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Re-examining the effects of verbal instructional type on early stage motor learning

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ABSTRACT

The present study investigated the differential effects of analogy and explicit instructions on early stage motor learning and movement in a modified high jump task. Participants were randomly assigned to one of three experimental conditions: analogy, explicit light (reduced informational load), or traditional explicit (large informational load). During the two-day learning phase, participants learned a novel high jump technique based on the 'scissors' style using the instructions for their respective conditions. For the single-day testing phase, participants completed both a retention test and task-relevant pressure test, the latter of which featured a rising high-jump-bar pressure manipulation. Although analogy learners demonstrated slightly more efficient technique and reported fewer technical rules on average, the differences between the conditions were not statistically significant. There were, however, significant differences in joint variability with respect to instructional type, as variability was lowest for the analogy condition during both the learning and testing phases, and as a function of block, as joint variability decreased for all conditions during the learning phase. Findings suggest that reducing the informational volume of explicit instructions may mitigate the deleterious effects on performance previously associated with explicit learning in the literature.

1. Introduction

According to the traditional cognitive framework of motor skill acquisition (Anderson, 1982; Fitts & Posner, 1967), the attentional demands and knowledge that underlie motor performance differ with respect to expertise. Although more advanced performance relies on automatised procedural systems that require little conscious attention, the early stages of skill learning involve the effortful serial processing of explicit, rule-based knowledge in working memory systems in order to approximate the successive steps of motor execution. While research indicates that novices may benefit from the self-focused attention engendered by explicit information (e.g., Beilock, Carr, MacMahon, & Starkes, 2002), research also suggests that explicit knowledge is associated with skill breakdown under pressure (e.g., Lam, Maxwell, & Masters, 2009b; Masters, 2000; Masters & Maxwell, 2004).

Theorising that explicit, rule-based information might interfere with skilled performance when reinvested into typically autonomous skills, Masters (1992) demonstrated that golf-putting skills acquired implicitly—without reliance on rule-based instruction or working memory systems—were more resilient to induced stressful conditions than those same skills gained

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through explicit means. Subsequent studies have since shown passively-acquired motor skills to be more robust under performance pressure (Hardy, Mullen, & Martin, 2001; Hardy, Mullen, & Jones, 1996; Masters, 1992), physiological fatigue (Masters, Poolton, & Maxwell, 2008; Poolton, Masters, & Maxwell, 2007), and concurrent cognitive demands (Masters, 1992, 2000) than performance underpinned by declarative knowledge.

However, despite such favourable findings in the laboratory, several factors have limited the application of implicit instructional methods in the field. Much of the difficulty in this regard stems from the cumbersome and logistically demanding techniques employed to encourage passive skill learning, such as dual-task learning (Hardy et al., 1996; Masters, 1992; Maxwell, Masters, & Eves, 2000), errorless or reduced-feedback learning (Maxwell, Masters, & Eves, 2003; Maxwell, Masters, Kerr, & Weedon, 2001) and subliminal learning (Masters, Maxwell, & Eves, 2001). As Poolton, Masters, and Maxwell (2006) explained, 'implicit motor learning paradigms are ecologically challenged, generally difficult to apply in the field, and result in slower learning than normal' (p. 678).

Recognising the need for more feasible implicit instructional methods, Masters (2000) proposed the concept of 'coaching by analogy' in which a series of complex movements or behaviours are conveyed through a single analogical cue. The premise is that such an 'all encompassing biomechanical metaphor' can be readily incorporated into existing coaching and instructional paradigms as it does not require unusual modifications to the learning environment (e.g., dual-task or subliminal learning), but simply an adjustment in the type of information (i.e., analogy versus explicit rules). Studies have since shown that participants learning tasks through analogical instruction report fewer task-relevant rules (Koedijker et al., 2011; Lam, Maxwell, & Masters, 2009a; Lam et al., 2009b; Liao & Masters, 2001; Poolton et al., 2006), exhibit no deficits in performance or kinematic variables (Lam et al., 2009b), and perform without disruption under stressful (Lam et al., 2009a) or dual-task conditions (Koedijker et al., 2011; Lam et al., 2009b; Liao & Masters, 2001). A potential methodological issue, however, makes it uncertain whether these observed advantages of analogy learning arose from the *type* of instruction or the reduced *volume* of instructions compared to traditional explicit methods. In this regard, the rules for the explicit conditions in previous empirical research have outnumbered the single-cue analogy instructions by ratios ranging from 5:1 (Koedijker et al., 2011) to as high as 12:1 (Liao & Masters, 2001), even though current motor learning literature and many coaching guides advise focusing on no more than two or three key points at any one time when teaching new motor skills (e.g., Mannie, 1998; McQuade, 2003; Schmidt & Wrisberg, 2004). Given that part of the inspiration behind the concepts of implicit and, subsequently, analogy learning was to reduce the load on attentional resources engendered by the task instructions, it would seem not only equitable, but also necessary from an experimental perspective, to explore the impact of explicit instructions in their leanest possible configuration as well. The aforementioned disparity in instructional volume might also explain the propensity for explicit learners to report more task-relevant rules in follow-up questionnaires than their analogy group counterparts, as they would have repeatedly read, memorised, and performed up to eleven additional instructional steps. As it stands, it is difficult to establish whether the performance deficits attributed to explicit learning in the existing literature resulted from conscious processing engendered by the instruction itself or from competition for available attentional resources.

1.1. Content under pressure

Although a fairer comparison with explicit learning would represent a positive methodological evolution, additional refinements might further enhance the usefulness of analogy and explicit learning research to those working in applied settings. Just as the impracticalities of implicit learning methods motivated the development of the concept of analogy learning, the artificial manipulations used to simulate pressure or competitive conditions in laboratory research could too benefit from the adoption of a more practical and, perhaps, more representative approach. Part of the original rationale for employing implicit instructional methods was that it might limit susceptibility to 'choking' (Masters, 1992), a phenomenon of pressure-induced skill failure (Baumeister, 1984); however, choking has typically been evaluated using contrived manipulations of pressure and distraction that are often unrealistic and disproportionate to the levels experienced in sport (Gucciardi & Dimmock, 2008; Hill, Hanton, Matthews, & Fleming, 2010). This trend has continued in analogy learning research with prize money (Lam et al., 2009b), evaluation (Lam et al., 2009a), audience observation (Law, Masters, Bray, Eves, & Bardswell, 2003), and secondary task loads such as reverse counting (Lam et al., 2009b) and tone monitoring (Orrell, Eves, & Masters, 2006) accounting for just a few of the task-irrelevant methods used to evaluate the robustness of skills learned under both explicit and analogy conditions. According to Jones and Hardy (1990), however, tasks that offer more authentic anxiety manipulations represent richer opportunities for exploring the relationships between anxiety and performance. Moreover, studies that employ ego-stressor methods manage to evoke only moderate levels of anxiety that are incommensurate with those experienced during competition (Williams & Elliot, 1999). To both enhance understanding of the differential impact of various types of verbal instruction and increase the utility of this research for those in the field, research designs ought to reflect the demands and pressures experienced within authentic performance environments (see Pijpers, Oudejans, & Bakker, 2005; Pijpers, Oudejans, Holsheimer, & Bakker, 2003).

1.2. The current study

The present study sought to address concerns regarding informational imbalance and representative pressure by introducing an explicit condition with reduced instructional volume and by implementing a task-appropriate pressure