THE EFFECTS OF CARBOHYDRATE AND CAFFEINE ON SELF-PACED INTERMITTENT EXERCISE

By

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A Research Project submitted in partial fulfilment of the requirements of the University of Chester for the degree of M.Sc. Sports Sciences (Nutrition)

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Abstract ii

The aim of this study was to examine the effect of adding caffeine to a carbohydrate electrolyte drink during a modified Loughborough Intermittent Shuttle Test (LIST), which incorporates an element of self-pacing (Part B). Ten recreationally active (age 21.8 ± 1.5 years, stature 183.9 ± 5.5 cm, mass 86.1 ± 5.9 kg, estimated VO_{2max} 48.5 ± 3.4 ml/kg·min^{-1}) team sport players performed three trials of the modified LIST. Each participant performed the LIST (single blind) after ingesting carbohydrate (CHO, 6.4 %) only, caffeine (CAF, 4 mg/kg/BM) only, or carbohydrate with caffeine (CHO+CAF, 6.4 % + 4 mg/kg/BM) in a volume of 5 ml/kg/BM one hour prior to testing and 2 ml/kg/BM after every 15 minute block. Movement demands and heart rate were measured using GPS, with physiological (Countermovement jumps, Blood lactate) and perceptual (RPE, gut fullness) measures being taken throughout. Analysis indicated no significant differences between trials ($P > 0.05$) therefore, effect sizes (Cohen, 1977) were used to detect possible differences between variables. During block 6, participants covered more distance ($d = 1.60$), sprinted faster ($d = 0.23$), and had a faster average speed ($d = 0.48$) in the CHO+CAF trial as opposed to the CHO trial ($P > 0.05$). Participants clearly engaged in separate pacing profiles throughout both parts of the LIST. Although effect sizes indicated some notable differences, it was concluded that the addition of CAF to CHO did not provide any significant ($P < 0.05$) ergogenic benefits compared with ingestion of CAF or CHO alone.

Declaration iii

No portion of the work referred to in this Research Project has been submitted in support of an application for another degree or qualification of this, or any other University or institute of learning.

The project was supervised by a member of academic staff, but is essentially the work of the author.

Oliver Davidson

Signed …….

Date ……

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Abbreviations

CHO = Carbohydrate (6.4 %).

CAF = Caffeine (4 mg/kg/BM).

CHO+CAF = Carbohydrate (6.4 %) with caffeine (4 mg/kg/BM).

***d* =** Effect size (Cohen, 1977).

Δ = Mean change between two variables.

LIST= Loughborough Intermittent Shuttle Test

BM = Body mass

The effects of carbohydrate and caffeine on self-paced intermittent exercise

1. Introduction

Various team games such as basketball, soccer and rugby are intermittent in nature, including periods of high intensity exercise (1-7 seconds) interspersed with periods of incomplete recovery over an extended period (60-90 minutes; Bangsbo, 2000; Cunniffe, Proctor, Baker, & Davies, 2009; Spencer, Bishop, & Lawrence, 2004). Within these sports, players often perform numerous bursts of explosive movements including sprinting, jumping, changing direction as well as altering of their pace (Stolen, Chamari, Castagna, & Wisloff, 2005).

The average oxygen uptake during intermittent match-play is approximately 70% of maximum oxygen uptake (VO_{2max}; Bangsbo, Mohr, & Krustrup, 2006). Often, throughout intermittent exercise high intensity efforts are repeated over an extended period of time (>90 minutes), and as a result players can experience symptoms of neuromuscular fatigue (Jagim, Wright, Brice, & Doberstein, 2013). Furthermore, an increased rate of anaerobic glycolysis required to maintain such high intensity repeated efforts can increase the depletion of muscle glycogen stores (Balsom, Wood, Olsson, & Ekblom, 1999), although it would be inappropriate to suggest that a single factor is responsible for fatigue during intermittent exercise (Bangsbo, 2000). Exercise induced fatigue has also been stated to be caused by an inadequate motor command in the motor cortex (Bishop, 2012). Exercise induced fatigue is often seen during the final stages of prolonged intermittent exercise, and may be caused by a reduced neural activation of the muscle due to impairment of the central

nervous system, which can affect mood, motivation, perceptions of effort and alertness (Bishop, 2012; Bangsbo, 2000).

It is potentially due to these causes of fatigue that significant reductions in sprint movements have been seen towards the end of team based games (Mohr, Krustrup, & Bangsbo, 2003; Bishop, 2012; Waldron, & Highon, 2014). For example, the distance covered by soccer players when sprinting was 43 % less in the last 15 minutes compared with the first 15 minutes of a match (Mohr et al., 2003), reinforcing the point that a player's ability to perform maximal exercise is reduced towards the end of games (Reilly and Thomas, 1976). This decline in performance throughout a match could also explain why Armatas et al. (2007) found that 32.8 % of goals were scored in the last period of a game (76^{th} - 90^{th} min). During exercise, athletes often reduce their work rate in order to limit substrate depletion from occurring before the end of an exercise bout and thereby increase the likelihood of winning a match (Tucker, 2009; Billaut et al., 2011).

Throughout intermittent exercise, players are required to self-regulate their exercise intensity, much like a time trial (Highton, Twist, Lamb, & Nicholas, 2012). An athlete's pacing strategy is organised in an anticipatory manner designed to optimise performance whilst preventing unreasonably large homeostatic disturbances during the exercise bout (Abbiss & Laursen, 2008; De Koning et al., 2011). The tendency of athletes to change pace during competitive situations is related to both how they rate their perceived exertion (rating of perceived exertion; RPE) and how much of the event remains (De Koning et al., 2011). An increase in RPE would suggest that working intensity is becoming more difficult to maintain, and as a result game players would reduce their working intensity (De Koning et al., 2011). RPE has been described as a

key mediator in the regulation of work load and could potentially explain how exercise intensity is altered to optimise performance and prevent homeostatic disruptions (De Koning et al., 2011; Tucker et al., 2009).

A commonly reported pacing profile in soccer match-play is termed 'slow-positive' whereby there is a gradual decline in total running intensity throughout the match (Waldron & Highton, 2014). Pacing profiles of team sports using part-match players suggest that intensity tends to peak at the start of exercise, followed by a reduction in intensity during the middle part of the bout, before intensity increases significantly towards the end (Tucker & Noakes, 2009; Waldron et al., 2014). This increase in intensity towards the end of match-play whereby athletes often use their remaining energy reserves describes the 'end-spurt' phenomenon (De Koning et al., 2011; Waldron et al., 2014).

Evidence of this was shown by Mohr, Nybo, Grantham, and Racinis, (2012) who identified that soccer players' sprint speeds increased between the 75th and 90th minute (28.6 km·h^{-1}) compared to speeds obtained between the 45th and 60th minute (27.7 km·h^{-1}). They also sprinted further in the last 15 minute interval (21.8 m) as opposed to between the 45th and 60th minute (20.4 m).

In soccer, the demands of match play have been analysed, and as a result protocols have been designed in an attempt to replicate these demands (Drust, Reilly, & Cable, 2000). The Loughborough Intermittent Shuttle Test (LIST) is a protocol that accurately simulates the activity patterns during a game of soccer (Nicholas, Nuttall & Williams, 2000). Modified versions of the LIST have been produced to include elements of self-pacing in order to investigate effects of pacing strategies within intermittent team sports (Highton et al., 2012). This modified LIST incorporating self-paced exercise has previously been

shown to possess a coefficient of variation of 1.7 and 5.4 % for distance covered and sprint performance (Ali, Gant, Foskett, Moss, & Lynch, 2009). Protocols that do not closely replicate the demands of match play should not be used for measurements of acute interventions such as nutritional supplements (Currell & Jeukendrup, 2008)

Considerable attention has focused on nutritional strategies to maximise carbohydrate stores, thereby minimising the potential effects of carbohydrate depletion (Bangsbo et al., 2006; Coyle, Coggan, Hemmert, & Ivy, 1986). As carbohydrate is the primary fuel source for high intensity intermittent exercise, inadequate muscle glycogen stores will limit the performance of repeated high intensity exercise bouts (Castell, Burke, Stear, & Maughan, 2010).

The influence of ingesting carbohydrate-electrolyte solutions immediately prior to and during prolonged intermittent, high intensity exercise designed to replicate field-based team games is becoming more common (Phillips, Sproule, & Turner, 2011). Ingesting carbohydrate has the potential to delay central and peripheral fatigue, improve match performance and aid rehydration especially towards the end of a game (Davis & Brown, 2001; Jentjens & Jeukendrup, 2003; Jeukendrup, 2014).

Goedecke et al. (2013) investigated the effects of carbohydrate ingestion versus a placebo on exercise performance during a simulated soccer match protocol. The ingestion of a 7 % carbohydrate solution improved time to fatigue suggesting an improved performance in the latter stages of a game. However, in this study the protocol focused on time to fatigue which is not specific to the nature of intermittent team sport players.

Similarly, Ali, Williams, Nicholas and Foskett, (2007) investigated the effects of carbohydrate ingestion on performance during the LIST. 16 male soccer players ingested either a 6.4 % carbohydrate electrolyte (CHO-E) solution or a placebo (PLA) solution before (5 ml/kg/BM) and during (2 ml/kg/BM) the LIST. Sprint performance (CHO-E= 2.50 ± 0.13 vs PLA= 2.53 ± 0.13 s) was significantly better maintained in the carbohydrate trial suggesting the importance of carbohydrate as a fuel source for maintaining glycogen levels in intermittent team sport players.

In addition to carbohydrate supplementation, research has focused on caffeine (a trimethylxanthine) supplementation to reduce feelings of pain and fatigue acting on the central nervous system (CNS), potentially increasing cognitive and endurance performance and enhancing lipolysis, decreasing the reliance on glycogen utilisation (Tarnopolski, 2008; Goldstein et al., 2010; Armstrong, Casa, Maresh, & Ganio, 2007; Stear et al., 2010; Plaskett & Cafarelli, 2001). Just like carbohydrate supplementation, caffeine supplementation has been described as an effective ergogenic aid for prolonged high-intensity exercise such as intermittent team sports (Goldstein et al., 2010).

Caffeine is often used as an aid to sports performance and is now appearing in many new products including sports drinks (Castell et al., 2010; Graham, 2001). It appears to exert positive effects on exercise capacity over a diverse range of protocols including prolonged submaximal exercise (Stear, Castell, Burke, & Spriet, 2010).

Stuart, Hopkins, Cook and Cairns (2005) investigated the effects of caffeine on simulated high-intensity team sport performance. Nine male rugby

players ingested either caffeine (6 mg/kg/BM) or a placebo (dextrose) 70 minutes before a rugby specific simulation protocol. The ingestion of caffeine as opposed to a placebo improved 30 m sprint speed (+ 2.3 %), and reduced fatigue by 10 % during the passing accuracy test, suggesting an improved performance in the latter stages of a game.

Despite previous established research focusing upon the separate ergogenic effects of caffeine (Stear et al., 2010; Plaskett et al., 2001; Stuart et al., 2005) and carbohydrate (Goedecke et al., 2013; Ali et al., 2007), very few studies have investigated the effect of combined carbohydrate and caffeine intake on intermittent exercise performance (Hulston & Jeukendrup, 2008), and therefore, this area requires more sport specific research (Roberts et al., 2010).

One study which has was conducted by Roberts et al., (2010). Eight male rugby union forwards ingested either a placebo or carbohydrate before and during a rugby union specific protocol, with pre-exercise caffeine ingestion (4 mg/kg/BM) before one of the carbohydrate trials (3 trials). 15 m sprints were performed faster and perceived exertion (RPE) was significantly lower (P = 0.020) in the carbohydrate with caffeine trial (13.5 ± 1.3) compared with carbohydrate (14.4 ± 1.5) or placebo (14.8 ± 2.0), reinforcing its proposed benefits of attenuating mental fatigue and reducing feelings of exertion.

Gant, Ali, and Foskett, (2010) investigated the effects of combined carbohydrate and caffeine co-ingestion on performance during the LIST. The addition of caffeine to a carbohydrate solution improved sprinting performance and counter-movement jumping suggesting that caffeine facilitated a reduced decline in exercise induced fatigue. However, the participants completed 6 x 15 m blocks of the LIST and therefore the protocol did not incorporate any form of

self-pacing which has previously been identified as an important notion affecting intermittent team sport performance.

Accordingly, the aim of this study is to investigate the effects of adding caffeine to a carbohydrate solution before a modified LIST which incorporates an element of self-pacing. Part A (prescribed) of the LIST acts as a fatiguing pre-load whereas part B (self-paced) is suggested to act as a performance test, resulting in an ecologically valid performance protocol (Ali et al., 2014).

From the present research it can be hypothesised that as a result of the potential benefits of combined carbohydrate and caffeine supplements, throughout the LIST, physiological performance will be better and reports of exertion (RPE) will be lower compared with the supplements alone. It is also hypothesised that, as a result of sparing glycogen levels following carbohydrate ingestion, and reduced feelings of exertion following caffeine ingestion, participants will be able to perform noticeably better during self-paced exercise (block 6).

2. Methods

2.1. Participants and Design

Ten recreationally active (age 21.8 ± 1.5 years, stature 183.9 ± 5.5 cm, mass 86.1 ± 5.9 kg, estimated VO_{2max} 48.5 ± 3.4 ml/kg·min^{-1}) team sport players (rugby union, *n* = 4; soccer, *n* = 3; basketball, *n* = 3) volunteered to participate in this study. After receiving an oral and written explanation of the study (appendix 1), all participants provided their written informed consent (appendix 2) and completed a pre-test health questionnaire (appendix 3). Participants were required to complete a food diary on the day prior to testing (appendix 4) which was replicated before each weekly trial, as well as perform an overnight fast from midnight the night before testing. Approval for this study was obtained from the ethics committee of the Faculty of Life Sciences, University of Chester (appendix 6).

A single-blind, repeated measures design was implemented in this study, in which participants completed 3 trials in a random order separated by 7-10 days. The three trials were carbohydrate only (CHO), caffeine only (CAF) and carbohydrate with caffeine (CHO + CAF). Each participant was required for a 4 week testing schedule (Figure 2.1), in which they were tested at the same time on approximately the same day on a weekly basis. They were asked to refrain from strenuous exercise for 24 hours prior to each trial whilst continuing with their normal diet and training regime up to the day prior to testing, on which diet was recorded and replicated. Participants were provided with a list of items which contained amounts of caffeine and asked to avoid these substances in the 48 hours prior to each testing visit (appendix 5).

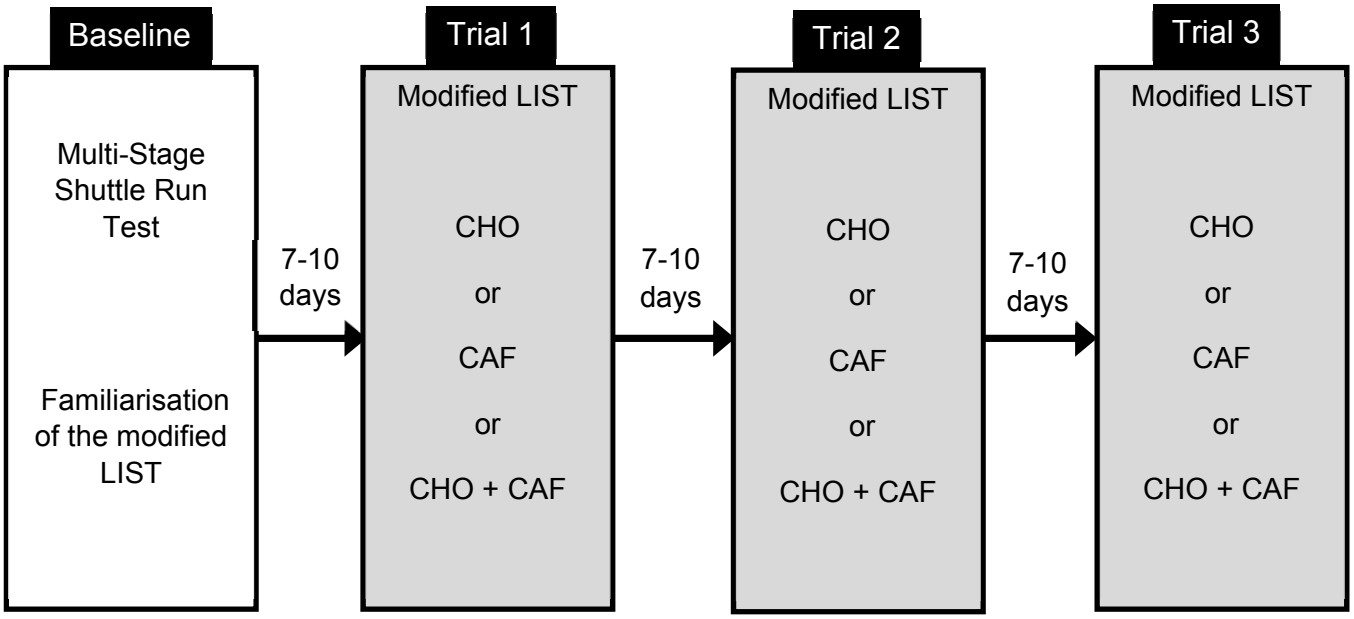

Figure 2.1. Four week testing schedule

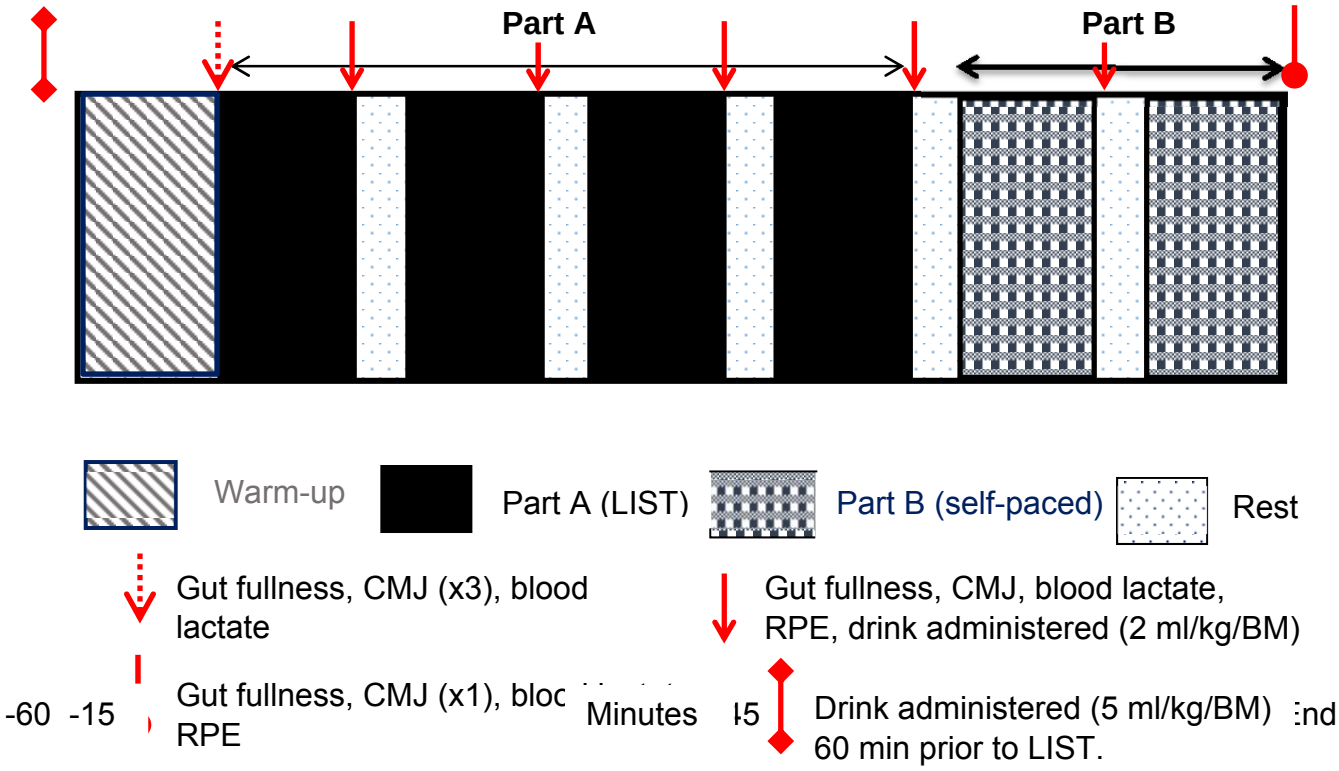

Figure 2.2. Schematic of the study design

2.2. *Procedures*

2.2.1. Baseline Measurements

Following a standardised warm up, participants completed the Multi-Stage Shuttle Run Test (MSSRT; Ramsbottom, Brewer, & Williams, 1988) on an indoor wooden surface (University gymnasium) to obtain an estimate of aerobic capacity ($VO_{2max)}$. The MSSRT consists of shuttle running between two markers placed 20 m apart at increasing running speeds (0.14 ms^{-1}) until exhaustion. From this estimate of VO_{2max}, running (95% of VO_{2max}) and jogging (55% of VO_{2max}) speeds were calculated for the LIST. Following this, participants performed two cycles of part A and two cycles of part B to familiarise themselves with the modified LIST.

2.2.2. The Modified - Loughborough Intermittent Shuttle Test (LIST)

Soccer match-play was simulated using the modified LIST (Figure 2.2). The test was completed on an outdoor AstroTurf pitch and all participants were asked to wear AstroTurf trainers for all 3 visits. During the modified LIST, participants ran alone completing four 15 minute blocks of a set pattern of exercise for 60 minutes (Part A) followed by two 15 minute blocks of self-paced exercise (Part B). Running and walking speeds were dictated by an audio CD throughout part A of the test. In part B, participants were asked to replicate the set pattern of exercise as best they could although without the audio CD. The LIST protocol, incorporating an element of self-pacing has been deemed a reliable test for measuring performance in intermittent team sports (Ali, Foskett, & Gant, 2014). Environmental temperature and humidity were both recorded throughout each testing visit (THG810, Oregon Scientific Ltd., Berkshire, UK).

2.2.3. Supplementation

Participants ingested one of three beverages, both before and during the LIST. All drinks, which were made on the day of testing, were issued in an opaque 1 litre bottle. All supplements were weighed out accurately and checked by a laboratory technician.

In the CHO trial participants were given a 6.4 % CHO solution (Lucozade Sport, GlaxoSmithKline, Brentford, U.K) in a volume of 5 ml/kg/BM one hour prior to exercise and 2 ml/kg/BM after every 15 minute block. This supplementation regimen was adopted from a combination of previous research utilising nutritional strategies during the LIST (Ali et al., 2007; Gant, Ali, & Foskett., 2010; Highton et al., 2012; Nicholas, Tsintzas, Boobis, & Williams., 1999). Mean ingestion was 430.5 ± 29.5 ml of CHO solution prior to testing and 172.2 ± 11.9 ml after every 15 minutes. This resulted in 32.4 ± 2.2 g of CHO being ingested one hour before testing and 12.9 ± 0.8 g being ingested after every 15 minutes. Over the first hour of exercise participants ingested 51.7 ± 3.2 g of CHO, which is within the guidelines of 30-60 g/h reported by Convertino et al., (1996).

In the CAF trial, participants ingested 4 mg/kg/BM of CAF in a powder form (Myprotein, Northwich, UK) mixed with an artificially sweetened orange flavoured non-carbohydrate solution in an amount relative to 5 ml/kg/BM. The CAF mixed with the non-CHO solution was ingested 1 hour before exercise due to previous research identifying that optimal absorption occurs after 1 hour of ingestion (Goldstein et al., 2010). Every 15 minutes during the modified LIST

they ingested just the artificially sweetened orange flavoured non-carbohydrate solution in an amount relative to 2 ml/kg/BM

In the CHO + CAF condition, the same 6.4 % CHO solution was ingested in a volume of 5ml/kg/BM before exercise mixed with 4 mg/kg/BM of CAF. After every 15 minute block just the CHO solution was ingested in a volume relating to 2 ml/kg/BM.

2.2.4. Movement demands and heart rate

During the LIST participants wore a portable GPS unit (5 Hz; SPI-Pro, GPSports, Canberra, Australia) which was placed between the scapular in a sports vest. In addition to this, a compatible heart rate monitor (Polar Electro Oy, Kempele, Finland) was tightly fitted around the participant's chest. Total distance covered (m), average speed ($km \cdot h^{-1}$), average heart rate (bpm), and peak speeds ($km \cdot h^{-1}$) for each block of each trial were collected. The coefficient of variation for distance covered and running speed when using this GPS unit is reported to be 1.8 and 1.7 % (Highton et al., 2012). Furthermore, average walk, jog, cruise and sprint speeds ($km \cdot h^{-1}$) were calculated from block 6 (self-paced). All GPS data was downloaded and analysed using Team AMS v 2.1 (GPSports, Canberra, Australia).

2.2.5. Neuromuscular function

Neuromuscular function was assessed using the counter-movement jump (CMJ) which required participants to adopt an upright position, and then on instruction from the researcher, flex their knees to 90 degrees and then jump vertically for maximal height onto a jump mat. Participants were instructed to keep their hands on their hips at all times and maintain a fully extended leg position during the jump and on landing. CMJ has been identified as a reliable

and valid measure (Markovic, Dizdar, Jukic, & Cardinale, 2004) and were recorded before and during the LIST (Figure 2.2) using a CMJ mat. (Probotics Inc, Huntsville, USA). Flight time (s) was used for data analysis.

2.2.6. Perceptual measures

Participant's RPE and gut fullness were measured after each 15 minute block of the LIST (Figure 2.2) using the Borg 6-20 scale (Borg, 1970) or the gut fullness scale which ranged from 1-10. Verbal instructions were given prior to testing.

2.2.7. Physiological measures

Capillary blood samples were collected and analysed for the concentration of lactate accumulated throughout the modified LIST. A capillary blood sample was taken from the fingertip using a portable blood lactate analyser (Lactate Pro; Arkray, Kyoto, Japan) after the 15 minute warm up, and also after each 15 minute block of the LIST (Figure 2.2).

Nude body mass was recorded after the initial fluid ingestion and immediately after the LIST to estimate fluid loss induced via exercise, taking into account the fluid consumed during exercise, using electronic scales (Seca, 877, Germany).

2.3. Statistical Analysis

All hypothesis testing was conducted using the statistical packages for social sciences (SPSS; v. 22; SPSS Inc., Chicago, IL), with the alpha level set at $P < 0.05$. Mean and peak values over each 15 minute block of the LIST were used for GPS and heart rate analysis. A Two-way repeated measures analyses of variance (ANOVA) was used to assess the variability of the type of beverage

and time factors. Mauchley's test was used to assess Sphericity and any violations were accounted for by the Greenhouse-Geisser statistic. Post-hoc paired *t*-tests using the Bonferroni adjustment were conducted to assess differences between blocks within trials. Effects sizes (*d*) (Cohen, 1977) were reported throughout by calculating the differences between the means divided by the standard deviation. Effect sizes (*d*) were quantified by the following criteria to help describe the practical significance of the findings: trivial < 0.2, small 0.2 – 0.6, moderate 0.6 – 1.2, large 1.2 – 2 and very large > 2 (Hopkins, 2006; Highton et al., 2012). Results are presented as means ± SD.

3. Results

Modified LIST performance

Distance covered

A two-way repeated measures ANOVA reported a significant main effect between blocks ($F_{(1.202, 10.819)}$ = 19.367, $P < 0.05$), but no differences between trials ($F_{(2,18)}$ = 1.171, $P > 0.05$) or any significant interactions between trial x block ($F_{(10,90)}$ = 1.199, $P > 0.05$). Post-hoc analysis of between blocks, showed that distance covered was significantly lower (∆17.4 ± 32.0 m) in block 3 (2049.6 ± 64.5 m) compared with block 2 (2067.1 ± 61.4 m) ($t_{(29)}$, 2.982, P = 0.006, d = 0.29). It was also significantly lower (∆66.1 ± 99.4 m) in block 5 (1981.2 ± 130.3 m) compared with block 4 (2047.3 ± 63.5 m) ($t_{(29)}$, 3.642, P = 0.001, d = 0.63) and lower (∆77.6 ± 53.1 m) in block 6 (1903.7 ± 143.8 m) compared with block 5 ($t_{(29)}$, 7.997, P = 0.000, d = 0.60). (Figure 3.1).

Maximum sprint speed

As expected, maximal speed changed between blocks ($F_{(5,45)}$ = 7.089, P < 0.05), however there were no significant differences between trials ($F_{(2,18)}$ = .422, P > 0.05) or an interaction effect between trial x block ($F_{(10,90)}$ = 1.051, P > 0.05). Post-hoc analysis of between blocks showed that average maximum sprint speed for block 2 (23.50 ± 1.95 km·h^{-1}) was performed significantly slower (∆1.03 ± 1.35 km·h^{-1}) than block 1 (24.54 ± 1.23 km·h^{-1}, $t_{(29)}$, 4.219, P = 0.000, d = 0.67). (Figure 3.1).

Average speed

A significant difference between blocks ($F_{(1.202,\ 10.819)}$ = 19.812, P < 0.05) was identified but no significant differences between trials ($F_{(2,18)}$ = .293, P > 0.05) or any interaction effects between trial x block ($F_{(10,90)}$ = 1.100, P > 0.05). There was significant differences between blocks 1 and 2 (P = 0.000, d = 0.59), 2 and 3 (P =0.004, d = 0.30), 4 and 5 (P = 0.000, d = 0.83) and finally blocks 5 and 6 (P = 0.000, d = 0.60) (Figure 3.1).

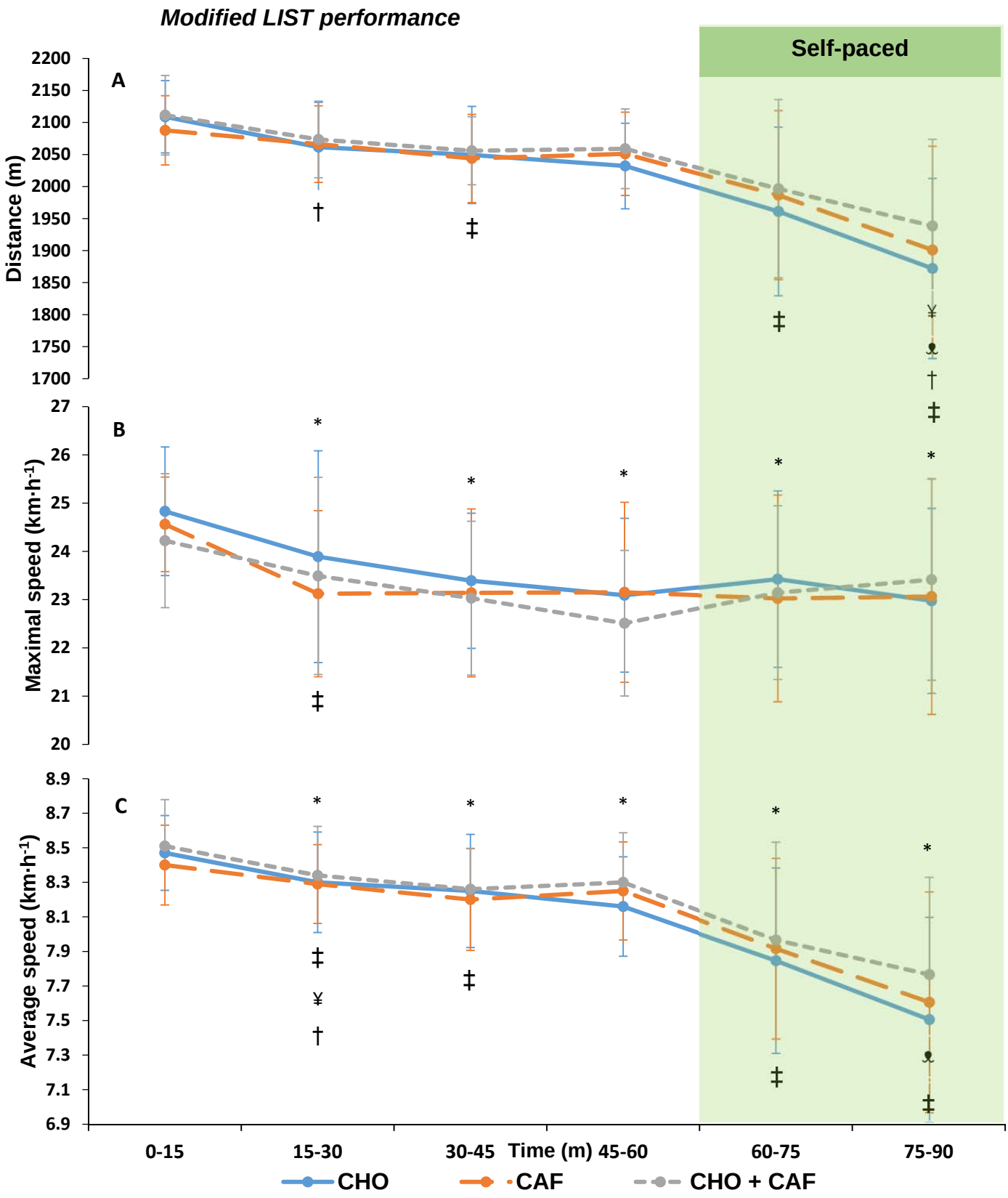

Figure 3.1. Changes in A) Distance covered, B) Maximum speed, and C) Average running speed during each 15 min block of the modified List. †= CHO+CAF, ᵴ= CAF, ¥= CHO. ‡= average of block across all 3 trials. Symbols denote significantly different from previous block. * denotes mean value significantly different from block 1. Values are mean ± *SD.*

Blood lactate and gut fullness

There was a main effect of block for blood lactate ($F_{(6,54)}$ = 6.085, P < 0.05) although no main effects were found between trials ($F_{(2,18)}$ = .501, P > 0.05) or any interaction effects between trial x block ($F_{(12,108)}$ = 1.371, P > 0.05). Post hoc analysis showed a significant difference between pre (3.1 ± 1.7 mmol·L^{-1}) and post block 1 (5.6 ± 2.4 mmol·L^{-1}, $t_{(29),}$ -5.350, P = 0.000, d = -1.27) values, and also a difference between post block 5 (5.1 ± 2.8 mmol·L^{-1}) and post block 6 (3.5 ± 1.5 mmol·$^{-1}$, $t_{(29),}$ 3.090, P = 0.004, d = 0.75) values. Several blood lactate levels were significantly elevated from baseline (P < 0.008) (table3.1)

ANOVA indicated significant differences between gut fullness values for block ($F_{(2.718,24.464)}$ = 4.306, P < 0.05), although there were no differences between trials ($F_{(2,18)}$ = .381, P > 0.05) or any trial x block interaction ($F_{(12,108)}$ = 1.161, P > 0.05). Gut fullness post block 5 (2.9 ± 1.4) and post block 6 (2.4 ± 1.4) were significantly different ($t_{(29),}$ 3.067, P = 0.005, d = 0.38). Although, further analysis showed that only block 5 in the CHO trial was significantly different from baseline ($t_{(9)}$ = -3.498, P = 0.007, d = 1.44) (Table 3.1).

Table 3.1. Average blood lactate, counter movement jumps and gut fullness values for each trial and block. * denotes significantly different from baseline. ¥ denotes mean value significantly different from previous block. Values are mean ± *SD.*

Condition	Baseline	0-15 min	15-30 min	30-45 min	45-60 min	60-75 min	75-90 min
		¥		*Blood lactate (mmol·L^{-1})*			¥
CHO	3.6 ± 1.5	6.2 ± 3.4	5.2 ± 1.4*	4.2 ± 2.3	4.6 ± 3.5	4.3 ± 3.1	3.2 ± 1.3
CAF	3.3 ± 2.3	5.3 ± 1.9	5.3 ± 2.3	4.9 ± 1.9	6.4 ± 3.0	5.9 ± 2.9	4.1 ± 1.6
CHO+CAF	2.5 ± 1.2	5.3 ± 1.5*	5.1 ± 1.9	5.3 ± 1.9*	5.2 ± 2.6*	5.3 ± 2.4*	3.4 ± 1.6
				Counter movement Jumps (s)			
CHO	0.62 ± 0.048	0.629 ± 0.067	0.625 ± 0.053	0.616 ± 0.051	0.617 ± 0.058	0.615 ± 0.049	0.617 ± 0.049
CAF	0.622 ± 0.049	0.628 ± 0.048	0.629 ± 0.046	0.616 ± 0.059	0.623 ± 0.044	0.611 ± 0.048	0.614 ± 0.056
CHO+CAF	0.626 ± 0.054	0.631 ± 0.059	0.631 ± 0.058	0.629 ± 0.050	0.609 ± 0.053	0.618 ± 0.059	0.627 ± 0.055
				Gut fullness (1-10)			¥
CHO	1.7 ± 0.7	2.2 ± 0.6	2.4 ± 0.7	2.4 ± 0.7	2.6 ± 0.8	2.8 ± 0.9*	2.5 ± 1.1
CAF	2 ± 1.1	2 ± 0.9	2.9 ± 1.4	3 ± 1.5	2.9 ± 1.8	3.2 ± 1.9	2.5 ± 1.8
CHO+CAF	2.4 ± 1.3	2.5 ± 1.1	2.8 ± 1.6	3.1 ± 1.7	2.8 ± 1.5	2.6 ± 1.3	2.3 ± 1.3

Assessment of neuromuscular function (CMJ)

ANOVA indicated there was a main effect of block for counter movement jumps ($F_{(6,54)}$ = 4.268, $P < 0.05$) but no effect between trials ($F_{(2,18)}$ = .253, $P > 0.05$) or an interaction effect between trial and block ($F_{(12,108)}$ = .965, $P > 0.05$). Further post hoc analysis using the Bonferroni adjustment showed no significant differences between trials, block or any interaction effect between trial x block ($P > 0.008$). (Table 3.1).

Heart rate and RPE

As expected heart rate values increased from baseline and analysis indicated a significant effect between blocks ($F_{(1.648,14.829)}$ = 9.753, $P < 0.05$) although not between trials ($F_{(1.9,17.096)}$ = .686) for CHO (181 ± 4 beats · min^{-1}),

CAF (179 ± 2 beats · min^{-1}), CHO+CAF (184 ± 3 beats · min^{-1}) or any interaction between trial x block ($F_{(4.234,38.107)}$ = .520, P = > 0.05). Significant differences were identified between blocks 1 and 2 (P = 0.000, d = - 0.43), 4 and 5 (P = 0.001, d = 0.42) and blocks 5 and 6 (P = 0.000, d = 0.47). Analysis revealed a main effect of block for RPE ($F_{(1.645, 14.807)}$ = 13.739, P < 0.05), although there was no differences between trials ($F_{(2,18)}$ = .037) nor any interaction effect between trial x block ($F_{(3.383, 30.447)}$ = .147, P > 0.05). Post hoc analysis of between blocks indicated that there were differences between blocks 1 and 2 (P = 0.000, d = - 0.70), 2 and 3 (P = 0.000, d = - 0.46), and blocks 3 and 4 (P = 0.000, d = - 0.37). (Table 3.2).

Table 3.2. Average heart rate and RPE values. * denotes significantly different from previous block. ¥ denotes mean value across all 3 trials is significantly different from previous block Expressed as means ± SD.

Condition	0-15 min	15-30 min	30-45 min	45-60 min	60-75 min	75-90 min
		¥	***Heart rate (beats .min)***		¥	¥
CHO	180.1 ± 12.39	185.5 ± 11.11	186.1 ± 11.76	183.9 ± 13.54	179.1 ± 15.22	173.6 ± 16.34*
CAF	179.8 ± 6.78	182 ± 7.47	182.8 ± 7.16	182.8 ± 6.49	178.4 ± 7.52	171.8 ± 7.48
CHO+CAF	183.5 ± 10.26	188.2 ± 10.94*	187.9 ± 10.94	186.8 ± 10.42	182.5 ± 13.03	177.9 ± 14.45
		¥	¥ ***RPE (6-20)***	¥		
CHO	13 ± 1.56	14.2 ± 1.81	15.5 ± 1.90*	16.1 ± 1.91*	15.8 ± 1.93	15.6 ± 1.96
CAF	12.5 ± 2.59	14.4 ± .32*	15.2 ± 1.93	15.9 ± 1.91	16.2 ± 1.40	16.7 ± 1.77
CHO+CAF	13.5 ± 1.84	14.5 ± 2.01	15.4 ± 2.27*	16.1 ± 2.18*	15.6 ± 1.65	15.9 ± 2.38

Block 6 movement classifications (km·h^{-})

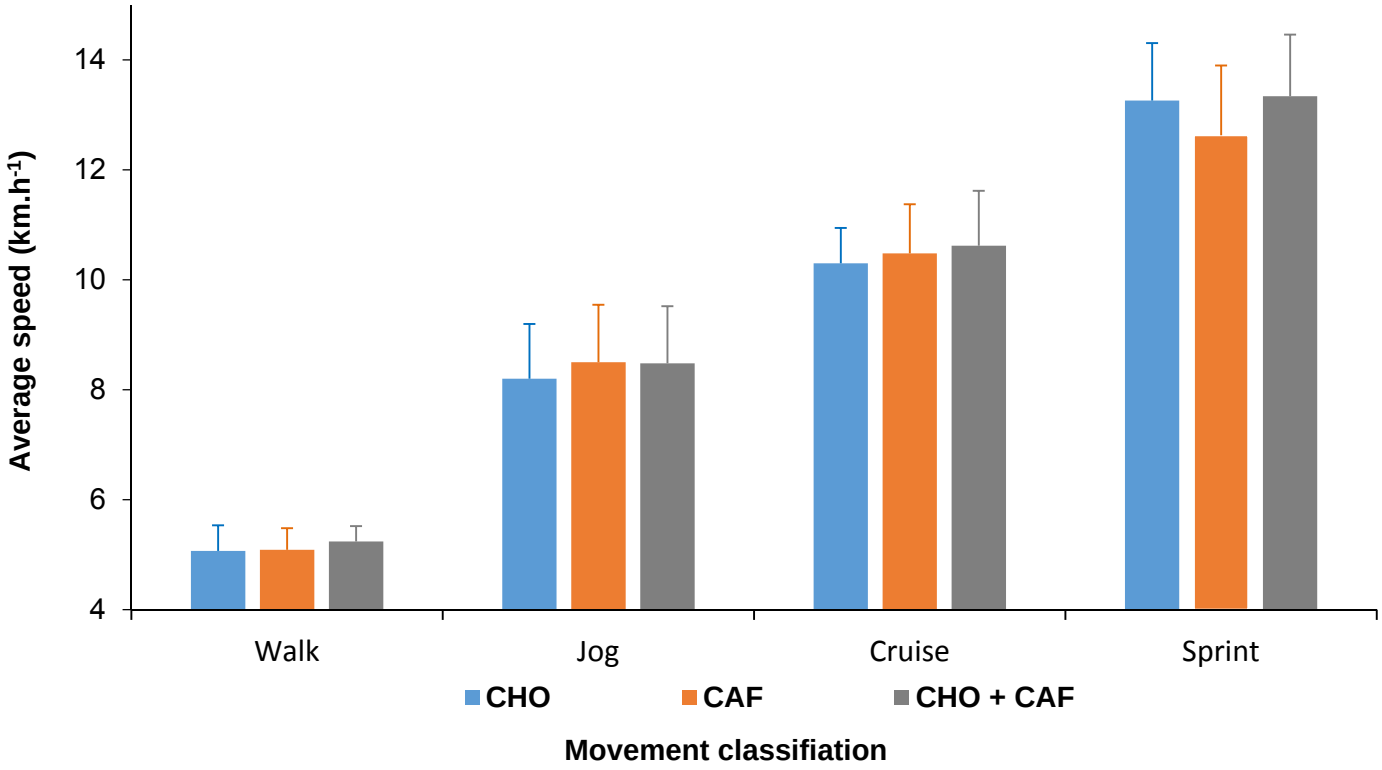

Figure 3.2. Average walk, jog, cruise and sprint speeds during self-paced exercise (block 6 only). Values are expressed as mean ± SD. No significant differences between trials ($F_{(2,18)}$ = 2.130, P > 0.05).

Sprint profile during self-paced exercise (block 6 only)

ANOVA indicated that there was a significant difference between trials at the first sprint point ($F_{(2,18),}$ = 4.570, P < 0.05). Although post hoc analysis showed no differences between trials, values were approaching significance (CHO vs CAF; P = 0.035, d = 0.99), (CHO vs CHO+CAF; P = 0.512, d = -0.29), (CAF vs CHO+CAF; P = 0.024, d = -0.91). No differences were identified between the middle sprints ($F_{(2,18)}$, = .399, P > 0.05) or the end sprints ($F_{(2,18),}$ = .977, P > 0.05) between trials (Figure 3.3).

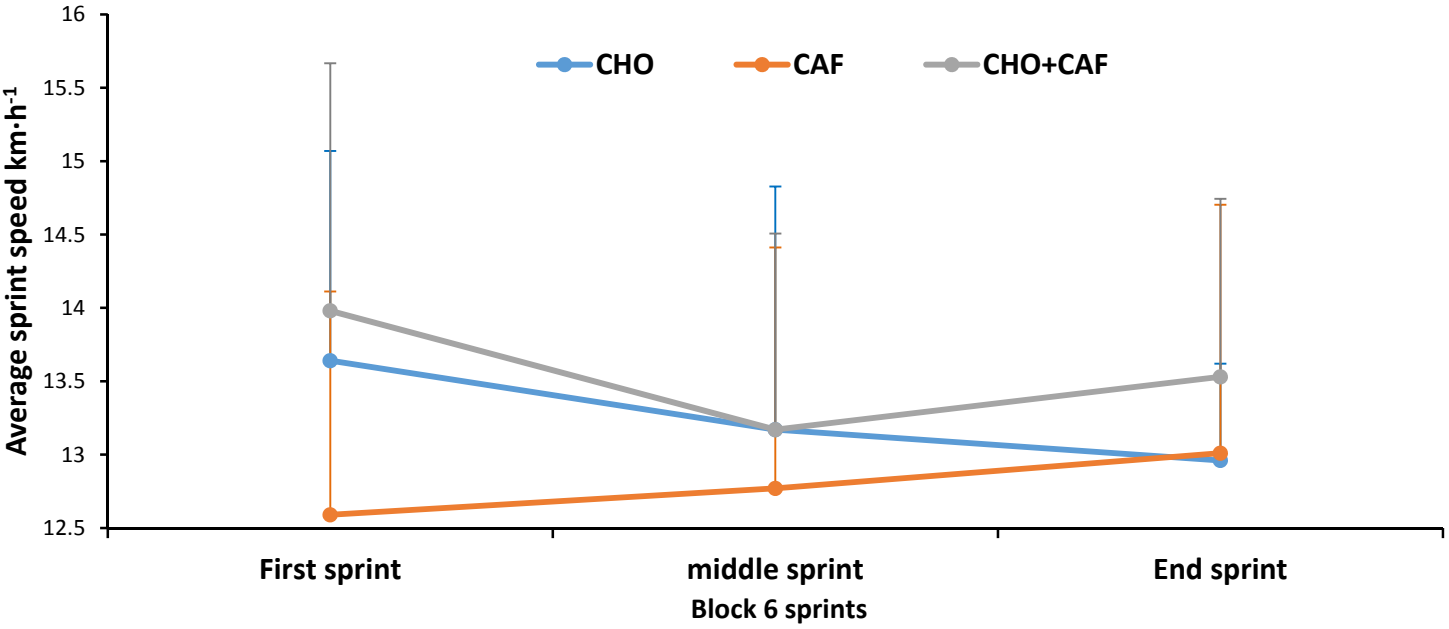

Figure 3.3. Average sprint speed profile during self-paced exercise (block 6). Values are mean ± SD.

Change in body mass

Body mass indicated a significant difference between pre and post measurements for all trials ($F_{(2,18)}$ = 4.434, P < 0.05). Although, changes in body mass between trials were insignificant ($F_{(2,18)}$ = .590, P > 0.05). (Table 3.3).

Table 3.3. Changes in body mass (kg) during modified LIST.

Condition	Pre LIST (kg)	Post LIST (kg)	(Δkg)	Cohen's *d*
CHO	86.02 ± 6.63	84.00 ± 6.41	2.01 ± .513	0.32
CAF	85.03 ± 6.13	83.14 ± 6.04	1.89 ± .423	0.33
CHO+CAF	85.27 ± 6.44	83.40 ± 6.24	1.87 ± .408	0.31

Environmental conditions

There were no differences between trials for temperature (CHO, 20.1 ± 1.91°C; CAF, 17.8 ± 0.58°C; CHO+CAF, 17.3 ± 1.73°C; P = 0.436). There was

a significant difference between humidity levels recorded between trials ($F_{(2,18)}$ = 4.725, P = 0.022), although further analysis indicated no significant differences (P > 0.01).

4. Discussion

4.1. Movement demands

It was noted that participants covered more distance (∆149.6 ± 328.1 m) in the CHO+CAF trial (12234.3 ± 442.4 m) compared with both the CHO (12084.7 ± 498.2 m, d = 0.33) trial, and CAF (12135.9 ± 473.3 m, d = 0.23) trials (P > 0.05). There was an effect of time (P < 0.05) which coincides with previous research reporting a decline in distance covered over time during intermittent team based activities (Ali et al., 2014; Bangsbo, 1994; Mohr et al., 2003; Reilly & Thomas, 1976).

During part A for all trials, participants adopted a 'parabolic-shaped' pacing profile which is identified by a reduced distance covered from the start (block 1) which then rises back up towards the end of the bout (block 4) (Abbiss et al., 2008). Participants may have increased their distance covered during block 4 as they recognised that it was there final block of prescribed pace, representing similar characteristics of the well documented 'end-spurt' phenomenon (De Koning et al., 2011; Waldron et al., 2014).

During part B, participants utilised a 'positive pacing' profile which is characterised by a gradual decline in distance covered from block 4 to block 5, and from block 5 to block 6 (P < 0.01; Abbiss et al., 2008; Waldron et al., 2014). Potential reasons for the reported decline in performance are glycogen depletion, neuromuscular fatigue and metabolic accumulation (Abbiss and Laursen, 2005).

During block 6, although not significant ($P > 0.05$) participants covered more distance in the CHO+CAF trial as opposed to the CHO ($d = 1.60$) or CAF ($d = 0.84$) trials. An explanation for these findings is the potential sparing of muscle glycogen levels and a significant delayed impairment of the CNS towards the end of exercise following CHO supplementation (Patterson & Gray, 2007; Yaspelkis, Patterson, Anderla, Ding & Ivy, 1993; Nybo, 2003), combined with a reduced RPE, reduced level of fatigue and enhanced exercise capacity (Stuart et al., 2005; Tarnopolski, 2008; Stear et al., 2010) following CAF supplementation.

Overall, average speed was highest in the CHO+CAF trial (8.19 ± 0.45 $km \cdot h^{-1}$) compared with the CHO (8.09 ± 0.50 $km \cdot h^{-1}$, $d = 0.22$) and CAF (8.11 ± 0.46 $km \cdot h^{-1}$, $d = 0.19$) trials, which was also found by Jacobson, Febbraio, Arkinstall, and Hawley, (2001). Average speed followed a similar profile to distance covered, with speeds reducing from block 1 to block 3 but then rising again in block 4, just like a 'U-shaped' pacing profile (Figure 3.1). During blocks 5 & 6 average speeds decreased in all 3 trials, indicating a 'positive pacing' profile. During block 6 however, there were higher average speed values recorded in the CHO+CAF (7.77 ± 0.56 $km \cdot h^{-1}$) trial as opposed to the CHO ($d = 0.48$) or CAF trial ($d = 0.28$). This is potentially down to the fact that maximum sprint speeds were higher following CHO+CAF supplementation.

Average maximum sprint speed reduced from block 1 to block 6 ($P < 0.01$, $d = 0.80$), which coincides with previous literature (Ali et al, 2014; Ali et al, 2007; Gant et al, 2010; Highton et al, 2012)**.** Sprint speeds throughout the LIST were similar between all trials ($P > 0.05$) although as expected there was a difference for time ($P < 0.05$), with post hoc analysis indicated block 1 being faster than all remaining blocks ($P < 0.01$; Figure 3.1).

During part A, average max speeds declined from block 1 (24.53 ± 0.35 $km \cdot h^{-1}$), to 2 (23.50 ± 0.50 $km \cdot h^{-1}$), to 3 (23.18 ± 0.44 $km \cdot h^{-1}$), and finally to block 4 (22.91 ± 0.45 $km \cdot h^{-1}$). In the CAF trial the performance pattern described the 'parabolic-shaped' pacing profile, whereas the during the CHO, and CHO+CAF trials participants seemed to engage in a more 'positive pacing' profile with speeds decreasing from block 1 to block 4 (Figure 3.1). During part B, there were minimal changes in speed suggesting an 'even pacing' profile (Abbiss et al., 2008). However, during block 6, although not significant ($P > 0.05$), participants sprinted quicker following CHO+CAF ingestion as opposed to CHO ($d = 0.23$) or CAF ingestion ($d = 0.16$), similar to the findings of Gant et al, (2010).

One potential reason for faster sprints following CHO+CAF supplementation in block 6 could be explained by the slower average sprint speed expressed during blocks 1-5. In the CHO+CAF trial participants reduced their intensity from block 1-5, potentially reducing the rate of anaerobic glycolysis and sparing glycogen stores for the final block, enabling them to increase intensity towards the end of exercise, mimicking the 'end-spurt' phenomenon (De Koning et al., 2011; Waldron et al., 2014). This is a typical characteristic of pacing strategies in team sports which are suggested to evenly distribute physical efforts in order to complete the exercise at the highest possible intensity whilst avoiding catastrophic failure. (De Koning et al., 2011; Edwards & Noakes, 2009).

4.2. Physiological and perceptual measures during the modified LIST

RPE, described as an accurate method of assessing exercise intensity (Impellizzeri, Rampinini, Cutts, Sassi, & Marcora, 2004), increased in a linear

fashion throughout the LIST. Average values between trials were similar (P > 0.05; Table 3.2), although, during block 6, the reported RPE values were lower in the CHO+CAF (15.9 ± 2.4) trial as opposed to the CAF (16.7 ± 1.8, d = 0.40) trial. This is interesting as it is already apparent that the participants were sprinting faster, covering more distance and also working at a higher average intensity in the CHO+CAF trial. This reduced RPE yet improved exercise performance during the latter stages of exercise is a well-established response to the co-ingestion of caffeine with carbohydrate (Gant et al., 2010; Cureton et al., 2007; Doherty & Smith, 2005).

Although no differences between trials for heart rate were identified (P > 0.05) during block 6, values were higher in the CHO+CAF trial (177.9 ± 14.45) compared with the CHO (173.6 ± 16.34) and CAF (171.8 ± 7.48) trial. This suggests that although participants appeared to be working harder and subsequently performing better during block 6, there perception of effort was unchanged. This supports previous evidence indicating that CHO+CAF reduces perceptions of pain (Plaskett et al., 2001; Davis et al., 2001; Tarnopolski, 2008).

Gut fullness in block 6 was significantly lower than block 5 (P = 0.007) suggesting gastric emptying was apparent as time progressed through the LIST. This suggests that the addition of CAF to a CHO drink does not negatively impact on an individual's perceived gut-fullness, any more than either CHO or CAF supplemented individually. Although no significant differences between performance, physiological or perceptual measures were reported between trials, it is a worthwhile finding that there were no negative effects of supplementing CHO with CAF.

4.3. Limitations

A main limitation of this study is that although analysis of movement classifications during block 6 was beneficial, a comparison with an alternative block (prescribed pace) would have been interesting. The relatively small sample size could have under powered the study, and subsequently prevented significant results. Due to time constraints food diaries were not analysed, and as a result pre-exercise dietary intake could have largely affected the findings of this study. Although drinks were closely matched for taste, colour and palatability, the reporting of ‘bitterness’ in some trials may have undermined any attempts to blind the participant to which supplement they consumed.

4.4. Conclusion

There were no significant differences identified in the current study between trials. However, the addition of CHO to CAF showed no negative effects on either performance, physiological or perceptual markers throughout the modified LIST compared to supplementing CHO or CAF individually. These findings do not warrant the prescription of CHO and CAF for team games players, as no positive effect on performance were highlighted. However the findings do warrant further investigation, as there is clearly a potential ergogenic benefit of the co-ingestion of CHO and CAF, with no negative effects reported during this study.

Future research may look to assess whether a dose response exists using the same study design, utilising the modified LIST, with varying doses of CAF supplemented (3-6 mg/kg/BM) combined with CHO.

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6. Appendices

Appendix one. Participant information sheet

Appendix two. Informed consent form

Appendix three. Pre-test health questionnaire

Appendix four. Example of food diary issued

Appendix five. List of substances to avoid 48h prior to testing

Appendix six. Ethical approval forms

University of Chester

Appendix 1. Participant information sheet

The Effects of carbohydrate and caffeine on Self-Paced Intermittent Exercise

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask the researcher if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.
Thank you for reading this.

What is the purpose of the study?
To investigate the effects of carbohydrate and caffeine ingestion upon exercise performance involving multiple sprints which aims to replicate the physiological demands of team sports such as football.

Why have I been chosen?
You have been chosen because you are a student at the University of Chester who fits between the ages of 18-30 and takes part in team sports. You will have to display adequate fitness levels for this research study through the use of a multi-stage shuttle run test (MSSRT). You will not be deemed eligible to take part if you fail to reach level 9 on the MSSRT as this was the limit suggested by Gabbett, (2005) that elite rugby league players should manage to reach. An assessment of the pre-test health questionnaire will also be taken by the researcher before the study can commence.

Do I have to take part?
It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect your rights in any way

What will happen to me if I take part?
If you decide to take part, you will be given this information sheet to keep and asked to sign the consent form. A screening process will take place and verbal instructions will also be issued to you before the study can commence. Following this, you will take part in a Multi Stage Shuttle Run Test which involves running between 2 markers placed 20 metres apart whilst keeping in time with a beep produced by speakers. Following this you will be asked to perform three trials of a, modified Loughborough Intermittent Shuttle Test (LIST). The modified LIST involves 90 minutes of exercise. Part A (first 60 minutes) includes a mixture of walking; jogging, running and maximal sprinting in time with an audio player, whilst part B (last 30 minutes) includes 2 blocks of 15 minute self-paced exercise which requires participants to perform the same

activity patterns but at a self-selected pace. You will perform this test 3 times under 3 different conditions. The 3 trials will be carbohydrate alone, caffeine alone and carbohydrate + caffeine. A food diary will be issued on the day prior to testing which should be replicated before each testing visit. Throughout testing measurements will be taken by the researcher including capillary blood lactate samples, rating of perceived exertion (RPE), gut fullness, heart rate, sprint times and countermovement jump using a jump mat.

What are the possible disadvantages and risks of taking part?
The test lasts for 90 minutes, and also requires you to perform a MSSRT which is physically demanding. There is a risk of muscle soreness up to 48h after exercise which could affect other training regimes. You are also issued with a list of foods and drinks which should be avoided 48h prior to testing due to their high caffeine content. Some mild discomfort may occur following capillary blood lactate samples. A risk assessment will be carried out to minimise all potential risks.

What are the possible benefits of taking part?
The results of the study can be transferred into your preparation for training and competition, which can enhance an individual's performance through the use of nutritional interventions. The MSSRT can inform the individuals what level of fitness they are at compared with others (Elite Performers).

What if something goes wrong?
If you wish to complain or have any concerns about any aspect of the way you have been approached or treated during the course of this study, please contact Professor Sarah Andrew, Dean of the Faculty of Life Sciences, University of Chester, Parkgate Road, Chester, CH1 4BJ. If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence (but not otherwise), then you may have grounds for legal action, but you may have to pay for this.

Will my taking part in the study be kept confidential?
All information which is collected about you during the course of the research will be kept strictly confidential so that only the researcher carrying out the research will have access to such information.

What will happen to the results of the research study?
The results will be written up into a dissertation for my final project of my MSc. Individuals who participate will not be identified in any subsequent report or publication.

Who is organising the research?
The research is organised and conducted by a student of the Department of Sport and Exercise Sciences at the University of Chester

Who may I contact for further information?
If you would like more information about the research before you decide whether or not you would be willing to take part, please contact:

Oliver Davidson
@chester.ac.uk **Thank you for your interest in this research.**

University of Chester

Appendix 2. Informed consent form

Title of Project: Effects of Carbohydrate and Caffeine on self-paced intermittent exercise.

Name of Researcher: Oliver Davidson

Please initial box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected. ☐
3. I agree to take part in the above study. ☐

_____	_____	_____
Name of Participant	Date	Signature
_____	_____	_____
Researcher	Date	Signature

University of Chester

Appendix 3. PRE-TEST HEALTH QUESTIONNAIRE

(PLEASE NOTE THAT THIS INFORMATION WILL BE CONFIDENTIAL)

Name:……. DOB:…….. Age:……

Practical/Project Title: **The effects of carbohydrate and caffeine on Self-Paced Intermittent Exercise**

Please answer these questions truthfully and completely. The purpose of this questionnaire is to ensure that you are fit and healthy enough to participate in this laboratory practical/research project.

Stature……. Mass……..

Resting Blood Pressure (measured by researcher) (mmHg)……/……

Resting Heart Rate (measured by researcher) (b.min^{-1})…….

	Yes	**No**
1. Have you in the past suffered from a serious illness or accident. If Yes, please provide details	☐	☐

……
……

	Yes	**No**
2. Have you consulted your doctor the last 6 months If Yes, please provide details	☐	☐

……
……
……

3. Do you suffer, or have you suffered from:

	Yes	No
Asthma	☐	☐
Diabetes	☐	☐
Bronchitis	☐	☐
Epilepsy	☐	☐
High blood pressure	☐	☐

	Yes	**No**
4. Is there any history of heart disease in your family	☐	☐

	Yes	**No**
5. Are you suffering from any infectious skin diseases, sores, cuts, or infections i.e., Hepatitis B, HIV, etc.? If Yes, please provide brief details	☐	☐

……
……

	Yes	No
6. Are you currently taking any medication	☐	☐

If Yes, please provide details

……
……
……

	Yes	No
7. Are you suffering from a disease that inhibits the sweating process	☐	☐

	Yes	No
8. Is there anything to your knowledge that may prevent you from participating in the testing that has been outlined to you?	☐	☐

If Yes, please provide details

……
……
……

Your Recent Condition

	Yes	No
• Have you eaten in the last 2 hours?	☐	☐

If Yes, please provide details

……
……

• Have you consumed alcohol in the last 24hr			☐	☐
• Evaluate your diet over the last two days.	**Poor**	**Average**	**Good**	**Excellent**
• Have you had any kind of illness or infection in the last 2 weeks			☐	☐
• Have you exercised in the last 2 days?			☐	☐

If Yes, please describe below

……
……
……

Persons will not be permitted to take part in any experimental testing if they:

- have a known history of medical disorders (i.e. hypertension, heart or lung disease)
- have a fever, suffer from fainting or dizzy spells
- are currently unable to train because of a joint or muscle injury
- have had any thermoregulatory disorder
- have gastrointestinal disorder
- have a history of infectious diseases (i.e. HIV or Hepatitis B)
- have, if pertinent to the study, a known history of rectal bleeding, anal fissures, haemorrhoids or any other similar rectal disorder.

My responses to the above questions are true to the best of my knowledge and I am assured that they will be held in the strictest confidence.

Name: (Participant)…… Date:…….

Signed (Participant): ……..

Name: (Researcher)…… Date:…….

Signed (Researcher): ……

Appendix 4. Daily Food Diary: Oliver Davidson MSc Dissertation Study

Name_____

The following food diary should be completed on the day of testing and is designed to provide a comprehensive overview of your food and fluid intake which you will be asked to repeat on your following testing visits. In completing this food diary, you should aim to adhere to the following guidelines, using the example below as a template:

- Record all food and fluid intake during the testing day including the time of ingestion
- Provide information on how meals are prepared (i.e. fried, poached, grilled etc.)
- Include ingredients which are added to foods during cooking, such as olive oil, salt, butter etc.
- Provide the amount and type of food consumed in the most accurate way possible (i.e. 1 cup full, teaspoon etc.)

Time	Food/Drink	Amount
9 am	Quaker porridge oats with skimmed milk	50 g, ¼ pint
	Muller fat-free Yogurt	1 average pot
10 am	Bacon sandwich (wholemeal bread) with ketchup	2 rashers, 2 slices, tablespoon

24H food diary prior to testing (week 1)

Time	Food/Drink	Amount

24H food diary prior to testing (week 2)

Time	Food/Drink	Amount

24H food diary prior to testing (week 3)

Time	Food/Drink	Amount

University of Chester

Appendix 5. MSc Research Dissertation

Research Title: The Effects of Carbohydrate and Caffeine on Self-paced Intermittent Exercise

Researcher: Oliver Davidson

A list of Caffeine sources to be avoided 48 hours prior to testing

- Any coffee including decaffeinated
- Normal tea
- Green tea
- Iced tea
- Soft drinks (e.g. Coca Cola, Diet Coke, Dr Pepper)
- Energy drinks (e.g. Red Bull, Relentless, Monster)
- Caffeine tablets
- Caffeine powder
- Pre-workout formulas
- Caffeine sports gels
- Any type of Chocolate or foods containing chocolate (cookies, brownies, cakes)
- Medication such as Lemsip and headache tablets.

If you are unsure about any products you are consuming, the researcher recommends that you briefly check the food/drink packet to check if there is any caffeine present.

Any questions about certain food/drink types or any general questions do not hesitate to get in touch with the researcher (Oliver Davidson).

Oliver Davidson (Researcher)

Faculty of Life Sciences
Research Ethics Committee

frec@chester.ac.uk

Appendix 6
Oliver Davidson

Chester

12th August 2014

Dear Oliver,

Study title: **The Effects of Carbohydrate and Caffeine on Self-paced Intermittent Exercise.**
FREC reference: **927/14/OD/SES**
Version number: **3**

Thank you for sending your application to the Faculty of Life Sciences Research Ethics Committee for review.

I am pleased to confirm ethical approval for the above research, provided that you comply with the conditions set out in the attached document, and adhere to the processes described in your application form and supporting documentation.

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Application Form	1	May 2014
Appendix 1 – List of References	1	May 2014
Appendix 2 – C.V. for Lead Researcher	1	May 2014
Appendix 3 – Participant Information Sheet	1	May 2014
Appendix 4 – Participant Consent Form	1	May 2014
Appendix 5 – Risk Assessment Form	1	May 2014
Appendix 6 – Daily Food Diary	1	May 2014
Appendix 7 – List of caffeine sources to avoid 48 hours prior to testing	1	May 2014
Appendix 8 – Pre-test Questionnaire	1	May 2014
Response to FREC request for further information or clarification		July 2014
FREC Application Form	2	July 2014
Appendix 1 – C.V. for Lead Researcher	1	July 2014
Appendix 2 – Participant Information Sheet	2	July 2014
Appendix 3 – Participant Consent Form	2	July 2014

Appendix 4 – Pre-test Health Questionnaire	2	July 2014
Appendix 5 – Risk Assessment Form	2	July 2014
Appendix 6 – Daily Food Diary	2	July 2014
Appendix 7 – List of caffeine sources to avoid 48 hours prior to testing	2	July 2014
Appendix 8 – Capillary blood sampling consent form	1	July 2014
Appendix 9 – Recovery Protocol	1	July 2014
Appendix 10 – List of References	2	July 2014
Response to FREC request for further information or clarification		August 2014
FREC Application Form	3	August 2014
Appendix 1 – C.V. for Lead Researcher	1	August 2014
Appendix 2 – Participant Information Sheet	3	August 2014
Appendix 3 – Participant Consent Form	2	
Appendix 4 – Pre-test Health Questionnaire	3	August 2014
Appendix 5 – Risk Assessment Form	2	August 2014
Appendix 6 – Daily Food Diary	2	
Appendix 7 – List of caffeine sources to be avoided 48 hours prior to testing	3	August 2014
Appendix 9 – Recovery Protocol	1	August 2014
Appendix 10 – Letter of Invitation	1	August 2014
Response to FREC request for further justification		August 2014

Please note that this approval is given in accordance with the requirements of English law only. For research taking place wholly or partly within other jurisdictions (including Wales, Scotland and Northern Ireland), you should seek further advice from the Committee Chair / Secretary or the Research and Knowledge Transfer Office and may need additional approval from the appropriate agencies in the country (or countries) in which the research will take place.

With the Committee's best wishes for the success of this project.

Yours sincerely,

Dr. Stephen Fallows
Chair, Faculty Research Ethics Committee

Enclosures: Standard conditions of approval.

Cc. Supervisor/FREC Representative