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Davids, K. (2007). Increases in jump-and-reach height through an external focus of attention: A commentary.

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Wulf et al.'s report of two experiments examining whether a participant's focus of attention influences jump-and-reach height is the latest paper in a series proposing beneficial effects of instructing participants to adopt 'an external focus of attention' during motor learning and performance. Here, the novel contribution of the data involves a generalisation to the constraints of a *maximum* force production task (more on these task constraints later) and the authors propose that their findings have implications for understanding how practitioners can enhance physical training. On the face of it, these findings seem straightforward to interpret. However, in this commentary, I will discuss two problems with the experiments in this paper which actually generalise to the extant programme of work on focus of attention in motor learning and performance. These issues are theoretical and methodological in nature as explained below.

<u>Data in search of a theoretical rationale?</u>

While the aim of the authors is to examine the generality of external focus of attention effects to the task constraints of maximal force production, it is not immediately clear what this paper actually adds to our *theoretical* understanding on the nature of augmented information for motor performance. In these studies, there is an assumption that, due to noise reduction, improved coordination in the jump must somehow be the mechanism behind better performance in the task for the instructed external focus of attention group. But how can we be sure about this interpretation? This reasoning is somewhat speculative and would have received stronger empirical support if some measures of movement coordination for the jump-and-reach action were recorded. Moreover, the assumption, invoked in other studies by Wulf and colleagues, that motor system noise might be behind the reported inferior performance of the internal focus and control groups, is theoretically questionable. The suggestion actually runs counter to a strong body of evidence in the neurobiology literature demonstrating the potentially beneficial effects that the *addition* of noise (e.g., in the form of stochastic resonance) might have on cognitive, perceptual and motor processes during learning and performance (for an overview see Schöllhorn et al., 2006).

In the programme of work by Wulf and colleagues a mixed theoretical paradigm has typically been used to explain findings, founded on the concept of *automaticity* from cognitive science as well as ideas from dynamical systems theory including *self-organisation* and *constraints*. These disparate ideas are uneasy theoretical companions to juxtapose and a convincing theoretical rationale for integrating these concepts into an overarching explanation of focus of attention effects is lacking. Moreover, their relation with theoretical usage in cognitive science and dynamical systems theory remains obscure. It is also worth noting that, perhaps for these reasons, no other area of human movement science research uses such a disparate mix of ideas from different theoretical approaches.

Elsewhere, a dynamical systems theoretical interpretation has already been provided for explaining the effects of focus of attention on motor learning and performance. A possible basis for explaining these effects relate to variations in the specifying informational constraints on action: known as movement dynamics and movement outcome effects (Al-Abood et al., 2002; Araújo et al., 2004; Davids, Button & Bennett, 2007). Araújo et al. (2004) argued that Bernstein's (1967) insights could be invoked to propose that motor learning and performance is constrained by information about the *image of the act* (focus on movement dynamics or topological form) and the *image of achievement* (focus on the movement effects to be achieved in the environment). These insights suggest how an external focus on the image of achievement might provide better opportunities to constrain learners' search for emergent task solutions during discovery learning. Empirical evidence from Whiting and Den Brinker (1982) and Vereijken and Whiting (1990) was reviewed in arguing that an external focus of attention might allow discovery learners to focus on an image of achievement alone. This instructional focus might provide a good opportunity for learners to exploit inherent self-organisation processes in satisfying task constraints, as exemplified in the study of learning to use a ski simulator by Vereijken and Whiting (1990). It appears that an external focus of attention may not interfere with inherent self-organisation of movement system dynamics as individuals explore task constraints during practice (Davids et al., 2007). Araújo et al. (2004) also suggested how an external focus might direct an individual's attention towards movement effects, rather than other external sources of information, yielding better learning and performance. From this perspective, data from a study of the tennis forehand drive by Wulf et al. (2000) could be re-interpreted to suggest that the effects of instructions towards an external focus of attention were not due to distracting performers from an explicit focus on their movement dynamics as suggested by the authors. Rather the emphasis on movement effects may have been influential in allowing emergent self-organising processes to inherently regulate task performance and learning.

From a practical perspective, it seems that augmented information on movement effects (image of achievement) can be used to direct performers in their exploration of functional, emergent movement solutions. For example, research has shown that an external focus of attention on the movement effects of a model's performance leads to better task performance by observers than a focus on the same model's movement dynamics. Al-Abood et al. (2002) reported that emergence of successful task solutions under constraints was restricted when feedback directed learners towards observing movement dynamics, resulting in less effective performance.

Challenges for experimentation on focus of attention

Regardless of theoretical orientation, a major challenge in substantiating the focus of attention effect is to empirically evaluate whether this concept is actually behind the reported effects in experimental work. There are at least two dimensions to this empirical challenge. First, perhaps a repeated measures design, as adopted in this paper by Wulf and colleagues, is not the most appropriate way to approach this type of research due to problems in controlling variations in previous experiences of participants. A between-group design has been used in other studies on this topic, and in this analysis of jump-and-reach performance, a simple performance pre-test would have ensured that random stratified samples were used in a between-group intervention. Another reason why a pre-testing experimental protocol is needed in the reported experiments of Wulf et al. is to establish a baseline and ensure that *maximal* force production was undertaken by all participants in all conditions of the jumping to reach task. Without this level of individualised analysis, one cannot be sure that the intended novel generalisation of this specific study has actually occurred. Second, although the experimental instructions may have solicited participants to focus on different informational sources (rung or fingertips), one cannot be sure whether participants complied with specific instructional constraints. Additionally, the instructional constraints may have unintentionally varied between conditions. To clarify, in this particular study, the specific task constraints actually required all participants to reach and touch a rung. To perform this type of interceptive action one needs to ultimately visually attend to the position of a specific rung, therefore leading participants to switch attention from fingers to rung in the internal focus of attention condition. It seems that no specific instructions on attentional focus were provided during the control condition so one cannot be sure of the specific focus of attention in this condition. But clearly participants did not jump blindly into the air in the control condition because they were required to reach and touch the furthest rung (necessitating that they fixated on it). Therefore, one cannot rule out the possibility that in the internal focus and control conditions, participants were switching between visual information sources in regulating the jump and reach action. These instructional constraints clearly differed with that of the external focus condition which was to focus solely on the rung. This is a non-trivial variation which might provide the basis for an alternative explanation for the findings. To be sure, ensuring 'purity' of instructional constraints is a difficult challenge that has remained problematic in all previous studies in this area of motor learning, but a manipulation check in these experiments may have provided some qualitative data to assess what the participants might have been focusing attention on. Without such manipulation checks, one cannot state with any certainty that participants were adhering to the specific instructional constraints of each condition.

To summarise, until a clearer theoretical elucidation of the possible mechanisms behind the focus of attention effect is allied to a more rigorous control of instructional constraints on different participant groups, the practical merit of this approach to providing augmented information during performance remains open to interpretation.

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