Digital Assessment of Depression, Acute Stress, and Socioeconomic Disparities Using Wearable and Smartphone Devices Across the Lifespan

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Traditional assessment of affective and behavioral functioning relies almost entirely on questionnaires, self-report interviews, and laboratory-based measurements. Although each of these approaches has important strengths, they are also subject to limitations. Recently, technological advances in mobile computing have allowed for the widespread adoption of consumer mobile technologies that may ameliorate many methodological limitations of traditional assessment methods as these devices contain a multitude of sensors enabling the scalable, unobtrusive, and ecologically valid collection of biobehavioral variables. Despite many review articles delineating the promise of these devices, research has largely been limited to single symptom profiles and homogenous populations. This symposium will address these gaps by presenting novel findings that utilize multimethod approaches (e.g., actigraphy, GPS, photoplethysmography, camera and light sensors) to examine how intensively longitudinal study designs leveraging consumer smartphone and wearable technology can be used to index mental health profiles, acute stress, and socioeconomic disparities across the lifespan and in diverse populations. First, Dr. Nelson will present a preregistered assessment of multiple clinical profiles using a computational psychiatry machine learning approach with large scale wearable data collection in a large nationally representative sample of adolescents. Second, Dr. Lockwood, will present a large-scale longitudinal study using newly-validated smartphone-based optic sensor to assess socioeconomic disparities. Third, Vega will present on how 6 months of smartphone sensor data during COVID-19 predicts weekly levels of depression and anxiety. Lastly, Harvie will present on how smartphone-based measures of photoplethysmography using a consumer wearable device tracks self-reported increases in perceived stress in children and adults.

Keywords: Depression; Digital Health; mHealth; Smartphone; Stress; Wearable

A Computational Psychiatry Approach to Assessing Mental Health with Wearable Devices in a Nationally Representative Adolescent Sample

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Adolescence is characterized by alterations in biobehavioral functioning, during which individuals are at heightened risk for psychopathology. This increased risk coincides with various developmental changes in biobehavioral functioning that can be assessed via wearable devices, providing the opportunity for continuous, scalable, unobtrusive, and ecologically valid measurement of real-world behaviors. We ran an elastic net machine learning model using wearable data collection in 5,686 nationally representative adolescents from the Adolescent Brain Cognitive Development Study dataset to examine how wearable features and deviation from personalized baselines predict a constellation of psychological symptoms as assessed by the Child Behavior Checklist, including anxious/depressed, withdrawn/depressed, internalizing, externalizing, and total clinical symptoms. The elastic net machine learning models indicated that Fitbit metrics didn’t perform well at predicting mental health outcomes as they explain less than 5% of CBCL outcomes across scales. It is important to note that models that
included physical activity and heart rate had the best prediction rates. Despite the small effect sizes, research indicates that small effects that are maintained over long periods of time can have a large effect on outcomes. Our next steps are going to be seeing how well elastic net and other approaches can classify whether participants surpass clinical threshold on the CBCL measures. This information may provide more clinically actionable information in the future. Ultimately, identifying models that can accurately predict various mental health complications via passive wearable sensing may provide a temporally sensitive digital marker of mental health degradation that may inform clinical prevention and just-in-time interventions.

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A large-scale assessment of socioeconomic disparities in stress and blood pressure in daily life

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Lower socioeconomic status (SES) is a robust predictor of cardiovascular health disparities in the United States. Stress-related psychosocial and physiological factors in everyday life are thought to have a significant role in these disparities but few large-scale studies measure these factors in daily life. We explored the relationship between SES and smartphone assessments of perceived stress, perceived coping, heart rate (HR), and blood pressure (BP) in daily life using a 3-week app-based study. We analyzed data from more than 160,000 daily responses from over 20,000 people. SES was measured using education level and a modified version of the MacArthur social status ladder focused on income and wealth. Perceived stress and coping were assessed with brief survey items focused on current perceptions. HR and BP were assessed with a newly-validated smartphone-based optic sensor. Lower education predicted higher systolic BP, higher diastolic BP, higher HR, and poorer perceived coping. Education was not significantly associated with perceived stress. Lower scores on the income ladder predicted higher HR, greater perceived stress, poorer perceived coping, and greater threat/challenge ratio. The income ladder was not significantly associated with systolic or diastolic BP. Taken together, these findings support the assertion that lower SES is linked with stress-related psychosocial and physiological risk factors for cardiovascular disease in daily life. These findings highlight the potential for intervening on these factors at the daily level to reduce long-term cardiovascular risk among those of lower SES.

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Smartphone sensor predictors of mental health during the COVID-19 pandemic

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The unprecedented societal disruption and collective trauma of the COVID-19 pandemic are likely to have broad and lasting effects on our community's mental, social, and physical well-being. We leveraged mobile technology to monitor behavior and mental health between May and December 2020. We remotely recruited 373 adult smartphone owners from an online registry (mean age 44 years, range 18-82; 71% female; 83% white; 68% college degree or higher). Of these, 273 participants installed a mobile application that passively collected data about location, nearby Bluetooth devices, screen time, phone calls, messaging, activity recognition, and data from any wearable device the participant already owned for up to six months. Two hundred and thirty participants also completed at least one weekly survey (mean 14, range 1-26) that included PROMIS measures of depressive symptoms and anxiety. In this symposium, we will present results from mixed-effects models and machine learning classification models using smartphone sensor features to predict weekly levels of depression and anxiety. Performance of the latter models will be compared to majority class baseline models, and feature importance will be
evaluated to determine which digital biomarkers had the greatest impact on model predictions. Developing models that can accurately predict mental health based on passive mobile sensing has the potential to improve timely detection and management of depression and anxiety symptoms.

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Extending Acute Stress Research Online: Psychophysiological Evidence in Children and Adults

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Research on acute stress typically takes place in controlled laboratory settings, with well-established patterns of physiological reactivity based on decades of research using gold-standard laboratory measures. In part due to the sustained shutdown of in-person research during the COVID-19 pandemic, researchers have begun to establish the feasibility of internet-delivered inductions of acute stress. Of note, the validation of remote data collection methods brings the potential for more inclusive sampling methods transcending traditional geographical barriers to participating in research. The present talk will summarize several studies with children and adults, where we have adapted stress-induction methodology and cardiac data collection to take place completely over video-chat mediated interactions. Across these studies, we find consistent evidence for stress-induced cardiac acceleration as indexed by smartphone-based measures of photoplethysmography (i.e., optical measure from camera) and consumer wearable devices (e.g., Fitbit), which track self-reported increases in perceived stress. Additionally, we find that social inputs impact participants’ physiological reactivity and recovery surrounding acute stressors.

We will present evidence on remote effects of social buffering related to the presence of a caregiver (N=31), interacting with a close friend (N=203), and interacting with a household pet (N=185). This talk will also detail the importance of using placebo groups for online acute stress research, given the potential for video-chat mediated interactions to exaggerate socially anxiety. As much of this work is ongoing, in the pursuit of an international replication and extension effort, we hope that attendees of this talk will find opportunities for group collaboration.

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