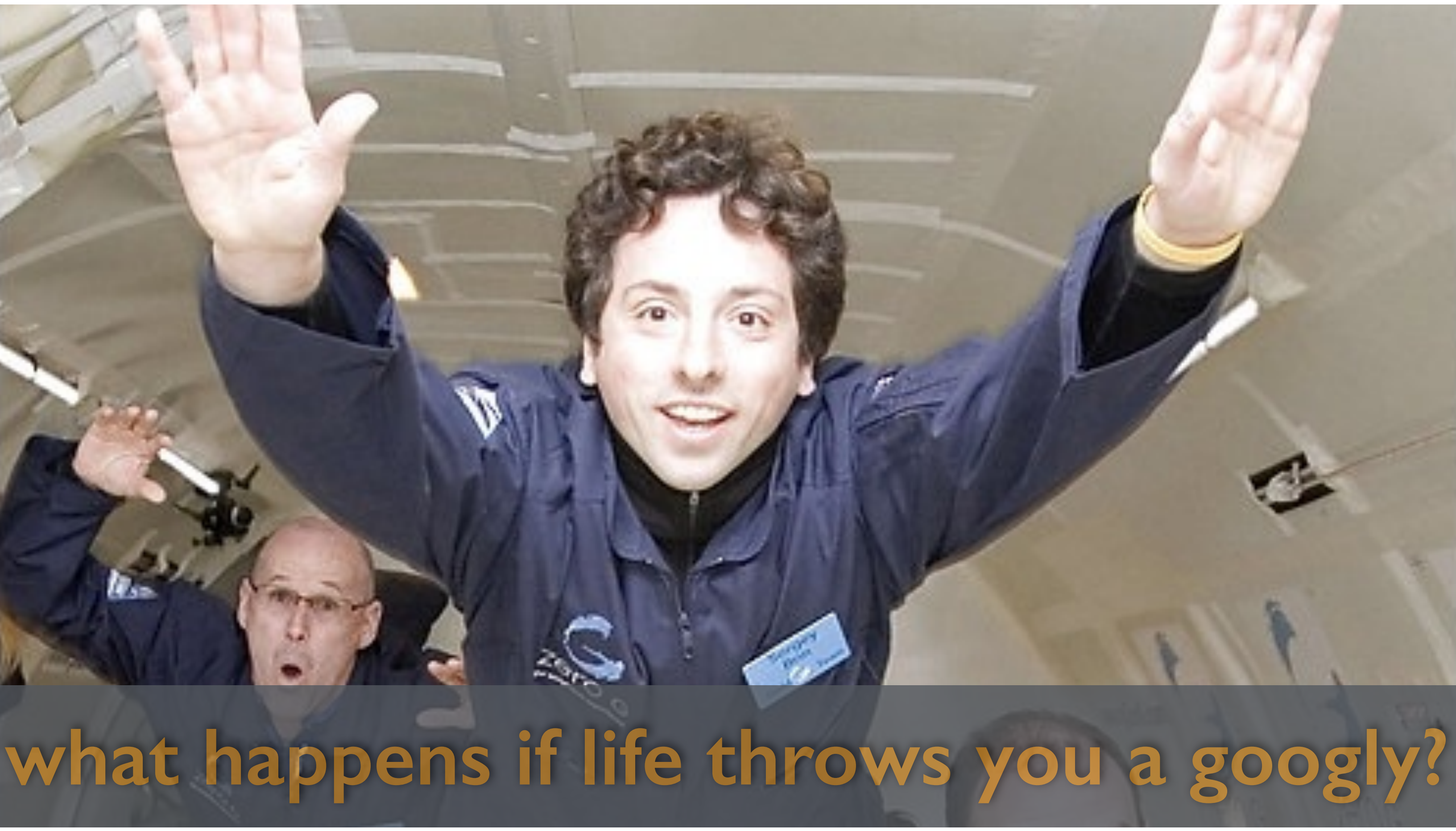
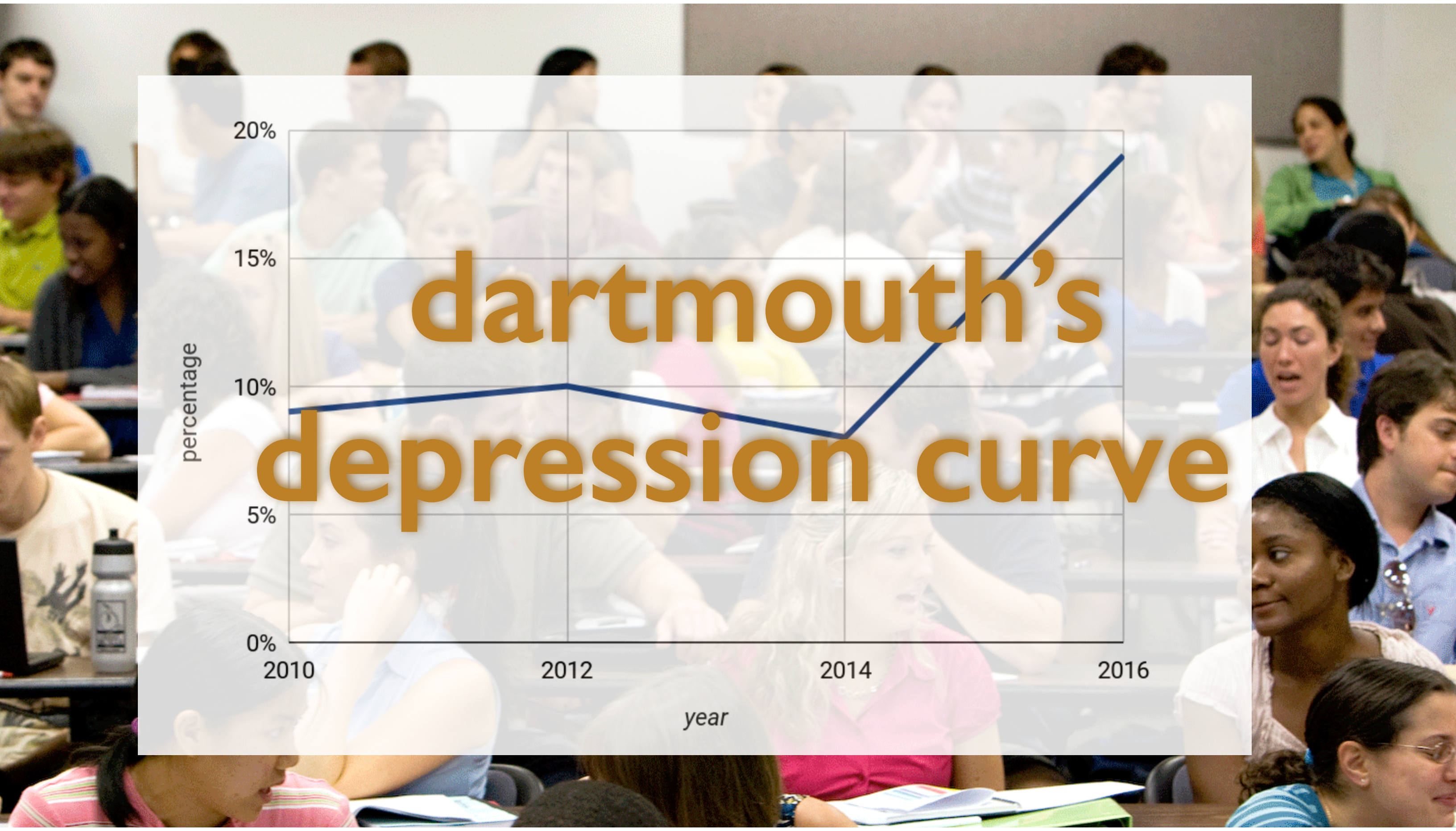

Future of Mental Health Sensing
on College Campuses
Andrew T. Campbell, Dartmouth College
HotMobile, February 12, 2018


what happens if life throws you a googly?

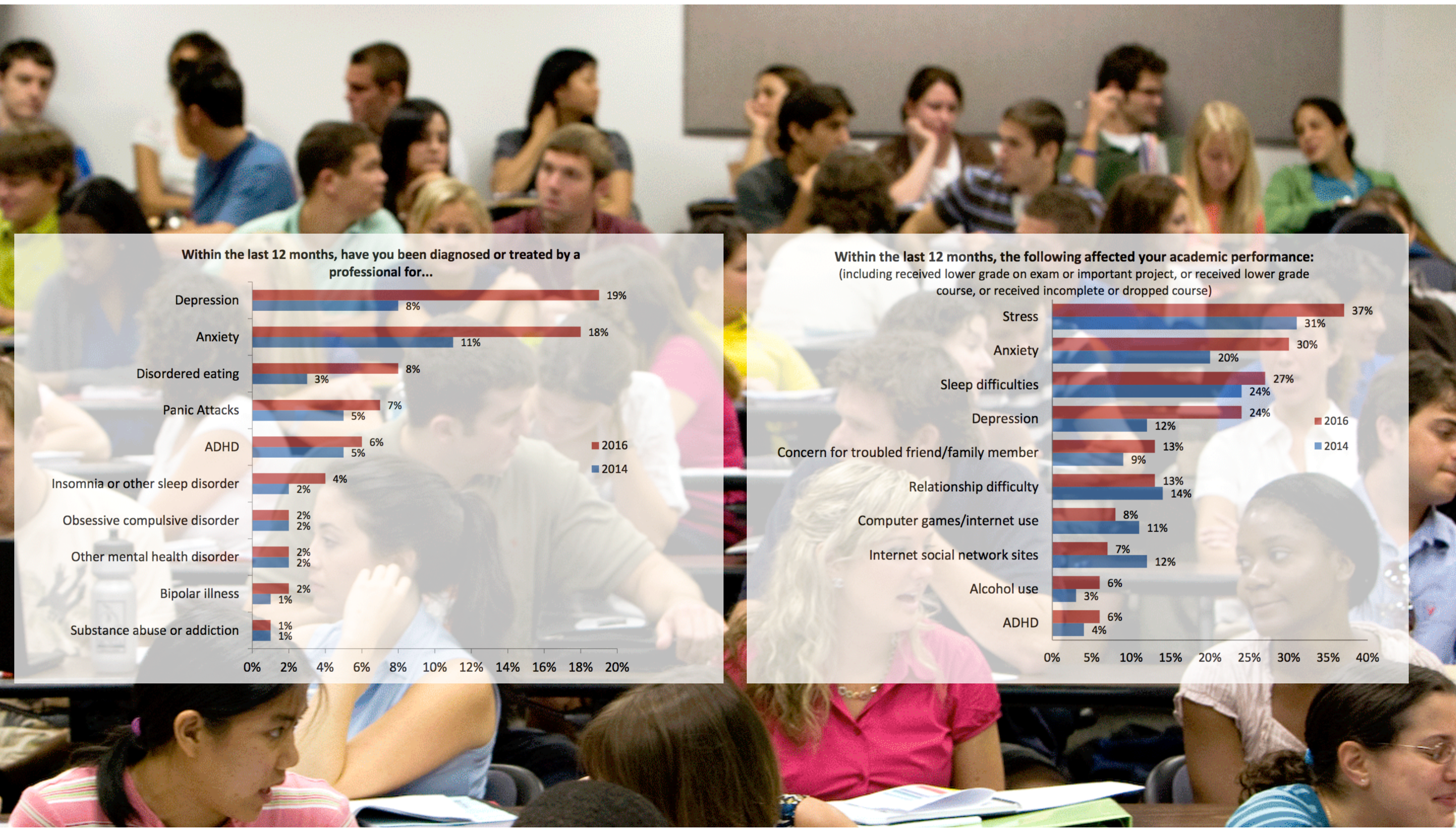

what is mental illness?


MY FIRST


fast forward 35 years


dartmouth's
depression curve
20%
15%
10%
5%
0%
percentage
2010
2012
2014
2016
year


19% of Dartmouth students were diagnosed with depression in 2016.
24% reported depression has having an impact on academic performance
28% have seen a mental health counselor


Within the last 12 months, have you been diagnosed or treated by a professional for...
Depression 19% 8%
Anxiety 18% 11%
Disordered eating 8% 3%
Panic Attacks 7% 5%
ADHD 6% 5%
Insomnia or other sleep disorder 4% 2%
Obsessive compulsive disorder 2% 2%
Other mental health disorder 2% 2%
Bipolar illness 2% 1%
Substance abuse or addiction 1% 1%
0% 2% 4% 6% 8% 10% 12% 14% 16% 18% 20%
2016
2014
Within the last 12 months, the following affected your academic performance:
(including received lower grade on exam or important project, or received lower grade course, or received incomplete or dropped course)
Stress 37% 31%
Anxiety 30% 20%
Sleep difficulties 27% 24%
Depression 24% 12%
Concern for troubled friend/family member 13% 9%
Relationship difficulty 13% 14%
Computer games/internet use 8% 11%
Internet social network sites 7% 12%
Alcohol use 6% 3%
ADHD 6% 4%
0% 5% 10% 15% 20% 25% 30% 35% 40%
2016
2014

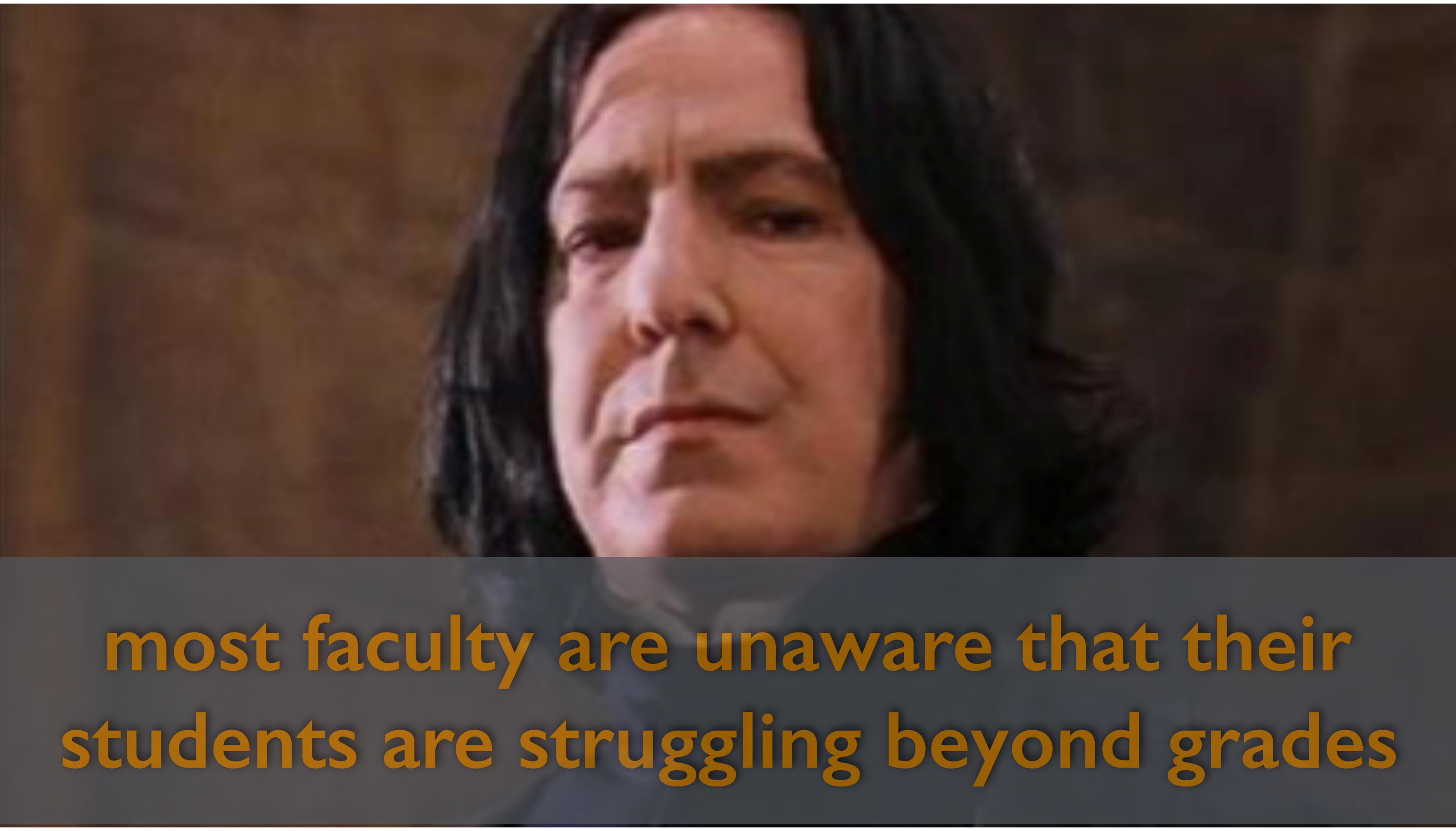

BIG
Questions

why do students burn out, drop classes, do poorly, even drop out of college when others excel?

what is the impact of stress, mood, workload, sociability, sleep and mental health on academic performance?

is there a set of behavioral trends or signature to the semester?

can mobile sensing and predictive modeling assess student mental wellbeing?


most faculty are unaware that their
students are struggling beyond grades

Instructor ______________________________

Date: ____________

Dean Lisa Thum

Please return to Hinman Box 6064 by **February 9, 2015** .

Instructor ______________________________

Date: ____________

Dean Larissa Hopkins

Please return to Hinman Box 6064 by **February 9, 2015** .

Instructor ______________________________

Date: ____________

Dean Larissa Hopkins

Please return to Hinman Box 6064 by **February 9, 2015** .

REPORT OF MIDTERM STANDING

The Office of the Dean of Undergraduate Students is in the process of assessing the current academic progress for the student listed below. An estimated grade from you, along with any relevant comments, would be especially helpful.

NOTE: Requests of this sort are made for a variety of reasons, and do not necessarily imply any deficiency in the student's current or past academic work.

Professor: **Campbell, Andrew T.**

Midterm grade____________ ☐ Actual ☐ Estimated

☐ Check here if grade not yet assigned

Comments:

REPORT OF MIDTERM STANDING

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Student name

Course:

Professor:

Midterm grade ____________ ☐ Actual ☐ Estimated

☐ Check here if grade not yet assigned.

Comments:

Instructor

REPORT OF MIDTERM STANDING

The Office of the Dean of Undergraduate Students is in the process of assessing this student's current academic progress. An estimated grade from you, along with any relevant comments, would be especially helpful.

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Student name:

Course:

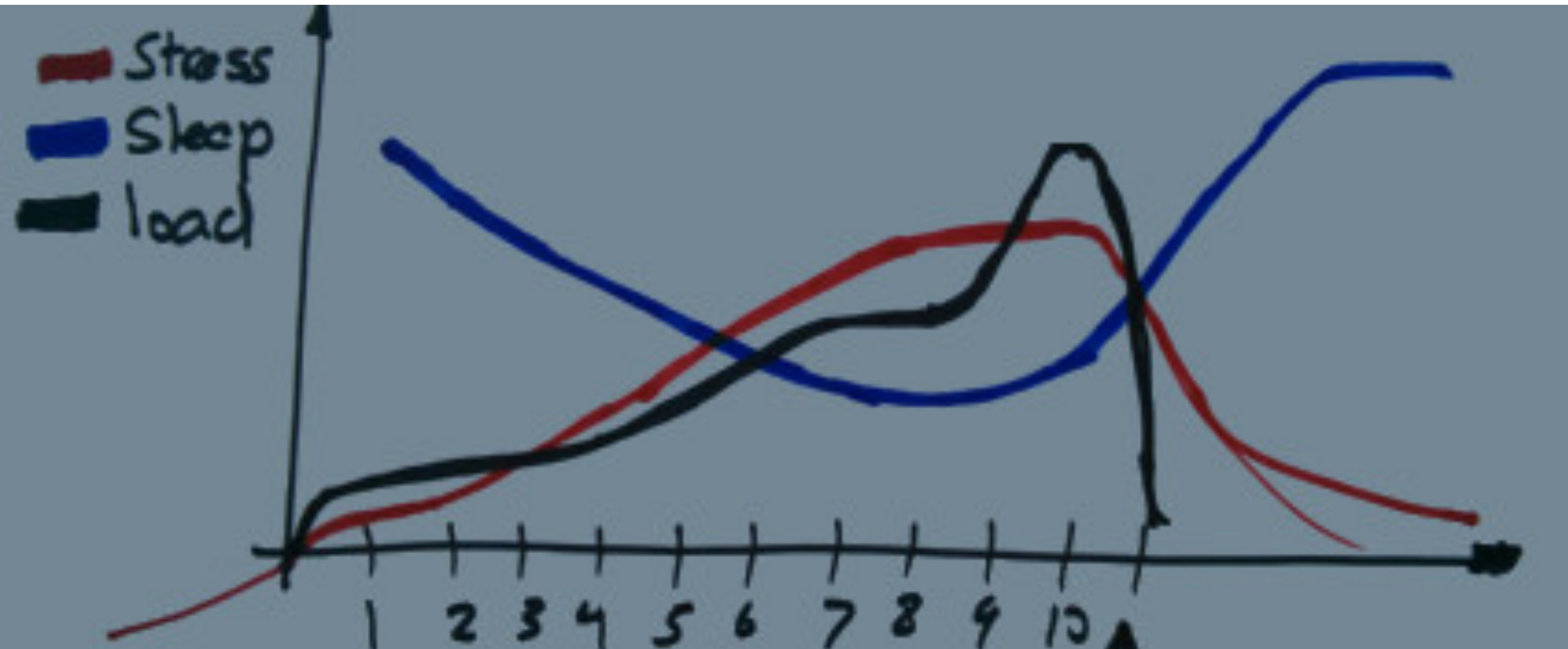
Professor: **Campbell, Andrew**

Midterm grade ____________ ☐ Actual ☐ Estimated

☐ Check here if grade not yet assigned.

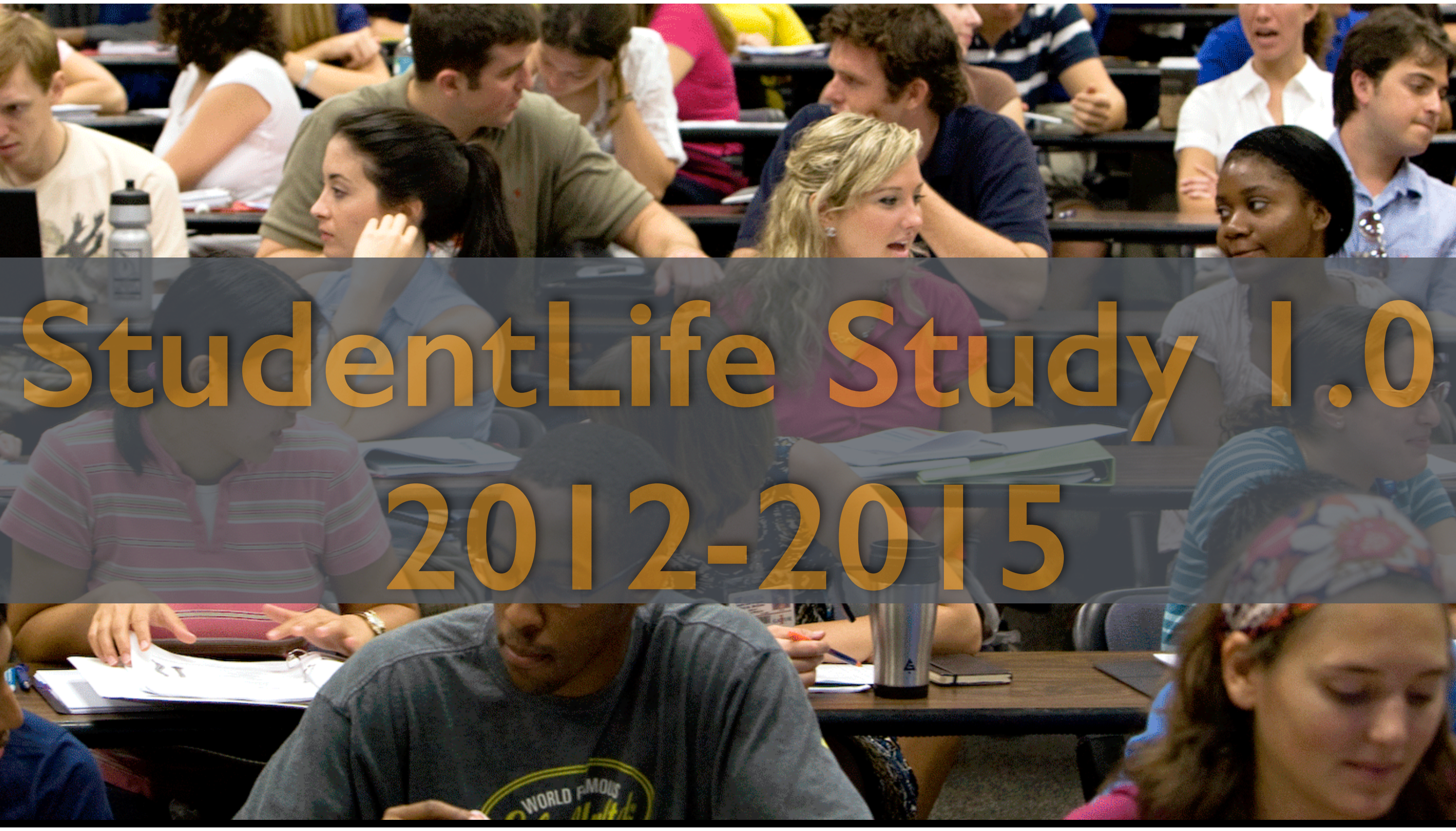
Comments:

Instructor ______________________________



we subjectively know there is a cycle to the term or semester

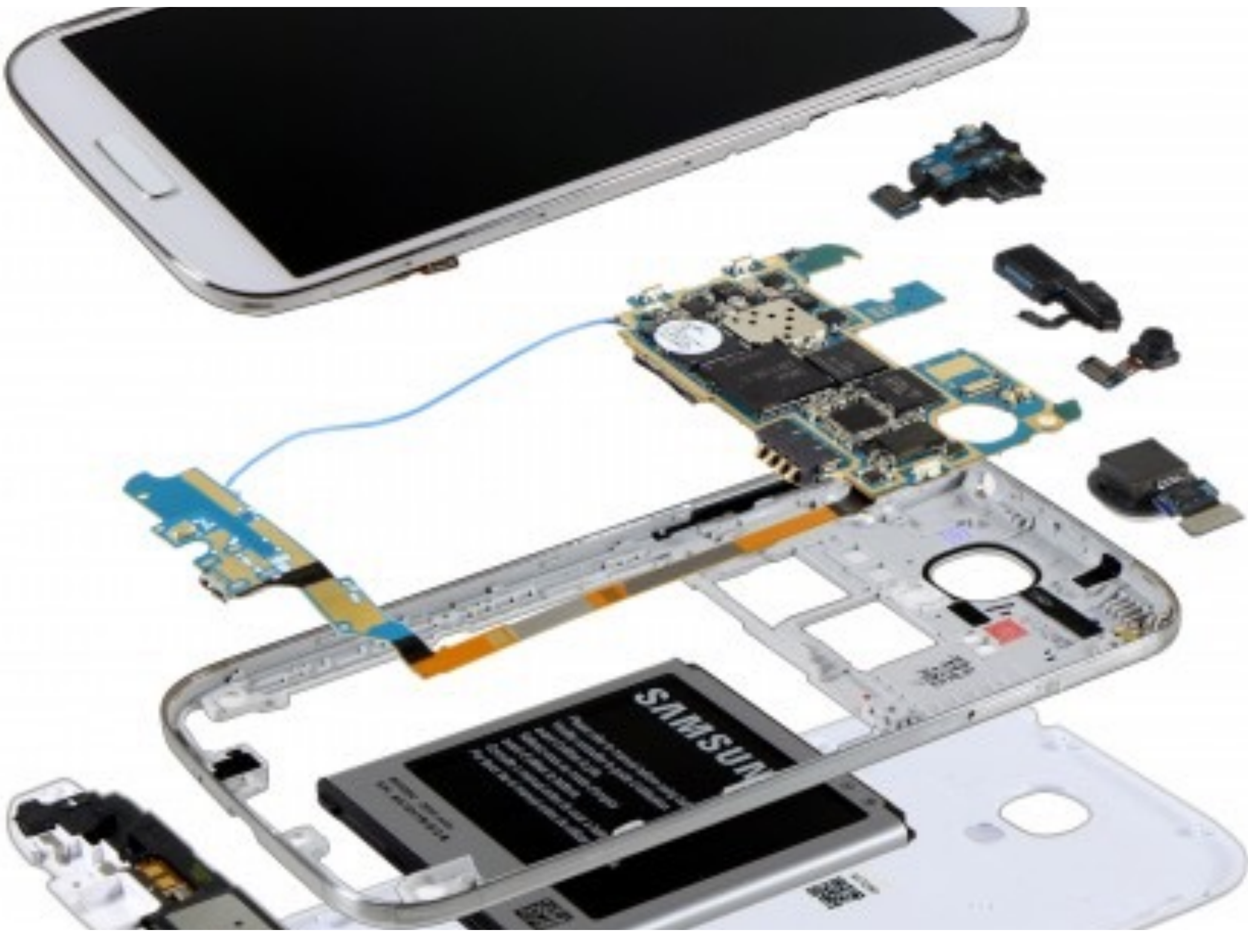
but there is no objective data

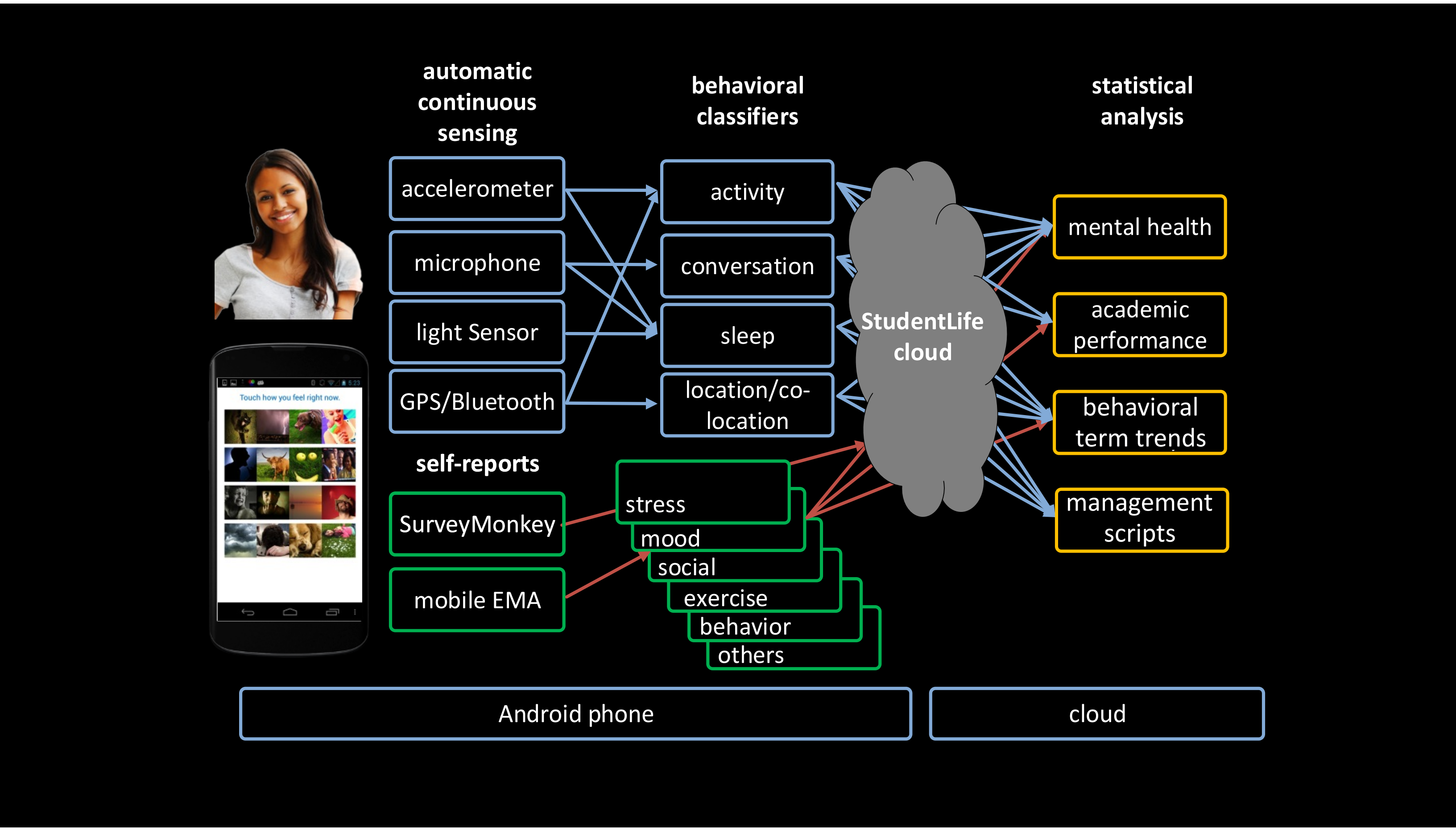

StudentLife Study 1.0
2012-2015

48 students over 10 week Spring 2013 term

- 10 female, 38 male CS students
- 30 undergraduates, 18 graduates
- 8 seniors, 14 juniors, 6 sophomores, 2 freshmen, 3 Ph.D students, 1 second-year Masters student, and 13 first-year Masters students
- 23 Caucasians, 23 Asians and 2 African-Americans.
- Gave out Androids to students in my Android programming class
- No feedback to students, only collection.
- No funding so begged and borrowed and just did it — you have believe.

sensing system




automatic continuous sensing
behavioral classifiers
statistical analysis
accelerometer
microphone
light Sensor
GPS/Bluetooth
activity
conversation
sleep
location/co-location
StudentLife cloud
mental health
academic performance
behavioral term trends
management scripts
Touch how you feel right now.
self-reports
SurveyMonkey
mobile EMA
stress
mood
social
exercise
behavior
others
Android phone
cloud

classifiers

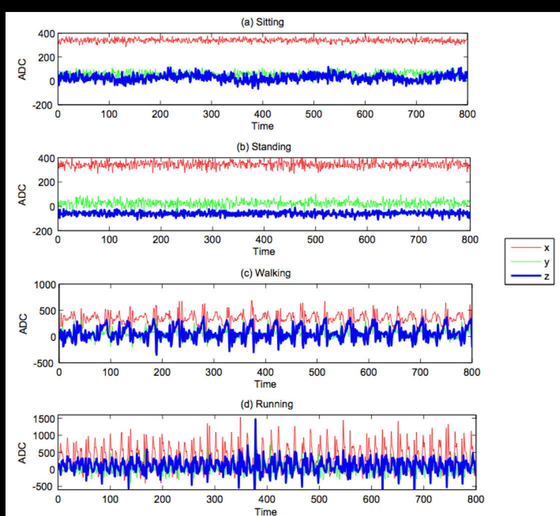
activity

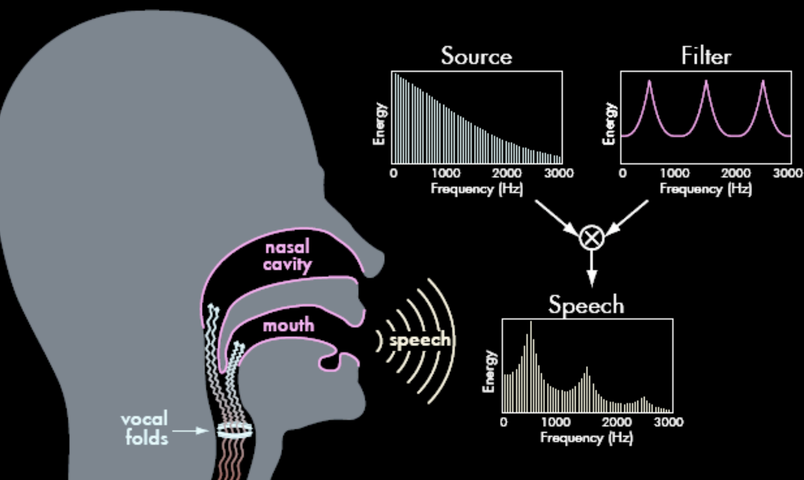
sitting

standing

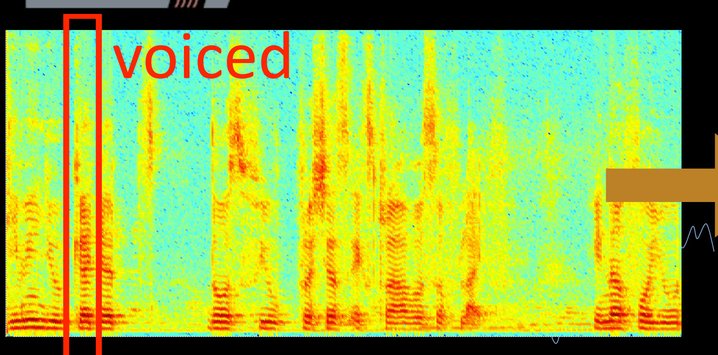
walking

running

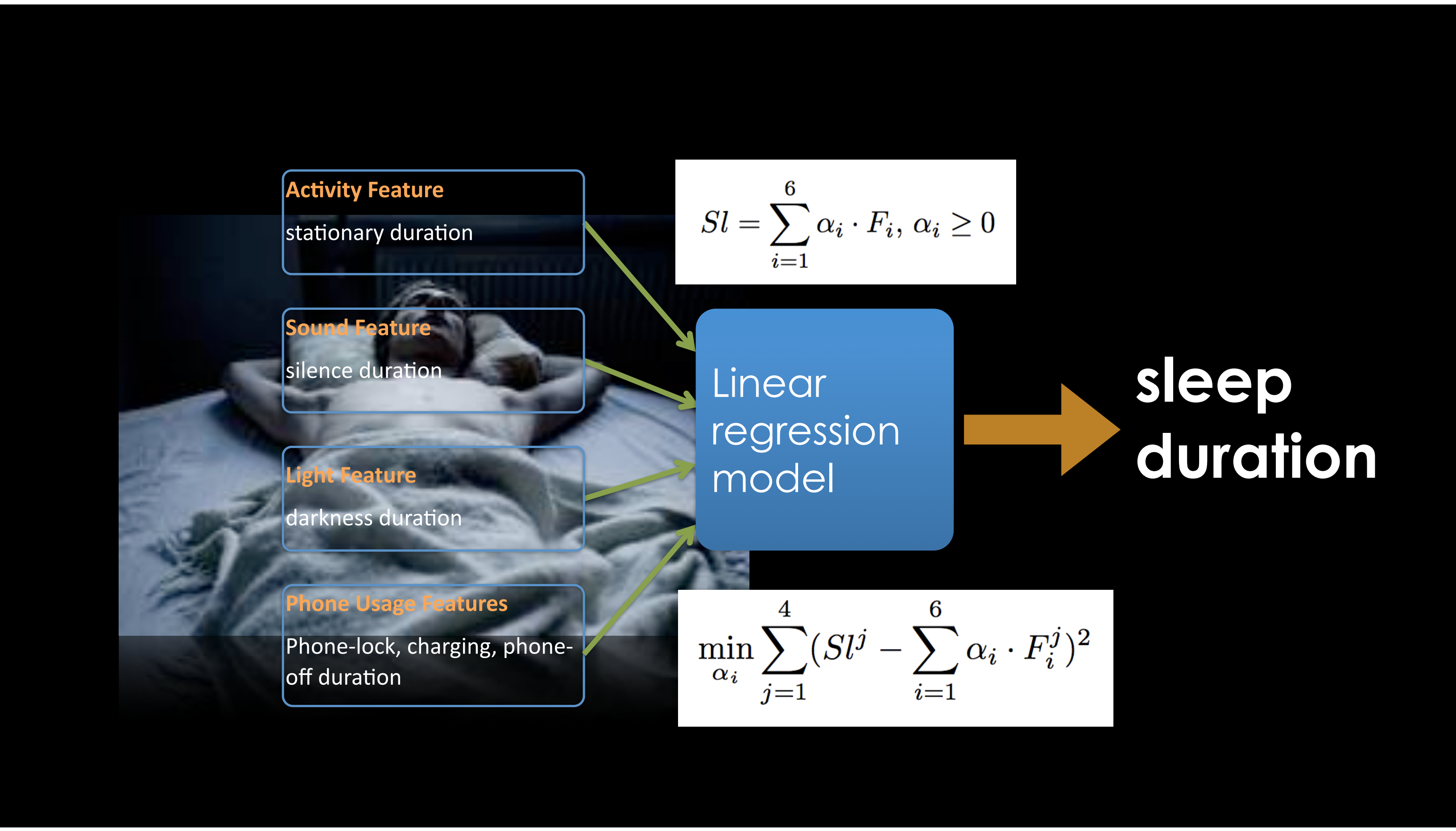




around conversation



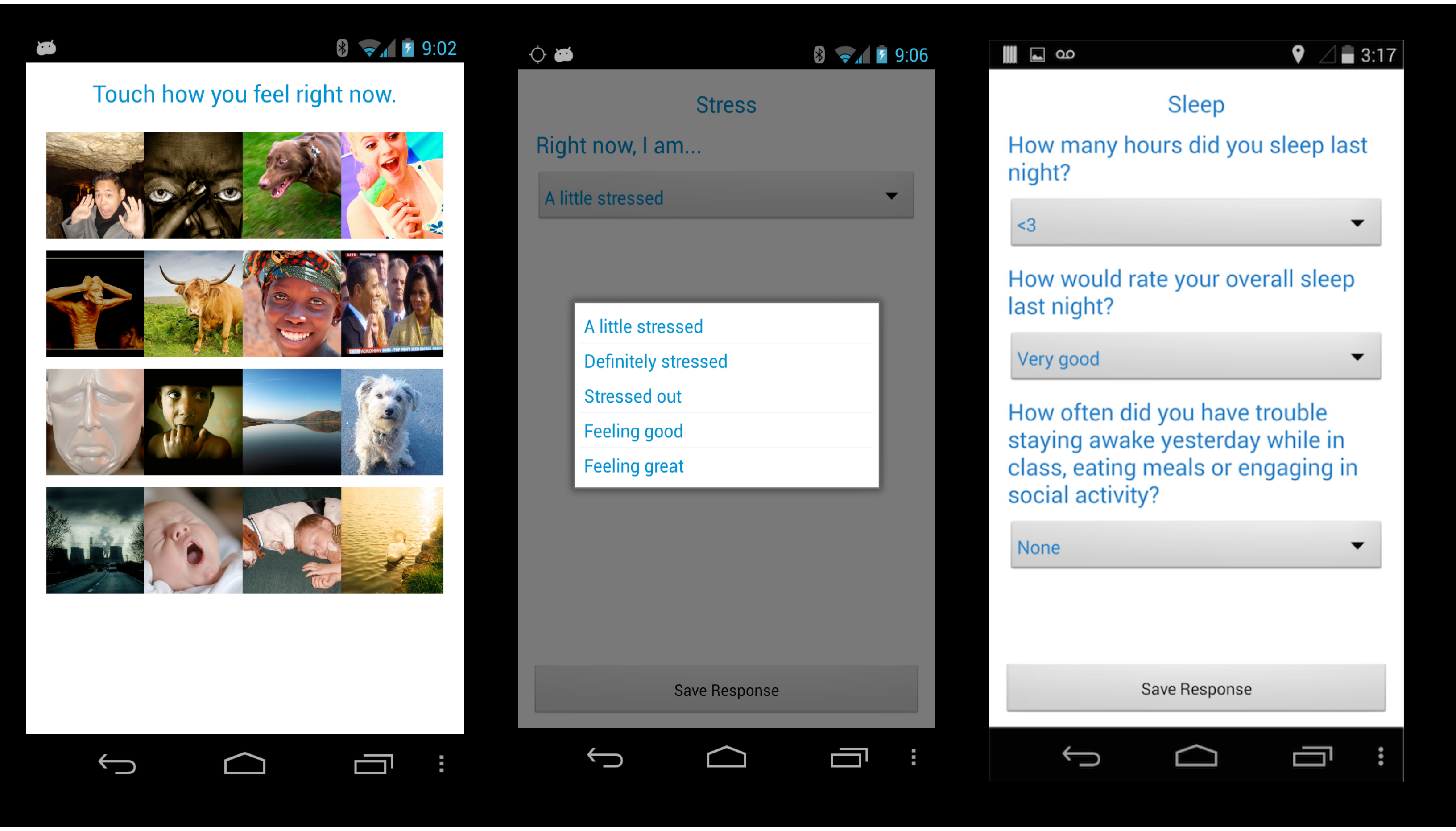
face-to-face conservation: duration and frequency

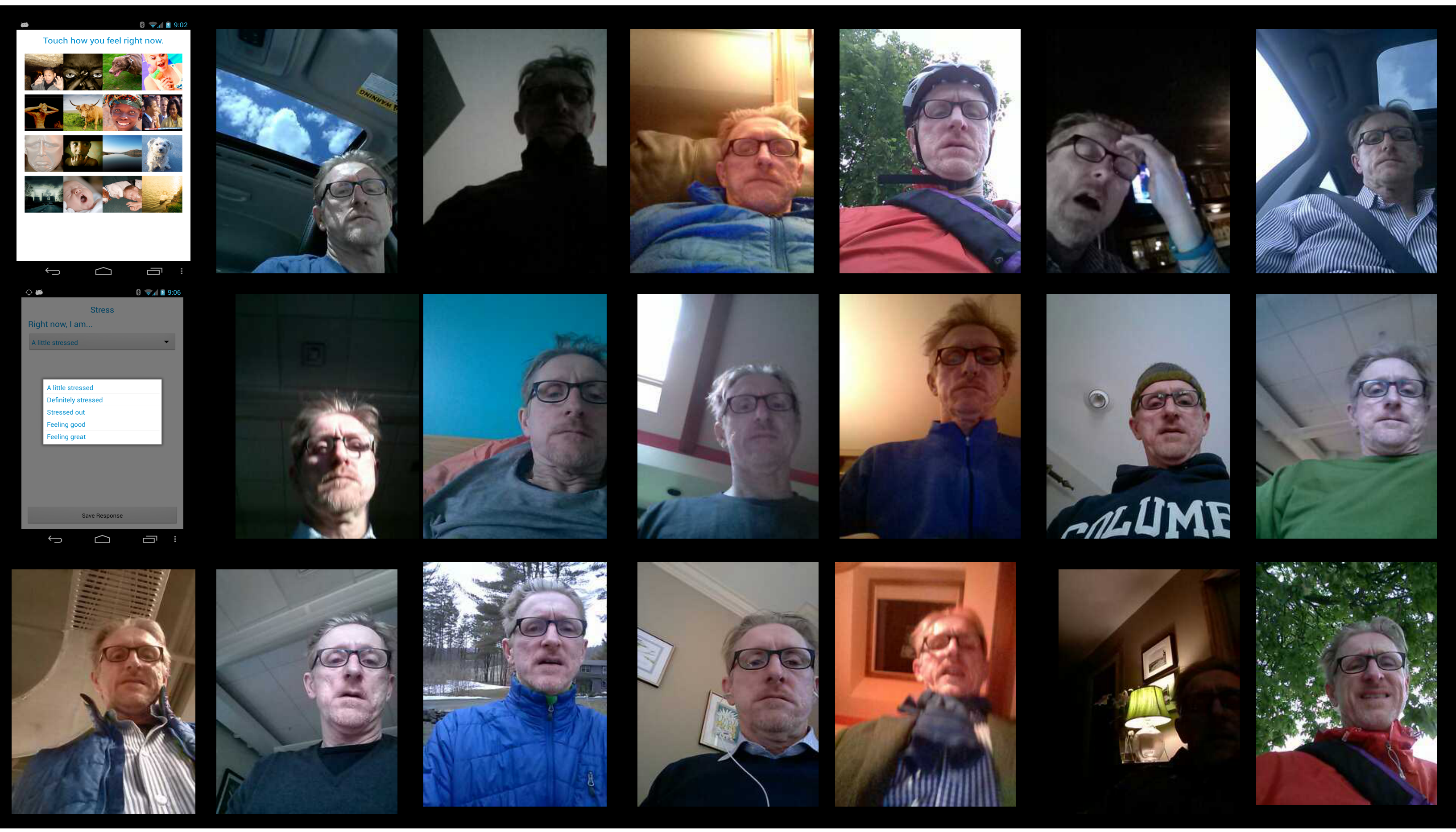

Activity Feature
stationary duration
Sound Feature
silence duration
Light Feature
darkness duration
Phone Usage Features
Phone-lock, charging, phone-off duration
$Sl = \sum_{i=1}^{6} \alpha_i \cdot F_i,\ \alpha_i \geq 0$
Linear regression model
$\min_{\alpha_i} \sum_{j=1}^{4} (Sl^j - \sum_{i=1}^{6} \alpha_i \cdot F_i^j)^2$
sleep duration

we also computed

- activity duration
- outdoor mobility
- indoor mobility
- location and co-location
- phone usage (apps, lock/unlock)


ecological momentary
assessment (EMA)


9:02
Touch how you feel right now.
9:06
Stress
Right now, I am...
A little stressed
A little stressed
Definitely stressed
Stressed out
Feeling good
Feeling great
Save Response
3:17
Sleep
How many hours did you sleep last night?
<3
How would rate your overall sleep last night?
Very good
How often did you have trouble staying awake yesterday while in class, eating meals or engaging in social activity?
None
Save Response


9:02
Touch how you feel right now.
9:06
Stress
Right now, I am...
A little stressed
A little stressed
Definitely stressed
Stressed out
Feeling good
Feeling great
Save Response

32,000 EMAs
>9000 facelog images

mental health surveys

PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

NAME:____________________ DATE:__________

Over the last *2 weeks*, how often have you been bothered by any of the following problems?
(use "✓" to indicate your answer)

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0			
6. Feeling bad about yourself—or that you are a failure or have let yourself or your family down	0			
7. Trouble concentrating on things, such as reading the newspaper or watching television	0			
8. Moving or speaking so slowly that other people could have noticed. Or the opposite — being so figety or restless that you have been moving around a lot more than usual	0			
9. Thoughts that you would be better off dead, or of hurting yourself	0			

add colu

(Healthcare professional: For interpretation of TOTAL, please refer to accompanying scoring card) TOT

depression severity	**minimal**	**minor**	**moderate**	**moderately severe**	**severe**
	1-4	5-9	10-14	15-19	20-27
number of students (pre-survey)	17	15	6	1	1
number of students (post-survey)	19	12	3	2	2

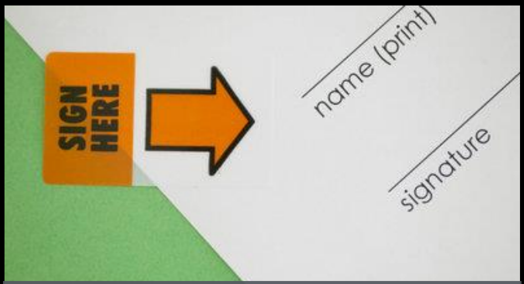
pre-post questionnaires

- depression scale
- perceived stress scale
- loneliness scale
- flourishing scale
- Big 5

study design

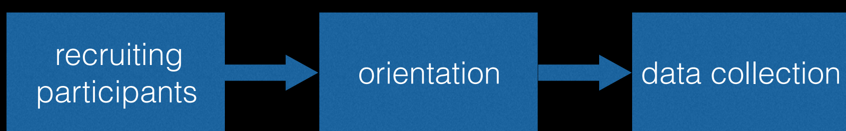
recruiting participants

recruiting participants → orientation



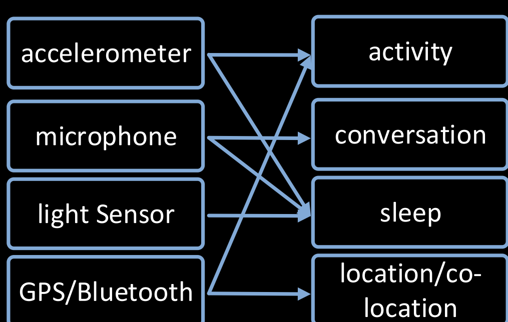
consent form

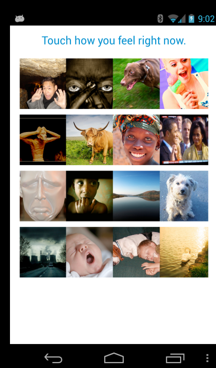
mental health pre-surveys

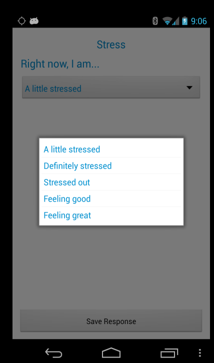


passive sensing

ecological momentary assessment (EMA)







recruiting participants → orientation → data collection → exit interview/ survey


exit interview

mental health post-surveys

educational data


dataset

Dataset size
53 GB of data, 32,000 EMAs, 48 pre-post surveys, interviews

Passive sensor data from phone
activity, sleep, face-to-face conversation frequency/duration, indoor and outdoor mobility, location, distance travelled, co-location, light, app usage, calendar, call logs

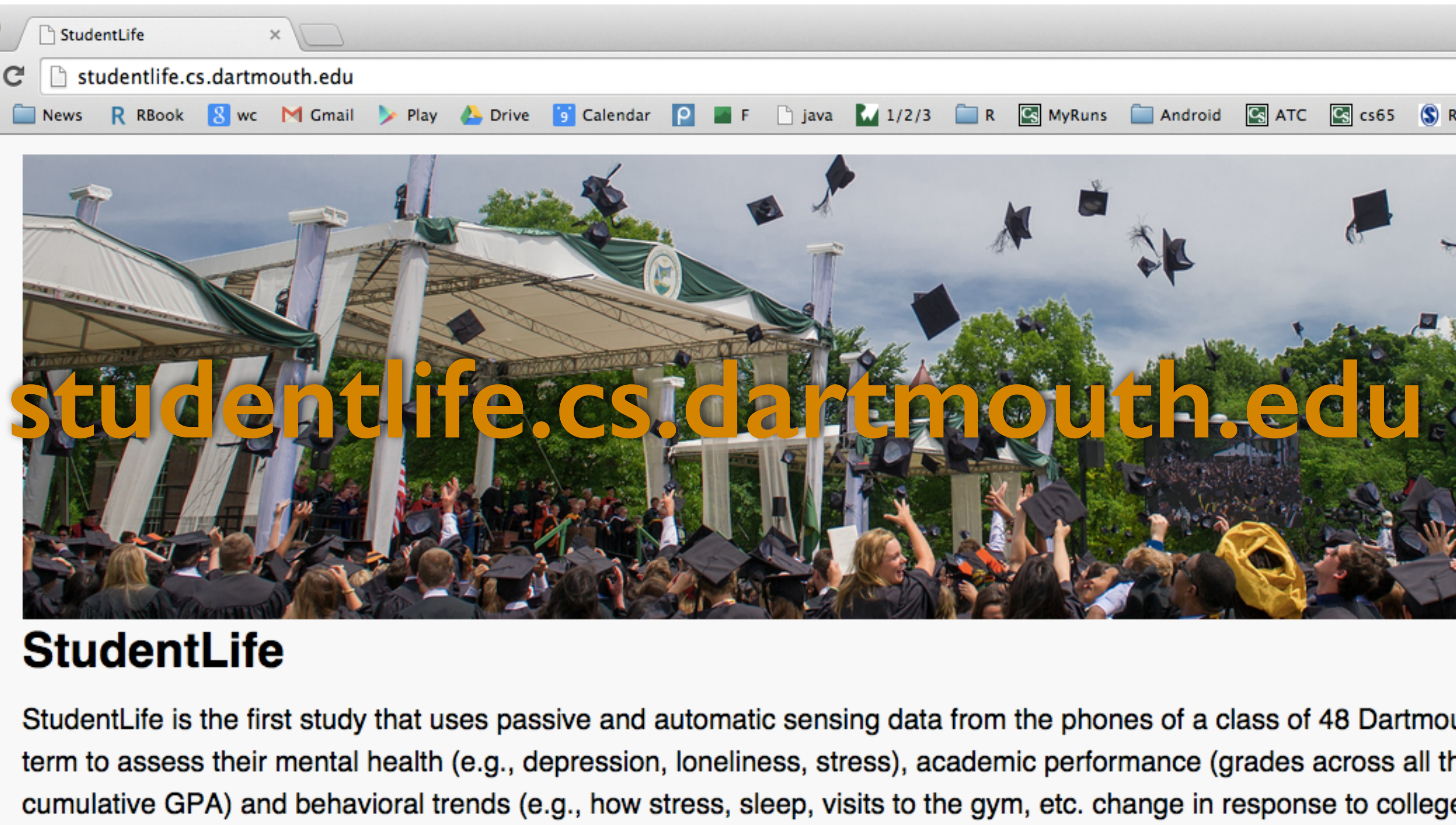
Experience sampling
pam (affect), behavioral, class, campus events, social events, sleep quality, exercise, comments, mood

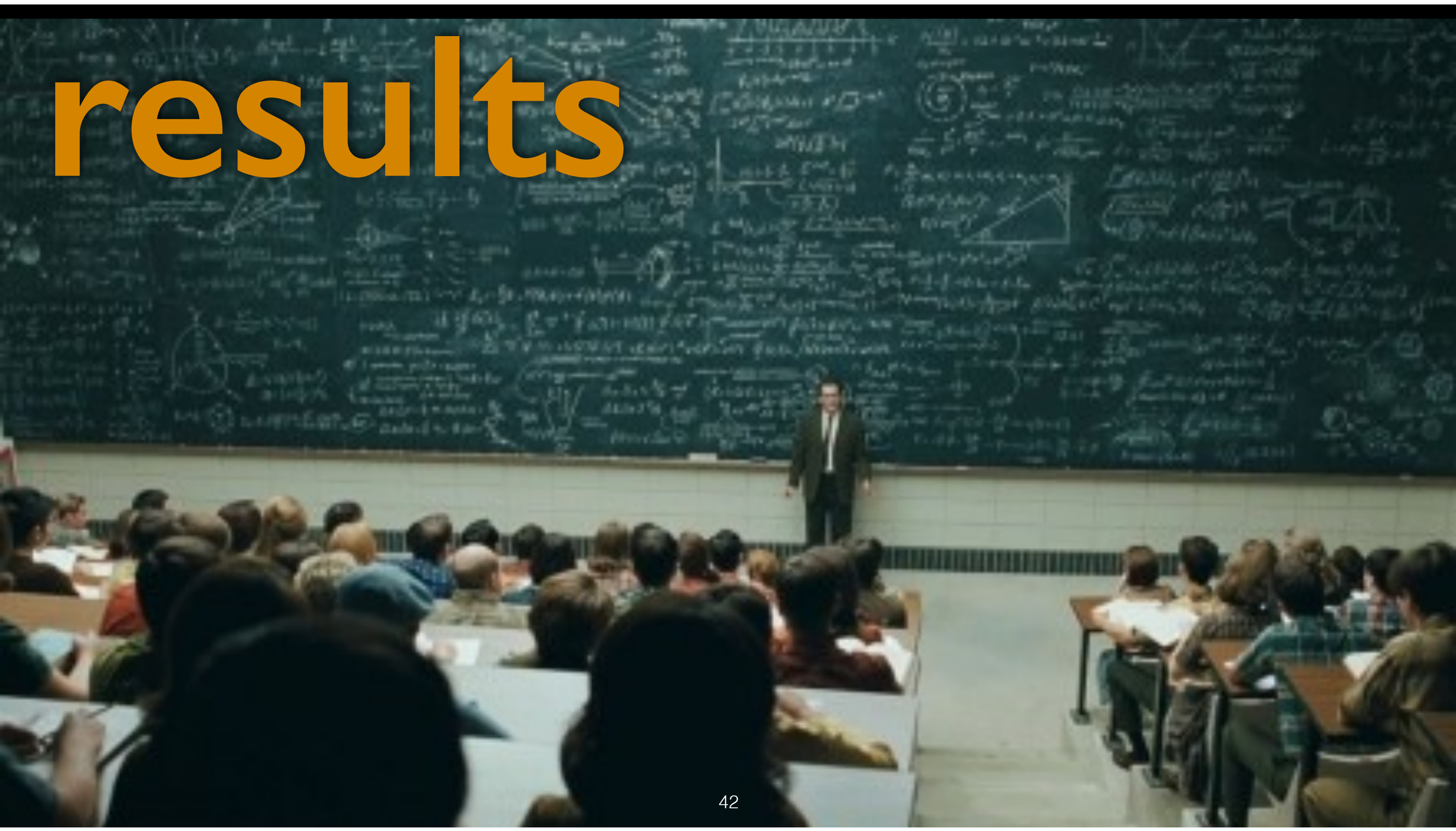
Pre-post surveys from Survey Monkey
stress, personality, mental and physical health, loneliness, mood, sleep

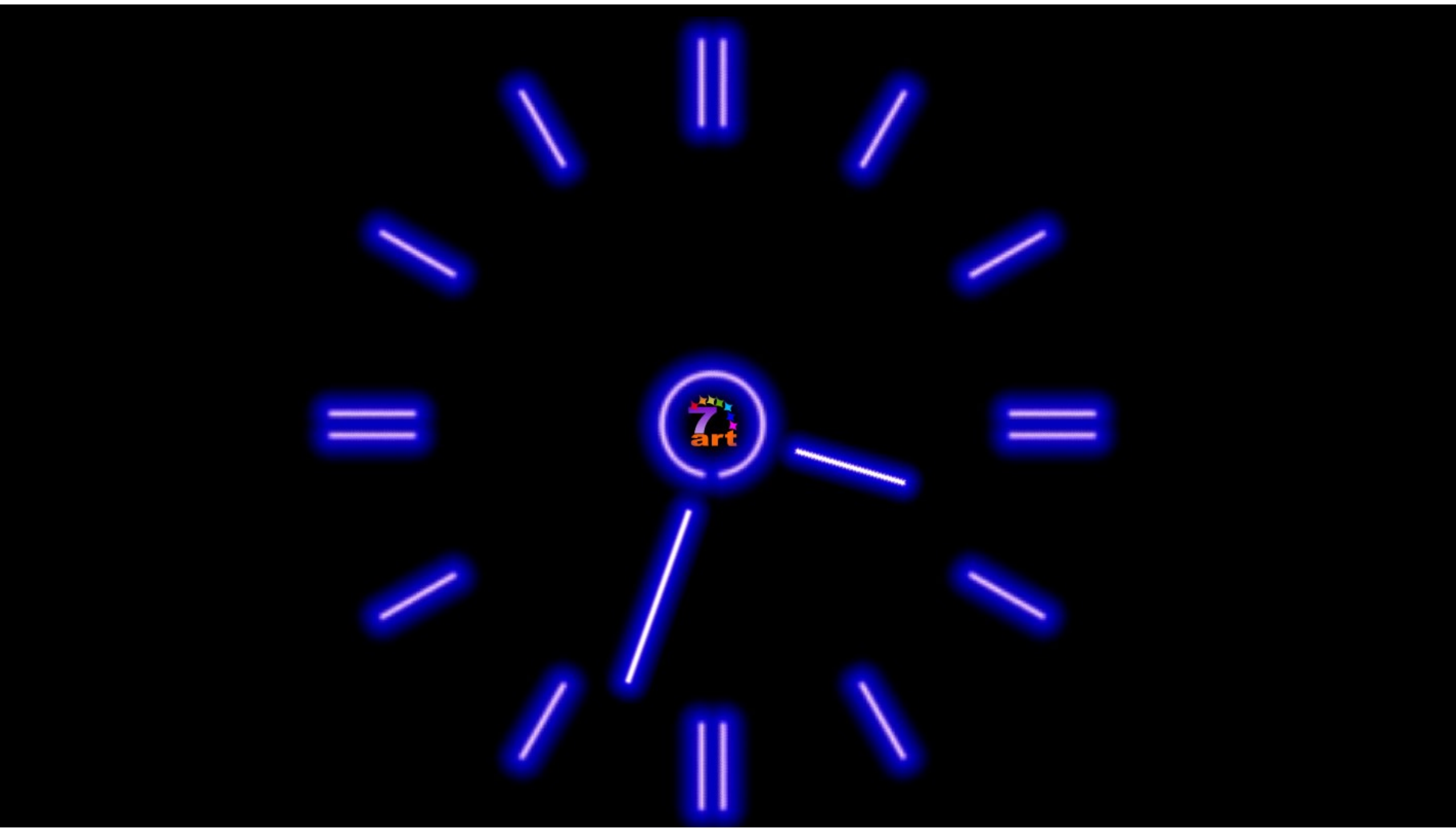
Transcripts: educational stats

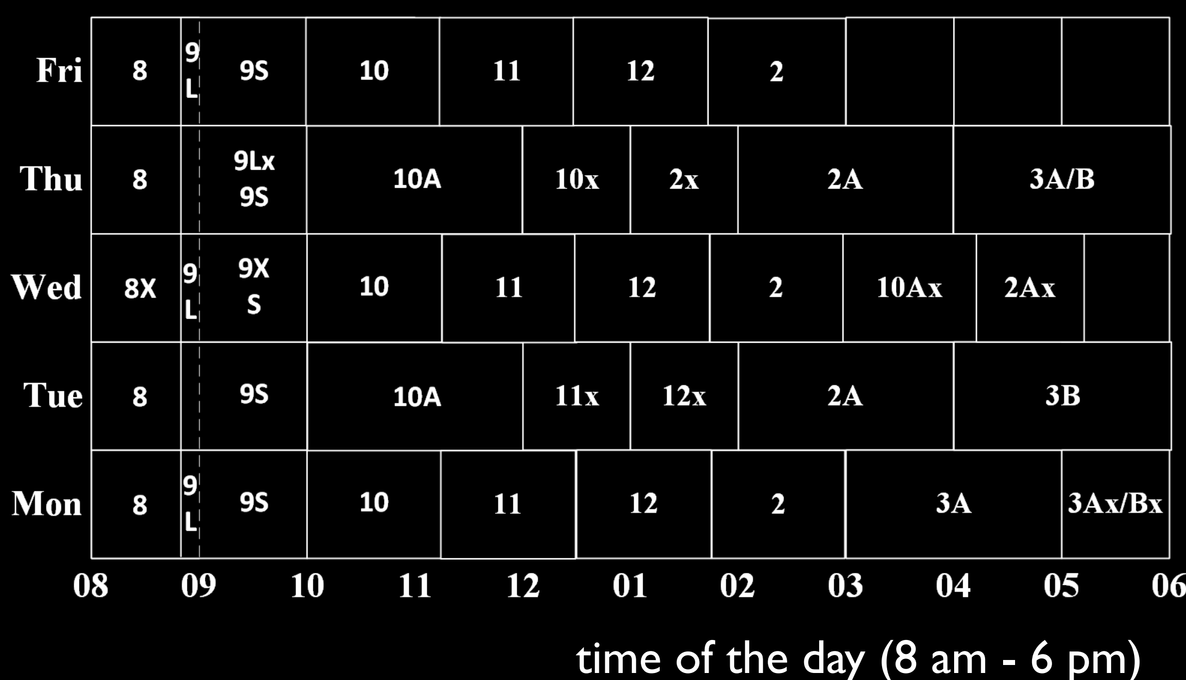
Other: Facebook (not released), face log images (not released), dining details, seating data

Entry-exit interviews (not released)
social net in class, classes information (deadlines for all classes), group review, study specific questions.

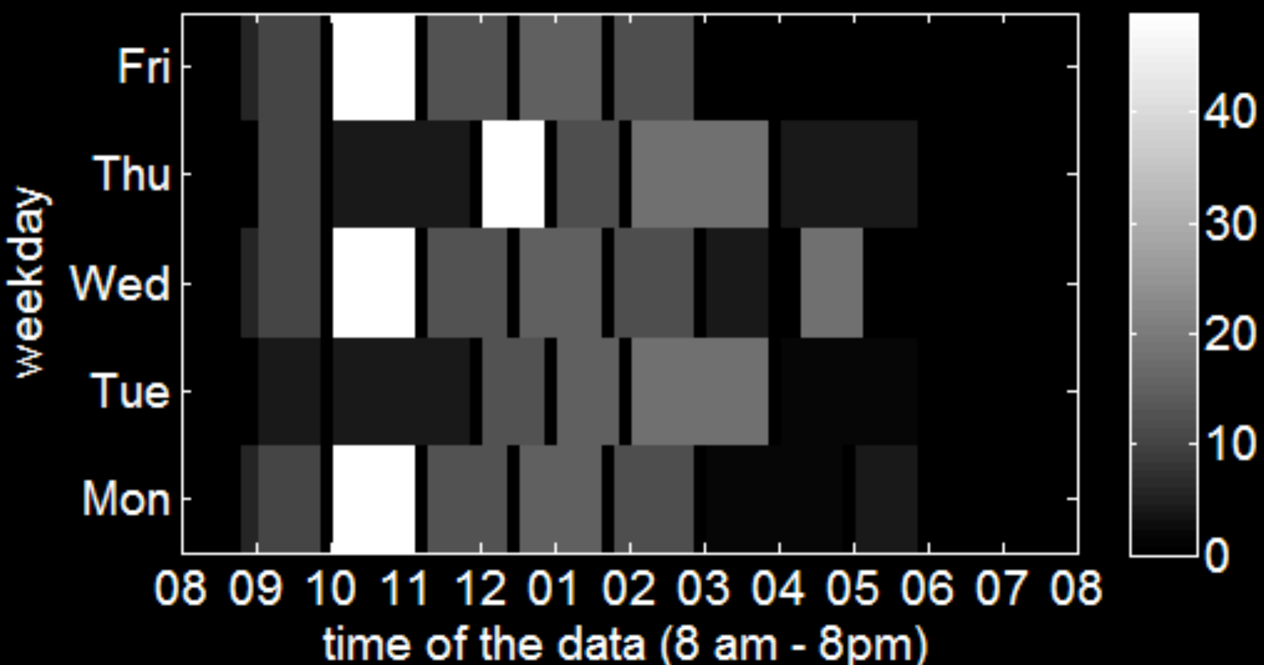

StudentLife
studentlife.cs.dartmouth.edu
News
RBook
wc
Gmail
Play
Drive
Calendar
F
java
1/2/3
R
MyRuns
Android
ATC
cs65
studentlife.cs.dartmouth.edu
StudentLife
StudentLife is the first study that uses passive and automatic sensing data from the phones of a class of 48 Dartmou
term to assess their mental health (e.g., depression, loneliness, stress), academic performance (grades across all th
cumulative GPA) and behavioral trends (e.g., how stress, sleep, visits to the gym, etc. change in response to college


results


7
art

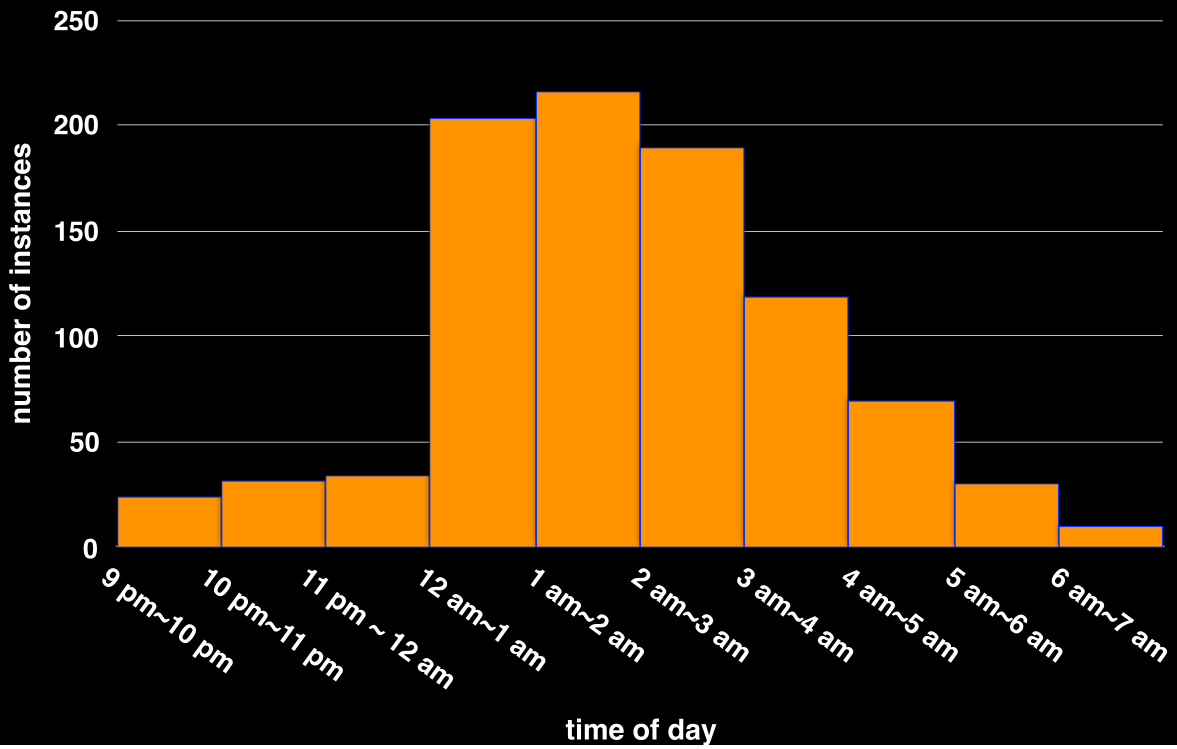

Fri
8
9 L
9S
10
11
12
2
Thu
8
9Lx 9S
10A
10x
2x
2A
3A/B
Wed
8X
9 L
9X S
10
11
12
2
10Ax
2Ax
Tue
8
9S
10A
11x
12x
2A
3B
Mon
8
9 L
9S
10
11
12
2
3A
3Ax/Bx
08 09 10 11 12 01 02 03 04 05 06
time of the day (8 am - 6 pm)

day: 9 am - 6 pm



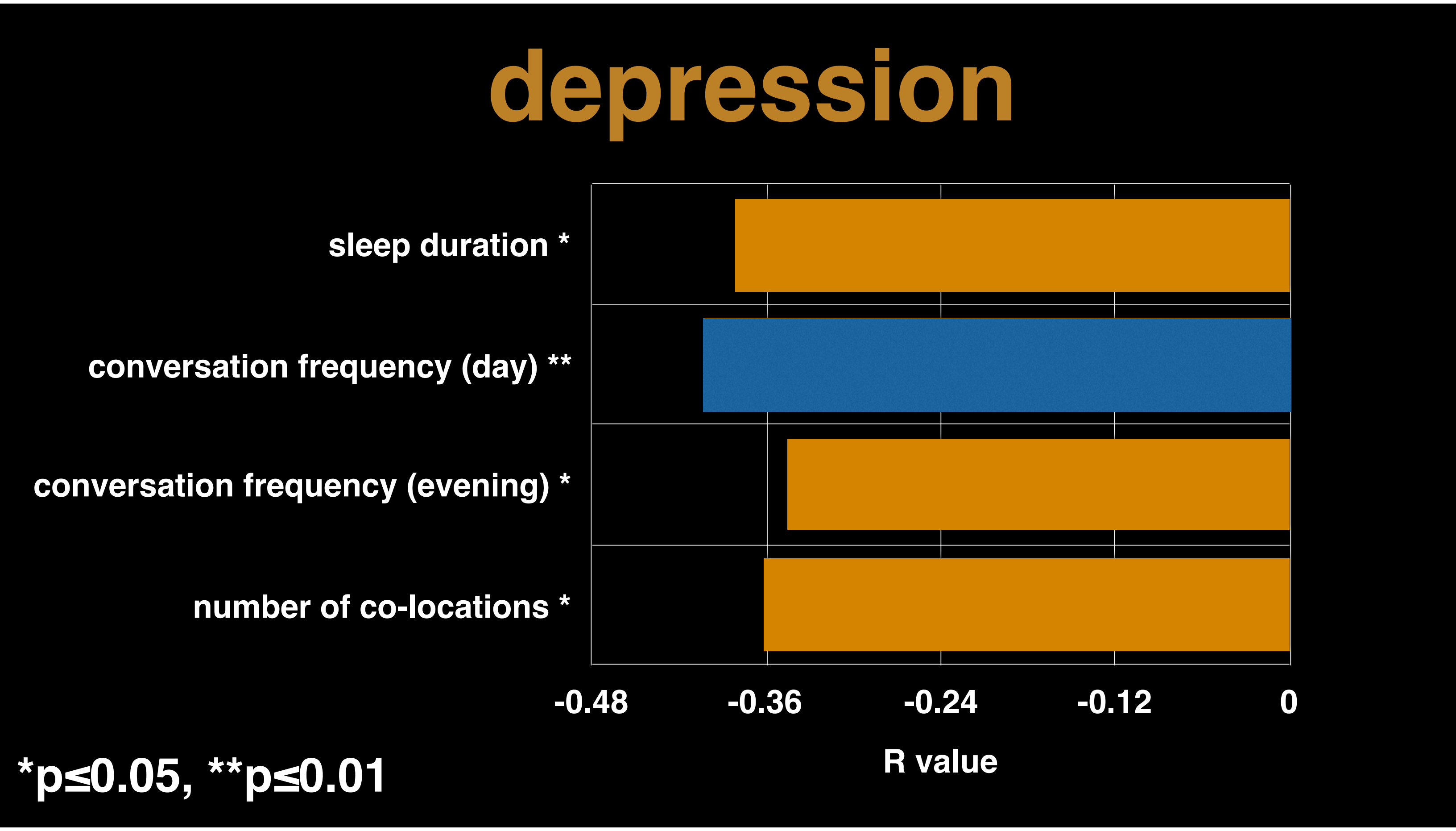
weekday
Fri
Thu
Wed
Tue
Mon
08 09 10 11 12 01 02 03 04 05 06 07 08
time of the data (8 am - 8pm)
0
10
20
30
40

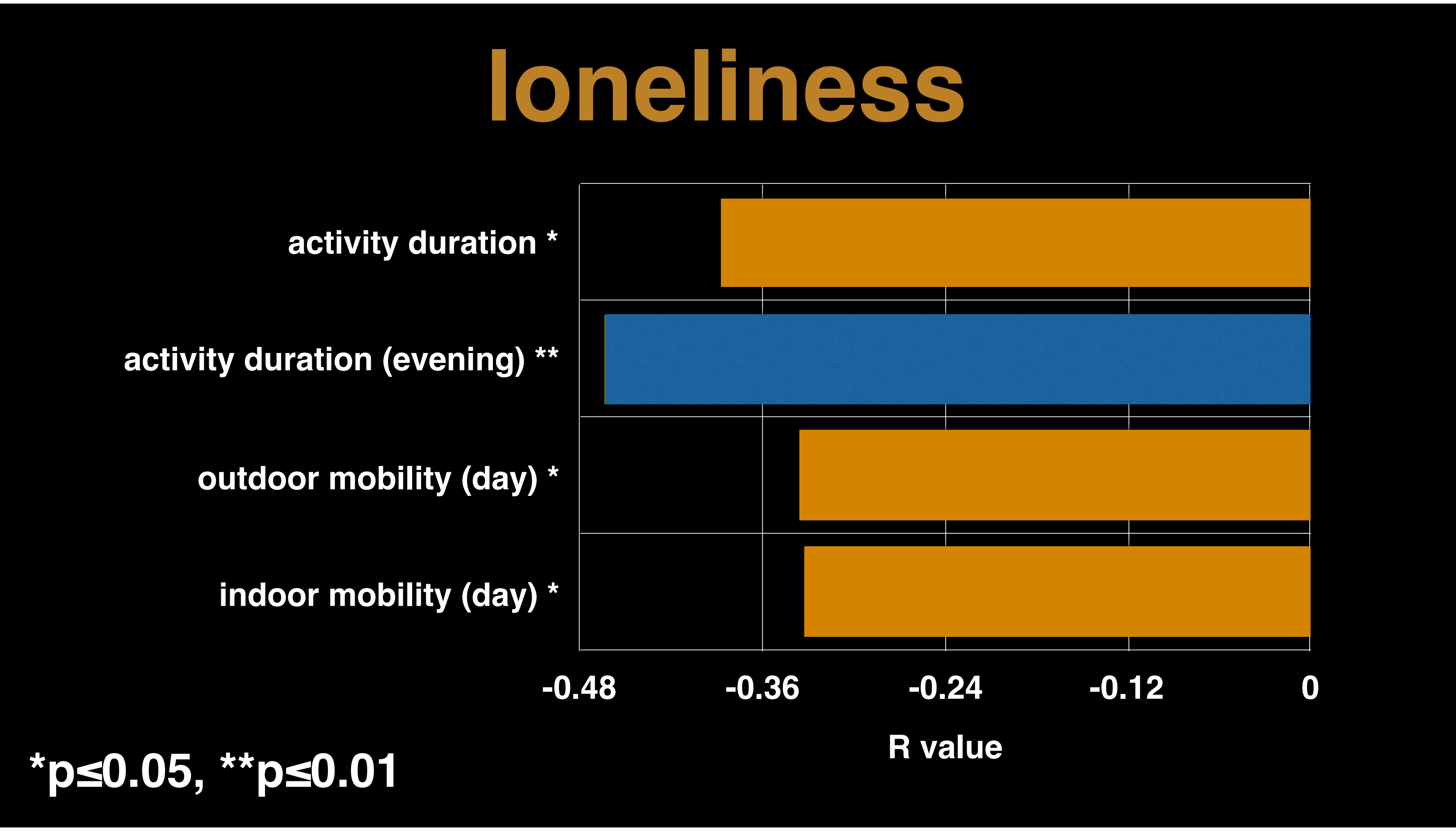
night: 12 am - 9 am



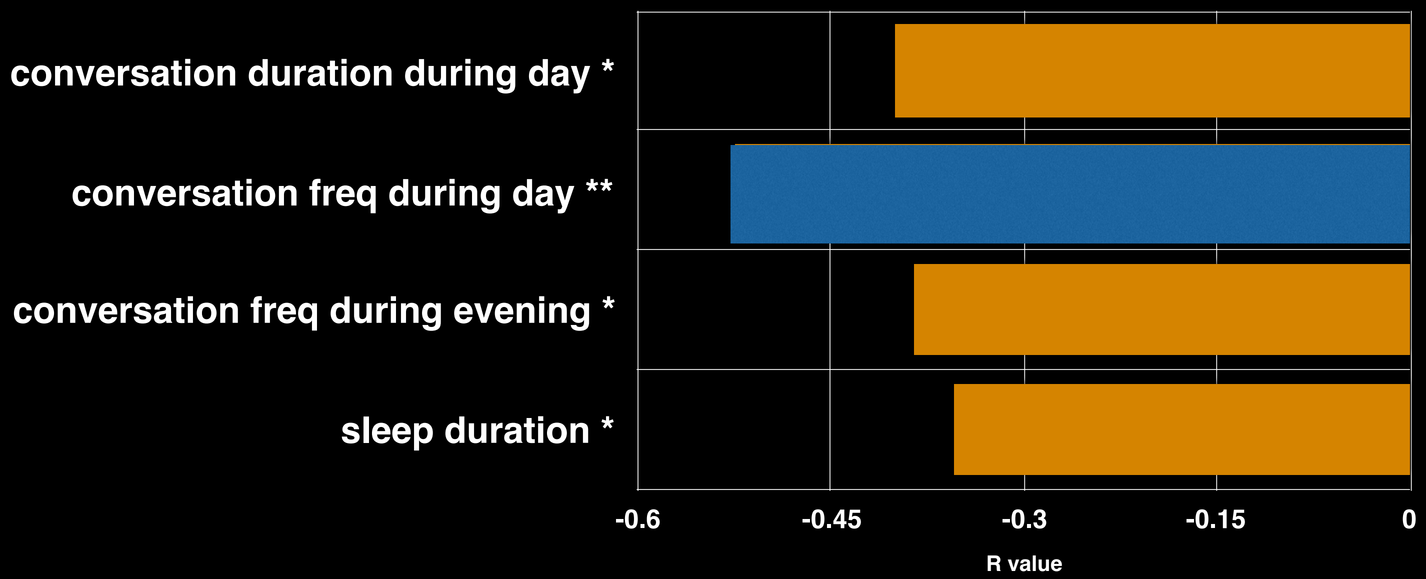
evening: 6 pm-12 am


mental
health


depression
sleep duration *
conversation frequency (day) **
conversation frequency (evening) *
number of co-locations *
-0.48
-0.36
-0.24
-0.12
0
R value
*p≤0.05, **p≤0.01

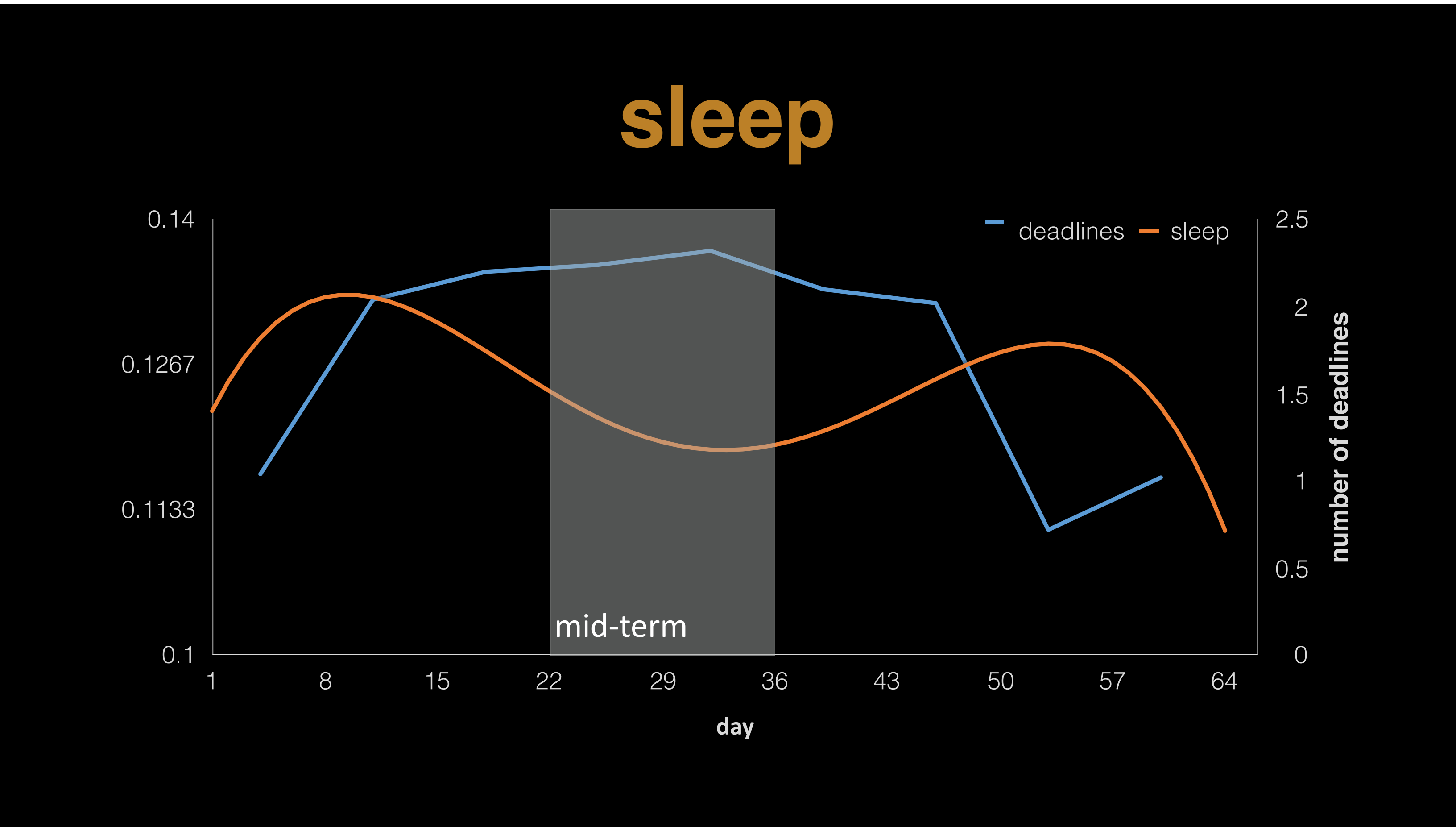

loneliness
activity duration *
activity duration (evening) **
outdoor mobility (day) *
indoor mobility (day) *
-0.48
-0.36
-0.24
-0.12
0
R value
*p≤0.05, **p≤0.01

stress

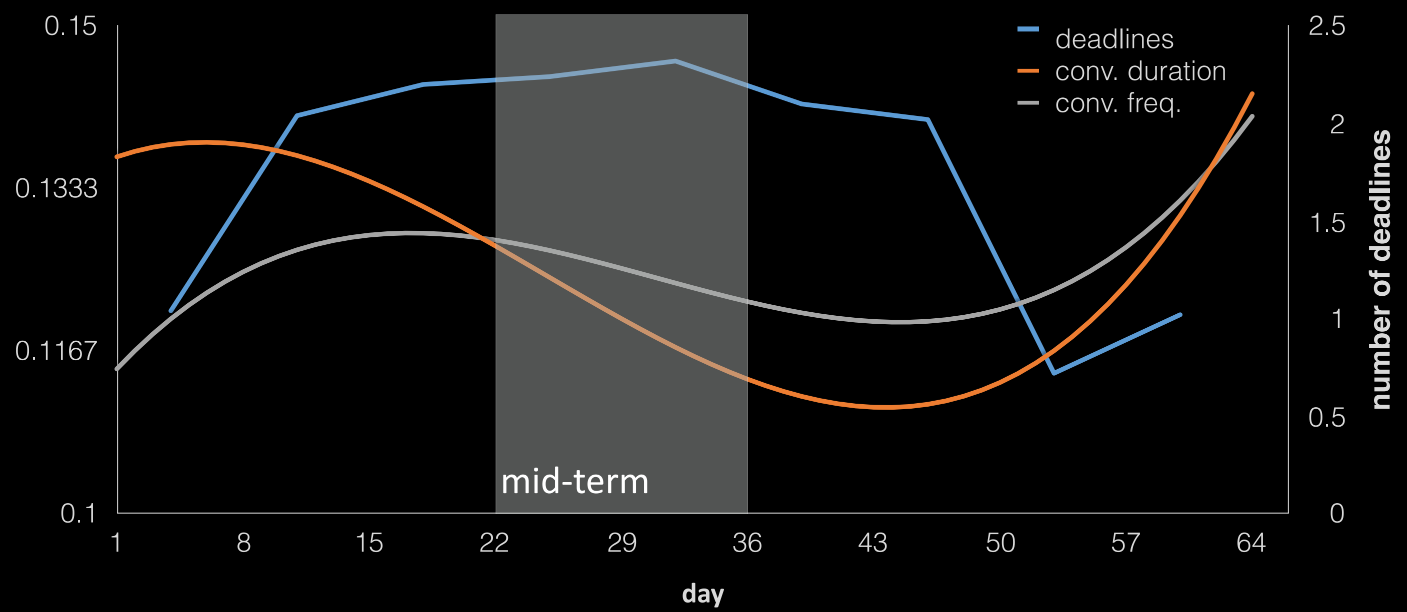


*p≤0.05, **p≤0.01

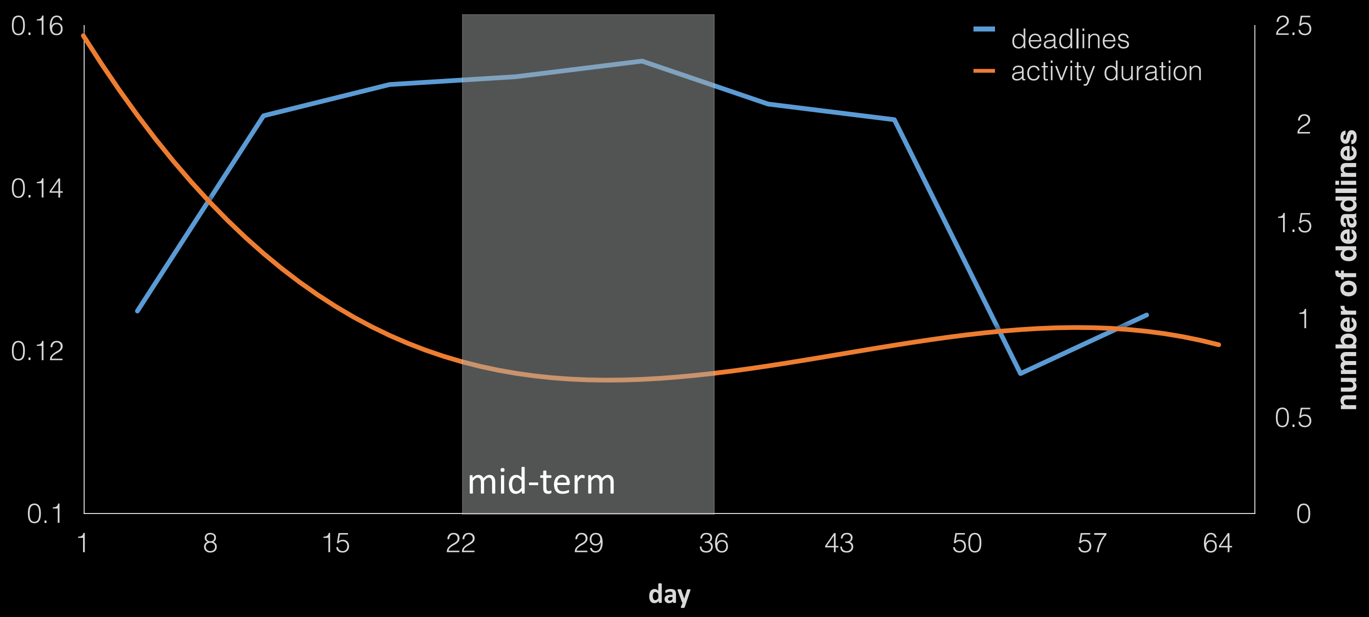

behavioral
trends


sleep
0.14
0.1267
0.1133
0.1
2.5
2
1.5
1
0.5
0
number of deadlines
deadlines
sleep
mid-term
1
8
15
22
29
36
43
50
57
64
day

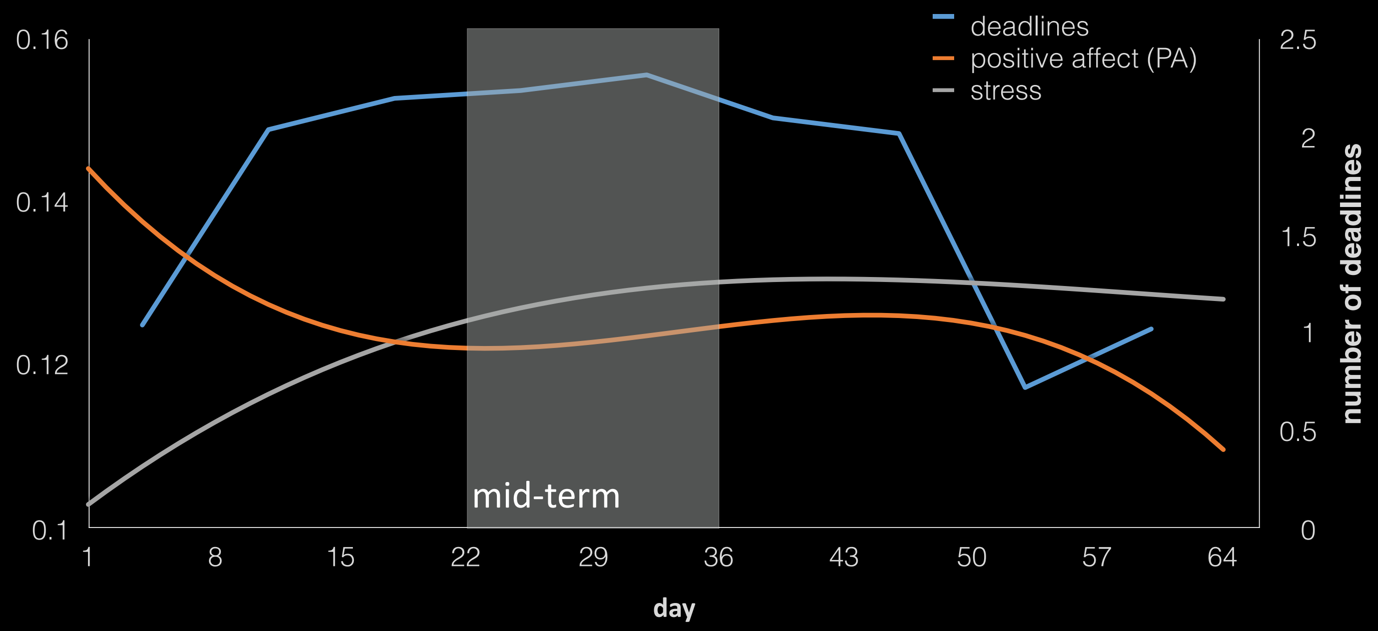
face-to-face conversation



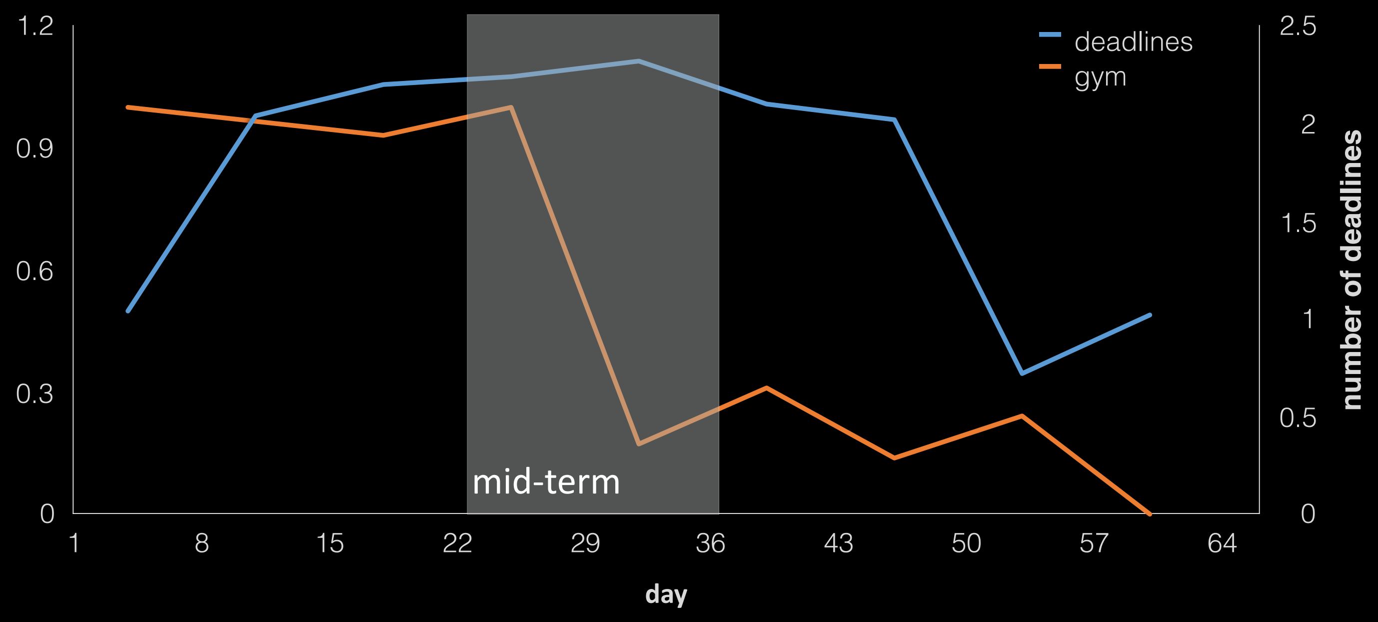
activity duration



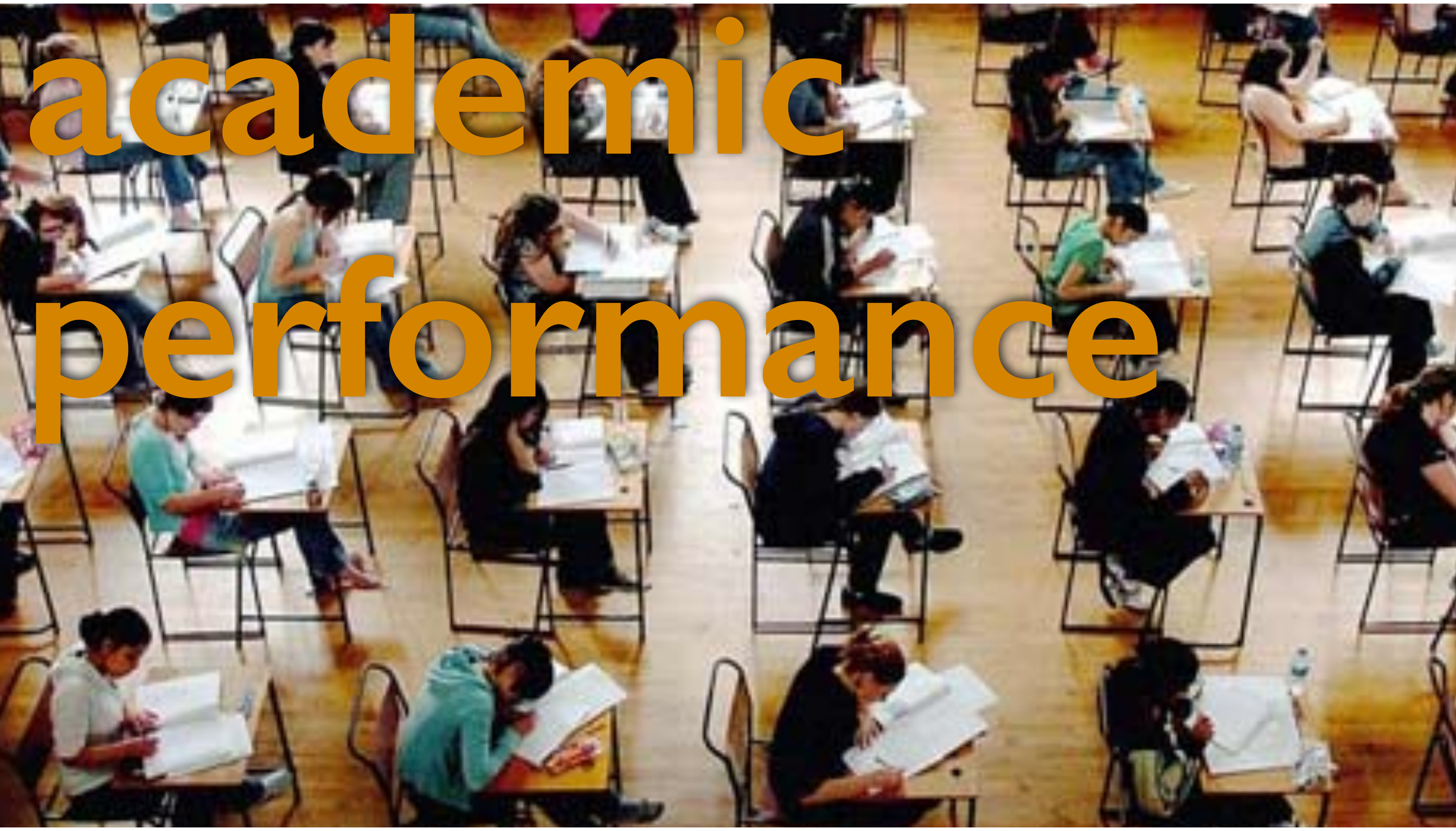
stress and affect



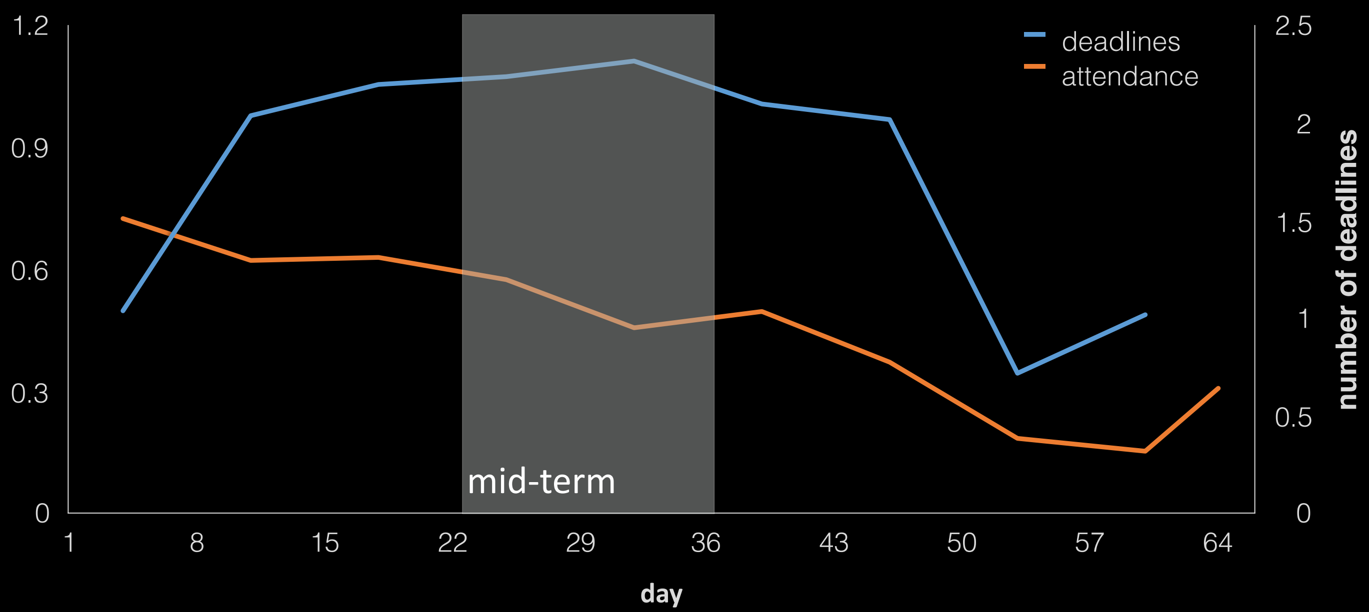
gym visits



1.2
0.9
0.6
0.3
0
mid-term
deadlines
gym
2.5
2
1.5
1
0.5
0
number of deadlines
1
8
15
22
29
36
43
50
57
64
day


academic
performance

class attendance

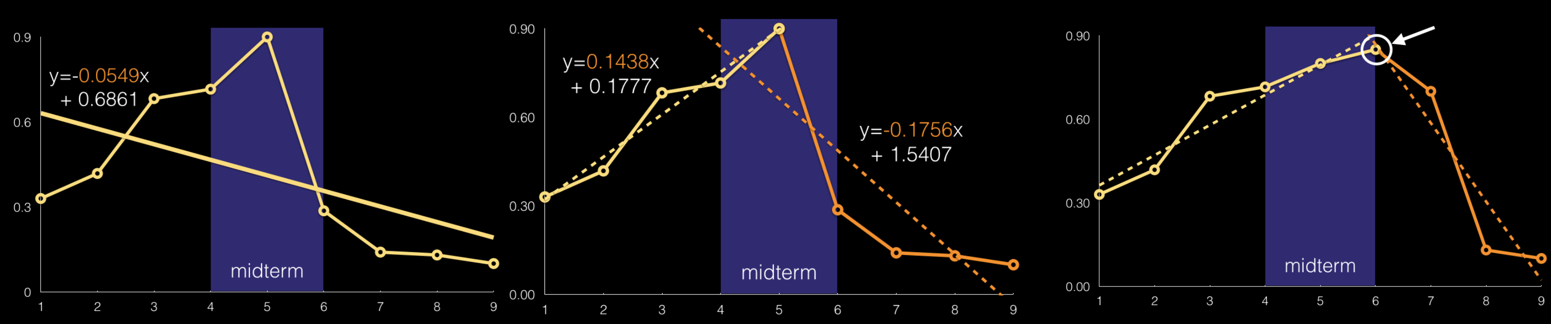



there is no correlation between
class attendance and grade!

idea

- look at individual differences between high and low peformers
- define higher level behaviors for studying and partying
- track behavior changes using time series analysis

capturing behavioral change

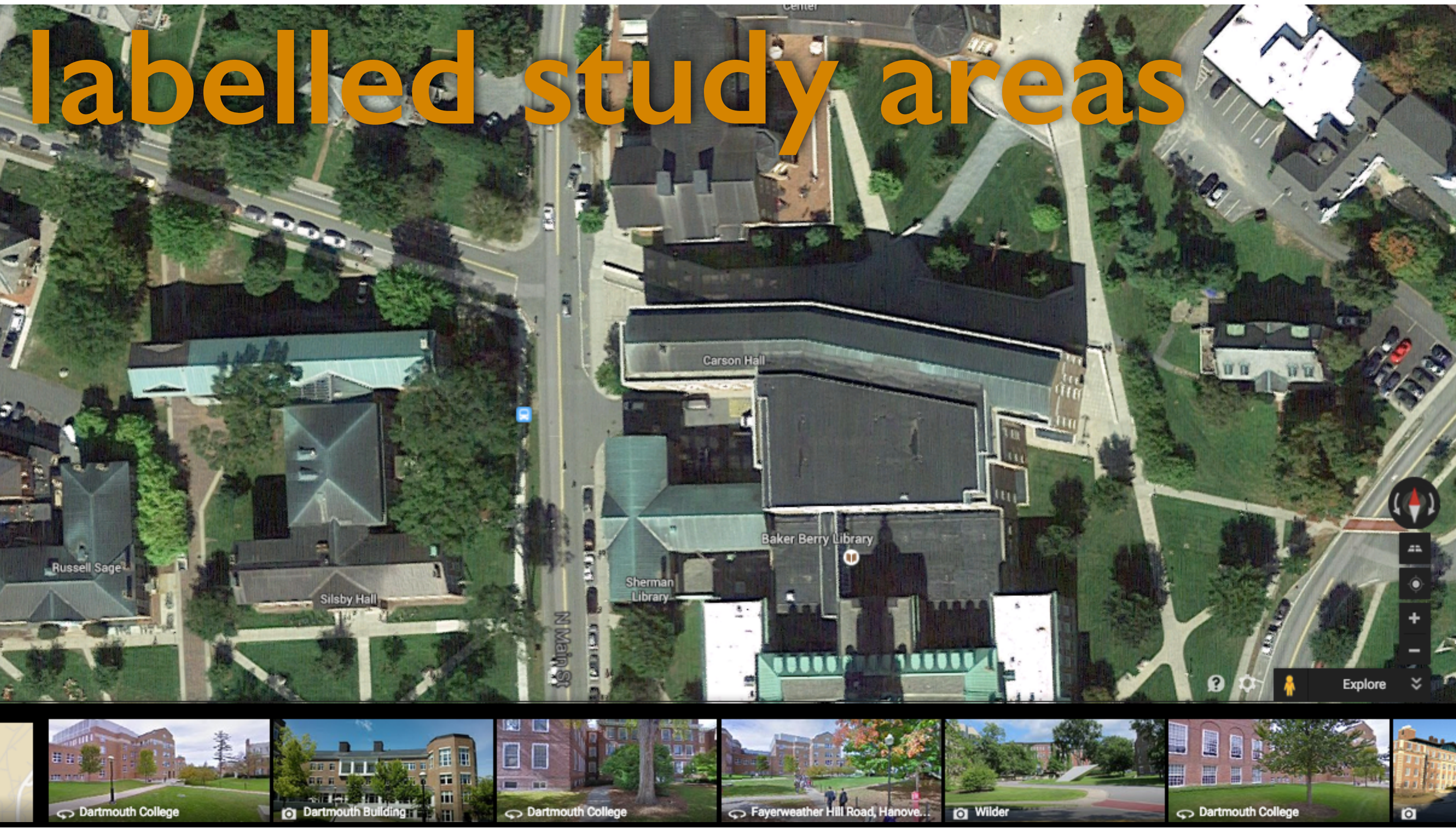


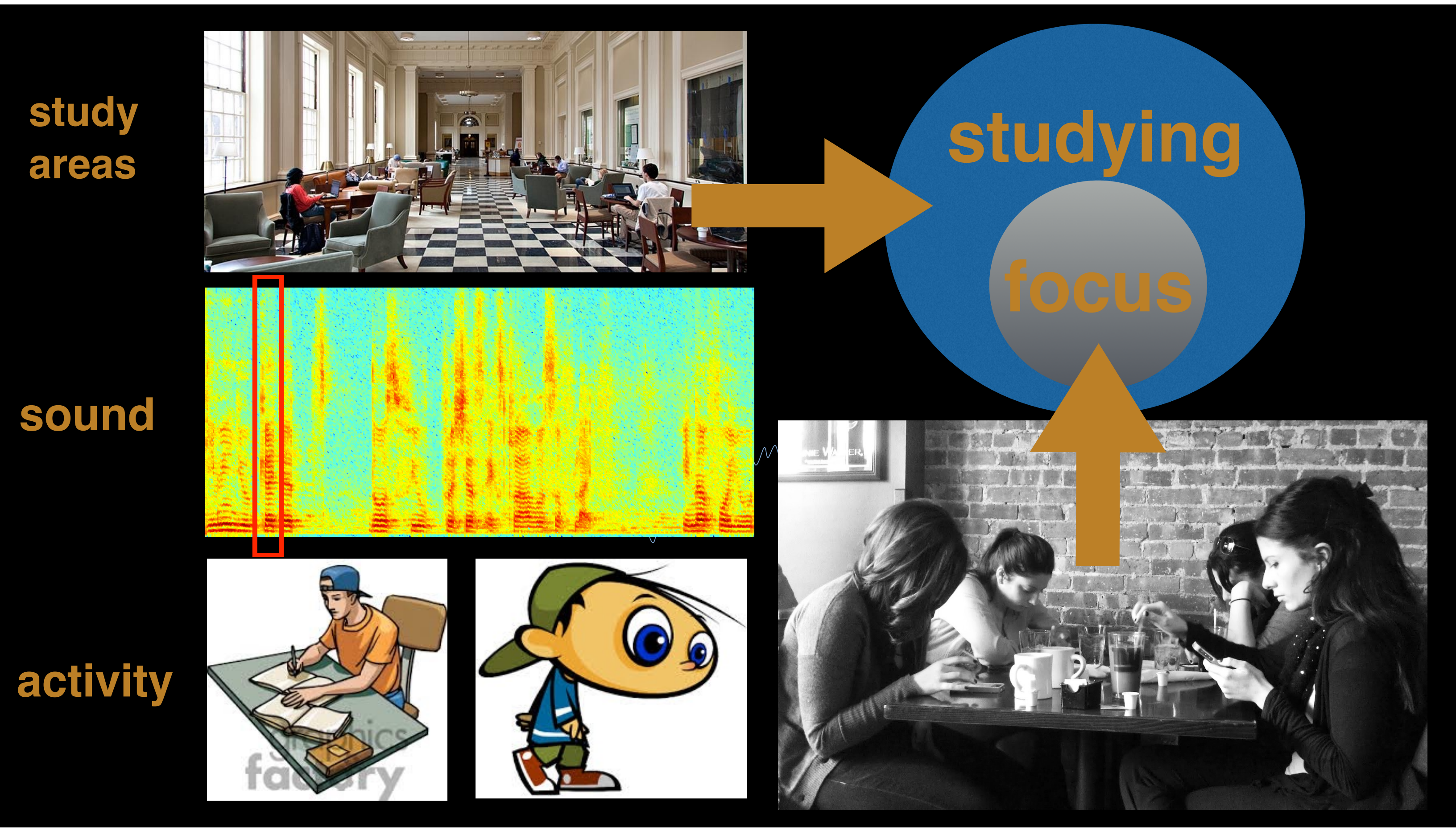
behavioral slope and breakpoints


studying

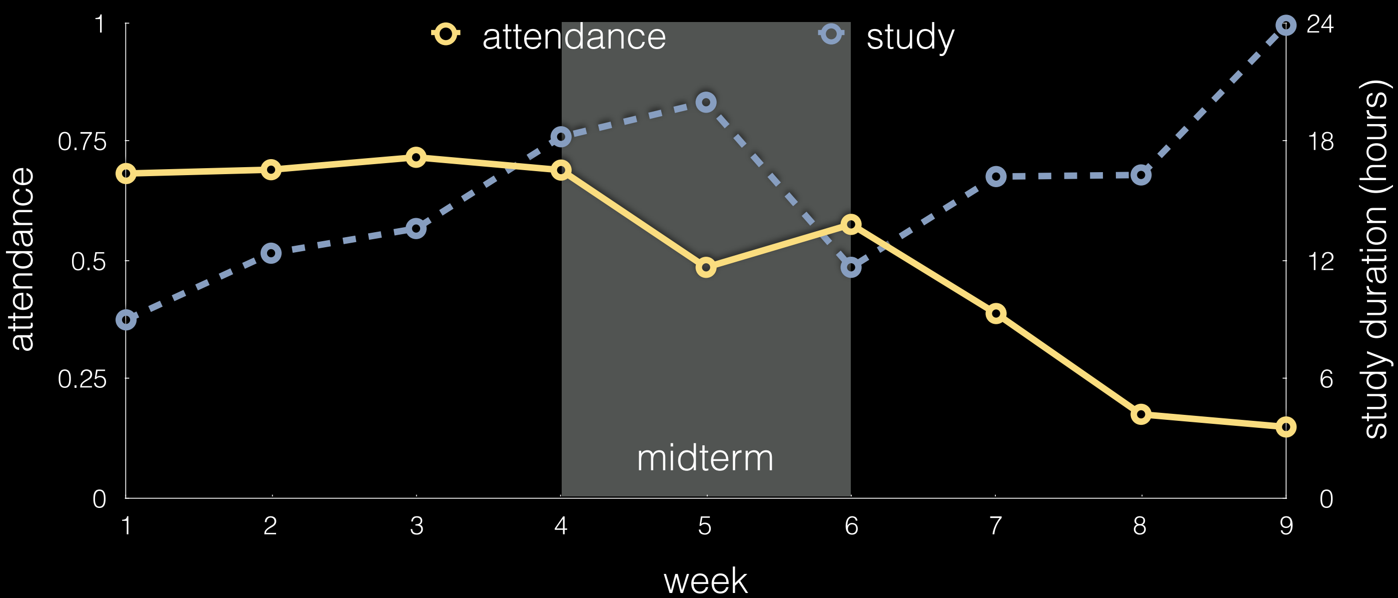

focus

labelled study areas

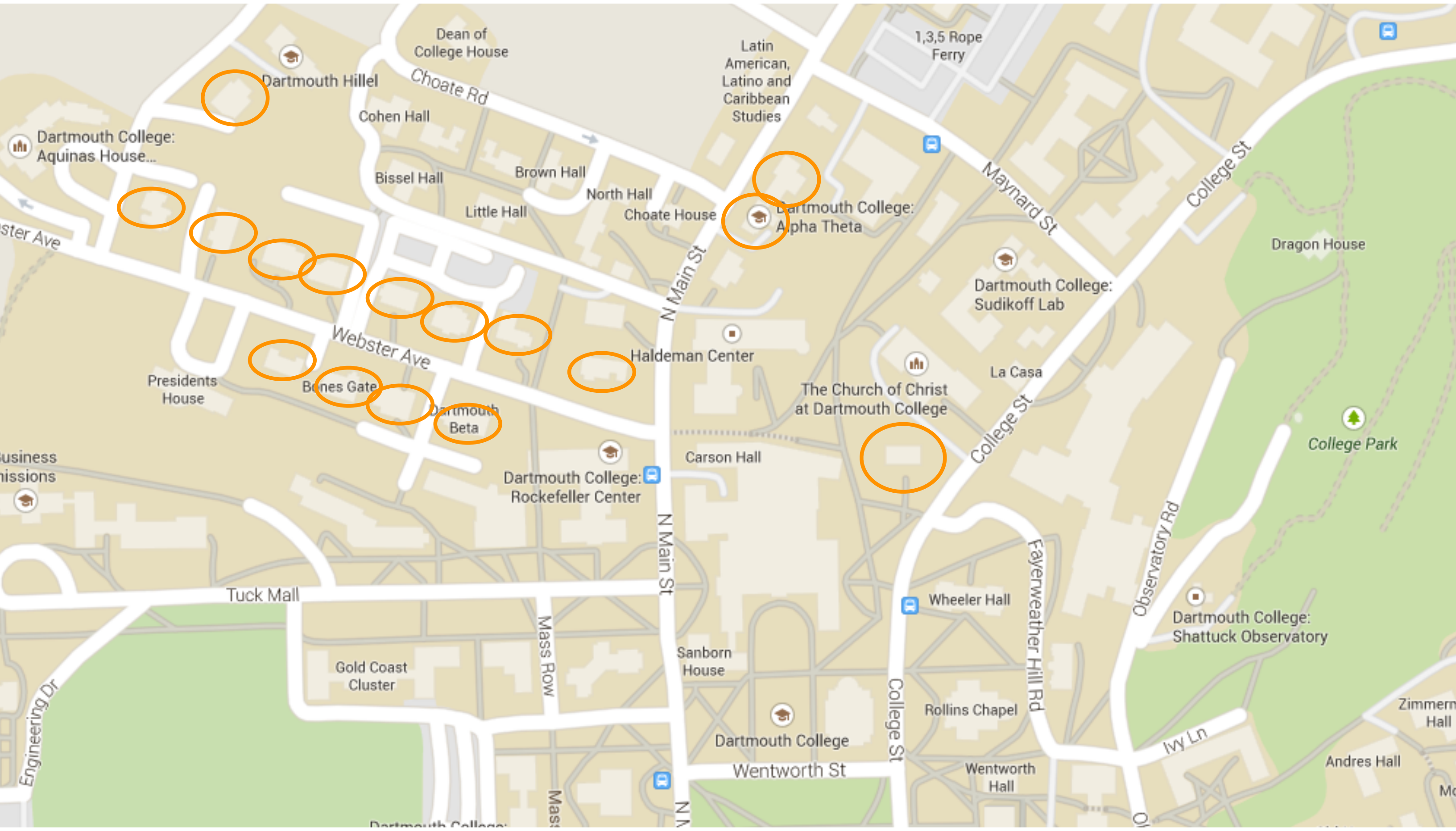



study
areas
sound
activity
studying
focus

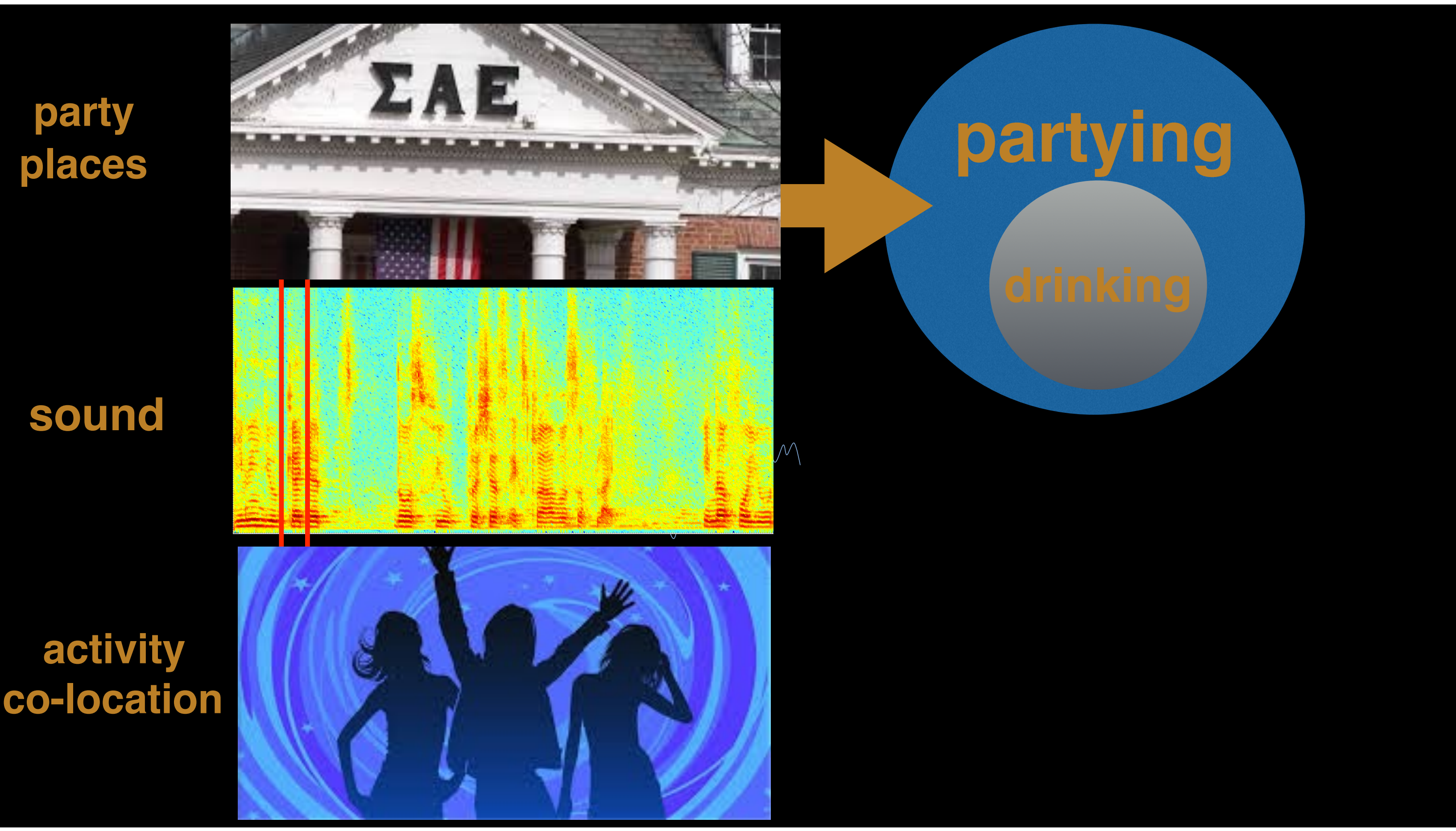
attending classes and studying

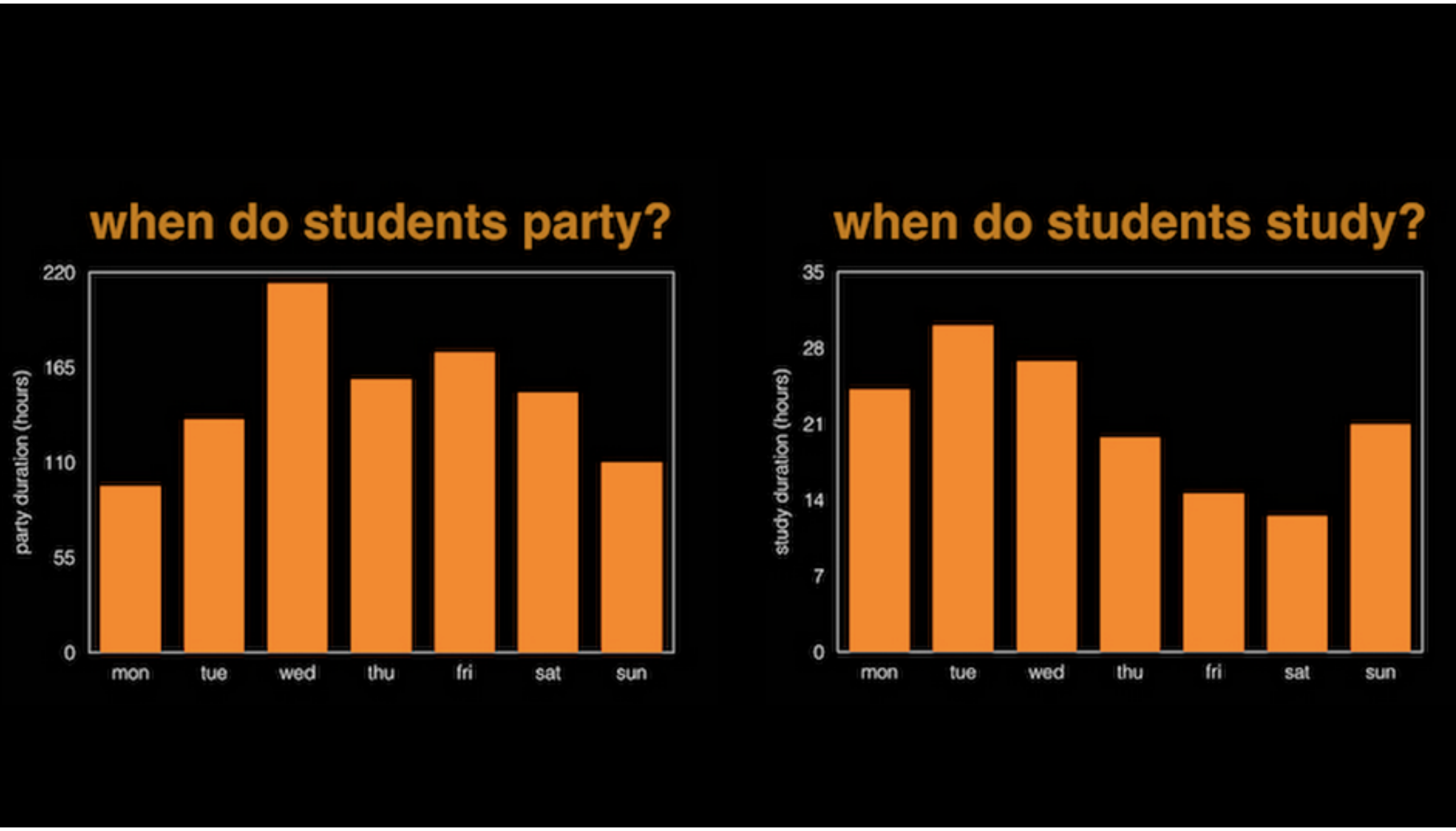


partying

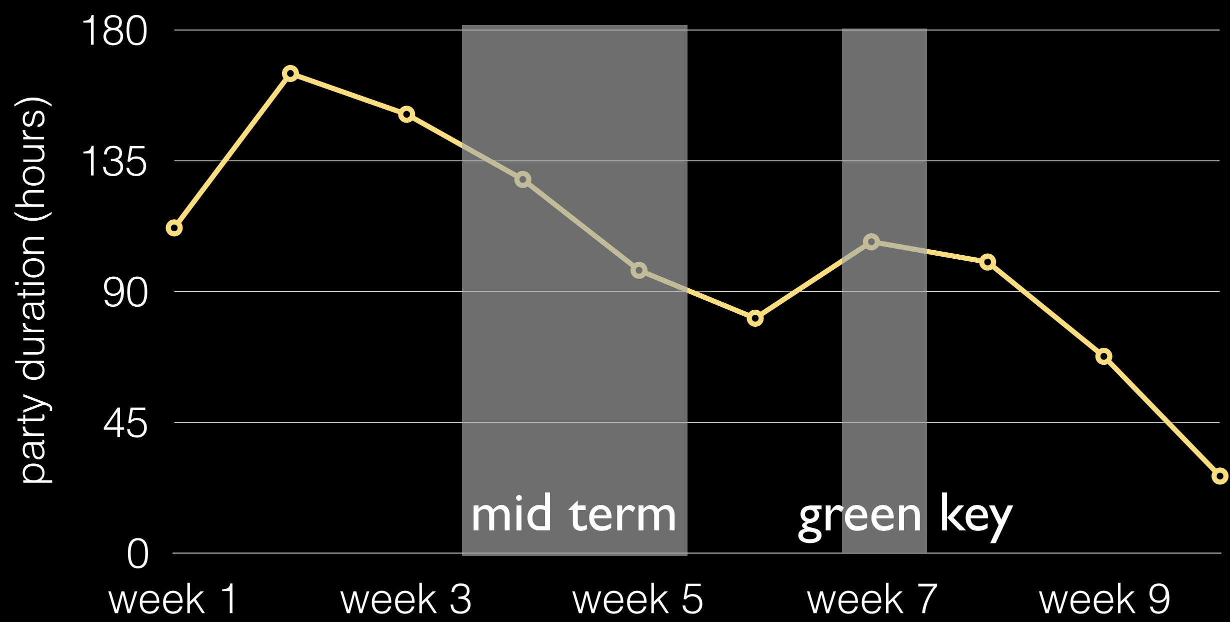


Dean of College House
Dartmouth Hillel
Choate Rd
Cohen Hall
Latin American, Latino and Caribbean Studies
1,3,5 Rope Ferry
Dartmouth College: Aquinas House...
Bissel Hall
Brown Hall
North Hall
Little Hall
Choate House
Dartmouth College: Alpha Theta
Maynard St
College St
Dragon House
Webster Ave
N Main St
Dartmouth College: Sudikoff Lab
Haldeman Center
La Casa
Presidents House
Bones Gate
The Church of Christ at Dartmouth College
Beta
College Park
Carson Hall
Dartmouth College: Rockefeller Center
Tuck Mall
Observatory Rd
Wheeler Hall
Fayerweather Hill Rd
Dartmouth College: Shattuck Observatory
Sanborn House
Gold Coast Cluster
Mass Row
Engineering Dr
Rollins Chapel
Dartmouth College
Wentworth St
Wentworth Hall
Ivy Ln
Andres Hall

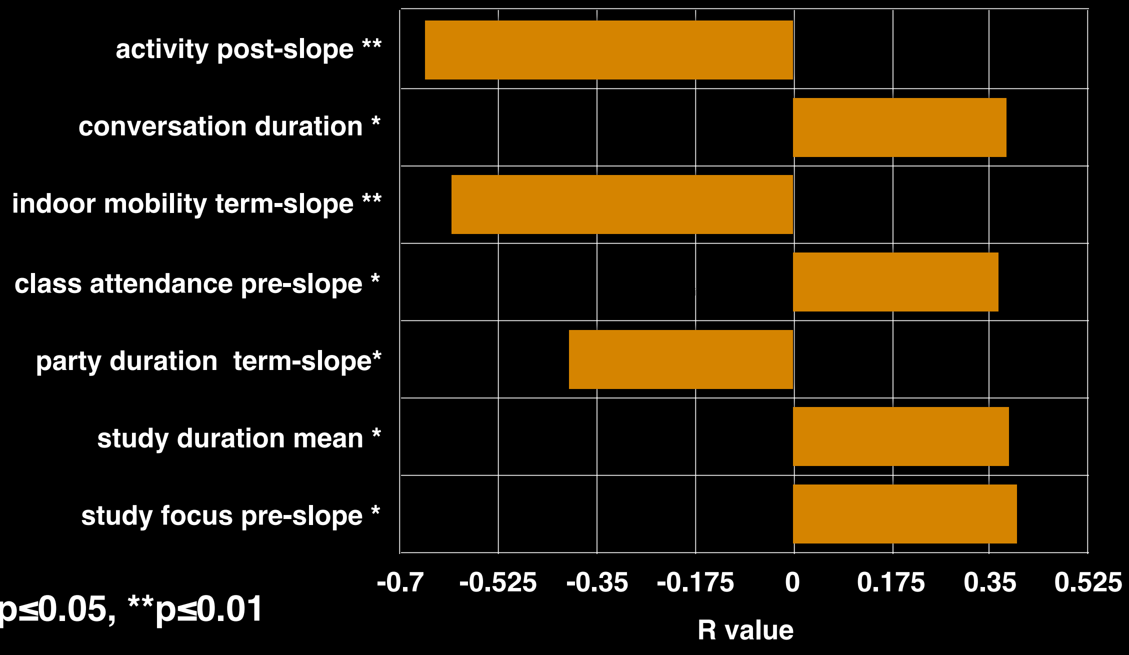

party
places
ΣΑΕ
sound
activity
co-location
partying
drinking


when do students party?
220
165
110
55
0
party duration (hours)
mon
tue
wed
thu
fri
sat
sun
when do students study?
35
28
21
14
7
0
study duration (hours)
mon
tue
wed
thu
fri
sat
sun

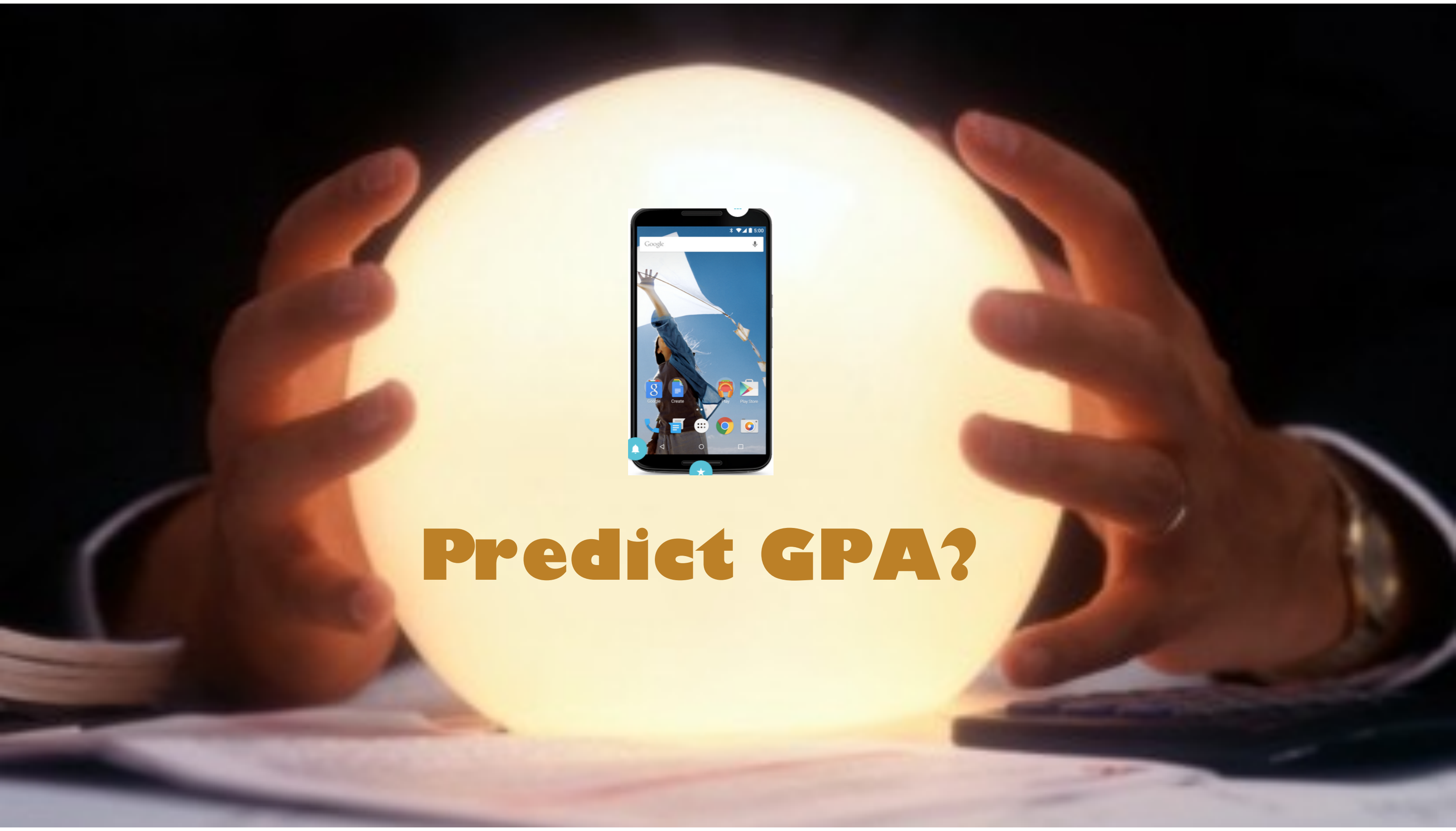
partying trends across the term

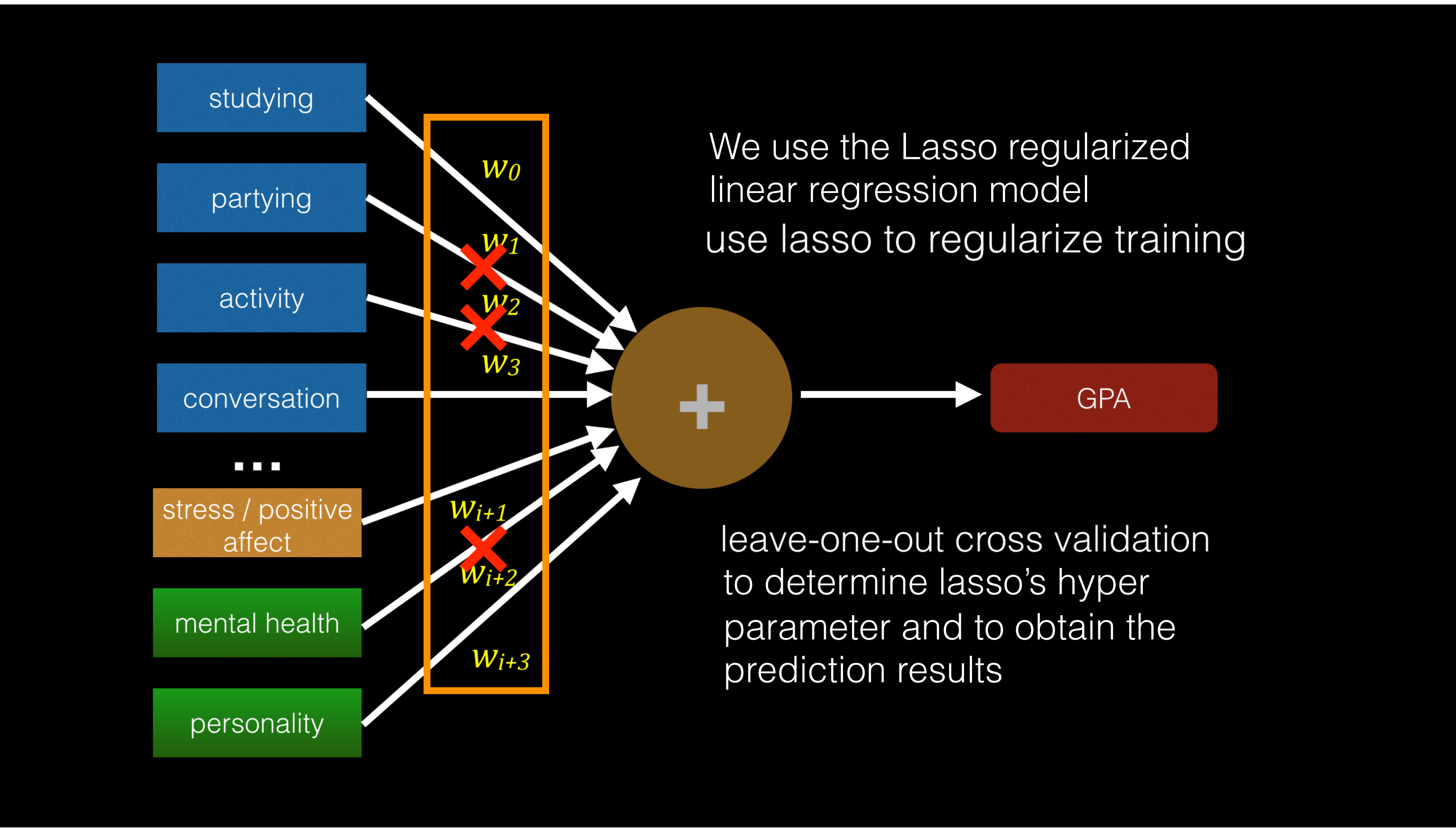


GPA

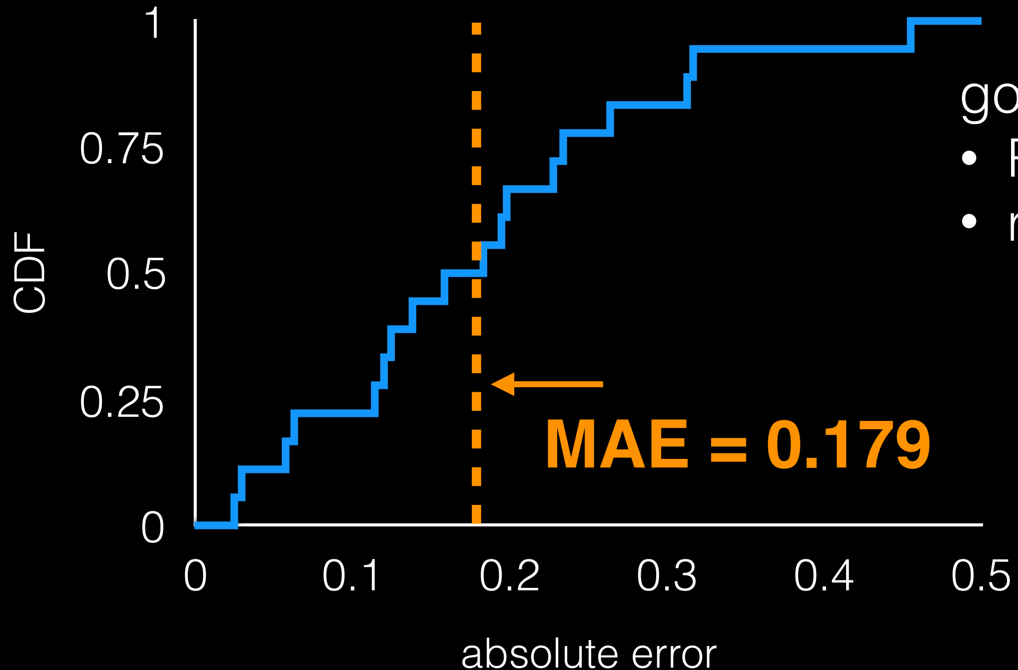


*p≤0.05, **p≤0.01


Predict GPA?


studying
partying
activity
conversation
...
stress / positive affect
mental health
personality
w_0
w_1
w_2
w_3
w_{i+1}
w_{i+2}
w_{i+3}
+
GPA
We use the Lasso regularized linear regression model
use lasso to regularize training
leave-one-out cross validation to determine lasso's hyper parameter and to obtain the prediction results

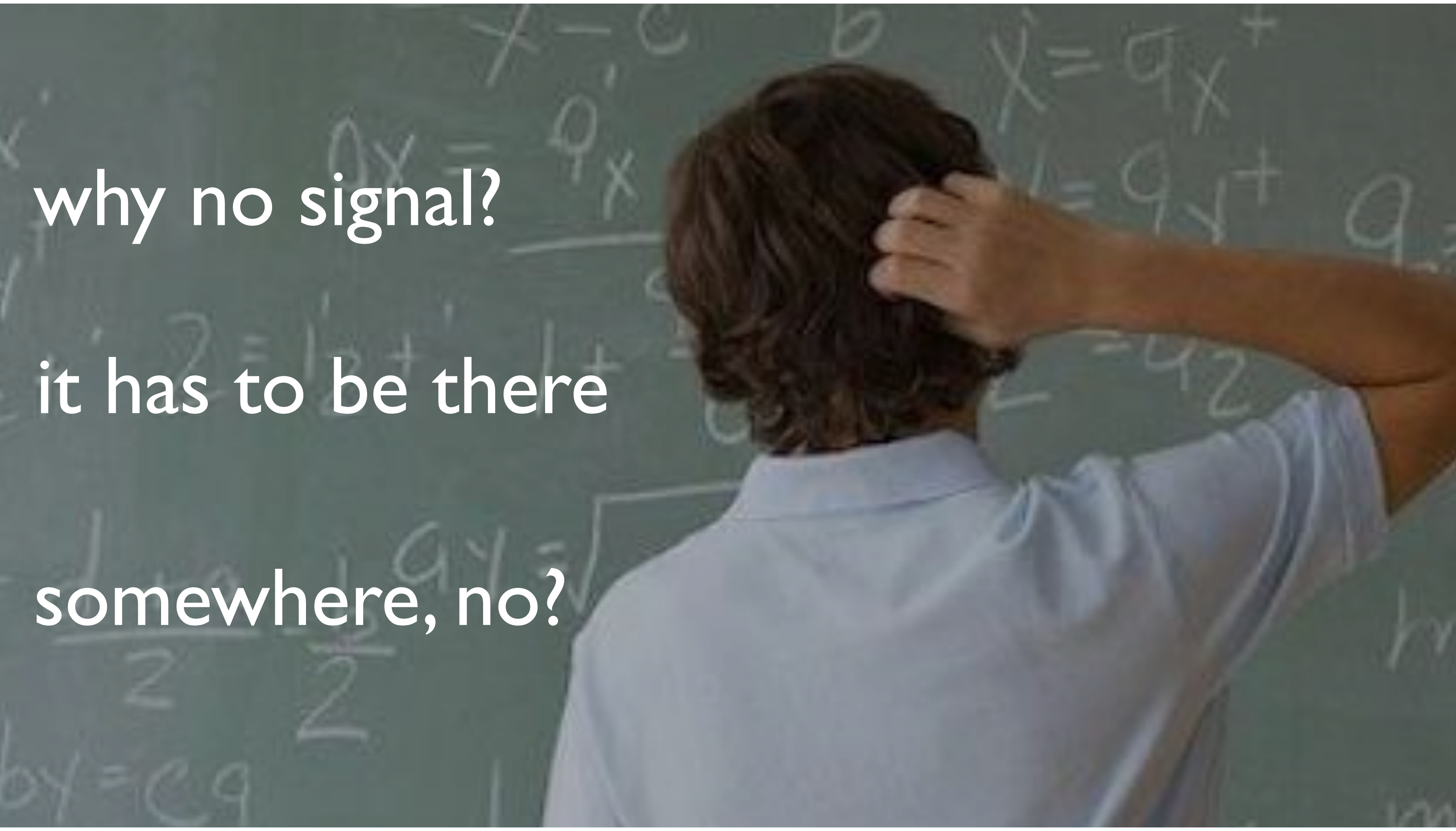
prediction performance

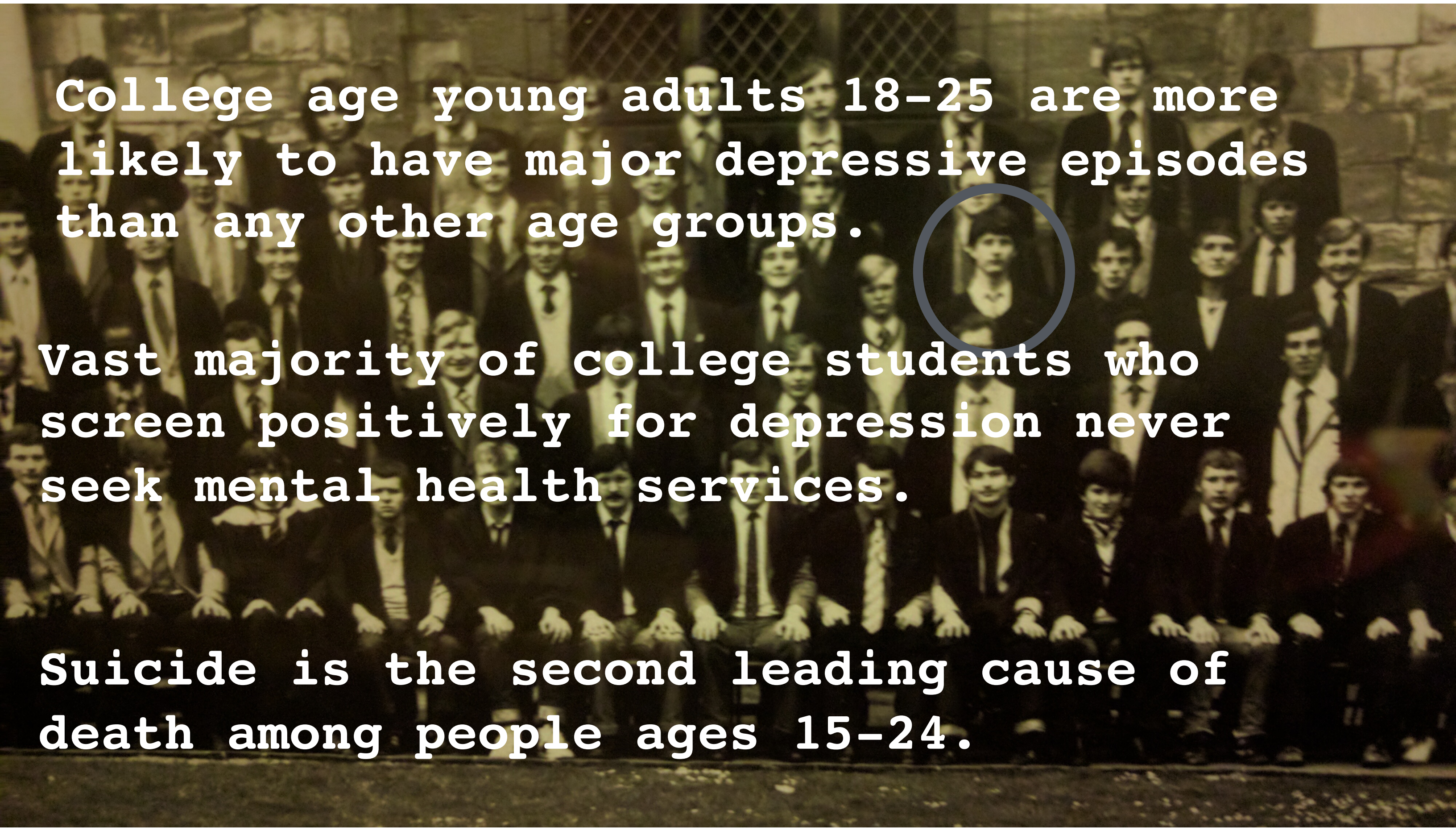


goodness of fit:

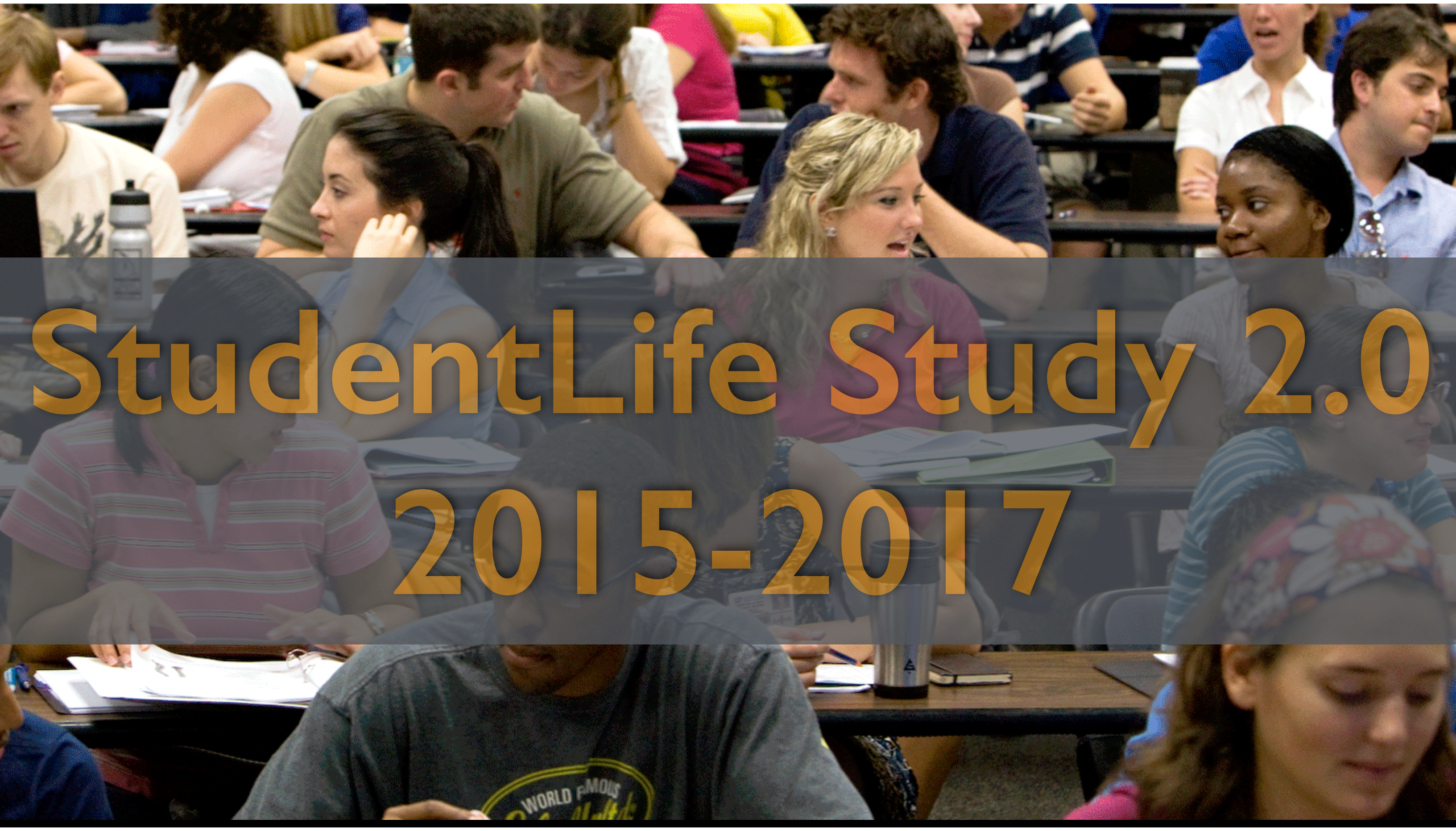
- $R^2 = 0.559$
- $r = 0.81$, $p < 0.01$

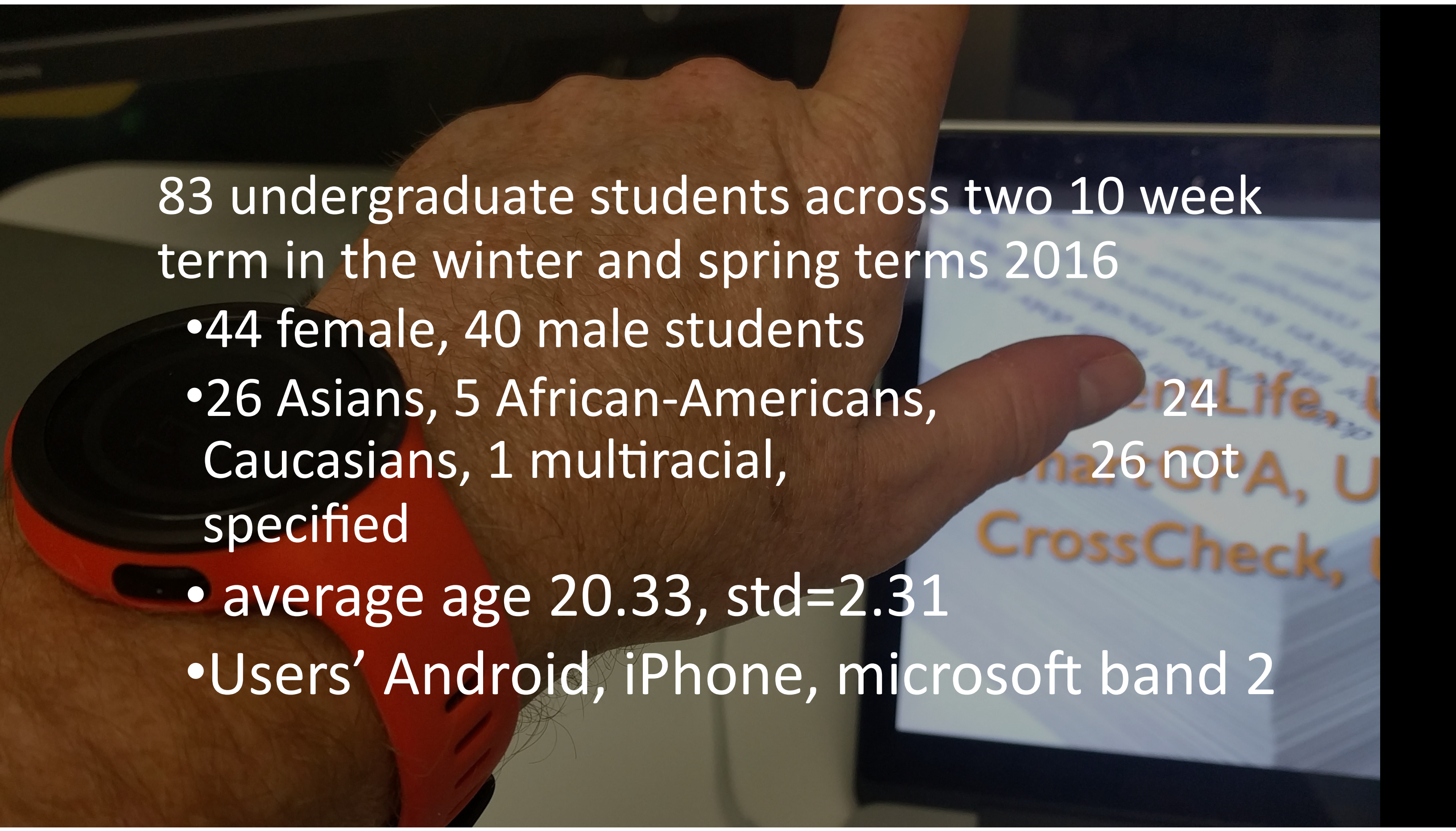

a professor’s intervention

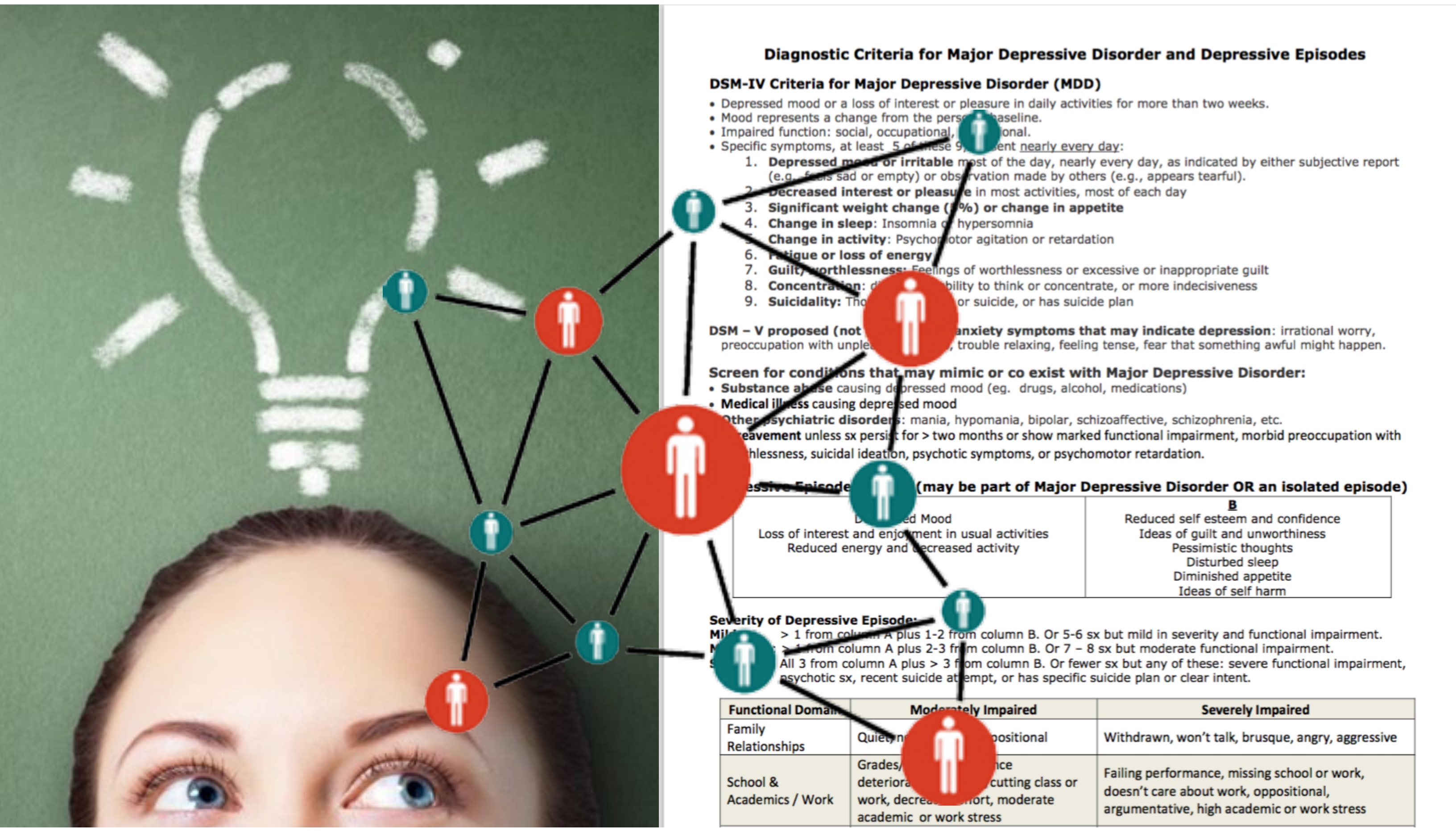

why no signal?
it has to be there
somewhere, no?

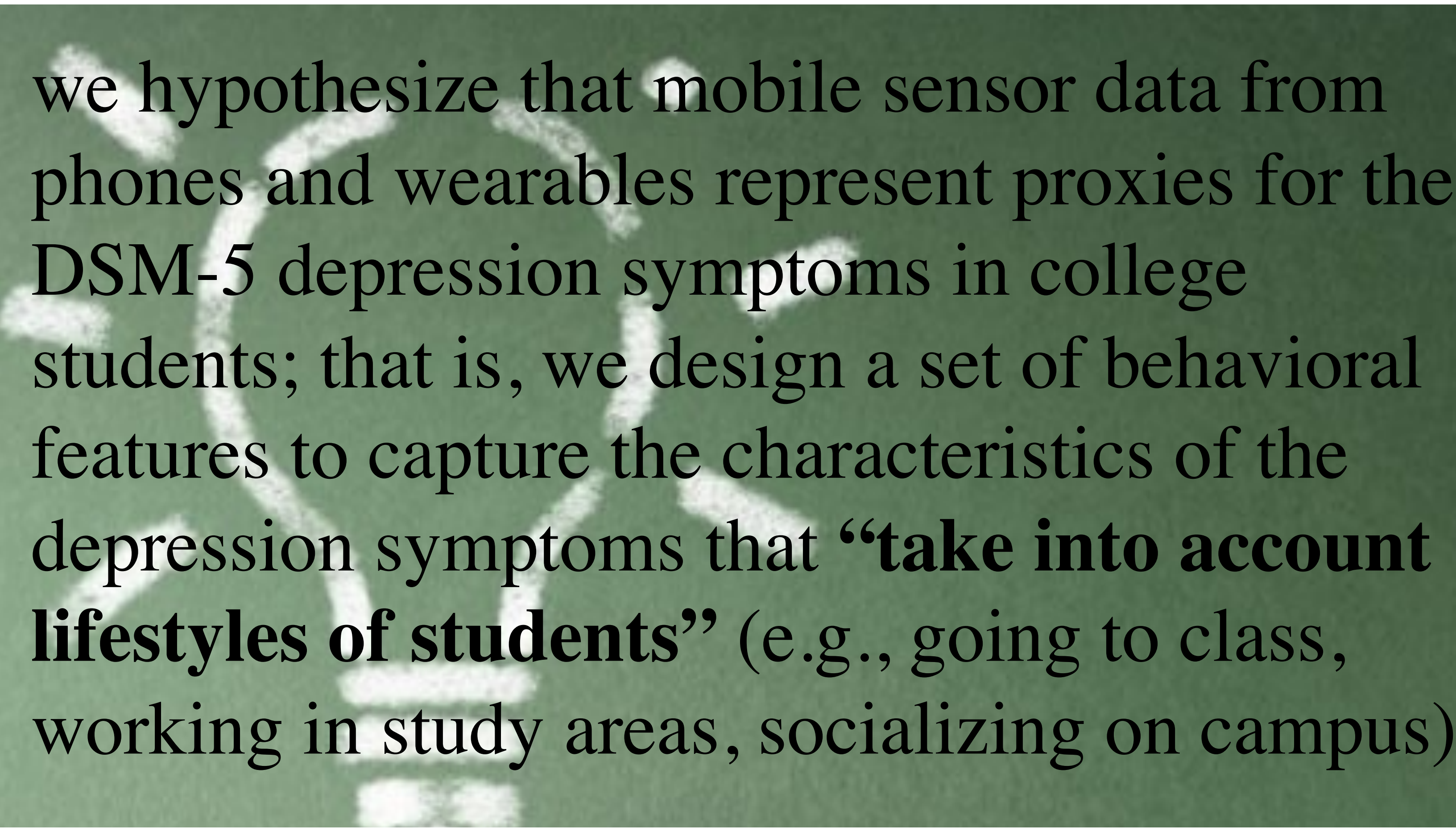

College age young adults 18-25 are more likely to have major depressive episodes than any other age groups.
Vast majority of college students who screen positively for depression never seek mental health services.
Suicide is the second leading cause of death among people ages 15-24.


depression sensing


StudentLife Study 2.0
2015-2017
WORLD FAMOUS


83 undergraduate students across two 10 week term in the winter and spring terms 2016
•44 female, 40 male students
•26 Asians, 5 African-Americans, 24 Caucasians, 1 multiracial, 26 not specified
• average age 20.33, std=2.31
•Users' Android, iPhone, microsoft band 2


Diagnostic Criteria for Major Depressive Disorder and Depressive Episodes
DSM-IV Criteria for Major Depressive Disorder (MDD)
• Depressed mood or a loss of interest or pleasure in daily activities for more than two weeks.
• Mood represents a change from the pers
• Impaired function: social, occupational,
• Specific symptoms, at least 5 of these 9
1. Depressed mo or irritable m st of the day, nearly every day, as indicated by either subjective report
(e.g., feels sad or empty) or obs rvation made by others (e.g., appears tearful).
Decreased interest or pleasu e in most activities, most of each day
3. Significant weight change (%) or change in appetite
4. Change in sleep: Insomnia or hypersomnia
Change in activity: Psychomotor agitation or retardation
6. Fatigue or loss of energy
7. Guilt/worthlessness: Feelings of worthlessness or excessive or inappropriate guilt
8. Concentration: d bility to think or concentrate, or more indecisiveness
9. Suicidality: Th or suicide, or has suicide plan
DSM – V proposed (not anxiety symptoms that may indicate depression: irrational worry,
preoccupation with unple , trouble relaxing, feeling tense, fear that something awful might happen.
Screen for conditions that may mimic or co exist with Major Depressive Disorder:
• Substance abuse causing depressed mood (eg. drugs, alcohol, medications)
• Medical illness causing depressed mood
Other psychiatric disorders: mania, hypomania, bipolar, schizoaffective, schizophrenia, etc.
eavement unless sx persist for > two months or show marked functional impairment, morbid preoccupation with
hlessness, suicidal ideation, psychotic symptoms, or psychomotor retardation.
essive Episode (may be part of Major Depressive Disorder OR an isolated episode)
B
ed Mood
Reduced self esteem and confidence
Loss of interest and enjoyment in usual activities
Ideas of guilt and unworthiness
Reduced energy and decreased activity
Pessimistic thoughts
Disturbed sleep
Diminished appetite
Ideas of self harm
Severity of Depressive Episode:
> 1 from column A plus 1-2 from column B. Or 5-6 sx but mild in severity and functional impairment.
> 1 from column A plus 2-3 from column B. Or 7 – 8 sx but moderate functional impairment.
All 3 from column A plus > 3 from column B. Or fewer sx but any of these: severe functional impairment,
psychotic sx, recent suicide attempt, or has specific suicide plan or clear intent.
Functional Domain
Moderately Impaired
Severely Impaired
Family Relationships
Withdrawn, won't talk, brusque, angry, aggressive
School & Academics / Work
Failing performance, missing school or work, doesn't care about work, oppositional, argumentative, high academic or work stress
work, decrea ort, moderate academic or work stress


we hypothesize that mobile sensor data from phones and wearables represent proxies for the DSM-5 depression symptoms in college students; that is, we design a set of behavioral features to capture the characteristics of the depression symptoms that **“take into account lifestyles of students”** (e.g., going to class, working in study areas, socializing on campus)

symptoms to phone behavioral features

change in sleep

- sleep onset, sleep wakeup, sleep duration

decreased interest in activities

- number of places visited, physical activity, time spent in study places and dorms, and social engagement

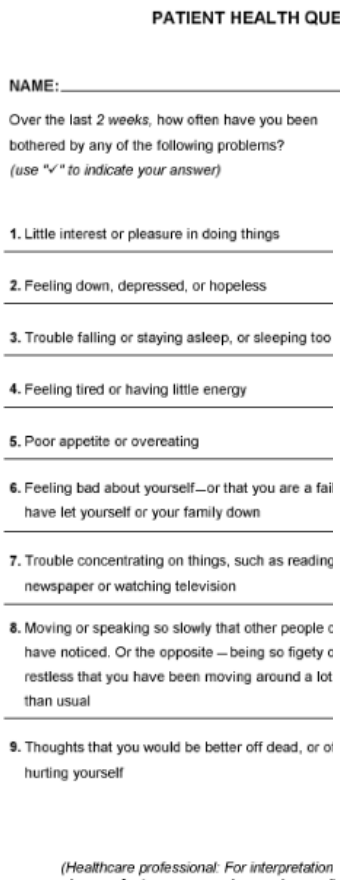
loss of concentration

- lock/unlock during the day, at study places and at dorms

depressed mood/fatigue

- heart rate/ heart rate variability


self-reported pre-post
PHQ8 and weekly PHQ4



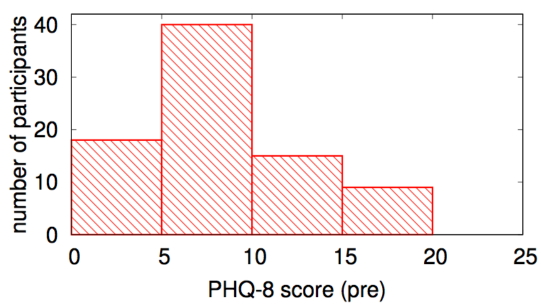
PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

NAME:________________________________ DATE:________________

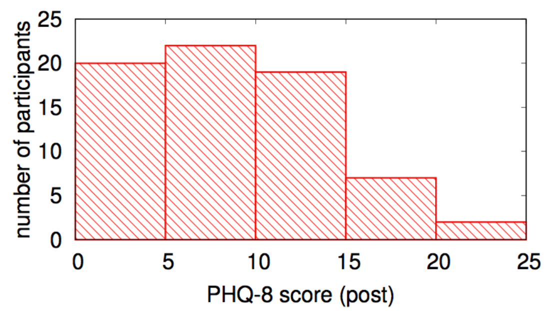
Over the last *2 weeks*, how often have you been bothered by any of the following problems?
(use "✓" to indicate your answer)

1. Little interest or pleasure in doing things
2. Feeling down, depressed, or hopeless
3. Trouble falling or staying asleep, or sleeping too
4. Feeling tired or having little energy
5. Poor appetite or overeating
6. Feeling bad about yourself—or that you are a fai have let yourself or your family down
7. Trouble concentrating on things, such as reading newspaper or watching television
8. Moving or speaking so slowly that other people c have noticed. Or the opposite — being so figety c restless that you have been moving around a lot than usual
9. Thoughts that you would be better off dead, or o hurting yourself

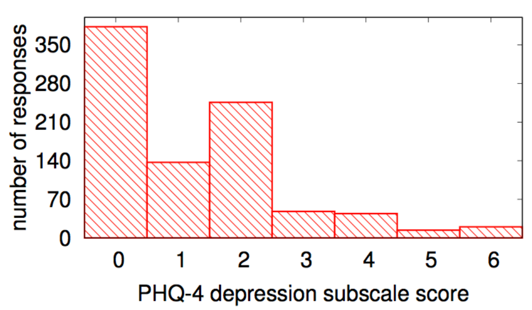
(Healthcare professional: For interpretation please refer to accompanying scoring card)



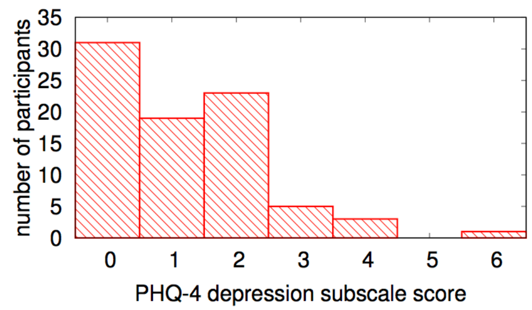
(a) The distribution of pre PHQ-8 scores



(b) The distribution of post PHQ-8 scores

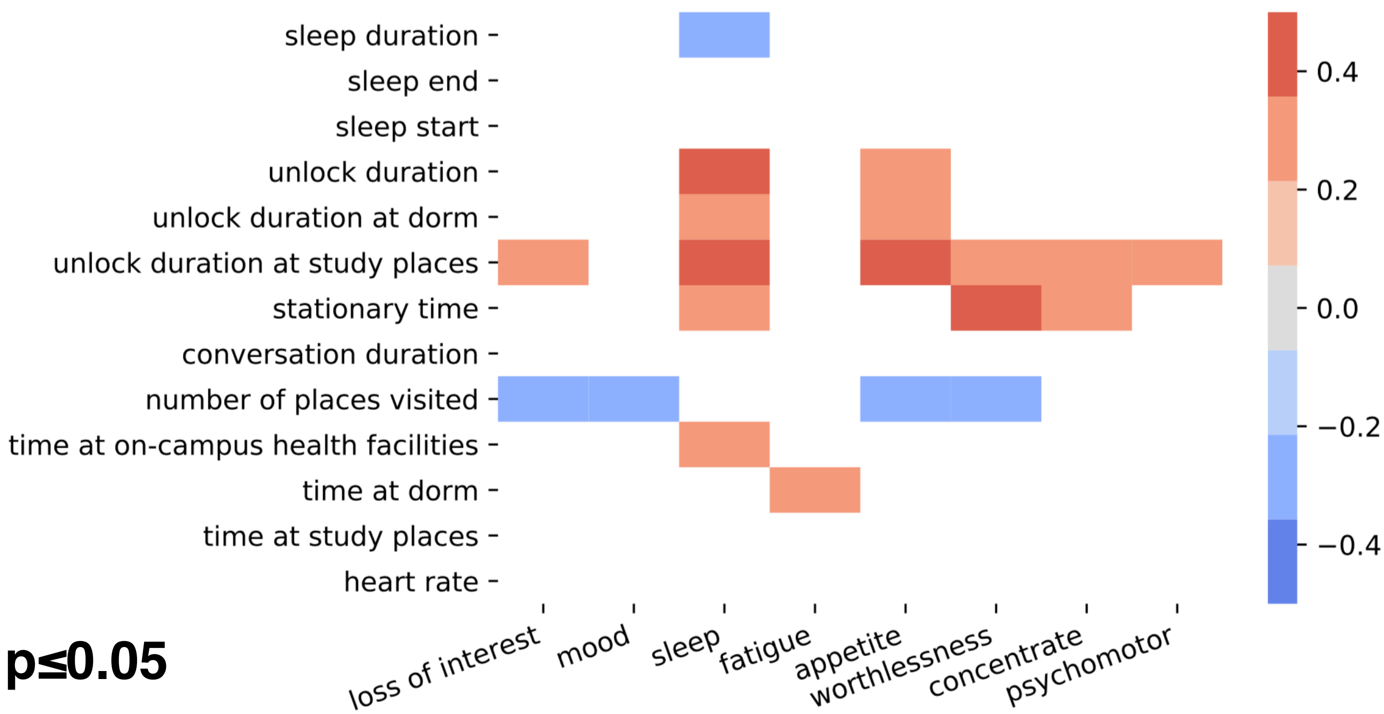


(c) The distribution of PHQ-4 depression subscale scores

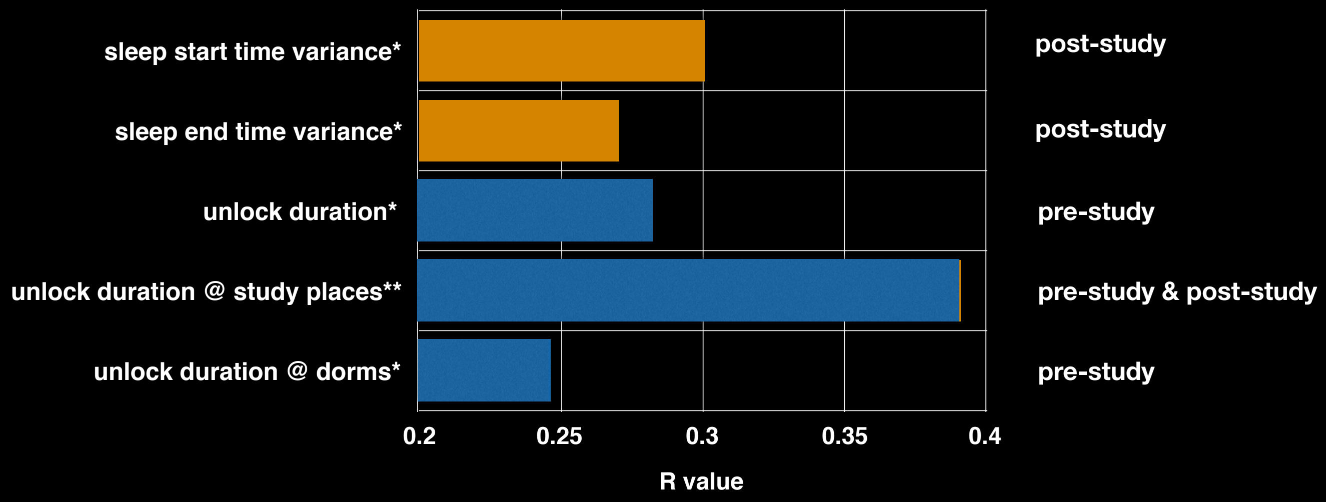


(d) The distribution of mean PHQ-4 depression subscale scores

correlation matrix of symptom features and PHQ-8 item scores

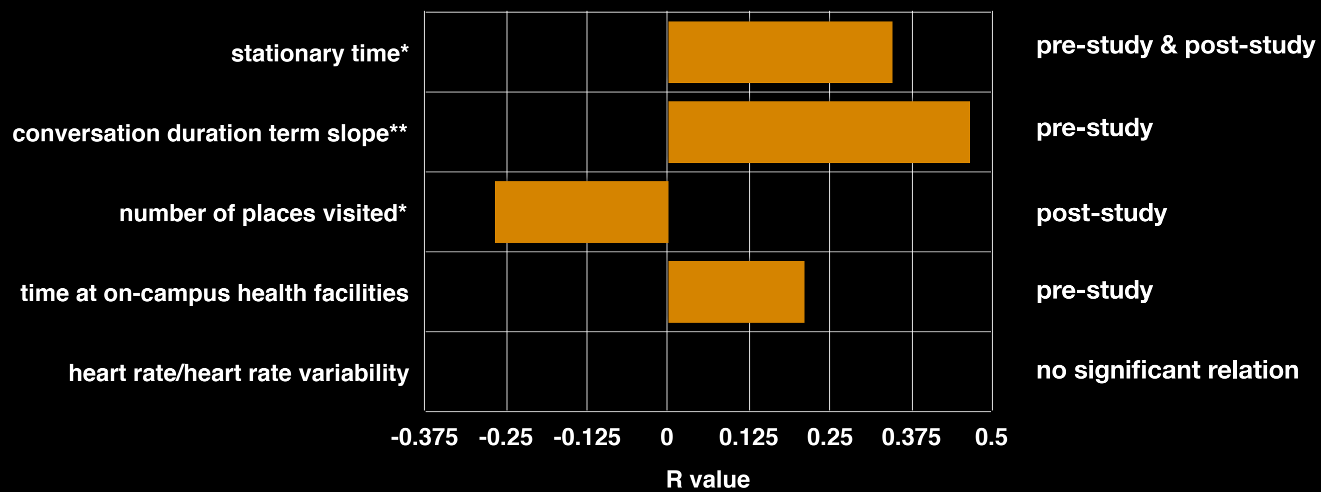


PHQ-8 score: sleep changes; and diminished ability to concentrate



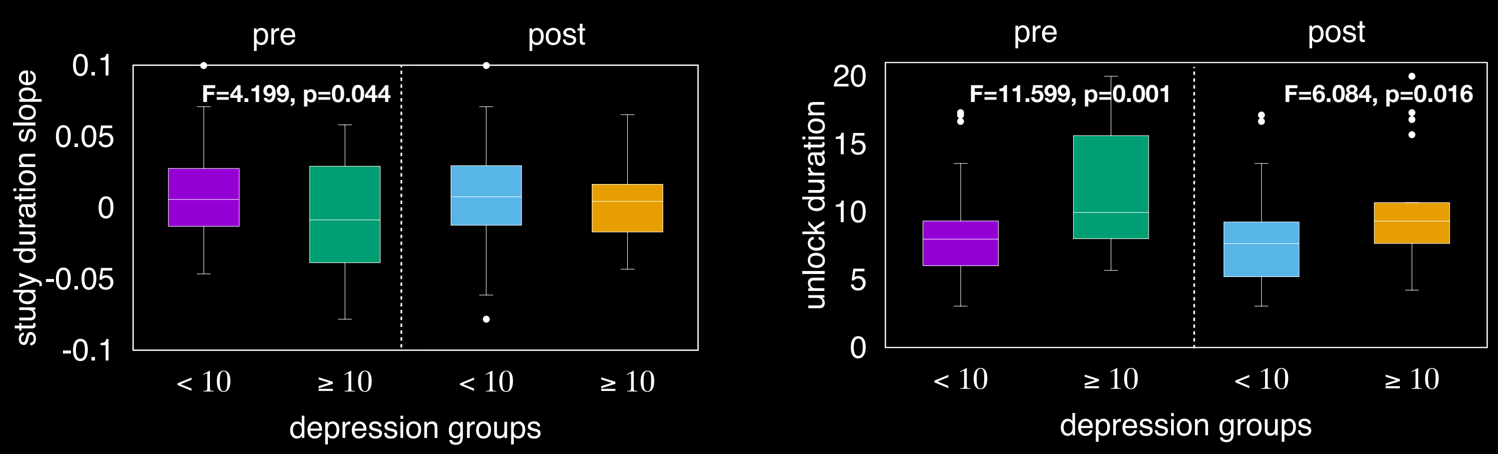
*p≤0.05, **p≤0.01

PHQ-8 score: diminished interest in activities; and depressed mood, fatigue



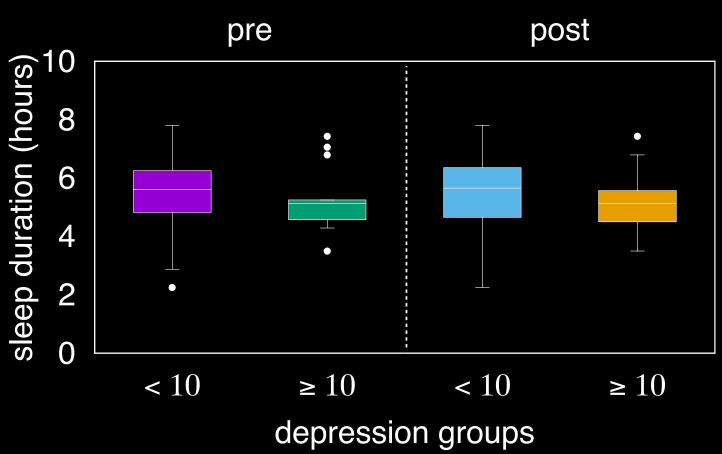
***p≤0.05, **p≤0.01**

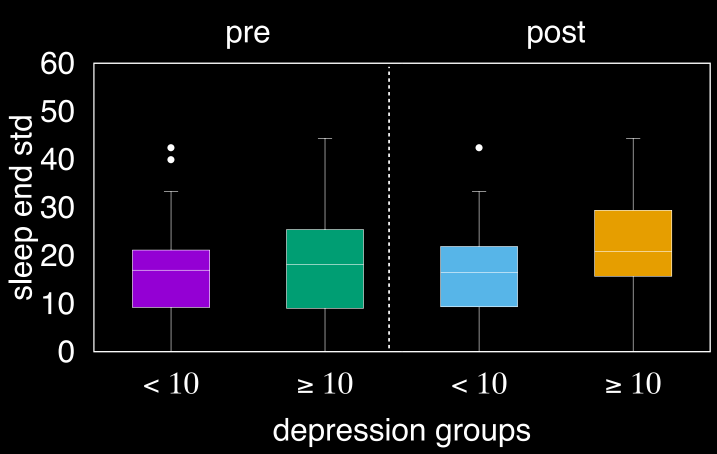
study places



We use ANOVA to determine whether or not the mean of the two groups (non-depressed and depressed) significantly differ.

sleep


pre
post
sleep duration (hours)
10
8
6
4
2
0
< 10
≥ 10
< 10
≥ 10
depression groups

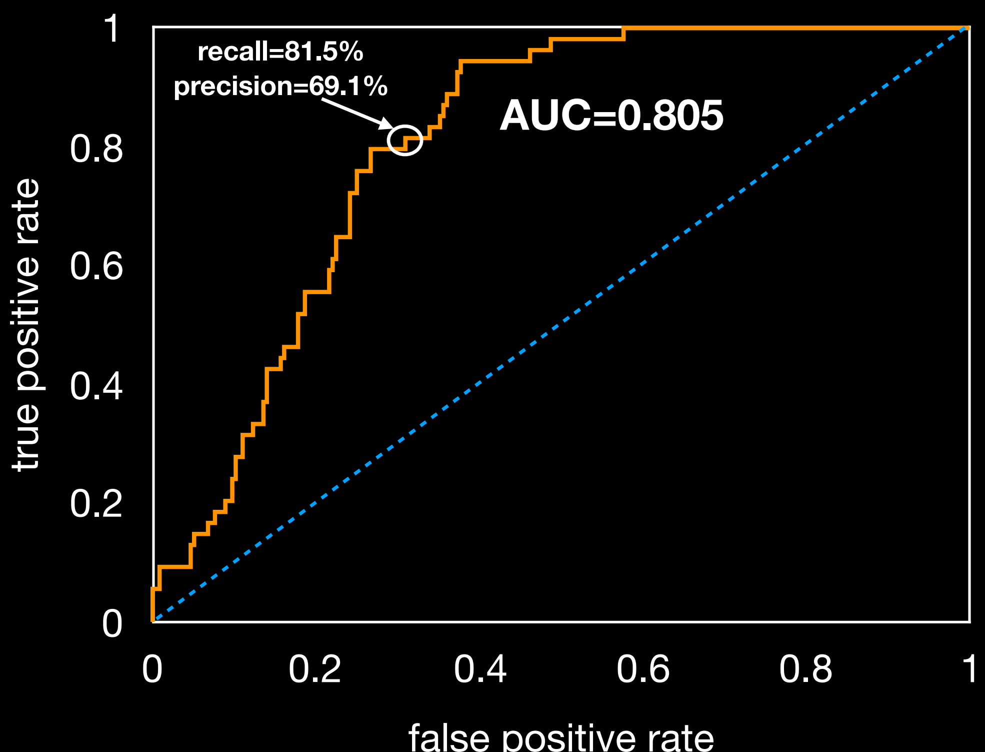

pre
post
sleep end std
60
50
40
30
20
10
0
< 10
≥ 10
< 10
≥ 10
depression groups

predicting weekly PHQ-4

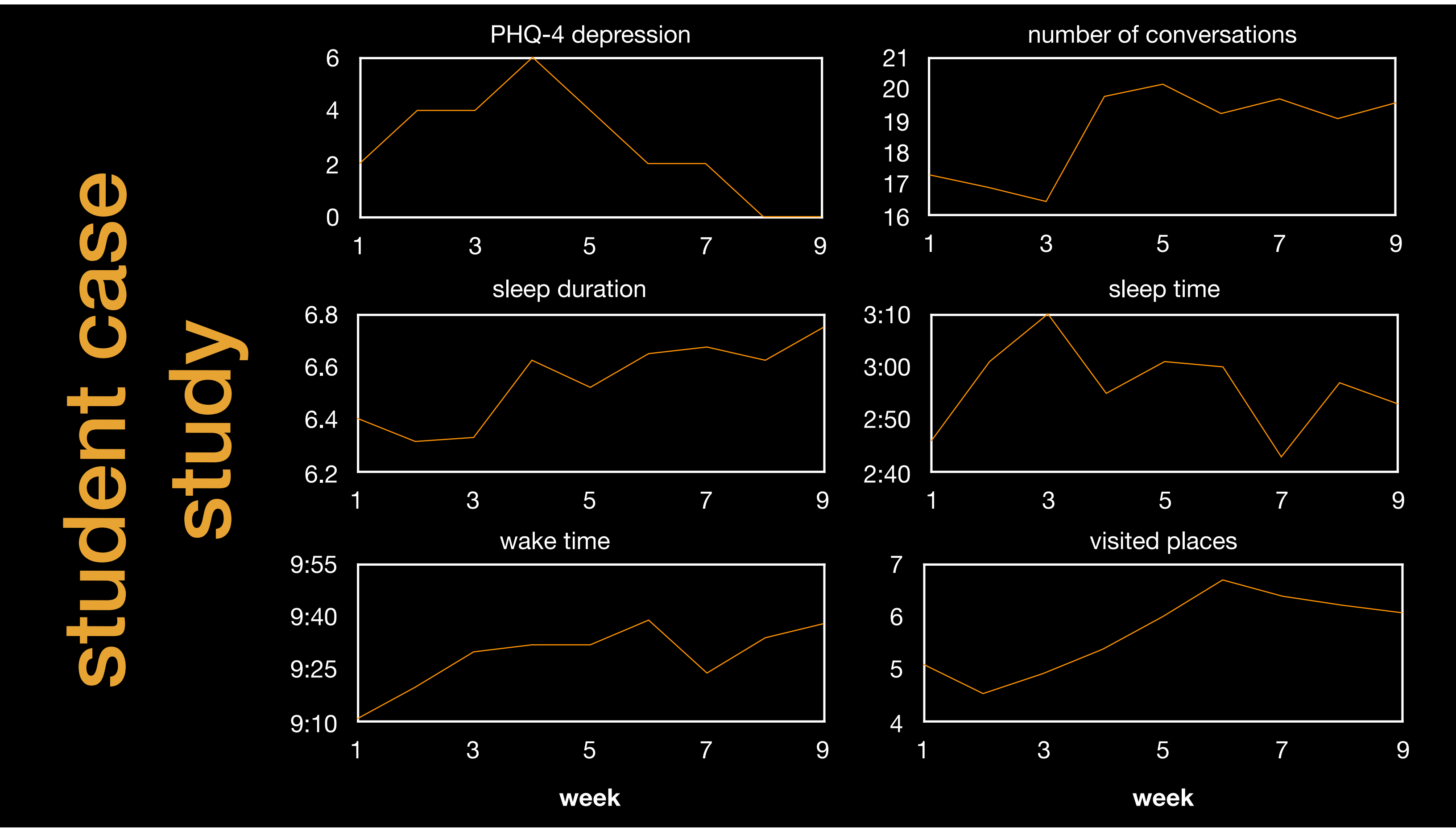
We use lasso regularized logistic regression to determine if a student is depressed or not; selected features are:

- sleep end
- unlock duration at study places
- stationary time, number of conversations
- number of places visited, time at dorm, time at study places
- median heart rate

predicting weekly PHQ-4



ROC curve of logistic regression model obtained from 10-fold cross validation for binary classification of depression


student case study
PHQ-4 depression
number of conversations
sleep duration
sleep time
wake time
visited places
week
week


WRAP
IT
UP

24/7 passive sensing is here!


we have a mountain to climb


•validity of sensors and
diagnostic predictive models
•flaky signals, real-world noise
•interventions
•over burdened clinicians
•privacy, privacy, privacy

new forms of intervention


personalized mental health sensing and intervention models are essential

People may experience:

Mood: mood swings, sadness, elevated mood, anger, anxiety, apathy, apprehension, euphoria, general discontent, guilt, hopelessness, loss of interest, or loss of interest or pleasure in activities

Behavioral: irritability, risk taking behaviors, disorganized behavior, aggression, agitation, crying, excess desire for sex, hyperactivity, impulsivity, restlessness, or self-harm

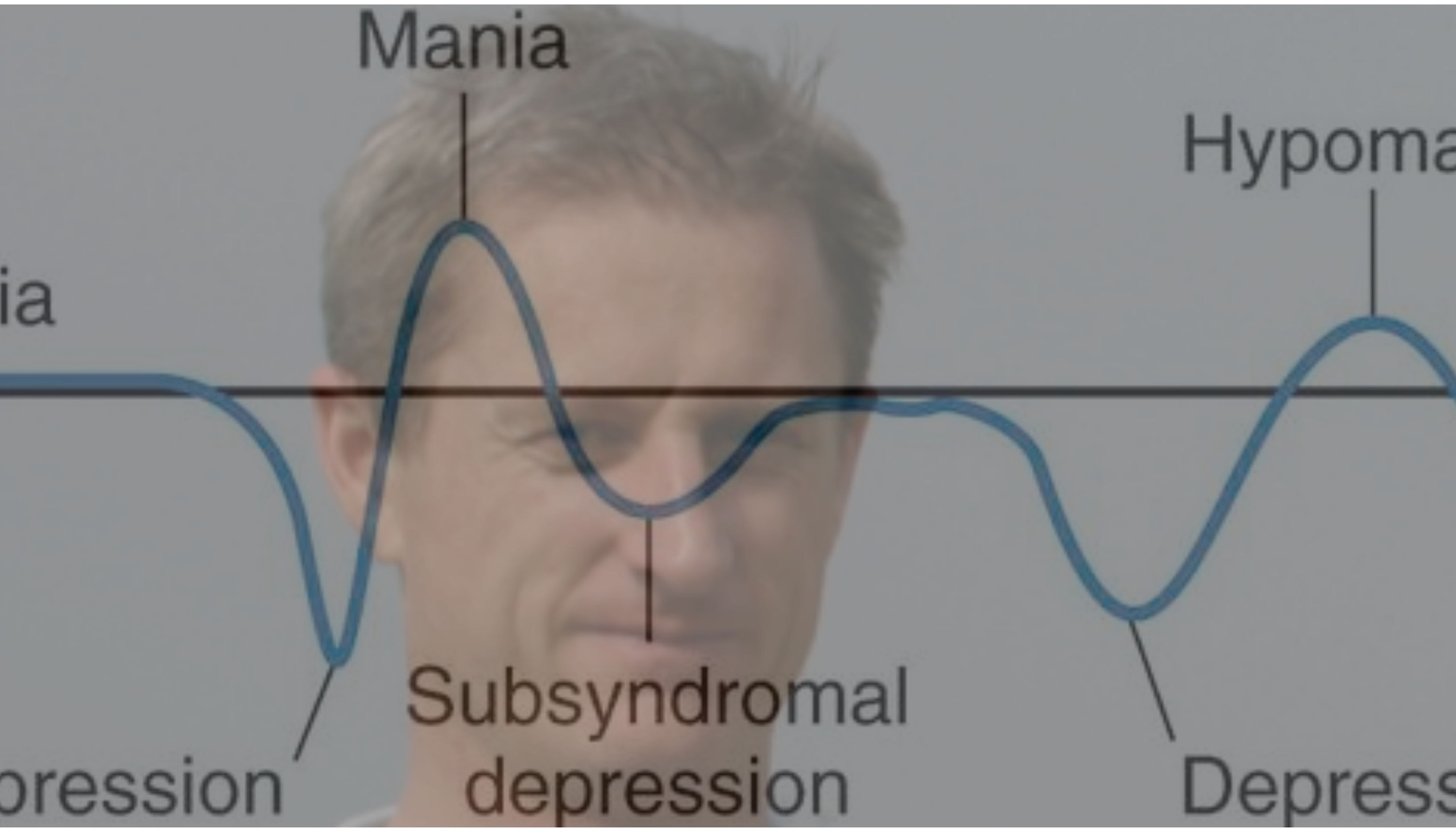
Cognitive: unwanted thoughts, delusion, lack of concentration, racing thoughts, slowness in activity, or false belief of superiority

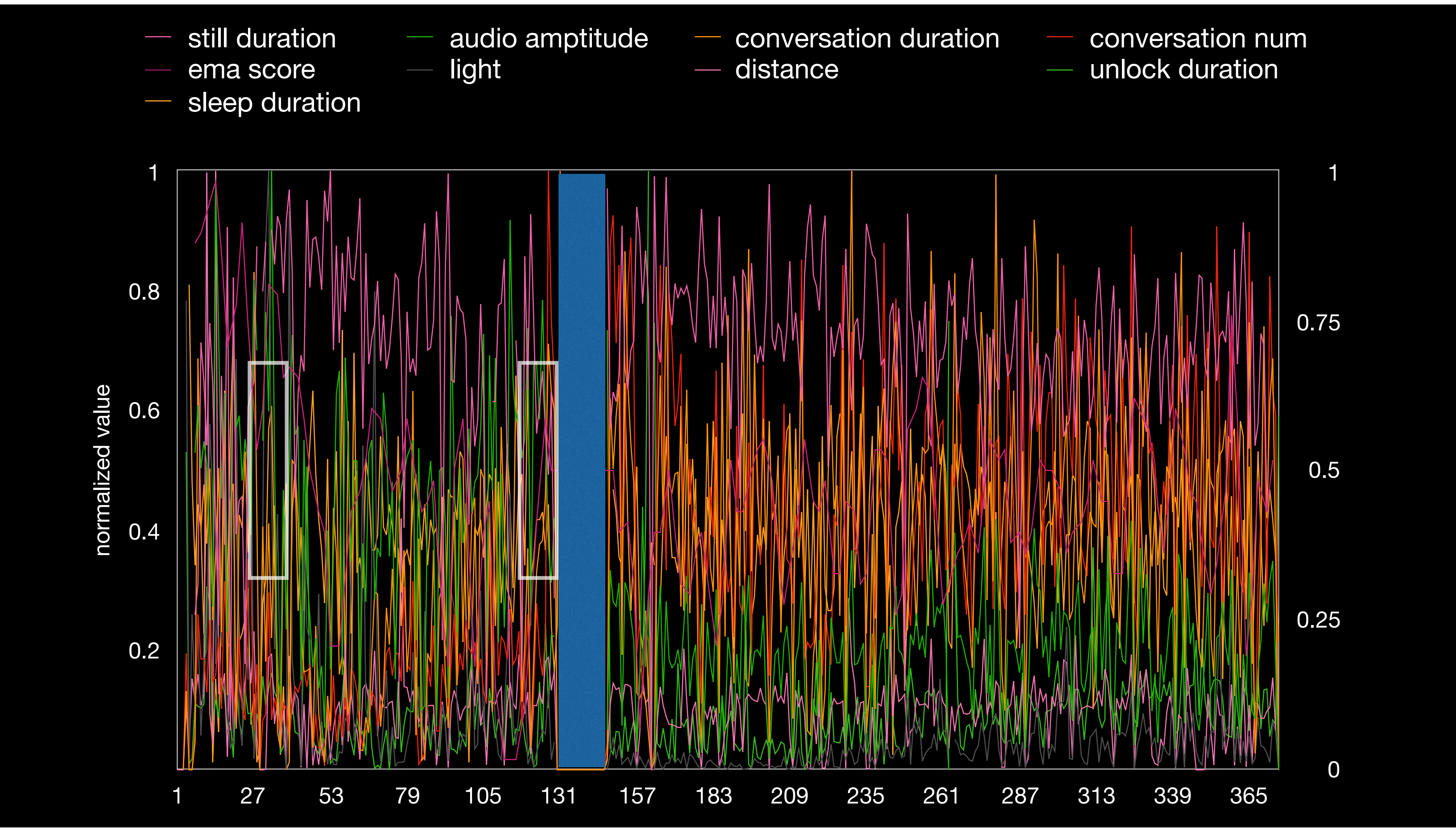
Psychological: depression, manic episode, agitated depression, or paranoia

Sleep: difficulty falling asleep or excess sleepiness

Weight: weight gain or weight loss

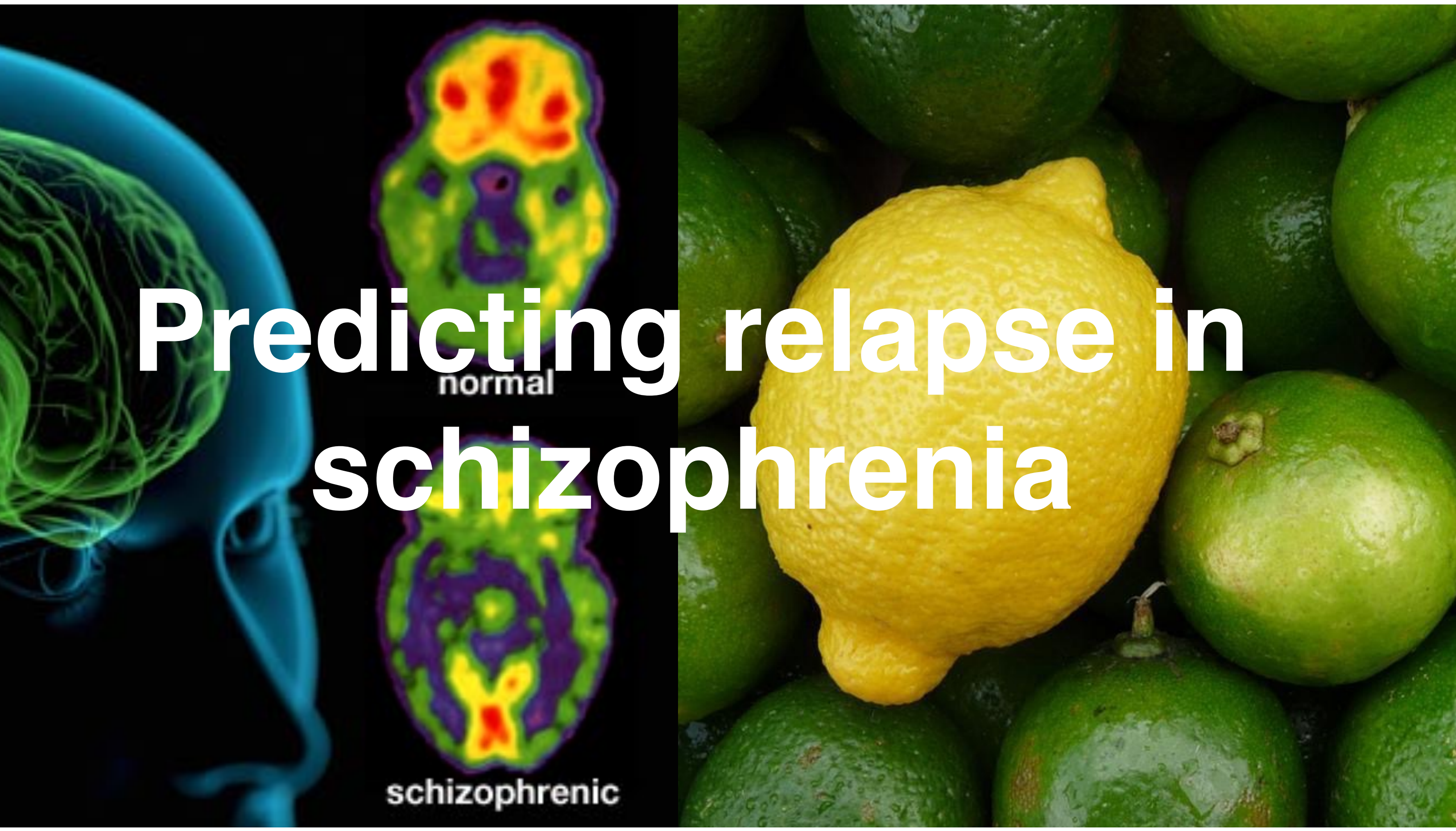
Also common: fatigue or rapid and frenzied speaking


Mania
Hypoma
ia
pression
Subsyndromal
depression
Depress

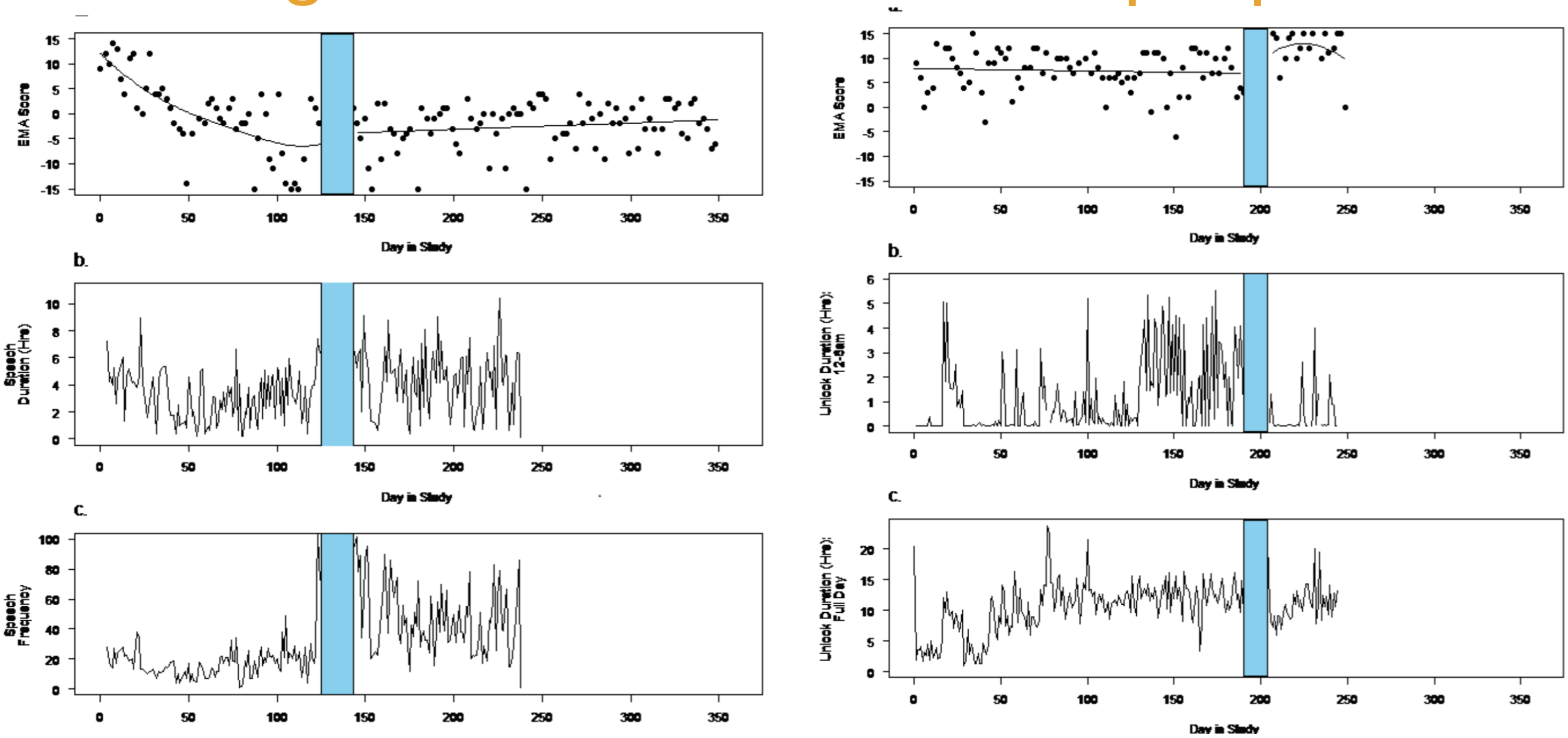


still duration
audio amptitude
conversation duration
conversation num
ema score
light
distance
unlock duration
sleep duration
normalized value
1
0.8
0.6
0.4
0.2
1
0.75
0.5
0.25
0
1
27
53
79
105
131
157
183
209
235
261
287
313
339
365

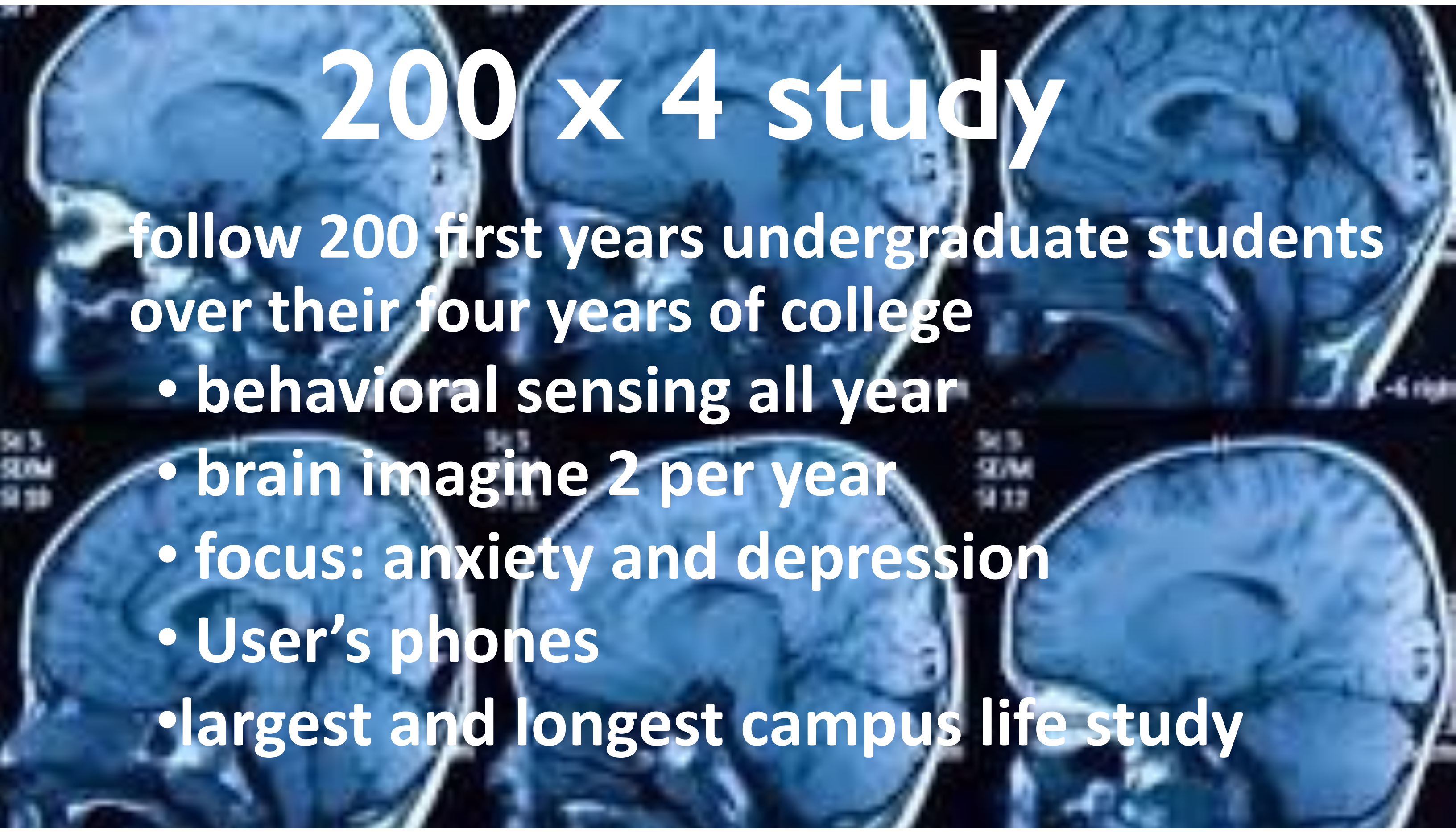
Predicting relapse in schizophrenia

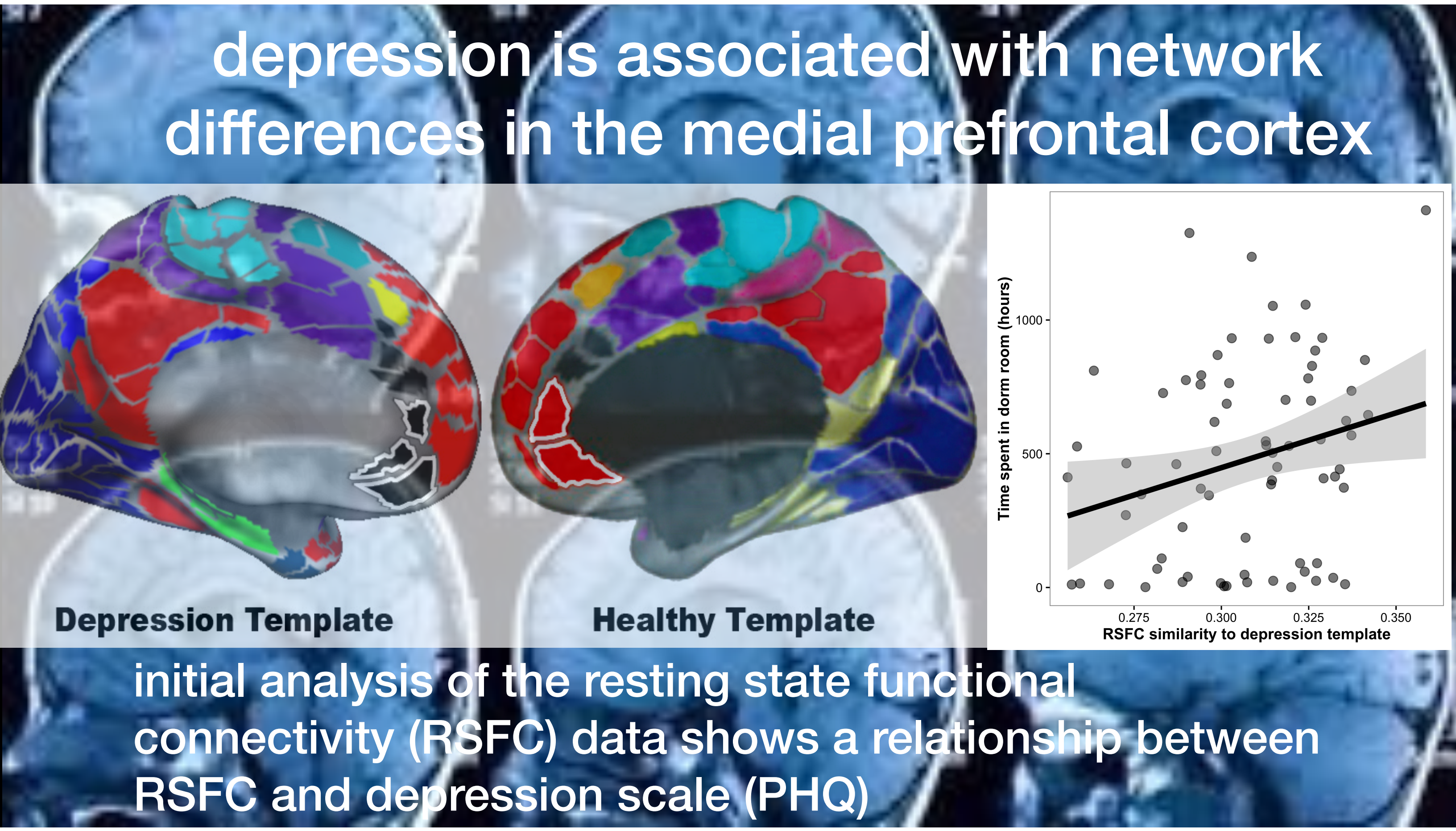


sensing time series from two relapse patients

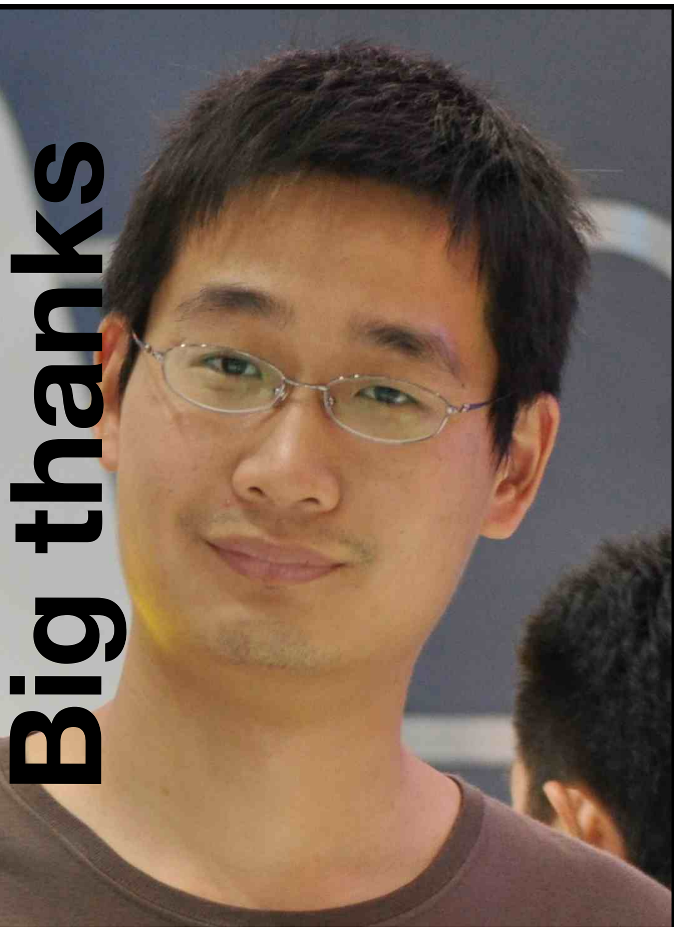



StudentLife Study 3.0
2017-


200 x 4 study
follow 200 first years undergraduate students over their four years of college
• behavioral sensing all year
• brain imagine 2 per year
• focus: anxiety and depression
• User's phones
•largest and longest campus life study


depression is associated with network differences in the medial prefrontal cortex
Depression Template
Healthy Template
Time spent in dorm room (hours)
1000
500
0
0.275
0.300
0.325
0.350
RSFC similarity to depression template
initial analysis of the resting state functional connectivity (RSFC) data shows a relationship between RSFC and depression scale (PHQ)

Big thanks



Dror Ben-Zeev and Rachel Brian (UW), Tanzeem Choudhury and Hane Aung (Cornell), Ethan Berke (was DHMC), Randy Colvin and Stefanie Tignor (Northeastern), Sam Gosling (UT Austin), Gabriella Harari (Stanford), Catherine Norris (Swarthmore), **Rui Wang**, Kizito Masaba, Shayan Mirjafari, Weichen Wang, and Xia Zhou, Emily Scherer (Dartmouth)

Related Work

Depression
David Mohr
Schizophrenia
Rosalind Picard
Dror Ben-Zeev
John Kane
HealthRhythms
Daniel Eisenberg
Jakob Bardram
Saeed Abdullah
Thomas Insel
Bipolar
MONARCA
Smartphone
Anind Dey
Gregory Abowd
Sohrab Saeb
BRIGHTEN
Social media
Verily
Tanzeem Choudhury
Jason Hong
Wearables
Patricia Arean
Big Black Dog
Paul Lukowicz
iarpa mosaic
Munmun De Choudhury
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UBICOMP
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DEPRESSION ON COLLEGE CAMPUSES CONFERENCE MARCH 13–14, 2018
mindstrong
Sandy Pentland
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CampusLife
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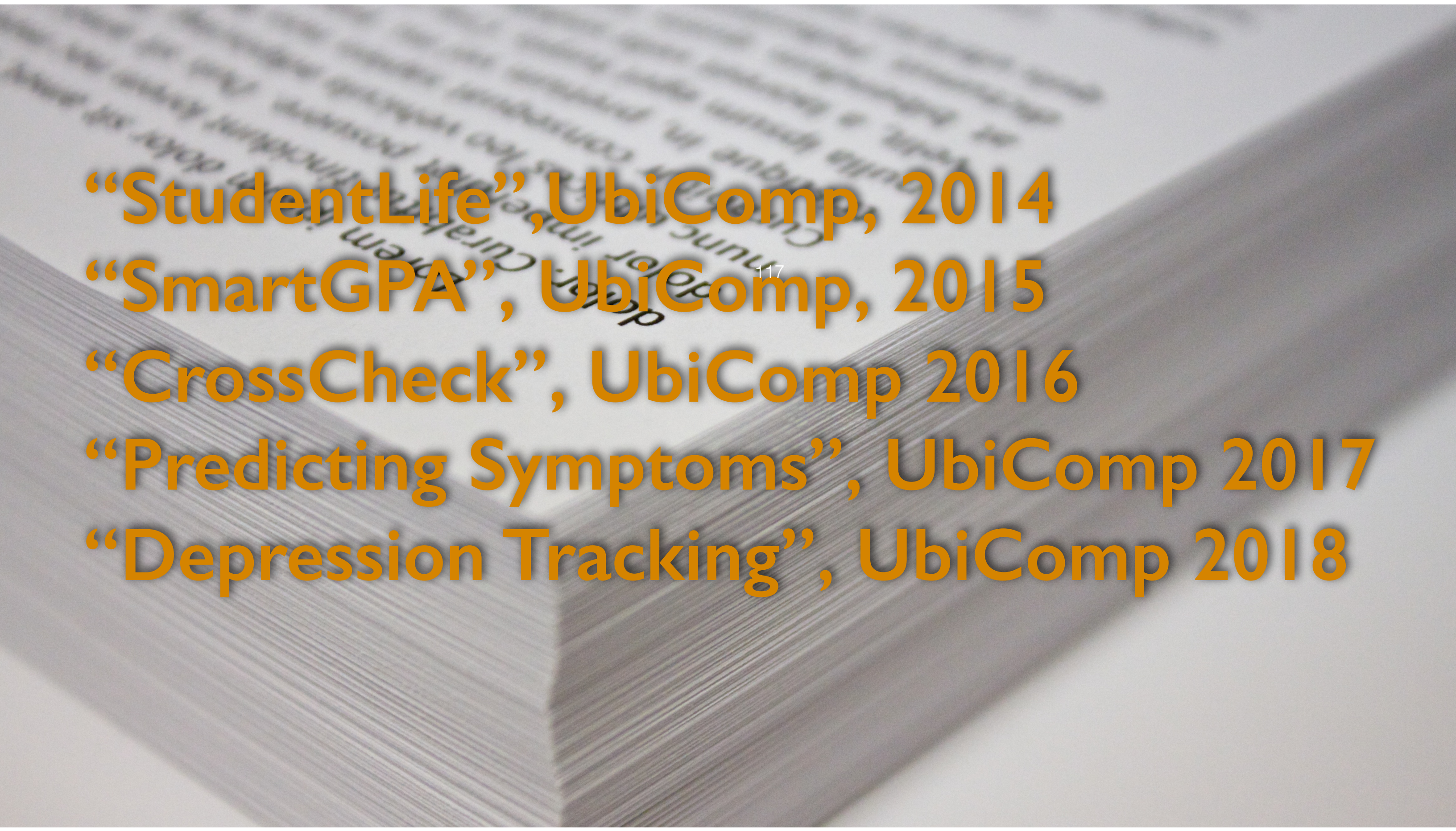
THANKS

NSF

Google


"StudentLife", UbiComp, 2014
"SmartGPA", UbiComp, 2015
"CrossCheck", UbiComp 2016
"Predicting Symptoms", UbiComp 2017
"Depression Tracking", UbiComp 2018


FUTURE
mobile mental health sensing


2018


• No major leaps forward yet
• Lots of small scale studies (N=100, T=20 weeks) with differing features/models and results
• No generalizable results , no repeated studies, and no randomized control trials (RCTs)
• Things are inconclusive but progress is being made and there is commercial activity — always a good sign
• Significant challenges remain


2023

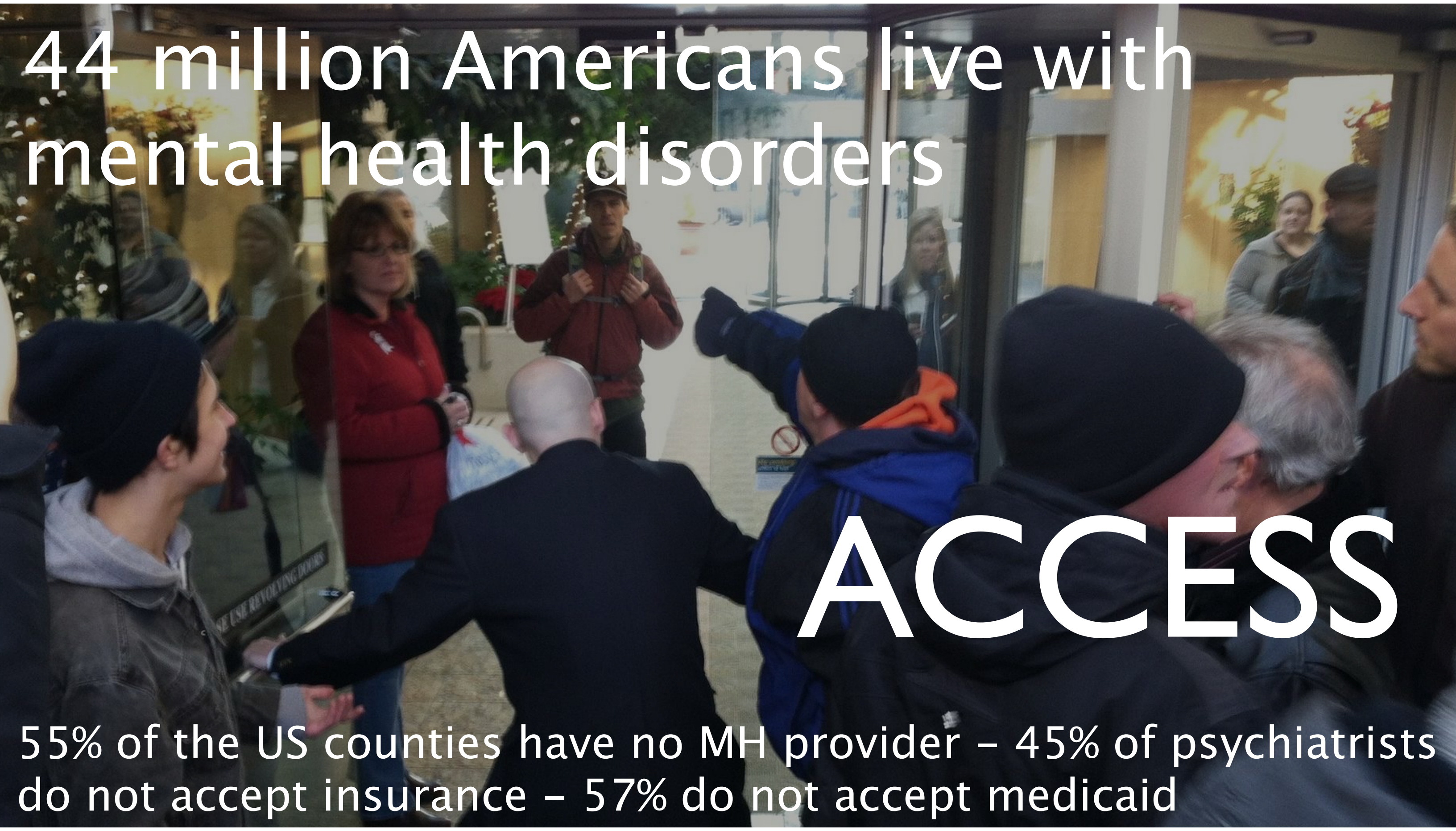
- Widely accepted feature set/models will emerge
- Breakthrough in personalized depression models and interventions proven out
- Advances in deep learning and wearables for mobile mental health — the phone will be a step toward that
- Multiple large scale RCT studies will confirm clinical validity of depression sensing across the general population
- Clinician acceptance of mobile PHQ9 prediction. Biz models emerge for payers/providers


2028

- Depression sensing driven intervention (e.g., next gen Cognitive behavioral therapy) is common
- Personalized depression and intervention models embedded not only mobile — maybe everything you touch (from social media, future wearables, your car)
- Mental health assistant — mental health sensing based AI
  - reactive model start the move:
    - “Hey Siri how am I doing today?”
  - proactive model will dominate:
    - “Andrew, go for a long run today — your open between 1-2 pm”
    - “I’ve booked an appointment for you to see Mark Tuesday”
    - “You didn’t take your meds yesterday — call Mark”

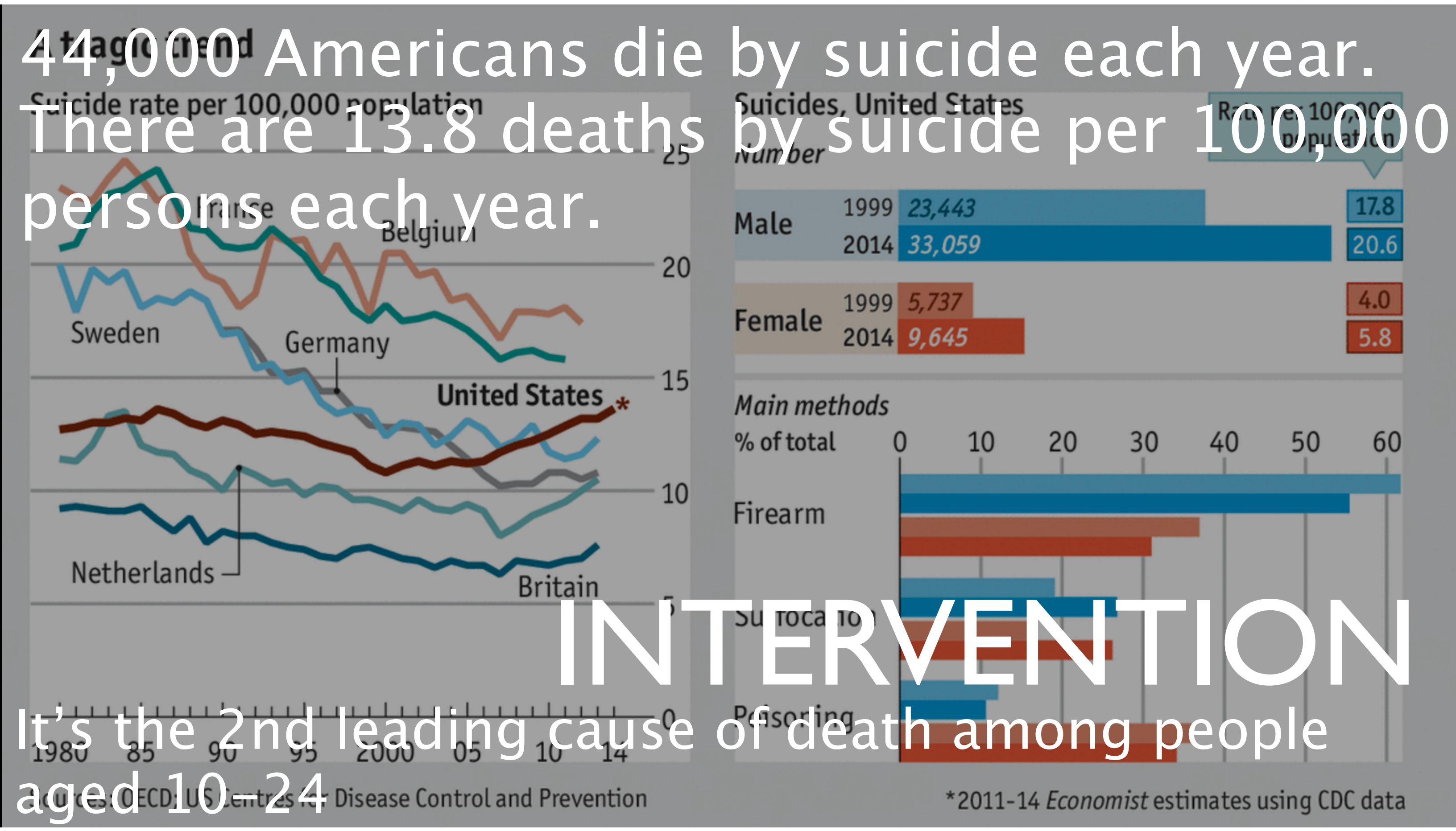

TODAY
Yesterday
Tomorrow


silent tsunami


44 million Americans live with
mental health disorders
ACCESS
55% of the US counties have no MH provider - 45% of psychiatrists
do not accept insurance - 57% do not accept medicaid

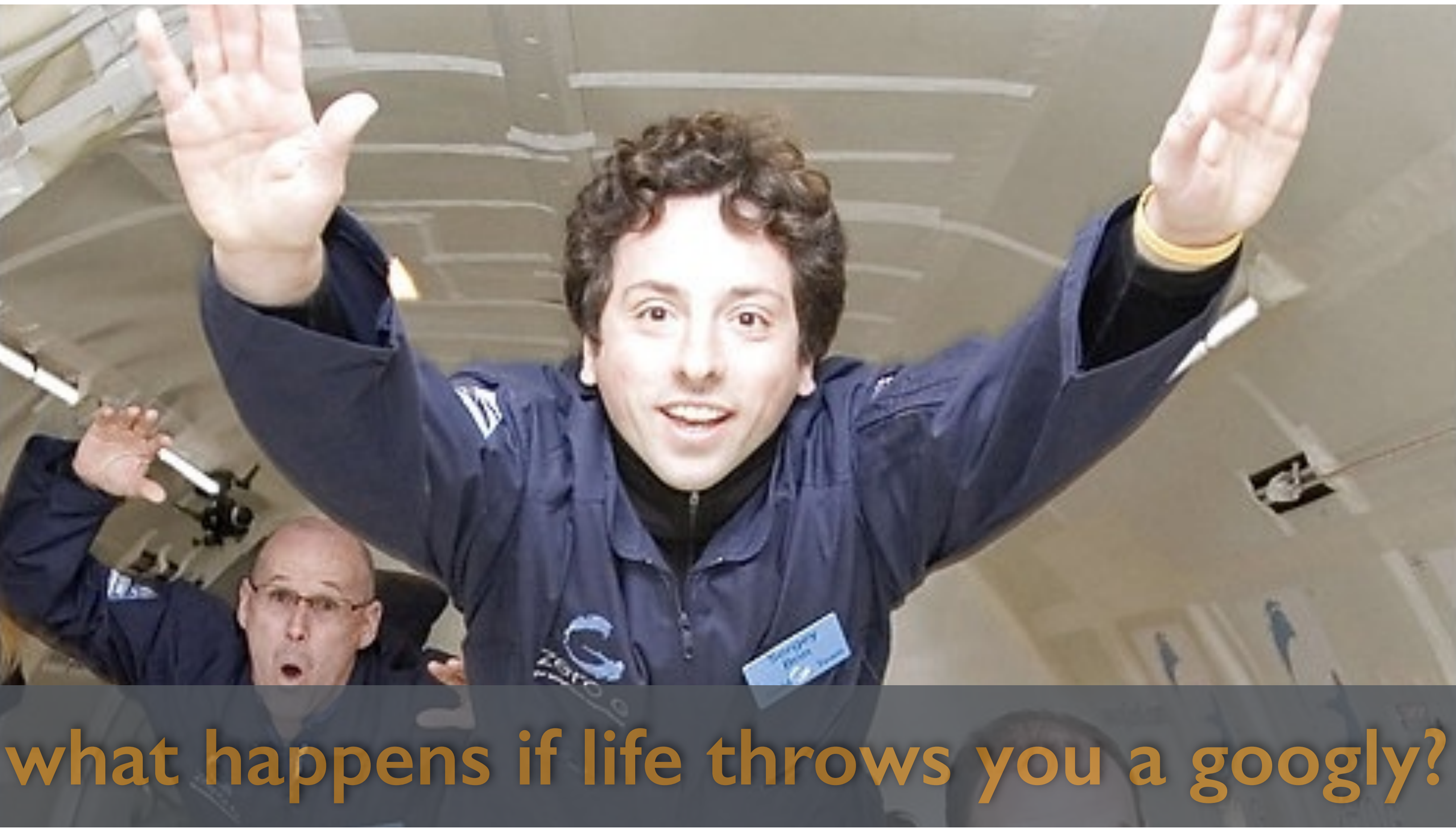

There are 10X more people with serious mental health (SMI) in prisons than in hospitals
JUSTICE
25% of homeless people have SMI.

44,000 Americans die by suicide each year.
There are 13.8 deaths by suicide per 100,000 persons each year.



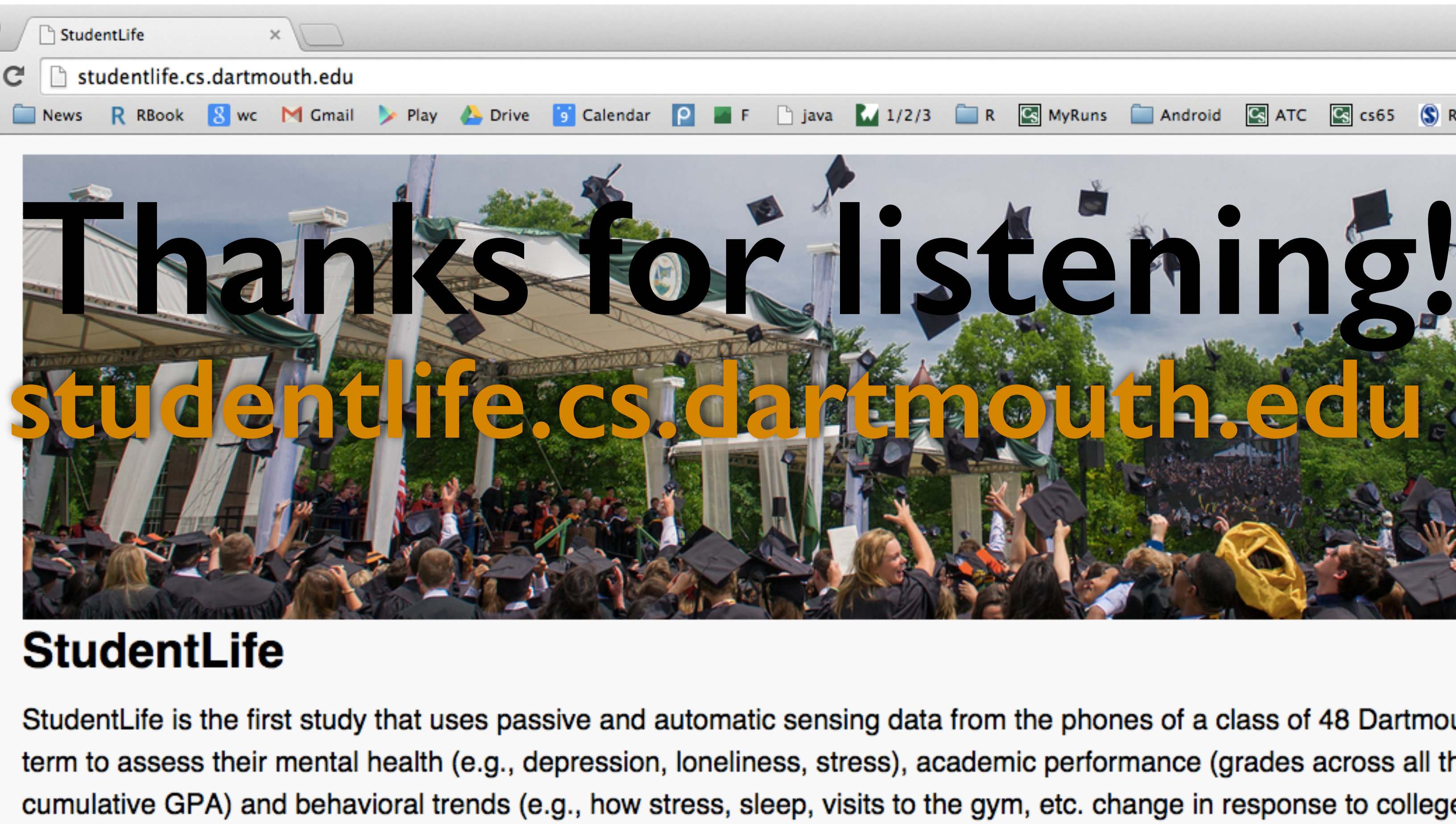
INTERVENTION

It’s the 2nd leading cause of death among people aged 10–24


what happens if life throws you a googly?


Mobile will detect it.


And deflect it.


StudentLife
studentlife.cs.dartmouth.edu
News
RBook
wc
Gmail
Play
Drive
Calendar
F
java
1/2/3
R
MyRuns
Android
ATC
cs65
Thanks for listening!
studentlife.cs.dartmouth.edu
StudentLife
StudentLife is the first study that uses passive and automatic sensing data from the phones of a class of 48 Dartmou
term to assess their mental health (e.g., depression, loneliness, stress), academic performance (grades across all th
cumulative GPA) and behavioral trends (e.g., how stress, sleep, visits to the gym, etc. change in response to college