ACUTE EFFECTS OF ATTENTIONAL FOCUS ON SHOT PUT PERFORMANCE IN ELITE ATHLETES

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Abstract:

The purpose of this study was to examine the influence of adopting an external, internal, and neutral focus of attention while executing an underhand and overhead shot put. Using a counterbalanced within-participant design, thirty highly skilled athletes (height 183±6 cm, body mass 78±7 kg, age 22.2±2.4 years) performed five underhand and five overhead shot puts. The results indicated that the shot put distances were greater ($p<.05$) when the participants were in the external condition compared to the internal and neutral conditions in both tests. Additionally, it was observed that the neutral condition provided better throwing results compared to the internal condition. These results support the *constrained action hypothesis*, and provide additional evidence that skilled athletes should adopt an external focus of attention when executing motor skills.

Key words: *attention, shot put, motor performance, coaching, verbal instructions*

Introduction

Coaches should use strategies that promote the best performance for their athletes. Recent studies in sports science indicate that providing instructions and feedback that direct an athlete's attention during practice towards the results of their movements rather than towards the movements themselves improves the efficiency of the movement pattern and the consequential movement outcome (Marchant, Greig, Bullough, & Hitchen, 2011; Makaruk, Porter, Czaplicki, Sadowski, & Sacewicz, 2012). Findings from this area of research strongly suggest that coaches should pay considerable attention to the content of instructions provided during training sessions as this directly influences how athletes direct their conscious attention. There are two common ways that attention can be explicitly directed. The first, an internal focus of attention, directs an athlete's conscious attention towards the movement of their own body during motor skill performance. The second is an external focus of attention, which shifts the focus of attention towards the result of the movement or the effects the movement has on the environment (Wulf, Höß, & Prinz, 1998). For example, a long jumper might be instructed to focus his/her attention on the dynamic movement of his/her free leg during the take-off. This is an example of an internal focus of attention because the athlete is focusing his/her attentional resources on the movement of his/her legs. An alternative strategy would be to instruct the athlete to focus on the trajectory of the jump. This strategy would promote an external focus of attention since the trajectory of the jump is a result of the movement.

Numerous studies have demonstrated that directing attention externally, rather than internally, is more beneficial for sport performance. For example, in a recent study by Freudenheim, Wulf, Madureira, Pasetto, and Correa (2010) the effects of attentional focus on swimming performance (i.e. 16 m front crawl) in intermediate swimmers were examined. Athletes using the internal focus were asked to focus on the movement of their arms (i.e. "Pull your hands back") or leg movements (i.e. "Push the instep down"). In the external condition, athletes were encouraged to concentrate on pushing the water back or pushing the water down. Results showed that the external focus group achieved better results compared to the group that adopted

an internal focus of attention. Several other studies have also demonstrated the performance benefits that are gained when adopting an external rather than an internal focus of attention across a variety of sport-related skills such as the standing long jump (Porter, Ostrowski, Nolan, & Wu, 2010; Wu, Porter, & Brown, 2012; Porter, Anton, & Wu, 2012), countermovement jump (Wulf, Zachary, Granados, & Dufek, 2007), bench press and back squat (Marchant, 2011), and distance running (Schucker, Hagemann, Bernd, & Volker, 2009). Despite this consistent finding across scientific literature it is interesting that in a recent study by Porter, Wu, and Partridge (2010) elite-level track-and-field athletes reported their coaches typically provided feedback during practice that promoted an internal focus of attention. Not surprisingly, the same sample of athletes reported that they typically used an internal focus of attention while competing.

In addition to comparing the effects of an internal and external focus of attention to each other, several studies have incorporated a control condition that did not receive instructions designed to overtly focus attention internally or externally. Studies that utilized a control condition report that when participants are provided neutral instructions (i.e. control condition) they typically perform similarly to trials completed in the internal condition (e.g. McNevin & Wulf, 2002; Wulf & Su, 2007; Porter, Nolan, Ostrowski, & Wulf, 2010).

Wulf, McNevin, and Shea (2001) proposed the constrained action hypothesis to explain the motor learning and performance benefits frequently observed when performers adopt an external relative to an internal focus of attention. This hypothesis suggests that directing conscious attention internally interferes with the automatic (i.e. non-conscious) processes of motor behavior. This interruption in automatic processing 'constrains' the motor program, which results in degraded motor performance. In contrast, when individuals concentrate on the effects of a movement (i.e. external focus), automatic control processes are facilitated. This facilitation allows the motor control system to self-organize (Bernstein, 1996) more naturally, without overloading the central and peripheral nervous systems. Several studies have been conducted providing support for the predictions of the constrained action hypothesis (Wulf, et al., 2001; Marchant, Greig, & Scott, 2009; Wulf, Dufek, Lozano, & Pettigrew, 2010; Lohse, Sherwood, & Healy, 2011; Makaruk, et al., 2012).

To our knowledge, no studies have addressed the effects of focus of attention on well learned throwing tasks in a highly skilled population. Therefore, the purpose of this study was to determine the effect of instructing skilled athletes to use external and internal foci when performing two well learned skills. We also implemented a control condition that did not receive explicit instructions to focus their attention. The control condition was designed to replicate "real-world" conditions, which usually refer to athletes being able to choose how to focus their attention rather than it being instructed to them by a coach or other practitioner. Using a control condition also helped determine if potential differences between the internal and external conditions were enhancing or debilitative, relative to the control condition. We hypothesized that when athletes were encouraged to focus externally, they would throw farther than when they were in the internal and control conditions.

Methods

Participants

Participants (N=30) were male (height 183±6 cm; body mass 78±7 kg; age 22.2±2.4 years) members of the Polish National League Athletics Club. Specifically, all participants were national-level sprinters, jumpers and throwers. All volunteers read and signed an informed consent prior to their involvement in the present experiment. The consent form and all experimental methods were approved by the university's Ethics Committee prior to the initiation of the study.

Apparatus and task

Testing took place outdoors on a shot put ring that was certified by the National Athletics Association of Poland. The wooden stop board was 1.22 m long on the inside, 11.4 cm wide, and 10 cm high. The landing sector was formed by lines projecting from the center of the throwing circle, and extended through the ends of the stop board. The landing surface was clay.

The same 4-kg metal shot put (Polanik, Poland) was used by all the participants. The distance the shot was put in each attempt was measured using the same metal tape measure (Polanik, Poland). Both the shot and the tape were certificated by the International Association of Athletics Federation (IAAF). Measurements were taken from the nearest point of the first mark made by the shot to the outer edge of the stop board.

Procedures

Participating athletes were tested in a pre-season period (i.e. in March). The experiment consisted of six testing sessions. Using a within-participant design, participants performed each of the three focus of attention conditions: internal focus (INF), external focus (EXF) and control (CON) in a randomized order that was counterbalanced across participants to avoid potential order effects. There were six sequences of treatment (INF-EXF-CON, INF-CON-EXF, EXF-INF-CON, EXF-CON--INF, CON-INF-EXF, CON-EXF-INF), and each

sequence had five participants randomly assigned to it. Each testing session was separated by two days. During each testing session the participants completed five trials of the underhand shot put (i.e. throw), followed by five trials of the overhead shot put (i.e. throw). For example, a participant who was assigned to the INT-EXF-CON sequence performed five trials of the underhand throw, followed by five trials of the overhead throw on day one using an internal focus of attention. Two days later the same participant performed five trials of the underhand throw followed by five trials of the overhead throw using an external focus of attention. Then two days later the same participant completed five trials of the underhand throw and five trials of the overhead throw in the control condition. This same pattern was repeated for all participants assigned to each of the respective counterbalance sequences described previously. Each testing session lasted approximately 50 minutes for each athlete and included a warm-up, five trials of overhead throws, and five trials of underhand throws. The warm-up consisted of an eight-minute jog, five minutes of dynamic stretching (e.g. swings, rotations, and bends), and skipping rope (i.e. six sets of ten jumps). Following the warm-up, participants were given a two-minute passive rest period. They were also provided with a two-minute rest between each throwing attempt. During this rest period the participants received one of the prescribed instructions. Additionally, participants were told before each trial that the goal was to put the shot as far as possible. When participants were in the INF condition they were given the following instruction: "When you are putting the shot, focus on extending your arms rapidly." When participants were in the EXF condition they were given the instruction: "When you are putting the shot, focus on hitting the visible target." The white "target" was round and was 40 centimeters high, and was placed directly in front of them. The distance of the target was adjusted per individual and was set as represented by their personal best throw which was established during pilot testing (i.e. see below). If a participant put the shot beyond the target, then the target was moved to the new "best" location for the following trials. When participants performed throws in the CON condition, they were simply told: "Perform the task to the best of your abilities." This instruction was designed to be neutral and not promote a specific focus of attention. Participants stood on the stop board during all throws, and were told that it was not necessary to remain on the stop board during or after the throw. All athletes were very familiar with both throws (i.e. underhand and overhead) as they had routinely used both during their training over the course of several years. Both throws are demonstrated in Figure 1.

Two weeks prior to the testing phase of this study, a pilot study was carried out to determine the reliability of tests and starting location of the target marker used in the EXF condition. The reliability of tests was assessed using intra-class coefficient (ICC). The ICC was .95 for the underhand throw, and .93 for the overhead throw. Thus, both assessments were considered reliable. Each of the five trials were measured in each experimental condition. However, the average of the best three throws was used for data analysis. At no time during the testing session were participants provided augmented feedback from the researcher about their throwing distances.

Figure 1. Starting positions for the underhand (left image) and overhead (right image) shot put.

Statistical analysis

Data were initially tested for normality and homogeneity of variance assumptions. Because the assumptions were not violated, a one-way repeated measures analysis of variance (ANOVA) was conducted to examine whether there were significant differences among the three conditions (i.e. INF, EXF, CON). When significant effects were observed, Tukey's *post-hoc* tests were applied. An alpha level of $p<.05$ was used as a significance criterion in all statistical comparisons. Cohen's effect-size statistics (ES) were calculated to determine the magnitude of observed differences between conditions using the following thresholds: >.5=large, .2-.5=moderate,<.2=small (Cohen, 1988). Statistica for Windows version 5.1 PL, software was used for all statistical calculations.

Results

Results of the repeated measures ANOVAs indicated a main effect for the underhand shot put ($F_{2,58}$=28.17; $p<.001$) as well as the overhead shot put ($F_{2,58}$=15.01; $p<.001$). The results of the *post-hoc* analysis revealed that all conditions differed significantly from each other for each of the throws (i.e. underhand and overhead). Specifically, the average throwing distances in both tests (presented in Figures 2 and 3), when the participants were in the EXF condition, were significantly greater than the achieved throwing distances when participants were in the INF condition (ES=.36 for the underhand throw; ES=.21 for the overhead throw) and CON conditions (ES=.22 for the underhand throw; ES=.10 for the overhead throw). The analysis also indicated that participants put the shot significantly further when they were in the CON conditions compared to the INF conditions (ES=.14 for the underhand throw; ES=.11 for the overhead throw).

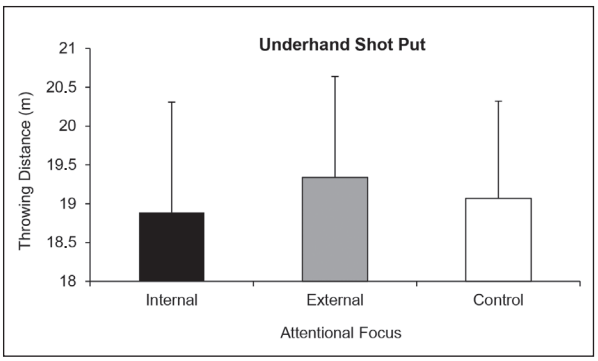

Figure 2. Mean throwing distances for the underhand shot put for the internal, external and neutral conditions. All conditions were significantly different from each other, p<.05. Error bars represent standard deviation.

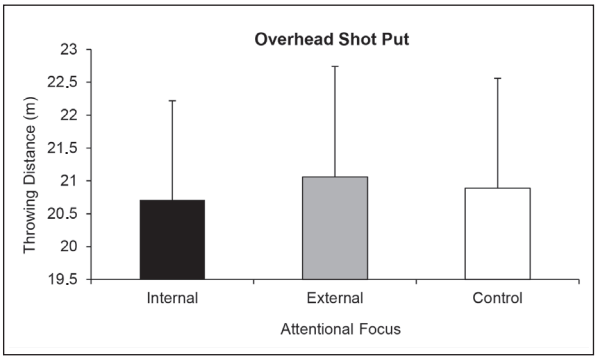

Figure 3. Mean throwing distances for the overhead shot put throw for the internal, external and neutral conditions. All conditions were significantly different from each other, p<.05. Error bars represent standard deviation.

Discussion and conclusions

The purpose of this study was to examine whether adopting an external focus of attention was more beneficial in a sample of highly skilled athletes performing a well learned shot put task compared to performing the same skill with an internal or neutral focus of attention. To examine this, we used a sample of highly trained athletes who competed at the national level in athletics. The results reported here support our hypothesis, presuming that the instructions promoting an external focus would result in significantly greater throwing distances compared to the trials following instructions promoting an internal or neutral focus. These findings are in line with previous studies (e.g. Porter, Nolan, et al., 2010; Wulf & Dufek, 2009), and suggest the advantages of using an external focus of attention generalizes to skilled athletes performing throwing-related tasks. An additional noteworthy observation from the present findings was that the sampled skilled athletes performed the throwing tasks more effectively while using a neutral focus compared to an internal focus of attention. The latter finding suggests that adopting an internal focus depressed motor performance relative to the control condition. When the findings are examined as a whole, it is clear that directing attention externally enhanced motor performance, while directing attention internally hindered performance.

It is well documented that putting the shot is strongly related to force generation (Stone, et al., 2003; Terzis, Georgiadis, Vassiliadou, & Manta, 2003). Therefore, a plausible explanation for the current findings is that when participants were instructed to focus externally, they generated more force compared to when they were instructed to focus internally or neutrally. This conclusion is supported by previous research. For example, in a study conducted by Wulf and Dufek (2009) participants who were instructed to focus externally produced greater center-of-mass displacement and jump impulse while executing a vertical jump compared to when they were instructed to focus internally. Similarly, enhancements in force productions, relative to an internal and neutral focus,

were also observed in a recent study by Makaruk et al. (2012). In that study, moderately skilled participants practiced plyometric drills for multiple weeks. Similar to the present findings, the results of the Makaruk et al. (2012) experiment revealed that the external group generated more force compared to the internal and control conditions, and the control condition produced more force compared to the internal condition. In addition to greater force production, it is also possible that adopting an external focus produced a more effective movement pattern by improving inter-muscular coordination (Wulf, et al. 2010). It is also possible that adopting an external focus of attention resulted in a more optimal trajectory angle of the shot put. Support for this conclusion is provided by the findings of a recent study which demonstrated that standing long jump trajectory angle was more optimal when using an external rather than an internal or neutral focus (Ducharme, Lim, Giraldo, Porter, & Wu, 2012). Clearly, additional research is needed to fully understand the exact mechanism that caused the results presented here.

Another possible explanation for our observed results may be a result of the inherent feedback that was available in the EXF condition. As indicated previously, there was a visible target located in front of the participants when they performed the trials in the EXF condition. The visible target provided additional non-verbal feedback to the athletes about their level of performance. The same feedback was not available to participants when they completed the trials in the INF and CON conditions. Presumably, after each trial was completed in the EXF condition, the participants were able to compare the just completed attempt to their best throw (i.e. indicated by the target). Specifically, if a shot landed short of the target, this indicated that the performance was below their best attempt. Conversely, if a shot landed beyond the target, the athletes were provided with visual feedback that they had surpassed their previous best throw. Undoubtedly, such visual feedback very likely served as a source of motivation for the thrower. It is possible that this additional performance-related feedback facilitated a more optimal external focus of attention, ultimately contributing to the performance benefits reported previously. This conclusion is supported by previous reports in the focus of attention literature (Staub, 2011). Additionally, one study demonstrated that using feedback to elicit an external focus of attention had a greater influence on performance compared to using only verbal instructions (Shea & Wulf, 1999). It is quite possible the combination of the external focusing instructions provided to participants in the EXF condition positively interacted with the visual feedback provided by the target. This combination of instruction and feedback may have contributed to our reported findings.

The results of the current research are consistent with the predictions of the *constrained action hypothesis*. The external focus of attention resulted in better performance compared to the neutral instruction. The results suggest that directing attention externally enhanced shot put performance by reducing the load on the motor control system which consequently facilitated a more autonomous motor behavior. Consequently, adopting an internal focus of attention is likely to have caused the movements to be more consciously controlled and resulted in an inefficient movement pattern. The conscious control of the neuromuscular control system by the participant in the INF condition explains the depressed motor behaviors compared to trials completed in the CON condition. The previously mentioned results suggest that experienced athletes should focus their attention externally when executing the shot put.

Interestingly, the result of the underhand and overhead shot puts produced the same experimental effects. This observation is intriguing considering the underhand shot put was performed facing towards the throwing direction which allowed for full vision of the landing sector. However, the overhead shot put was performed backwards not allowing vision of the shot put's inflight or of the landing sector (see Figure 1). This indicates that having visual contact with the shot put and the landing sector is not necessary to benefit from an external focus of attention. Such a finding suggests that the benefits of an external focus of attention probably depend on the cognitive and neuromuscular systems rather than on the visual system. Support for this inference has been provided in a study conducted by Graydon and Townsend (1984). In that study the authors demonstrated that the gymnast did not heavily rely on visual perception to execute a gross motor skill. Rather, the authors reported that the sampled gymnast relied heavily on the proprioceptive and vestibular systems to successfully perform motor skills. Moreover, the findings of a recent study provided further evidence that focus of attention effects are not reliant on vision (Schlesinger, Porter, & Russell, 2013). Additional research is needed to fully understand how the visual system interacts with the focus of attention.

There are limitations to the present findings which consequently offer directions for future research. One limitation is that the participants in the present study performed relatively few trials in each condition (i.e. five trials per condition per day) in relatively few testing sessions (i.e. three days). Future research should expand on this methodology by having participants perform many more practice trials over several weeks of practice. Doing so would bring a better understanding to this field of research and would also increase the generalizability of our findings to more naturalistic practice environments. A second limitation of this

study is that we evaluated highly skilled sprinters, jumpers, and throwers/putters. Future studies need to be conducted with lower-skilled athletes from a number of sports to see if the same motor behaviors are replicated. This would be valuable for both theoretical and practical reasons.

In conclusion, the findings of the present study demonstrated that when experienced athletes adopted an external focus, they achieved better shot put performance compared to when they focused on the movements of their arms. Additionally, the presented findings demonstrate that it is more effective to explicitly instruct skilled athletes to focus externally rather than letting them use their "normal" focus, which was the case in the CON condition. Therefore, experienced athletes should be encouraged to focus on the results of their movements, which will likely result in enhanced motor performance. Moreover, the findings of this study demonstrate that subtle changes in the verbal instructions used by practitioners can greatly impact the outcome of the instructed motor skill. With this in mind, practitioners should be very mindful of the exact content of the instructions they provide to the athletes, students, patients, or clients they are working with.

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AKUTNI UČINCI FOKUSA PAŽNJE NA IZVEDBU BACANJA KUGLE U VRHUNSKIH SPORTAŠA

Cilj je ovog istraživanja bio utvrditi utjecaj usvajanja vanjskog, unutarnjeg ili neutralnog fokusa pažnje tijekom bacanja kugle pothvatom naprijed te preko glave. Korištenjem eksperimentalnog nacrta s uravnoteženim ponovljenim mjerenjima unutar ispitanika. Trideset vrhunskih sportaša atletičara raznih disciplina (tjelesne visine 183±6 cm, tjelesne težine 78±7 kg u dobi od 22,2±2,4 godine) izvelo je pet bacanja kugle pothvatom prema naprijed i pet bacanja preko glave. Rezultati su pokazali da je duljina hica bila veća ($p<.05$) kada se primjenjivao vanjski fokus pažnje u usporedbi s unutrašnjim i neutralnim fokusom pažnje u oba testa. Nadalje, zamijećeno je da su rezultati bacanja bili bolji u uvjetima korištenja neutralnog fokusa pažnje nego kada se primjenjivao unutarnji fokus pažnje. Rezultati potvrđuju *hipotezu ograničene akcije* te nude dodatne dokaze da bi vrhunski sportaši trebali koristiti vanjski fokus pažnje prilikom izvođenja motoričkih zadataka.

Ključne riječi: *pažnja, bacanje kugle, motorička izvedba, treniranje, verbalne instrukcije*