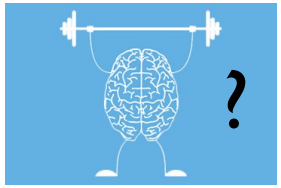
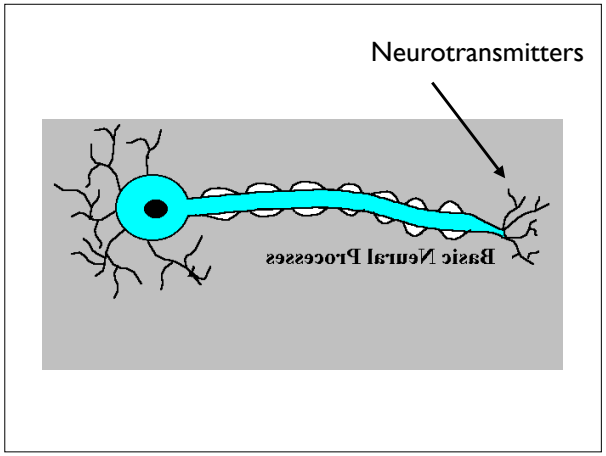
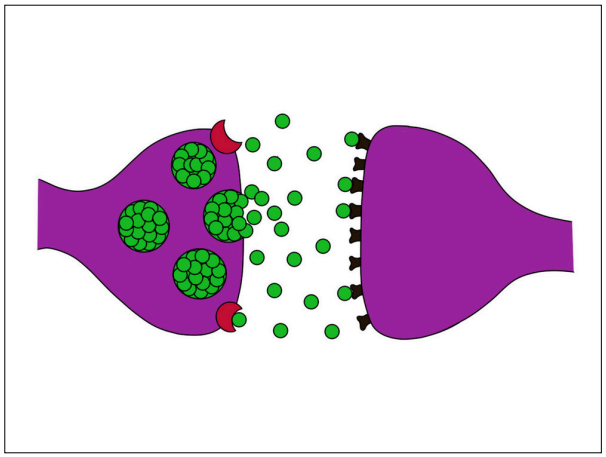
Drugs, Performance, Enhancement

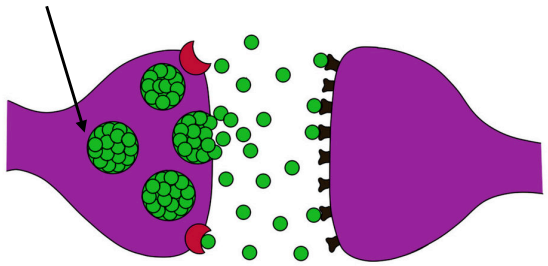






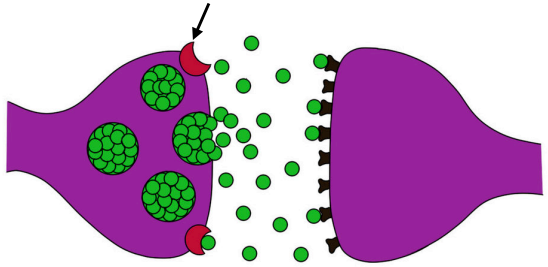
How to alter neural activity

Make more neurotransmitters



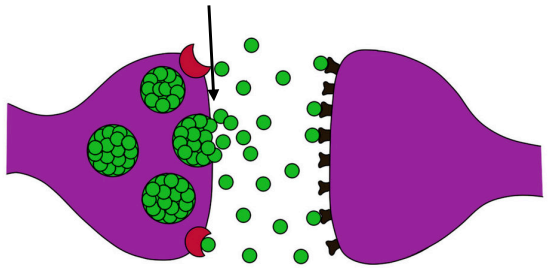
Parkinson's Disease
Give the brain the dopamine precursor
(L-DOPA; "levodopa")

Slow down reuptake



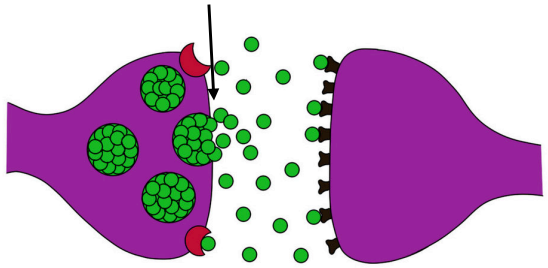
Depression
Inhibit pre-synaptic neurons from re-absorbing serotonin
(Serotonin-selective reuptake inhibitor, SSRI; e.g. "Prozac")

Release more neurotransmitters



ADHD
Make synapses release more dopamine & norepinephrine
(Stimulants such as amphetamine; e.g. "Adderall")

Release more neurotransmitters



ADHD

Make synapses release more dopamine & norepinephrine

(Stimulants such as amphetamine; e.g. "Adderall")

# of Adderall (or similar) **prescriptions** nationwide:

~15 million

NEUROSCIENCE

The unknowns of cognitive enhancement

Can science and policy catch up with practice?

By **Martha J. Farah**

"Man is not going to wait passively for millions of years before evolution offers him a better brain." These words are attributed to the 20th century Romanian psychopharmacologist Cornelia Giurgea, an early advocate of cognitive enhancement—that is, the use of medications or other brain treatments for improving normal healthy cognition. Contemporary attempts at cognitive enhancement involve an array of drugs and devices for modifying brain function, such as pills taken by students to help them study, or electrical stimulators focused on prefrontal cortex by electronic game players ("e-gamers") to sharpen their skills. What is known about current methods of cognitive enhancement? What specifically do they enhance, for whom, and with what risks? We know surprisingly little.

der (ADHD), in which executive function is impaired, they are assumed to enhance executive function in healthy individuals as well. However, the current evidence suggests a more complex state of affairs. The published literature includes substantially different estimates of the effectiveness of prescription stimulants as cognitive enhancers. A recent meta-analysis suggests that the effect is most likely real but small for executive function tests stressing inhibitory control, and probably nonexistent for executive function tests stressing working memory (*5*).

Why, then, do these drugs continue to be used for enhancement? One possibility is that there are important individual differences in people's response to them, with some people benefiting (*2*). In addition, stimulants have other effects for which they may be used. In a report entitled "Just How Cognitive Is 'Cognitive Enhancement'?," sociologist Scott Vrecko interviewed students

Nothing here applies to clinical use. If you are prescribed any of these drugs, **listen to your provider**!

Medical Use

Prescribed by a healthcare professional for **clinical symptoms** of inattention, impulsivity, and hyperactivity

Non-Medical Use

Used (or abused), often illegally, by people to whom the medication is **not prescribed**; e.g., addiction, recreation, or (perceived) **enhancement**

Non-Medical Use

Used (or abused), often illegally, by people to whom the medication is **not prescribed**; e.g., addiction, recreation, or (perceived) **enhancement**

Dangerous! For real.

Drugs like these are contraindicated for many conditions and interactions you may not even be aware of, but that a professional would check for.

(plus, it's illegal)

https://studentaffairs.jhu.edu/chew/alcohol-and-other-drugs/

JOHNS HOPKINS UNIVERSITY

HOMEWOOD STUDENT AFFAIRS
Center for Health Education & Wellness

Why even have this conversation?

Because psychology is the quest to understand interesting human behaviors, and this is one of them

Because **you** make decisions about substances that affect your mind, without knowing the science

Medical Use

Prescribed by a healthcare professional for **clinical symptoms** of inattention, impulsivity, and hyperactivity

Non-Medical Use

Used (or abused), often illegally, by people to whom the medication is **not prescribed**; e.g., addiction, recreation, or (perceived) **enhancement**

Who?
How Many?

Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Substance Abuse and Mental Health Services Administration
Center for Behavioral Health Statistics and Quality

RESEARCH REPORT

Non-medical use of prescription stimulants among US college students: prevalence and correlates from a national survey

Sean Esteban McCabe[1], John R. Knight[2], Christian J. Teter[3] & Henry Wechsler[4]

University of Michigan, Substance Abuse Research Center, Ann Arbor, MI, Harvard Medical School and Children's Hospital Boston, Center for Adolescent Substance Abuse Research, Boston, MA,[2] Northeastern University, Bouvé College of Health Sciences, McLean Hospital Alcohol and Drug Abuse Treatment Program, Boston, MA[3] and Harvard School of Public Health, Department of Society, Human Development and Health, Boston, MA USA[4]

Prevalence and Correlates of Prescription Stimulant Use, Misuse, Use Disorders, and Motivations for Misuse Among Adults in the United States

Wilson M. Compton, M.D., M.P.E., Beth Han, M.D., Ph.D., Carlos Blanco, M.D., Ph.D., Kimberly Johnson, Ph.D., Christopher M. Jones, Pharm.D., M.P.H.

Objective: The authors sought to simultaneously examine the prevalence and correlates of prescription stimulant use, misuse, use disorders, and motivations for misuse in the U.S. adult population.

Method: This was a nationally representative household population study of adults age 18 or older from the 2015 and 2016 National Surveys on Drug Use and Health (N=102,000). Measurements included prescription stimulant use, use without misuse, misuse without use disorders, and misuse with use disorders, as well as sociodemographic characteristics, health conditions, and mental health factors.

Results: Among U.S. adults, 6.6% (annual average) used prescription stimulants overall; 4.5% used without misuse, 1.9% misused without use disorders, and 0.2% had use disorders. Adults with past-year prescription stimulant use disorders did not differ from those with misuse without use disorders in any of the examined sociodemographic characteristics and in many of the examined substance use problems. The most commonly reported motivations for misuse were to help be alert or concentrate (56.3%). The most likely source of misused prescription stimulants was by obtaining them free from friends or relatives (56.9%). More frequent prescription stimulant misuse and use disorder were associated with an increased likelihood of obtaining medications from physicians or from drug dealers or strangers and less likelihood of obtaining them from friends or relatives.

Conclusions: Approximately 16.0 million U.S. adults used prescription stimulants in the preceding year (annual average), 5.0 million misused prescription stimulants, and 0.4 million had use disorders. Cognitive enhancement was the most commonly reported reason for misusing prescription stimulants. Patients who are using their medication for cognitive enhancement or diverting their medication to others present a high risk.

Am J Psychiatry 2018; 175:741–755; doi: 10.1176/appi.ajp.2018.17091048

# of American adults (that includes you) who use prescription stimulants for non-medical use:

5 million

% of college students who use prescription stimulants for non-medical use:

>7% (nationally)

but higher for schools with following properties:

competitive admissions
northeast US
non-commuter school

and higher for students who are:

male
white
in fraternities

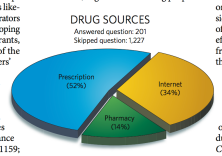
~20% of scientists!

Poll results: look who's doping

In January, *Nature* launched an informal survey into readers' use of cognition-enhancing drugs. **Brendan Maher** has waded through the results and found large-scale use and a mix of attitudes towards the drugs.

The US National Institutes of Health is to crack down on scientists 'brain doping' with performance-enhancing drugs such as Provigil and Ritalin, a press release declared last week. The release, brainchild of evolutionary biologist Jonathan Eisen of the University of California, Davis, turned out to be an April Fools' prank. And the World Anti-Brain Doping Authority website that it linked to was likewise fake. But with a number of co-conspirators spreading rumours about receiving anti-doping affidavits with their first R01 research grants, the ruse no doubt gave pause to a few of the respondents to *Nature*'s survey on readers' use of cognition-enhancing drugs.

The survey was triggered by a Commentary by behavioural neuroscientists Barbara Sahakian and Sharon Morein-Zamir of the University of Cambridge, UK, who had surveyed their colleagues on the use of drugs that purportedly enhance focus and attention (*Nature* **450,** 1157–1159; prescribed for cardiac arrhythmia that also have an anti-anxiety effect. Respondents who had not taken these drugs, or who had taken them for a diagnosed medical condition were directed straight to a simple questionnaire about general attitudes. Those who revealed that they had taken these drugs, or others, for non-medical, cognition-enhancing purposes behind 'other' which received a few interesting reasons, such as "party", "house cleaning" and "to actually see if there was any validity to the afore-mentioned article".



Our question on frequency of use, for those who took drugs for non-medical purposes, revealed an even split between those who took them daily, weekly, monthly, or no more than once a year. Roughly half reported unpleasant side effects, and some discontinued use because of them. Some might expect that negative side effects would correlate positively with a low frequency of use, but that doesn't seem to be the case in our sample (see bar graph, below). Reported side effects included headaches, jitteriness, anxiety and sleeplessness.

Neuroscientist Anjan Chatterjee of the University of Pennsylvania in Philadelphia predicts a rise in the use of these drugs and other neuroenhancing products and procedures as they become available (A. Chatterjee *Cam. Q. Healthc. Ethics* **16,** 129–137; 2007).

Why?

Most popular reason: **Enhancement**

Poll results: look who's doping

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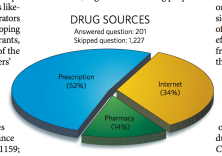

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Article

Attention, Motivation, and Study Habits in Users of Unprescribed ADHD Medication

Journal of Attention Disorders
1–14
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DOI: 10.1177/1087054715591849
jad.sagepub.com
SAGE

Irena P. Ilieva[1] and Martha J. Farah[1]

Abstract

Objective: Despite the limited effectiveness of ADHD medications on healthy cognition, prescription stimulants' cognitive enhancement use is increasing. This article examines enhancement users' attention, motivation, and study habits. **Method:** A total of 61 users of unprescribed stimulants and 67 controls (no history of prescription stimulant use) completed tests of objectively measured and subjectively reported attention. Self-reports on study habits, as well as motivation during laboratory attention testing, were also administered. **Results:** Our data replicated previous findings of relatively lower self-reported attention functioning in users. Extending past research, we showed that user-control differences in attention were still present but less pronounced on objective measures than on self-report. In addition, we obtained evidence of lower motivation during cognitive testing and less optimal study habits among users, as compared with their non-using peers. **Conclusion:** Unprescribed stimulant use is more strongly related to compromised study habits, low motivation, and a subjective perception of attention problems than to objective attention performance. *(J. of Att. Dis. XXXX; XX(X) XX-XX)*

"Enhancement" users believe they are worse at studying, paying attention, focusing, than their peers

"Enhancement" users believe that stimulants such as Adderall will improve their focus and attention, even when such drugs have not been prescribed to them

Are they right?

Which "enhances" best?

A. A dose of Adderall
(without a prescription)

B. A cup of coffee

C. Sleeping two more hours

"Enhancement" users **believe** they are worse at studying, paying attention, focusing, than their peers

"Enhancement" users **believe** that stimulants such as Adderall will improve their focus and attention

Are they right?

Sustained Attention

the ability to stay focused on a specific task for an extended, continuous period of time

"Go / No-Go Task"

GO!

"Go / No-Go Task"

NO
GO!

“Go / No-Go Task”

NO
GO!

“Go / No-Go Task”

NO
GO!

“Go / No-Go Task”

“Go / No-Go Task”

...for half an hour

not so different than studying

“Enhancement” users **believe** they are worse at studying, paying attention, focusing, than their peers

“Enhancement” users **believe** that stimulants such as Adderall will improve their focus and attention

Are they right?

"Enhancement" users **believe** they are worse at studying, paying attention, focusing, than their peers

"Enhancement" users **believe** that stimulants such as Adderall will improve their focus and attention

Are they right?

Users vs. Nonusers

When participants who had used unprescribed stimulants only once were excluded, the interactions between user status and attention test type emerged significant on all three measures—impulsivity, inattention, and overall attention performance—showing comparable performance on the objective test between the two groups but lower perceived attention among users than controls: for inattention subtests, $F_{interaction}(1, 121) = 4.78$, $p = 0.02$, one-tailed; for impulsivity subtests, $F_{interaction}(1,121) = 7.91$, $p < 0.01$, one-tailed; and for overall attention performance, $F_{interaction}(1, 121) = 3.83$, $p = 0.03$, one-tailed (see Figure 1).

Users vs. Nonusers

Non-medical users don't even "need" the drug! They are **objectively** on the same footing at nonusers; they just **believe** they are worse

(not so surprising; after all, they weren't prescribed it!)

"Enhancement" users **believe** they are worse at studying, paying attention, focusing, than their peers

"Enhancement" users **believe** that stimulants such as Adderall will improve their focus and attention

Are they right?

"Enhancement" users **believe** they are worse at studying, paying attention, focusing, than their peers

"Enhancement" users **believe** that stimulants such as Adderall will improve their focus and attention

Are they right?

Psychological Bulletin
2011, Vol. 137, No. 5, 717–741

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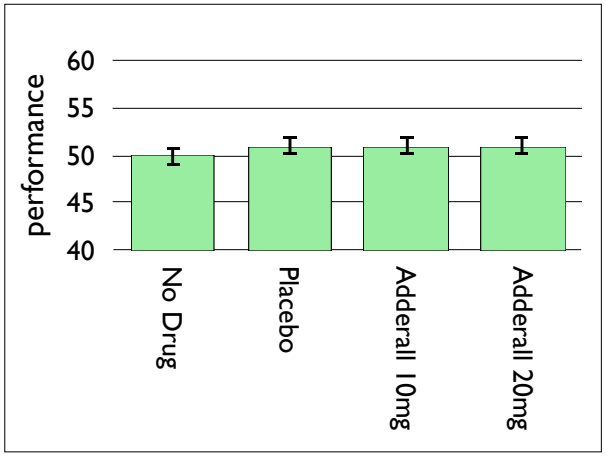
0033-2909/11/$12.00 DOI: 10.1037/a0023825

Are Prescription Stimulants "Smart Pills"? The Epidemiology and Cognitive Neuroscience of Prescription Stimulant Use by Normal Healthy Individuals

M. Elizabeth Smith and Martha J. Farah
University of Pennsylvania

Use of prescription stimulants by normal healthy individuals to enhance cognition is said to be on the rise. Who is using these medications for cognitive enhancement, and how prevalent is this practice? Do prescription stimulants in fact enhance cognition for normal healthy people? We review the epidemiological and cognitive neuroscience literatures in search of answers to these questions. Epidemiological issues addressed include the prevalence of nonmedical stimulant use, user demographics, methods by which users obtain prescription stimulants, and motivations for use. Cognitive neuroscience issues addressed include the effects of prescription stimulants on learning and executive function, as well as the task and individual variables associated with these effects. Little is known about the prevalence of prescription stimulant use for cognitive enhancement outside of student populations. Among college students, estimates of use vary widely but, taken together, suggest that the practice is commonplace. The cognitive effects of stimulants on normal healthy people cannot yet be characterized definitively, despite the volume of research that has been carried out on these issues. Published evidence suggests that declarative memory can be improved by stimulants, with some evidence consistent with enhanced consolidation of memories. Effects on the executive functions of working memory and cognitive control are less reliable but have been found for at least some individuals on some tasks. In closing, we enumerate the many outstanding questions that remain to be addressed by future research and also identify obstacles facing this research.

Keywords: amphetamine, enhancement, neuroethics, psychopharmacology, stimulant



Prescription Stimulants' Effects on Healthy Inhibitory Control, Working Memory, and Episodic Memory: A Meta-analysis

Irena P. Ilieva, Cayce J. Hook, and Martha J. Farah

Abstract

■ The use of prescription stimulants to enhance healthy cognition has significant social, ethical, and public health implications. The large number of enhancement users across various ages and occupations emphasizes the importance of examining these drugs' efficacy in a nonclinical sample. The present meta-analysis was conducted to estimate the magnitude of the effects of methylphenidate and amphetamine on cognitive functions central to academic and occupational functioning, including inhibitory control, working memory, short-term episodic memory, and delayed episodic memory. In addition, we examined the evidence for publication bias. Forty-eight studies (total of 1,409 participants) were included in the analyses. We found evidence for small but significant stimulant enhancement effects on inhibitory control and short-term episodic memory. Small effects on working memory reached significance, based on one of our two analytical approaches. Effects on delayed episodic memory were medium in size. However, because the effects on long-term and working memory were qualified by evidence for publication bias, we conclude that the effect of amphetamine and methylphenidate on the examined facets of healthy cognition is probably modest overall. In some situations, a small advantage may be valuable, although it is also possible that healthy users resort to stimulants to enhance their energy and motivation more than their cognition. ■

Does AMP enhance…

Go / No Go?	X
Stroop?	X
Word Recall?	X
Intelligence Tests? (incl. SAT-M and SAT-V)	X
Long-Term Memory?	**maybe** (but maybe not; and if so, it's a small effect)

Table 2
Means and standard deviations of performance on each dependent measure for the baseline, placebo and mixed amphetamine salts condition.

Task (Measure)	Condition	*N*	*M*	*SD*
Face Recognition (number correct)	Baseline	44	29.05	3.25
	Placebo	44	27.61	4.25
	MAS	44	28.05	4.78
Word Recall (number correct)	Baseline	44	4.25	2.69
	Placebo	44	4.50	4.05
	MAS	44	4.59	3.36
Word Recognition (number correct)	Baseline	44	35.16	4.21
	Placebo	44	34.93	5.65
	MAS	44	34.39	5.04
Digit Span Backward (number correct)	Baseline	42	9.57	2.51
	Placebo	42	10.05	2.70
	MAS	42	10.17	2.80
Digit Span Forward (number correct)	Baseline	42	11.83	1.77
	Placebo	42	12.24	1.59
	MAS	42	12.17	1.67
Object-2-Back (omissions)	Baseline	45	10.38	4.90
	Placebo	45	8.98	4.59
	MAS	45	8.84	5.06
Go/No-go (commissions)	Baseline	42	13.95	5.24
	Placebo	42	15.12	6.20
	MAS	42	14.55	5.50
Flanker (inhibition cost)	Baseline	43	1.16	.05
	Placebo	43	1.16	.06
	MAS	43	1.16	.05
Remote Associations (number correct)	Baseline	46	8.35	2.10
	Placebo	46	7.89	2.50
	MAS	46	8.48	2.18
Embedded Figures (number correct)	Baseline	36	2.88	1.79
	Placebo	36	3.25	1.87
	MAS	36	3.39	1.78
Raven (number correct)	Baseline	37	7.27	1.87
	Placebo	37	8.19	2.16
	MAS	37	8.11	1.84
SAT Math (number correct)	Baseline	45	12.98	5.39
	Placebo	45	13.76	6.48
	MAS	45	13.07	6.18
SAT Verbal (number correct)	Baseline	45	29.42	6.68
	Placebo	45	30.73	7.25
	MAS	45	30.29	7.51

Contents lists available at SciVerse ScienceDirect

Neuropharmacology

journal homepage: www.elsevier.com/locate/neuropharm

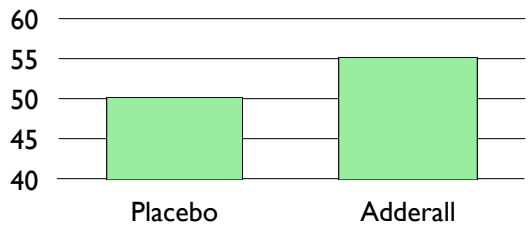
Objective and subjective cognitive enhancing effects of mixed amphetamine salts in healthy people

Irena Ilieva*, Joseph Boland, Martha J. Farah

University of Pennsylvania, United States

How did the drug influence your performance on the tests?

1 = "the drug impaired my performance extremely";
25 = "the drug somewhat impaired my performance";
50 = "the drug had no effect";
75 = "the drug somewhat improved my performance";
100 = "the drug improved my performance extremely."



Does AMP enhance…

"Feelings" of productivity?

YES

even when it doesn't enhance **actual** productivity

Costs of "Enhancement"?

Non-Medical Use

Used (or abused), often illegally, by people to whom the medication is **not prescribed**; for, e.g., addiction, recreation, or (perceived) enhancement

Dangerous! For real.

Drugs like these are contraindicated for many conditions and interactions you may not even be aware of, but that a professional would check for.

(plus, it's illegal)

Psychopharmacology (2009) 202:541–547
DOI 10.1007/s00213-008-1369-3

ORIGINAL INVESTIGATION

When we enhance cognition with Adderall, do we sacrifice creativity? A preliminary study

Martha J. Farah · Caroline Haimm · Geena Sankoorikal · Anjan Chatterjee

Received: 19 June 2008 / Accepted: 3 October 2008 / Published online: 15 November 2008
© Springer-Verlag 2008

Remote Associates Test

Which one word unites these three words, by being able to appear before or after them?

table manners

round table

table tennis

Remote Associates Test

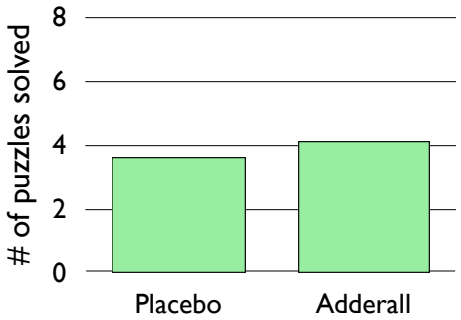
Which one word unites these three words?

fire department

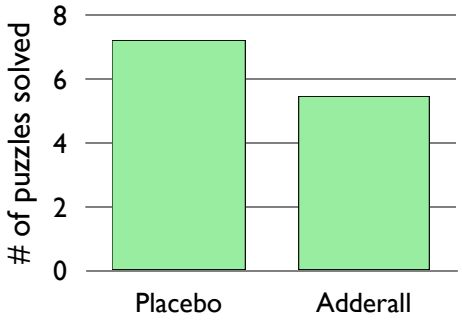
forest fire

firestone!

Those who may need it…



Those who don't…



"Enhancement" with non-medical use of prescription stimulants

You probably don't need it in the first place

It probably doesn't actually enhance cognition
(even if it makes you **feel** you are enhanced)

It may even impair you

It is dangerous and illegal

Which "enhances" best?

A. A dose of Adderall

B. A cup of coffee

C. Sleeping two more hours

Which "enhances" best?

A. A dose of Adderall

B. A cup of coffee

C. Sleeping two more hours

ARTIFACT
-COFFEE-

Legal

Not particularly dangerous

(though you can overdose [and people have];
don't drink 10 Venti-sized cold brews in one hour)

Maybe even healthy!

HEALTHY LIVING 07/12/2017 02:33 pm ET | **Updated** Jul 12, 2017

More Evidence Coffee Is Really Good For You

BRB, making a latte run.

U.S. EDITION Wed, Oct 18, 2017 **Newsweek** SIGN IN SUBSCRIBE

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IS COFFEE GOOD FOR YOU? NEW STUDY SHOWS THE DRINK MAY HELP PEOPLE LIVE LONGER—EVEN IF IT'S DECAF

MOST READ

Trump Unaware He's the President of U.S. Virgin Islands

Journal of Psychophysiology 13 (1999) 37–48

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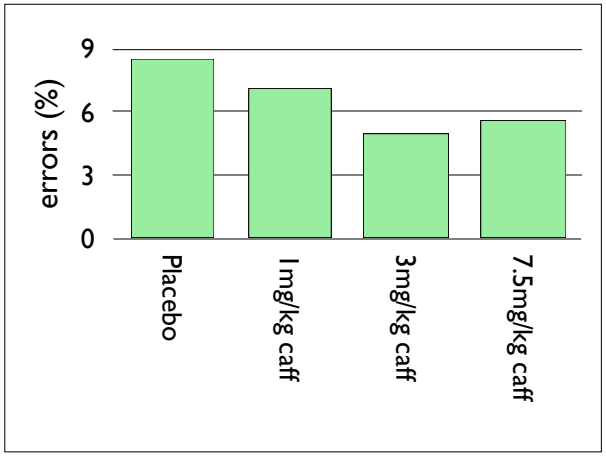
The Influence of Different Doses of Caffeine on Visual Task Performance

Judith Ruijter[1], Monicque M. Lorist[2], and Jan Snel[1]

[1]Dept of Psychonomics, University of Amsterdam, and [2]Experimental and Work Psychology, University of Groningen, Groningen, The Netherlands

GO!



Psychopharmacology (2002) 164:250–261
DOI 10.1007/s00213-002-1217-9

ORIGINAL INVESTIGATION

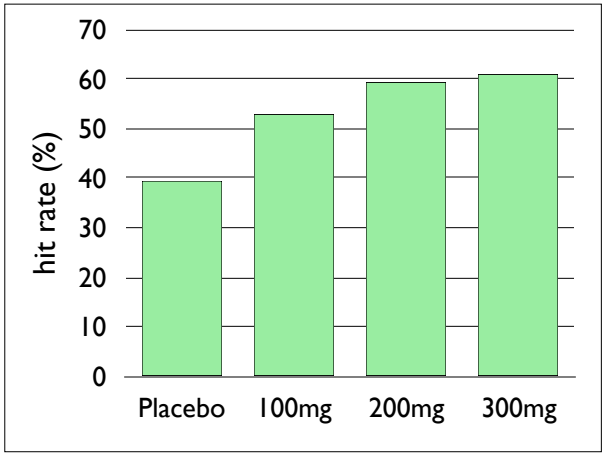
Harris R. Lieberman · William J. Tharion ·
Barbara Shukitt-Hale · Karen L. Speckman ·
Richard Tulley

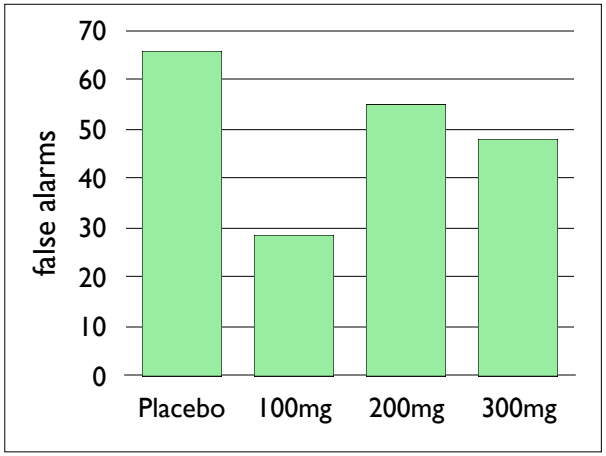
Effects of caffeine, sleep loss, and stress on cognitive performance and mood during U.S. Navy SEAL training

GO!

GO!

NO GO!





A sweet spot

one strong cup

"Enhancement" with caffeine

It really does work!

One cup is enough

More than that doesn't help, and may even hurt

(*Much more* than that could physically harm you)

Which "enhances" best?

A. A dose of Adderall

B. A cup of coffee

C. Sleeping two more hours

Which "enhances" best?

A. A dose of Adderall

B. A cup of coffee

C. Sleeping two more hours

Definitely Legal

Can't overdose

Healthy in every way

Free, available, not addictive…

Sleep Deprivation and Vigilant Attention

JULIAN LIM [a,b] AND DAVID F. DINGES[b]

[a]*Department of Psychology, University of Pennsylvania, Philadelphia, Pennsylvania, USA*

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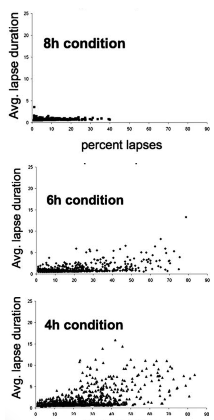
Sleep deprivation severely compromises the ability of human beings to respond to stimuli in a timely fashion. These deficits have been attributed in large part to failures of vigilant attention, which many theorists believe forms the bedrock of the other more complex components of cognition. One of the leading paradigms used as an assay of vigilant attention is the psychomotor vigilance test (PVT), a high signal-load reaction-time test that is extremely sensitive to sleep deprivation. Over the last twenty years, four dominant findings have emerged from the use of this paradigm. First, sleep deprivation results in an overall slowing of responses. Second, sleep deprivation increases the propensity of individuals to lapse for lengthy periods (>500 ms), as well as make errors of commission. Third, sleep deprivation enhances the time-on-task effect within each test bout. Finally, PVT results during extended periods of wakefulness reveal the presence of intersecting circadian and homeostatic sleep drives. A theme that links these findings is the interplay of "top-down" and "bottom-up" attention in producing the unstable and unpredictable patterns of behavior that are the hallmark of the sleep-deprived state.

Key words: sleep deprivation; psychomotor vigilance; lapses; time-on-task; caffeine; modafinil; amphetamine

GO!

Sleep Restriction

4 hours a night for two weeks
6 hours a night for two weeks
8 hours a night for two weeks



RAPID PUBLICATION

The Cumulative Cost of Additional Wakefulness: Dose-Response Effects on Neurobehavioral Functions and Sleep Physiology From Chronic Sleep Restriction and Total Sleep Deprivation

Hans P.A. Van Dongen, PhD;[1] Greg Maislin, MS, MA;[1] Janet M. Mullington, PhD;[2] David F. Dinges, PhD[1]

[1]Unit for Experimental Psychiatry, Division of Sleep and Chronobiology, Department of Psychiatry, and Center for Sleep and Respiratory Neurobiology, University of Pennsylvania School of Medicine; [2]Beth Israel Deaconess Medical Center and Harvard Medical School

Objectives: To inform the debate over whether human sleep can be chronically reduced without consequences, we conducted a dose-response chronic sleep restriction experiment in which waking neurobehavioral and sleep physiological functions were monitored and compared to those for total sleep deprivation.
Design: The chronic sleep restriction experiment involved randomization to one of three sleep doses (4 h, 6 h, or 8 h time in bed per night), which were maintained for 14 consecutive days. The total sleep deprivation experiment involved 3 nights without sleep (0 h time in bed). Each study also involved 3 baseline (pre-deprivation) days and 3 recovery days.
Setting: Both experiments were conducted under standardized laboratory conditions with continuous behavioral, physiological and medical monitoring.
Participants: A total of *n* = 48 healthy adults (ages 21–38) participated in the experiments.

sleep deprivation showed that the latter resulted in disproportionately large waking neurobehavioral and sleep δ power responses relative to how much sleep was lost. A statistical model revealed that, regardless of the mode of sleep deprivation, lapses in behavioral alertness were near-linearly related to the cumulative duration of wakefulness in excess of 15.84 h (s.e. 0.73 h).
Conclusions: Since chronic restriction of sleep to 6 h or less per night produced cognitive performance deficits equivalent to up to 2 nights of total sleep deprivation, it appears that even relatively moderate sleep restriction can seriously impair waking neurobehavioral functions in healthy adults. Sleepiness ratings suggest that subjects were largely unaware of these increasing cognitive deficits, which may explain why the impact of chronic sleep restriction on waking cognitive functions is often assumed to be benign. Physiological sleep responses to chronic restriction did not mirror waking neurobehavioral responses, but cumulative

Sleep Restriction

4 hours a night for two weeks
6 hours a night for two weeks
8 hours a night for two weeks

Sleep Deprivation

0 hours a night for X nights

4 h of sleep for 7 days

=

0 h of sleep for 1 night

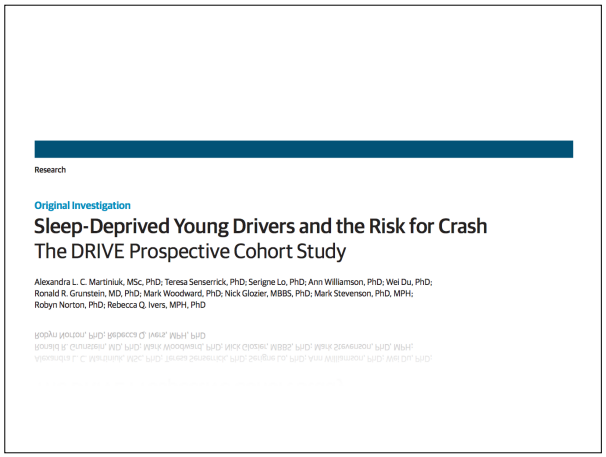
6 h of sleep for 10 days

=

0 h of sleep for 1 night

!

"Claims that humans adapt to chronic sleep restriction within a few days … are not supported by the present findings."



Research

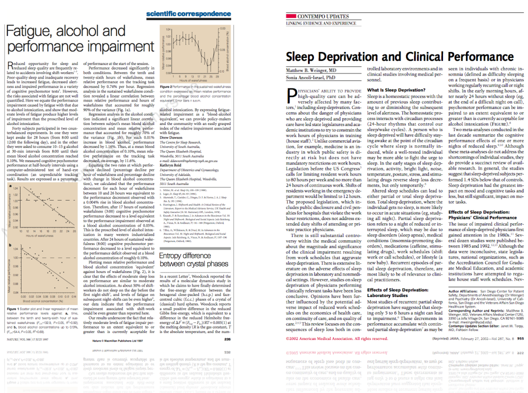
Original Investigation

Sleep-Deprived Young Drivers and the Risk for Crash
The DRIVE Prospective Cohort Study

Alexandra L. C. Martiniuk, MSc, PhD; Teresa Senserrick, PhD; Serigne Lo, PhD; Ann Williamson, PhD; Wei Du, PhD; Ronald R. Grunstein, MD, PhD; Mark Woodward, PhD; Nick Glozier, MBBS, PhD; Mark Stevenson, PhD, MPH; Robyn Norton, PhD; Rebecca Q. Ivers, MPH, PhD

<6h vs. >6h per weeknight:
15% more run-off-road car crashes

<6h vs. >6h per weekend night:
55% more run-off-road car crashes!



24 hours of being awake

is equivalent in performance cost to

Blood-Alcohol Level of **0.085%!**

"Enhancement" with sleep

It really does work!

Just 1 to 2 hrs more = **massive** improvement

100% safe, 100% legal!

Could **save your life**, and the lives of others

Which "enhances" best?

A. A dose of Adderall
B. A cup of coffee
C. Sleeping two more hours

Which "enhances" best?

1 Sleeping two more hours
2 A cup of coffee
3 A dose of Adderall

THINK LIKE A PSYCHOLOGIST!

when making decisions about your own mind,
educate yourself on the science of those decisions!