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Brief communication

Sleep restriction and serving accuracy in performance tennis players, and effects of caffeine

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HIGHLIGHTS

- Poor sleep before a sports competition is common, but has little effect on strength
- Little is known about judgement and accuracy skills, as in tennis
- Two studies of 5 h Vs usual sleep effects on serving accuracy; one with 80 mg caffeine
- Both showed impairments with sleep loss, particularly for women
- Caffeine did not counteract this impairment

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ABSTRACT

Athletes often lose sleep on the night before a competition. Whilst it is unlikely that sleep loss will impair sports mostly relying on strength and endurance, little is known about potential effects on sports involving psychomotor performance necessitating judgement and accuracy, rather than speed, as in tennis for example, and where caffeine is 'permitted'. Two studies were undertaken, on 5 h sleep (33%) restriction versus normal sleep, on serving accuracy in semi-professional tennis players. Testing (14:00 h–16:00 h) comprised 40 serves into a (1.8 m × 1.1 m) 'service box' diagonally, over the net. Study 1 (8 m;8f) was within-Ss, counterbalanced (normal versus sleep restriction). Study 2 (6 m;6f -different Ss) comprised three conditions (Latin square), identical to Study 1, except for an extra sleep restriction condition with 80 mg caffeine vs placebo in a sugar-free drink, given (double blind), 30 min before testing. Both studies showed significant impairments to serving accuracy after sleep restriction. Caffeine at this dose had no beneficial effect. Study 1 also assessed gender differences, with women significantly poorer under all conditions, and non-significant indications that women were more impaired by sleep restriction (also seen in Study 2). We conclude that adequate sleep is essential for best performance of this type of skill in tennis players and that caffeine is no substitute for 'lost sleep'. 210

1. Introduction

Sleep prior to a competition can be disrupted by anxiety, travel, and jet-lag, and it is not unusual to have had only 4–5 h sleep on the night before a competition, including waking up early for 'warm-up' sessions etc. Whilst sleep loss is unlikely to affect cardio-respiratory and muscle function and physical work capacity (eg. [1–3]) adverse cognitive effects (rather than motor output) are well known (eg. [4–7]) as are mood changes ([8,9]).

Athletes are increasingly utilising caffeine (a permitted substance) to enhance physical endurance and physical recovery after strenuous exercise. However, it remains of questionable benefit to sports involving strength and power, such as sprinting ([10,11]). Although caffeine is effective in overcoming 'sleepiness' as reflected in monotonous and unstimulating performance measures, such as the psychomotor performance test (PVT — [7,12–14]), little is known about whether caffeine is effective in counteracting putative sleep loss effects on sports involving psychomotor performance necessitating judgement and accuracy, rather than speed, as in tennis serves, for example, and where caffeine is 'permitted'. As far as we can ascertain this aspect of caffeine in sports performance has not been investigated.

We report on two studies, a year apart, on the effects of sleep restriction versus normal sleep on an objective measure of serving accuracy (rather than power) in semi-professional men and women tennis players. The first study comprises sleep restriction alone, and the second involves a similar restriction, in an independent group, and compares caffeine with placebo, given double blind. Study 1 also compared men and women.

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2. Method — study 1

2.1. Participants

Sixteen performance tennis players, (8 m, 8f), aged 18–22y were recruited from the University's first and second teams, their having represented the University in the British University Sport Association's national competitions. They were good sleepers, having an average habitual sleep duration of between 6.5 h and 8 h, and were neither morning nor evening types [15]. They scored <10 on the Epworth Sleepiness Scale (ESS — [16]), and were modest consumers of alcohol and coffee. They had the procedures fully explained, signed consent forms, and received a gift voucher on completion of the study. The investigation, as well as Study 2, had full approval of the University's Ethical Committee. Participants had been told that the study was looking at the effects of sleep reduction on serving performance, as nothing was known about the topic, and that there may be no effect. Moreover, that we had no preconceptions about the outcome.

2.2. Design and procedure

There were two, within Ss conditions, normal sleep versus sleep restricted by 2–2.5 h by delayed bed-time (same rising times), with conditions balanced between participants, and given a week apart. Participants wore wrist-worn Actiwatches [Cambridge Neurotechnology, UK] the night before (from 18:00 h that evening) and slept in their normal beds. Actimeters were downloaded and checked for compliance with the required sleep durations (normal vs 5 h) the following morning before testing.

For three days and nights prior to experimental periods they kept logs of estimated sleep onset, and morning wakening and rising times, to ensure usual compliance with habitual sleep duration. They had to avoid alcohol and caffeinated drinks for 24 h before experimental days, and on this morning ate a light breakfast, consisting of cereal or toast but nothing fried. Lunch consisted of water and sandwiches consumed between 12:30 and 13:00 h. Testing was between 14:00 h and 16:00 h, to control for potential circadian effects (cf. [17]), as well as to coincide with the bi-circadian 'dip', that would have been enhanced by a prior night's sleep restriction. On arrival at the tennis court, participants were allowed a warm up according to their usual requirements, which had to be identical for both testing occasions. They were then given a basket of 40 new Slazenger tennis balls with which to serve. Each service was hit from the participant's desired point on the baseline (replicated on the second occasion).

Participants were asked not to consider their shots as 'first or second serves' but to aim their serve into the set target in the diagonal service box (see below) across the net, which was clearly marked with white masking tape. They were told that a serve would be considered accurate if it passed over the net and hit within the service box opposite. If it touched any of the boundary lines then it was 'out'. They were asked to do their usual best and that there was no demand to deliver in a rush, but at a steady pace.

Of the forty serves, the first 10 were discounted, to allow for any further 'warm-up', although participants were not aware of this. The accuracy (hit or miss) of each serve was logged by an experimenter situated near the target box but out of direct visual range of the participant. Once each participant completed the 40 serves they were debriefed and given some information about the accuracy of their serves, but not given their actual score (this was disclosed after the second condition). Afterwards, they were allowed to 'warm down' at their own discretion.

Participants used their own individual racquet, with string tension approximately between 50 and 65 pounds (cf. [18]).

2.3. Apparatus

The size of the target, located within the service box (see Diagram 1), was determined with the help of the University tennis coach, following a series of pilot tests that would allow an average 65% hit rate by comparable tennis players, under normal conditions. Target dimensions were: 1.8 m long by 1.1 m wide.

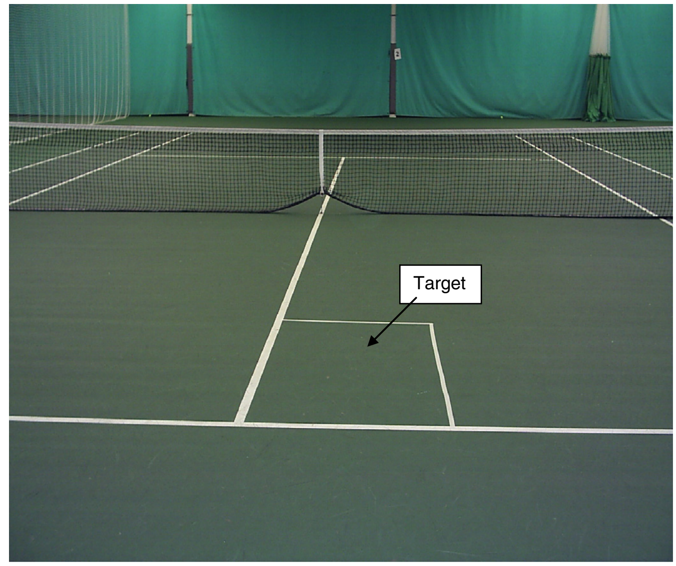

Diagram 1. Layout of target box.

3. Method — study 2

3.1. Participants

Twelve different performance tennis players (6 m, 6f), age range 19–23 years, from the same source as for Study 1,who fulfilled identical criteria, were recruited the following year. This group happened to be rather longer sleepers than those for Study 1, but the level of sleep restriction was still 2–2.5 h (see Results).

3.2. Design, procedure and apparatus

There were three conditions, given a week apart, in a repeated-measures, Latin square design. Conditions were identical to those of Study 1, except that there were two sleep restriction conditions, incorporating a sugar free drink given 30 min before testing under all three conditions. Under one of the restrictions the drink contained 80 mg caffeine, given double blind. This design gave six combinations of the three conditions, with two participants per combination. Participants were instructed as before, but were additionally told that the study was looking at caffeine effects, and that one of the conditions would include a modest dose of caffeine in the drink. Procedures for the 40 serves and the target box specifications were identical to those of Study 1

4. Results

4.1. Study 1

Group mean sleep durations (by actimeter) the night before testing, under baseline and sleep restriction were 395 min (s.e. 8.2 min) and 258 min (s.e. 4.8 min) respectively. A two-way (replicated) ANOVA on sleep duration X gender, for hits (max score = 30) within the service box, was significant for sleep condition ($F = 38.7$, df:1,28; $p < 001$), and is evident in Fig. 1a. There was also a significant gender difference ($F = 28.1$, df:1,28; $p < 001$), to be seen in Fig. 1b. There was no significant interaction; that is, no relative difference in the effect of sleep reduction between men and women.

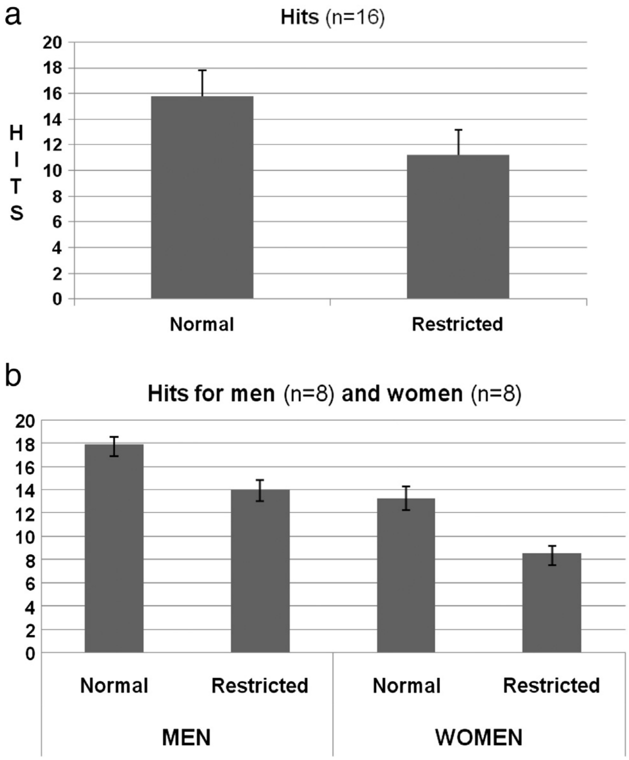

Fig. 1. Study 1: upper (a) - group means (standard error bars) for hits within the target box for both conditions (maximum score = 30). Lower b) data as for (a) but sub-divided by gender. There were significant differences between conditions for (a) and (b - for both men and women) - see Results.

4.2. Study 2

Mean sleep durations for baseline, sleep restriction alone and with caffeine were 465 min (s.e. 10.2 min), 325 min (s.e. 6.8 min) and 315 min (s.e. 7.3 min) respectively. A one-way, between conditions ANOVA was significant ($F = 93.0$; df:2,22 $p < 0.001$). Post hoc '*t* tests' between pairs of conditions were significant ($p < 0.02$) for baseline versus each of the sleep reduction conditions; there was no significant difference between the two sleep reduction conditions (caffeine versus no caffeine). It is apparent from Fig. 2b that although women generally performed more poorly, the nil effects of caffeine (as well as the effects of both sleep reductions) were relatively similar for men and women.

5. Discussion

It appears from both studies that sleep reduced by about one third affects serving performance in young men and women players. Although men, here, generally performed better than women, the outcomes with regard to sleep loss were consistent for both sexes. Also it can be seen that inasmuch that Study 2 replicates Study 1 in terms of effects of sleep loss (nil caffeine) versus baseline, the differences between the two conditions are very similar across studies, for both men and women.

Of course, we cannot be certain that the effects of sleep loss are purely cognitive, rather than due to participant 'expectancy' effects. Inasmuch that as coaches tend to advocate the importance of adequate sleep, then players might anticipate poorer performance and apply less effort following sleep reduction, despite our exhortations for them to do their best. However, these findings do seem to reflect laboratory based, non-sports-related findings pointing to detrimental effects of sleep loss on executive function [5,7].

In Study 2, caffeine at the dose given had no effect in improving deteriorating performance, and a larger dose could have been more effective. However, we were restricted in the amount of caffeine able to be given, as it could not be at a pharmacological level, but within acceptable 'social' limits, for example, as found in an average cup of coffee or in a 'functional energy drink' (eg 250 ml can of 'Red Bull'). For tennis players, adequate sleep would seem to be essential, at least for accurate serving performance.

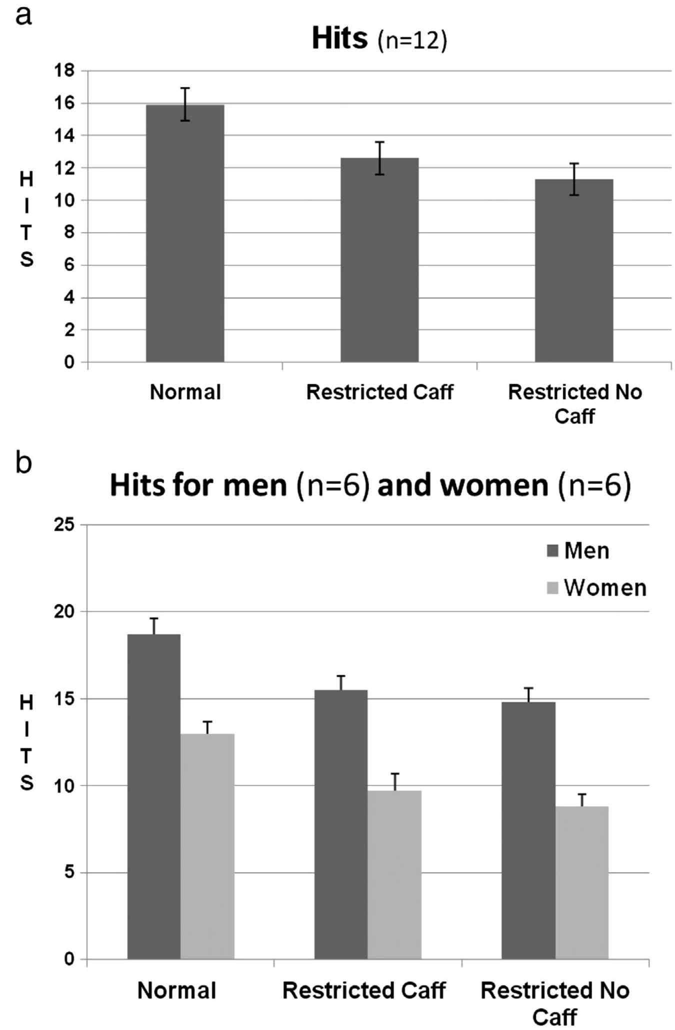

Fig. 2. Study 2: upper (a) - group means for hits (standard error bars) for the three conditions. Whereas the overall ANOVA was significant (see Results), with both reduction conditions being significantly poorer than baseline, there was no difference between the two reduction groups, indicating no effect of caffeine. Lower (b) findings as for (a), but for men and women separately.

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