Sleep Composition and Sleep EEG: Age, Sex, Ethnicity and Alcohol Effects in NCANDA

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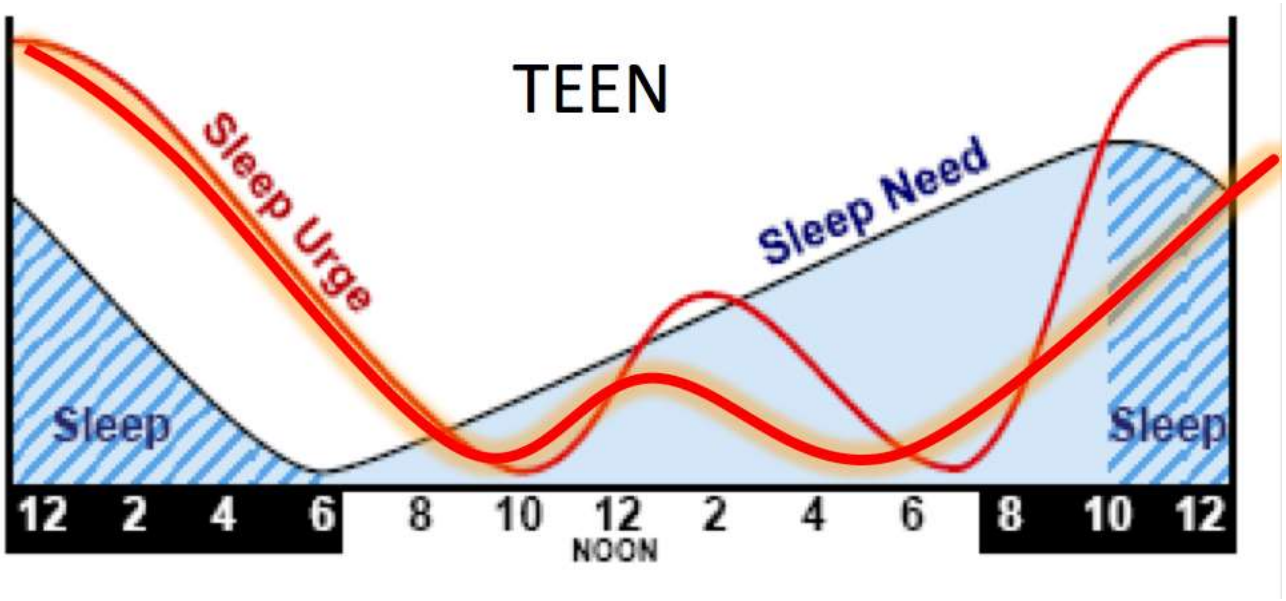
Why is sleep important?

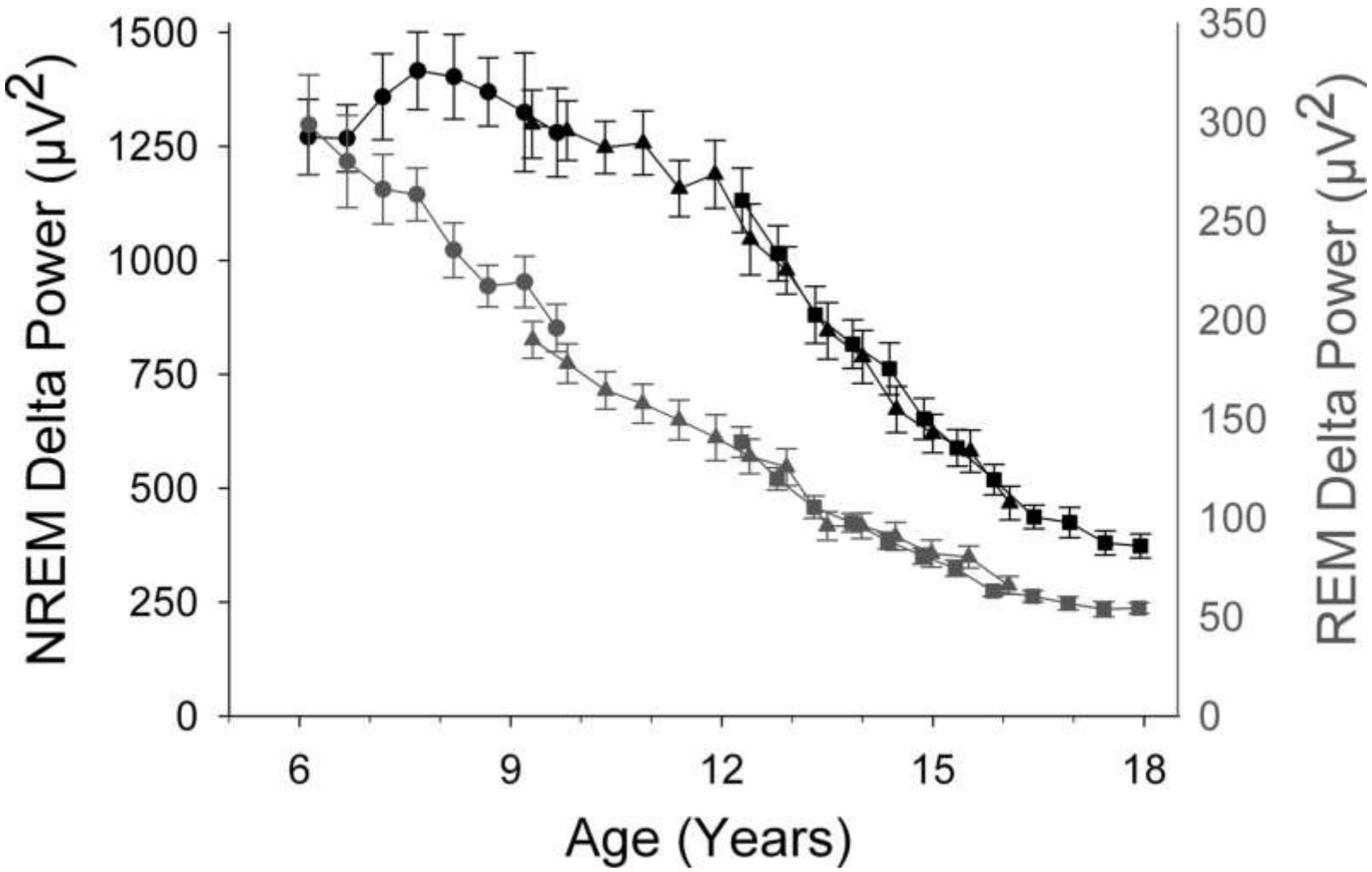
- Sleep architecture and timing undergo dramatic changes during adolescence
  - 50% reduction in SWS
  - 65% reduction in EEG delta power
  - Two hour circadian phase delay
  - Onset of insomnia symptoms
- Sleep is greatly disturbed in AUD
  - Reduced SWS and delta
  - Insomnia (long-lasting, potential pathway to relapse)
- Disturbance of sleep and sleep timing during childhood and adolescence are predictive of AUD and SUD development.
- Drugs effective in alcoholism (acamprosate, gabapentin) also improve sleep

Teens experience a two hour circadian delay



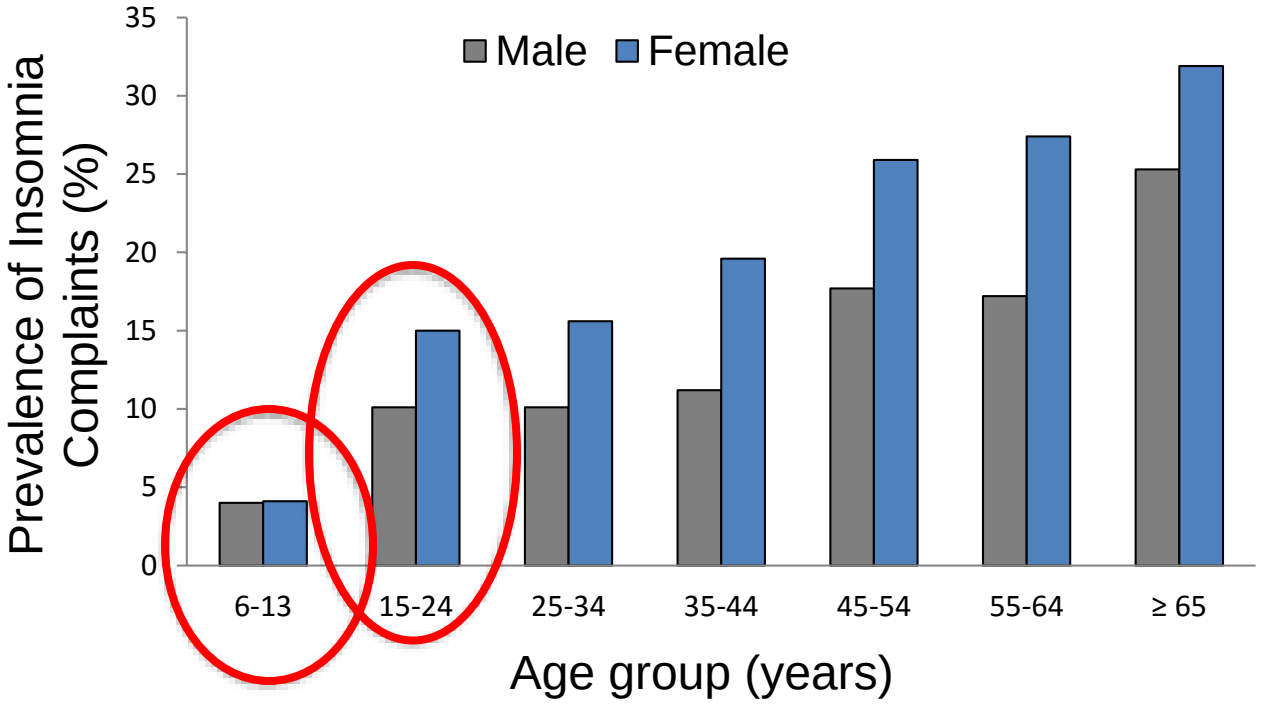
Social Jet lag

Delta Power Decreases Dramatically across Puberty



Feinberg & Campbell (2013) Am J Physiol Regul Integr Comp Physiol

Insomnia starts in adolescence



Zhang et al., 2009;
Ohayon, 1997

National Epidemic of sleep deprived adolescents

Table 1
Prevalence of insufficient, borderline, and optimal sleep on an average school night among high school students, by gender, race/ethnicity, and grade (United States – 2007)

	Insufficient (≤7 h)		Borderline (8 h)		Optimal (≥9 h)	
	%	95% CI	%	95% CI	%	95% CI
Overall	[illegible]	(66.9–70.9)	23.5	(21.8–25.3)	7.6	(6.8–8.4)
Gender						
Female	71.3	(69.2–73.2)	22.5[M]	(20.5–24.6)	6.3[M]	(5.5–7.1)
Male	66.6[F]	(64.1–69.1)	24.5	(22.6–26.6)	8.8	(7.7–10.1)
Race/Ethnicity						
White, non-Hispanic	69.2	(66.3–71.9)	24.4	(21.8–27.2)	6.5[H]	(5.7–7.3)
Black, non-Hispanic	71.2	(68.9–73.4)	20.6[W, H]	(18.8–22.6)	8.2	(6.7–9.9)
Hispanic	65.6[B]	(61.3–69.6)	23.8	(21.3–26.4)	10.6	(8.7–12.9)
Grade						
9th	57.7[10,11,12]	(54.8–60.5)	29.7	(27.1–32.5)	12.5	(10.5–15.0)
10th	67.6[11,12]	(64.8–70.2)	25.4[9]	(23.0–27.9)	7.1[9]	(5.8–8.5)
11th	75.1	(72.4–77.7)	19.5[9,10]	(17.2–22.0)	5.4[9,10]	(4.6–6.3)
12th	78.2	(75.2–81.0)	17.7[9,10]	(15.4–20.4)	4.0[9,10,11]	(3.1–5.2)

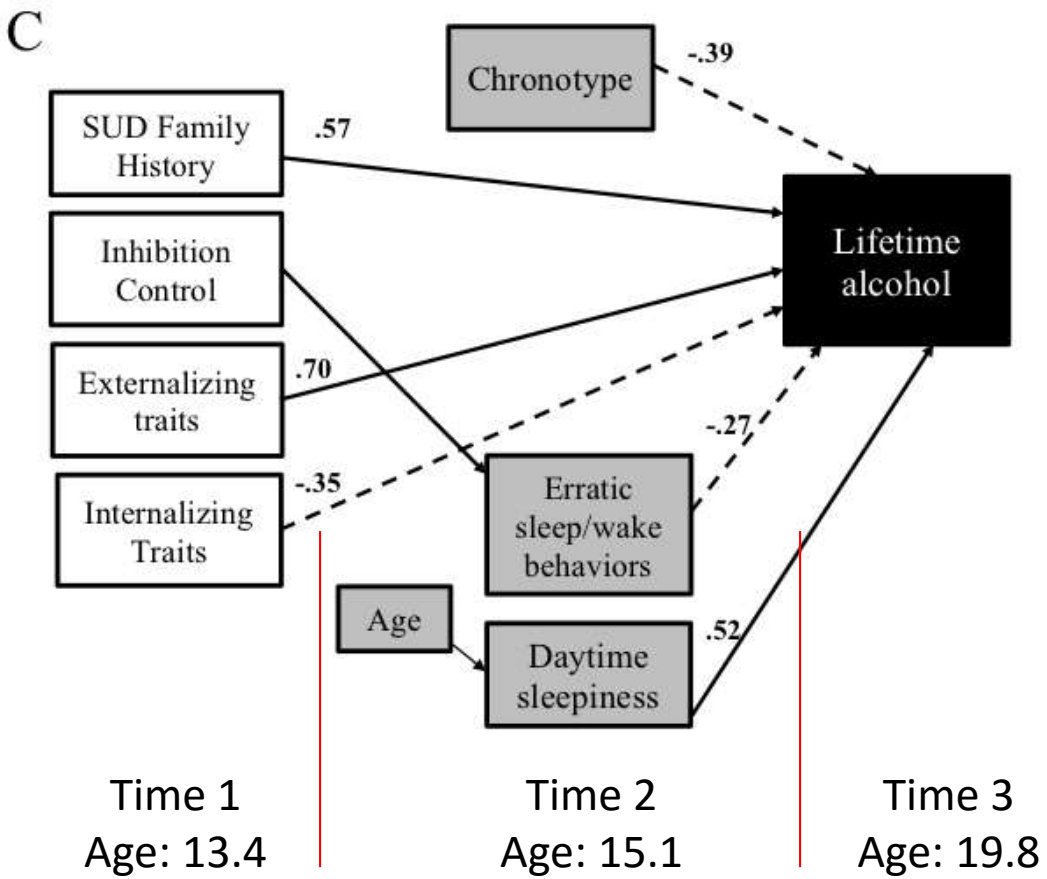
F = female; M = male; W = white, non-Hispanic; B = black, non-Hispanic; H = Hispanic.

9 = 9th grade; 10 = 10th grade; 11 = 11th grade; 12 = 12th grade. The subgroups (denoted by a superscript) have a higher prevalence of insufficient, borderline, or optimal sleep hours than the row subgroup according to pairwise *t*-test at $p < .05$.

Several studies show predictive relations between sleep and substance use.

- Wong et al. (2004, 2010) childhood sleep problems, (3 to 8 yrs) predict alcohol problems during adolescence and young adulthood.
- Pieters et al. (2010) sleep problems and more evening-type tendencies (e.g., favoring later bedtimes), related to alcohol use (similar predictive magnitude as externalizing disorders)
- Negriff et al. (2010) greater eveningness in girls predicted alcohol, nicotine and THC use
- Hasler et al. (2014) AUD+ youth had greater sleep disturbance at baseline. Presence of insomnia in AUD- youth predicted alcohol use at follow-up

An example from within the NCANDA consortium

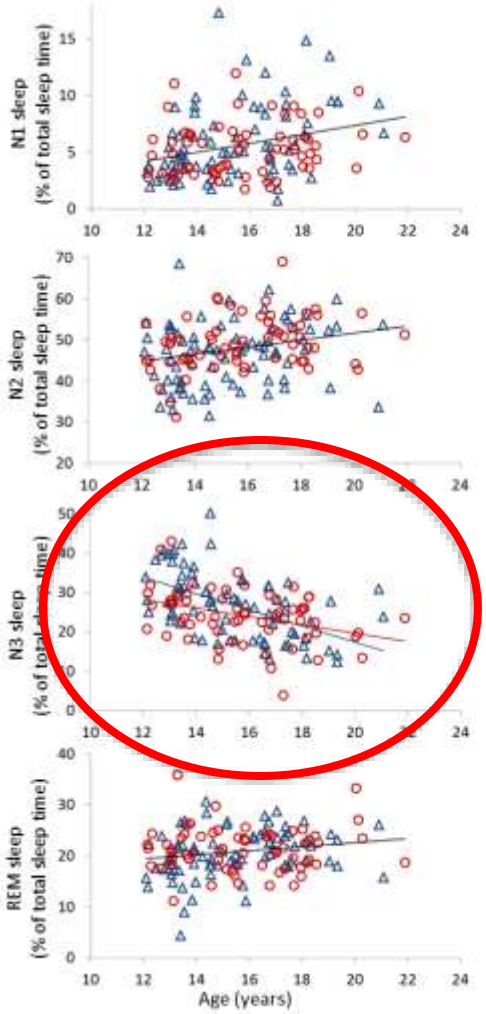


Nguyen-Louie et al. *Developmental Psychology* submitted

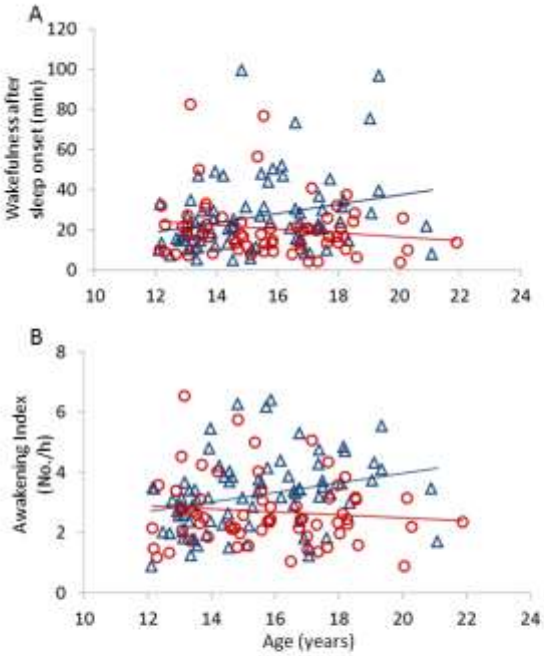
Characteristics of the NCANDA sleep sample

	Boys (n = 77)	Girls (n = 64)
Age (years)	15.4 (2.2)	15.8 (2.3)
Body mass index percentile	59.7 (26.8)	56.9 (29.0)
Ethnicity (No.) Caucasian	59	45
Asian	10	10
African-American	6	9
Other/undeclared	2	
Pubertal development score[a]	2.8 (0.7)*	3.4 (0.7)
Exceeds baseline drinking criteria (N)	10	14

Older adolescents have less slow wave sleep and more REM sleep.



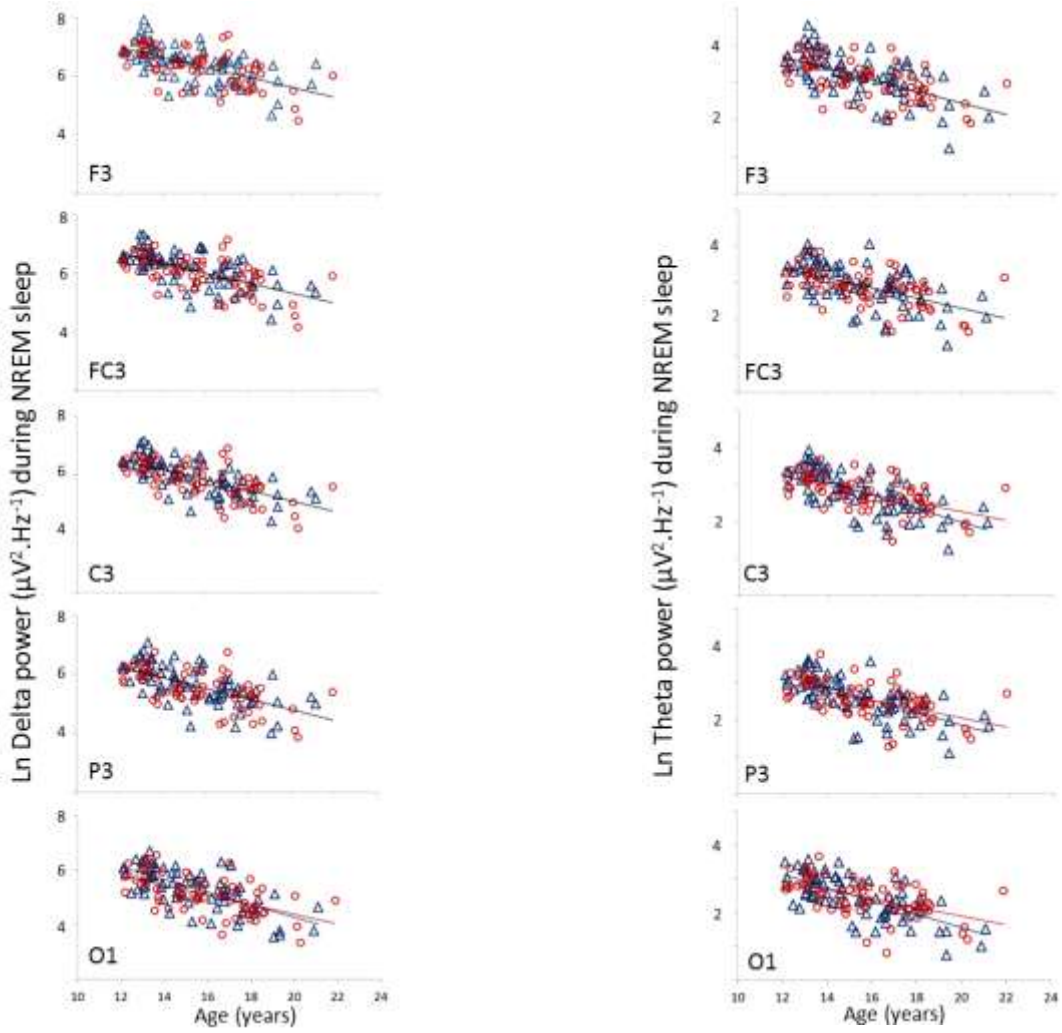
N = 141 adolescents



Older boys have more wake-time than younger boys

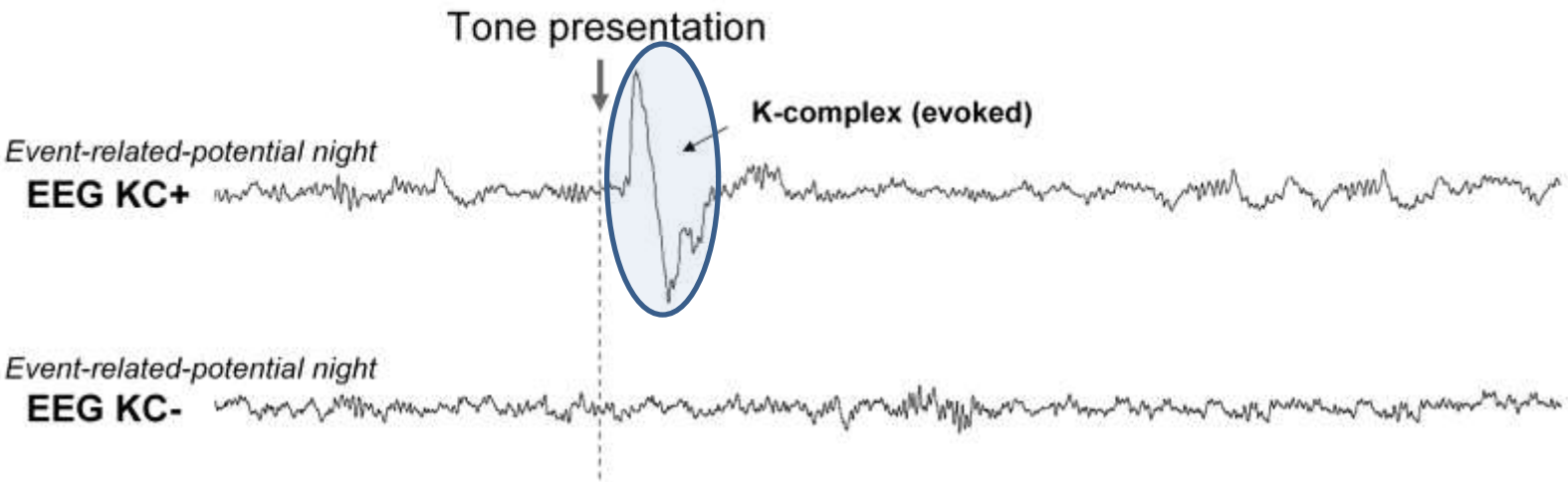
Baker et al., Sleep 2016

Older adolescents have lower sleep-related delta and theta power across the scalp



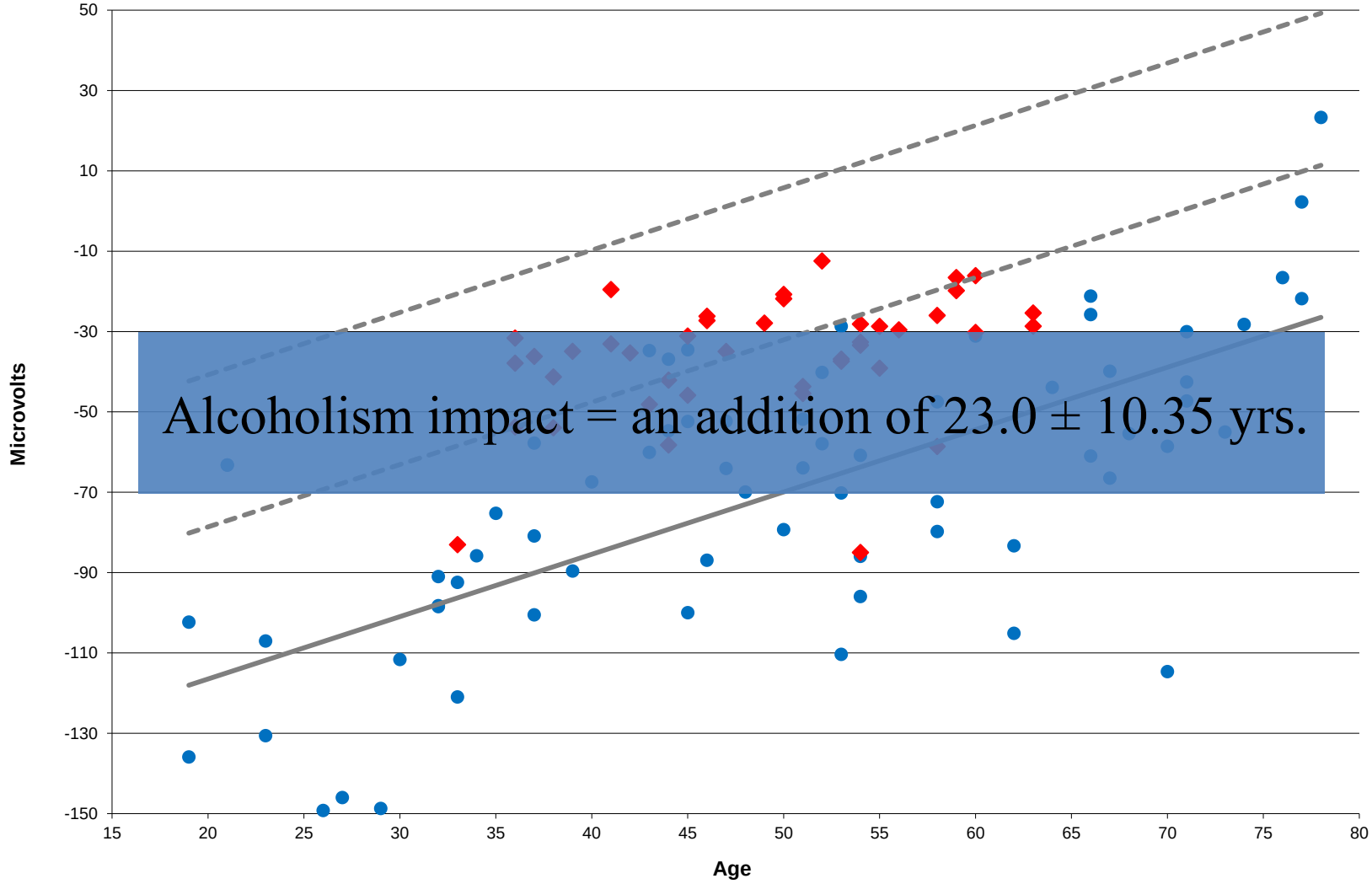
Baker et al., Sleep 2016

Experimental evoking of slow-wave K-complexes during sleep



- KC incidence and amplitude are reduced in adults with AUD
  Colrain et al. (2009) *Biological Psychiatry*
- KC amplitude increases with abstinence from alcohol in adults with AUD
  Colrain et al. (2012) *Alcohol*
  Colrain et al. (2015) *ACER*
- KC incidence is reduced in heavy drinking youth
  Colrain et al. (2013) *ACER*

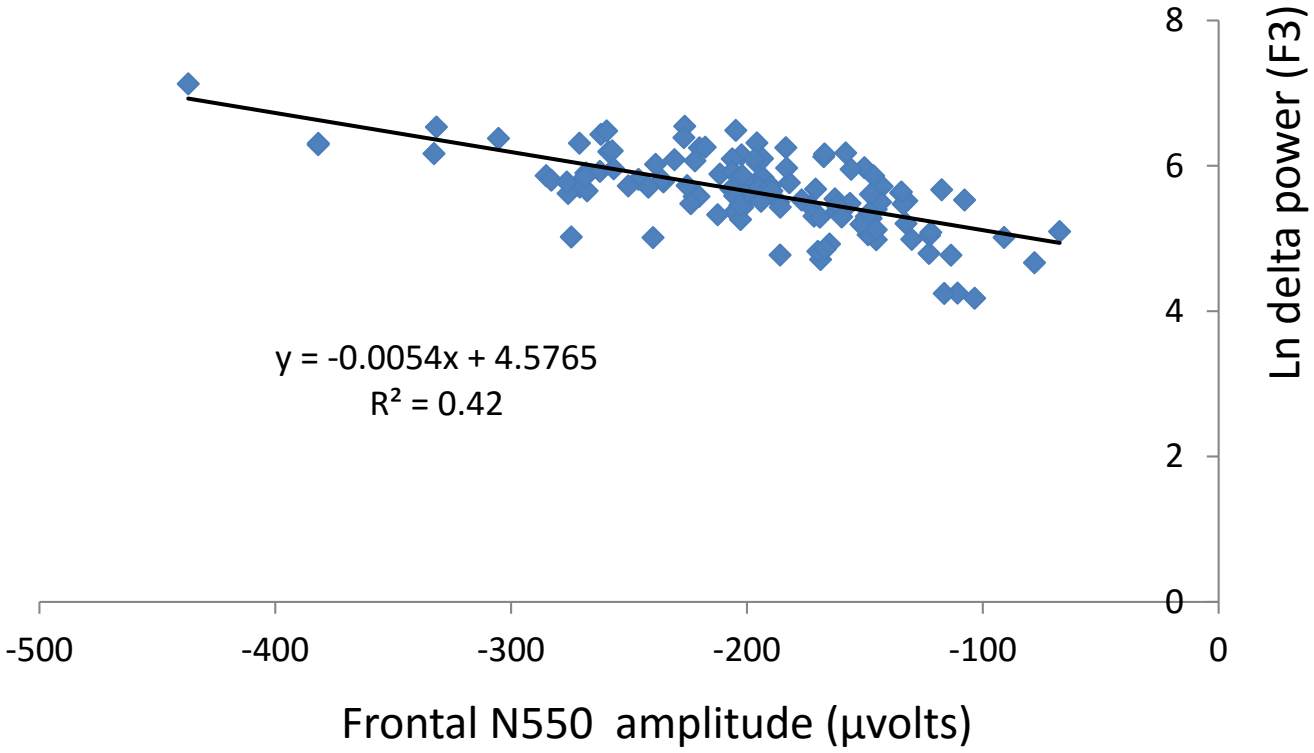
N550 Amplitude at Fz: alcoholics relative to normal aging



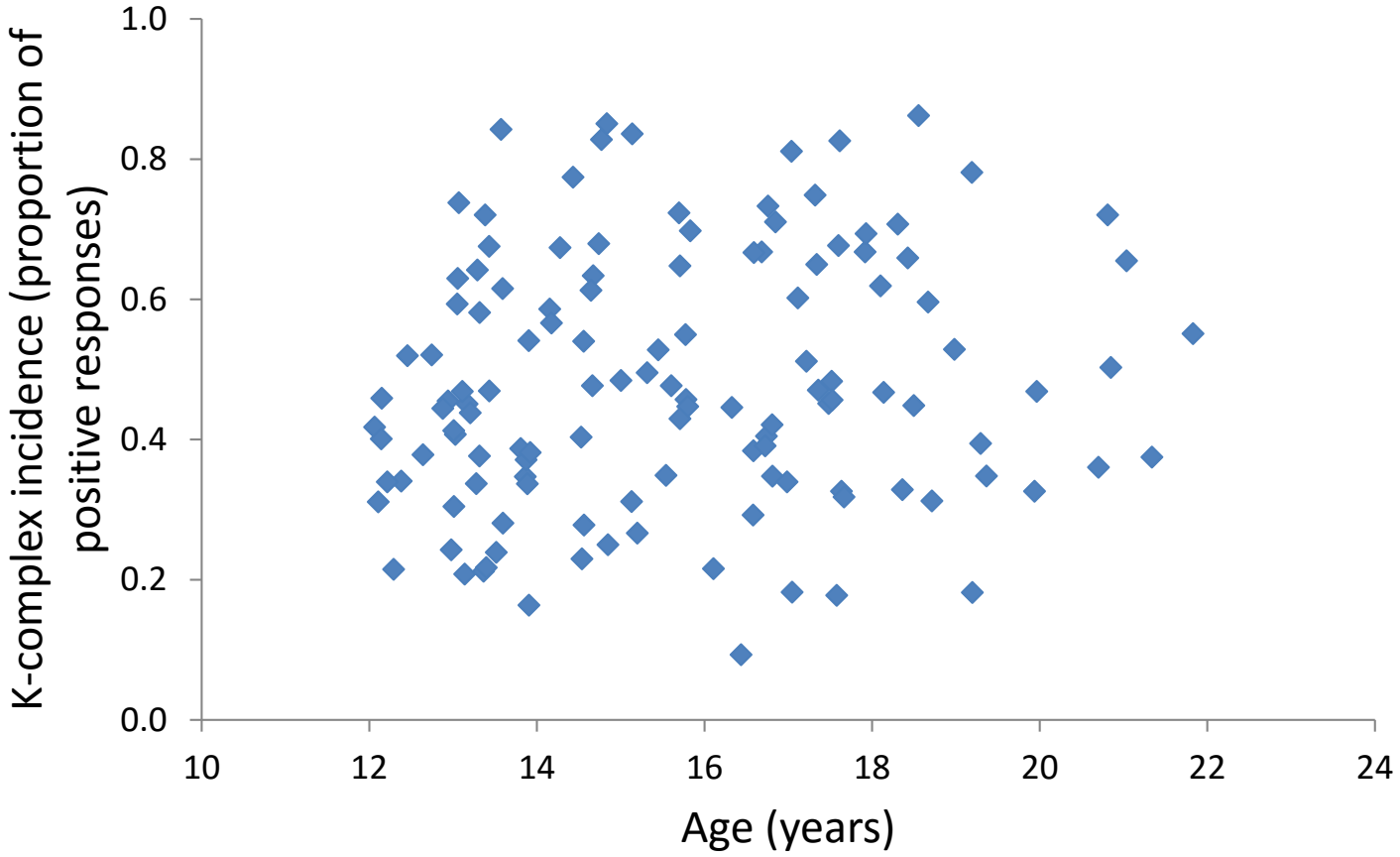
Colrain et al. (2009) *Biological Psychiatry*

Colrain et al. (2010) *Neurobiology of Aging*

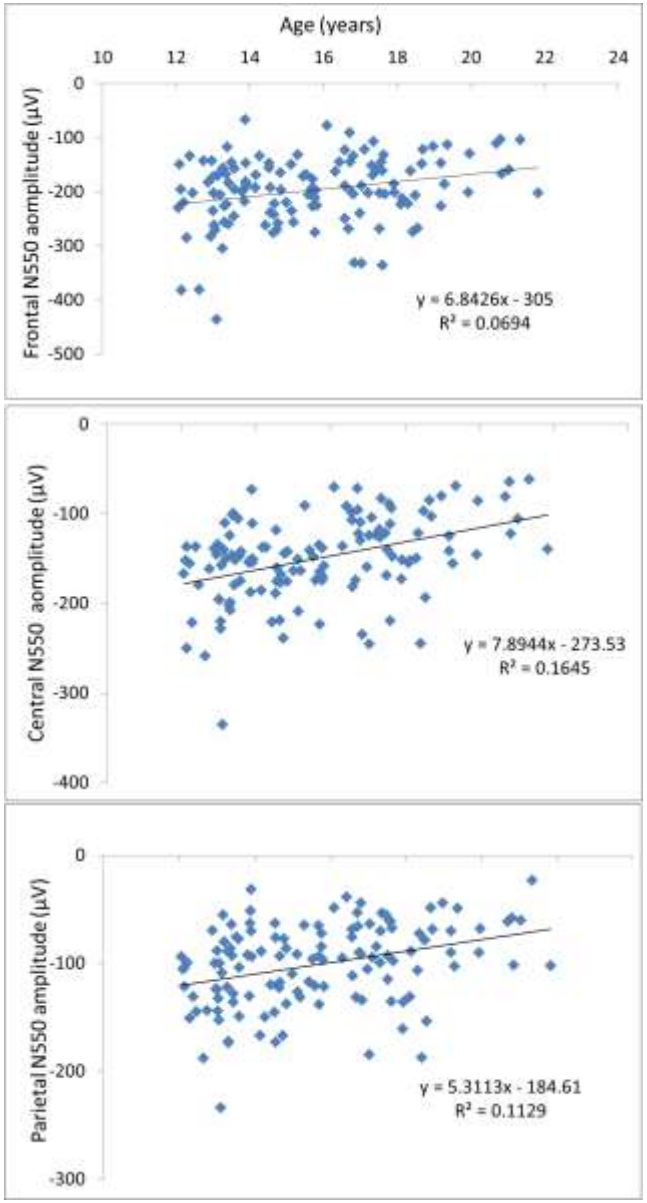
N550 (K-complex) amplitude is strongly correlated with delta power



Incidence of K-complexes in response to a tone is unrelated to age



Older adolescents have smaller N550 amplitude at central and parietal sites



What about Family History?

- For N550 amplitude, compared a sub-group of 13 FH+ vs 13 sex and age-matched FH- adolescents: no differences in KC amplitude or incidence ($_{\text{all } p>0.3}$).

	Age	KC incidence (KC+prop (SD))	KC amplitude (SD) at electrode F (microV)
FH+ (n=13)	17.3 y	0.56 (0.15)	-175.82 (44.0)
FH- (n=13)	17.3 y	0.53 (0.17)	-195.24 (64.4)

- Note: FH+ = positive FH for alcohol (family history of alcohol or drug problems in a biological parent or two or more 2nd degree relatives)

What can we expect when our sample starts drinking?

- Ongoing adolescent drinking studies at the University of Melbourne point to differences between heavy and light drinking youth and sex differences in acute alcohol effects.

	LIGHT DRINKERS (HD)		HEAVY DRINKERS (LD)	
SEX	MALE	FEMALE	MALE	FEMALE
n	6	6	8	5
AGE (YEARS)	19.17 ± 0.98	20.17 ± 0.98	19.50 ± 1.07	19.60 ± 0.89
30 DAY ALCOHOL*	11.36 ± 7.89	17.11 ± 8.79	138.20 ± 93.56	92.59 ± 34.26

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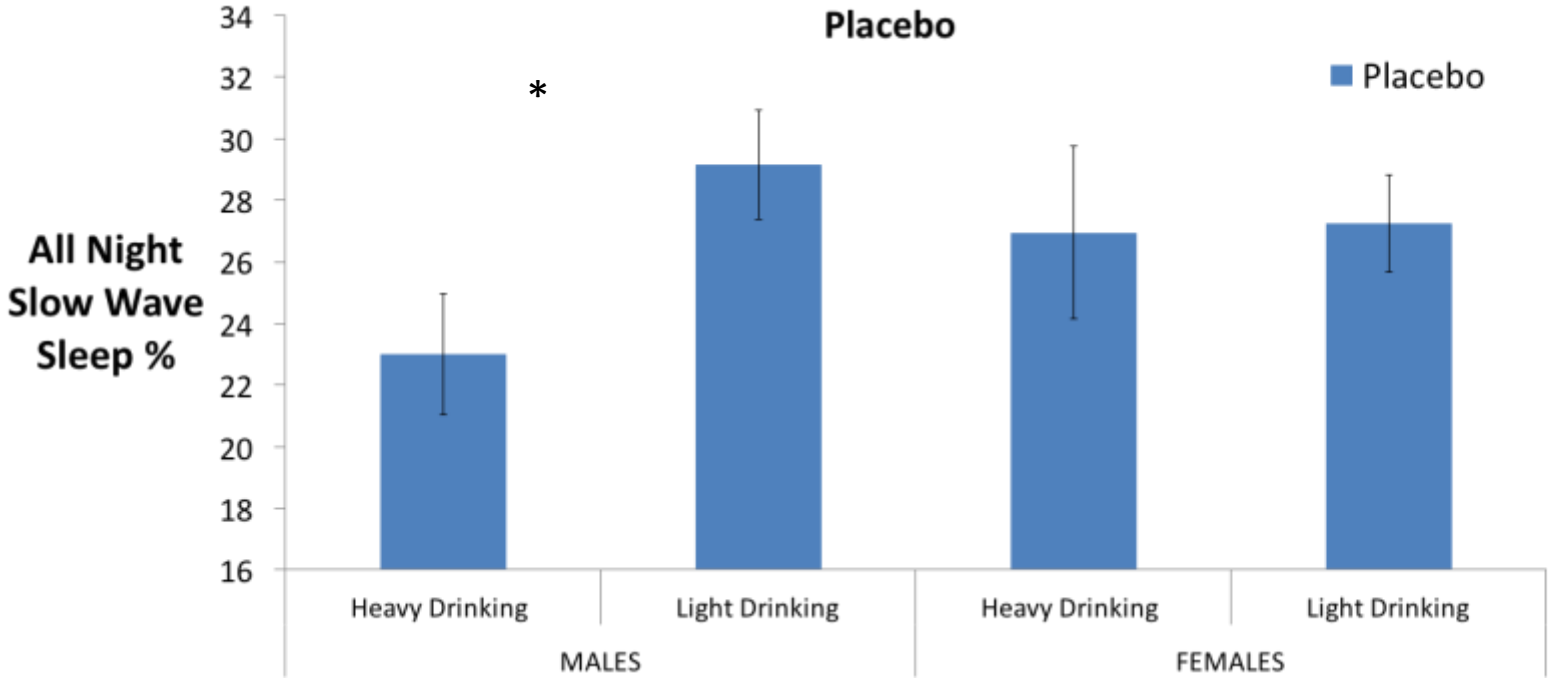
Heavy drinking young men have less SWS



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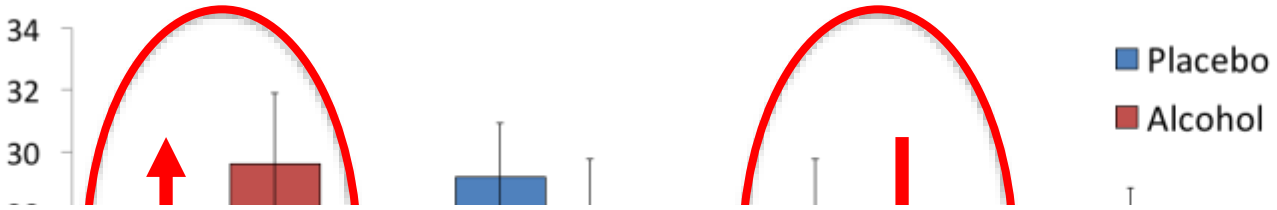
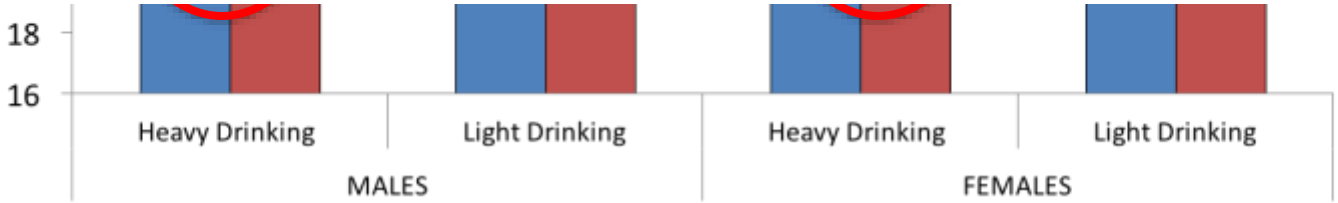
Also… sex differences in how acute alcohol consumption effects sleep



NCANDA will tell us whether these effects are the consequences of drinking or evidence of a premorbid disposition



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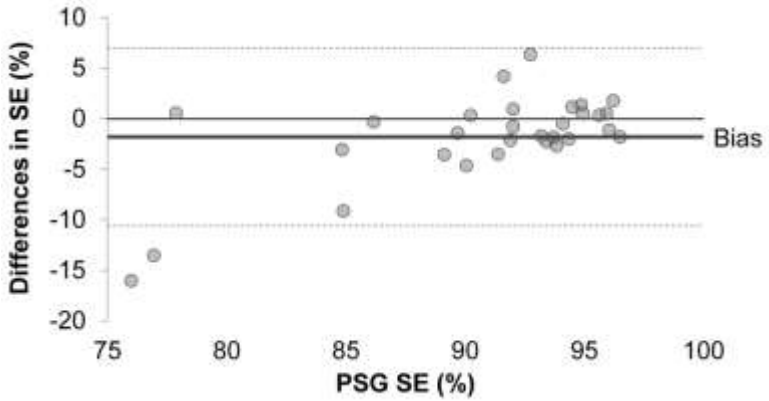
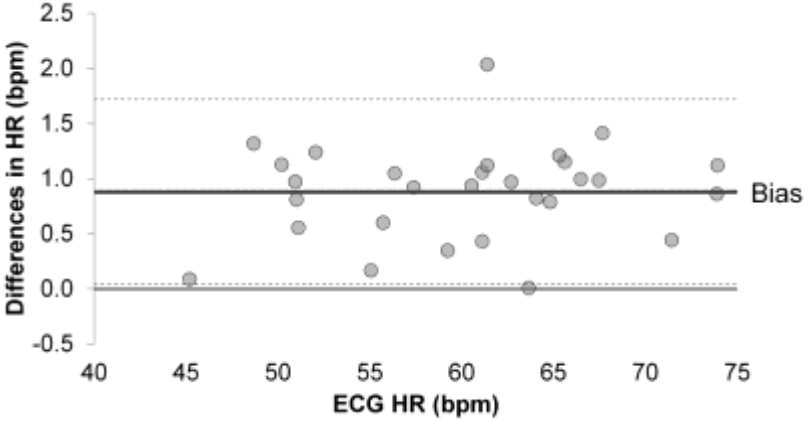
Gourlay, Colrain et al. RSoA 2016 Poster # 121 (Tuesday), Abstract #585

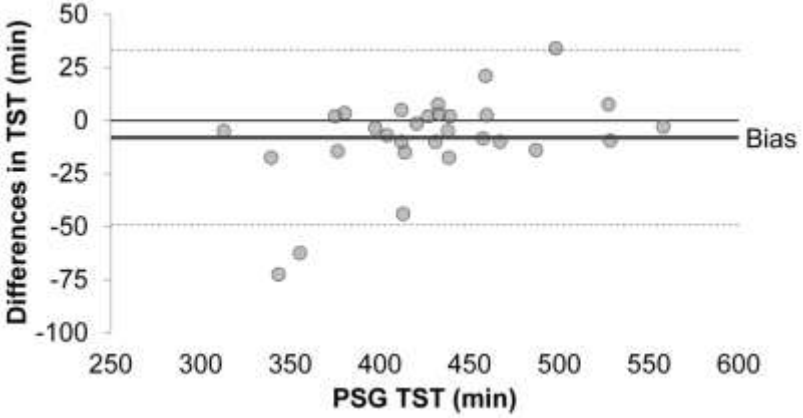
Where we are heading…

- Ongoing analysis of follow-up data
- Use of commercial sleep tracking devices to track sleep over multiple nights in relation to alcohol use, binge drinking, etc.
- Huge potential for innovative science
  - 1st ever combination of brain MRI and sleep EEG data in a longitudinal design across adolescence
  - Powerful test of models of sleep's involvement in subsequent AUD/SUD development
  - Powerful test of consequences of alcohol consumption effects on sleep and EEG in those previously tested when naïve
  - What is the impact of alcohol use on the health of the autonomic nervous system and autonomic-sleep interactions?

NCANDA: out of the lab and into the home



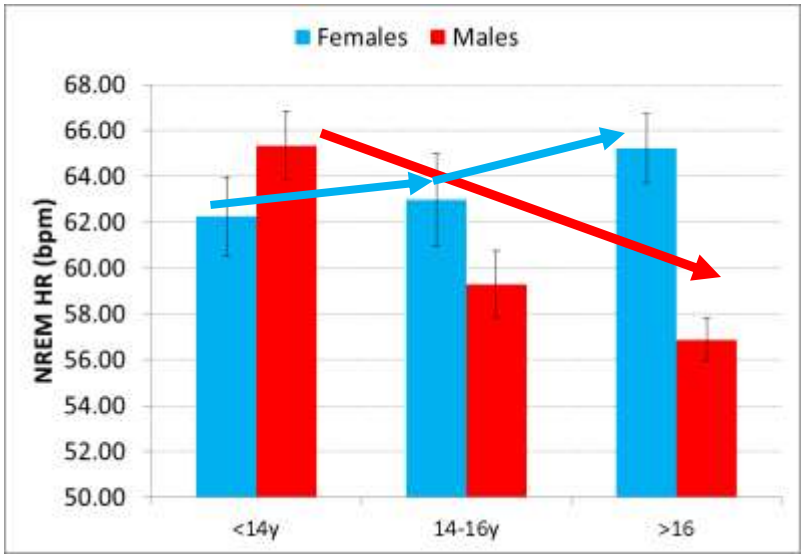


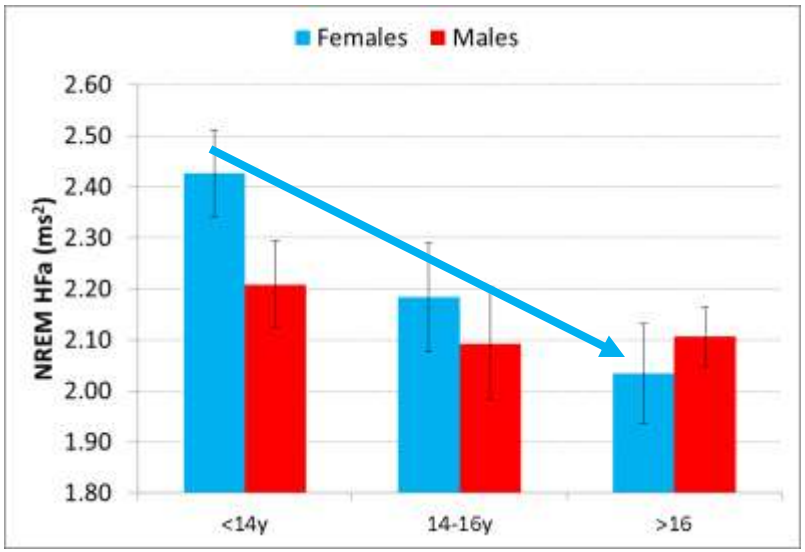


Fitbit is a valid tracker of sleep in adolescents compared with gold-standard polysomnography and can be used to track sleep and HR over many nights at home.

de Zambotti et al. (2016) *Chronobiology International*

Sleep: a window into the development of the ANS across adolescence





de Zambotti et al (*in preparation*)

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