

# Caffeine Use in Children and Adolescents: Impact on Sleep and Alertness



Judith Owens MD MPH

Children's National Medical Center

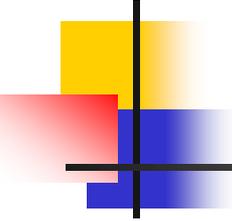
NIH Workshop: The Use and Biology of Energy Drinks:  
Current Knowledge and Critical Gaps

# Objectives

- Describe "drivers" of caffeine/energy drink use in children
  - How caffeine is perceived
  - Sources of information about caffeine
- Summarize caffeine and performance effects in children
- Summarize caffeine and sleep effects
  - Association with other sleep health behaviors
- Identify knowledge gaps, future research directions



No disclosures

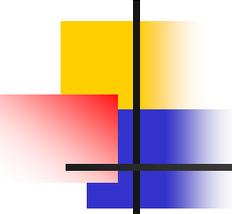


# Expectancies in Caffeine Use

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- Perceived “energy boost”; cost concerns 11-18yo (Aus)<sup>1</sup>
- Increased use in depressed adolescents suggest expectancy to regulate mood, alleviate depression, reduce anxiety<sup>2</sup>
- Reversal of effects of sleep disturbance

*<sup>1</sup>O’Dea 2003; <sup>2</sup>Whalen 2008*

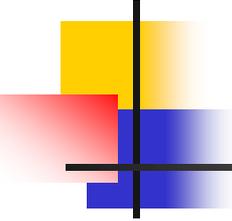


# Caffeine Expectancies

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- Self-report caffeine use HS students (n=196)
  - 68/86% 48/24hr use (6.1% ED)
  - Gender: ED consumption M>F; appetite suppression F>M
  - Expectancies for withdrawal/dependence, sleep disturbance, energy but *overall expected impact low*
  - Mixed use (coffee/soda) vs low caff/high soda clusters
    - Earlier TOD consumption, ↑ consumption ED
    - Higher expectancies for energy/performance/mood enhancement; appetite suppression
    - Reasons: "Getting through the day"; fun/experimentation
    - Increased daytime sleepiness

*Ludden & Wolfson 2010*

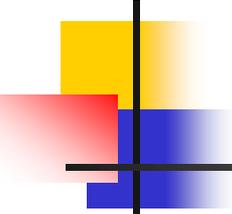


# Caffeine Expectancies

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- Energy drink consumption in female 2ndary students (SA)<sup>1</sup>
  - 52% users; popularity attributed to advertising by 35.0%
  - Reasons for use:
    - “Vitality” (25.6%); “to be alert” (20.8%)
    - Current energy drink use correlated with consumption by a family member or close friend
    - Active ingredients not known by 69.6%
- Protective effect awareness of effects 6<sup>th</sup>-8<sup>th</sup> graders (n=913) (It)<sup>2</sup>: 60.4% vs 6.4% low vs high consumers endorse ED “bad for your health”

<sup>1</sup>Aluqmany et al 2011; <sup>2</sup>Gallimberti 2013



# Caffeine Expectancies

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- Qualitative study of 16-21yo vs 22-35yo regarding factors driving purchase intent ED
  - Highest levels consumption
  - Ads: emphasis packaging/image; little awareness age-specific marketing
  - Brand loyalty, familiarity
  - Association use with social function; image > efficacy
  - Energy seeking (kick/hit) = highest caffeine content
  - Less concern safety (assumed) despite awareness potential health effects
  - Concern sugar content
  - Taste (> physiologic impact, social function)

# Marketing



- ABA: Voluntary restriction of marketing/sales to <12yo
- “Drinks” (8-32oz) single-serving nonresealable vs “shots” (2-2.5oz)
- Portion size; 2/3 standard size can encourages rapid, multiple consumption
- Consumer confusion with “sports drinks” for rehydration
- Advertise “performance enhancement”
- Youth-targeted advertising > adults: MTV, Comedy Central, Adult Swim; social media, sponsorship extreme sports
  - Children <12yo saw 62 energy beverage ads=“children drinks” (2010)
- Targeting younger groups
  - Advocare “Spark” (marketed for adults/teens): 120mg caffeine
  - “KickStart Spark” (marketed for 4 year olds and up): 60mg caffeine/8oz

# Marketing



Photo: @BevNET.com

Product	Total (mg)	Product	Total (mg)
Red Bull	80-192	Cocaine	280
Rockstar	80-240	BooKoo	360
Monster Energy	160-320	Fixx	500
Full Throttle	200	WiredX505	505
Venom Energy (Black Mamba)	170	5Hr Energy (2.5oz)	200
SoBe No Fear	174	No-Doz*	200
Blow	240		
Jolt	280		

*\*Label lists side effects, age limit, "not substitute for sleep"*

*FDA limits caffeine content sodas to 71 mg/12 oz*

# Explore the world of Red Bull

Motorsports



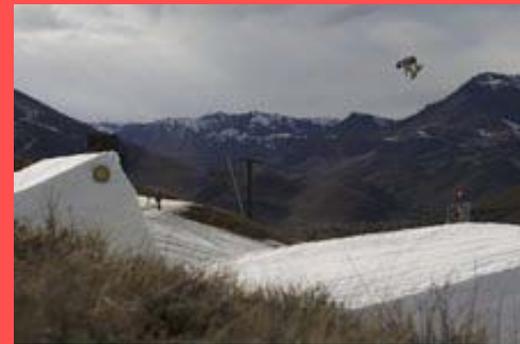
Bike



Surfing

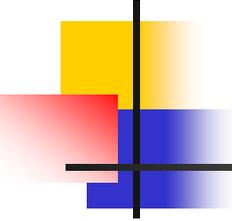


Skateboarding



Snowboarding



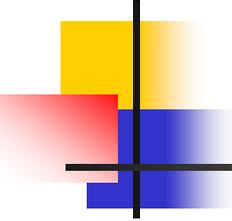


# Energy Drinks: Performance Effects

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- Reported improved work and exercise endurance, mental performance, alertness
- 3 studies young adults, Red Bull vs H<sub>2</sub>O, placebo<sup>1</sup>:
  - Decrease reaction time, increase subjective alertness and aerobic endurance, improvement memory, concentration, anaerobic endurance; inconsistent increase HR
- Study placebo vs caffeine/taurine combination in college students<sup>2</sup>: no effect memory; ↓ HR, ↑ BP

<sup>1</sup>Alford et al, 2001 <sup>2</sup>Bichler et al, 2006



# Caffeine: Performance Effects

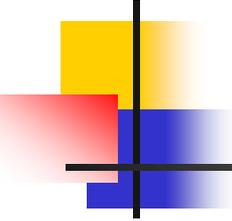
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- Does caffeine improve cognitive performance?
  - Lab studies in adults show improvement attention, psychomotor skills (ie, reaction time)
  - Mixed effects short/long-term memory, complex cognitive functions
- Does caffeine improve or just restore performance after impairment secondary to sleepiness?
  - High rate basal sleepiness in “normal” study participants
  - Rebound sleepiness following acute discontinuation
  - Withdrawal associated with caffeine dependence

# Caffeine: Performance Effects

- Role of improved sleep off caffeine?
- Homeostatic sleep drive and circadian-mediated time of day effects (mid-day > evening)?
- Effect on real world daytime function is “not fully known”

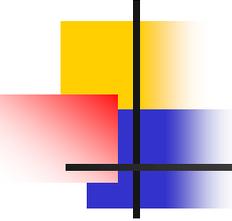




# Caffeine: Performance Effects

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- Literature of DB PC studies in adults:
  - Caffeine improves performance on simple and complex attention tasks, and affects the alerting, and executive control networks
  - Inconclusive evidence on dose-related performance effects of caffeine, or influence of habitual caffeine consumption on performance effects
  - Caffeine's effects cannot be attributed to withdrawal reversal
  - BUT, these effects have not been studied in children

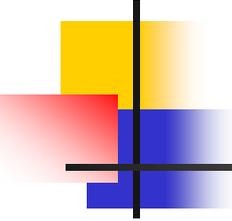


# Caffeine: Performance Effects

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- Healthy children: mixed results; improved vigilance/reaction time, attention, manual dexterity; little evidence for cognitive effects
  - Effects dependent dose and previous exposure
  - Evidence of withdrawal-related deterioration in performance
    - Lower response time; persists for 1 week<sup>1</sup>

*<sup>1</sup>Bernstein et al, 1998*

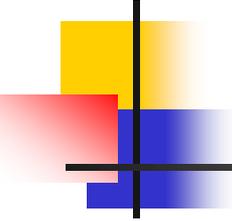


# Caffeine: Performance Effects

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- DB placebo-controlled study 35 9-11 yo caffeine consumers vs low/non-consumers<sup>1</sup>
  - Post overnight abstinence, consumers had poorer performance cognitive task
  - Accuracy improved more in consumers following caffeine compared to placebo
  - Supports withdrawal reversal hypothesis of caffeine effects

*<sup>1</sup>Heatherly et al, 2006*



# Caffeine: Effects on Sleep

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- Sleep: dose-related reduction TST, increased SOL, reduction SWS; intake 300mg → 2hr decrease SD, 2x increase NW<sup>1</sup>
  - Effect SOL, TST 150 mg caffeine > 10 mg methylphenidate
  - Insomnia common reason for cessation/reduction
  - Sleep disturbance → sleepiness → increased use
  - Withdrawal → sleepiness/fatigue (78% studies)

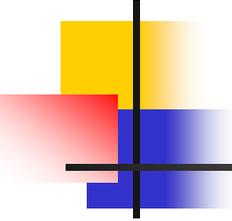
<sup>1</sup>James, 1998

# Caffeine: Effects on Sleep

- 2004 NSF poll:  $\geq 1$  serving/day: 33% older/28% younger school-age, 18% preschoolers; associated with less sleep
- 2006 NSF Poll: Those adolescents consuming 2+/d more likely to have:
  - Sleep problems: later bedtime, increased SOL, difficulty staying asleep, shorter SD, WD/WE discrepancy
  - Daytime sleepiness: napping, falling asleep in school/ doing homework, feeling cranky, irritable; report depression, get lower grades
- Daytime sleepiness may be mediator of negative impact of caffeine on academic achievement<sup>1</sup>

*1James et al 2010*



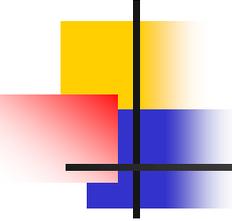


# Caffeine: Effects on Sleep

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- Randomized discontinuation caffeine in 12-24 mth old Guatemalan daily coffee drinkers increased sleep 30 min/night<sup>1</sup>
- Dose-dependent insomnia reported in ADHD children treated with caffeine
- Parent-reported increased difficulty sleeping with caffeine in low consumers<sup>2</sup>

*<sup>1</sup>Engle et al, 1999; <sup>2</sup>Rapoport et al, 1984*

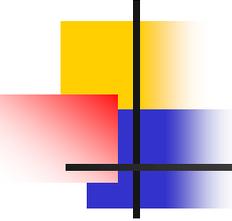


# Caffeine: Effects on Sleep

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- NICHD survey (1998): high caffeine intake 6-10<sup>th</sup> graders associated 2x difficulty sleeping, am fatigue<sup>1</sup>
- Survey of 7-9<sup>th</sup> graders (2 week sleep diary and caffeine use)<sup>2</sup>:
  - Intake range 0-800mg/d; mean intake range 0-380mg/d  
20% averaged >100mg/d; increased on weekends, in boys
  - Higher caffeine intake associated with ↓ sleep duration, increased WASO

*<sup>1</sup>Orbeta et al 2006, <sup>2</sup>Pollack et al, 2003*

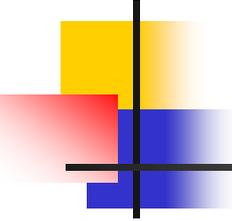


# Caffeine: Effects on Sleep

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- Survey of 7-9<sup>th</sup> graders (2 week sleep diary and caffeine use)<sup>1</sup>:
  - Intake range 0-800mg/d; mean intake 53mg/d; 20% averaged >100mg/d; increased on weekends, in boys
  - Higher caffeine intake associated with ↓ sleep duration, increased WASO
- 1998 NICHD US survey > 15,000, grades 6-10<sup>2</sup>
  - >1/2 moderate to high intake
  - High consumers almost 2x difficulty sleeping, am fatigue

<sup>1</sup>Pollack et al, 2003, <sup>2</sup>Orbeta et al, 2006

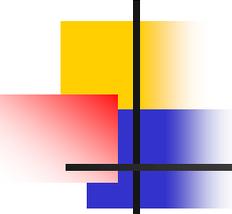


# Caffeine: Effects on Sleep

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- High school students reporting consuming the most caffeine also had the highest levels of multitasking with media-related electronic products<sup>1</sup>
- Caffeine consumption is also linked to nicotine use in adolescents<sup>2</sup>
  - May further disrupt sleep and perpetuate the cycle of sleep fragmentation – daytime sleepiness- stimulant use<sup>3</sup>

*<sup>1</sup>Calamaro 2009, <sup>2</sup>Martin 2008; <sup>3</sup>Jaehne 2009*



# Future Research Directions

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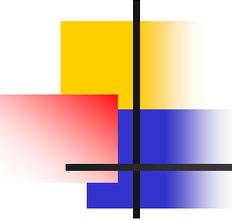
- Consumption rates across groups, across products
- Knowledge gaps among consumers
- Reasons for use, expectancies
- Social context of consumption types, amts, timing
- Impact of performance in children/adolescents, inc attention, school/athletic
- Impact on sleep and alertness
- Genetic factors
  - Higher concordance rates monozygotic twins caffeine consumption, tolerance, etc
  - Polymorphisms A2A receptor gene/adenosine deaminase linked individual differences

*Coffee!*



*You can  
sleep when you're dead!*

*Thanks for your  
attention!*

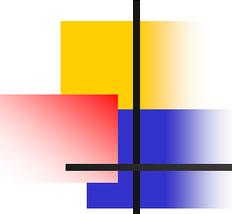


# Energy Drinks: Regulation

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- FDA does not regulate or label caffeine content in energy drinks<sup>1</sup>
  - 1980: FDA proposes elimination caffeine soft drinks
  - 1981: Manufacturers claim caffeine “flavor enhancer”
  - 1990 NLEA requires strict beverage labeling<sup>2</sup>
  - 1994 Dietary Supplement Health and Education Act; some energy drinks classified as “dietary supplements”
  - FDCA does not require disclosure caffeine content

*<sup>1</sup>Reissig et al, 2009 <sup>2</sup>Pomerantz 2013*

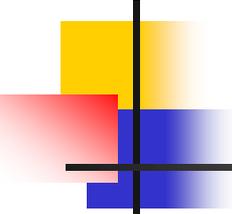


# Caffeine/ED Regulation

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- Health CA maximum recommended caffeine intake:
  - Children 4-6y 45 mg/day\*
  - Children 7-9y 62.5 mg/day\*
  - Children 10-12y 85 mg/day\*
- CA (2011-13): max caffeine per single-serve container 180mg, all non-resealable containers one serving, requires caffeine content on label and include warnings for use by children and certain sensitive adults; ED reclassified as “food”
- Healthy Kids Association (Aus)
  - “Until a safe consumption level of caffeine for children is determined, beverages with added caffeine as an ingredient are not recommended for school aged children”
- Warning labels/restrictions: Iceland, Sweden, Norway, Denmark, France, Turkey, Italy, EU, S Korea, India

\* 2.5 mg/kg body wt/day based on average body wt



# Caffeine/ED: Regulations

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- IOM (2007) recommends prohibiting sale of caffeinated products in school
- Stimulant containing energy drinks have no place in the diets of children or adolescents AAP (2011)
  - “Sleep disturbances...are considered variable and individualized effects”
- AMA (2013): Recommends no marketing to <18yo
- 74-78% US parents agreed energy drinks should not be marketed/sold to children/teens and 85% supported regulations requiring caffeine content disclosure and warning labels<sup>1</sup>