

An External Focus of Attention Results in Greater Swimming Speed

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ABSTRACT

We examined effects of attentional focus on swimming speed. Participants' task was to swim one length of a pool (16 m) using the front crawl stroke. In Experiment 1, intermediate swimmers were given attentional focus instructions related to the crawl arm stroke or the leg kick, respectively. Participants were instructed to focus on "pulling your hands back" or "pushing the instep down" (internal focus), or on "pushing the water back/down" (external focus), respectively. Swim times were significantly shorter with an external focus. In Experiment 2, a control condition was included. Times were significantly faster in the external focus compared with both the internal focus and control conditions. These findings have implications for enhancing performance in swimming.

Key words: Arm Pull, Attentional Focus, Front Crawl, Leg Kick, Swimming Performance

INTRODUCTION

Over the past decade or so, numerous studies have demonstrated performance and learning advantages of an external relative to an internal focus of attention (for a review, see [1]). Instructions or feedback that direct performers' attention to the movement effect, or desired movement outcome (external focus), rather than the coordination of their body movements (internal focus), have been found to result in greater movement effectiveness (e.g., accuracy, balance, speed) as well as increased movement efficiency (e.g., reduced EMG activity). For example, in basketball [2, 3], volleyball ([4], Exp. 1), soccer ([4], Exp. 2), dart throwing [5], and golf [6], movement accuracy was enhanced by instructions or feedback inducing an

external focus. Similarly, for a variety of balance tasks, focusing on the stability of the support surface, as opposed to that of one's feet, has been shown to facilitate postural stability (e.g., [7-9]). Importantly, external focus benefits have not only been shown relative to internal focus conditions, but also relative to control conditions (e.g., [8-11]). This suggests that, left to their own devices, individuals tend to adopt less optimal (possibly, internal) foci. The external focus advantage has been shown to be generalizable across tasks, skill levels, and age groups (see [1]).

A focus on the movement effect appears to promote automaticity in movement control, whereas a focus on the movements themselves tends to constrain the motor system due to the performer's attempts to exert conscious control over his or her movements (constrained action hypothesis [12]). Support for this view comes from findings showing reduced probe reaction times or attentional demands [12], and higher-frequency, reflex-based (i.e., automatic) movement adjustments [12, 13] when performers adopt an external compared to an internal focus. Thus, an external focus seems to speed the learning process, resulting in higher performance levels and a state of automaticity sooner [1].

Additional evidence for the view that an external focus helps individuals achieve an advanced stage of learning sooner is provided by findings demonstrating increased movement efficiency with an external focus (for a review, see [14]). In a typical learning process, less and less muscular energy is required as individuals learn to reduce unnecessary co-contractions and exploit passive forces [15]. This increase in movement economy also appears to be facilitated when performers are instructed to adopt an external focus. Several studies have shown that external relative to internal focus instructions, or no instructions, resulted in reduced muscular activity (e.g., [3, 16-18]). Using a biceps curl task, Vance et al. (2004) first demonstrated that performers lifted the same weight, at the same frequency, with less EMG (i.e., electromyographic) activity when they were instructed to focus on the weight bar (external focus) compared to their arms (internal focus). Subsequent studies by Marchant and colleagues (2008, 2009) revealed that an external focus, relative to internal focus and control conditions, resulted in greater maximum force production on a biceps curl task, using an isokinetic dynamometer. When participants were asked to focus on the crank hand-bar, as opposed to their arms or were not given focus instructions, they produced significantly greater peak joint torque. Interestingly, this was achieved with significantly less muscular (EMG) activity.

These findings are in line with other findings showing that individuals jump higher when they adopt an external focus of attention, relative to an internal focus or no focus [19, 20], and that this is accomplished with less EMG activity [21]. In those studies, participants performed a vertical jump-and-reach task. Under the external focus condition (i.e., rungs of the measurement device) relative to the internal focus condition (i.e., finger with which the rungs were to be touched), jump height, center-of-mass displacement, jump impulse, and leg joint moments were greatest with an external focus. Thus, individuals jumped higher by producing greater forces when they adopted an external focus – and did so with less muscular activity. The generation of maximum forces requires that the direction and timing of the contributing forces be optimal. This entails an effective coordination pattern between agonist and antagonist muscle groups, as well as an effective recruitment of muscles fibers within a muscle (e.g., [22]). Unnecessary co-contractions would result in less-than-maximal force output. Indeed, various sets of findings suggest that an external focus optimizes those coordination patterns, whereas an internal focus leads to inefficient co-contractions [3, 17, 18].

Taken together, those findings suggest that an external focus leads to movements being produced more efficiently (i.e., with less metabolic or mental energy). As a consequence, maximum force production is increased, or sub-maximal forces are produced with less

muscular energy (for a review, see [14]). Based on those findings, one would predict that individuals should be able to maintain a certain sub-maximum force level (e.g., 80% of maximum) longer, or increase the force level for a given period of time (e.g., 10 s). If this were the case, it could have important implications for longer-duration, continuous skills (e.g., running, swimming, bicycling). If an individual is able to increase the force output over a certain duration, given his or her current physical capabilities (e.g., aerobic or anaerobic capacity), this should result in a shorter overall time for a given distance. Some preliminary evidence in support of this notion comes from a study by Totsika and Wulf [7], in which participants' task was to ride a Pedalo a distance of 7 m. Movement times were reduced when they adopted an external (pushing boards under feet forward) relative to an internal focus (pushing feet forward). In that study, however, the task was novel for participants and required learning a new coordination pattern (i.e., timing and direction of forces applied to the pedals). Also, no control condition without focus instructions was used.

In the present study, we wanted to examine whether (moderately) skilled participants, who had already acquired the basic coordination pattern, would benefit from instructions inducing an external focus. We chose a swimming task (16 m crawl) to determine the effects of different attentional foci on swimming speed. In Experiment 1, a mixed factorial design was used, with different groups receiving internal or external focus instructions related to either the arm stroke or leg kick, respectively. Both aspects of the technique were included to assess the generalizability of the attentional focus effect. In Experiment 2, a control condition with no specific focus instructions was included to compare the influence of attentional focus instructions to a more "natural" condition. Instructions in that experiment referred only to the arm stroke. We hypothesized that instructions to adopt an external focus would generally result in the shortest swim times.

EXPERIMENT 1

INTRODUCTION

In the first study, different groups of participants were given focus instructions that referred either to the arm stroke or leg kick, the main propulsive crawl components. Yet, in both groups all participants swam under both external and internal focus conditions to reduce influences of skill level (i.e., technique) or endurance. The internal and external focus instructions differed only minimally in each group. In the internal focus conditions, participants were instructed to focus on their hands or leg actions, respectively, whereas in the external focus conditions, participants were instructed to focus on the effects of their movements on the water while swimming one length of the pool (16 m). The order of attentional focus conditions was counterbalanced to control for effects of practice or fatigue. We did not make any predictions regarding the swim times of the two groups (with arm-stroke or leg-kick instructions), as these would be expected to depend on the group members' skill levels. However, we expected to see shorter swim times when participants were instructed to adopt an external compared to an internal focus, irrespective of the aspect of the technique they referred to.

METHOD

PARTICIPANTS

Forty undergraduate students (24 men, 16 women) of mean age 23.1 years ($SD = 3.49$) participated in the study (two were later removed from analysis). All participants were intermediate crawl swimmers familiar with the pool. All were undergraduate physical

education majors who were able to swim crawl, but did not swim competitively. All participants signed the informed consent form. They were not aware of the purpose of the study.

TASK AND PROCEDURE

The task required participants to swim one length in an outdoor swimming pool (16 m) using the front crawl stroke. Participants were tested individually in a separate lane of the pool. They were instructed to swim as fast as possible, pushing off from the inside of the pool. Different groups of participants were instructed to focus attention on the arm stroke (14 men, 8 women) or the leg kick (10 men, 8 women). In the internal focus condition, participants were asked to focus on “pulling your hands back” (arm stroke) or “pushing the instep down” (leg kick), while in the external focus conditions, they were instructed to focus on “pushing the water back” (arm stroke) or “pushing the water down” (leg kick), respectively. Instructions were provided after a warm-up period (10 min swimming at slow speed), with participants still being inside the pool. They were also encouraged to maintain the instructed focus throughout the entire length of the pool. Finally, to ensure that the instructions were understood, the experimenter asked each participant if he or she had any questions related to the task or attentional focus. Each participant swam 16 m under each of the two attentional focus conditions, with the order of conditions counterbalanced among participants. Half of the participants started with the internal focus condition, while the other half started with the external focus condition. A stop watch was used to measure the time. The timer was initiated when the participant’s feet left the wall and stopped when he or she touched the wall on the other side. A swim coach who was experienced at manually timing swimmers in competitions – accurately monitoring the swimmers’ feet leaving the wall and their hands touching the wall at finish – was in charge of taking the time. This was his only role in the study. To avoid unintentional experimenter bias, he was not aware of the study purpose or hypotheses. After swimming the first 16 m under one instructional condition (internal or external), participants were asked to rest for 3 minutes. They were then given the other instruction and swam another length of 16 m. After the second trial, a manipulation check was performed by asking participants if they followed attentional focus instructions.

DEPENDENT VARIABLE AND DATA ANALYSIS

The dependent variable was the time needed to cross the swimming pool (16 m). The chronometer captured the time in seconds and tenths of seconds. As all participants performed under both internal and external focus conditions in a counterbalanced order, we included order as a factor in the analysis of variance (ANOVA). Thus, swim times were analyzed in a 2 (group: arm stroke, leg kick) x 2 (order: internal-external, external-internal) x 2 (focus: external, internal) ANOVA with repeated measures on the last factor.

RESULTS

MANIPULATION CHECK

Two of the original 40 participants (both women in the group that was given instructions related to the leg kick) indicated that they focused their attention on swimming as fast as possible, but not on the attentional focus instructions per se. Therefore, their data were not included in the analysis.

SWIM TIMES

There was no difference in swim times between the groups receiving instructions regarding the arm stroke versus leg kick. However, participants generally swam faster when they were

instructed to adopt an external focus (mean: 12.32 s; SD: 2.17 s) compared to an internal focus (mean: 12.64 s; SD: 2.18 s) (see Figure 1). The main effect of attentional focus was significant, with $F(1, 34) = 5.77, p < .05$, $\text{Eta}^2 = .15$, whereas the main effect of group was not significant, $F(1, 34) < 1$. The order of focus conditions (internal-external, external-internal) did not have a significant impact on the results. There was no main effect of order, $F(1, 34) = 2.28, p > .05$. Also, the interactions of group and focus, group and order, focus and order, all F s ($1, 34$) < 1 , as well as group, focus, and order, $F(1, 34) = 2.93, p > .05$, were not significant.

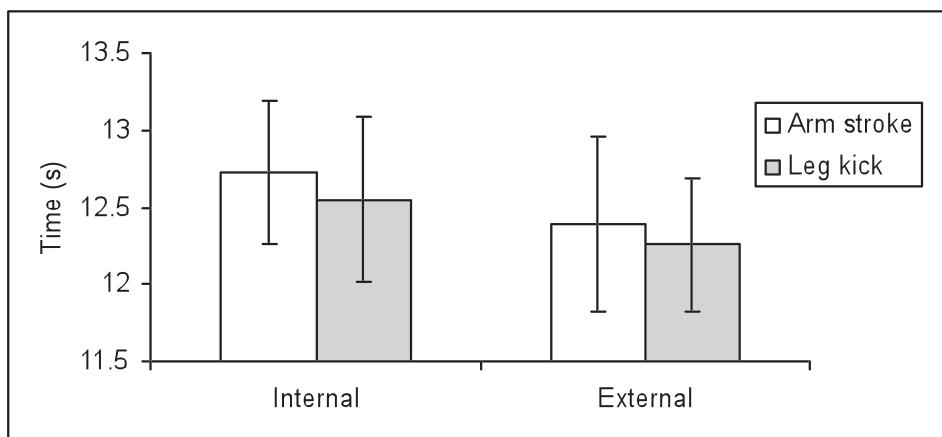


Figure 1. Swim Times (Means and Standard Errors) for One Length of the Pool (16 m) with Focus Instructions Related to the Arm Stroke or Leg Kick, Respectively, in the Internal and External Focus Conditions (Experiment 1).

DISCUSSION

Based on previous findings indicating increased movement efficiency as a function of an external focus of attention, the purpose of this experiment was to examine whether those benefits would translate into improved performance of a continuous skill. The present results confirmed our hypothesis. Participants swam faster when they were instructed to focus on moving the water back or down (external focus) as opposed to moving their limbs back or down (internal focus). Thus, the minor difference in the wording of instructions resulted in a significant advantage for the external focus condition. This effect was independent of whether the instructions referred to the arm stroke or leg kick, and it was also independent of whether the internal or external focus condition was performed first.

Of course, we cannot exclude the possibility that participants did not maintain the instructed focus 100% of the time (even though they were asked to do so). Yet, the vast majority of participants (38 of 40) indicated that they adopted the instructed focus. Whether or not this was indeed the case, the results demonstrate that the attentional focus instructions had the predicted effect on performance. Also, even though the time savings with an external focus may be numerically small (about .3 s over 16 m), races are often won or lost by much smaller margins.

It is interesting to note that the external focus resulted in a similar reduction in swim times when the instructions referred to the arm stroke (.34 s) or leg kick (.29 s). This may be

somewhat surprising given the relative contribution of the leg kick (about 10% of propulsion). Yet, previous research (e.g., [3, 20, 21, 23]) has shown that focusing on one aspect of the skill (e.g., finger movements) can impact other components of the skill (e.g., leg movements). That is, an internal focus on one part of the body appears to have a more global influence on the motor system, impairing overall performance. Thus, the focus on the leg kick may not only have constrained leg movements but a larger part of the motor system. Similarly, the instructions related to the arm stroke presumably had a broader influence, with the result that both types of instructions produced similar time differences.

An important question is whether the adoption of an external focus can *enhance* swimming performance, or whether an internal focus has a *detrimental* effect, relative to 'normal' conditions. If an external focus produced shorter swim times for a given distance, this would have important practical implications. Therefore, in a second experiment, we included a control condition without specific focus instructions.

EXPERIMENT 2

INTRODUCTION

Previous attentional focus studies in which control conditions were used have almost exclusively found benefits of external focus instructions compared to both internal and control conditions, which did not differ from each other (e.g., [6, 8, 9, 11, 20, 23-26]). This finding may suggest that individuals spontaneously focus on their movements when not instructed to direct their attention to the intended movement effect. Despite the apparent ubiquity of this effect, we deemed it important to examine whether external focus instructions could decrease swim times relative to 'normal' (control) conditions. Furthermore, given that in Experiment 1 the attentional focus instructions had similar effects on both arm stroke and leg kick, the instructions in Experiment 2 referred only to the arm stroke, which is the main propulsive crawl component and is responsible for about 90% of the propulsion in skilled swimmers [27]. Thus, the task and procedure were similar to those used in Experiment 1, with the exception that a control condition was included in a within-participant design, and the instructions were related to the arm stroke.

METHOD

PARTICIPANTS

Thirty undergraduate students (16 men, 14 women) of mean age 23.7 years ($SD = 3.81$), all of whom were intermediate crawl swimmers, participated in the study. All participants gave their informed consent, and they were not aware of the study purpose. Participants in Experiment 2 were different from those in Experiment 1.

TASK AND PROCEDURE

The task and procedure were similar to those used in Experiment 1. Participants were asked to swim one length in an outdoor swimming pool (16 m) three times using the front crawl stroke. For each trial, participants were given different instructions. As in the first experiment, they were asked to focus on "pulling your hands back" (internal focus), or "pushing the water back" (external focus), or they were not given any focus instructions (control condition). The order of the three conditions was counterbalanced among participants (control-internal-external, internal-external-control, or external-control-internal). There were 3-minute rest periods between trials.

DATA ANALYSIS

Swim times were analyzed in a 3 (order: control-internal-external, internal-external-control, external-control-internal) x 3 (focus: internal, external, control) ANOVA with repeated measures on the last factor.

RESULTS

SWIM TIMES

Participants swam faster in the external focus condition (mean: 12.73 s; SD: 2.11 s) compared to both the internal focus (mean: 13.13 s; SD: 2.18 s) and control conditions (mean: 13.02 s; SD: 2.20 s) (see Figure 2). The main effect of attentional focus was significant, with $F(2, 54) = 6.81, p < .01$, $\eta^2 = .20$. Post-hoc test (Bonferroni) indicated that swim times in the external condition were significantly shorter than those in the other two conditions ($p < .05$), while the times in the internal focus and control conditions did not differ from each other ($p > .05$). The Order main effect was not significant, $F(2, 27) < 1$. Also, there was no interaction of focus and order, $F(4, 54) < 1$.

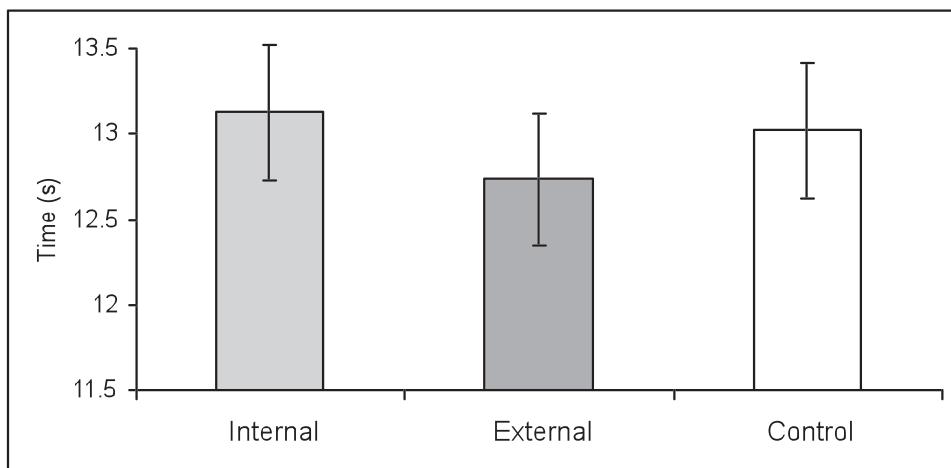


Figure 2. Swim Times (Means and Standard Errors) for One Length of the Pool (16 m) with Focus Instructions Related to Arm Stroke in the Internal Focus, External Focus, and Control Conditions (Experiment 2).

DISCUSSION

In line with previous findings [8, 9, 23-25], instructions directing participants' attention to the movement effect (water) resulted in superior performance compared to those directing attention to their body movements (hands), or no focus instructions. Also consistent with earlier studies was the finding that internal and control conditions yielded similar results. Thus, an external focus significantly enhanced swimming performance compared to normal conditions. It is interesting that the benefits of an external focus are not only seen in balance tasks [11] or those requiring accuracy [6], but also in tasks involving maximum effort, including the producing maximal forces [17] or jumping as high as possible [20]. The present findings indicate that this advantage also extends to longer-duration tasks that are more reliant on anaerobic capacity.

CONCLUSION

The present study followed up on previous findings demonstrating greater movement efficiency (e.g., reduced EMG activity, greater force production, or both) when individuals were instructed to adopt an external relative to an internal focus of attention (for reviews, see [14, 28]). Given that movement efficiency is a critical factor in continuous skills (e.g., running, cross-country skiing, rowing, bicycling), we wanted to examine whether the benefits of an external focus of attention would translate into improved performance in this type of activity. The present results demonstrated that this was the case. Participants swam faster when they were instructed to focus on moving the water back (or down) compared to when they were instructed to move their limbs back (or down), or when they were not given focus instructions.

While many previous studies have shown that the attentional focus induced by instructions or feedback can influence performance and learning, most previous studies have used dependent measures such as movement accuracy, postural sway (on balance tasks), maximum force production, or muscular activity (EMG). To our knowledge, the present findings are the first to demonstrate performance differences for a continuous sport skill when performers adopted different foci of attention. This finding corroborates the assumption that an external focus results in the production of a more efficient movement pattern (i.e., a more effective coordination within or among muscles) – enabling the individual to produce a greater amount of force over a given period of time, or maintain a given force output for a longer period of time. In either case, the expected result would be enhanced performance in activities that require sustained physical effort.

In future studies, it may be interesting to examine how exactly the performer's attentional focus affects movement production. For example, does one's focus influence the overall 'forcefulness' with which the movement pattern is executed (i.e., parameterization of the movement)? Or, does it also affect the relative forces or relative timing of the movement pattern (e.g., acceleration of the hand under water)? Furthermore, does the performer's focus result in changes in movement kinematics (e.g., path of the hand or foot under water)? The answers to those questions could provide more insight into how the motor system manages to produce more effective and efficient outcomes when the performer focuses on the movement effect he or she wants to achieve.

The present study was concerned with the immediate effects of attentional focus on swimming performance. Future studies may want to examine those effects in a learning paradigm, as most previous attentional focus studies have done (see [1], for a review). This would involve different groups of participants practicing under the different focus conditions, with learning being tested in retention or transfer test (without focus instructions). Extant evidence suggests that the advantages of practice with an external focus are indeed learning effects (i.e., relatively permanent) and transfer to novel situations, including those in which performers are prevented from adopting the respective focus (e.g., [7, 11, 29]).

The present results have obvious implications for (competitive) swimming, and presumably other endurance-based sports, where often fractions of a second determine rankings. Previous studies have shown that attentional focus effects generalize to a wide range of levels of expertise – for example, from novice to expert golfers [6]. Although it remains to be seen whether the performance benefits seen for intermediate swimmers in the present study generalize to different skill levels (e.g., expert swimmers), it appears likely that the external focus instructions used in the present study would be beneficial for a relatively wide range of levels of expertise. In contrast to other sports or skills that involve implements

(to which the performer's attention could be directed), it may be a little more challenging for swim coaches to word instructions in a way that attention is directed externally. In some studies, metaphors or analogies have been used successfully [4], as these provide an image of the goal movement without referring directly to the performers' body movements. For example, swimmers could be asked to think of a torpedo after pushing off the wall. The correct leg motion in crawl or butterfly may be facilitated by instructing swimmers to imagine they are using fins. Creative coaches will be able to design similar instructions that induce an external focus of attention – thereby enhancing movement effectiveness and efficiency, and consequently their athletes' performance.

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