Caffeine Maintains Vigilance and Improves Run Times During Night Operations for Special Forces

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Purpose: This study examined the effects of caffeine (CAF) on vigilance, marksmanship, and run performance during 27 h of sustained wakefulness in Special Forces personnel. ***Methods:*** There were 31 soldiers (29.8 $\pm$ 5.4 yr, 86.4 $\pm$ 8.6 kg) who were divided into placebo (PLAC, n = 15) and CAF (n = 16) groups. A 6.3-km control run was completed on the morning of Day 1. In the evening of Day 2, soldiers performed a control observation and reconnaissance vigilance task (ORVT) in the field. This 90-min task was repeated twice more between 02:00 and 06:00 on Day 3 during an overnight period of sleep deprivation. Marksmanship was assessed before and after the ORVT. PLAC or 200 mg of CAF gum was administered at 01:45, 03:45, and approximately 06:30 on Day 3. A final 6.3-km run commenced within 30 min of receiving the final dose. ***Results:*** ORVT was maintained in CAF at control levels of 77 $\pm$ 13% during the overnight testing. However, values decreased significantly for PLAC from 77 $\pm$ 15% to 54 $\pm$ 29% and 51 $\pm$ 31% during the first and second overnight testing periods, respectively. CAF had no effect on marksmanship but improved 6.3-km run times by 1.2 $\pm$ 1.8 min. Run times slowed for PLAC by 0.9 $\pm$ 0.8 min from approximately 35 min during the control run; the changes in performance were significant between groups. ***Conclusions:*** It was concluded that CAF maintained vigilance and improved running performance during an overnight field operation for Special Forces personnel.

Keywords: continuous operations, physical and cognitive performance, ergogenic and cognitive aids, psychomotor task, marksmanship.

SPECIAL FORCES units are comprised of elite combat personnel who are often required to engage in continuous operations that demand peak cognitive and physical performance. Reconnaissance and intelligence gathering missions often are conducted under the cover of darkness and, as such, provide little opportunity for sleep. It is well documented that inadequate sleep degrades cognitive function (see 2,10,20). In addition, physical tasks that require self-pacing and motivation are also degraded by sleep loss (23,24,32). Thus, under conditions where adequate sleep is not an option, other strategies should be considered that prevent or minimize the extent of the degradation in cognitive and physical function and, thereby, extend the period of operational effectiveness.

Caffeine is one such strategy that has been studied for its effectiveness in a military context (22,24,25,34,35). Caffeine acts as an adenosine receptor antagonist (for review see 12) and a recent extensive review also concluded that the consumption of caffeine in moderate doses is associated with few, if any, adverse effects in young healthy adults (26). Findings from several studies have demonstrated caffeine's effectiveness for improving physical and cognitive performance in both rested (1,5,16,21) and sleep-deprived subjects (17,24,29). Caffeine also has been reported to have no effect on marksmanship in rested soldiers (13) but has been shown to improve engagement time and vigilance during both simulated (34,35) and live-fire (25) marksmanship tasks in sleep-deprived soldiers and those fatigued from prior exercise (14).

The present investigation represents an extension of our previous laboratory (24) and field studies (25) that have demonstrated the effectiveness of caffeine for maintaining cognitive and physical performance throughout a night of sleep deprivation for conventional force personnel. Our interest in the present study, however, was to assess whether caffeine could be of benefit to highly trained Special Forces personnel who might believe they are more resistant to the negative effects of sleep deprivation documented with other subject populations. To ensure face validity for our findings, our field tests were designed specifically for these soldiers with the assistance of the unit's training staff. We hypothesized that those soldiers who received caffeine during the overnight period of sleep deprivation would maintain their physical and cognitive function closer to control values than those receiving placebo.

METHODS

Subjects

The study was granted approval by the human ethics review committee of Defense R&D Canada – Toronto,

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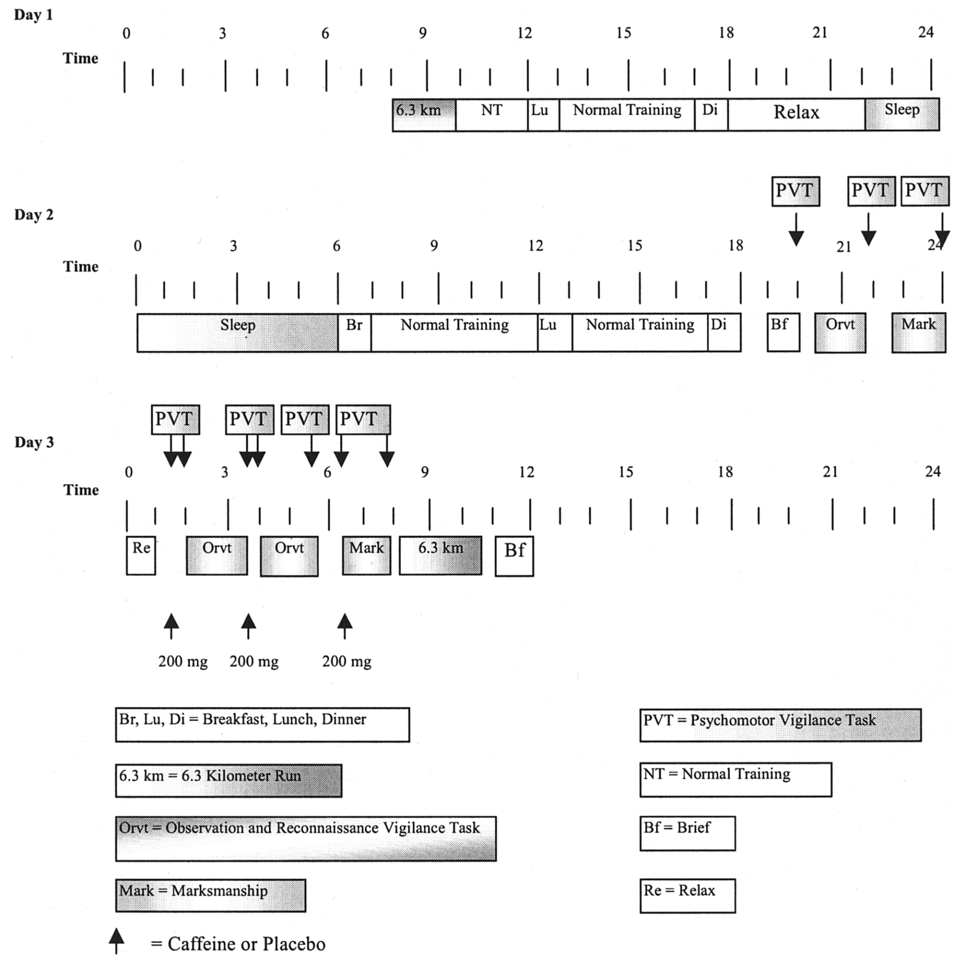

Fig. 1. A depiction of the timeline of the experimental protocol.

the Walter Reed Army Institute of Research, and the New Zealand Defense Force. There were 31 male Special Forces personnel with mean ± SD values for age of 29.9 ± 5.3 yr, height 179.6 ± 5.3 cm, and body mass of 86.4 ± 8.6 kg who participated in this study. All were cleared to participate in the study by their base medical officer. An initial briefing was provided where the soldiers were fully informed of the details, discomforts, and risks associated with the experimental protocol, and written informed consent was obtained. During the briefing the soldiers were separated according to their primary role as shooters or non-shooters and were divided into groups of four identified with letters from A through H. Two soldiers in each of these groups were designated to receive CAF ($n = 16$) and the other two received placebo (PLAC, $n = 15$) in a double-blind manner. The soldiers were informed that no coffee or caffeine-containing products were to be consumed for 12 h prior to the performance of the 6.3-km control run on Day 1 of the study, and following their morning breakfast on Day 2 until after the study was completed on the morning of Day 3. Daily caffeine consumption was categorized by their response to a questionnaire. Following the briefing, soldiers underwent training on the psychomotor vigilance task (PVT) as described below. Volunteers were not selected if they were taking any medication or if they had given blood within 30 d of the study.

Procedures

Day 1: The timeline for the study is depicted in **Fig. 1**. Between 08:00 and 10:00 of Day 1, the soldiers performed their control 6.3-km run consisting of three laps around the inside of a fenced area. The soldiers wore their combat clothing and boots, and carried approximately 11 kg of additional weight with their rifle, tactical assault vest, and canteens of water. Fluid replenishment was not permitted throughout the run. Start times were staggered by 10 min for each group. During the run the soldiers were told to give their best effort. Lap times and total time were recorded to the nearest second. Normal training activities were conducted for the remainder of this day.

Day 2: Soldiers reported at 06:00 following an 8-h sleep period and performed their normal training on Day 2. However, at 19:00 they reported for a briefing that described the sequence of activities throughout the night. At 19:45 they were transported from their base camp to the range. A PVT was performed by all subjects in the range shack, after which they walked approximately 300 m to the range to begin the observation and reconnaissance vigilance task (ORVT) that is described below. This ORVT, which represented the control session, lasted 90 min. The soldiers then walked back to the range shack, performed another PVT, and were then transported back to their base camp. From 22:30 until

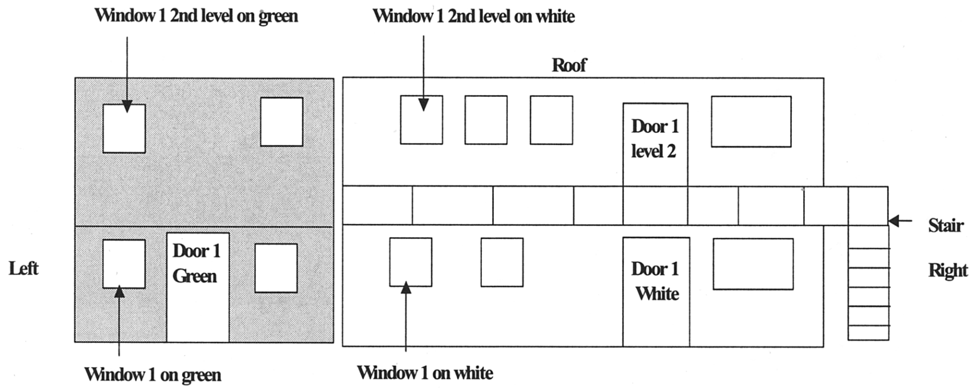

Fig. 2. A schematic representation of the building façade used during the observation and reconnaissance vigilance task. The front of the building façade was white whereas the left side of the façade was green.

24:00 control marksmanship testing was performed. Soldiers performed the shooting task in their groups.

Day 3: At 01:00 the soldiers were again transported back to the range and at 01:40 another PVT was performed in the range shack. At 01:45 two sticks of caffeine or placebo gum were administered and chewed for 5 min and a PVT immediately followed. Each piece of the caffeine gum (Stay Alert®, Amurol Confectioners, Yorkville, IL) contained 100 mg of the drug. Recent findings have shown that the caffeine contained in this gum is absorbed more rapidly into the circulation, presumably through the buccal tissue, than caffeine ingested in pill form (18). Both the placebo and caffeine gum also contained sugar, gum base, corn syrup, natural and artificial flavors, fructose, glycerine, sucralose, artificial color, and butylated hydroxytoluene.

The soldiers then walked to the range and began their first ORVT at 02:00. At 03:30 the soldiers returned to the range shack and performed another PVT at 03:40. This entire cycle was then repeated with the chewing of two additional sticks of gum beginning at 03:45 and ending at 05:45 when soldiers were transported back to the base camp. At 06:15 the marksmanship testing commenced. After each group of soldiers completed their marksmanship testing they reported to the base gym to perform the 6.3-km run. Because only four soldiers at a time could be tested for marksmanship, the timing of the last dose of gum varied somewhat among the groups. However, the amount of time that elapsed between the chewing of the gum, the testing of the marksmanship, and the subsequent performance of the run was consistent for all soldiers. A final briefing to all participants was made at 11:00, after which they were released.

Tests

PVT: The PVT is a test of continuous vigilance. The task is comprised of the subject reacting to a visual cue, which appears in the middle of a screen of a small hand-held Palm Pilot. The subject's task was to press a designated key as soon as possible after the visual cue appeared. The amount of time between each presentation of the cue was randomized between 1 and 5 s. The total time of the task was 5 min with an average of 50 presentations per test session. Performance was recorded on a minute-by-minute basis, allowing for a number of analysis methods. Variables measured include reaction time, and the number of minor (a reaction time greater than 0.5 s) and major lapses (a reaction time greater than 3 s) before responding to the cue. Dinges (11) defined a lapse as a response time greater than 0.5 s. The reader should be aware that our classification of major and minor lapses is not mutually exclusive.

ORVT: Prior to the start of this task, all subjects synchronized their watches and made sure that they had a flashlight, notebook, and pen to record their remarks. Soldiers assumed a seated or prone position 4–5 m apart with half of the group at 175 m and the others 200 m away from a building façade (**Fig. 2**) that was lit with interior and exterior lights. The width of the range precluded all of the soldiers from being positioned the same distance from the façade; however, the smaller groupings of four soldiers were used to ensure that there was no bias in the number of CAF or PLAC participants positioned at either 175 or 200 m. The soldiers were required to record the where, when, and what of any activity that occurred around this building over a 90-min observational period. Within each 15-min block, one activity was randomly presented as shown in **Table I**. Each activity was awarded a maximum of 3 points; 1 point for recording the appropriate time of the activity, 1 point for describing the activity accurately, and a 3rd point if they stated accurately where the activity happened. Thus, the total possible points awarded for this activity was 18 and scores were expressed as a percentage of this total possible score.

Marksmanship task: The marksmanship task evaluated both accuracy, target engagement, and response time for four soldiers at a time. All soldiers were tested with a pistol and those designated as shooters were also tested using a standard military assault weapon. For the accuracy component, the individual stood 10 m from two vertically aligned (one for each weapon) paper targets that presented an approximate 25 × 20 cm head and torso outline of a terrorist. A total of 10 rounds were fired at the designated target for that weapon with scoring shots represented by any hit within the outline

TABLE I. DETAILS CONCERNING THE TIMINGS AND DESCRIPTION OF THE ACTIVITIES USED DURING THE OBSERVATION AND RECONNAISSANCE VIGILANCE TASK.

	Control (20:20–21:50 of Day 2)			Session 1 (02:00–03:30 of Day 3)			Session 2 (04:00–05:30 of Day 3)		
Block of Time (min)	Block Time	Real Time	Activity	Block Time	Real Time	Activity	Block Time	Real Time	Activity
1–15	8 min	20:31	11	10 min	02:12	1	6 min	04:09	8
16–30	27 min	20:50	6	23 min	02:25	3	17 min	04:20	11
31–45	36 min	20:59	7	42 min	02:44	4	31 min	04:34	2
46–60	51 min	21:14	8	49 min	02:51	10	59 min	05:02	5
61–75	64 min	21:27	3	63 min	03:05	8	67 min	05:10	9
76–90	85 min	21:48	2	80 min	03:22	11	78 min	05:21	6

Activity	
1	Terrorist with rifle moves into Door 1 on green and then moves back inside.
2	Terrorist with rifle runs out door 1 on green and enters door 1 on white.
3	Terrorist appears in window 1 on white, draws curtain back, and then disappears.
4	Terrorist moves out of shadows on right side of building, lights a cigarette, and then moves back inside.
5	Terrorist moves out of shadows on left side of building, lights a cigarette, and then moves back in.
6	Terrorist and one hostage move out of door 1 on green. The terrorist kills the hostage and then moves back inside the same door.
7	Hostage that was killed gets back up and enters door 1 on green.
8	Terrorist with rifle runs out from right side of building and moves into door 1 on white.
9	Terrorist appears in window 1 on second level on white, draws curtain back, and then disappears.
10	Terrorist moves past windows 1, 2, and 3 on second level on white, appears in door, and then disappears.
11	Terrorist moves up stairs and walks back and forth on roof.

of the target. The lights in the indoor range remained on throughout this phase of the testing.

The second component was a target engagement and response time task. Again soldiers stood 10 m from targets that were presented in three rows of three, randomly numbered 1 through 9. A target number was identified as the lights in the room were turned off. The soldiers were instructed that when the lights were turned back on they were to shoot twice at the identified target. The lights would come on for 4 s and then be turned off again as another target number was identified. This procedure was repeated until five different targets were engaged, thus representing a maximum possible score of 10. The time that the room remained dark between target engagements varied from 5 to 30 s. The target numbers that were to be engaged and the time that the room remained dark between target engagements were randomized for each group of shooters. The scoring for the accuracy and reaction time components was expressed as a percentage of the maximum score.

Data Management

Data analyses for the various tasks were based on different numbers of soldiers. For the 6.3-km run, five soldiers in PLAC and one from CAF were unable to perform the control run because they were recovering from injury and thus were eliminated from the analysis. This information was not disclosed until after the soldiers had been allocated to their respective drug or placebo groups. By chance, therefore, more soldiers in PLAC were unable to perform the control run. A further three soldiers from the PLAC and one from the CAF group did not complete the second 6.3-km run because of blisters that developed after the initial run or because of a sprained ankle that prevented the completion of the second run. The final analysis, therefore, was based on 8 soldiers in PLAC and 14 in CAF. All of the soldiers completed the PVT and the ORVT tasks. Data analyses for the marksmanship task were restricted to those soldiers designated as shooters (n = 10 for both PLAC and CAF). Weapon malfunction eliminated one CAF shooter for the testing of target engagement and response time with the pistol and one PLAC shooter for both the accuracy and target engagement tests for the assault weapon. Although the non-shooters were assessed with the pistol, their recent training had not included practice with this weapon. Thus their data were excluded from the analyses because of this confounding effect.

Statistical Analyses

An analysis of variance with one grouping factor (drug) and one repeated factor (time of testing) was used to determine the difference between and within

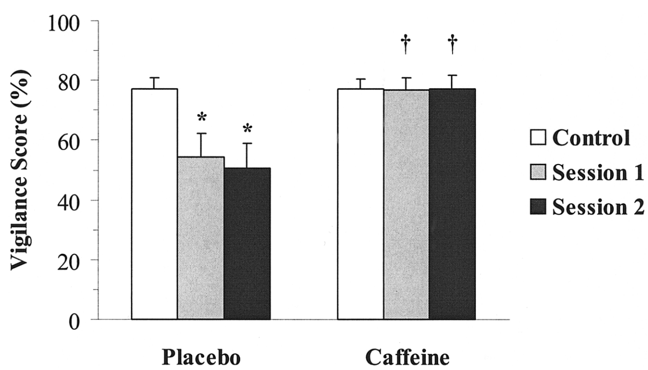

Fig. 3. Observation and reconnaissance vigilance scores expressed as a percentage (%) of the total possible score of 18. * indicates a significant difference from the control placebo score whereas † indicates significant difference between the caffeine and placebo groups. Values are means ± SD.

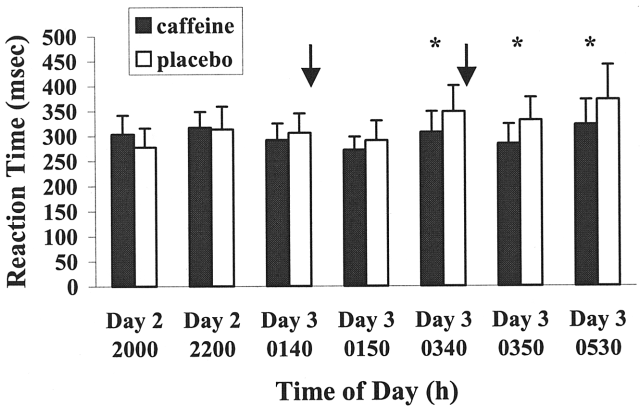

Fig. 4. Reaction time scores during the psychomotor vigilance task performed in the range shack before or after the observation and reconnaissance task conducted during the evening of the second day and the early morning of the third day of the trial. The arrows indicate when 200 mg of caffeine or placebo gum was administered. * indicates a significant difference between the placebo and caffeine groups. Values are means ± SD.

each group for each of the dependent measures. To correct for the violation of the sphericity assumption with the repeated factor, a Huynh-Feldt correction was applied to the F-ratio. Where necessary, when a significant F-ratio was obtained, a Newman-Keuls post hoc analysis was used to isolated differences among treatment means. For all analyses, an α level of ≤ 0.05 was used to represent statistical significance.

RESULTS

One soldier in CAF and three in PLAC were nonusers of caffeine. For the remaining soldiers, caffeine consumption varied considerably from a low of 10 to a high of 700 $mg \cdot d^{-1}$. Average daily caffeine consumption was not different between the CAF (230.0 ± 133.7 $mg \cdot d^{-1}$) and PLAC (273.8 ± 232.9 $mg \cdot d^{-1}$) groups.

The performance for the ORVT is depicted in **Fig. 3**. The significant decrement in performance for PLAC from their control trial to the first and second early morning sessions was 22.8 and 26.7%, respectively. CAF showed no decrement in performance from their control level and values were significantly greater than PLAC during the morning sessions.

Baseline values for both reaction time and lapses were not different between groups recorded during the evening of Day 2. Reaction time during the PVT conducted before and after the ORVT slowed throughout the early morning of Day 3 for the PLAC group, whereas values slowed for the CAF group only during the testing conducted at 05:30 on Day 3 of the trial (**Fig. 4**). Values between groups were significantly different beginning with the testing conducted at 03:40 of Day 3. There was a main effect of group for lapses recorded during the night. The CAF group had significantly fewer lapses (1.8 ± 2.1) compared with the PLAC group (3.6 ± 3.1). CAF did not affect the accuracy or target engagement and response time scores for either the pistol or the assault weapon. There was, however, an overnight decrement in performance in the pistol target engagement and response time performance in both groups (**Table II**).

The time to complete the 6.3-km distance was significantly slower for CAF compared with PLAC for the control run (**Table III**). However, following the overnight period of sleep deprivation, 6.3-km run times were not different between groups. The change in run time expressed as a percentage of the control value was significantly different between groups. Whereas a slowing of 2.6 ± 2.4% was observed for PLAC, those soldiers receiving CAF improved by 2.5 ± 4.7%. The completion of the second and third laps during the run was also significantly faster for CAF following the overnight period of sleep deprivation (Table III).

DISCUSSION

The results from this study have shown that the use of caffeine is an effective strategy to extend the period of operational effectiveness for Special Forces personnel during an overnight period of sustained wakefulness. The use of 600 mg of caffeine throughout the night maintained alertness and vigilance during our field observational task while performance decreased for those receiving placebo, enhanced run performance, and had no effect (positive or negative) on shooting accuracy. These findings, therefore, are consistent with previous laboratory (24,35) and field studies (25) that tested the efficacy of a similar dose of caffeine on cognitive and physical performance and marksmanship during a period of sustained wakefulness with conventional forces personnel. The novelty of the present study relates to the face validity of our approach, which ensured that our findings would be applicable and meaningful within the Special Forces community.

TABLE II. MARKSMANSHIP ACCURACY AND TARGET ENGAGEMENT SCORES EXPRESSED AS A PERCENTAGE OF THE MAXIMUM SCORE OF 10 FOR THE PISTOL AND ASSAULT WEAPON.

	Pistol				Assault Weapon			
	Accuracy		Target Engagement		Accuracy		Target Engagement	
	CAF	PLAC	CAF	PLAC	CAF	PLAC	CAF	PLAC
Control	97.0 ± 9.5	93.0 ± 12.5	92.2 ± 9.7	87.3 ± 5.3	100 ± 0	100 ± 0	100 ± 0	100 ± 0
Post	95.0 ± 8.5	96.0 ± 8.4	78.9* ± 19.6	74.5* ± 16.6	100 ± 0	100 ± 0	100 ± 0	98.9 ± 3.3
n	10	10	9	10	10	9	10	9

The control test was performed in the late evening of Day 2 of the study design whereas the post-testing was conducted in the early morning of Day 3 following a night of sleep deprivation. Values are means ± SD for the caffeine (CAF) and placebo (PLAC) groups.
* indicates a significant main effect where both groups showed a decrease during the post-testing compared with control values.

TABLE III. LAP TIMES AND TOTAL 6.3-KM RUN TIMES IN MINUTES FOR THE CAFFEINE AND PLACEBO GROUPS.

	Caffeine (n = 14)				Placebo (n = 8)			
	Lap 1	Lap 2	Lap 3	Total	Lap 1	Lap 2	Lap 3	Total
Control	10.64 ± 0.87	12.15 ± 1.59	12.53 ± 1.77	35.32* ± 4.16	10.38 ± 0.84	11.67 ± 1.39	11.77 ± 1.37	33.82 ± 3.54
Post	10.72 ± 0.79	11.73† ± 1.10	11.88† ± 1.00	34.32 ± 2.81	10.71 ± 1.02	11.91 ± 1.33	12.07 ± 1.47	34.69 ± 3.70

The control test was performed in the morning of Day 1 of the study design whereas the post-testing was conducted in the morning of Day 3 following a night of sleep deprivation. Values are means ± SD. * indicates a significant difference between the caffeine and placebo groups whereas † indicates a significant difference from the control test.

The impact of caffeine on cognitive function is well documented for both rested (1,21) and sleep-deprived (4,17,28,36,37) individuals during controlled laboratory studies. Typically, effects have been assessed using computer-based tasks to measure reaction time, vigilance, and alertness (4,17,37). Since Special Forces personnel often encounter extended operations that restrict or reduce opportunities for sleep, the use of caffeine to maintain cognitive function, in theory, could be an effective countermeasure. However, until recently, it was not known whether the findings from these computer-based tests would also be evident during the conduct of military activities. McLellan et al. (25) studied the effects of caffeine on vigilance during both a marksmanship and urban operations task constructed as part of a 55-h field exercise with conventional forces personnel that included only 3 h of sleep during the first night of the trial. The tasks produced both consistent and sensitive findings that revealed the impact of sleep deprivation and the beneficial effects of caffeine (25). In a similar context, the findings from the ORVT in the present study also revealed immediate and consistent decrements in vigilance during the overnight period of sleep deprivation that were countered with caffeine. It is also interesting to note that the differences in vigilance between groups during the ORVT occurred at a time when differences in reaction time were also observed between groups during the performance of the PVT. A separate manuscript will examine the relationship between the soldiers' performance during these tests, which were constructed for our field trials (25, the present study), and the PVT.

Physical performance is more resistant to sleep deprivation (30,33), but nonetheless, those physical tasks that involve self-pacing and motivational efforts to continue are impacted by sleep deprivation (23–25,32). Consistent with these reports was the reduction in running performance for the placebo group in the present study. Caffeine has ergogenic properties for rested individuals when it is ingested prior to or during exhausting exercise (6,8,15,19) and it appears to respond in a threshold-dependent manner (7,16,27) with lower threshold values being necessary to observe effects in non-users compared with users of the drug (5). Caffeine's ergogenic effect on sleep-deprived individuals is less consistent. Our previous studies have revealed that 600 mg of caffeine provided throughout an overnight period of sleep deprivation either restored running performance to levels consistent with a rested state (24) or had no effect (25). The present study revealed an improvement in 6.3-km running performance for the soldiers receiving caffeine that was significantly greater than the reduction in performance observed for the placebo group.

Although the total dose of 600 mg of caffeine was similar for all of our studies during the overnight period of sleep deprivation, the number, timing, and amount of each dose varied depending on the particular study design. For example, our initial laboratory study (24) delivered a large 400-mg bolus of caffeine late in the evening with subsequent smaller 100-mg doses at 03:00 and 05:00 in the morning. The last dose of caffeine occurred about 2 h before a run to exhaustion where performance times were similar to control values. Our next design (25), which was a field study, began with a smaller 100-mg dose of caffeine during the late evening and continued with subsequent 200-mg or 100-mg doses every 2 h until 04:00 in the morning. The last 200-mg dose occurred 5 h before a 5-km run where performance times were significantly reduced from control values and not different from the placebo response. In the present study, three equal 200-mg doses of caffeine were delivered with the last dose occurring approximately 45 min prior to the performance of the final 6.3-km run. Thus, the timings and dose of caffeine that are administered during the overnight are important considerations if heavy or potentially exhaustive exercise is part of the military scenario. This is especially true for Special Forces personnel, where escape and evasion tactics may be required to safely reach an extraction point.

The reader is cautioned that changes in run times were small and that no differences were evident between groups after the sleep deprivation period. However, it must be remembered that the change in performance was significantly different between groups. Given that these soldiers covered 1 km every 6 min, the change in performance would represent a difference of approximately 350 m between the caffeine and placebo conditions after the period of sleep deprivation. It is not known whether this magnitude of change would have an impact within the context of Special Forces' operations.

Previous studies have used firearms training simulators to assess the impact of caffeine on marksmanship in rested (13), physically fatigued (14), and sleep-deprived soldiers (34,35). Caffeine had no effect in the rested state (13), but decreased target engagement time and increased the number of shots fired at foe targets in either the physically fatigued (14) or sleep-deprived state (34,35). In our previous field study (25), caffeine maintained the vigilance of target recognition at control levels during an overnight period of sleep deprivation compared with the significant decline that was observed under placebo conditions. In the present investigation, we did not have access to a firearms training simulator and were not able to assess marksmanship vigilance on a live-fire range as was done previously (25). Thus, we assessed live-fire marksmanship accuracy and constructed a marksmanship task to determine the impact of caffeine on the accuracy of target engagements. Regardless of whether the assault weapon or pistol was used, caffeine had no affect on our measures of marksmanship during the overnight period of sleep deprivation. Target engagement times with a firearms training simulator have been reported recently to be approximately 3 s under control or rested conditions (35). These times increased significantly to 3.3 s during an overnight period of sleep deprivation, but were maintained at control levels following caffeine administration (35). The fact that the room remained illuminated for 4 s during the target engagement task in the present investigation may have been too long to allow for the discrimination of the effect of caffeine on target engagement times. Decreasing the illumination period to 3 s and/or videotaping the marksmanship task would be options to consider for future investigation. It should also be emphasized that caffeine had no negative effects on marksmanship in the present study, a finding that is consistent in all of the previous reports (12,13,24,33,34).

Caffeine is an A_1 and A_{2a} adenosine receptor antagonist (for review see 12). Cholinergic neurons projecting to the basal forebrain have been implicated in the control of arousal and are under A_1 receptor control (3,31). In addition, intracerebroventricular injections of adenosine receptor antagonists (such as caffeine) in the rat have shown increases in brain neuronal discharge, spontaneous locomotor activity, and treadmill run times to exhaustion (3,9). Thus, the increased alertness and vigilance for CAF measured during the overnight period of sustained wakefulness with the field ORVT and the computer-based PVT together with the improved performance during the 6.3-km run most likely reflects the impact of the drug on central processes involved in arousal and motivation.

In summary, the present study has demonstrated the effectiveness of caffeine for maintaining vigilance and improving running performance for Special Forces personnel during an overnight period of sleep deprivation, but did not affect marksmanship. Although the finding with regard to marksmanship is at odds with some of our previous work, the more consistent beneficial effects of caffeine on physical performance and vigilance support the recommendation that during periods of unavoidable sleep loss the use of caffeine can extend the period of operational effectiveness during the conduct of military operations.

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