A year in the life of a college freshman: Using deep digital phenotyping to characterize fluctuations in affect, sleep, academics and social behavior

Constanza M. Vidal Bustamante[1], Garth Coombs[1], Habib Rachimi-Eichi[1], J.P. Onnela[2], Justin T. Baker[3], Randy L. Buckner[1]

[1] Department of Psychology and Center for Brain Science, Harvard University; [2] Harvard T.H. Chan School of Public Health; [3] Psychotic Disorders Division, McLean Hospital

cvidal@g.harvard.edu

BACKGROUND

- Late adolescence is characterized by greater exposure to stressful life experiences, substantial changes in sleep, academic, and social behavior, and elevated risk for psychopathology[1]. The transition to college life can be particularly stressful due to increased academic and social demands and oftentimes disrupted sleep patterns.

- Stressful experiences have been consistently associated with poor mental health outcomes[2,3], but little is known about how affect and behavior fluctuate over extended periods of time, especially in relation to real-life stressors.

- Our lab has developed a deep-phenotyping approach to the study of affect and behavior, leveraging the use of wearables and smartphones to study college freshmen for a full year as they transition to college life.

Research Aims

1. Describe fluctuations in affect, sleep, academic and social activity over the year of the average college freshman

2. Examine daily metrics' associations to global clinical symptoms and whether they characterize different student profiles

3. Leverage COVID pandemic to assess how same students respond to a new stressful life transition, 2 years later

METHODS

- **Year-long freshman study:** 49 Harvard College first-year students recruited at beginning of Fall semester for a year-long deep digital phenotyping study[4]. Data were collected over full academic year (256 days).

- **Demographics:** 50% female; 63% White, 14% Black, 10% Asian. At baseline, 12% reported psychiatric diagnosis in their lifetime (8% active); by end of study, 16% reported dx in their lifetime (12% active).

- *COVID follow-up study (2 years later):* Week after being sent home due to pandemic, students invited to participate in 3-month follow-up study (daily and biweekly surveys; no actigraphy). 43 of original 49 students enrolled. 14% reported new dx since freshman study. 32% of follow-up sample reported dx in their lifetime.

GENEActiv actigraphy wristband worn continuously over the year

In-house DeepPhenotypingSleep[5] pipeline used to estimate sleep events, in turn processed into daily metrics:
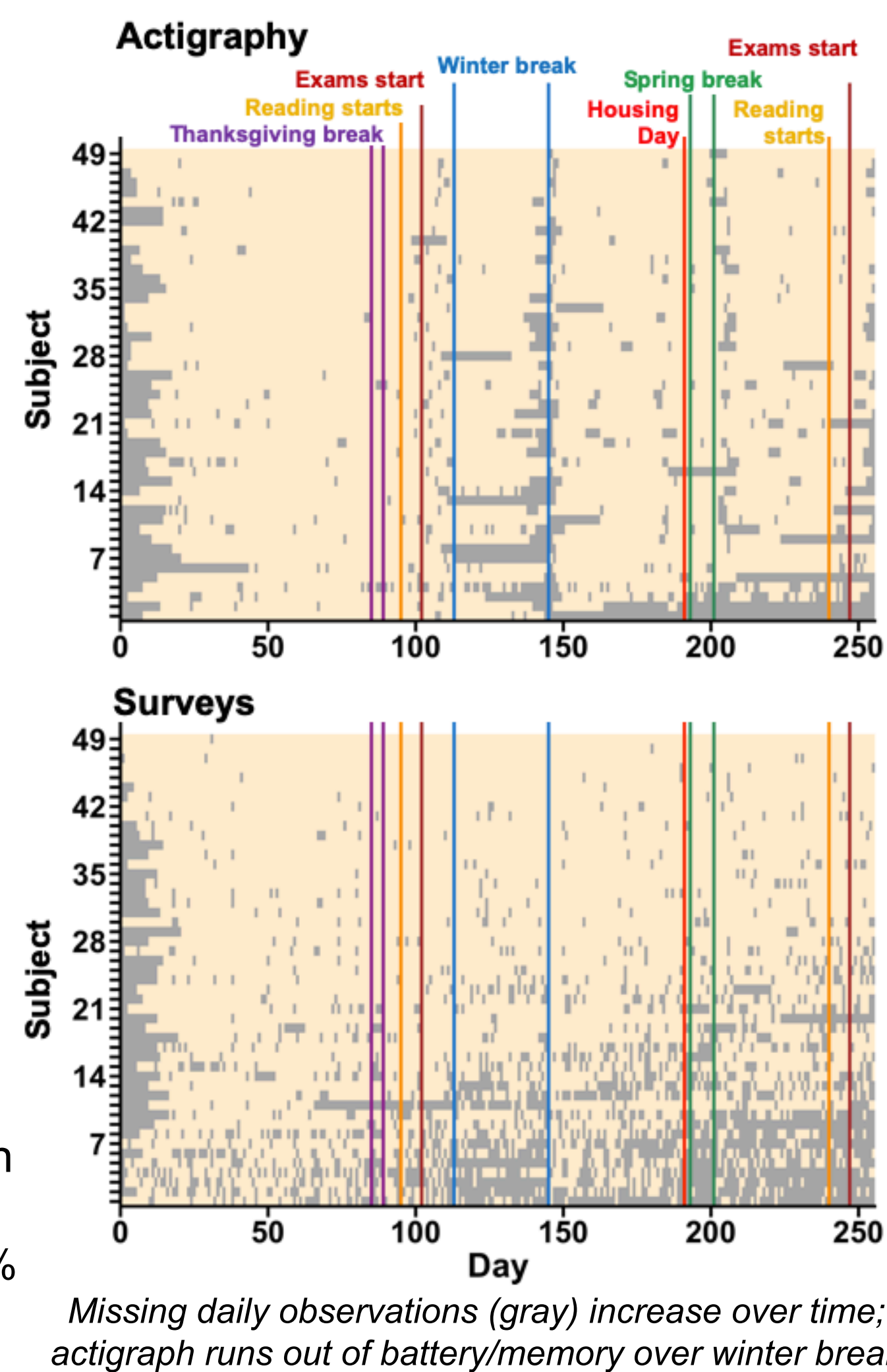
- Night sleep event duration
- Sleep timing regularity index: Assesses deviations from each individual's average sleep schedule (higher score = more regular)

Daily survey before sleep via Beiwe[6] smartphone app

1-5 Likert scale; items probed sleep quality, energy and physical activity levels, time spent on homework and socializing, stress levels and sources, and positive and negative affect.

Symptoms Checklist 90-R collected 3x freshman year: Subject-average Global Symptom Severity Index used in analysis (median-split approach to assign "Low" and "High" clinical groups; each 50% female, no differences in missing data)


Missing daily observations (gray) increase over time; actigraph runs out of battery/memory over winter break

RESULTS

1 **A year in the life of a college freshman:** Sample-averaged patterns by school vs break periods, day of week, and special events in academic and social student calendars
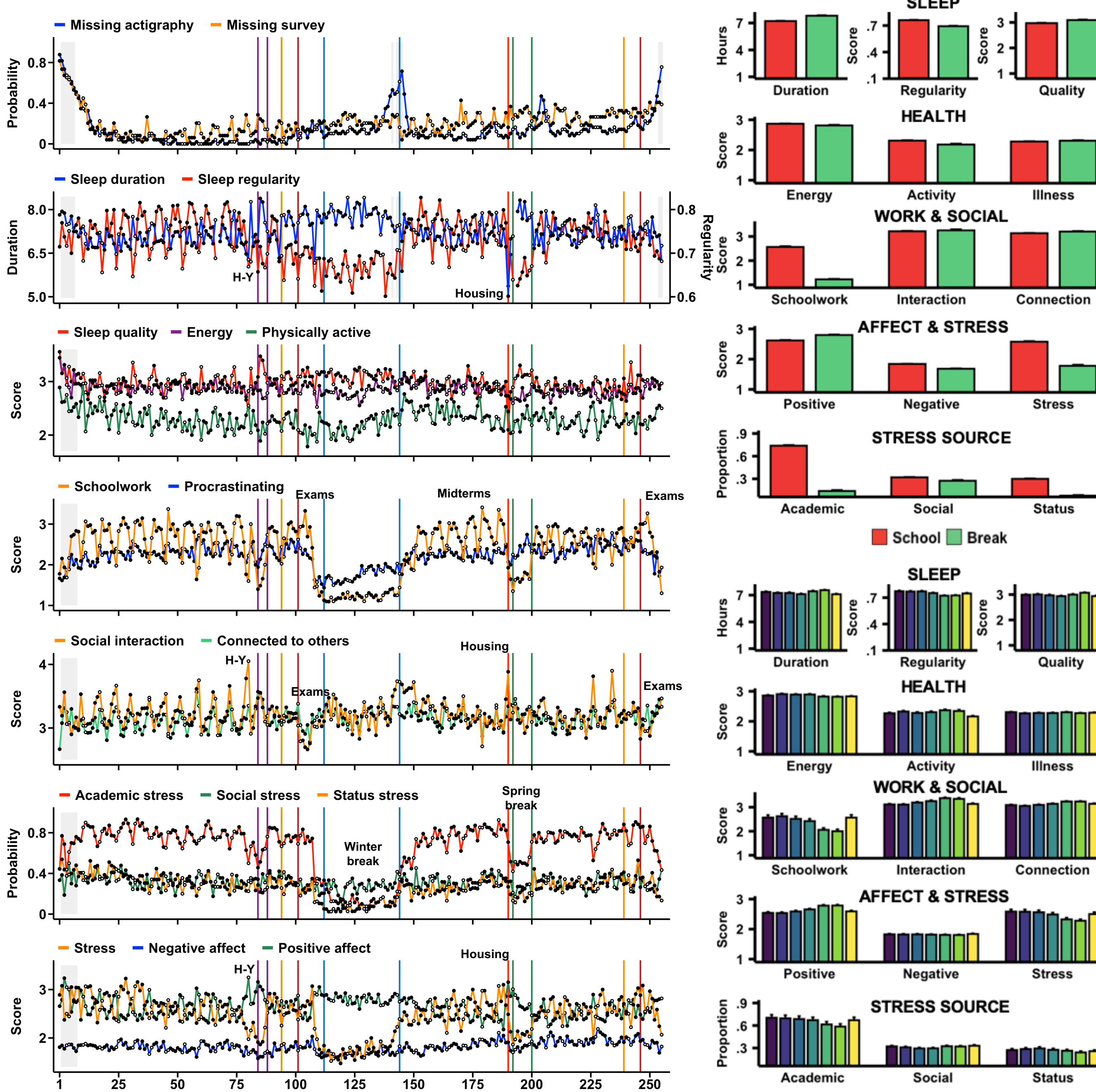

- Homework and grades much more frequent stressors than social relationships or status

- Breaks: Overall more relaxed, doing better compared to during the school semester (but only slight differences in socializing and social stress)

- Fri-Sat: More sleep, more social, less stressed than during week; catching up on Sundays

- Midterm and final exams periods: Increases in stress, schoolwork, decreases in social interaction. Harvard-Yale football game (H-Y) and Housing Day (shared, university-wide social events): Peaks in positive affect, interaction, and short sleep duration night before

Day-level group averages (not including Winter)

Subject-level averages (not including Winter)
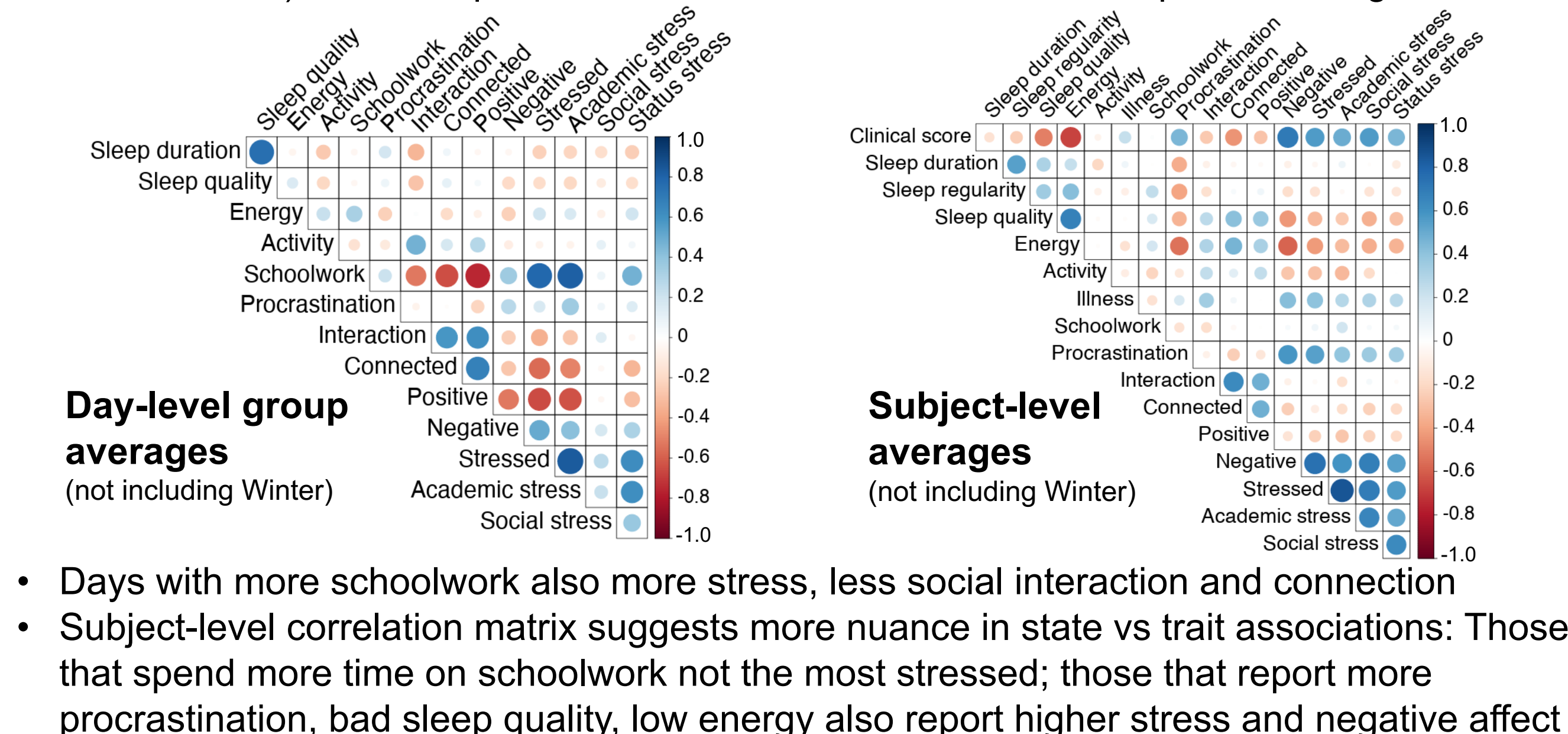
- Days with more schoolwork also more stress, less social interaction and connection

- Subject-level correlation matrix suggests more nuance in state vs trait associations: Those that spend more time on schoolwork not the most stressed; those that report more procrastination, bad sleep quality, low energy also report higher stress and negative affect

2 **Global clinical symptom score tracks daily metrics**

Exploratory: Groups by median-split over subject-averaged clinical score
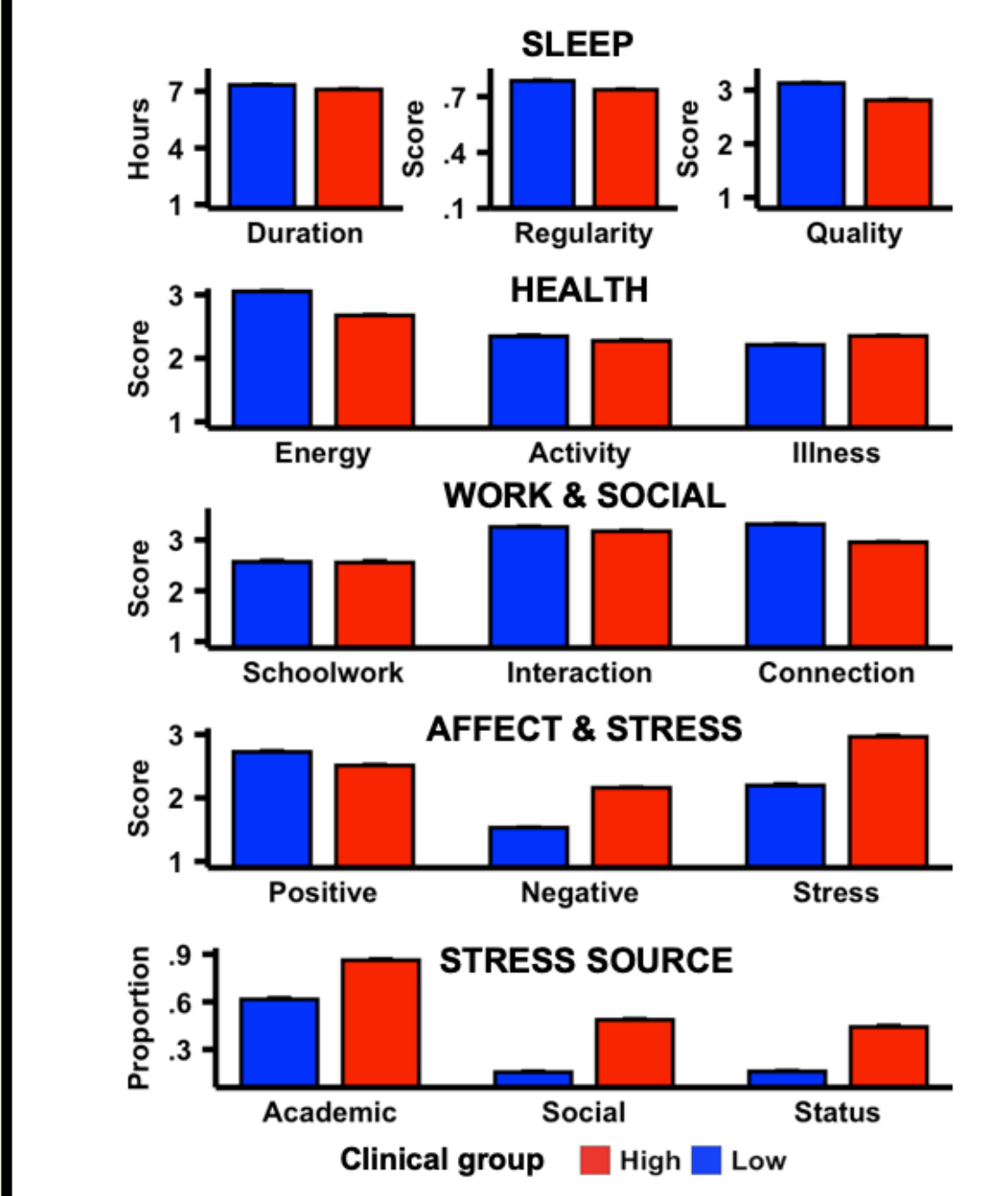
- Differences in psychological distress more closely tied to affective appraisal than behavior

3 student profiles

Best solution according to latent profile analysis with cross-validation over subject-averaged daily metrics

Profile 1 (N=12): little stress/neg. affect, high physical activity, less time on schoolwork and more socializing

Profile 2 (N=17): best sleep, little activity, high acad. stress but overall best pos. affect

Profile 3 (N=20): struggling across the board, including high procrastination and social stress

3 **New stressful life transition: COVID pandemic**

Follow-up data shown by freshman year labels; Left: biweekly surveys; Right: daily surveys
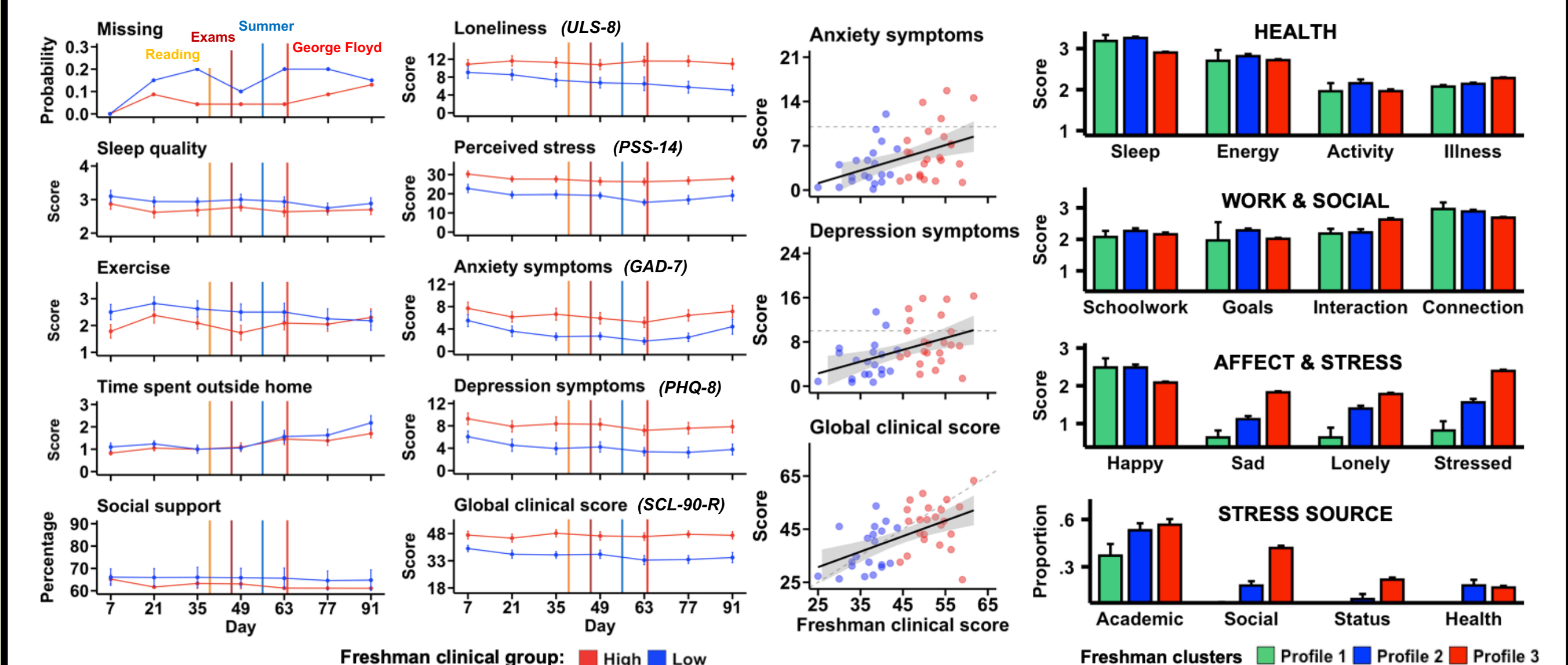
- Student profile characteristics largely maintained two years later, under pandemic

DISCUSSION

- Feasibility of deep digital phenotyping over extended time periods
- Distinct time patterns in students' affect, sleep, academics, social behavior
- Academics most frequent stressor across all students, over social / status
- Student profiles: Multidimensional assessment of behavior and affect helpful to identify who is struggling (not only high academic stress but also social stress, poor sleep, low energy, procrastination)
- Profiles are roughly maintained two years later, under COVID pandemic
- Reported diagnostic labels do not tell the full story regarding who is likely to struggle during a stressful life transition
- Limitations: Small sample, missing data, self-report, observational study

Future directions

Closer look at individual differences and directionality of associations

Develop pared down study design that can be applied to larger samples

Use methods and results to inform and assess interventions for student wellbeing

REFERENCES 1. Kieling, C., Baker-Henningham, H., Belfer, M., Conti, G., Ertem, I., Omigbodun, O., … Rahman, A. (2011). Child and adolescent mental health worldwide: evidence for action. *The Lancet, 378*, 1515–1540
2. Hammen, C. (2005). Stress and Depression. *Annual Review of Clinical Psychology, 1*(1), 293–319
3. McLaughlin, K. A., Greif Green, J., Gruber, M. J., Sampson, N. A., Zaslavsky, A. M., & Kessler, R. C. (2012). Childhood Adversities and First Onset of Psychiatric Disorders in a National Sample of US Adolescents. *Archives of General Psychiatry, 69*(11), 1151.
4. Coombs, G. (2020). Using single-subject designs to probe dynamics associated with stress and transitions to college life (*Unpublished doctoral dissertation*). Harvard University, Cambridge, Massachusetts.
5. Rachimi-Eichi, H., Coombs, G., Vidal Bustamante, C.M., Onnela, J.P., Klerman, E.B., Baker, J.T., Buckner, R.L. Longitudinal sleep analysis from accelerometer data (*in prep*).
6. Torous, J., Kiang, M. V., Lorme, J., & Onnela, J. P. (2016). New tools for new research in psychiatry: a scalable and customizable platform to empower data driven smartphone research. *JMIR Mental Health, 3*(2), e16.