

Caffeine and Sport: Robbing Peter to Pay Paul?



New Zealand



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Caffeine

- Tea - China
- “Qah’wa” - wine of the bean
- 90% of adults consume caffeine every day
- Pharmacological ergogenic aid



V ICED COFFEE (600ml)
Caffeine: **160mg**

RED BULL (355ml)
Caffeine: **114mg**

PURE ENERGY (568ml)
Caffeine: **182mg**

ROCKSTAR (500ml)
Caffeine: **160mg**

NOS (568ml)
Caffeine: **182mg**

RED BULL (250ml)
Caffeine: **80mg**

MOTHER (250ml)
Caffeine: **80mg**

V GREEN (500ml)
Caffeine: **155mg**

V BLUE (500ml)
Caffeine: **155mg**



HANGOVER (59ml)
Caffeine: **200mg**



COFFEE
Brewed (236ml)
Caffeine: **108mg**
Instant (236ml)
Caffeine: **57mg**
Espresso (44ml)
Caffeine: **77mg**



CUP OF TEA (236ml)
Caffeine: **42mg**



LIFT PLUS (250ml)
Caffeine: **80mg**



COKE (355ml)
Caffeine: **34mg**



V POCKET ROCKET (60ml)
Caffeine: **120mg**



WADA and caffeine

- The use of a substance before or during sports competition should be banned if two of the following criteria are met:
 - Benefit from an increase in performance
 - Put his/her health at risk
 - Violate the spirit of the sport
- Banned in 1984 due to reported abuse of caffeine (Delbeke and Debackere 1984)
 - Urine sample $>12 \mu\text{g}\cdot\text{mL}^{-1}$
- Removed from prohibited list in 2004





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Early Lead

Caffeine could be headed to World Anti-Doping Agency's prohibited substance list

By [Marissa Payne](#) March 8 



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Caffeine use in athletes

Del Coso et al (2011)

- 20,686 samples between 2004-2008
- 0.6% (124) exceeded $12 \mu\text{g}\cdot\text{mL}^{-1}$
- 74% of athletes consume caffeine before or during competition
- 19% co-utilisation with other substances
- Endurance athletes have higher consumption
- Increased use in older athletes (>30 y)





"We take a lot of things...to get those little extra one-percenters. **You can get 7 per cent extra work output from taking these tablets...**a big increase at this end of sport."



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How a rugby star swapped sport for coffee shops

By Phil Mercer
BBC, Sydney

26 July 2015 | Business

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Former Australian rugby union captain George Gregan looks back on his time in the game, and how he built up a food and hospitality business.



Performance benefits: Endurance exercise



Bridge & Jones (2006)

- 8 well-trained male runners
- 3 mg/kg (60 min pre)
- 8 km race on track
- **↑1.2% (24 s)**, with ↓RPE but

↑HR



Bruce et al (2000)

- 8 well-trained male rowers
- 6 or 9 mg/kg (60 min pre)
- 2000 m ergometer row
- **↑1.3% and ↑1.0%**

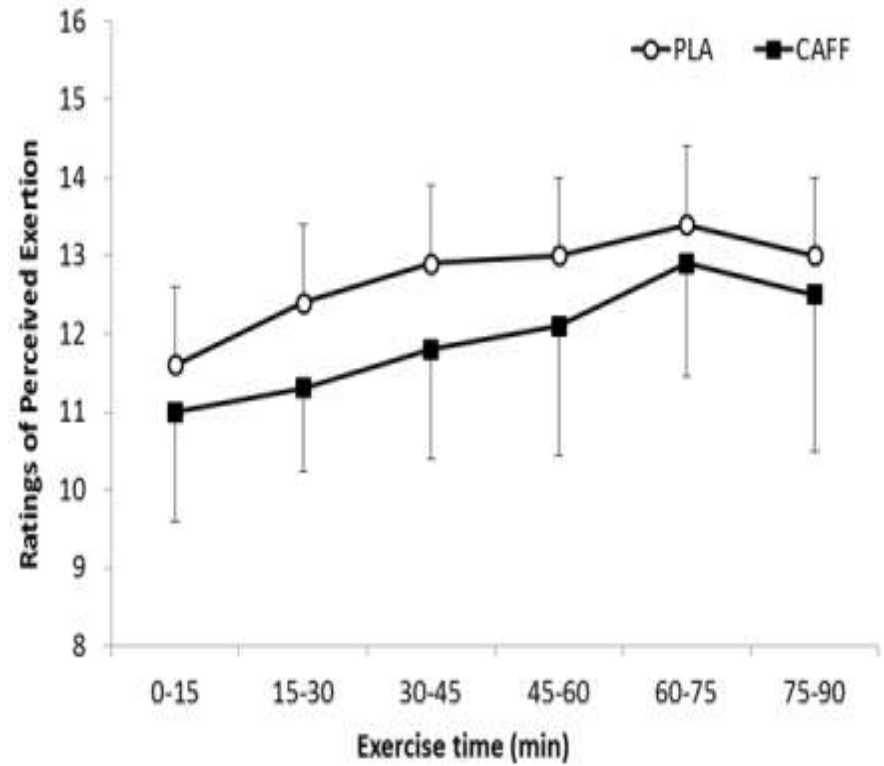
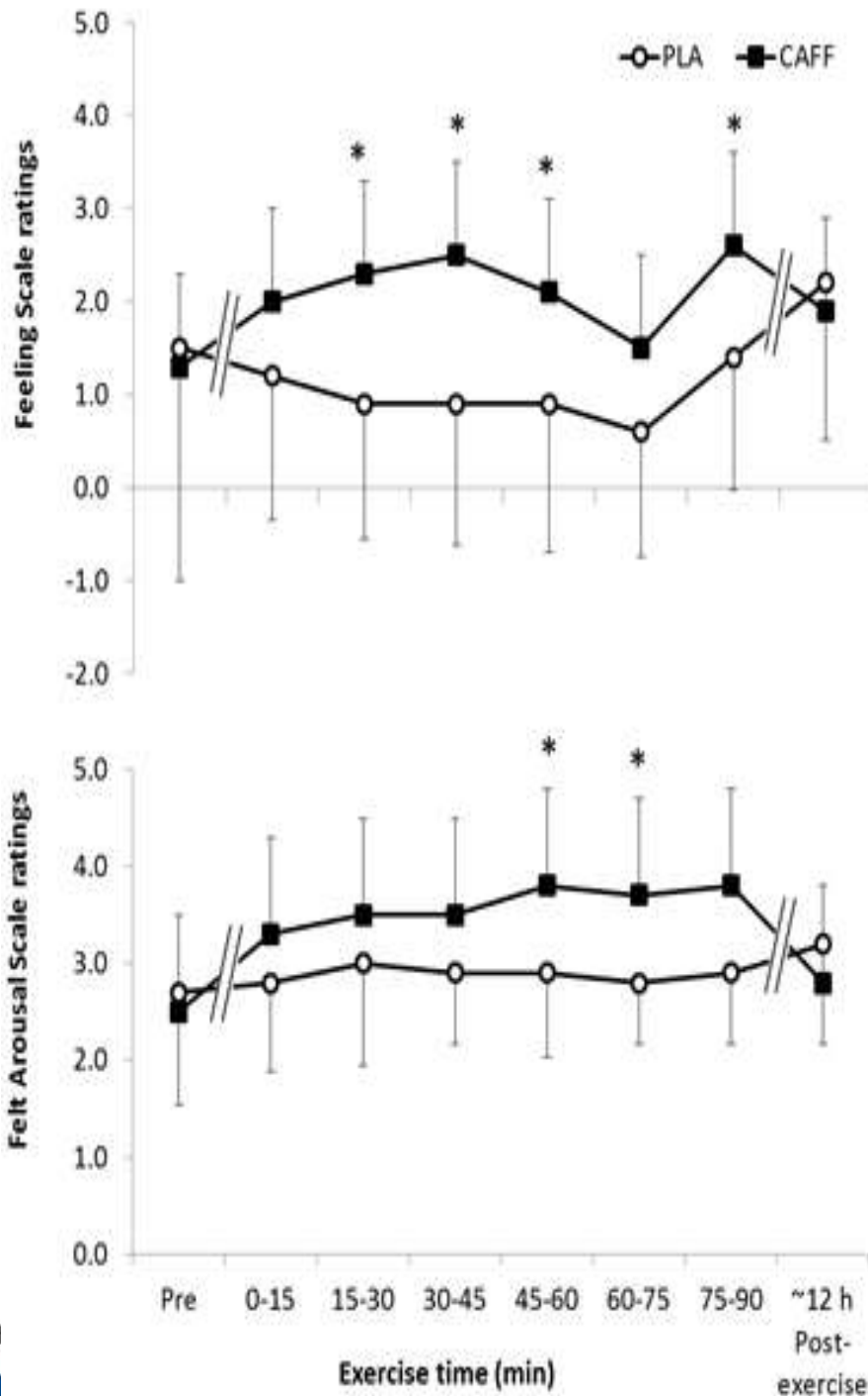
Performance benefits: Team sports

- Foskett, Ali and Gant (2009)
- 12 male players
- 6 mg·kg⁻¹ 60 min pre
- ↑4.5% skill performance
- ↑2.7% jump performance

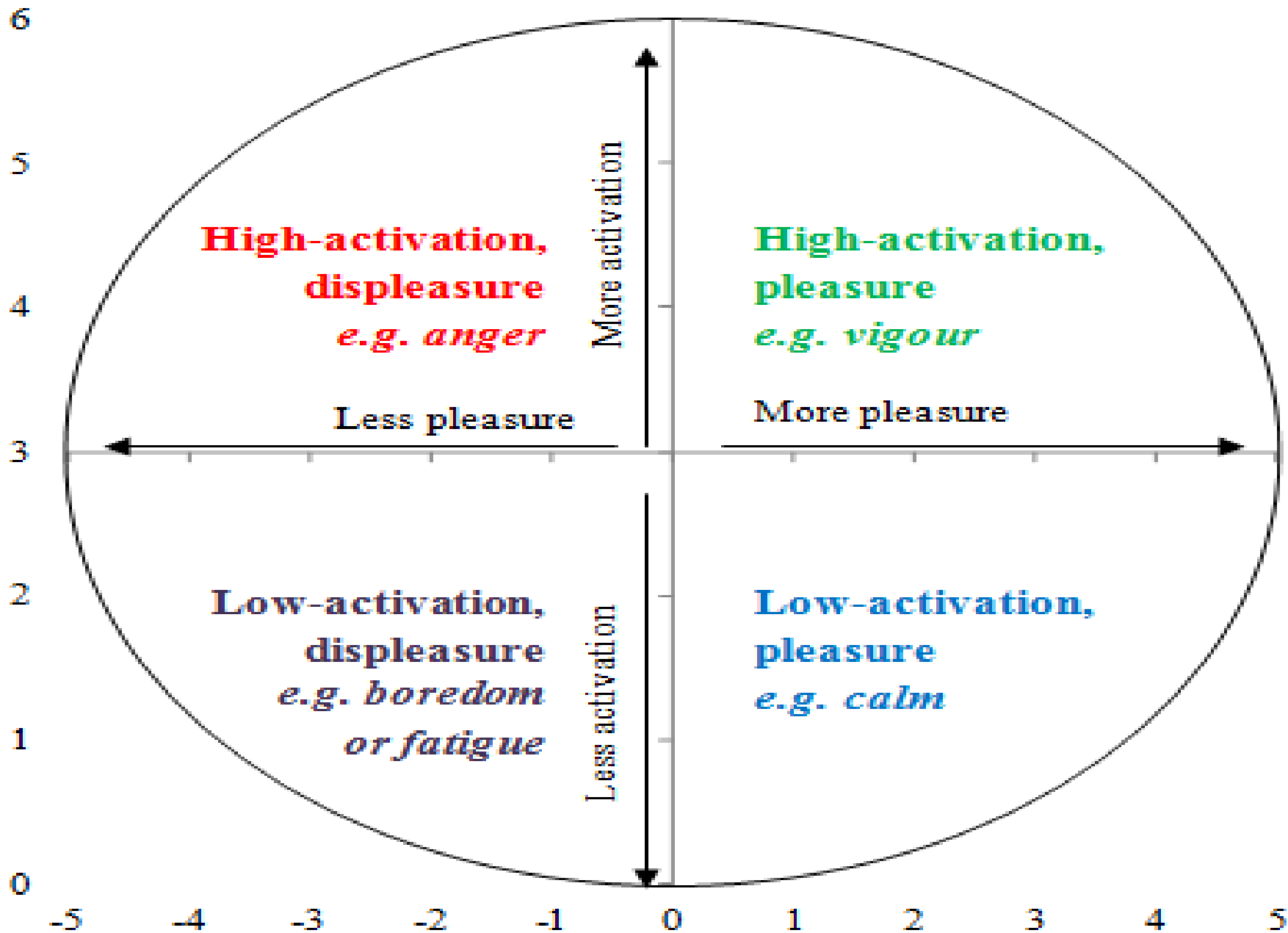


Psychological factors

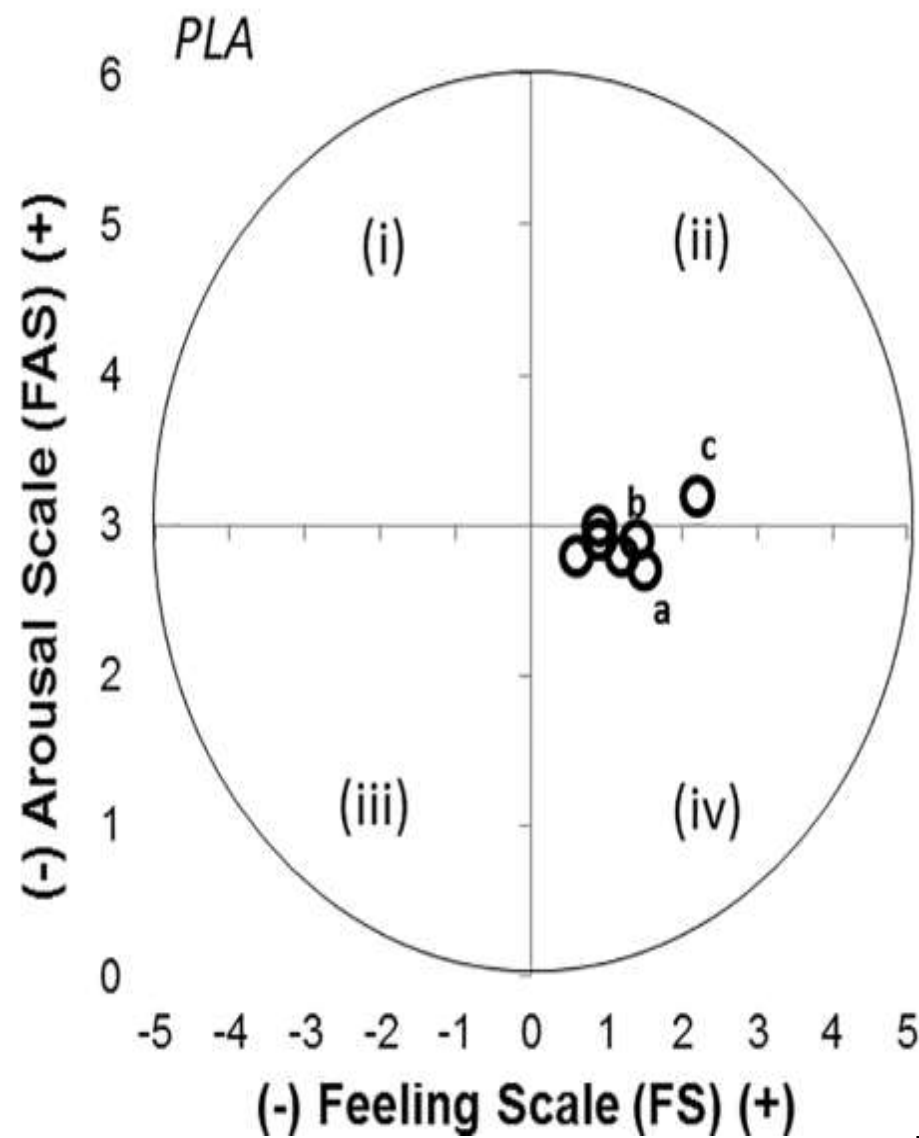
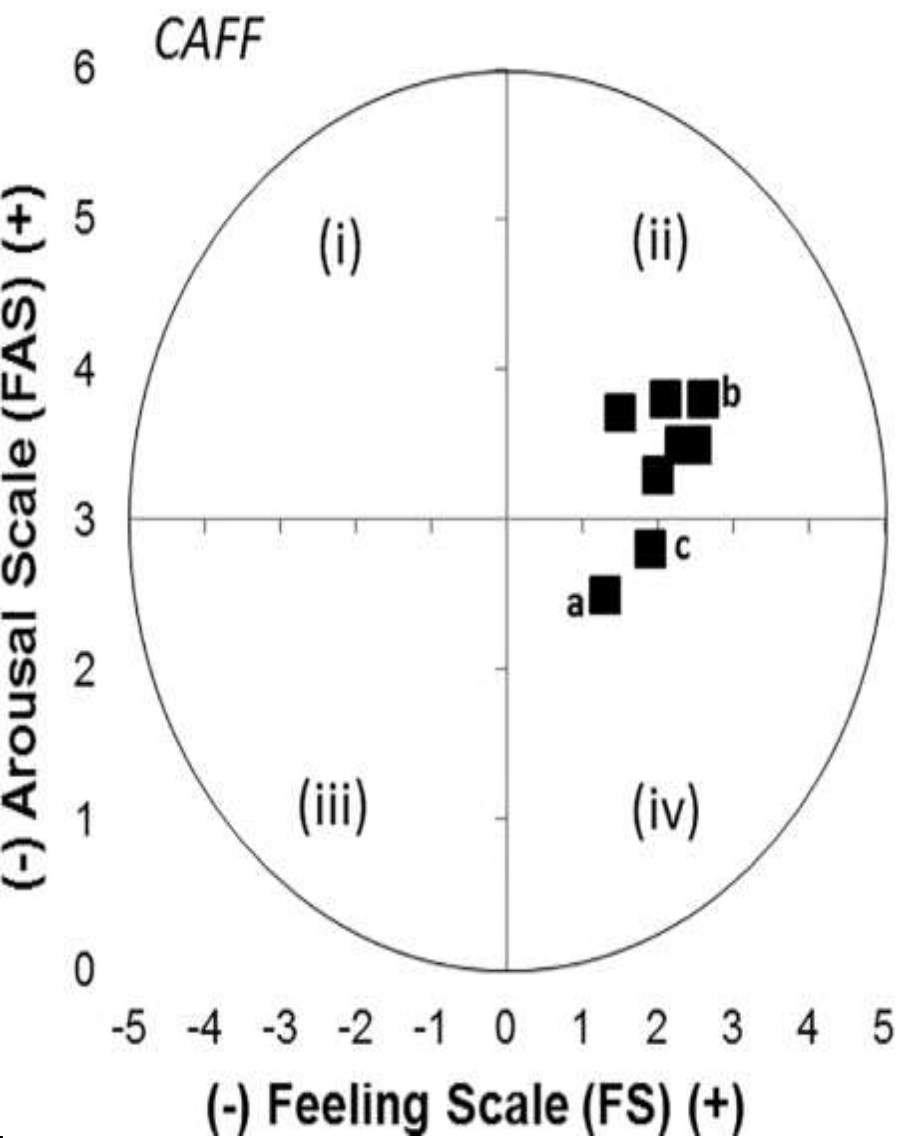
	Acute intake	Tolerance	Caffeine cessation
Mental alertness	Increases	No change	Decreases
Mood	Improves	No change	Degrades
Jitteriness	Increases (or no change)	Decreases	No change
Tiredness	Decreases	No change	Increases
Headache	Decreases	Decreases	Increases
Nervousness	Increases (or no change)	Decreases	Decreases
Pain perception	Decreases	No change	Increases
Sleep	Decreases	Decreases (or no change)	Prolongs
Forever discovering			

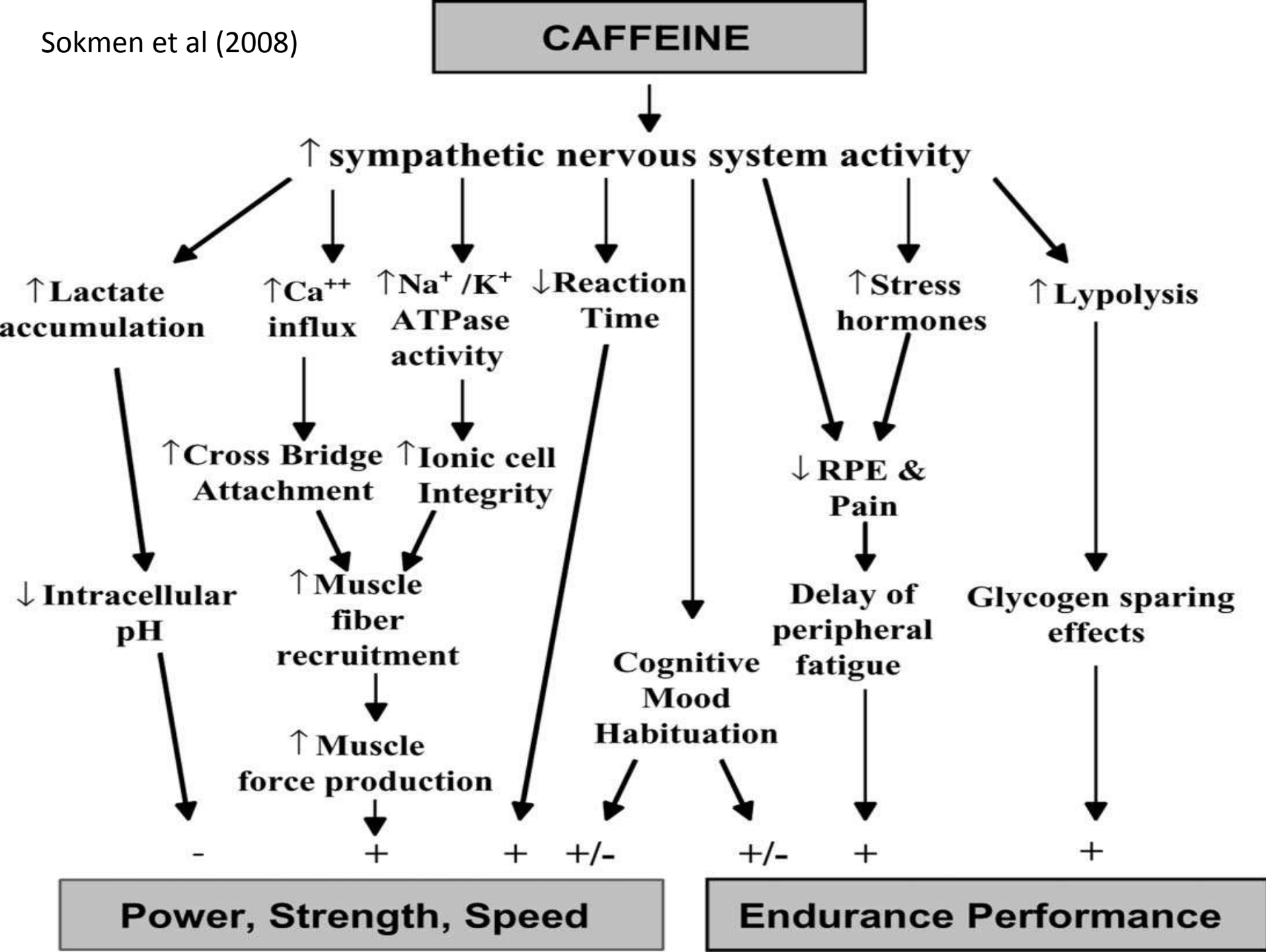


(-) Activation (FAS) (+)

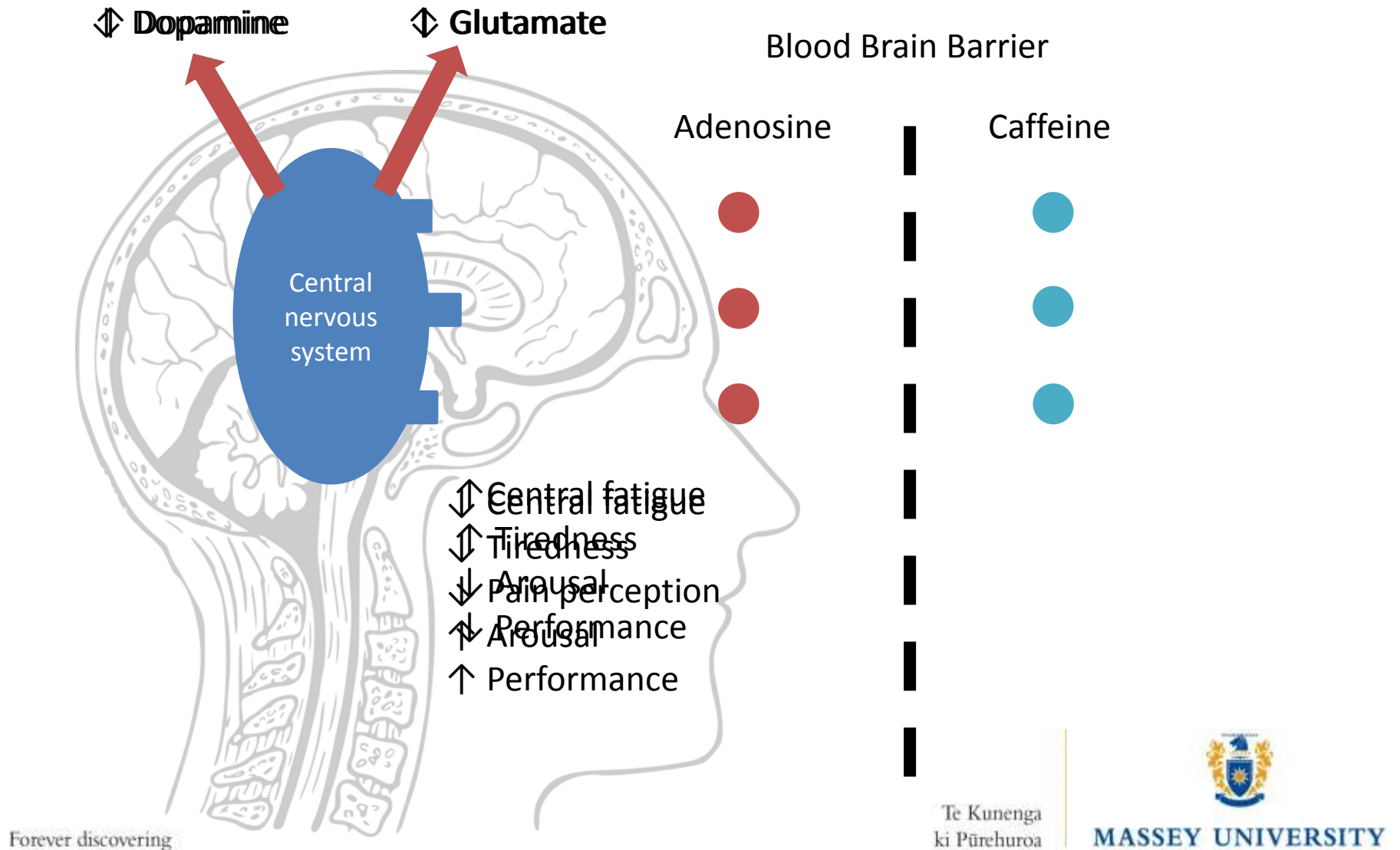


(-) Feeling Scale (+)





Adenosine receptors (ADORA)

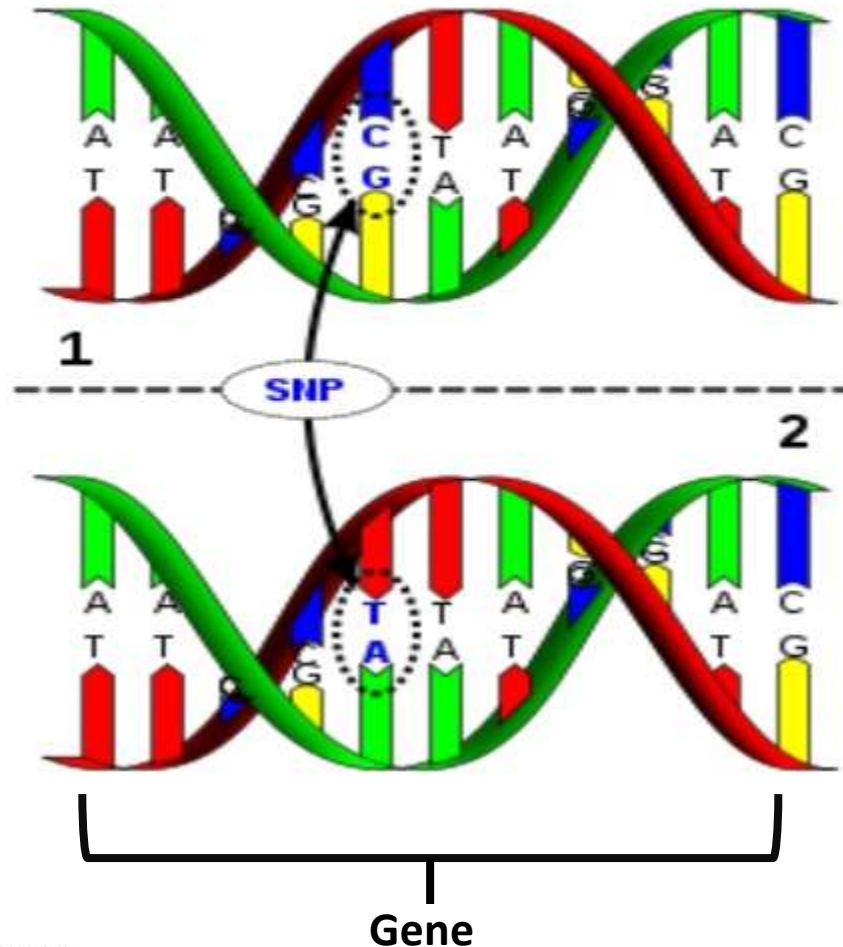


Variations in responses to caffeine ingestion

- A number of studies have reported large inter-individual differences in performance after caffeine ingestion (Doherty et al, 2002; Astorino & Roberson, 2009).
- A number of factors may contribute to this variation
 - Gender
 - Habitual intake
 - Oral contraceptives
 - Smoking
 - Other drugs
 - Genetics



Single nucleotide polymorphism (SNP)



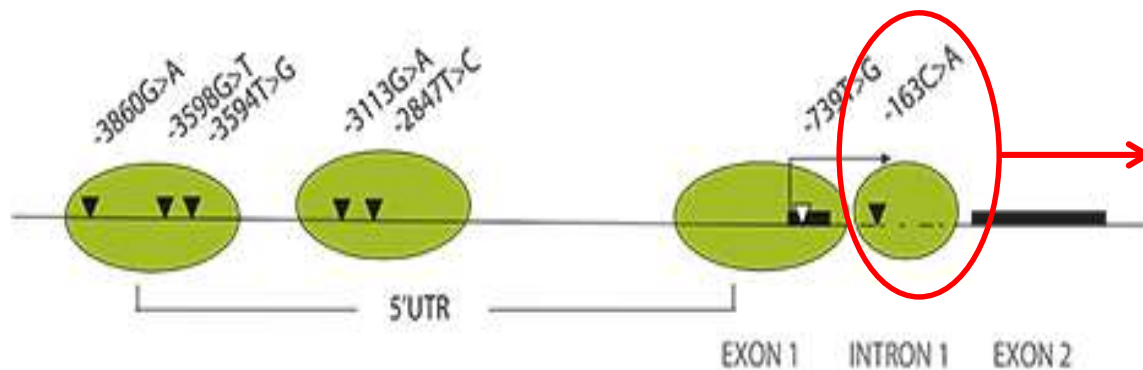
Base pairs

- Adenine
- Guanine
- Cytosine
- Thymine

Allele

- Different variations of the same gene
- Results in different phenotypes (characteristics)

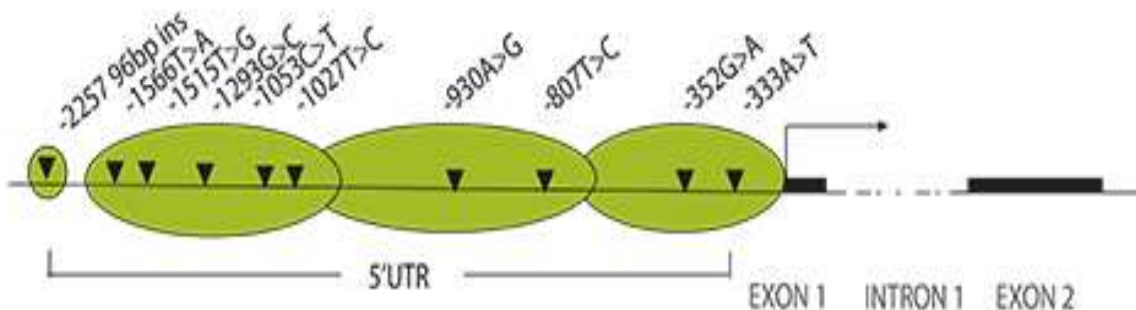
CYP1A2



- A/A (High inducibility)
- A/C (average inducibility)
- C/C (low inducibility)



A/A = Fast metabolism
A/C = average/slow metabolism
C/C = ultra slow metabolism



Distribution of CYP1A2 genotypes

Population	A/A (% fast)	A/C (% slow)	C/C (% ultra slow)
Russians (304 M & F)	34.2	48.7	17.1
Tatars (245 M & F)	43.7	46.5	9.8
Bashkirs (141 M & F)	34.7	53.9	11.3
German (185 M & F)	44.8	45.1	10.0
Swedish (80 M; 114 F)	49.2	42.7	8.1
Koreans (76 M; 74 F)	38.1	47.7	14.2
Italian (110 M)	29.8	68.3	1.9
NZ students (169 M; 148 F)	48.1	42.5	9.4
Average	40.3	49.4	10.2

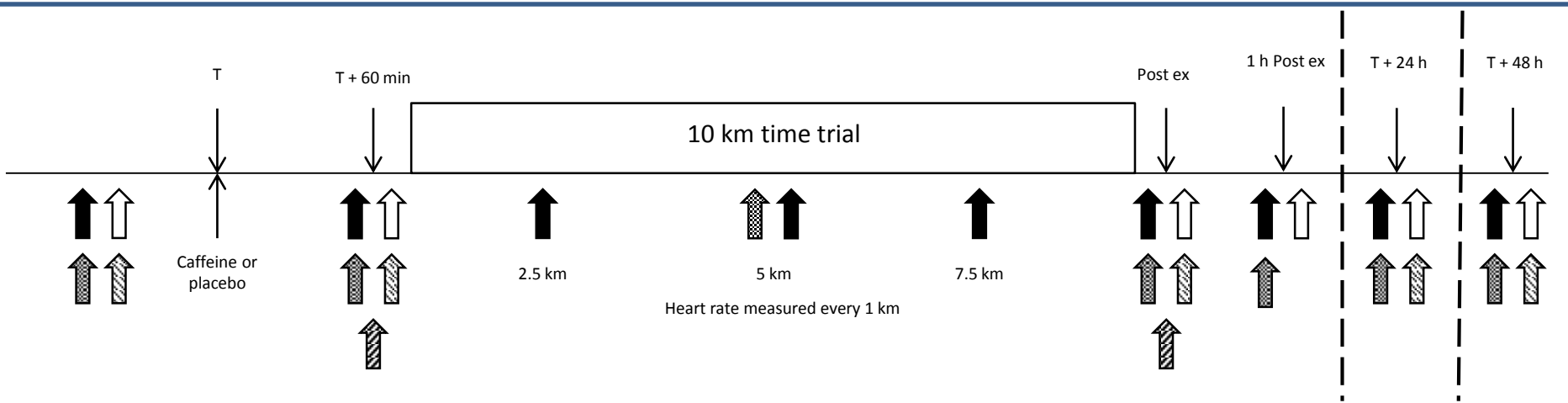


Methods






- Tested CYP1A2 genotype of 17 participants (14 slow, 2 fast, 1 unknown).
- Participants had two tests one week apart (double-blind, placebo, cross over design).
- Participants performed:
 - 10km time trial run (Treadmill)
 - Cognitive tests (Vigilance, attention, reaction time)
 - Perceptual and mood questionnaire (exertion, arousal, feeling, mood)
 - Leg strength and power tests (Vertical jump, quadriceps concentric and eccentric contractions)
 - Collected blood, urine and saliva samples at multiple stages over 48h following caffeine ingestion (caffeine metabolites, genotyping).



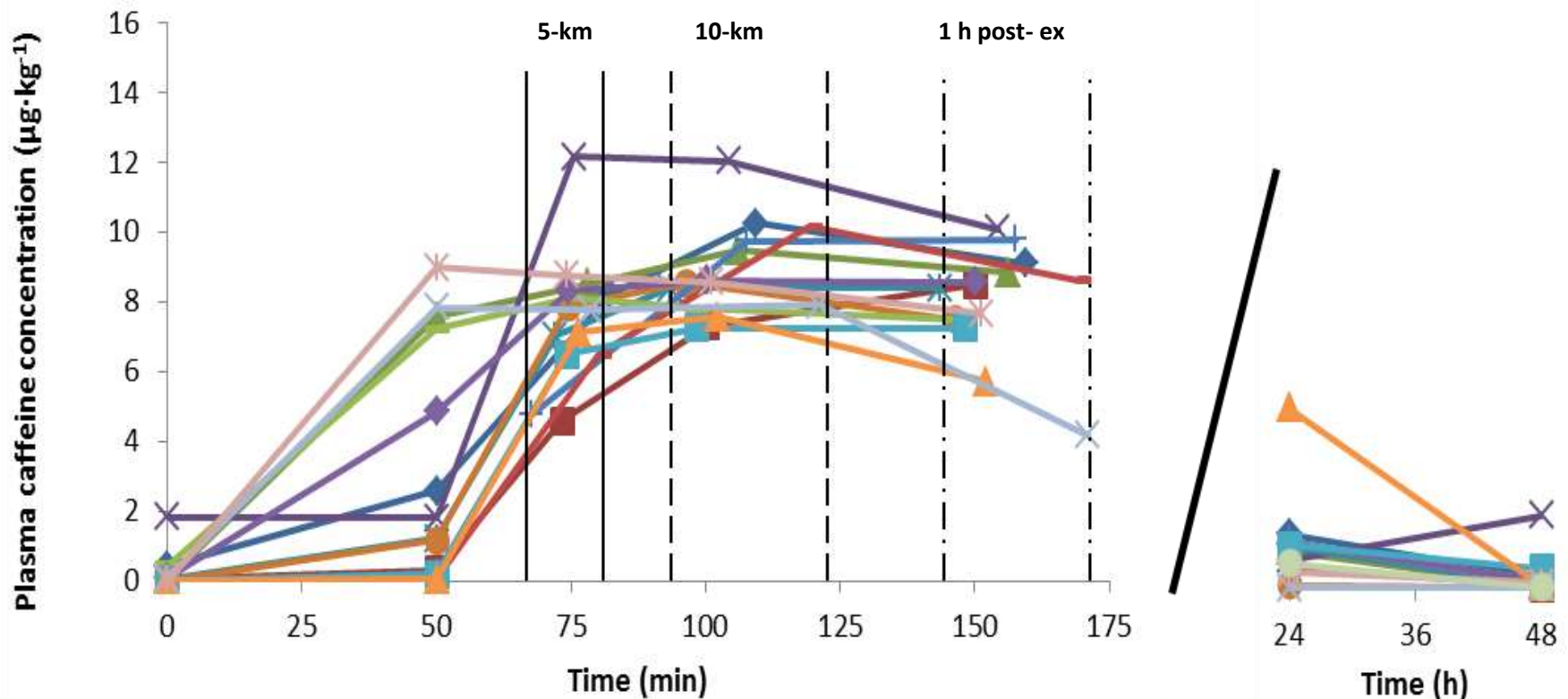
Schematic diagram of protocol



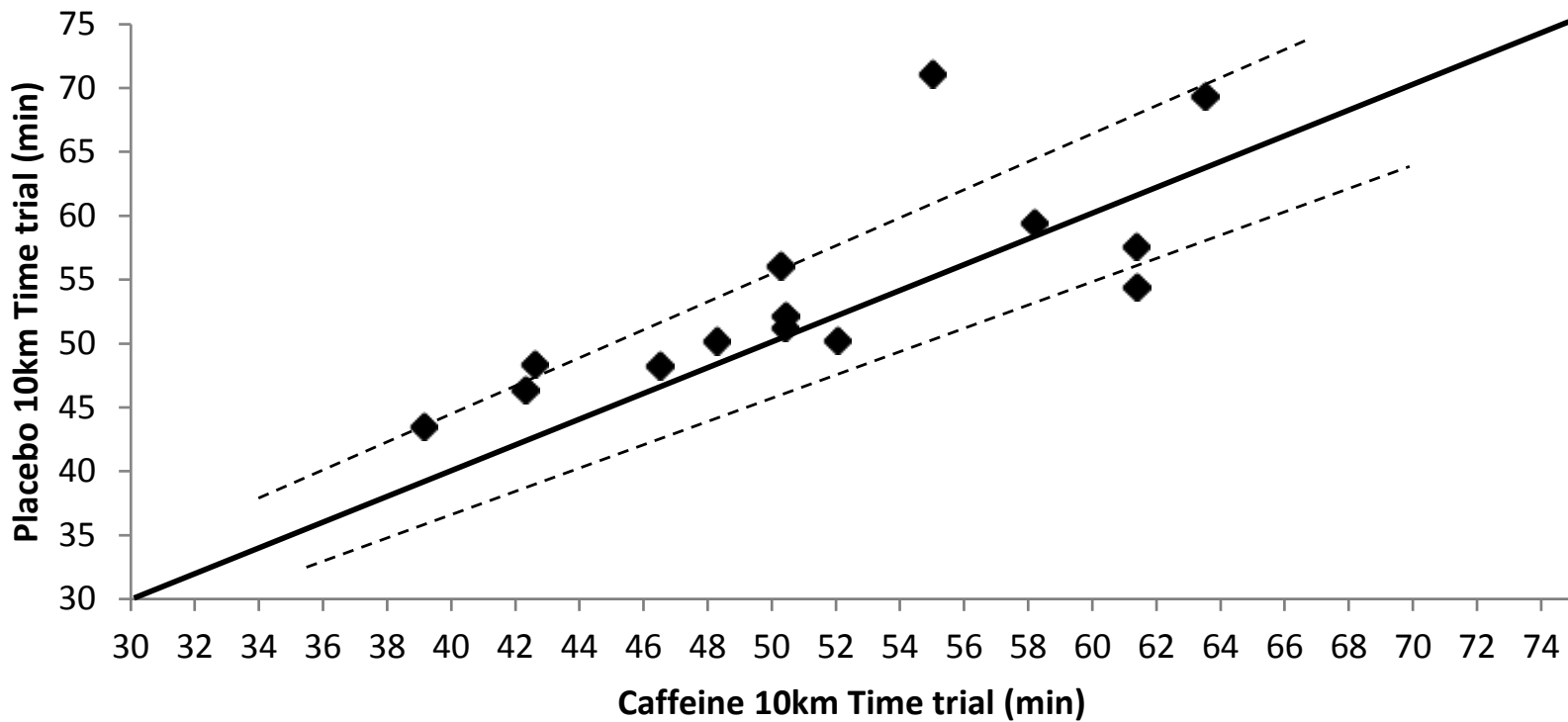
Key

-  Perceptual scales (RPE, FS, FAS), (RPE only taken during exercise).
-  Cognitive testing, POMS, Urine sample
-  Blood & saliva sample, Water (2ml kg⁻¹ bm⁻¹)
-  Squat jump, countermovement jump, Biodex
-  Body mass

Caffeine concentrations in slow metabolisers



10km time trial run



Results

- Non-significant faster run times (approx. 2 min faster on caffeine overall)
- Faster reaction times during cognitive tests
- No difference in correct answers during cognitive tests
- No difference in leg strength or power measures
- Arousal and overall positive feelings were slightly increased following caffeine ingestion compared to placebo.



Kyle – ongoing studies

- Repeat study in fast metabolisers.
- Investigate how fast and slow metabolisers respond to different doses of caffeine administered at different times.
- Add ADORA2A genotyping into the studies.
- Investigate caffeine consumption habits in the general public and specifically athletes.
- Carry out widespread genotyping on the general population and athletes for caffeine related genes (CYP1A2, ADORA2A, etc.)
- **Create more personalised recommendations for athletes and consumers of caffeine based on genetic results.**





How DNA-testing kits are becoming big business

By Suzanne Beame
Technology of Business reporter

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"It's made me follow the right training and make little changes to my diet."

A growing number of start-ups, such as 23andMe, FitnessGenes, UBiome, DNAFit, Orig3n and Habit, are moving into this space, promising that mail-order genetic tests can change your life for the better.



Orig3n is one of a growing number of start-ups entering the DNA-testing market

Some researchers believe the global market for such kits could be worth more than \$10bn (£7.7bn) by 2022.

But how do they work and how reliable are they?

Potential health risks with caffeine

Increased risk of suicide / fatality

Bone loss

Toxic effects:
vomiting,
abdominal
pain,
CNS effects

Dehydration

Immune
function

Cardiovascular
complications

Psychological:
anxiety,
depression,
mood

Sleep-
related
problems

League: Caffeine and sleeping pill inquiry could affect Kiwis coach and players



By: Elliott Smith, | Latest News | Saturday February 1 2014 16:02

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Stephen Kearney's case for keeping his Kiwis coaching job may be strengthened by the outcome into an investigation into the misuse of sleeping pills and energy drinks.

A review is underway into the allegations players combined the two in the final stages of the tournament.

If the review shows he was not complicit and players were not fit to play, NZRL boss Phil Holden says it will play a role in the appointment process.

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Leeds Sleep Evaluation Questionnaire

How would you describe the way you currently fall asleep in comparison to usual?

- | | | |
|----------------------------------|-------|-------------------------|
| 1. More difficult than usual | _____ | Easier than usual |
| 2. Slower than usual | _____ | More quickly than usual |
| 3. I feel less sleepy than usual | _____ | More sleepy than usual |

GTS - getting to sleep

How would you describe the quality of your sleep compared to normal sleep?

- | | | |
|---|-------|--------------------------------------|
| 4. More restless than usual | _____ | Calmer than usual |
| 5. With more wakeful periods than usual | _____ | With less wakeful periods than usual |

QOS - quality of sleep

How would you describe your awakening in comparison to usual?

- | | | |
|--|-------|--------------------|
| 6. More difficult than usual | _____ | Easier than usual |
| 7. Requires a period of time longer than usual | _____ | Shorter than usual |

AFS – Awake following sleep

How do you feel when you wake up?

- | | | |
|----------|-------|-------|
| 8. Tired | _____ | Alert |
|----------|-------|-------|

How do you feel now?

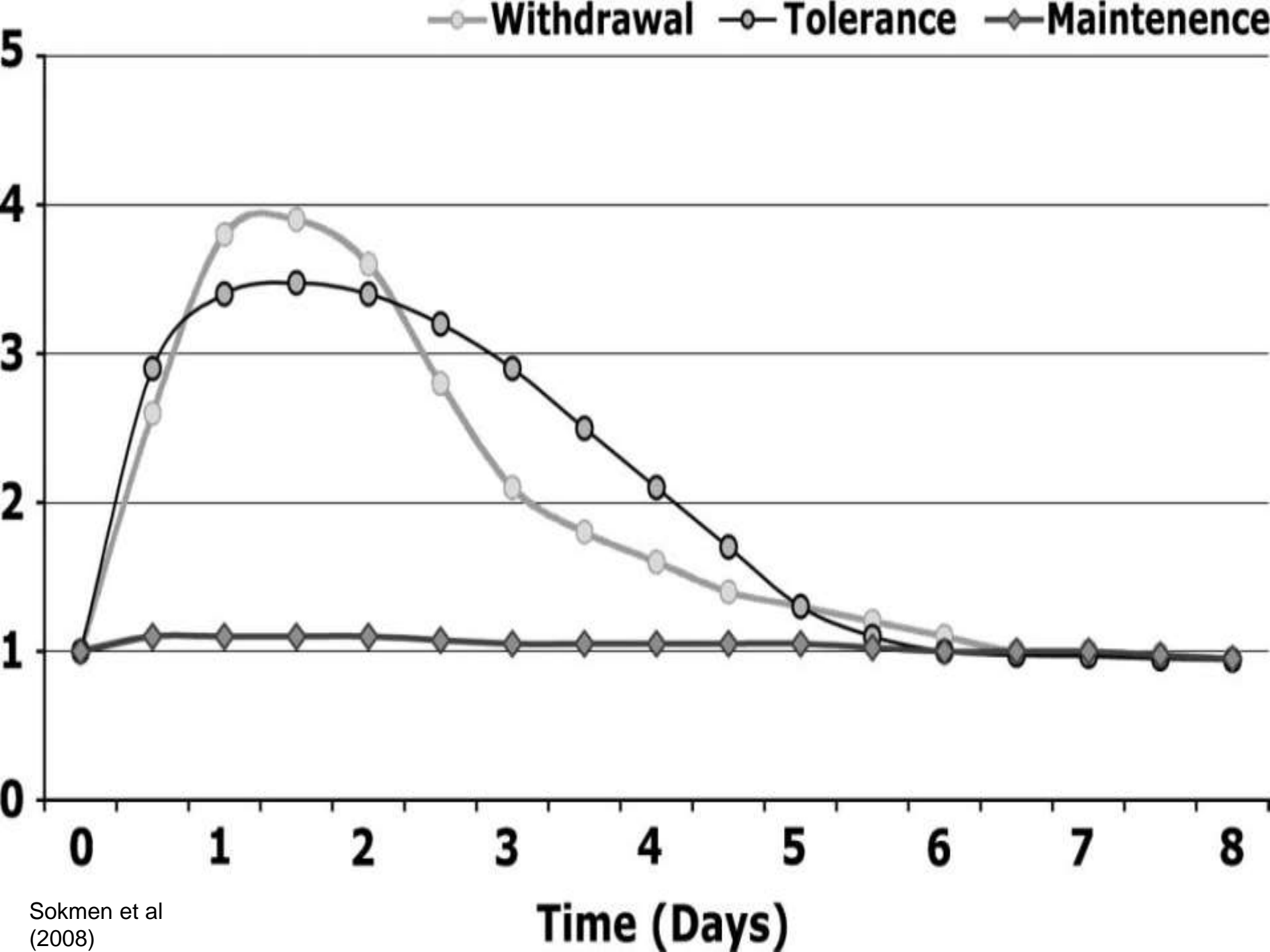
- | | | |
|----------|-------|-------|
| 9. Tired | _____ | Alert |
|----------|-------|-------|

BFW – behaviour following wakening

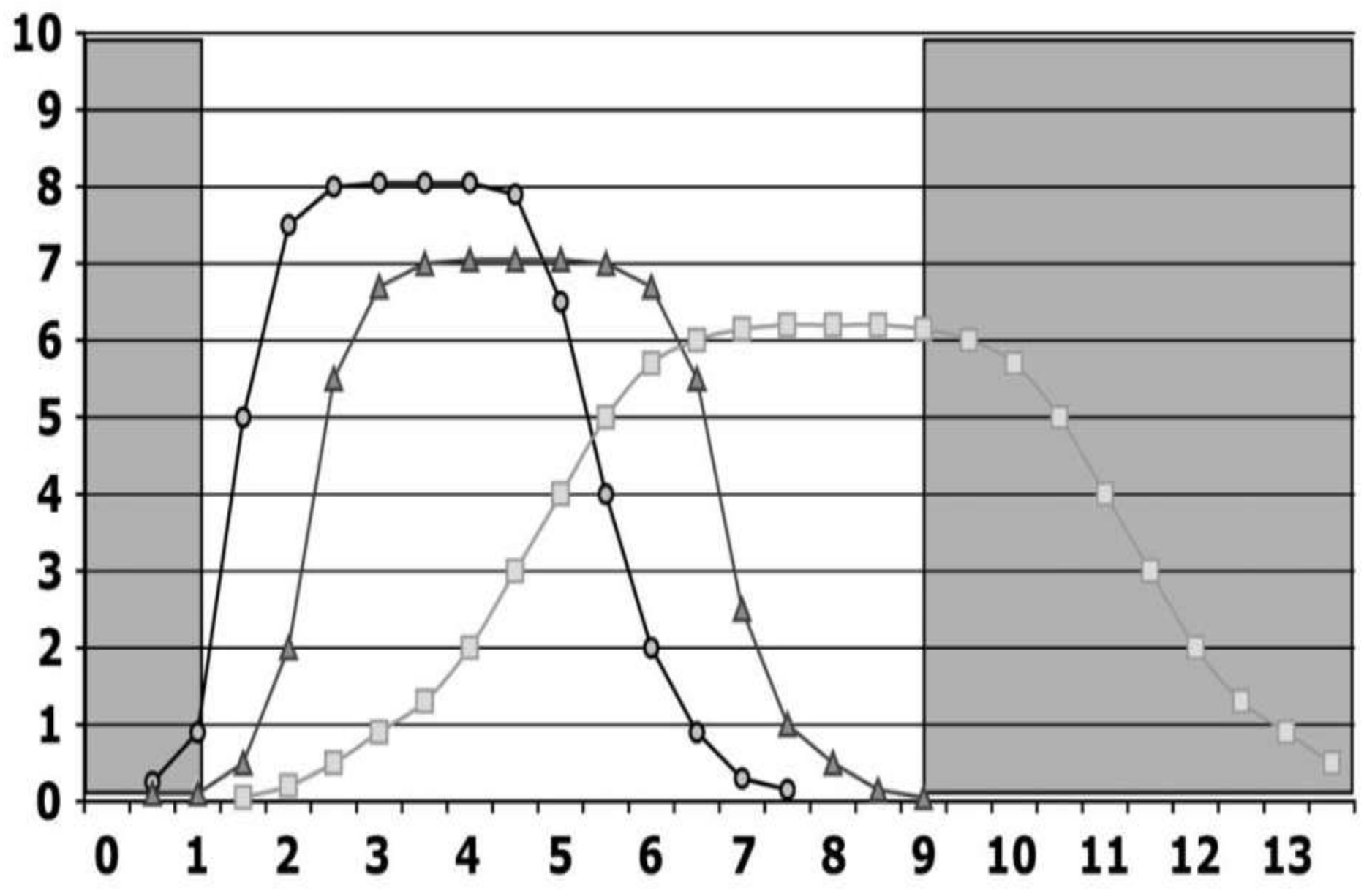
How would you describe your balance and co-ordination upon awakening?

- | | | |
|-------------------------------|-------|---------------------------|
| 10. More disrupted than usual | _____ | Less disrupted than usual |
|-------------------------------|-------|---------------------------|

Variable	Description	Baseline (cm)	PLA (cm)	CAFF (cm)
Getting to sleep	Easier (0 cm) or harder (10 cm)	3.2 ± 2.4	3.1 ± 1.7	5.9 ± 3.2 ^{# §}
	Quicker (0 cm) or slower (10 cm)	3.2 ± 2.3	2.8 ± 1.5	5.9 ± 3.2 ^{# §}
	Drowsiness level before sleep	4.7 ± 2.5	3.3 ± 1.9	6.3 ± 2.7 [§]
Quality of sleep	Restful (0 cm) or restless (10 cm)	2.4 ± 1.5	3.8 ± 2.3	7.1 ± 2.5 ^{# §}
	Less (0 cm) or more (10 cm) periods of awakesness	2.6 ± 1.6	5.4 ± 2.6	7.0 ± 2.5 [#]
Awakening	Easier (0 cm) or more (10 cm) difficult	3.9 ± 1.8	4.0 ± 1.9	4.3 ± 1.7
	Shorter (0 cm) or longer (10 cm) time	3.9 ± 2.0	4.0 ± 2.0	4.1 ± 1.7
Feeling on awakening	Alert (0 cm) or tired (10 cm)	4.6 ± 2.4	5.5 ± 2.6	5.6 ± 2.7
Feeling now	Alert (0 cm) or tired (10 cm)	4.0 ± 2.0	4.0 ± 3.1	4.9 ± 2.3
Balance/coordination on awakening	Less (0 cm) or more (10 cm) clumsy	4.2 ± 1.5	4.5 ± 1.9	4.4 ± 1.6



○ Non-Users ▲ Average Caffeine Users □ Heavy Caffeine Users



Sokmen et al (2008)

Caffeine Dose (mg·kg·BW⁻¹)

Type of caffeine?



Effect of different protocols of caffeine intake on metabolism and endurance performance

GREGORY R. COX,¹ BEN DESBROW,¹ PAUL G. MONTGOMERY,² MEGAN E. ANDERSON,¹ CLINTON R. BRUCE,³ THEODORE A. MACRIDES,⁴ DAVID T. MARTIN,¹ ANGELA MOQUIN,¹ ALAN ROBERTS,² JOHN A. HAWLEY,² AND LOUISE M. BURKE¹

CONTROL 27:05 ± 0:42min	CAFFEINE 26:36 ± 0:42 min 1.9% [-0.6 – 4.41%]
ExtraCHO 26:55 ± 0:43 min 0.6% [-1.8 – 3.1%]	COKE 26:15* ± 0:43 min 3.3*% [0.8 - 5.9%]

Effect of
caffeine:
2.2%*
[0.5 - 3.8%]

Effect of additional
CHO:
1.0% [-0.7 – 2.7%]

Fig. 6. Effect of intake of 3×5 ml/kg of various cola-flavored drinks (control, Caffeine, ExtraCHO, Coke) late in exercise on the performance of a 7 kJ/kg TT at the end of 2-h steady-state cycling at 70% of $\dot{V}O_{2\text{peak}}$. Values are means \pm SE for 8 subjects, with %improvement ($\pm 95\%$ confidence intervals) compared with control treatment. * Different from control, $P < 0.05$. See METHODS for explanation of cola drinks.

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28 September 2013 Last updated at 23:01



London 2012 athletes 'had bad teeth'

By James Gallagher

Health and science reporter, BBC News



Dentists have found "striking" levels of bad teeth in athletes competing at the London 2012 Olympic Games.

A fifth of athletes surveyed said their oral health actually damaged their training and performance.

The study, published in the **British Journal of Sports Medicine**, suggested cavities, tooth erosion and gum disease were common.

Researchers said athletes, as a group, had worse dental health than other people of a similar age.

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Caffeine and sport: pros and cons

- Performance:
 - Endurance
 - Team sports
 - Muscle endurance
- Via:
 - Metabolism
 - Neuromuscular
 - CNS effects (mood / pain)
- Potential issues:
 - Sleep / recovery
 - Use with other substances
 - Withdrawal effects
 - Behavioural
 - Genetics



Practical applications

- **Non-users:** test efficacy before competition
- **Moderate users:** reduce but not completely remove
- **Heavy users:** will need to limit use
- **Timing:**
 - 3 h before power/sprint
 - 1 h before endurance / team sports
- **Dosage** will depend on individual and effect required
- **Anhydrous caffeine** superior to coffee
- **Genetic analysis** may allow athletes to better plan supplementation



I PROMISED MY DOCTOR



ONLY ONE CUP A DAY...