Abstract

Purpose: To examine responses to a simulated rugby league protocol designed to include more stochastic commands, and therefore require greater vigilance, than traditional team sport simulation protocols.

Methods: Eleven male university rugby players completed two trials (randomised and control) of a rugby league movement simulation protocol, separated by 7-10 days. The control trial (CON) consisted of 48 repeated ~115 s cycles of activity. The stochastic simulation (STOCH) was matched for the number and types of activity performed every 5.45 min in CON, but included no repeated cycles of activity. Movement using GPS, heart rate, RPE and Stroop test performance were assessed throughout. MVC peak torque, voluntary activation (%) and global task load were assessed after exercise.

Results: The mean mental demand of STOCH was higher than CON (Effect size (ES) = 0.56; ±0.69). Mean sprint speed was higher in STOCH (22.5 ± 1.4 vs. 21.6 ± 1.6 km·h^{-1}; ES = 0.50; ±0.55), which was accompanied by a higher RPE (14.3 ± 1.0 vs. 13.0 ± 1.4; ES = 0.87; ±0.67) and a greater number of errors in the Stroop Test (10.3 ± 2.5 vs. 9.3 ± 1.4 errors; ES = 0.65; ±0.83). MVC peak torque (CON = -48.4 ± 31.6 N·m, STOCH = -39.6 ± 36.6 N·m) and voluntary activation (CON = -8.3 ± 4.8%, STOCH = -6.0 ± 4.1%) was similarly reduced in both trials.

Conclusions: Providing more stochastic commands, which requires greater vigilance, might alter performance and associated physiological, perceptual and cognitive responses to team sport simulations.

Key Words: Team sports; vigilance; voluntary activation; attentional focus

Introduction

The use of team sport match simulation protocols in sports science research is now common. These protocols seek to negate the large variation (~15%) in running distance and intensity observed between matches,[1] which might otherwise mask meaningful changes in performance owing to an intervention. Furthermore, physiological and perceptual responses can be measured regularly in a controlled environment, which would not be feasible in competition. Accordingly, in rugby league, various iterations of the Rugby League Movement Simulation Protocol (RLMSP) have successfully been used to examine changes in performance.[2,3,4]

One aspect of competitive rugby league match play, which has often been excluded from simulation protocols, is the stochastic nature of performance. For example, the current interchange rugby league simulation protocol comprises repeated cycles of activity (115 s) lasting 46 min.[5] The use of short repeated cycles is common in team sport simulation protocols,[6,7,8] with few exceptions,[9] which is likely an attempt to maintain the consistency of performance in such activities.[5] However, preserving high internal validity and associated reliability might compromise the external validity of such protocols.[3]

The predictable and repetitive nature of current protocols compared to the stochastic nature of match play, which requires decisions to be made based on information retrieved from a dynamic environment, might influence exercise performance and associated physiological and perceptual responses in several ways. For example, with sustained vigilance during a repetitive activity, a 'zoning out' might occur causing disengagement from the task.[10] Task disengagement and reduced vigilance negatively affects decision making,[10] whilst maintaining vigilance is associated with a greater 'mental demand' (i.e. the amount of mental and perceptual activity required to complete a task, including thinking, deciding, calculating, and remembering).[11] Mentally demanding tasks not only cause mental fatigue after a rugby match,[12] but can also affect perceived exertion[13] and running performance.[14] Vigilance and associated task engagement might also cause an altered attentional focus,[10] which can alter perceived exertion[13] and performance.[15] Finally, the predictable nature of existing simulation protocols might result in a different pacing strategy to that observed in matches,[2,16] where players must regulate their exercise intensity whilst preserving the capacity to perform unpredictable periods of exercise at an intensity greater than the match average.[16]

To the best of our knowledge, the effects of a stochastic order of activity during simulated match play, compared to a conventional simulation comprising repeated cycles, are currently unknown. It is important to understand the extent to which making the required activity less predictable, and therefore increasing the requirement for vigilance, might alter an individual's response to such protocols if they are to be used in practice. Therefore, the purpose of the study was to investigate the effects of a stochastic order of activity on performance in, and physiological and perceptual responses to, the Rugby League Movement Simulation Protocol for Interchange Players (RLMSP-i).

Methods

Participants

Eleven male university rugby players (league and union; age = 21.2 ± 2.0 y, body mass = 80.5 ± 6.4 kg, stature = 1.80 ± 0.10 m, predicted maximal oxygen uptake [VO_{2max}] = 50.8 ± 3.8 $ml\cdot kg^{-1}\cdot min^{-1}$) completed the experiment. *A priori* calculations showed that a sample of at least 10 participants was required, [17] based on a smallest worthwhile change (Cohen's d = 0.2) of 0.23 $km\cdot h^{-1}$ for sprint performance and a typical error of 0.28 $km\cdot h^{-1}$ taken from an in-house reliability study. Participants provided written informed consent and completed a pre-test health questionnaire. Ethics approval was granted by the Faculty of Medicine, Dentistry and Life Sciences Research Ethics Committee, University of Chester (1011-15-TM-SES).

Design

After an initial baseline visit to predict VO_{2max} (using a progressive shuttle run test)[18] and habituate participants with all of the experimental procedures, each participant completed two trials of RLMSP-i,[5] separated by 7-10 days, in a randomised cross-over design. Trials were completed at the same time of day (± 2 h) and differed in that either the standard protocol (CON), or a protocol with a more stochastic series of commands (STOCH), was used. Participants were instructed to refrain from strenuous activity and avoid caffeine and alcohol in the 24 h before each trial. A self-reported food diary was recorded for the 48 hours immediately before trial one and replicated in the 48 hours before trial two. Participants began each trial in a similarly hydrated state (pre-exercise urine osmolality for CON = 615 ± 292 $mOsmol\cdot kg^{-1}$ and STOCH = 621 ± 303 $mOsmol\cdot kg^{-1}$).

Procedures

In the two trials, participants performed a standardised 10 min warm-up before performing the RLMSP-i on an artificial synthetic grass surface. Participants ran alone, following the instruction of an audio signal that dictated the speed and type of movement between various coloured cones. The RLMSP-i lasted 46 min, comprising two 23 min bouts separated by 20 min passive recovery. The CON trial comprised 24 repeated ~115 s cycles of activity.[5] In the STOCH protocol, the order of events was re-ordered to be non-cyclical and less predictable (but was the same for every participant), with no repeated 'cycles'. In an attempt to guarantee high and low-intensity actions were not 'bunched' in the STOCH protocol, we ensured that the number and type of each movement were identical for both protocols within each quartile of each bout (i.e. every 5.45 min; see Waldron et al.[5]). For example, this resulted in a range of 36.6 to 136 s between 20.5 m sprints in CON and between 26.83 to 95.19 s in STOCH. In both CON and STOCH, the required movements were dictated via a pre-recorded audio signal played through a sound system.

Throughout the RLMSP-i, participants were fitted with a GPS unit positioned between the scapulae (10 Hz MinimaxX S5, firmware 6.75, Catapult Innovations, Melbourne, Australia). The satellites available and horizontal dilution of precision (HDOP) for all testing visits ranged from 12 – 17 and 0.5 – 1.5 AU, respectively. Participants' heart rate (HR) was collected throughout the RLMSP-i using a HR monitor (Polar Electro Oy, Kempele, Finland) wirelessly connected to the GPS. GPS data were analysed for speed ($m \cdot min^{-1}$), low (<14 $km \cdot h^{-1}$) and high speed running (> 14 $km \cdot h^{-1}$), peak speed, sprint to contact speed, PlayerLoad^{TM} (AU) and time at high metabolic power >20 $W \cdot kg^{-1}$ (s). In a separate in-house investigation, using a sample of $n = 20$ university rugby players, the inter-day coefficient of variation (CV %) was determined for each movement variable and ranged from 1.4 – 6.5%.

Blood was analysed for lactate concentration (B[La]; Lactate Pro, Arkray, Japan) from a fingertip capillary sample 5 min before and immediately after the first and second bout of the RLMSP-i (typical error = 1.15 $mmol \cdot l^{-1}$). Participants' rating of perceived exertion (RPE, 6-20 scale; Borg, 1985) was recorded every quartile (5.45 min) of the first and second bout during each trial. A global RPE for the session (*s*RPE, 0-10 scale) was recorded within 20 min of completing each trial. Cognitive function was assessed using a commercially available Stroop Test application on a tablet computer (EncephalApp Stroop)[19] 5 min before and immediately after the first and second bouts of the RLMSP-i, which required participants to react 80 times as quickly as possible by touching the corresponding colour at the bottom of the screen to various coloured words (red, blue and green). Typical error of measurement was calculated as 5.56 s and 1.65 for Stroop test time and errors, respectively.

Isometric force and voluntary activation of the knee extensors in the dominant leg were measured using a dynamometer before and 15 min after the RLMSP-i (Biodex 3, Biodex Medical Sytems, Shirley, NY, USA). Participants sat in an upright position with 90° flexion in the hip and knee; straps were tightly secured across the thorax and hip to minimise extraneous body movements from the dynamometer. Participants performed four MVCs (each 4 s duration) with 2 min rest between efforts. Force output was A/D converted at a sampling frequency of 1,000 Hz (AcqKnowledge III, Biopac Systems, Massachusetts). Transcutaneous electrical stimulation of the quadriceps muscle was delivered using a constant-current stimulator (Digitimer DS7, Hertfordshire, UK) to determine voluntary activation. Two rectangle self-adhesive surface electrodes (5 × 13 cm; Axelgaard Manufacturing Co. Ltd., Lystrup, Denmark) were applied distally and proximally across the knee extensors. The outline of both electrodes was drawn on to the skin using a permanent marker to minimise variability of electrode placement between sessions. Paired electrical stimuli (100 Hz; at 20% above the amperage required for pre-determined peak twitch torque) were delivered to the relaxed muscle pre-contraction (control twitch), and 3 s into the MVC (superimposed twitch). Voluntary activation (VA%) was calculated as a ratio of the superimposed twitch relative to the twitch response of the relaxed muscle (1- [superimposed twitch/control twitch] ×100). Peak MVC from the 4 contractions was calculated as the mean torque 50 ms before the superimposed stimulation delivery. In-house typical error of measurement was 10.8 $N \cdot m$ and 1.64 % for MVC and VA%, respectively.

Subjective task load was measured ~20 min after each trial of the RLMSP-i using the National Aeronautics and Space Administration Task Load Index (NASA-TLX). Participants rated six subscales of task load (mental demand, physical demand, temporal demand, frustration, effort, and performance). Each subscale was presented as a 10 cm line with visual anchors at either end (e.g. low/high), corresponding to an unseen numerical scale from 0-100 AU. A weighted scoring of the six subscales was ascertained using 15 pairwise comparisons between each subscale (e.g. mental demand vs. effort). Participants were instructed to circle the descriptor that represents the most important contributor to task load during the RLMSP-i. The weighted score corresponded to the number of times each subscale is selected as being the most important contributor to global task load. A task load (weighted rating) score was then calculated by multiplying the weighted score by the rated score for each individual subscale.

Statistical Analysis

All data are reported as means ± SD. Changes in dependent variables were analysed using effect sizes and 95% confidence intervals (ES; ±confidence interval). In using this approach, the reader can interpret our results in terms of traditional statistical significance should they wish to (i.e. if our confidence interval crosses 0, then $P \geq 0.05$), or as a 'compatibility interval' (i.e. the range of values compatible with our data that would not be deemed different to our observed effect at the 0.05 level). We interpreted our data based on the magnitude of the observed change between trials, calculated as the mean difference between trials divided by the pooled SD of trials, and considered as: small ≥ 0.2, moderate ≥ 0.6 and large ≥ 1.2. We considered a substantial effect to be any ES ≥ 0.2 or ≤ -0.2, with a confidence interval that did not cross *both* ES -0.2 and 0.2. Effects were considered to be unclear when the 95% confidence interval crossed both substantially positive and negative effects. The above calculations were completed using a predesigned spreadsheet.[17]

Results

The mean speed was higher during the STOCH trial over the entire simulation. Differences between trials were unclear for low intensity distance, high intensity distance, sprint to contact speed, PlayerLoad^{TM} and high metabolic power (see Table 1). Similarly, differences between trials across bout quartiles for speed, high speed running and sprint to contact speed across the protocol were generally unclear (Figure 1A, B and C). However, for mean sprint speed (that is, the mean of the peak speed attained in each sprint), there was a mean increase in the STOCH trial compared to the CON across all quartiles of the protocol (Figure 1D).

************Insert Table 1 about here************

************Insert Figure 1 about here************

Physiological and perceptual responses to the trials are shown in Table 2. Unclear differences were observed between trials in %HR$_{max}$ across the entire protocol (ES = 0.15; ±0.38). After the first and second bout, blood lactate concentration increased less after the STOCH compared to the CON trial. Participants reported higher average RPE (ES = 0.87; ±0.67) and *s*RPE (ES = 0.52; ±0.60) after the STOCH protocol.

************Insert Table 2 about here************

The reduction in isometric knee-extensor torque after exercise was small for the CON (-48.4 ± 31.6 N·m, ES = 0.56; ±0.25) and STOCH (-39.6 ± 36.6 N·m, ES = 0.48; ±0.30). Accordingly, the difference in post-exercise knee extensor peak torque between trials was unclear (CON = 282.7 ± 80.7 N·m, STOCH = 279.0 ± 66.7 N·m; ES = 0.04; ±0.19). Voluntary activation (VA%) decreased after exercise in both the CON (-8.3 ± 4.8%; ES = 0.95; ±0.68) and STOCH (-6.0 ± 4.1%; ES = 1.23; ±1.04) protocols (Table 2).

The time taken to complete the Stroop test after STOCH (75.0 ± 4.3 s) was higher than CON (72.2 ± 4.3 s) (ES = 0.59; ±0.62). The total number of attempts required to complete the task was higher (ES = 0.65; ±0.83) after the STOCH (10.3 ± 2.5) compared to the CON trial (9.3 ± 1.4; Table 3).

************Insert Table 3 about here************

Total task load score was higher (ES = 0.25; ±0.38) in the STOCH (67.1 ± 9.8 AU) compared to the CON trial (61.9 ± 19.2 AU). Differences in task load subscales were unclear between trials, with the exception of mental demand, where a small increase in the STOCH trial was observed (ES = 0.56; ±0.69; Figure 2).

************Insert Figure 2 about here************

Discussion

This is the first study to seek to manipulate and quantify the mental demands associated with simulated rugby activity. Our data shows that having more unpredictable movement commands than those traditionally used in team sport simulations might result in a small increase in how mentally demanding the exercise is perceived to be. This would be consistent with observations that repetitive[20] and learnable actions[21] necessitating less vigilance require fewer attentional resources and result in lower mental fatigue.[22] As such, the unpredictable order of events employed in the STOCH trial might have increased vigilance requirements for participants to respond correctly to the upcoming audio command. Greater mental demands also occur when uncertainty of a signal's origin (in this case the nature of the command) is increased,[22] which results in a greater 'vigilance decrement' (i.e. a decrement in information processing and resulting cognitive performance). The observation here that elements of Stroop test performance were worse in the STOCH trial would support such a notion. Given that we observed a small effect with confidence intervals that incorporate zero, we encourage other researchers to examine the vigilance requirements of team sport simulations to determine whether mental demands are indeed affected. Future studies might also explore whether cognitive function that more closely replicates match-like actions (e.g. decision making for skill execution) is influenced by the degree of mental demand associated with simulated match activity.

RPE is a key determinant of performance and fatigue in team sports such as rugby.[3] The potentially higher mental demand associated with the modified RLMSP-i might explain the observed increase in state and session RPE in the

STOCH trial. RPE is informed by numerous afferent and efferent factors,[16] including the cognitive demands of a task.[23] Indeed, McLaren et al.[24] recently demonstrated that cognitive RPE explained a significant proportion of variance in session RPE reported during rugby conditioning sessions. However, others have reported no difference in RPE when performing a mentally demanding task during exercise;[25] additional explanations for the observed increase in RPE are therefore needed.

The greater vigilance required to correctly respond to the commands in the STOCH trial potentially resulted in participants adopting a greater associative attentional focus (i.e. participants' attention was directed toward pertinent information associated with completing the RLMSP-i, such as sprinting to the correct cone).[10] If true, this could explain the higher RPE *and* increased sprint performance in the STOCH trial. Task association can increase RPE relative to task dissociation,[26] due to a greater internal focal awareness of physiological sensations. Furthermore, task association, particularly when it is external (where attention is focussed on completing the outcome of the task rather than the bodily movements required and associated physiological responses), can enhance performance across a variety of exercise tasks, such as maximal force production, vertical jumping, sprinting and endurance exercise.[15] An alternative explanation for our observations of altered performance is that the CON trial induced more boredom, which has can negatively affect exercise intensity [27]. However, a limitation of our research is that we did not assess attentional focus or boredom, and therefore such a mechanism for our observations is speculative. Further research should explore the influence of attentional focus on simulated team sport performance with differing mental demands.

Afferent feedback from multiple physiological systems is thought to influence RPE,[16] and both heart rate and B[La] are related to athletes' RPE during small-sided games.[28] In the present study, %HRmax was not different between trials, and is therefore unlikely to have resulted in a higher RPE. The lower B[La] in the STOCH trial might be expected to be associated with a lower RPE. However, the reliability of B[La] measured during the RLMSP-i is poorer than other measures (CV% = 13.4 – 19.7%; interchange bout 1 and 2, respectively). It is also well established that work performed immediately before sampling influences blood lactate concentrations.[29] After the final maximal intensity effort (20 m maximal sprint and 8 m sprint to contact), there was 1.11 min and 0.26 min until the end of the protocol for CON and STOCH, respectively. Given that participants seemingly have an increased external load during STOCH (i.e. sprinting faster and covering more distance), the higher blood lactate concentration during CON is likely to reflect the movement activity before sampling rather than an overall increase in exercise intensity (which might increase in RPE).

For the first time, this study assessed changes in MVC and VA% after a simulated rugby league match. The proportional decrease in MVC and VA% response was similar after the STOCH (12 and 7%, respectively) and CON (14 and 9%, respectively) trials. The MVC response is comparable to the mean values reported for rugby league players immediately (8 ± 11%) and two hours after competitive match play (12 ± 13%).[30] However, Duffield et al.[30] reported no difference in VA% when comparing baseline (90.1 ± 6.7%) to immediately (-0.4%) and two hours (-0.8 %) after match play. These disparities in VA% reported after actual and simulated rugby league match play might be due to procedural differences, such as stimulation site, stimulation frequency, the exercise intensity of the RLMSP-i and participant training status.[31] It is also possible that the greater amount of high intensity running in the current protocol (~1230 m) compared to that reported by Duffield et al.[30] (~877 m), induced a greater degree of central fatigue. Nonetheless, the observed decrement in VA% in STOCH (-6.5%) and CON (-9.1%) trials of the RLMSP-i when compared to baseline (92.9 ± 4.5% and 91.3 ± 8.1%, respectively), suggest reductions in force generating capacity of the knee extensors after movements replicating rugby league match play are due to both central and peripheral mechanisms.[16]

The similar neuromuscular response to both conditions is consistent with research reporting no difference in both MVC and VA% after periods of mental exertion.[32] Unlike the negative effects of mental fatigue on endurance performance,[33] mental fatigue seemingly does not impair maximal force production over a short duration.[32] This might explain why greater maximal sprints occurred in the stochastic protocol, despite the small potential increase in mental demand.

The present study has several limitations that should be acknowledged. As we previously stated, the proposed mechanism of the STOCH trial being affected by task association is speculative and would have benefited from a direct attempt to assess attentional focus. However, these methods are associated with numerous threats to validity.[34] Secondly, whilst we endeavoured to ensure that the number, type and relative spacing of demanding activities – such as sprinting - were as well-matched between protocols as feasible, it cannot be discounted that the activity performed immediately before and after demanding activities influenced their outcome. Whilst this, in itself, is a notable outcome of this research, future studies might wish to explore the extent to which this, rather than altered mental demands for example, affects simulated team sport performance. Thirdly, we acknowledge that the new STOCH protocol, which does not have short (~115 s) repeated cycles of activity, cannot be used to compare performance between distinct small time periods (for example, changes across 2 min periods), given that no two short periods will be the same. However, given that we have matched the number and frequency of commands for each ~5.45 min, we feel that changes over approximately 5 min can be explored with the STOCH protocol. **Finally, we acknowledge that some of our observed effects have confidence intervals that contain zero or the interval demarcating a 'trivial' effect (i.e. ES = -0.2 to 0.2). As such, we encourage researchers to replicate and/or extend our investigation to clarify if more stochastic simulation protocols do indeed change perceived mental demands and elements of running performance.**

Practical Implications

- Those designing team sport simulation protocols should note that physiological, perceptual and performance responses can be influenced by the order of events that are performed. Such differences might have important implications for the validity of team sports protocols.

- More repetitive movement patterns, which require less vigilance, might reduce repeated sprint performance in team sports protocols. We propose that less predictable movements be used when seeking to maximise external work in players.
- These findings also have implications for those seeking to replicate the movement and mental demands of match play in training situations and promote the use of practices that employ stochastic rather than repetitive movements, e.g. small-sided games.

Conclusions

Manipulating the order of events to be more stochastic during a simulation of rugby league match-play potentially increases the mental demand of this activity, which appeared to be associated with increased self-paced sprint performance, impaired decision making capacity and increased perceived exertion. Accordingly, when simulating match play, the cognitive demand and vigilance requirement associated with the task should be considered. Investigations into the mental demands of competitive rugby league match play are needed, such that valid training and research replications of match demands can be made.

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Tables

Table 1. Speed, low intensity activity (<14 km·h^{-1}), high intensity running (≥14 km·h^{-1}), mean sprint speed, player load and time at high metabolic power for control and random trials during the whole simulation. Mean ± SD, Effect Size (± 95% CI)

	Trial		**ES (95% CI)**
	CON	**STOCH**	
Speed (m·min^{-1})	104.0 ± 5.1	105.5 ± 4.0	0.26 (0.44)
Low (m·min^{-1})	77.0 ± 3.9	77.8 ± 3.8	0.19 (0.80)
High (m·min^{-1})	26.7 ± 4.9	27.7 ± 4.3	0.19 (0.68)
Sprint to Contact (km·h^{-1})	13.2 ± 1.4	13.5 ± 1.1	0.17 (0.48)
Sprint Speed (km·h^{-1})	21.6 ± 1.6	22.5 ± 1.4	0.50 (0.55)
PlayerLoad^{TM} (AU)	459 ± 52	450 ± 47	0.17 (0.53)
Metabolic Power >20 W·kg^{-1} (s)	246 ± 40.2	252 ± 48	0.11 (0.63)

Low = low intensity activity, <14 km·h^{-1}; High = distance covered high speed running, ≥ 14km·h^{-1} per minute; Sprint to Contact = maximum speed achieved during the 8 m sprint to contact; Sprint Speed = an average of the maximum speed during each 20 m sprint.

Table 2. Physiological, perceptual and neuromuscular responses to the RLMSP-i. Mean ± SD, effect size (± 95% CI).

	Trial		**ES**
	CON	**STOCH**	**(95% CI)**
%HR$_{max}$	83.1 ± 7.2	81.9 ± 3.9	0.15 (0.38)
B[La] (mmol·l^{-1})			
- Pre	2.5 ± 1.1	2.6 ± 0.7	0.10 (0.64)
- Mid	6.0 ± 2.5	4.9 ± 1.9	0.40 (0.39)
- Post	5.9 ± 2.7	5.1 ± 5.9	0.28 (0.39)
RPE	13.0 ± 1.4	14.3 ± 1.0	0.87 (0.67)
*s*RPE	5.5 ± 1.8	6.5 ± 1.3	0.52 (0.60)
Peak torque (N·m)			
- Pre	331.1 ± 79.9	318.6 ± 76.3	0.56 (0.30) &
- Post	282.7 ± 80.7	279.0 ± 66.8	0.48 (0.25)*
VA (%)			
- Pre	91.3 ± 8.1	92.9 ± 4.5	0.95 (0.68) &
- Post	83.0 ± 8.0	86.9 ± 7.4	1.23 (1.04)*

%HRmax = percentage of heart rate maximum; RPE = rating of perceived exertion; sRPE = session rating of perceived exertion. VA = voluntary activation. * Refers to the pre-post change for CON and STOCH, respectively.

Table 3. Reaction time and accuracy during the Stroop test for control and random trials, Mean ± SD, Effect Size (± 95% CI).

	Trial		ES (95% CI)
	CON	**STOCH**	
ST - Time (s)			
Pre	75.6 ± 5.3	76.9 ± 5.8	0.21 (0.71)
Mid	73.6 ± 7.3	73.2 ± 6.5	0.06 (0.49)
Post	72.2 ± 4.3	75.0 ± 4.3	0.59 (0.62)
Total	221.5 ± 15.1	225.1 ± 14.5	0.22 (0.49)
ST - Attempts (*n*)			
Pre	9.5 ± 1.6	10.4 ± 3.2	0.51 (0.77)
Mid	9.7 ± 2.0	9.3 ± 1.3	0.21 (0.56)
Post	9.3 ± 1.4	10.3 ± 2.5	0.65 (0.83)
Total	28.5 ± 4.4	29.9 ± 6.5	0.30 (0.54)

ST-time = Stroop test reaction time; ST-attempts = Stroop test number of attempts.

Figure Captions

Figure 1. A) speed, B) high speed running, C) sprint to contact speed and D) sprint speed during the RLMSP-i trials. Mean ± SD, with ES; ±95% CI.

Figure 2. NASA-Task Load Index weighted rating of the six subscales. MD = mental demand; PD = physical demand; TD = temporal demand; P = performance; E = effort; F = frustration. Mean (dark line) with individual plots (circles), ES; ±95% CI.