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Examining the time course of attention in a soccer kick using a dual task paradigm

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ABSTRACT

A dual-task paradigm was implemented using a repeated measures design to determine the time course of attention demands during performance of a soccer penalty kick. Experienced soccer players ($N = 15$) were asked to perform a 12-yard soccer-style penalty kick. As part of the dual task paradigm, participants were instructed to respond to an audible cue that was administered during one of three probe positions (PP) during the penalty kick. Probe position 1 (PP1) was operationalized as the participant's second to last step (taken with the non-kicking foot), probe position 2 (PP2) was the next to last step (taken with the kicking foot), and probe position 3 (PP3) was the last step (taken with the non-kicking, or "plant foot") just prior to the kicking foot making contact with the ball. Kicks were taken with both the dominant foot (DF) and the non-dominant foot (NDF). It was hypothesized that reaction time to the audible cue (RT) would be slowest at the beginning and end of the performance of the motor skill in both the DF and NDF situations and that RT would be slower when kicking with the NDF, but that the kicking foot would not affect the pattern of attentional demands. Results indicated that RT was slowest at PP1 for both the DF and the NDF and that RT was significantly slower at PP1 for the DF than for the NDF. This suggests that soccer players engage in more complex planning during the preparatory phases when executing a kick with their dominant foot. Future research should be designed to further our understanding of foot dominance with regard to kicking and to explore attentional demands of striking tasks.

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1. Introduction

Research has been conducted to advance our understanding of the attention demands of particular sport skills. Attention is well defined by William James (1890, pp. 403–404) who stated:

> It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state which in French is called *distraction*, and *Zerstreutheit* in German.

This definition assumes volitional control over when and what we focus our attention on. During sport performance, we are frequently under a barrage of multiple streams of information and must select where to direct our attentional capacities. James' classic definition infers that multi-tasking may require a prioritization of tasks for successful completion of one or both tasks. This definition is consistent with the capacity theory of attention (Kahneman, 1973), which suggests that attention is a limited resource (Singer, Hausenblas, & Janelle, 2001). Based upon this theory, it is expected that the cognitive demands of performing multiple tasks may exceed attentional capacities and performance decrements may appear on one or more tasks.

Given this premise that attention is limited, a dual-task paradigm has been used in research to measure the attentional demands of a specific task (Kahneman, 1973). After providing baseline performance measures, individuals are asked to complete two concurrent tasks while maintaining one of the tasks as their primary task. Their performance on the two tasks performed simultaneously is then compared to their performance on the tasks individually. If performance is maintained on the primary task, but diminishes on the concurrent secondary task (typically a reaction time, RT, task), it is inferred that the primary task required a majority of the individual's cognitive resources and that there were not enough resources remaining to complete the secondary task successfully. If there is little or no decline in the performance of the secondary task, it is implied that the primary task did not require substantial attention and there was sufficient residual processing capacity for both tasks. Thus, the dual-task paradigm can be used to accurately quantify attentional demands during performance of a primary task.

The dual-task paradigm has been used to quantify attention during motor task performance and to make inferences regarding whether or not a person is using implicit or explicit processes in the performance of the task (Lam, Maxwell, & Masters, 2010). Implicit processes are expected to require fewer attentional resources and, hence, to be less vulnerable to interference from other attention-demanding tasks. Explicit processes are expected to require more attentional resources, and this is thought to be reflective of the performer identifying and testing hypotheses related to the achievement of particular outcomes. As a result, explicit processes are expected to be more easily disrupted by performing a secondary task (i.e., the secondary task used in a dual-task paradigm). Of relevance to this study which is focused on understanding patterns of attentional demands during motor task performance is a study testing the time course of attentional demands during a golf putting task performed by novices. Lam et al. (2010) found that when learning the task, performance on the secondary task was worse during the movement preparation phase (prior to the initiation of the backswing) than during execution of the motor task (the forward swing of the putter). Based upon these findings and those of other similar studies (Carson, Chua, Byblow, Poon, & Smethurst, 1999; Lam, Maxwell, & Masters, 2009), the authors concluded that movement preparation requires greater attentional resources than does movement execution.

Other researchers using dual-task techniques have used more than two probes to further delineate the time course of attention in various motor skills (Castiello & Umilta, 1988; Prezuhy & Etnier, 2001; Price, Gill, Etnier, & Kornatz, 2009; Rose & Christina, 1990; Sibley & Etnier, 2004; Singer et al., 2001). In discussing the extant literature, Prezuhy and Etnier (2001) suggested that tasks should be categorized based on their required interactions with external stimuli as this may be the factor driving the *pattern* of attentional demands. According to Prezuhy and Etnier, gross motor skills such as horseshoe pitching