____

Pitcher: _____

	5	
	4	Top Letters
	3	
	2	
	1	
	0	Belt Line
	-1	
	-2	Mid-Thigh
	-3	
	-4	Bottom Knees
	-5	

Figure 1. Chart used for data collection

PROCEDURES

All participants performed a ten-minute dynamic warm up led by an athletic trainer, this was followed by a five-minute cord warm up for their arms. The cord warm up included internal/external rotation exercises, front shoulder raises, pull-downs, and flexion/extension exercises for the wrist and forearm. This experiment utilized a within participant design and the two focus conditions were counter balanced across days so each participant performed each condition in a random order. The two conditions were external focus, and internal focus. Participants were read the appropriate set of instructions before beginning each session. After every five trials participants were asked what they were supposed to be focusing on. If they could not recall the proper instructions, the researcher reminded them what they were supposed to focus on for that particular session. Each participant was told to throw the baseball to the center of the target with maximum effort, but no other specific instructions on how to throw the ball were provided. Participants completed 60 trials under each condition, 20 trials per day over a six-day period for a total of 120 trials. Participants were provided a different set of instructions each day. The days they threw with the internal condition, participants were told to “focus on getting extension by taking your fingers towards the target.” The days they threw with the external condition, participants were told to “focus on creating maximum backspin on the ball.” Participants were not

informed of the purpose of the study, nor were they debriefed following their participation.

DATA ANALYSES

The researcher recorded the trials using a camcorder positioned about five meters in front and to the left side of the target. Once all the trials were finished the researcher reviewed the video to chart where each trial hit on the target. To record the trials a chart set up to look like the target was used (see Figure 1). Once the data were collected, the researcher counted the number of pitches thrown to each section of the target, and then totaled them up for that day. The totals were then reversed scored for data analysis. The Statistical Package for the Social Sciences (SPSS) version 17 was used for all statistical calculations. A univariate analysis of variance (ANOVA) was conducted for absolute error and constant error. The reliability of the dependent variable was determined by calculating interclass correlation coefficient reliabilities (ICCRs). The criterion for significance was set using an alpha level of $p=0.05$.

RESULTS

Results of the ANOVA conducted on constant error indicated that there was no significant difference between the Internal (M constant error = -1.68, SD = 2.78) and External (M constant error = -1.64, SD = 2.88) focus of attention conditions, $F(1, 1318) = 0.069, p= 0.793$ (see Figure 2).

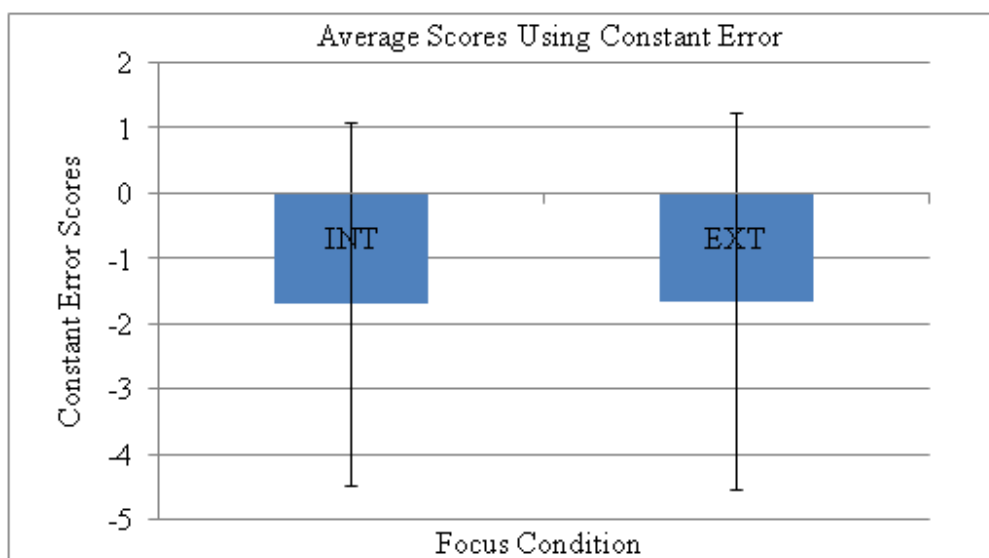


Figure 2. Average constant error scores for the Internal (INT) and External (EXT) conditions. Error bars represent standard deviation.

The results of the ANOVA for absolute error also indicated there was no significant difference between the Internal (M absolute error = 2.74, SD

= 1.73) and External (M absolute error = 2.80, SD = 1.77) focus of attention conditions, $F(1, 1318) = 3.063, p= .582$, (see Figure 3).

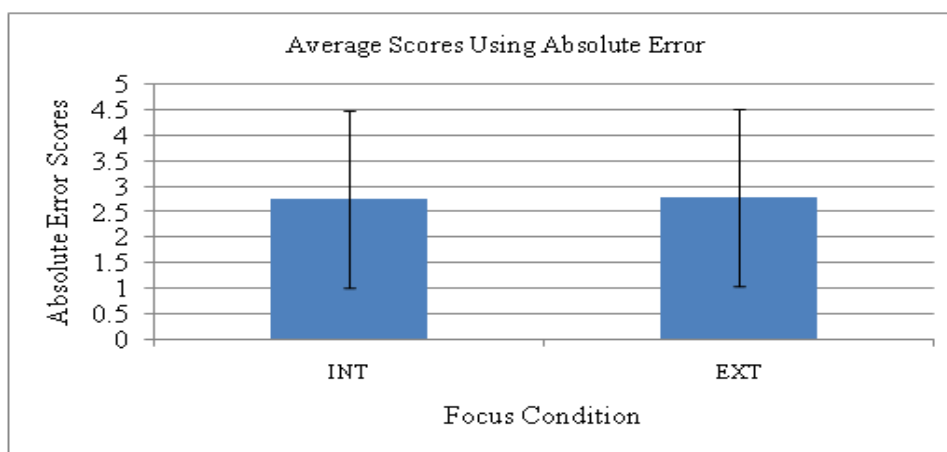


Figure3. Average absolute error scores for the Internal (INT) and External (EXT) conditions. Error bars represent standard deviation.

The ICCRs determined that the dependent variable was reliable for absolute error ($r=0.95$) and constant error ($r=0.84$) measures.

DISCUSSION

The purpose of this study was to examine whether using verbal instructions to induce different forms of attentional focus (i.e., internal or external) influenced throwing accuracy in highly skilled collegiate baseball pitchers. In order to achieve this objective, each participant completed 60 trials under each condition over a six-day period for a total of 120 pitches. It was hypothesized that using an external focus would yield better accuracy than an internal focus. However, results of the statistical analysis revealed there were no accuracy differences between the external focus and internal focus of attention conditions.

When coaches give instructions to their athletes, they typically give instructions that reference specific body parts or body movements. This in turn would likely induce an internal focus of attention (Wulf, 2007a). Porter et al. (2010) looked at the types of verbal instructions and feedback provided by experienced track & field coaches during practice, and how this information influenced elite athletes' focus of attention during competition. Results indicated that 84.6% of participants reported that coaches provided instructions during practice that promoted an internal focus of attention and participants reported they utilize internal focus cues 69% of the time during competition. These results are inconsistent with motor learning research, which shows learning and performance are typically enhanced when using an external focus of attention during motor skill execution.

Previous research suggests that internally focusing on one's own movements constrains the motor

system and leads to movements that are less accurate (Wulf & Su, 2007). This can be explained by the constrained action hypothesis which states when performers utilize an internal focus of attention they may actually constrain or interfere with automatic control processes that would normally regulate the movement, whereas an external focus of attention allows the motor system to more naturally self-organize (Wulf, et al., 2001). The results of the present study do not demonstrate advantages in accuracy using either external or internal focus instructions. These findings are not consistent with the predictions of the constrained action hypothesis (Wulf et al., 2001) citation. While this finding appears to be counter to several studies exploring the benefits of an external focus when compared to an internal focus, one explanation may be the participants chose what they wanted to focus on rather than following the prescribed instructions. Meaning, even though they were instructed to focus either internally or externally they may have ignored the given instructions and sought out the most efficient source of information to complete the task.

In previous studies, advantages in learning and performance when using external focus instructions compared to internal focus or no focus instructions have been reported (Mc Nevin & Wulf, 2002; Wulf & Su, 2007; Wulf et al., 2007). However, in the current study there were no benefits shown for either internal or external focus instructions. In a study done by Porter, Nolan, Ostrowski, & Wulf (2010), participants performed an agility task under an external focus, internal focus, and a control condition. The authors examined the generalizability of the benefits of using an external focus of attention. They also assessed the rate of compliance in which participants followed prescribed instructions by using a manipulation check. This manipulation check also helped determine what

participants focused on when they were given a neutral set of instructions (i.e., control condition). What they found was an external focus of attention facilitates agility performance compared to an internal focus or control condition, which is consistent with previous research (McNevin, & Wulf, 2002; Wulf & Su, 2007; Wulf et al., 2007). Also, results indicated when participants were given a neutral set of instructions (i.e., control condition) their performances didn't differ from an internal focus condition. What was interesting though is when participants were in the control condition they only focused internally 10% of the time (Porter et al., 2010).

Results of the attentional switching calculations suggested when participants in the control condition were provided a neutral set of instructions they chose to frequently switch their attention. Consequently, this strategy likely constrained the movements and interfered with the development of automatic processing, resulting in performance outcomes similar to participants who were directed to focus internally (Porter et al., 2010). In the present study, participants may have focused on something other than the prompted instructions they were given in order to find the most efficient method to improve performance. By not having a control condition or manipulation check to see what participants focused on in the present study, there was no way to measure how accurately participants followed the prescribed instructions. This limitation should be considered when designing future experiments. Nevertheless, the present results suggest there may be a limit to the performance-enhancing effects of external focus instructions when used under real-world conditions.

In a study by Wulf (2008), world-class balance performers were examined on the effects of internal and external attentional focus instructions relative to no instructions (i.e. control condition). Participants were required to balance on a semi-inflated rubber disk. They were instructed to focus on reducing movements of either their feet (internal focus) or the disk (external focus), or they were not given attentional focus instructions (control). The results showed that regardless of type of instruction, the balance experts produced similar postural sway (Wulf, 2008). While there were no differences between conditions in the amount of postural sway, the frequency of movement adjustments was higher in the control condition, relative to both external and internal focus conditions. This suggests that movement

automaticity and postural stability were greatest when the balance experts were free to adopt their "normal" focus of attention (Wulf, 2008). In other words, the instructions given in the present study may not have produced the optimal focus of attention for the assessed skilled pitchers. With increasing proficiency, individuals tend to control actions at higher levels (Vallacher, 1987). Meaning, the skilled pitchers in the present study were able to control their actions at a high level and both focus of attention instructions may have elicited a low-level effect. This would in turn disrupt automatic control processes used to throw a pitch. Future research should more thoroughly investigate how the skill level of the learner interacts with the optimal attentional focus needed to successfully achieve a desired action goal.

Although the benefits of using an external focus of attention has been effective for a wide range of skill levels and motor learning tasks, the participants in the present study did not demonstrate these same benefits. While the current study provides an initial view into how pitchers perform when using verbal instructions, there are some limitations to the findings reported here, which raise questions to be addressed in future studies. Future research should use the same methods but implement a control condition in order to see whether participants' accuracy was different than when using an external or internal focus of attention. Future researchers can also use a manipulation check in order to see if participants switched their focus to something other than their prescribed instructions. This would also be valuable in understanding how participants focus their attention when they are allowed to choose what to consciously attend to. In addition, future studies should use a between-participant design and implement a retention test following practice in order to see if the verbal instructions given result in enhanced motor skill learning.

Bullpens are commonly used by pitching coaches to evaluate their pitchers and have them work on their accuracy. Because of this, it is imperative that coaches provide their athletes with the most effective instructions to enhance the accuracy of their athletes. It is important for coaches to understand that what they say may impact the performance of their players. Although players may listen to what their coaches instruct them to do, they will actively seek out the most efficient sources of information and not adhere to specific instructions despite repeated reminders and encouragement, which may ultimately interfere

with any instructions (Poolton, Maxwell, Masters, & Raab, 2006). Pitching coaches who utilize bullpens in practice must ensure that focus instructions are consistent among their athletes. Providing any inconsistency in instructions may lead to unreliable performance measures due to various types of attentional focus they may induce.

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