Title of Article: The effects of a field-based priming session on perceptual, physiological and performance markers in female rugby sevens players

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Authors: Billy R.J. Mason[1], Andrew J. McKune[1,2], Kate L. Pumpa[1,3], Jocelyn K. Mara[1], Alexander C. Engel[1,4], Liam P. Kilduff[5], Nick B Ball[1]

Affiliations: 1 - University of Canberra Research Institute for Sport and Exercise, Bruce, ACT, Australia;
2 - School of Health Sciences, Biokinetics, Exercise and Leisure Sciences, University of KwaZulu-Natal, Durban, KZN, South Africa;
3 – University College Dublin, Belfield, Dublin 4, Ireland;
4 – University of New South Wales, Sydney, NSW, Australia;
5 – Applied Sports Technology, Exercise and Medicine Research Centre (A-STEM), Swansea University, Swansea, United Kingdom

Contact: Billy Mason - Room 12C7, University of Canberra, Bruce, ACT, 2617, Australia. billy.mason@canberra.edu.au. +61430440903

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ABSTRACT

Purpose: This study aimed to determine the effects of a field-based priming session on perceptual, physiological and performance responses in female rugby sevens athletes.

Methods: Thirteen highly trained female rugby sevens players (age: 20.7 ± 2.0 years; height: 169.3 ± 4.8 cm; weight: 68.8 ± 7.9 kg) completed either a 20-min field-based priming session or control condition. Perceptual, physiological and performance variables were collected at baseline (PRE), and 5 (POST5), 30 (POST30), and 120 minutes (POST120) post intervention. Data were analysed using Bayesian mixed effects models.

Results: The priming protocol had a larger increase in mental readiness (Maximum a posteriori [MAP] = 20, 95% high-density intervals [HDI] = -4 – 42, probability of direction [PD] % = 95, % in region of practical equivalence [ROPE] = 9.7), physical readiness (MAP = 20.1, 95% HDI = -4.6 – 42.1, PD% = 93, % in ROPE = 10.6), and testosterone (MAP = 14.9, 95% HDI = 0.5 – 27.7, PD% = 98, % in ROPE = 5.6) than the control POST30. Cognitive performance decreased POST120 in the priming condition for congruent (MAP = 0.02, 95% HDI = -0.06 – 0.00, PD% = 95, % in ROPE = 6.4) and incongruent tasks (MAP = 0.00, 95% HDI = -0.07 – 0.00, PD% = 98, % in ROPE = 3.2) when compared with the control.

Conclusions: Perceptual and physiological markers improved POST30 in the priming condition. Findings indicate that perceptual and physiological responses to priming were not coupled with performance improvements. Priming was not accompanied by perceptual, physiological or performance improvements at POST120.

KEYWORDS

preconditioning, physical performance, readiness, women's football, sport

INTRODUCTION

Rugby sevens is a physically demanding sport, with athletes required to perform repeated bouts of high intensity running, rapid changes of direction and frequent collisions across 2 x 7-minute halves of play[1]. Rugby sevens differs from other rugby codes in that tournaments are often contested across 5-6 matches over 2-3 days of competition[1,2]. This format presents challenges specific to rugby sevens, such as managing fluctuating phases of physiological and psychological readiness to perform throughout a tournament[1]. One strategy often implemented 2-3 hours prior to the first match of the day is a 'blow-out' session[3,4], with the aim of this session to provoke an acute ~~positive~~ physiological response to improve subsequent performance[3,4].

The term 'blow-out' is commonly used in rugby sevens[3], and fits within the broader pre-competition strategy of priming[5,6]. Literature supports the use of short duration, high-intensity priming exercise to improve physical[3,7-9] and cognitive performance[8] in multiple~~s~~ sports, including rugby. However, the majority of research on game day priming has applied exercise interventions 4-6 hours prior to subsequent performance[5]. The 4-6-hour timeframe, whilst applicable to afternoon competition, is not practical for rugby sevens as matches typically commence earlier in the day. When considering the use of priming interventions in rugby sevens, a shorter recovery interval (i.e., ~2 hours) would be more practical as the first match of the day often starts as early as 8:00am

Studies that have applied shorter recovery periods between the priming stimulus and subsequent performance have reported mixed results[3,10]. Increases in upper-body, but not lower-body, peak power output were observed 1 hour 45 minutes after 4 sets of 3 high velocity banded back squats and banded bench press in male academy rugby players[10]. Field based interventions have also been applied, with Marrier et al.[3] implementing a 30-minute priming session 2 hours prior to subsequent performance in elite under 18 male rugby sevens players. The session included a warm up, accelerations, small-sided games and 2 x maximal effort 50m sprints and led to trivial changes in a repeat-sprint ability and possibly lower total distance and deceleration counts during a simulated rugby sevens match when compared to the control (i.e. no exercise).[3]

Although performance outcomes differed in these studies, an increase in self-reported mood[10], and improvements in perceived recovery-stress states[3] were reported and may contribute to an athlete's readiness to perform. It is important to note, these studies used male participants only with no known studies investigating the acute priming responses in female athletes following a ~2-hour recovery.

Multiple factors can contribute to perceptual, physiological and performance changes following exercise[11], and numerous studies have reported acute hormonal responses alongside improved outcomes in males[7,9]. Morning resistance training, running and cycling has been shown to attenuate the diurnal decline in testosterone[7] and cortisol[7,9] 5-6 hours post exercise in male rugby players. Whilst causal links cannot be made, these changes coincided with improvements in back squat and bench press strength, counter-movement jump (CMJ) peak power output, 40 m sprints, and repeat-sprint ability[7,9]. Further evidence suggests significant correlations between salivary testosterone and sprinting velocities across 10-30 m, and strong negative associations between the T:C ratio and squat jump relative mean power output in elite male rugby players[12]. Additionally, the relationship between testosterone and cortisol has been suggested as a measure of athlete 'readiness', a term used by Serpell et al. to describe physical, psychological, and behavioural preparation to compete[13]. In priming studies where hormonal markers are not assessed, readiness has been measured using subjective questionnaires[8,10].

Studies have also investigated changes in cognitive performance following priming exercise, with improvements in Stroop task performance in male cricket players[8] and no change in reaction time in male rugby players[9] following a ~5-hour recover period. Due to the dynamics of rugby sevens and the need for decision making and fast reaction times to improve on-field performance[4], cognitive performance should be considered a marker of interest when assessing the effects of a priming intervention for female players.

Several studies present benefits to implementing priming interventions to improve performance in males, however, there is a scarcity of literature exploring responses in female athletes. Due to the known physiological differences between sexes (i.e. males having greater lean mass, increased rates of muscle fatigue, and higher testosterone concentrations)[14,15], the aim of this study was to investigate the effects of a 20-minute field-based priming session on perceptual, physiological and performance markers in female rugby sevens athletes. The use of a field-based session 2 hours prior to competition, was due to the practicality and relevance of implementing a priming session during rugby sevens tournaments.

METHODS

Subjects

Thirteen highly trained female rugby sevens players (age: 20.7 ± 2.0 years; height: 169.3 ± 4.8 cm; weight: 68.8 ± 7.9 kg) competing in a national universities rugby sevens competition volunteered to participate in this study. To account for differences in menstrual cycle phases, participants reported their menstrual cycle history, contraceptive use, and contraceptive type if applicable. Ethical approval was provided by the University of Canberra Human Ethics Committee (HREC-11877), and all participants provided written informed consent prior to commencing the study.

Design

Using a randomised controlled design, participants were allocated to either a priming (n=7) or control (n=6) condition. Participants arrived at the testing facility in a fasted state at 06:50 and had their height, weight and menstrual cycle history details collected. All participants then provided baseline (PRE) perceptual, physiological and performance measures before commencing their allocated condition. The intervention group completed a 20-minute field-based priming session, whereas the control group completed no activity and remained seated indoors. Subsequent perceptual, physiological and performance measures were collected 5 minutes (POST5), 30 minutes (POST30) and 120 minutes (POST120) post each condition as outlined in Figure 1. Participants remained at the testing facility for the duration of the study and were instructed to remain in a restful state between assessments. Water was consumed *ad libitum* and a standardized snack containing ~26 g carbohydrates, ~7 g fat and ~4 g protein was provided immediately after the POST30 measures were collected.

FIGURE 1 ABOUT HERE

Methodology

Perceptual measures

Rating of perceived exertion (RPE) was assessed using Borg's 6-20 point category scale[16]. Participants rated their perceived exertion with a score of '6' indicating 'no exertion at all' and '20' indicating 'maximal exertion'[16]. To assess readiness to perform, participants completed a subjective questionnaire based on variables previously used by McLean et al.[17] (i.e. fatigue, muscle soreness, stress). The questionnaire was expanded from that used previously[17] to have each response reported on a 100 mm Visual Analogue Scale to improve response sensitivity, and to include an additional variable of ‘readiness’. Readiness was presented in the context of perceived ‘physical readiness’ and ‘mental readiness’ to perform in an upcoming rugby sevens match.

Physiological measures

To assess changes in salivary testosterone and cortisol concentrations, samples were collected at PRE, POST30 and POST120. Participant were placed in a seated position with samples collected via unstimulated, passive drool. Participants were instructed to lean forward slightly with their heads tilted down and eyes open to accumulate saliva in the floor of the mouth for one minute. At the end of the minute the saliva was swallowed, and participants were instructed to accumulate saliva in their mouth for a further three minutes. During the three minutes, participants were able to dribble any accumulated saliva into a polypropylene cryovial (2ml capacity) at any time. Care was taken to allow saliva to dribble into the collecting tubes with minimal orofacial movement. All samples were stored at -90 °C until analysis. Participants received training in the saliva collection procedure and were supervised by a member of the research team to ensure they adhered as closely as possible to standardized collection guidelines[18,19]. Samples were analysed for testosterone and cortisol in duplicate via enzyme immunoassay kits according to the manufacturer’s instructions (Salimetrics, LLC, State College, PA). The results are expressed as pg/mL for testosterone and µg/dL for cortisol. To reduce between-person variability, samples from the same participant were tested using the same analysis kit. The coefficients of variation were <5% for intra-assay variability and <10% for inter-assay variability. Blood lactate concentrations were assessed via a capillary blood sample taken from a finger prick at PRE, POST5, POST30, POST120. All samples were collected at rest by the same practitioner under the same environmental conditions and analysed using the Edge handheld lactate analyzer (Transatlantic Science, USA).

Physical and cognitive performance measures

Lower-body power was assessed using CMJ jumps. All jumps were performed on dual force plates (ForceDecks, VALD, Brisbane, Australia) with force-time data analysed using proprietary software. After completing an initial 1-second weighing period[20], participants were instructed to start in a tall standing position with feet hip width apart and hands on hips. Two warm-up jumps were performed at 50% and 75% of perceived maximal effort using a self-selected dip, followed by three maximal effort CMJs each interspersed with a 20-second rest[21]. Participants were provided a countdown of “3,2,1, jump” for all repetitions, and were instructed to “jump as high as possible" for each repetition[21]. The best of three CMJs as determined by jump height measured using the impulse-moment method[20] were included in the analysis. Jump height and peak power output were assessed as performance metrics. To investigate changes in jump strategy, contraction time, and flight time/contraction time for the highest jump were also analysed.

To assess changes in cognitive performance, a modified Eriksen Flanker Task[22] was completed at PRE, POST5, POST120. This computer-based assessment included 12 familiarizations followed by 90 trials at each timepoint, with participants required to respond as quickly and accurately to one of six possible conditions shown on the screen. The conditions included a left and right option for a congruent, incongruent and switch task. For congruent and incongruent conditions, the correct response was the direction of the middle arrow, irrespective of the flanking (outside) arrows[22]. The exception to this rule was for the switch task with the flanking X's, where the participant was required to indicate the opposite direction of the middle arrow. Reaction time and accuracy was collected using E-Prime (Version 3.0; Psychological Software Tools, Sharpsburg, PA, USA) and combined into a composite score for analysis.

Priming intervention

The priming intervention commenced with a 10-minute warm up comprised of dynamic stretching and mobility, muscle activation exercises, run specific drills and 2 x 10 and 2 x 20m accelerations of increasing intensity. Following a 1-minute recovery, participants completed 6 x 40 m repeat shuttle sprints (20 m out, 20 m back) interspersed with a 20-second recovery period as used previously[9]. A 1-minute break was provided before participants completed 4 sets of 3 repeated 5 m shuttles to a tackle bag from a prone start, with each set commencing on the minute. All priming activities were performed at maximal intensity with verbal encouragement provided throughout. The distance covered in the session was 1120 ± 49 m, inclusive of 121 ± 37 m of sprint distance (>6.0 m.s), which was recorded via a global positioning system (Catapult, Melbourne, Australia). The control group remained seated indoors out of sight of the priming group for 20 minutes, performing minimal activity only as required. Upon completion of each condition, players remained at the testing facility in a restful state with no access to mobile phones. A 30-minute nutrition presentation was delivered by a dietician between POST30 and POST120 assessments.

Statistical Analyses

All analyses were conducted using R (version 4.2.2) in RStudio (version 2022.12.0+353, Posit Software PBC, Boston, USA)[23]. For all response variables, separate Bayesian gaussian mixed models were created (using the *brms* R package[24]) and consisted of an interaction term for condition and timepoint, and menstrual cycle phase was included as a covariate. A random intercept was specified for each participant. An additional truncation term was included in each model to specify the lower and upper bounds (if relevant) of the response. For example, the model expectation for readiness variables could not be less than 0 and more than 100. The prior distributions for perceptual outcome measures and the jump outcome measures each were informed by findings from Mason et al[10], who found no effect for the priming condition. Similarly, for all other outcome measures, weakly informative prior distributions for marginal effects were specified in such a way that they followed a gaussian distribution with a mean of 0, and a realistic, but relatively wide standard deviation. The prior distribution for the random effect of the participants was specified using a Half-Cauchy distribution. The posterior distributions of the marginal effects from the Bayesian models are described using the maximum a posteriori (MAP, i.e., the most likely point estimate for the marginal effects) and 95% high-density intervals (HDI, i.e., credible intervals for the marginal effects), probability of direction (PD, i.e., probability of positive or negative marginal effect), and the percentage of the 95% HDI within a region of practical equivalence (ROPE)[25]. A smaller percentage of the 95% HDI within a ROPE indicated a more practically meaningful effect. The ROPE for the marginal effects for each model was calculated as ± 0.2 times the standard deviation of the response variable[26], so that values outside the ROPE could be considered as at least ‘small’ effects, according to Cohen[27].

RESULTS

The RPE was higher POST5 in the priming condition (MAP = 4.5, 95% HDI = 3.4 – 5.8, PD% = 100, % in ROPE = 0.0) than the control condition when compared to PRE, with negligible changes POST30 and POST120. Compared with PRE, the priming protocol had a larger increase in perceived mental readiness (MAP = 19.5, 95% HDI = -3.8 – 41.7, PD% = 95, % in ROPE = 9.7; Figure 2, Supplementary file 1) and physical readiness (MAP = 20.1, 95% HDI = -4.6 – 42.1, PD% = 93, % in ROPE = 10.6; Figure 3, Supplementary file 2) than the control condition POST30. There was no evidence that markers of muscle soreness, fatigue or stress were different between the control and priming conditions at any timepoints.

FIGURES 2 AND 3 ABOUT HERE

When compared to the control condition, there was a greater increase in testosterone concentrations POST30 in the priming condition (MAP = 14.9, 95% HDI = 0.5 – 27.7, PD% = 98, % in ROPE = 5.6; Figure 4, Supplementary file 3) when compared to PRE values. There was insufficient evidence of meaningful changes in testosterone concentrations at any other timepoint. Changes in cortisol levels and the T:C ratio were negligible at POST30 and POST120 in both conditions when compared to PRE measures. Compared to PRE, the priming protocol had a larger increase in blood lactate POST5 in the priming condition (MAP = 2.8, 95% HDI = 1.3 – 4.1, PD% = 100, % in ROPE = 0.0; Figure 5, Supplementary file 4) when compared to the control. There was insufficient evidence to suggest meaningful differences in blood lactate concentrations between groups at POST30 and POST120 compared to PRE.

FIGURES 4 AND 5 ABOUT HERE

There were no meaningful differences in jump height, peak power, contraction time or flight time/contraction time at any timepoint across conditions. Compared to PRE, there was a reduction in cognitive performance POST120 in the priming condition for the congruent (MAP = 0.02, 95% HDI = -0.06 – 0.00, PD% = 95, % in ROPE = 6.4; Figure 6, supplementary file 5) and incongruent cognitive task (MAP = 0.00, 95% HDI = -0.07 – 0.00, PD% = 98, % in ROPE = 3.2; Figure 7, supplementary file 6) compared with the control condition. There was insufficient evidence to suggest an association between menstrual cycle data, and perceptual, physiological or performance changes in either condition.

FIGURES 6 AND 7 ABOUT HERE

DISCUSSION

The aim of this study was to investigate the effects of a 20-minute field-based priming session on perceptual, physiological and performance markers in female rugby sevens players. The findings show an increase in mental and physical readiness POST30 in the priming condition compared to the control. This increase in readiness aligned with a greater increase in testosterone levels from PRE to POST30 for the priming condition compared to the control condition. There were no meaningful differences between jump performance at any timepoints, however compared to PRE values, cognitive performance was impaired POST120 in the priming condition when compared to the control. The findings from the present study differ from those which observed increased physical performance alongside an increase in testosterone concentrations post intervention[7,9]. However, it is difficult to make direct comparisons with these studies due to the sex of the participants, the use of different recovery intervals, and the timing of assessments.

It is important to note that to our knowledge, this is the first study to investigate the effects of a field-based priming intervention with a 2-hour recovery interval specifically with female athletes. Woolstenhulme et al. investigated the impact of morning resistance training on afternoon performance in female basketball players, finding no difference in vertical jump, anaerobic power or shooting accuracy after a 6-hour recovery[28]. These findings, combined with those from the current study, suggest that the sex of participants may account for some of the differences in the effects observed. This is further supported by research comparing testosterone responses of males and females at rest and following different exercise intensities[29]. At baseline, males had a higher testosterone concentration than females (27.1 ± 9.2 vs. 1.5 ± 0.7 µg.L) and experienced significant elevations from baseline following heavy resistance training[29]. In comparison, no significant differences were observed in females following high load resistance training[29]. When considering skeletal muscle composition and function, females generally have a greater proportion of type I to type IIa muscle fibers than males. This can lead to a reduction in muscle strength and size, yet a greater resistance to muscle fatigue in females when compared to males [14,30]. Whilst speculative, these factors may contribute in different magnitudes to the observed priming effects.

When implementing priming interventions, consideration must be given to the combination of volume, load, and intensity of exercise[5]. Research investigating changes in upper- and lower-body power output 1 hour 45 minutes after a priming session reported greater improvements in performance when a higher relative load was lifted[10]. It was also reported that an increase in mechanical load by adding change of direction to a repeat-sprint protocol may lead to greater increases in testosterone compared with straight line sprints[9]. In the present study, an average of 1120 ± 49 m of total distance, including 120 m ± 37 m of sprinting (i.e., >6 m.s), was completed. The sprint distance equated to roughly 60% of a similar sprint intervention[7] however the authors in the previous study did not report distance within specific velocity thresholds. As the participants of the current study were regularly exposed to maximal velocity and repeat-sprints over various distances as part of training, the stimulus in the priming bout may have been insufficient to elicit a favorable response. Although it could be argued that the priming session may have exceeded the required intensity or volume, this is not reflected by the RPE and readiness scores, or the blood lactate responses observed in the current study. The intensity of the priming session may also contribute to the lack of increase observed in cognitive performance at POST120. An inverted U relationship exists with cognitive performance and exercise, with moderate exercise shown to improve cognitive performance[31]. Low or high exercise intensities can lead to no change or a reduction in cognitive performance in comparison[31]. This poses the question of whether the intensities needed to see cognitive performance benefits are the same as those required to improve physical performance. Whilst outside of the scope of the present study, this provides an opportunity for future research.

The findings from this study provide insight into acute perceptual, physiological and performance responses to a field based priming session in female rugby sevens players. Although results varied across timepoints, this study showed favorable outcomes at POST30 before returning to PRE levels or below at POST120 in the priming group. A limitation of this study that must be acknowledged is the small sample size. Although a larger sample size may have increased the certainty of outcomes, participants in this study were highly trained rugby sevens athletes and recruiting from outside of this cohort would have conflicted with the aim of this study. To account for small sample sizes when using highly trained athletes, researchers should consider implementing repeated measures study designs. Based on the findings of this study, future research into the volume and intensity of exercises included in field-based priming sessions is warranted. Due to the physical and cognitive demands of rugby sevens, additional research exploring priming intensities or interventions to acutely improve both elements would prove beneficial.

PRACTICAL APPLICATIONS

This study supports the use of a 20-minute field-based priming session to improve self-perceived mental and physical readiness to perform, and testosterone levels in female rugby sevens players after a 30-minute recovery. Whilst improvements in these markers at POST30 may be beneficial, consideration must be given as to whether this strategy and timing fits within the context of other game day preparation strategies. No changes in perceived muscle soreness, stress or fatigue, or cortisol concentration were found at any timepoint, however a reduction in cognitive performance was observed POST120 in the priming condition when compared with the control. The authors suggest higher intensities may be needed to elicit a priming response 2 hours post exercise, however further research is needed to confirm this result.

CONCLUSION

This study aimed to explore the acute perceptual, physiological and performance response to a field-based priming session in female rugby sevens players. There were no changes in jump performance at any timepoints, however self-perceived readiness and testosterone levels were improved 30 minutes post the priming session. Priming was not accompanied by improvements in perceptual, physiological or performance at POST120. These findings indicate that perceptual and physiological responses to priming may not necessarily be coupled with performance improvements.

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LIST OF FIGURES

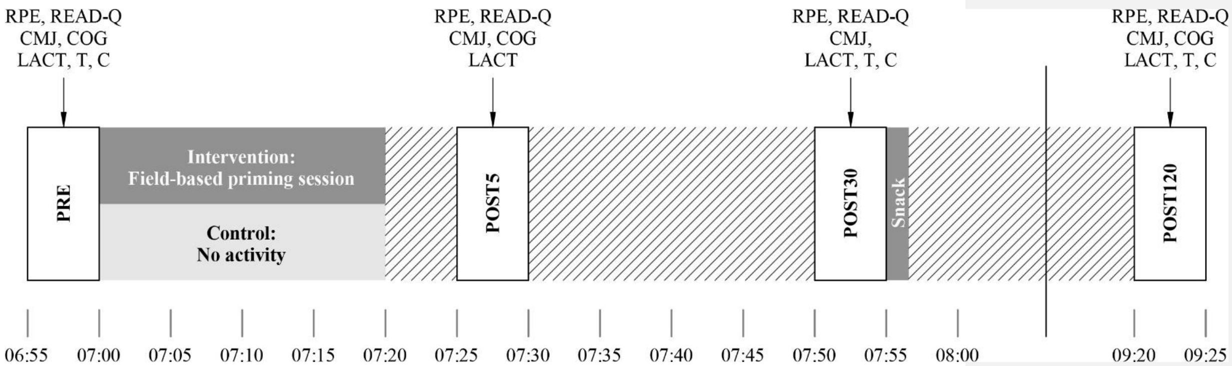


Figure 1: Overview of study protocol. RPE = rating of perceived exertion; READ-Q = readiness to perform questionnaire; CMJ = counter-movement jump; COG = Flanker task; LACT = blood lactate; T = testosterone; C = cortisol; [hatched box] = passive recovery; PRE = baseline measures, POST5 = 5 minutes post intervention measures; POST30 = 30 minutes post intervention measures; POST120 = 120 minutes post intervention measures

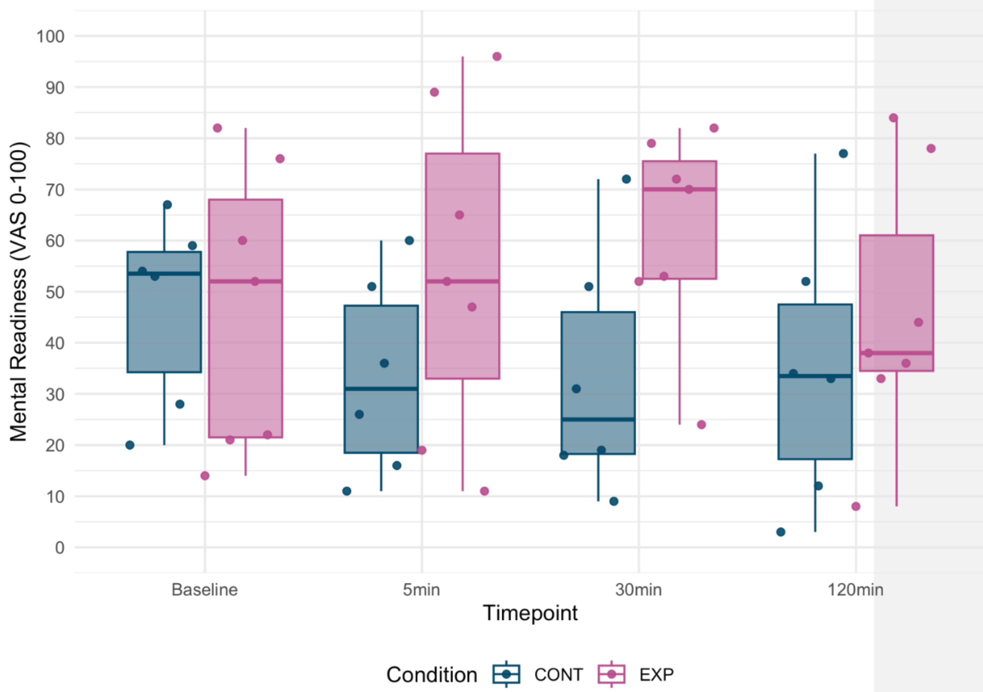


Figure 2: Mental readiness at each timepoint by condition. The points show the observed values for individual participants within a timepoint and condition. CONT = control group; EXP = experimental group.

Figure 3: Physical readiness at each timepoint by condition. The points show the observed values for individual participants within a timepoint and condition. CONT = control group; EXP = experimental group.

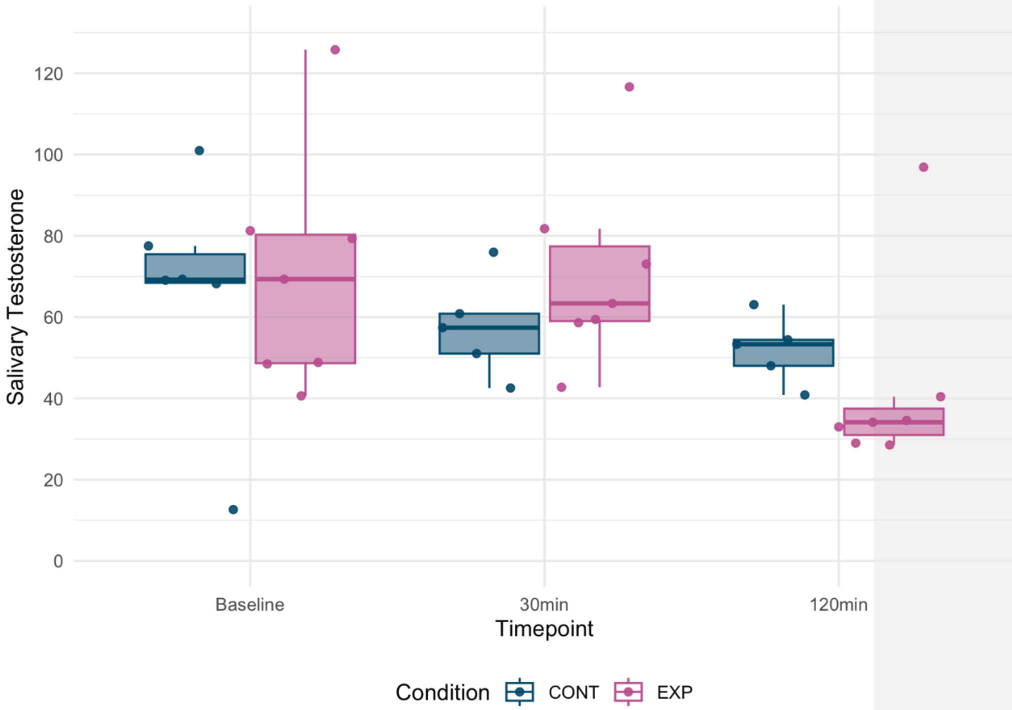
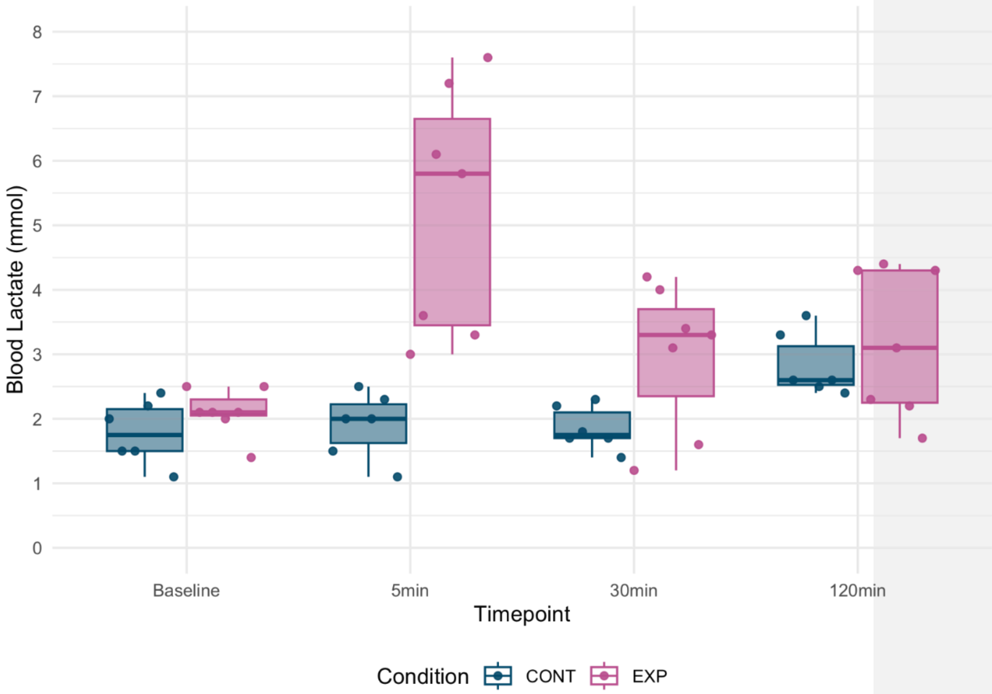


Figure 4: Salivary testosterone at each timepoint by condition. The points show the observed values for individual participants within a timepoint and condition. CONT = control group; EXP = experimental group.



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671 Figure 5: Blood lactate at each timepoint by condition. The points show the
672 observed values for individual participants within a timepoint and condition.
673 CONT = control group; EXP = experimental group.

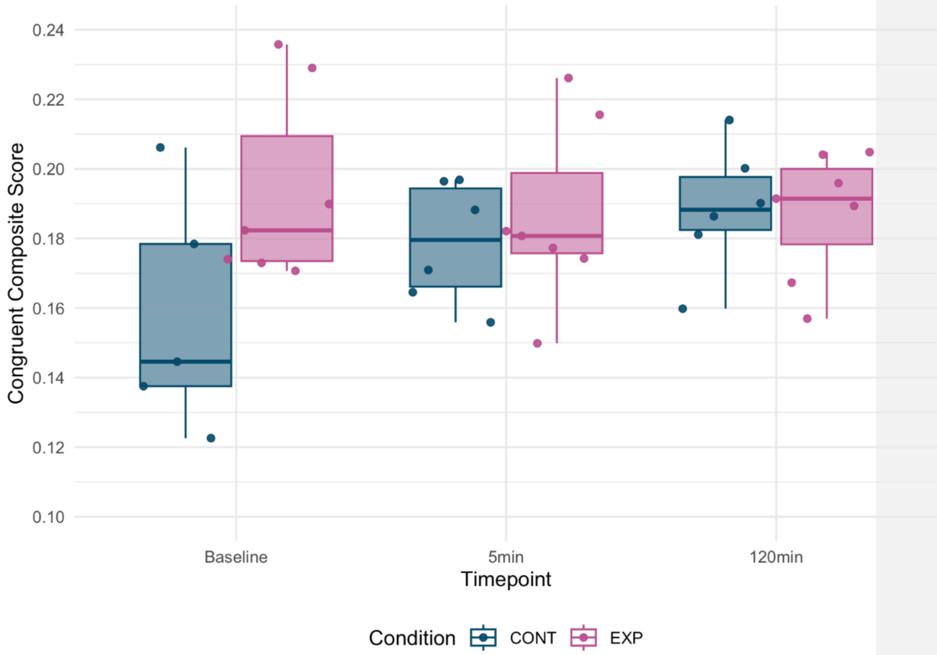

Figure 6: Flanker task congruent composite score at each timepoint by condition. The points show the observed values for individual participants within a timepoint and condition. CONT = control group; EXP = experimental group.

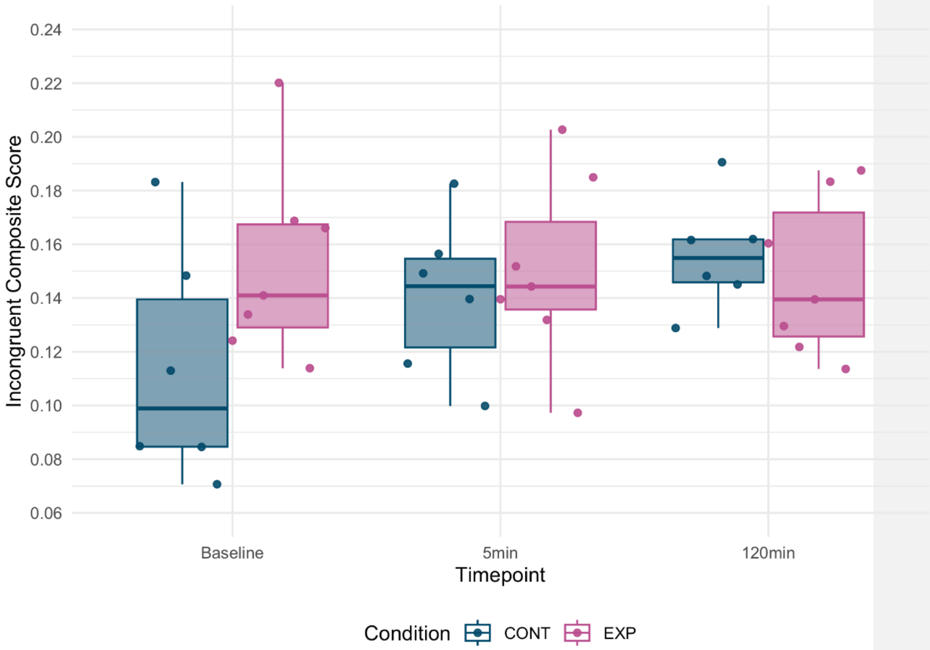

Figure 7: Flanker task incongruent composite score at each timepoint by condition. The points show the observed values for individual participants within a timepoint and condition. CONT = control group; EXP = experimental group.