

Mobile technologies in psychiatry: providing new perspectives from biology to culture

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The revolution in mobile technologies has come to psychiatry, as it has to diverse other health care domains (1). It has permitted scientists and clinicians not only to recognize the mechanisms of psychopathology for “most people” with a given disorder, but also to better understand the individual in his or her specificity. In this way, mobile technologies have permitted the field to come full circle and to ask empirical questions that have traditionally been limited to qualitative case studies.

Mobile technologies also have their limitations but, when combined with classic methods in psychiatry, they provide new and powerful opportunities for both research and treatment.

We present here a brief overview of the use of mobile technologies in psychiatry, including its history, validity and applications for understanding the role of diverse constructs from biology to culture.

HISTORY OF MOBILE TECHNOLOGIES IN PSYCHIATRY

The research methods most commonly used in psychiatry are confronted by two major barriers that impede direct tests of theories of etiology and hinder knowledge of underlying mechanisms.

The first barrier concerns the very brief time periods in which many pathological phenomena express themselves. Examples of such rapidly fluctuating phenomena include the association of stress and mood, craving and substance use, cognition and specific behaviors, and many other topics that are central to modern theories of mental disorders. These associations are limited to periods ranging from seconds to hours, but they are paradoxically studied most frequently over periods of weeks, months or years through the use of retrospective questionnaires and assessments of the “general” status of patients.

While laboratory research protocols may overcome some of these temporal barriers, a second major constraint concerns the limited ecological validity of the data collected by traditional methods. It is often impossible to confirm that behaviors or psychological states observed in hospital settings or induced by laboratory protocols reflect the phenomenon of interest as it would occur naturally.

Ambulatory monitoring provides a partial solution to both barriers by permitting the repeated assessment of behavior, emotion and other experiences at numerous times through-

out the day and in the natural contexts of daily life.

Despite its apparent novelty, ambulatory monitoring has been used in the field of mental health for over three decades. The initial work of Larson and Csikszentmihalyi (2) used the term “experience sampling method” to refer to the collection of information on the experiences of individuals within the flow of daily life. This ambulatory methodology was soon after applied to psychiatry by a prolific team of Dutch researchers (3), and increasingly used by research groups around the world.

Most studies conducted in this earlier period used paper-based methods where individuals would complete a questionnaire concerning their experiences or activities following a signal generated by a pre-programmed wristwatch or beeper. However, paper-based methods have been progressively replaced by computerized assessments that use mobile electronic devices (e.g., personal digital assistant micro-computers or smartphones). This electronic approach is particularly characteristic of ecological momentary assessment (4), an ambulatory monitoring technique for the assessment of variables in real time and in natural settings. A principal benefit of electronic mobile assessments over paper-based methods is their ability to verify the timing of data collection, and thereby provide prerequisite information for conclusions of causality or for understanding the direction of association among correlated variables.

MOBILE TECHNOLOGY RESEARCH PROTOCOLS AND THEIR VALIDITY

Mobile technologies permit flexibility in their applications and much variation has been seen in the design of studies. As a common rule, the repeated measures approach requires that each electronic interview should be limited to a few minutes in order to reduce patient burden. However, even very brief electronic interviews typically permit the assessment of dozens of variables, and the use of gated questions provides highly efficient interviews as new questions are asked only when pertinent and as a function of the initial responses of participants.

The actual number of observations per day depends on the nature of variables being examined, their expected duration, and the scientific questions at hand. For example, time-budget surveys that attempt to assess the natural frequency of discrete behaviors may use 10 or more assessments per day,

whereas the study of more stable variables may require only two or three assessments. The interviews administered to patients may occur at fixed or random time intervals depending on study objectives, and may be “signal-based” (where the researcher determines the moment of data collection) and/or “event-based” (where the participant decides the moment to respond according to the occurrence of a particular event or experience).

Concerning the number of days of mobile assessment, the most commonly used time span is one week, which allows researchers to assess variables over the usual pattern of work and leisure days. Again, considerable variation has been observed in the length of studies, ranging from one day to several weeks depending on the goals of the particular study.

The validity of mobile technology protocols has been examined in diverse psychiatric populations. Table 1 presents a summary of highly similar research studies (5,6) that have included non-clinical controls, as well as patients with anxiety disorders, mood disorders, schizophrenia, and substance dependence. Excellent compliance rates have been observed across these populations with a negligible loss of materials.

Despite concerns that the repeated assessment methodology may become cumbersome for patients and that they may increasingly miss electronic interviews over the course of the study, no such fatigue effects have been observed. By contrast, patients demonstrate that they become increasingly familiar with the assessment device and require less time to complete the electronic interviews over the course of the study.

ILLUSTRATIONS OF MOBILE TECHNOLOGY RESEARCH

Mobile technologies have been extensively used to investigate the role of psychological variables, such as subjective reports of emotional states, behavior, perceived stress and other experiences. However, the data collected also provide new insights into the role of a large diversity of constructs that traditionally apply very different methods.

A first illustration concerns the role of biological markers found to be associated with a given disorder. For example, while specific biological and genetic markers may be more

frequent among family members of alcohol-dependent individuals, the manner in which they may increase individual vulnerability to this disorder remains unclear. In a study using mobile technologies to examine the association of emotions and alcohol use, anxiety was found to predict the use of alcohol in subsequent hours of the same day, and a decrease in anxiety symptoms was observed when alcohol was eventually consumed (7). Importantly, this “self-medication” effect varied significantly as a function of whether the individual had a family history of alcoholism. That is, individuals with a positive family history needed a greater dose of alcohol to obtain the same “anxiolytic” effects as individuals without a family history of this disorder. Such applications of mobile technologies may therefore inform us as to the potential mechanisms through which biological or heritable factors lead to increased vulnerability. In the same way, recent research has combined mobile technology data with magnetic resonance imaging findings in order to understand the full significance of brain markers for depression (8). The combination of these state-of-the-art methods allows clinical research to be linked with daily life experience in a manner that is not possible using traditional research techniques.

At the other end of the spectrum, the roles of societal or cultural factors in mental disorders are also increasingly examined using mobile technologies. Previous studies using these methods have demonstrated the specific characteristics of subgroups within a given society, such as by gender or ethnicity (9), and other research has also examined the influence of cultural variation in geographically distinct locations. For example, Grondin et al (10) tested a cognitive theory of depression in cities that varied by individualistic or collectivist cultural histories. They found important differences across sites, and as a function of specific markers of cultural investment. Such results may reflect differences in the value attributed to social or achievement-oriented events in these cultures, thereby affecting the validity of a highly influential theory when generalized to different populations. In the same way, the role of cultural influences can be examined using mobile technologies relative to a wide range of daily life activities, interactions and cognitions, in order to understand the specificity of different populations and subgroups.

Table 1 Feasibility and validity of mobile technology research in psychiatry

Variable	Controls (n=280) ^a	Anxiety disorders (n=45) ^a	Mood disorders (n=41) ^b	Substance dependence (n=85) ^a	Schizophrenia (n=47) ^a
Compliance (%)	85	75	86	80	69
Loss of materials (%)	2	0	0	0	2
Duration (min)	2.9	4.2	4.5	2.9	3.6
Fatigue effects ($\gamma \pm SE$)	0.03 \pm 0.03	0.02 \pm 0.05	0.01 \pm 0.03	0.03 \pm 0.03	-0.04 \pm 0.05
Training effects ($\gamma \pm SE$)	-0.18 \pm 0.03*	-0.28 \pm 0.05*	-0.12 \pm 0.20*	-0.13 \pm 0.03*	0.31 \pm 0.04*

^aJohnson et al (5); ^bHusky et al (6); *p < 0.01

CONCLUSION

The use of mobile technologies in psychiatry has provided new insights to understanding the etiology and expression of mental disorders. It has been shown to be feasible and valid for a wide range of psychiatric disorders and its cost renders it increasingly accessible to researchers around the world. Like all approaches, mobile technology methods also have their limitations, but their combination with traditional research paradigms allows for a more complete understanding of the patient in his or her specificity.

This methodology is also certain to provide new and more effective means of treatment in the years to come, including personalizing interventions with the capacity to encourage patients in real-time to perform exercises or to apply prescribed treatments as they should ideally be followed in their daily lives.

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