Energy drink components: effects on mood and behavior

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Conflict of Interests

Emma Childs has no personal financial relationships with commercial interests relevant to this presentation

Overview

- Common methods to measure mood and cognition
- Effects of components alone and with caffeine
- Summary of consistent effects
- Directions for future study

Energy Products

Common ingredient is *CAFFEINE*
Sometimes other methylxanthines:
theobromine or theophylline

Mood

- Self-report questionnaires: Subjects rate their current feelings with respect to lists of adjectives e.g. alert, calm, energized. Repeated measurements over time after a challenge.

    – Profile of Mood States (POMS): 72-items scored from 0 (*not at all*) to 4 (*extremely*) yielding 8 scales; *Anxiety, Depression, Anger, Vigor, Fatigue, Confusion, Friendliness, Elation*.

    – Visual Analogue Scales (VAS) are 100mm horizontal lines anchored at the left with "*not at all" (0)* and the right *"extremely" (100).*

⚠️ Attention ⚠️

Simple

Complex

Simple Reaction Time (SRT)

+
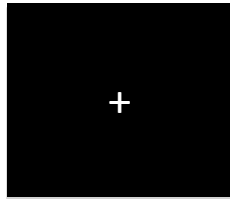
Subjects must respond as quickly as possible when the '+' appears

Choice Reaction Time (CRT)

2   4   5   3
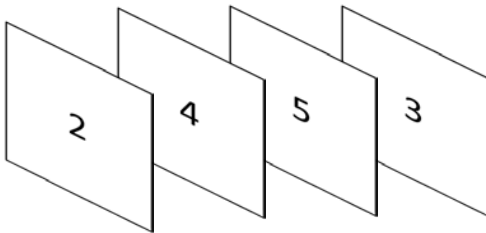
Subjects must press 'left' mouse button after 2 or 3 and 'right' after 4 or 5

Rapid Visual Info Processing (RVIP)

8 1 3 4 2 6 7
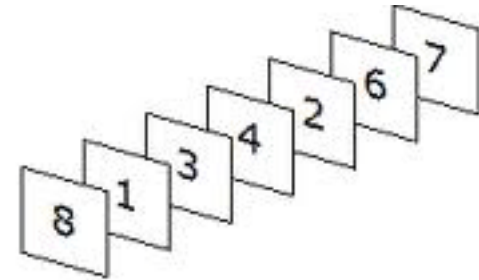
Subjects must respond after 3 odd or 3 even numbers in a row

Outcome measures:

accuracy

reaction time
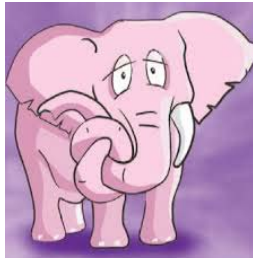
Memory
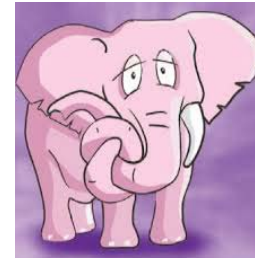
Working

Mental arithmetic
 - serial 3s, 7s
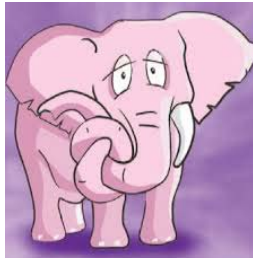
Memory

Working

N-back task

'1-back'
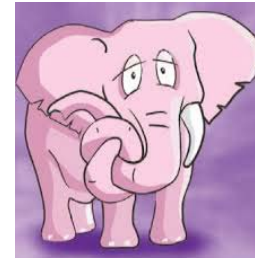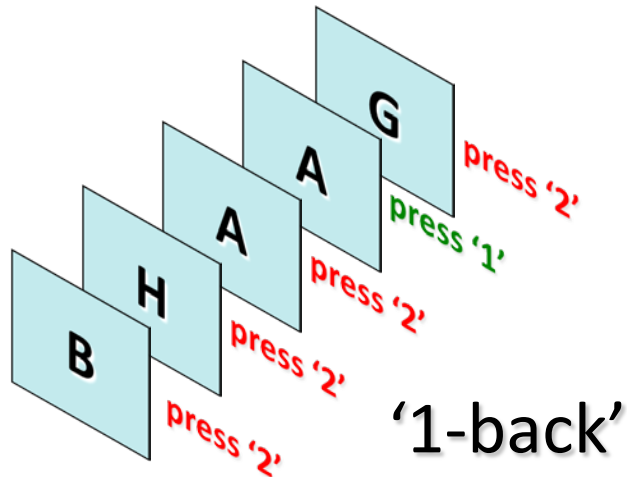
Subjects must match current letter
to that presented 'n' letters ago

Memory

Working

N-back task

'3-back'
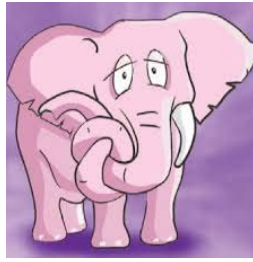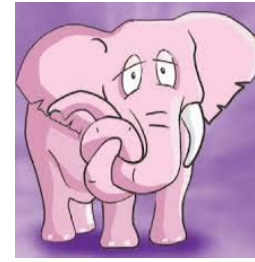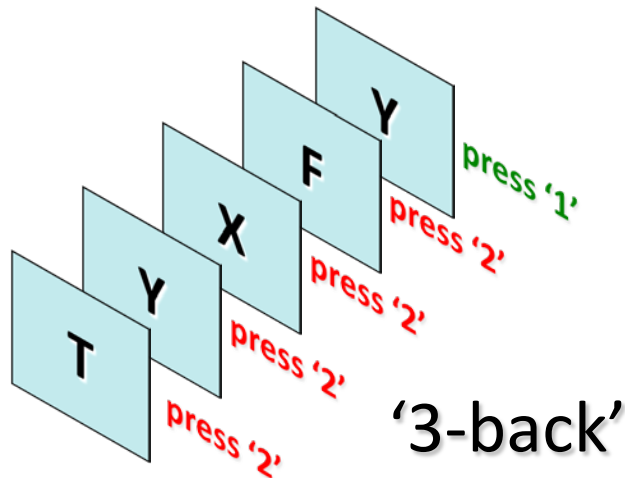
Subjects must match current letter
to that presented 'n' letters ago

Long-term

Delayed recall
- free, cued
- words, pictures

Other measures:

- Impulsivity:
  - Motor impulsivity
  - Cognitive impulsivity
- Risky behavior
- Decision making
- Rewarding properties

Data selected

- Studies that reported effects of the most common components of energy products upon mood and behavior were selected for review.

- Studies that reported effects of the component alone or with and without caffeine were considered.

- NB: studies that compared effects of a "blend" or combination of components with and without caffeine were not considered for this presentation.

Controlled studies

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long

EPs=Energy Products

↑increase ↓decrease ✖no effect –no data

■ alone ■ with caffeine

Caffeine alone *(many studies)*

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	↑

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

Energy products *(few studies)*

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

Guarana
(contains methylxanthines; caffeine, theobromine, theophylline)

Alone

- Increase in calmness and alertness with 75mg (some prolonged effects, 6h)
- Improved 'secondary' memory
- No effects on attention

With caffeine

- Increased accuracy on attention tasks

(Galduroz and Carlini 2004, 2006; Mayer and Ball, 2004

Haskell et al., 2007; Kennedy et al., 2004)

Guarana *(contains methylxanthines)*

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–
Guarana	10-400mg	37.5mg-1g	↑ –	↑ –	✖ ↑	✖ –	↑ –

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

Yerba mate

(tea-like plant containing methylxanthines; caffeine, theobromine, theophylline)

- In laboratory animals, improved short- and long-term memory, and *synergistic* effects with caffeine BUT probably higher doses than present in energy products
- No human data on mood and behavioral effects

Yerba Mate

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–
Guarana	10-400mg	37.5mg-1g	↑ –	↑ –	✖ ↑	✖ –	↑ –
Yerba Mate	?	–	– –	– –	– –	– –	– –

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

Taurine

(2-aminoethanesulfonic acid)

Alone

- increased fatigue, decreased vigour at 1h

- improved attention (Accuracy, Reaction time)

With Caffeine

- 200mg Caff +2g Taurine decreased fatigue at 1h

- 80mg Caff + 1g Taurine attenuated caffeine-induced decreases in attention task reaction times

- 150mg caff + 2g Taurine decreased # errors in skilled task after 24h sleep deprivation, no further decrease in attention task reaction times.

(Peacock et al., 2013; Giles et al., 2012; Aggarwal et al., 2011)

Taurine *(complex effects)*

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–
Guarana	10-400mg	37.5mg-1g	↑ –	↑ –	✖ ↑	✖ –	↑ –
Yerba Mate	?	–	– –	– –	– –	– –	– –
Taurine	1-2g	1-2g	↓ ↑	✖ ↓	↑ ↓	✖ –	✖ –

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

Glucose

(present in many EPs)

Alone
- Levels are higher than those considered optimal (6-8%) to maximise carbohydrate use
- No clear mood effects
- High Glu meal decreased subjective energy and performance over 2-3h in comparison to a low Glu meal

With Caffeine
- Glu prolonged (2h) fatigue-reducing effect of Caff+Tau
- 80mg Caff in Glu drink improved mood & reaction time
- No increased effect of Caff + Glu on attention performance wrt Caff or Glu alone, but reduced energy utilization during task

(Giles et al., 2012; Young and Benton, 2013;
Adan and Serra-Grabulosa, 2010; Smit et al, 2004,
Scholey and Kennedy 2004)

Glucose

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–
Guarana	10-400mg	37.5mg-1g	↑ –	↑ –	✖ ↑	✖ –	↑ –
Yerba Mate	?		– –	– –	– –	– –	– –
Taurine	1-2g	1-2g	↓ ↑	✖ ↓	↑ ↓	✖ –	✖ –
Glucose	20-60g	30-75g	✖ ↑	✖ ↑	↑ ↑	– –	– –

EPs=Energy Products

*anxiety at high doses

↑increase ↓decrease ✖no effect –no data

■ alone ■ with caffeine

Ginseng

(contains saponins)

Panax Ginseng

Alone

- No clear mood effects

- Improved accuracy on attention tasks (400mg)

- Improved long term memory performance and speed (400mg)

With caffeine

- No data

(Kennedy et al, 2001, 2002, 2004)

Ginseng

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–
Guarana	10-400mg	37.5mg-1g	↑ –	↑ –	✖ ↑	✖ –	↑ –
Yerba Mate	?		– –	– –	– –	– –	– –
Taurine	1-2g	1-2g	↓ ↑	✖ ↓	↑ ↓	✖ –	✖ –
Glucose	20-60g	30-75g	✖ ↑	✖ ↑	↑ ↑	– –	– –
Ginseng	25-200mg	200-600mg	✖ –	✖ –	↑ –	✖ –	↑ –

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

Gingko biloba
(the oldest living tree)

<u>Alone</u>

- In healthy young adults limited evidence of
  - Improved mood, attention accuracy, working memory and long-term memory over long periods
- But others studies show no effects
- Effects more consistent in elderly and cognitively impaired

<u>With Caffeine</u> – no data

(Kennedy et al., 2002; Canter et al., 2007)

Gingko biloba *(inconsistent)*

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–
Guarana	10-400mg	37.5mg-1g	↑ –	↑ –	✖ ↑	✖ –	↑ –
Yerba Mate	?		– –	– –	– –	– –	– –
Taurine	1-2g	1-2g	↓ ↑	✖ ↓	↑ ↓	✖ –	✖ –
Glucose	20-60g	30-75g	✖ ↑	✖ ↑	↑ ↑	– –	– –
Ginseng	25-200mg	200-600mg	✖ –	✖ –	↑ –	✖ –	↑ –
Gingko biloba	10mg	2-360mg	✖ –	✖ –	✖ –	✖ –	✖ –

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

St John's Wort
*(a natural antidepressant,
contains flavinoids)*

Alone

- No clear effects on mood, or most attention and memory tasks in healthy adults

With caffeine – no data

(Timoshanko et al., 2001: Siepmann et al., 2002)

St. John's Wort

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–
Guarana	10-400mg	37.5mg-1g	↑ –	↑ –	✖ ↑	✖ –	↑ –
Yerba Mate	?		– –	– –	– –	– –	– –
Taurine	1-2g	1-2g	↓ ↑	✖ ↓	↑ ↓	✖ –	✖ –
Glucose	20-60g	30-75g	✖ ↑	✖ ↑	↑ ↑	– –	– –
Ginseng	25-200mg	200-600mg	✖ –	✖ –	↑ –	✖ –	↑ –
Gingko biloba	10mg	2-360mg	✖ –	✖ –	✖ –	✖ –	✖ –
St John's Wort	250mg	250mg-1.8g	✖ –	✖ –	✖ –	✖ –	✖ –

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

Dimethylamylamine
(a NE releaser)

FDA issued warning against consumption of drinks containing DMAA in April 2013

Alone

- Increased fatigue and lightheaded

With caffeine

- Increased euphoria

(Bloomer et al., 2011a, b)

Dimethylamylamine/Methylhexanamine

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–
Guarana	10-400mg	37.5mg-1g	↑ –	↑ –	✖ ↑	✖ –	↑ –
Yerba Mate	?		– –	– –	– –	– –	– –
Taurine	1-2g	1-2g	↓ ↑	✖ ↓	↑ ↓	✖ –	✖ –
Glucose	20-60g	30-75g	✖ ↑	✖ ↑	↑ ↑	– –	– –
Ginseng	25-200mg	200-600mg	✖ –	✖ –	↑ –	✖ –	↑ –
Gingko biloba	10mg	2-360mg	✖ –	✖ –	✖ –	✖ –	✖ –
St John's Wort	250mg	250mg-1.8g	✖ –	✖ –	✖ –	✖ –	✖ –
DMAA	?	50-75mg	↓ ✖	↓ ↑	– –	– –	– –

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

Summary

	Doses		Mood		Attention	Memory	
	EPs	Studies	Alert	Well-being		Short	Long
Caffeine	80-300mg	25-300mg	↑	↑*	↑	↑	(↑)
Decaf. 5h Energy			↑	–	–	–	–
Guarana	10-400mg	37.5mg-1g	↑ –	↑ –	✖ ↑	✖ –	↑ –
Yerba Mate	?		– –	– –	– –	– –	– –
Taurine	1-2g	1-2g	↓ ↑	✖ ↓	↑ ↓	✖ –	✖ –
Glucose	20-60g	30-75g	✖ ↑	✖ ↑	↑ ↑	– –	– –
Ginseng	25-200mg	200-600mg	✖ –	✖ –	↑ –	✖ –	↑ –
Gingko biloba	10mg	2-360mg	✖ –	✖ –	✖ –	✖ –	✖ –
St John's Wort	250mg	250mg-1.8g	✖ –	✖ –	✖ –	✖ –	✖ –
DMAA	?	50-75mg	↓ ✖	↓ ↑	– –	– –	– –

EPs=Energy Products
*anxiety at high doses

↑increase ↓decrease ✖no effect –no data
■ alone ■ with caffeine

Future Studies

- Relatively few studies so replication needed
- Yerba mate not studied
- Taurine and Glucose in combination with caffeine on memory tasks
- Ginseng, Gingko biloba, St John's Wort in combination with caffeine

Design considerations

- In well-rested *and* fatigued participants
- Adolescents
- Long-periods (up to 6h)
- 'Real-world' tasks (e.g. driving simulations)
- Impulsivity tasks (Howard and Marczinski, 2010)
- Risky behavior and decision making
- Expectancy effects
- Rewarding properties

Further reading:

- *McLellan and Lieberman, 2012:* Do energy drinks contain active compounds other than caffeine?

- *Eudy et al., 2013:* Efficacy and safety of ingredients found in preworkout supplements.

- *Haskell et al., 2013:* Behavioural effects of compounds co-consumed in dietary forms of caffeinated plants.

The Use and Biology of Energy Drinks: Current Knowledge and Critical Gaps
August 15-16, 2013
Neuroscience Center Building • Rockville, MD

Thank you!