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Full Length Article

Effects of scaling task constraints on emergent behaviours in children's racquet sports performance

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ABSTRACT

Manipulating task constraints by scaling key features like space and equipment is considered an effective method for enhancing performance development and refining movement patterns in sport. Despite this, it is currently unclear whether scaled manipulation of task constraints would impact emergent movement behaviours in young children, affording learners opportunities to develop relevant skills. Here, we sought to investigate how scaling task constraints during 8 weeks of mini tennis training shaped backhand stroke development. Two groups, control (n = 8, age = 7.2 ± 0.6 years) and experimental (n = 8, age 7.4 ± 0.4 years), underwent practice using constraints-based manipulations, with a specific field of affordances designed for backhand strokes as the experimental treatment. To evaluate intervention effects, pre- and post-test match-play characteristics (e.g. forehand and backhand percentage strokes) and measures from a tennis-specific skills test (e.g. forehand and backhand technical proficiency), were evaluated. Post intervention, the experimental group performed a greater percentage of backhand strokes out of total number of shots played (46.7 ± 3.3%). There was also a significantly greater percentage of backhand winners out of total backhand strokes observed (5.5 ± 3.0%), compared to the control group during match-play (backhands = 22.4 ± 6.5%; backhand winners = 1.0 ± 3.6%). The experimental group also demonstrated improvements in forehand and backhand technical proficiency and the ability to maintain a rally with a coach, compared to the control group. In conclusion, scaled manipulations implemented here elicited more functional performance behaviours than standard Mini Tennis Red constraints. Results suggested how human movement scientists may scale task constraint manipulations to augment young athletes' performance development.

1. Introduction

Racquet sports, like tennis, are characterised by repeated, dynamic interceptive actions, and participants require a high level of technical and physical proficiency to be able to generate and maintain effective movement patterns (Farrow & Reid, 2010a). With elements such as motor coordination, on court movement and game tactics to consider, inexperienced participants can find the sport's demands particularly challenging (Breed & Spittle, 2011). Consequently, tennis federations have developed modified versions of the sport, theoretically underpinned by Newell's (1986) constraints-led approach, designed to augment skill development and enable inexperienced participants' performance behaviours to more closely reflect those required in the full version of the game (Timmerman et al., 2015).

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The British Lawn Tennis Association's Mini Tennis (MT) is one such scaled game version (Hammond & Smith, 2006). MT comprises three structured, progressive stages (Red, Orange and Green), with scoring format, court dimensions, net height and ball characteristics modified at each stage to facilitate participants' functional movement behaviours (Fitzpatrick, Davids, & Stone, 2016). However, many scaled formats of tennis, including MT, have been implemented based on expert practitioner opinion and experiential knowledge, requiring empirical evidence to affirm potential functional benefits (Buszard, Farrow, Reid, & Masters, 2014). Accordingly, recent research has strived to substantiate the implementation of MT constraints for enhancing children's skill acquisition (Kachel, Buszard, & Reid, 2015; Timmerman et al., 2015).

Constraints are boundaries pertaining to the performer, the task or environment which confine and/or facilitate the behavioural movement patterns that a complex dynamical system can adopt (Newell, 1986). Adapting task constraints encourages performers to explore how manipulations shape available affordances (possibilities for action). Research has suggested that effective manipulation of constraints in children's sport can facilitate emergence of functional coordinative movements (Arias & et al., 2012). In tennis, scoring format, court dimensions, net height and ball characteristics are considered key task constraints that can be scaled to influence movement behaviours. Modifying these aspects, through scaling, enables inexperienced participants to perform, without the need to contend with the challenging constraints of Full Ball tennis. However, it is important that the modifications simplify movement demands while maintaining perception-action couplings that are functional in the full version of the game (Buszard, Reid, Masters, & Farrow, 2016). For example, a reduced compression tennis ball that bounces lower facilitates inexperienced participants' groundstroke performance, by allowing them to adopt a swing height that is scaled to their physical dimensions. It has been proposed that this re-scaling of movement is more conducive to skill development than the swing height needed to strike a higher-bouncing, standard tennis ball (Kachel et al., 2015).

Evidence suggests that the constraints employed within MT influence participants' emergent behaviours; for example, low compression balls positively influence children's forehand groundstroke performance (Buszard et al., 2014; Larson & Guggenheimer, 2013). Low compression balls also enable participants to maintain control of rallies for longer, facilitating the development of a wider range of strokes (Martens & de Vylder, 2007). Timmerman et al. (2015) investigated effects of modifying court dimensions and net height on emergent behaviours, showing that, although average rally length did not differ between conditions, reducing court dimensions and net height created an enhanced learning environment for children. A 5-week intervention study with four groups (scaled court-modified ball, scaled-court-standard ball, standard court-modified ball, standard court-standard ball) (Farrow & Reid, 2010b) demonstrated that, while stroke proficiency of all groups improved, participants in the two scaled-court groups were afforded more hitting opportunities during practice sessions and demonstrated greater hitting success and rally ability than the standard court-standard ball group. Farrow and Reid (2010b) concluded that the *standard court-standard ball* group underwent a poorer overall learning experience, and that scaled conditions can be used to effectively simplify tennis for children.

MT was designed to reduce the speed of the game, such that children's emergent behaviours closely reflect those needed in the full version of the sport (Buszard et al., 2016). Despite considerable evidence to suggest that MT task constraints augment children's technical and tactical development, claims that MT evokes emergent behaviours that closely resemble those of the full game have, thus far, been largely speculative. Fitzpatrick et al. (2016) investigated this concept, examining effects of MT and Full Ball task constraints on children's movement behaviours; MT Red constraints elicited longer rallies and fewer errors than Full Ball constraints. Thus MT Red participants were afforded more opportunities to perform strokes in a relevant performance environment. However, findings also indicated that MT Red participants performed considerably more forehands than backhands (i.e. 2:1 ratio) during match-play; in contrast, the ratio of forehands performed compared to backhands in Full Ball is closer to 1:1 (Reid, Morgan, & Whiteside, 2016). The disparity may be even greater within MT coaching sessions; in Farrow and Reid's (2010b) intervention study, the scaled court-modified balls condition elicited a mean ratio of approximately 6:1 in favour of the forehand. This focus on the forehand is reflected within the literature, with several studies examining the effects of MT constraints on forehand performance (Buszard et al., 2014; Hammond & Smith, 2006; Larson & Guggenheimer, 2013), but few investigating the impact on backhand performance.

Fitzpatrick et al. (2016) noted that this disparity between forehand and backhand performance at MT Red may lead to a skill imbalance over time, to the possible detriment of performance development. For example, if MT Red constraints do not afford participants sufficient opportunity to perform backhands, the stroke may not adequately develop, thus potentially affecting development by allowing weaknesses to emerge. It is currently not known whether a constraints-based intervention can alleviate this asymmetry in groundstroke performance. Hence, based on application of Newell's (1986) constraints-led approach, we developed a movement intervention designed to enhance skill acquisition, while simultaneously accounting for the asymmetry between groundstrokes at MT Red. The movement intervention included adaptations to internal court dimensions, recovery box location and scoring format. The aim of the study was to investigate effects of these manipulations over an 8-week intervention on children's match-play behaviours and performance on a tennis-specific skills test, with a focus on backhand stroke development.

2. Methods

2.1. Participants

Sixteen participants, each of an appropriate age for MT Red, and with a minimum of 6 months of tennis playing experience, participated voluntarily and were randomly assigned to one of two groups: control (n = 8, age = 7.2 ± 0.6 years, tennis playing experience = 1.9 ± 0.6 years) and experimental (n = 8, age = 7.4 ± 0.4 years, tennis playing experience = 2.1 ± 0.6 years). All participants were right-handed and used double-handed backhands. Informed consent was provided by all participants and their

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