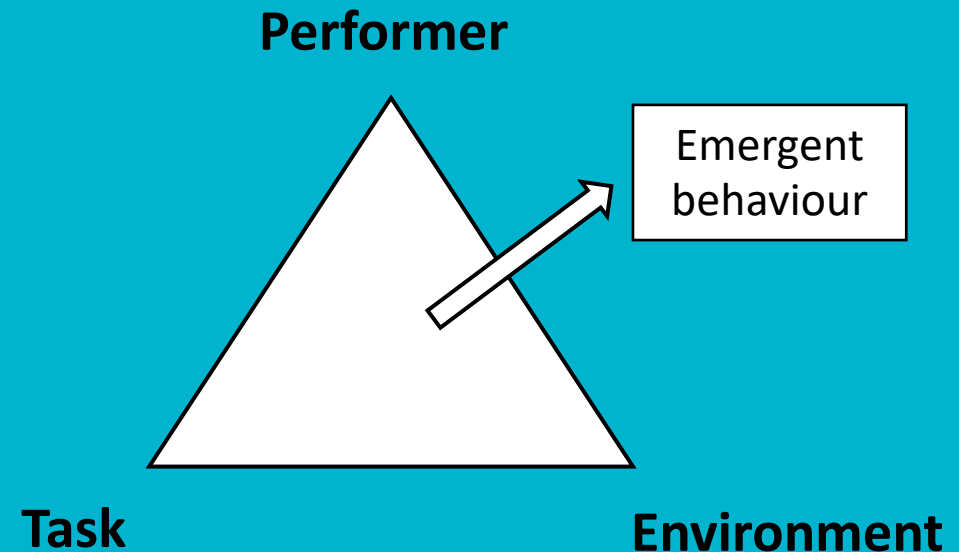# *SHU – Rouen Winter School*

Ecological Dynamics Workshop
- Constraints in Action

Tuesday 10th January 2023

Dr Anna Fitzpatrick

Lecturer in Sport Coaching and Elite Performance

Performer

Emergent behaviour

Task

Environment

This afternoon's workshop…

In this workshop, we are going to:

- Discuss the implications of manipulating constraints to improve safety in sport.

- Identify appropriate constraint manipulations to enhance skill development in a real-life coaching scenario.

- **Newell's (1986) constraints-led approach**

- Constraints are 'boundaries' that can **restrict** or **facilitate** the emergent behaviours of an athlete during a sporting contest (Davids et al., 2008).

- **Effective coaches** manipulate constraints to facilitate learning.

- **Performance analysts** can measure/quantify effects of constraints.

- Limbo challenge…

**Performer**

Perception

Emergent behaviour

Task   **Environment**   **Action**
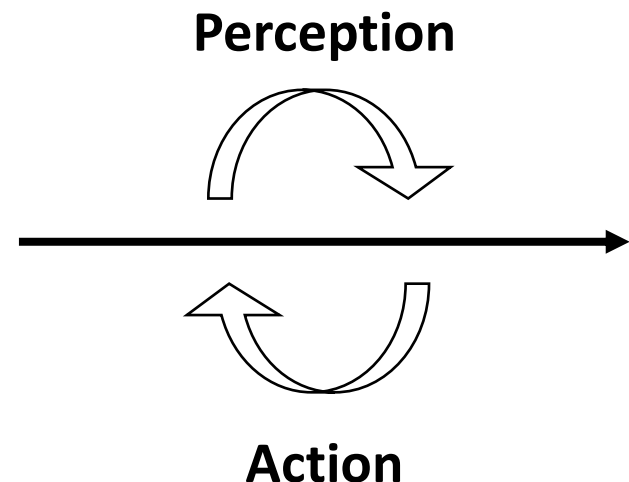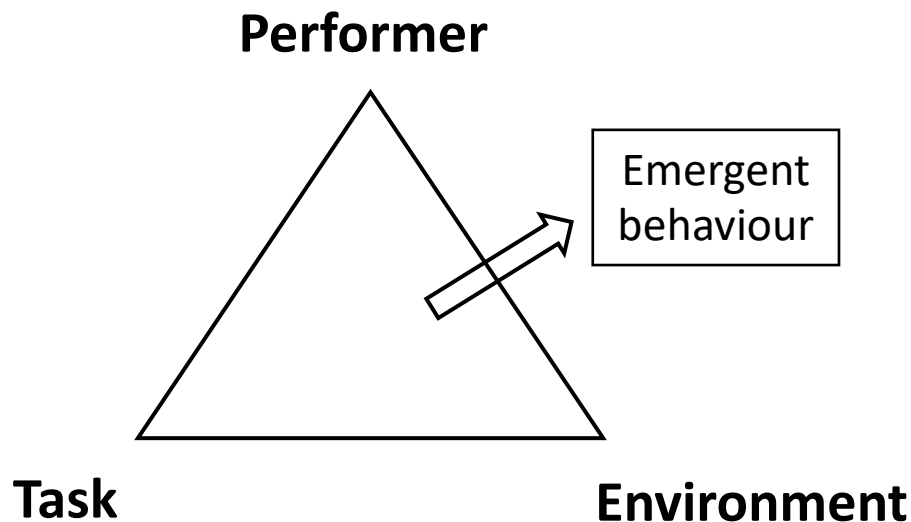
▸ American football: specially designed fiberglass helmets (hard shells) introduced due to high rates of concussion & traumatic brain injury.

▸ Aim: reduce injury prevalence & severity.

▸ What do you think happened - did it work?

1. Injury rates increased
2. Range of injuries increased

Why?!

Performer
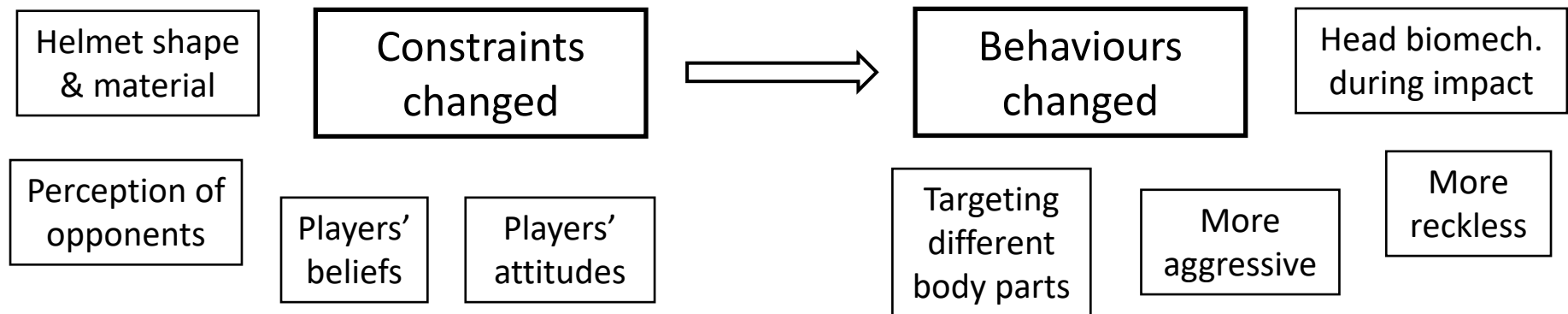
Emergent behaviour

Task   **Environment**
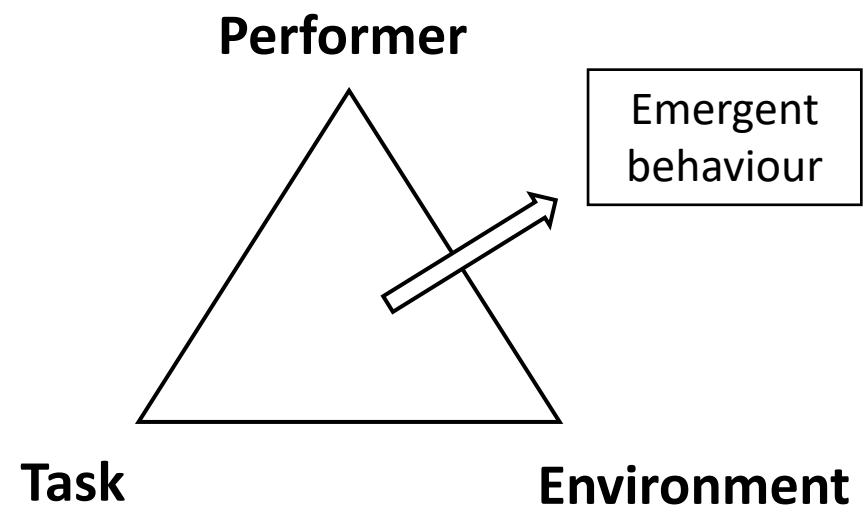
▸ Why might injury rates and the range of injuries have increased?

1. Redesigned helmet led to more neck & spinal cord injuries on impact.

2. False sense of security – players believed their heads were protected → tackled harder & went head-first into tackles.

3. Helmet was viewed as a weapon → players used it to attack/hit others.

4. Players perceived opponents' heads to be protected, so aimed their tackles elsewhere, leading to more torso and limb impact injuries.

Helmet shape & material	Constraints changed		Behaviours changed	Head biomech. during impact
Perception of opponents	Players' beliefs	Players' attitudes	Targeting different body parts	More aggressive
				More reckless

▸ Any constraint manipulations should:

◦ Encourage intentional effects & desirable behaviours.

◦ Avoid unintentional, contraindicated effects.
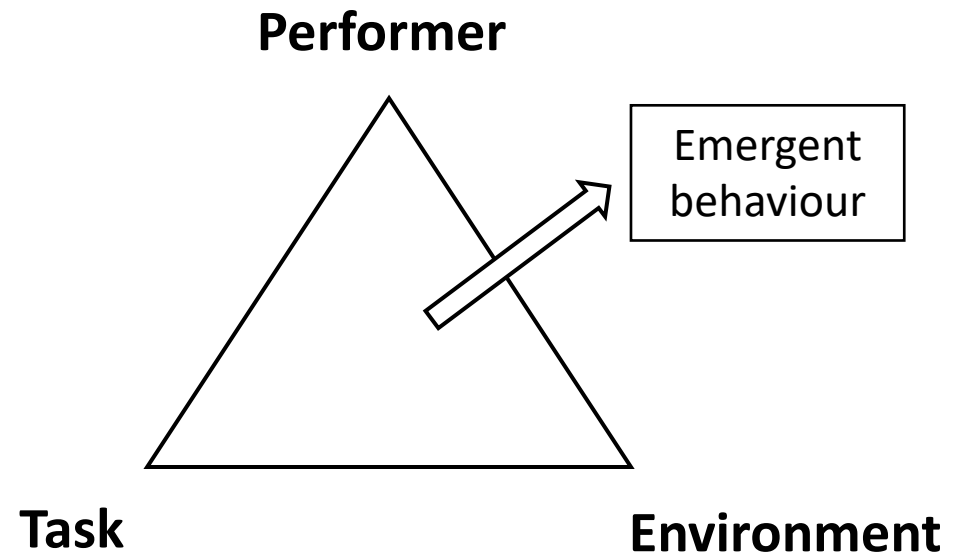
Performer

Emergent behaviour

Task   **Environment**

Fitzpatrick, Davids & Stone (2016)

Effects of Lawn Tennis Association mini tennis as task constraints on children's match-play characteristics

Anna Fitzpatrick[a], Keith Davids [b] and Joseph Antony Stone[a]

[a]Academy of Sport and Physical Activity, Sheffield Hallam University, Sheffield, UK; [b]Centre for Sports Engineering Research, Sheffield Hallam University, Sheffield, UK

ABSTRACT

The Lawn Tennis Association's mini tennis (MT) is a modified version of tennis consisting of progressive stages; however, there have been few attempts to evaluate how MT might shape performance behaviours. Here, we examine effects of playing MT on the emergence of children's match-play behaviours in 48 junior tennis players. Performance in 1010 match-play points were filmed and coded across 4 tennis stages (MT Red, MT Orange, MT Green and Full Ball), using a notational analysis system. Recorded performance variables included rally length, first serve percentage and shot type, for the purpose of analysing inter-stage comparisons. Results showed a series of specific adaptations to playing characteristics across the stages, including rally length, shot variety and serve success. MT Red rallies (7.36 ± 6.06) were longer than Full Ball rallies (3.83 ± 2.40), and a higher percentage of forehands were played at MT Red ($66.40 \pm 8.49\%$) than at Full Ball stage ($45.96 \pm 6.47\%$). Findings suggested that MT stages can afford children more opportunities to develop their skills and elicit different match-play characteristics than Full Ball task constraints. Coaches, therefore, should consider the nature of emergent adaptations when designing practice environments to facilitate learning in young tennis players.
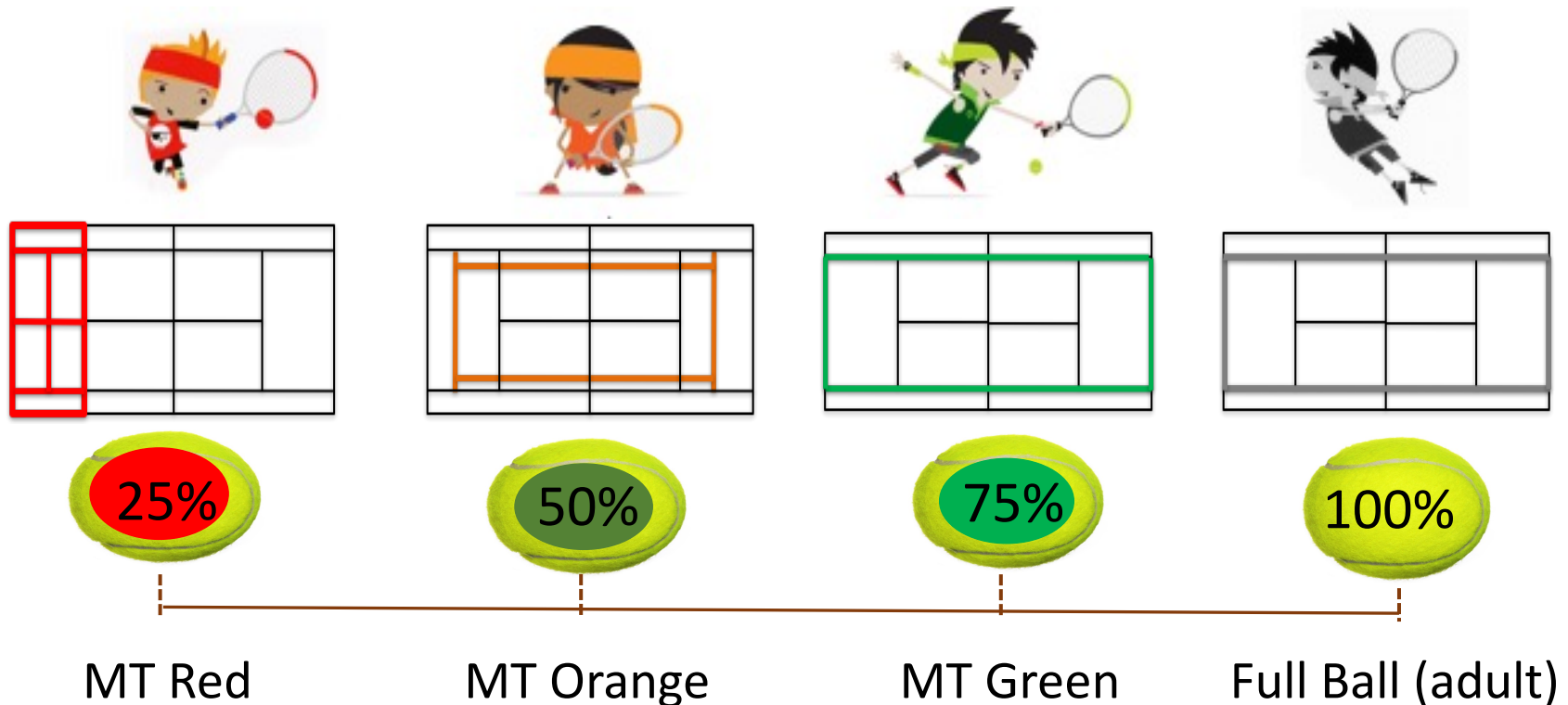
- Lawn Tennis Association (LTA) Mini Tennis (MT) is a modified version of tennis consisting of three progressive stages.

- Court dimensions, ball compression, racket size & scoring format (i.e., **constraints**) differ.

25%	50%	75%	100%
MT Red	MT Orange	MT Green	Full Ball (adult)

- To enhance children's skill development (i.e., learning).

- To reduce the speed of the game, such that children's emergent behaviours more closely resemble those of Full Ball (adult) tennis (Timmerman et al., 2015):

    - match-play behaviours

    - technique

BUT…

- No research investigating **combined** MT constraints.

- MT implemented based solely on rational argument & coaching opinion (Timmerman et al. 2015).

Study aims:

(i) To ascertain whether skill development is enhanced through MT.

(ii) To establish whether MT constraints elicit emergent behaviours that reflect those of adult tennis.

Method

- Over 1000 match-play points filmed across four tennis stages.

- Key Performance Indicators

    - Average rally length
    - Shot type (forehands and backhands)

Figure 1. Average rally length at each tennis stage
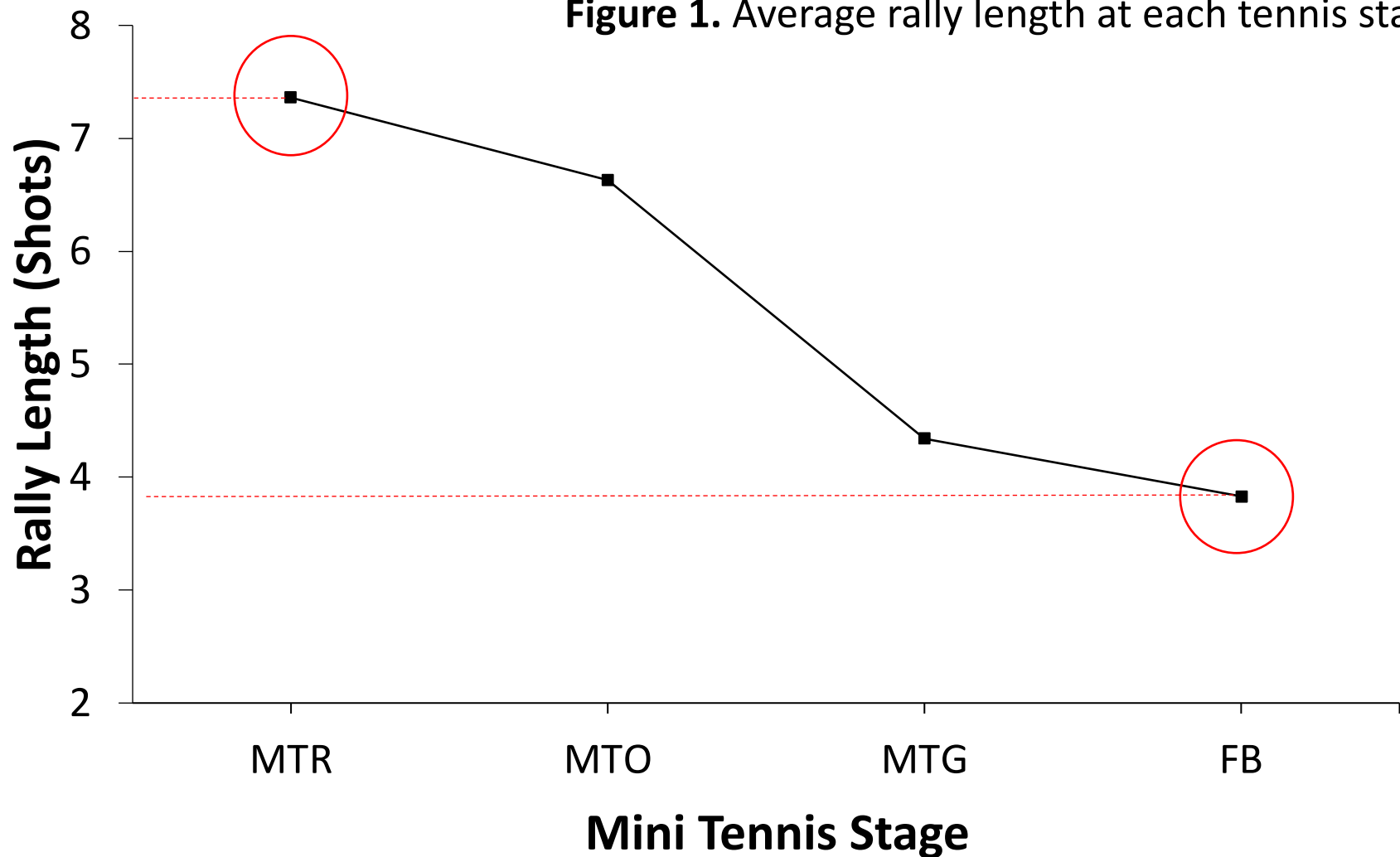
Key Results: Shot Type

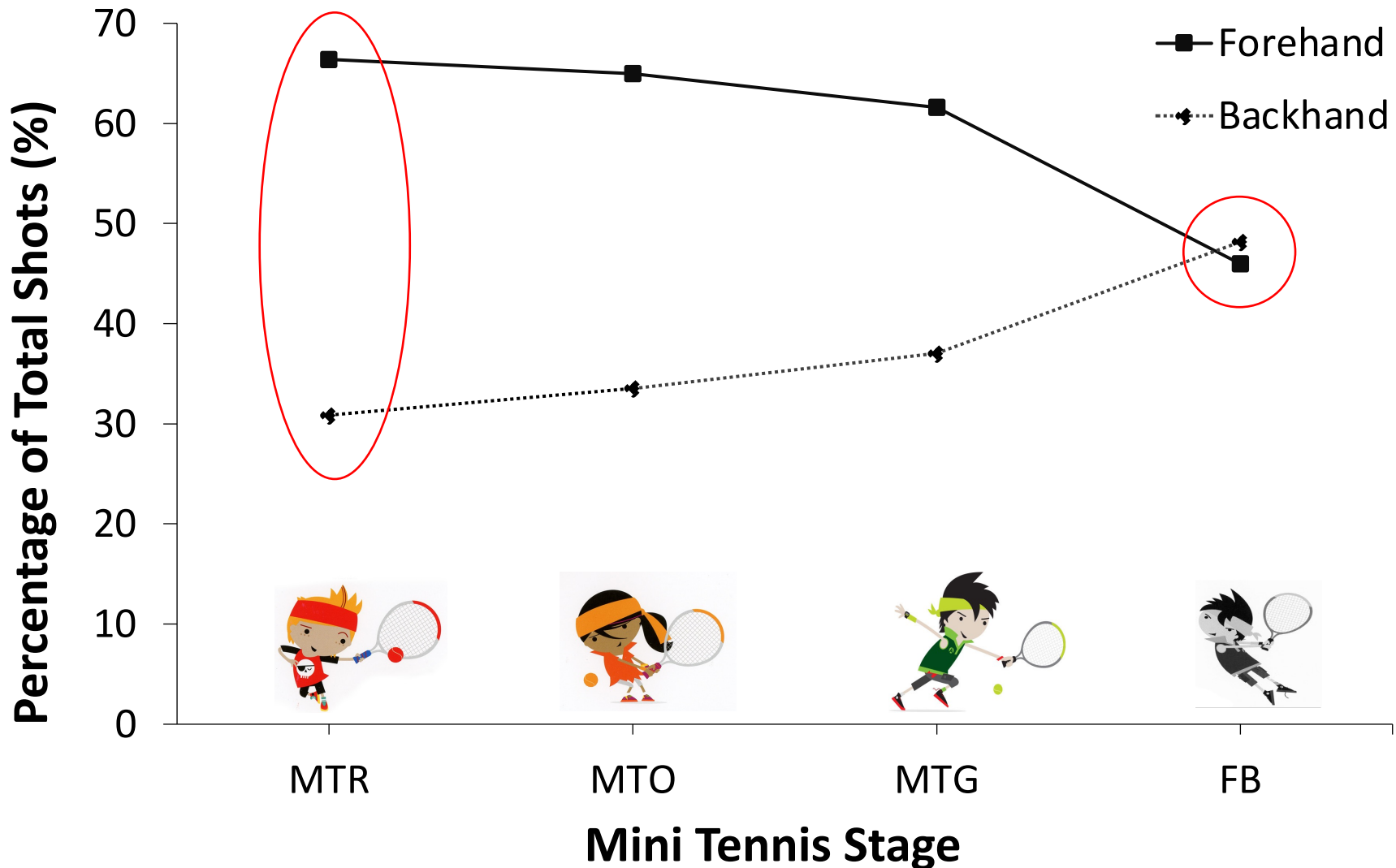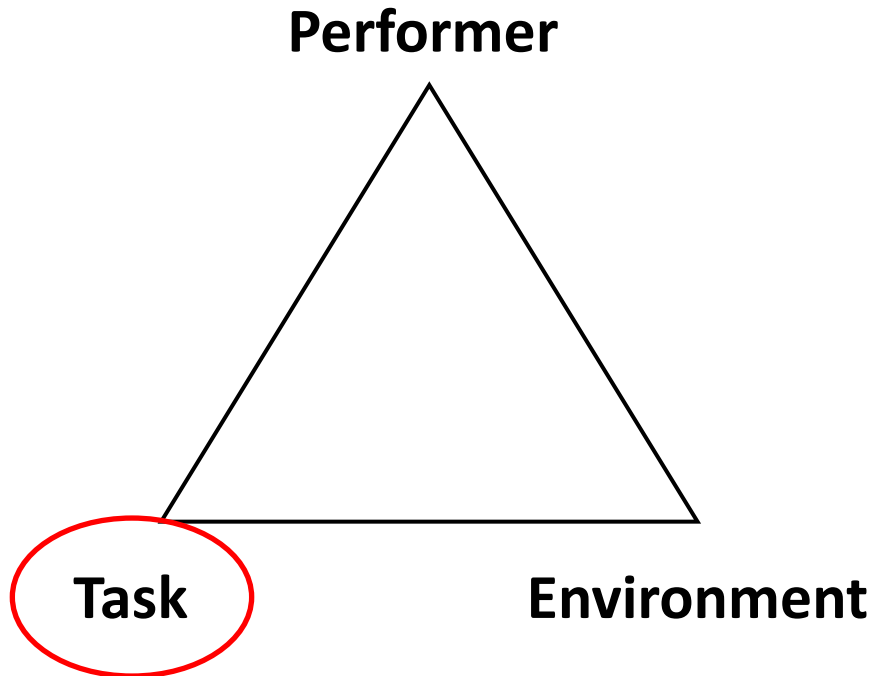**Figure 2.** Shot type breakdown at each tennis stage

Conclusion & Implications

- MT constraints afford children more opportunities to develop skills. ✅

- MT elicits different emergent behaviours compared to Full Ball – forehand/backhand asymmetry. ❌

- Implications?

Performer

Task

Environment

Types of task constraint manipulation:
- Change the space
- Change the rules
- Modify the equipment
- Practice organisation

- In small groups, design 3 constraints-based activities/adaptations that could be implemented during MT coaching sessions, to address the issues identified in Fitzpatrick et al. (2016).

- Encourage desirable behaviours.

- Avoid unintentional/contraindicated behaviours.

Mini Tennis Intervention

| Pre-test | → | 8-week intervention | → | Post-test |

- 1-hour coaching session per week for 8 weeks.

- 2 groups: same drills & activities for both groups throughout.

Activity	Duration (minutes)
Introduction and group warm-up	6
Skill practice 1	12
Skill practice 2	12
Competition/points-based activity	15
Fun, skill-based game	10
Cool down and session review	5

- **Three modifications:**

1) Adjusted centre lines

2) Adjusted recovery box

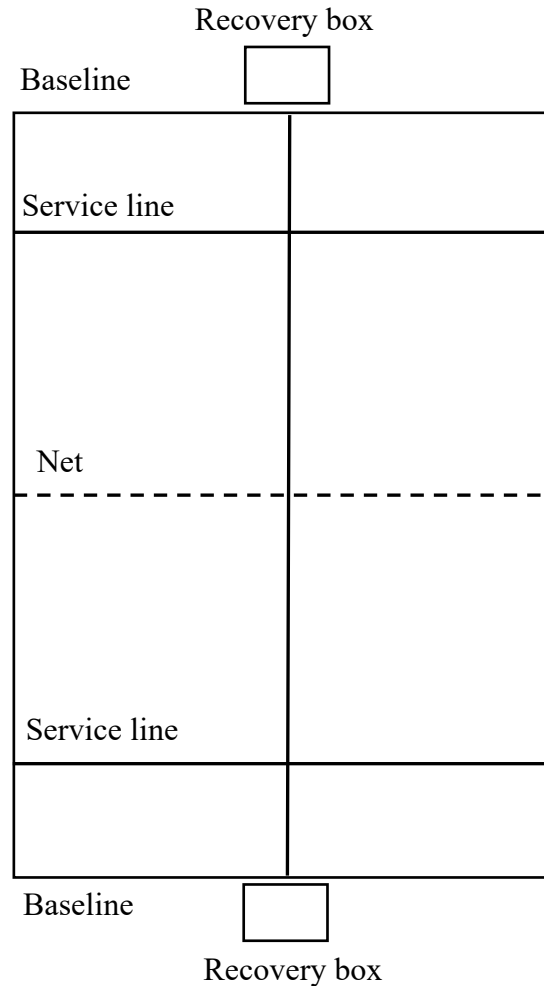3) Bonus points for causing a **perturbation** using the backhand

Recovery box

Baseline

Service line

Net

Service line

Baseline

Recovery box

Figure 1. Centre line and recovery box locations for control (left) and experimental group (right).

Data collected (KPIs) pre- and post-intervention:

- Shot type (percentage of forehands and backhands)

- Rally performance score (average rally length when rallying with the coach)

- Technical Proficiency Score (forehand & backhand)

  - 2 x independent coaches rated each player's technique.

  - Rate 4 aspects (score out of 7):
    (i) movement to the ball
    (ii) preparation and backswing
    (iii) forward swing and ball contact
    (iv) movement/recovery after shot

  - Result = two **technical proficiency scores** per participant, one for the forehand, one for the backhand (each out of 28).

Strokes hit per session…

- Control group played 117.0 (± 7.7) shots per session.

- Experimental group played 120.3 (± 8.3) shots per session.

- Why?

- No difference ($p > 0.05$), so post-intervention differences not attributable to differences in frequency of actions practiced.
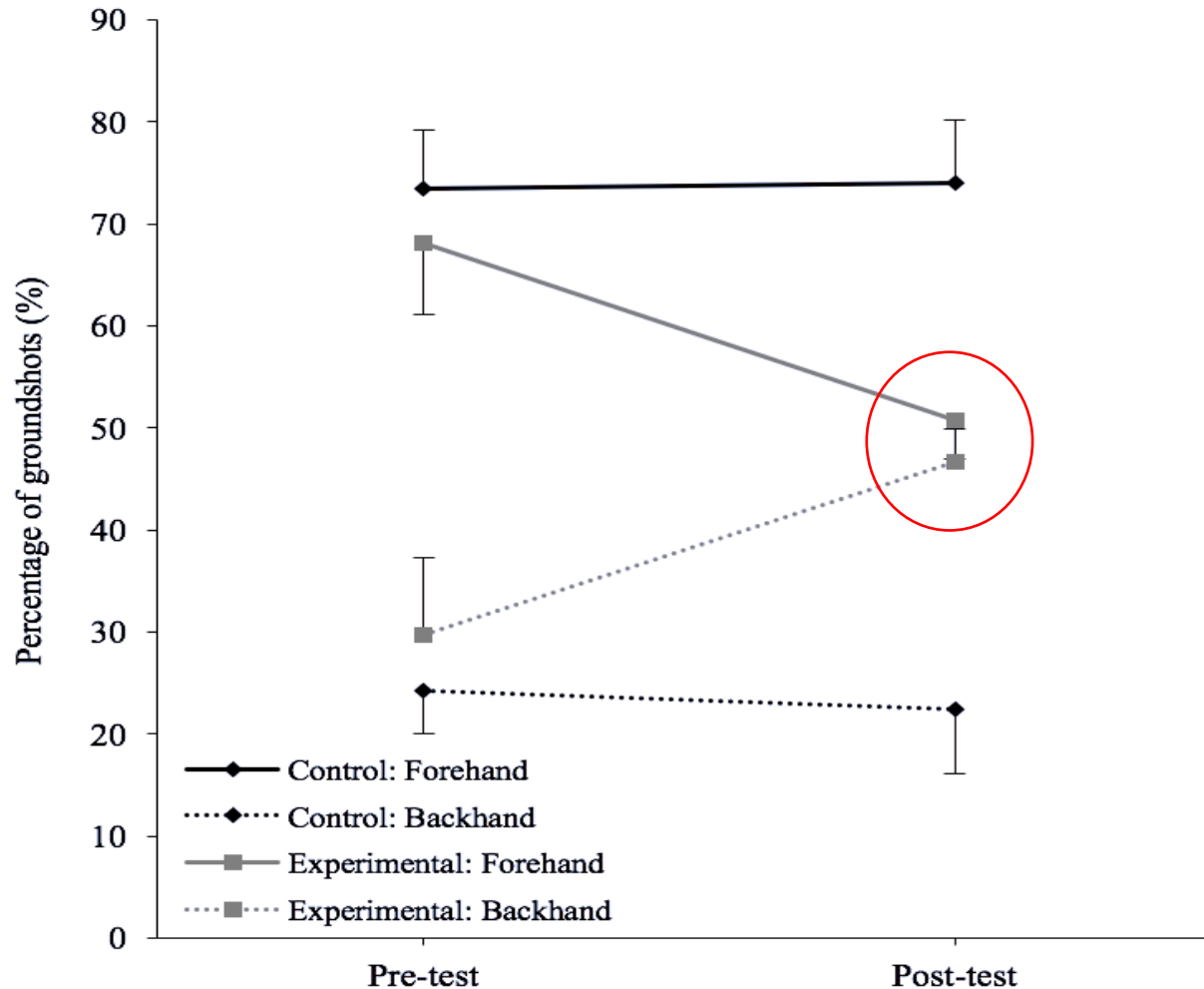
Figure 2. Percentage of forehands & backhands performed by each group during pre- & post-testing.

Results: Rally Performance Scores
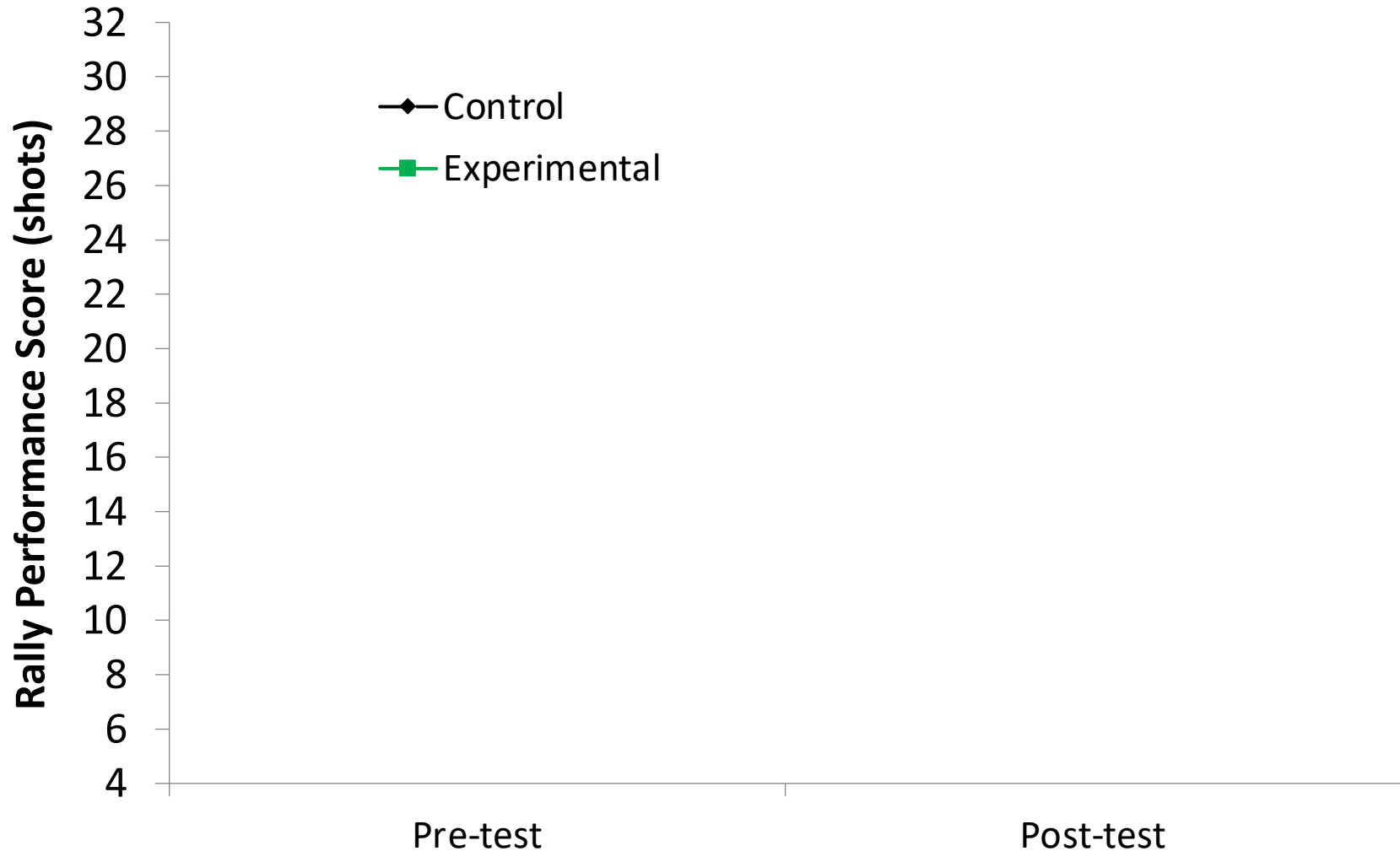

Figure 3. TSST rally performance scores for each group during pre- and post-testing.
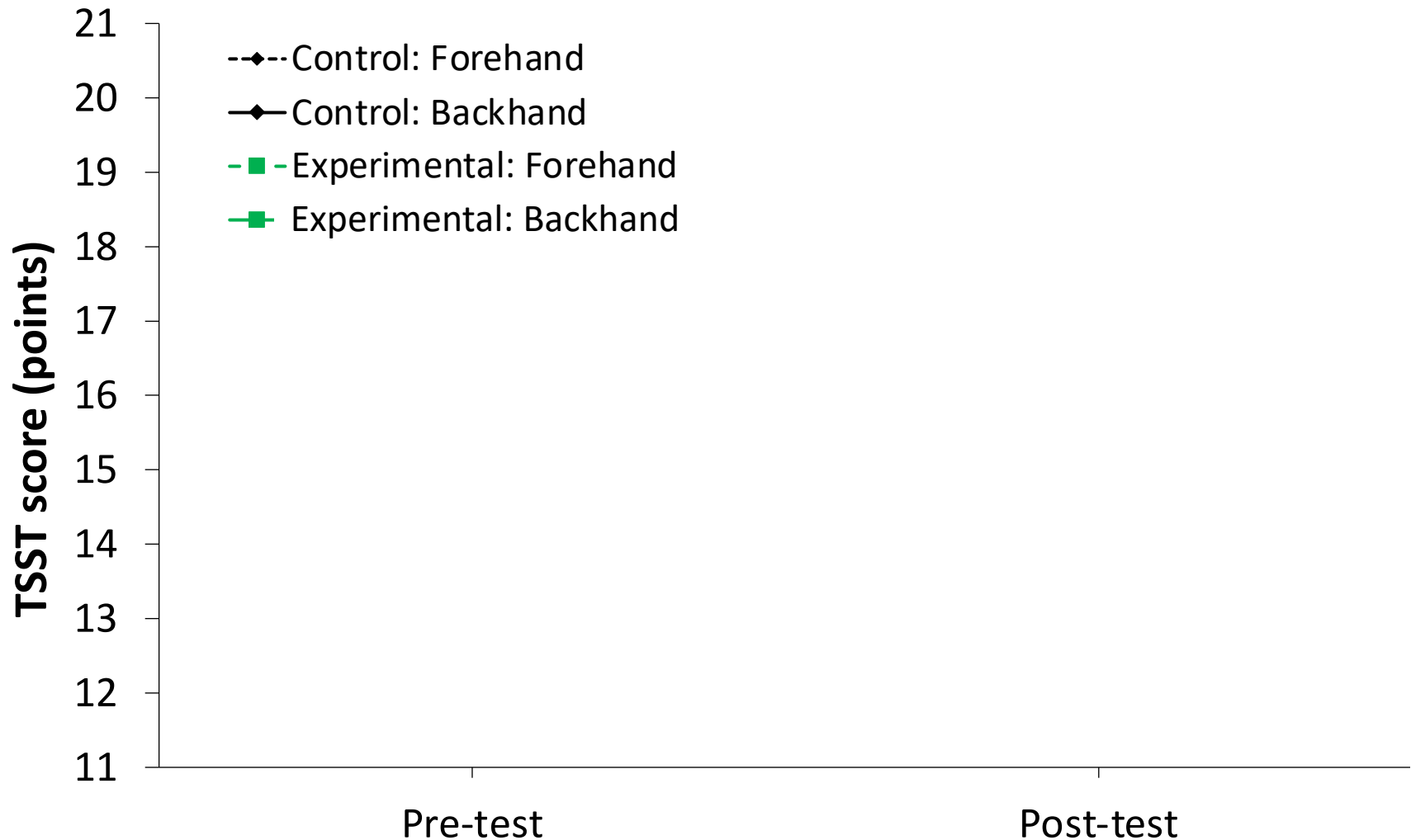
Figure 4. TSST technical proficiency scores for each group during pre- and post-testing.

Constraints Research Summary

- Intervention complemented MT constraints, alleviating the asymmetry between forehand & backhand performance.

- Experimental group showed improved rally ability, and enhanced forehand and backhand technical proficiency.

- Coaches may wish to implement similar modifications, to promote balanced shot development.

Any Questions?

▸ **Recommended YouTube video:** David Epstein Ted Talk: Are athletes really getting faster, better, stronger?

References

- Bernstein, N. A. (1967). *The co-ordination and regulation of movements*. Pergamon Press.

- Davids, K., Button, C., and Bennett, S. (2008). Dynamics of skill acquisition: A constraint-led approach. Human Kinetics.

- Fitzpatrick, A., Davids, K., and Stone, J. A. (2016). Effects of Lawn Tennis Association mini tennis as task constraints on children's match-play characteristics. *Journal of Sports Sciences, 35*(22), 2204-2210.

- Fitzpatrick, A., Davids, K., and Stone, J. A. (2018). Effects of scaling task constraints on emergent behaviours in children's racquet sports performance. *Human Movement Science, 58*, 80-87.

- Newell, K.M. (1986). Constraints on the development of coordination. In M. G. Wade & H. Whiting (Eds.), *Motor development in children: Aspects of coordination and control* (pp. 341-361). Martinus Nijhoff.