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Increased jump height and reduced EMG activity with an external focus

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ABSTRACT

Jump height is increased when performers are given external focus instructions, relative to an internal focus or no focus instructions (Wulf & Dufek, 2009; Wulf, Zachry, Granados, & Dufek, 2007). The purpose of present study was to examine possible underlying neurophysiological mechanisms of this effect by using electromyography (EMG). Participants performed a vertical jump-and-reach task under two conditions in a counterbalanced order: external focus (i.e., focus on the rungs of the measurement device) and internal focus (i.e., focus on the fingers with which the rungs were to be touched). EMG activity of various muscles (anterior tibialis, biceps femoris, vastus lateralis, rectus femoris, gastrocnemius) was measured during jumps. Jump height was greater with an external compared to an internal focus. While there were no differences in muscle onset times between attentional focus conditions, EMG activity was generally lower with an external focus. These results suggest that neuromuscular coordination is enhanced by an external focus of attention. The present findings add to the evidence that an external focus facilitates the production of effective and efficient movement patterns.

1. Introduction

Over the past decade or so, numerous studies have shown that the focus of attention an individual adopts during the execution of a motor skill influences performance – and, perhaps more importantly, skill learning (for reviews, see Wulf, 2007a, 2007b). In particular, if attention is focused on the

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movement effect, or outcome, one is attempting to achieve (external focus) as compared to attention focused on one's body movements (internal focus), the result is typically greater movement effectiveness. This has been demonstrated for a variety of (complex) laboratory and sport skills, including those performed in golf (e.g., Wulf, Lauterbach, & Toole, 1999; Wulf & Su, 2007), basketball (Al-Abood, Bennett, Hernandez, Ashford, & Davids, 2002; Zachry, Wulf, Mercer, & Bezodis, 2005), soccer (e.g., Wulf, McConnel, Gärtner, & Schwarz, 2002, Experiment 2), volleyball (Wulf et al., 2002, Experiment 1), dart throwing (Marchant, Clough, & Crawshaw, 2007), as well as for various balance skills (e.g., Totsika & Wulf, 2003; Wulf, Höß, & Prinz, 1998). The benefits of adopting an external focus are not only seen relative to internal focus conditions, but also in comparison to control conditions without specific focus instructions (e.g., Landers, Wulf, Wallmann, & Guadagnoli, 2005; Marchant, Greig, Scott, & Clough, 2006; Wulf, Landers, Lewthwaite, & Töllner, 2009; Wulf & McNevin, 2003; Wulf, Weigelt, Poulter, & McNevin, 2003; Wulf et al., 1998). This suggests that an external focus *enhances* performance and learning, presumably because individuals are inclined to adopt an internal focus even when they are not explicitly instructed to do so.

The majority of studies on attentional focus have used various measures of movement accuracy (e.g., deviation from a target) or balance (e.g., postural sway) to assess movement effectiveness (see Wulf, 2007a, 2007b, for reviews). Recent studies have demonstrated that force production is also influenced by the performer's focus of attention. In the first study to examine this issue, Vance, Wulf, Töllner, McNevin, and Mercer (2004) used a biceps-curl task, with performers being instructed to focus either on the movements of the curl bar (external focus) or of their arms (internal focus). The results showed that muscular activity (i.e., as measured by electromyography, EMG) was significantly reduced in the external relative to the internal focus condition. Given that the weight lifted was identical under both conditions, this finding indicated that movements were performed more efficiently with an external attentional focus. Marchant and colleagues (Marchant, Greig, & Scott, 2009a, 2009b; Marchant et al., 2006) extended those findings. In one study, Marchant et al. (2006) demonstrated that an external focus in a series of repetitions on a biceps-curl task resulted in less EMG activity not only compared to an internal focus, but also compared to no focus instructions (control condition). In another study, Marchant et al. (2009a) found beneficial effects of an external focus on maximum force production. Using an isokinetic dynamometer, these researchers had participants produce maximum voluntary contractions of the elbow flexors under internal focus (i.e., arm muscles) or external focus (i.e., crank hand-bar) conditions. The results showed that participants produced significantly greater peak joint torque when they focused externally – and that this was achieved with significantly less muscular (EMG) activity.

In another series of studies, Wulf and Dufek (2009) and Wulf, Zachry, Granados, and Dufek (2007) used a task that required whole-body coordination to produce maximum force, namely, a vertical jump-and-reach task. Using a Vertec™ measurement device, participants performed the task under each of two conditions: focus on the rungs that were to be touched (external focus) or focus on the finger with which the rungs were to be touched (internal focus). Jump height and vertical center-of-mass (COM) displacement were greater in the external than internal focus condition (Wulf et al., 2007). In addition, impulse and lower extremity joint moments were greater with an external focus as well (Wulf & Dufek, 2009) – indicating that individuals jumped higher by producing greater forces.

Findings showing that an external focus enables individuals to lift the same weight (Marchant et al., 2006; Vance et al., 2004), and to produce greater impulses, joint moments (Wulf & Dufek, 2009), as well as peak forces with less muscular activity (Marchant et al., 2009a) provide converging evidence that movements are produced more efficiently when attention is directed to the desired movement effect. But how is motor control optimized by an external focus? The predominant explanation for the attentional focus effects centers on the idea that an internal focus induces conscious control and constrains the motor system, whereas an external focus promotes automaticity in movement control ("constrained action hypothesis"; Wulf, McNevin, & Shea, 2001). Support for this notion has been provided in previous studies (e.g., McNevin, Shea, & Wulf, 2003; Wulf, Shea, & Park, 2001). This assumption implies that an external focus leads to a more advanced stage of learning sooner – in which performance is not only more effective, but in which movement efficiency is enhanced as well (Wulf, 2007b). In line with this view, Vanezis and Lees (2005) who compared "good" and "poor" jumpers found that, while there were no major differences with regard to the technique used, the two