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Research inspired by Tennis Play and Stay: What have we learnt about equipment modification in tennis?

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ABSTRACT

Since the inception of the Tennis Play and Stay campaign in 2007, considerable research has focused on the effect of modifying equipment on children's tennis experience. Most studies have examined equipment modification from a motor skill perspective, with the typical experiment examining the effect of manipulating equipment on children's performance. Indeed, evidence consistently supports equipment modification as a viable method to improve tennis performance (Buszard, Reid, Masters & Farrow, 2016; Farrow, Buszard, Reid, & Masters, 2016).

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INTRODUCTION

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This article reviews studies that have examined equipment modification in junior tennis. We divided research into five areas: (1) the acute effect of equipment modification on beginners, (2) the acute effect of equipment modification on skilled players, (3) the effect of equipment modification on skill development, (4) the effect of equipment modification on implicit processes when executing a skill, and (5) the identification of key variables to guide equipment modification.

Acute effect of equipment modification on beginners.

When 6-year-old children attempt to play a forehand, their ability to hit the ball accurately is influenced by the racket and ball that they use. In a study of children aged 6 to 9 years, the combination of a 48 cm racket and a low compression "red" ball resulted in superior hitting accuracy in a forehand task compared to other racket and ball combinations (see Figure 1; Buszard, Farrow, Reid, & Masters, 2014a). Nine racket-ball combinations were examined, including and 3 rackets (48 cm, 58 cm and 68 cm) and 3 balls (red, green and yellow). In the same study, children swung the racket with a low-tohigh trajectory and made contact with the ball in front and to the side of their body more often when using the "red" ball. Hence, simplifying the skill by modifying the equipment had a positive effect on children's performance. Similar results were reported in a study of children aged 7 to 9 years rallying with a professional coach (note: these children had 2.5 ± 1.2 years experience playing tennis). When children used a lower compression ball, compared to a standard ball, they struck the ball 6.5 km/h faster and with better accuracy (Larson & Guggenheimer, 2013).

A limitation of these studies is that they examined tennis skills in an environment away from a matchplay context. This issue was rectified in an examination of matchplay performance across the four stages within the Play and Stay campaign (red, orange, green and yellow). Results revealed a trend of longer rallies under conditions of greater scaling (Fitzpatrick, Davids, & Stone, 2016). This suggests that children learning to play tennis on the red stage are exposed to more hitting opportunities (note: in this study, children in the red stage had 2.1 ± 0.9 years experience playing tennis). This is consistent with the argument that modifying tennis equipment can heighten the likehood of player's achieving success.

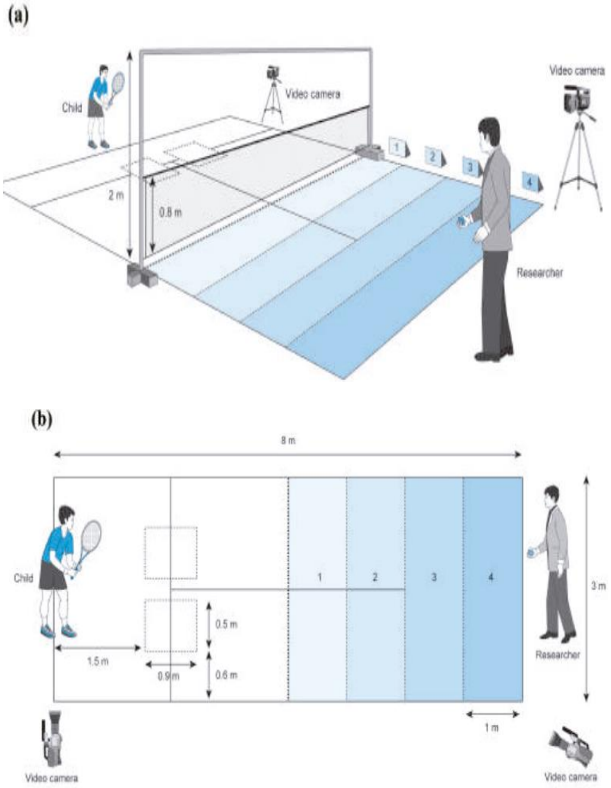


Figure 1. The effect of various racket-ball combinations on hitting performance. A) An illustration of the task set-up. Children's aim was to hit a forehand so that the ball travelled under a 2 metre frame and landed deep in the court. A scoring system was used to measure hitting accuracy. B) The mean hitting scores for each racket-ball combination. These figures were extracted (and modified) from Buszard et al. (2014).

Acute effect of equipment modification on skilled players

The rule change mandating all 10 and under tournaments to use lower compression balls had a significant impact on junior tennis. Despite some public criticism for the rule change, research focusing on skilled 10 and under players supports the change. Compared to a standard yellow ball, playing matches with the lower compression "green" ball resulted in skilled players striking the ball at a comfortable height more often (i.e., between the upper leg and shoulder) and approaching the net on more occasions (Kachel, Buszard, & Reid, 2015). The duration of time between each shot (sometimes referred to as racket-to-racket time) was also faster when using the green ball compared to the yellow ball. Notably, the time between shots more closely resembled that of a professional match. This is assumed to aid skill development, as children will learn to become attuned to the constraints of matchplay that also feature in matchplay as they grow.

Extensions to this study have focused on the effect of manipulating court size and net height for talented 10 and under players. Whilst court size had minimal effect on matchplay performance, lowering net height by 22 cm was found to increase winners, volleys and shots played at a comfortable height, at the same time as fewer shots were played behind the baseline (Timmerman et al. 2015). The authors concluded that a lower net height promoted a more aggressive style of matchplay.

Effect of equipment modification on skill development

Three studies have examined the effect of modifying equipment on children's motor skills over a practice period. Hammond et al. (2006) revealed no differences in skill improvements between children exposed to a lower compression ball and children exposed to a standard ball after 8 weeks of practice. However, we should interpret this result with caution, as skill level and age were not controlled for between experimental groups.

More compelling evidence came from a study of 8 year old children who were divided into four practice groups: a scaled court-low compression ball group, a scaled court-standard ball group, a full-size court-low compression ball group, and a full size courtstandard ball group (Farrow & Reid, 2010). The only group to show no performance improvement following 5 weeks of practice was the full size court-standard ball group. Evidently, the adult (or full size) conditions limited hitting opportunities during practice, which seemingly limited the learning experience.

The effect of modifying tennis equipment was also examined during Physical Education classes in primary school (Buszard, Reid, Masters, & Farrow, 2016). The aim was to identify if modifying equipment also facilitates enhanced performance and learning when children practiced in large groups. Surprisingly, however, children displayed similar improvements in hitting performance regardless of whether they practiced with a 48 cm racket or a 68 cm racket. The lack of difference was possibly due to insufficient hitting opportunities during practice. Nonetheless, children who practiced with the 48 cm racket did display greater improvements in hitting technique (according to a checklist that described what a desirable forehand should look like).

Effect of equipment modification on implicit processes when executing a skill

Modifying tennis equipment was examined through the lens of implicit motor learning. Implicit motor learning refers to the acquisition of a motor skill with minimal conscious awareness of the step-by-step processes of how the skill is performed (Masters & Poolton, 2012). One method to encourage implicit motor learning is to reduce errors accumulated during practice. When errors are infrequent, the performer is less inclined to analyse their movements, as there is no error to correct (Maxwell, Masters, Kerr, & Weedon., 2001). It was therefore hypothesised that the modification of equipment to simply

skills would encourage a more implicit style of learning (Buszard, Farrow, Reid, & Masters, 2013). Whilst no research has examined implicit motor learning per se, it was observed that lesser skilled children maintained stable performance on a forehand task whilst simultaneously counting backwards when using modified equipment (Buszard, Farrow, Reid, & Masters, 2014). When using adult equipment, however, performance declined significantly. Consequently, it was concluded that the modification of sports equipment to simplify skills promotes implicit processes when executing a motor skill. Research needs to investigate whether the simplification of skills via equipment modification encourages implicit motor learning over a period of practice.

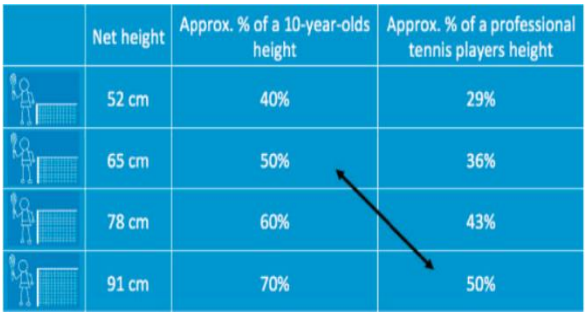
Identifying key variables to guide equipment modification

Whilst it is clear that modifying equipment simplifies the execution of skills and therefore leads to better performance, it unclear as to how equipment should be modified. For instance, should rackets be scaled based on a child's height? Or are other variables, such as grip size or strength, more relevant? Gagen, Haywood and Spaner, (2005) attempted to answer this question by asking children aged 4 to 10 years to strike a ball as hard as possible with four different rackets that varied in length and mass. To the authors' surprise, however, no physical characteristic predicted the optimal racket for each child. The optimal racket was defined as the racket that resulted in the ball being struck closest to the centre of the strings coupled with increased racket velocity.

Timmerman et al. (2015) investigated whether scaling the court size and net height based on racket-to-racket time (i.e., mean time between each player striking the ball) of a professional match would result in desirable matchplay performance. A racket-to-racket time ratio between a 10-year-old match and a professional match was calculated. This ratio was then used to scale court size and net height. Contrary to the authors' hypothesis, however, lowering the net height based on this ratio did not decrease racket-to-racket time, indicating that this rationale was not appropriate.

Recently net height scaling was also examined from the perspective of children's height. The standard net height is approximately 50% of a professional tennis player's height (see Figure 2). It was therefore hypothesised that 50% of a child's height would represent the optimal net height (Limpens, Buszard, Shoemaker, Savelsbergh, & Reid, unpublished). Results offered support for this hypothesis, with desirable matchplay characteristics emerging when the net height was approximately 40% and 50% of children's height. These included more first-serves in, more winners and more shots played from inside the baseline. Significantly, however, rally length was unrealistically short when the net height was closer to 40% of children's height.

Figure 2. Net height viewed as a percentage of a player's height. The average height of a 10 year old is compared with the average height or a professional tennis player (male and female combined). The standard net height is 50% of the average professional player's height. Limpens et al. (unpublished) hypothesised that the optimal net height for children would therefore be 50% of their height. For the average 10 year old, this equates to a 65 cm net height.



CONCLUSION

Studies consistently provide support for children playing tennis with modified equipment. For this research to advance, studies need to focus more on skill development, as opposed to merely performance. Understanding the effect of progressing through each stage of the Play and Stay pathway should be a key focus moving forward. More emphasis also needs to be placed on the measurement of motor skills. Specifically, the use of three-dimensional motion analysis software to measure movement kinematics will provide more compelling data regarding the effect of equipment on coordination. For instance, preliminary data from a recent study highlights the movement adaptations that take place when children use a 68 cm racket compared to a 53 cm racket. As expected, children adapted to the larger racket by choking the racket (i.e., holding the racket higher. on the grip) and swinging with reduced velocity – both of which are considered undesirable adaptations. The use of more sensitive measures of movement kinematics might also indicate a link, if one exists, between equipment and injuries. Finally, more attention needs to be directed towards the key variables to guide equipment modification, such as the ratio between physical characteristics and equipment size.

In summary, the Play and Stay campaign has inspired a large body of research on equipment modification, yet, more work remains if the tennis community is to reap the rewards from modifying the game.

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