

Multi-faceted Rich Data Sensing for Understanding College Student Health

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The revolution in sensor technology development has the potential to revolutionize observational methodology. In the fields of HCI, CSCW, and medical informatics, ethnography is a methodology that has been widely deployed to capture rich data about the user and their experience in a real world context. Ethnographic studies have yielded valuable insights about health behaviors and practices in a range of contexts such as home health care, hospital settings and college life. Ethnographic studies answer the "why" of health practices whereas laboratory and survey studies answer the "what". Compared with laboratory and survey studies on health, ethnographic studies can provide data on how people's health practices interact with their real world environment.

Ethnographic observation uncovers meaning. Laboratory experiments create an abstract model of the world by controlling for variables that may influence the target behavior observation. However, there are many things that cannot be simulated in a laboratory such as a person's motivations. *In situ* behavioral observation is an ideal way to gain an understanding of a person's behavior and experience. Combined with a capture of participants' internal states, it can present a fairly comprehensive picture of a person's experience.

For most college students, stress is a part of life. A national survey in 2013 found that 83% of students reported feeling overall stress during the last year [1]. Stress has been attributed to a number of factors that affect students, e.g. exams, demands on time, work and social life, and financial pressures. Stress, in turn, has been linked by many studies to detrimental health. As there are so many potential factors that can affect college student stress and health, it is critical to gain a broad and deep understanding of context and practices in student life and how this could impact health. A goal then in understanding college student health is to investigate how to provide an accurate and grounded understanding of both the extent and ways college students' behavioral practices affect their health.

Grand challenges

While current state-of-the-art sensors can provide an overview of a range of patterns based on different data types, we are not yet at the point where sensors can provide the richness of nuanced behavior, mood, physiological states, and context that can benefit the researcher in gaining deep insight into *reasons* for behavior. A grand challenge for the field of HCI is to develop a suite of sensor and other technologies that can capture rich data comparable to the data that ethnographic studies yield--that could provide nuanced understandings of how and why people experience certain moods and practice certain behaviors in various contexts.

While already platforms exist to collect a range of sensor data, measures are still quite limited. For example, while sensors can collect information about the environment (light, temperature, ambient noise, geolocation, weather, etc.) there is still much information lacking about the environment that might explain *why* a person behaves how they do in that environment. Even video data is limited especially if the video camera is restricted to a certain viewpoint. Data such as conversations, micro-behaviors, social interactions, and background pressures are examples of data that could be collected to enable the researcher to gain a nuanced understanding of the individual in their environmental context.

A related challenge is that as the use of sensors continue to expand for *in situ* investigation, so must means be developed to protect people's privacy. With video and audio collection of individuals designed to capture sensitive health behaviors in context, data of people in the proximity, not in the study, could invariably be collected. Solutions such as data filtering is one example to counter this. New forms of data filtering of data (especially visual data) is needed that can capture detailed data of the participant while preserving the privacy of others. Also, how can participants review huge streams of their own data in order to delete what they feel is private?

There are further challenges. As we enter into the widespread use of sensor tracking of behavior, a generation of new scholars will need to be educated in this new methodology. New data analysis techniques, new social science methodologies, the development of new ethical criteria for studies and new human subjects research protections will need to be developed. The use of sensors in data tracking will require interdisciplinary teams of researchers: social scientists working alongside of computer engineers, and data scientists.

Toward an ethnographic understanding of college life

To date, my team and I have collected data on 124 college students, tracked multi-modally for seven days, all waking hours, on the following measures: computer and phone usage (time-stamped usage of all apps), stress

(based on heart-rate variability from worn chest-strap heart monitors), mood (from experience sampling), personality traits and demographic measures (a comprehensive general survey), sleep patterns, end-of-day mood (from daily surveys), location (in class, in buildings on campus) and institutional data (GPA, SAT scores). Among other findings, it was discovered that there is a positive relationship of stress with computer duration and multitasking. Stress is mitigated with social media use [2,3]. However, while we have gained insight from this multi-modal approach, the results have raised a range of questions and challenges for measures that can capture more detailed observations of how context, attitude and behavior interact to affect negative health behaviors.

Specific challenges for developing precision-tracked data for studying college life

- Reliability (e.g. of GSR sensors) needs improvement.
- Multi-modal measures can collect, e.g., internal states such as stress, mood; behavior such as exercise, sleep patterns; online activity (computer and phone app usage), social interactions (e.g. strong or weak ties), and context (location, etc.). Yet a wider net must be cast to capture nuanced events, for example conversations, student reactions to events, mood changes, and interactions with others, *in situ*.
- Feedback in near real-time could lead students to learn about impactful behavior related to stress, depression, and health. Visualizations and types of data to use for feedback need to be investigated.
- Just-in-time interventions could save lives, e.g. in preventing suicides or in health emergencies. Research is needed to understand how, in what form, and who should be involved in such interventions.
- Human factors need to be considered so that comprehensive data capture will not be a burden on users.

Limitations

There remain significant limitations related to sensor use in HCI. We cannot infer causality when two events co-occur though different time lags can be used to explore relationships among events: any number of underlying covariates can explain a relationship. As with any observational study, sensor data is still not "objective" as a human chooses the data to capture, analyzes, and interprets the data. Making the data available to the public could provide multiple interpretations. Participant compliance is another limitation. Last, with big data collection, there is the concern that significant differences may not be meaningful.

Background

Gloria Mark is a Professor in the Department of Informatics at the University of California, Irvine. For the last ten years she has done studies of people's behavior *in situ*, using first ethnographic means, and since 2010, multi-faceted observation using precision-tracking with sensors. She has studied the usage and consequences of information technology use *in situ* on college students on and off campus, and information workers in the workplace. She has also collected *in situ* data on 72 information workers for two weeks in and out of the workplace on computer usage, stress, daily mood, sleep patterns, attention focus, exercise, eating, and a wide range of demographic/personality factors. She received her PhD in Psychology from Columbia University. She has worked at the German National Research Center for Information Technology (now Fraunhofer Institute) and has been a visiting researcher at Microsoft Research, The MIT Media Lab, IBM, and Boeing. In 2006 she received a Fulbright scholarship for research in Berlin. She has published in top conferences and journals in the fields of HCI, where she has won, and received honorable mention for, best paper awards. She has been the technical program chair for the premiere ACM CSCW'12, ACM CSCW'06, and ACM GROUP'05 conferences, and is on the editorial board of the top journals in the field of human-computer interaction: *ACM TOCHI* and *Human-Computer Interaction*. Her work has appeared in the popular press such as *The New York Times*, *the BBC*, *NPR*, *Time*, and *The Wall Street Journal*, and she was invited to speak at the South x Southwest (SXSW) conference.

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