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Ecological Momentary Assessment in Behavioral Medicine: Research and Practice

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Introduction

The goal of behavioral medicine is to promote "the study of the interactions of behavior with biology and the environment, and the application of that knowledge to improve the health and well-being of individuals, families, communities and populations" (Society of Behavioral Medicine, 2010). To study such complex interactions, an equally sophisticated research approach is warranted. Exclusively studying participants' behavior, biology, and well-being in a laboratory or via participants' retrospective reports excludes a central component of behavioral medicine: the real-life context of the environment. To thoroughly study how psychosocial processes influence and are influenced by health, researchers should consider using Ecological Momentary Assessment as part of their program of research (EMA; Smyth & Stone, 2003; Stone & Shiffman, 1994; Stone, Shiffman, Atienza, & Nebeling, 2007).

EMA is a framework for assessing momentary self-reports in situ, typically implemented as *electronic diaries* on a handheld computer or smartphone (Kubiak & Krog, 2012), with the goal to obtain ecologically valid, real-life data. As such, it enables researchers to study these processes in context, optimizing the chance that interventions based on this knowledge will be effective when employed in people's daily lives. Overlooking this step can jeopardize the translation of research into practice. For example, in cancer coping literature, studies consistently find that the quality of social relationships matters greatly to adjustment and physical health, but social support interventions based on this knowledge are relatively less effective (Coyne, Stefanek, & Palmer, 2007; Helgeson & Cohen, 1996). Therefore, using a

The Handbook of Behavioral Medicine, First Edition. Edited by David I. Mostofsky.

more naturalistic approach is necessary to "determine the kind of naturally-occurring support and support intervention that should influence these mechanisms" (p. 144; Helgeson & Cohen, 1996). EMA can help bridge such gaps between research and the design of effective interventions in behavioral medicine.

The implementation of EMA usually entails a signal-contingent protocol, an event-contingent protocol, or a combination of both (see Conner & Lehman, 2012). *Signal-contingent sampling schemes* are among the most frequently used: Participants are "beeped" at several (random) times a day to complete an electronic diary record. While signal-contingent sampling is most suitable to obtain representative daily life self-reports on psychological variables, such as symptoms or well-being, it is less suitable to capture less frequent events, such as whether a participant is actively engaging in certain health behaviors. For obtaining the latter kind of data, *event-contingent sampling* is used. For this type of sampling, participants are instructed to complete diary entries themselves whenever the event of interest occurs (Moskowitz & Sadikaj, 2012). For example, participants can complete diary entries whenever they engage in binge eating (Stein & Corte, 2003) or smoke a cigarette (Moghaddam & Ferguson, 2007). Modern software platforms for EMA also allow protocols that go beyond self-report only. For instance, cognitive tests can be included (Kubiak & Krog, 2012). Online analysis of the records entered into the diary offer new possibilities for sophisticated adaptive sampling schemes where question and sampling patterns change depending on what patients entered on previous occasions (see Siewert et al., 2011, for an example).

A brief history of EMA in behavioral medicine

The concept of studying participants in their natural context is not novel, but is still underutilized (Conner, Tennen, Fleeson, & Feldman Barrett, 2009). Some of the very first studies collected participants' reports of their momentary experiences, such as symptoms and behaviors (Favill & Rennick, 1924), mood (Flügel, 1925), and laughter (Kambouropoulou, 1926) over the course of several days or weeks. These methods developed through various disciplines, and therefore under different labels, such as experience sampling, daily diary assessment, and other, domain-specific approaches. Experience sampling was originally developed to capture representative momentary experiences by random signal-contingent sampling throughout participants' days or weeks (Hektner, Schmidt, & Csikszentmihalyi, 2007). Daily diaries, on the other hand, tend to require participants to report their experiences once per day, typically at the end of each day over the study period (Bolger, Davis, & Rafaeli, 2003; Conner et al., 2009).

In a similar vein, the Rochester Interaction Record (RIR) was developed as a domain-specific assessment tool to answer basic questions surrounding the small, mundane social interactions that comprise most of daily life (Reis & Wheeler, 1991; Wheeler & Nezlek, 1977). The RIR originally required participants to complete information about the quality of every social interaction that day lasting 10 minutes or longer (Reis, Nezlek, & Wheeler, 1980; Wheeler & Nezlek, 1977). This was first done as a daily diary method, in which participants responded at the end of each day, but now is more commonly used in real time, as an event-based sampling method where participants complete the measures as soon as possible after an event of interest (e.g., ostracism; Nezlek, Wesselmann, Wheeler, & Williams, 2012).

EMA and Other Methods of Ambulatory Assessment in Behavioral Medicine

Momentary reports are not the only type of methods that can be employed to understand how human experience, states, and behavior unfold and interact in their natural context. The overarching notion of *Ambulatory Assessment* developed from a psychophysiological and behavioral perspective, encompassing not only momentary self-reports but also methods that monitor cardiovascular activity during strenuous work, environmental triggers of psychological symptoms, or behavioral disorders manifested in daily life that do not require participants' reports (Fahrenberg, 1996). Combining EMA with other methods of Ambulatory Assessment, such as physiology and/or behavior, raises interesting and important possibilities for the study of behavioral medicine (Kubiak & Stone, 2012). Analyzing such rich data sets that combine different levels of interest (experience, physiology, behavior, context) offer the opportunity to disentangle (causal) relationships across levels. This is of particular importance when studying disorders relevant to behavioral medicine, as they usually manifest themselves on different levels. With the capabilities of today's technology for real-time analysis of physiological signals and EMA data, adaptive EMA schemes (also labeled *adaptive monitoring*, cf. Siewert, Kubiak, Jonas, & Weber, 2011, or interactive monitoring, cf. Ebner-Priemer, Koudela, Mutz, & Kanning, 2012) have become feasible where, for example, the physiological signal triggers EMA beeps, making it easy to capture episodes of interest. Table 20.1 summarizes key features of EMA and other methods of Ambulatory Assessment that can be combined with momentary self-reports to answer specific research questions.

Physiological monitoring. The first attempts at ambulatory physiological monitoring yielded electrocardiogram (ECG) devices that were substantially large in size and weight (Fuller & Gordon, 1948; Holter & Gengerelli, 1949). Since this essentially prohibited the study of physiology in *normal* daily life, they were soon replaced by more practical, lightweight methods (Holter, 1961; Wilhelm, Perrez, & Pawlik, 2012). Though some were obtrusive, these first studies laid the foundation for researchers to understand behavioral medicine in context. For example, endocrinological studies in daily life typically use salivettes, which are a fairly easy-to-use

Table 20.1 Ecological momentary assessment and other approaches of ambulatory assessment.

	Domain			
	Subjective experience	*Physiological processes*	*Social behavior*	*Physical activity*
Examples of target variables	Momentary affect, satisfaction with social interactions; pain	Heart rate, tidal respiratory volume, salivary cortisol levels	Number and quality of social interactions	Exercise frequency and intensity, sleep quality
Methodological approach	EMA	Ambulatory monitoring	Naturalistic observation	Activity monitoring
Examples of technical solutions	(Electronic) diary, Rochester Interaction Record	Multimodal physiological monitoring systems portable ECG; salivettes	The EAR; Passive Telemetric Monitoring	Pedometer; Actiwatch
Burden for participant	Intrusiveness, interruption of daily life	Interruption of daily life, burden of the size of device	Intrusion of privacy	Minimal, depending on the size of device
Burden for researcher	Instructing and training participants	Instructing and training participants; financial cost	Coding and transcribing sound data (EAR)	Financial cost
Reference	Stone et al. (2007)	Ebner-Priemer & Kubiak (2007)	Mehl et al. (2012); Goodwin et al. (2008)	Ebner-Priemer & Bussmann (2012)

method for participants to provide saliva samples throughout their day, in order to assess hormones such as cortisol (Schlotz, 2012). Combined with EMA, these methods yield data about how physiology changes within and in response to people's natural environments, providing critical information about real health risk factors in daily life. Furthermore, physiological signals, such as an increase in heart rate or an increase in physical activity, may also serve as a trigger to prompt patients completing a momentary self-report (Ebner-Priemer et al., 2012; Myrtek & Foerster, 2001). Disadvantages to this type of method include the cost of assays and of more elaborate monitoring devices. Further, methods that require participants to interrupt their daily life (e.g., to provide a saliva sample) can be burdensome for participants. Though these costs should be seriously considered when deciding whether and how to employ physiological EMA methods in one's own research, the benefits of the knowledge gained by using them often outweigh them (e.g., Bhattacharyya et al., 2008).

Monitoring of social behavior and context. Researchers often want to know about the objective aspects of social environments or automatic behaviors that participants cannot report. Behavioral observation was first used among researchers who did not trust self-reports or the constraints of in-lab observation to accurately capture behavior (Mehl, Gosling, & Pennebaker, 2006; Stone et al., 2007). Barker and Wright (1951) employed a research team to record everything a 7-year-old boy did for one 14-hour day, simply to study his behavior in its natural context. Similarly, one study had a female researcher live with three breastfeeding women for 2 days every month for 1 year to record their food weight and milk secretion, as well as take notes on their home activities and emotional reactions (Hunscher, Vincent, & Macy, 1930; Wilhelm et al., 2012). Naturalistic observation, in conjunction with EMA, can be used to measure the discrepancy between objective aspects of social environments, such as actual support received, and participants' perceptions of support received, which can yield meaningful information relevant to coping outcomes (Bolger, Zuckerman, & Kessler, 2000). This method allows researchers to study social environments without being filtered through participants' perceptions. It is also optimized for the assessment of automatic behaviors such as language use. Observation is necessary because participants can only report what they notice and remember, which necessarily excludes automatic behaviors that can be coping-relevant (e.g., swearing; Robbins et al., 2011; sighing; Robbins, Mehl, Holleran, & Kasle, 2011). The electronically activated recorder (EAR) is one naturalistic observation method that records snippets of ambient sounds as people carry out their normal, daily life (Mehl et al., 2001; Mehl & Robbins, 2012). As an unobtrusive device that clips to participants' waistline, the EAR captures an acoustic sample of uninterrupted social life. The EAR, however, is not without its limitations. Though there is essentially no practical burden for participants (i.e., no measures to complete and the device is lightweight), it does create a potential psychological burden for them (Mehl, Robbins, & große Deters, 2012). Because it records snippets of ambient sounds in daily life, privacy is a central concern. For this reason, all EAR participants have the chance to review and delete any sound files they do not want researchers to hear, before any research personnel listens to them. This ensures that participants only provide the information they would like to share with study personnel. For researchers, on the other hand, most of the burden of naturalistic observation methods lies in processing many hours of data. However, this burden does not greatly differ from the coding and/or transcribing that is required for in-lab observation data processing (e.g., Heyman, 2004).

Activity monitoring. Activity monitoring in natural settings can assess health behaviors such as exercise frequency and sleep quality, yielding important information about their association with quality of life, health risks, and clinical endpoints including mortality. Assessing these behaviors via EMA methods is critical to accurate measurement. Across several studies, discrepancies between self-reported and activity-monitored movement range from 44% to 138% (Bussmann & Ebner-Priemer, 2012). These discrepancies are consistently found across age groups. Both parent-reported activity of children and seniors' reports of the amount of walking fail to show an association with objective assessments of physical activity. Examples of activity monitoring include pedometers, which count the number of steps taken, and wrist actigraphy (e.g., Actiwatch, Philips Healthcare, Eindhoven, Netherlands), which also provide data about movement, but include its intensity. For example, actigraphy has been able to distinguish the motor activity patterns of depressed versus non-depressed participants, where depressed participants engaged in lower motor activity levels during the day, but higher activity levels while sleeping, compared to non-depressed participants (Volkers et al., 2003). In addition to yielding clinically relevant, accurate data, activity monitoring places little to no burden on participants. Most devices are very small and lightweight, allowing participants to carry out their normal, daily lives during monitoring periods. The burden to researchers, however, can be substantial financial cost, depending on the method used (e.g., pedometers are fairly inexpensive, but wrist actigraphy can at times be more costly).

Advantages and Disadvantages of the EMA Approach

To achieve the goal of behavioral medicine, and to improve health and well-being by applying knowledge of psychosocial influences on health, these processes must be studied within the same context to which they will later be applied: people's normal, daily life. There are several methodological and conceptual advantages to using EMA in behavioral medicine. The basic methodological rationale for EMA is threefold, according to Stone and colleagues (2007): (1) to avoid memory problems and bias associated with retrospective self-reports, (2) to achieve ecological validity, and (3) to enable the study of dynamic processes over time, within persons. Conceptually, EMA allows researchers to include discovery-oriented, in addition to theory-driven, studies in their program of research (Lewin, 1951; Reis, 2012).

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A large body of evidence supports the idea that "memory is reconstructive and recall is heuristic" (Stone et al., 2007, p. 6). Problems with memory can introduce systematic, rather than random, bias in data because people use estimation strategies and lay theories about "what must have been" to report the frequency and intensity of their states and behavior (Schwarz, 2007; 2012). Use of lay theories is supported by research finding that predicted and remembered feelings are strongly related, but that both types of reports differ from assessments done in real time. For example, patients are prone to reporting that their past condition was worse than their present condition, regardless of whether or not they have improved (e.g., chronic pain; Linton & Melin, 1982). This means that using retrospective patient reports of intervention efficacy can artificially inflate results, seriously altering conclusions that the behavioral medicine community may make about such interventions.

Another common source of bias is the excessive influence of recent and salient events on current reports (Stone et al., 2007). For example, Cohen and colleagues (1988) found that induced mood affects participants' reports of negative life events and levels of social support. This finding challenges conclusions from past retrospective self-report studies of the effects of social support on stress. In studies exclusively employing retrospective self-report methods, shared method variance may account for the majority of the relationship between predictors and outcomes. Collecting momentary reports or observations of phenomena in real time drastically reduces, and, in some cases, eliminates, this concern, bypassing the biases associated with using retrospective self-reports.

In-lab observational or experimental methods also eliminate problems with memory and bias, but do share some of the same ecological validity challenges as retrospective self-reports. Ecological validity is the extent to which a study represents the conditions under which a phenomenon occurs in the "real world." Brunswik (1956) advocated "representativeness" in sampling both participants *and* contexts for studies' results to be maximally generalizable. Indeed, a substantial body of evidence has revealed that what happens in a controlled, laboratory setting may not occur over the course of normal, daily life. For example, "white coat hypertension," where patients' blood pressure is higher in a doctor's office compared to ambulatory assessments in their natural setting (Pickering et al., 1988), is a well-known phenomenon. Similarly, Smyth and Stone (2003) explain that there is "surprisingly weak" concordance between in-lab and naturalistic studies of endocrine reactivity (p. 39). They point out that studies of plasma and urine catecholamine responses and cortisol responses to stressors in the laboratory do not mirror those found in EMA studies of stressors in real life. Conner and Barrett (2012) further explicate this point by discussing evidence that physiological processes (e.g., acute autonomic, hormonal, or immune responses) are more closely linked with people's experiences, rather than traits, which underlies the stronger association between bodily processes and EMA measures of psychosocial processes, compared to findings from retrospective reports. Clearly, context can influence important health

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markers, and therefore ecological validity should be given serious consideration in behavioral medicine research.

EMA facilitates measurement of experiences and states to allow examination of how these processes unfold over time in a natural setting (Stone et al., 2007). For instance, studies of the relationship between psychosocial processes and health often acknowledge that these factors likely influence each other in a dynamic process (e.g., the biopsychosocial model; Engel, 1980), but only EMA designs allow the empirical study of processes that occur in such close temporal proximity to one another. One study underscoring this assertion found that daily measures of affect, but not aggregate measures of depression, predicted heart rate variability among people with coronary artery disease (Bhattacharyya, Whitehead, Rakhit, & Steptoe, 2008). Another striking example was demonstrated in two studies of cardiovascular patients who underwent ambulatory ECG monitoring in their daily lives. The first study found that ischemic episodes in daily life, including those that were asymptomatic, predicted earlier death for patients (Gottlieb et al., 1988). The second study instructed participants to rate their emotions approximately three times per hour for 2 days, in addition to the ambulatory ECG monitoring, and revealed that negative emotions such as tension, sadness, and frustration predicted increased risk for ischemia during the subsequent hour (Gullette et al., 1997), revealing that cardiovascular patients who experience more frequent negative emotion may be at higher risk for earlier death. Together, these findings highlight the significant impact that daily life studies can make in researchers' and clinicians' understanding of biopsychosocial processes.

In addition to the various methodological reasons for employing EMA in studies of behavioral medicine, Reis (2012) discusses a long-standing conceptual rationale. Methodological pluralism (Campbell & Fiske, 1959) allows discovery-oriented and theory-driven studies to coexist in a program of research, while maximizing internal and external validity. Lewin (1951), the father of modern social psychology, also advocated field studies in order to ground psychological theories in their real-world implications. While EMA is optimized for capturing mundane events that comprise the majority of daily life and helping researchers uncover associations between behaviors, states, and environments, controlled laboratory research tests the causal direction of these associations. Because context can influence behavior, experiences, and states, it needs to be both studied with EMA *and* controlled for in laboratory studies. In other words, understanding a phenomenon in the "real world," with all its contextual components, is equally as important as isolating those components in a laboratory setting (Reis, 2012).

As one complementary part of a program of methodologically pluralistic research, EMA is not without its own difficulties. First, not all studies require EMA. Rare and important events (e.g., a wedding) and regular and frequent events (e.g., showering and other routine hygiene behaviors) within participants' awareness do not require momentary assessments (Schwarz, 2007). Likewise, if you are interested in studying people's perceptions of a general aspect of their lives (e.g., global relationship satisfaction), rather than their in-the-moment assessment of it (e.g., daily happiness in a relationship), then a retrospective report is warranted (Reis, 2012).

Second, EMA studies often place more burdens on participants. Studies using EMA methods require participants to carry a device for assessment. While most methods are designed to be as small and unobtrusive as possible, this may still result in a higher refusal rate and/or more missing data and attrition within the study. In turn, EMA studies may yield a less representative sample than traditional in-lab or survey studies, in which participants are required to complete measures on fewer occasions than in EMA studies (Barta, Tennen, & Litt, 2012).

EMA also generally requires participants to periodically interrupt their day to complete measures. Though the repeated assessment involved in ESM is an advantage to using this method, it can also be a challenge because it imposes more burden on participants. It can be inconvenient or disruptive to stop one's current activity to complete a questionnaire. For example, if ESM is employed at time-based intervals, the signal to complete the measure may interrupt a nap, a test, or an emotional conversation. Instructing participants to complete these measures does not greatly differ from instructing them to complete single-assessment, retrospective questionnaires, but because many ESM studies employ handheld computerized devices, participants will have to be familiarized with them (Hektner et al., 2007). This will be increasingly less of a problem, however, as technology becomes a more common part of people's lives.

Momentary self-report methods also share a few of the problems associated with retrospective self-reports. Problems with recall and social desirability are greatly reduced when assessed in-the-moment, but can still occur. Further, reactivity is a problem in which the assessment itself influences behavior or states (Gunthert & Wenze, 2012; Kazdin, 1974). Some of these problems can be remedied using momentary observational (e.g., the EAR; Mehl, Pennebaker, Crow, Dabbs, & Price, 2001) or physiological assessments (e.g., ambulatory monitoring of heart rate) in conjunction with EMA, but certainly no single method eliminates all potential challenges.

Finally, EMA yields "rich," complex data, especially if one employs sophisticated sampling schemes or opts for multimodal monitoring and combines EMA with other Ambulatory Assessment approaches such as physiological monitoring. However, in the past decades, data analytical approaches have evolved that are apt to tackle the complications with analyzing EMA statistically. These include, among others, multilevel analyses and mixed models (Nezlek, 2012), evolving standards for momentary self-report psychometrics (Shrout & Lane, 2012), or analytical rationales building on time series that may prove to be particularly useful for single-case analyses in a clinical context (Rosmalen et al., 2012).

In summary, EMA methods introduce solutions to long-standing problems with laboratory and retrospective self-report methods, in many cases, allowing more accurate assessments of health-relevant constructs. However, no single method is flawless, and therefore the most optimal use of EMA methods may be to include it in a program of methodologically pluralistic research.

EMA in Behavioral Medical Practice

Essentially, EMA is related to diary approaches, which have been a cornerstone in behavioral medical treatment from the very beginning (Ferguson & Taylor, 1980). Diary approaches have been important tools in the treatment of many relevant somatic diseases, such as pain, asthma (National Heart, Lung and Blood Institute, 2012; see chapter 35), or diabetes mellitus (American Diabetes Association, 2012; see Chapter 36): Patients record self-care-related behavior, symptoms, and situations to optimize their disease self-management. Moreover, diaries are an important source of information for healthcare professionals to assist the patient and to offer tailored advice. Besides common medical conditions, diary techniques are often used in stress management interventions (Linden, 2004) or cognitive behavioral approaches in general (Beck, 2001).

Electronic diaries and sophisticated sampling schemes offer new opportunities for practice applications that go beyond what can be achieved with conventional paper–pencil diaries. This holds for both clinical applications in one-to-one therapeutic settings and for evaluation research, where EMA now is the gold standard to assess patient-reported outcomes. In the remaining part of this chapter, we want to highlight two selected applications of EMA in behavioral medicine and outline some important recent developments.

EMA as a tool in outcome research. Patient-reported outcomes (e.g., self-reported health behavior, symptoms, well-being, health-related quality of life) play an increasingly important role in the evaluation of treatments, and ultimately in health economics and health policy with regard to decisions about reimbursement. This also pertains to outcome research related to behavioral medical interventions. Recent shifts in policies of government agencies reflect the necessity to assess patient-reported outcomes in a momentary fashion: For example, the US Food and Drug Administration (FDA) argues that patient-reported outcomes based on retrospective self-reports are likely to be of limited validity and recommends "the [patient-reported outcome] instrument use appropriate methods and techniques for enhancing the validity and reliability of retrospectively reported data (e.g., ask patients to respond based on their worst (or best) experience over the recall period or make use of a diary for data collection)" (FDA, 2009, p. 13). The FDA's position statement specifically points toward memory biases that may hamper the validity of retrospective self-reports. At the time of this writing, outcome research still needs to adopt this policy and implement EMA-style patient-reported outcomes, particularly in behavioral medical intervention research as compared to drug evaluation trials. Exceptions, however, do exist. For example, Hermanns et al. (2007) used a symptom diary as a primary outcome for a behavioral medical intervention design to improve the perception of low blood glucose levels in people with diabetes. To take full advantage of EMA in outcome research, further issues have to be resolved pertaining to standards of EMA patient-reported outcome measures. For instance, Stone, Broderick, Schneider, and Schwartz (2012) examined momentary measures in the domain of pain with the aim of how to best use momentarily assessed pain ratings as an outcome measure. They conclude that mean pain ratings based on momentary report may not be the most suitable outcome measure for treatments as other ways of aggregating momentary reports better reflect the patients' perceived change in symptomatology.

EMA as an intervention tool. Until now, EMA has primarily been used as an assessment tool. Exact "time stamping" of records, that is, each momentary self-report is recorded together with an objective time stamp, and the option to collect data in a signal-contingent fashion are among the key advantages that EMA has compared to conventional paper–pencil diaries. Its potential benefits as a tool for intervention in behavioral medicine have yet to be explored. Self-monitoring and diary approaches are a cornerstone in the treatment of various medical conditions, not only for diagnostics but also as a component of treatment in itself. Diary techniques are highly reactive (Barta et al., 2012). While this can be considered a nuisance from a research perspective, taking a therapeutic angle, reactivity may offer benefits such as an increased focus on symptoms or improved symptom awareness in patients, in addition to potential positive effects on the patients' motivation to actively engage in self-management (cf. Kanfer & Arnold,).

EMA offers new opportunities to enhance existing diary techniques, for example, by means of online analysis of data and the implementation of feedback features. To give two examples for this augmented EMA, we want to draw on two studies – one in diabetes research, and one in the domain of emotion regulation. Online analysis of data and feedback of results may be used to improve the accuracy of symptom perception. Perceiving fluctuations in blood glucose and especially recognizing low blood glucose levels (hypoglycemia) in time is essential for people with type 1 diabetes (Cryer, 2002). EMA has been used to study symptom perceptions of low blood glucose levels in diabetes early on (e.g., Clarke et al., 1995). Going beyond the assessment-only approach, Kubiak, Hermanns, Kulzer, and Haak (unpublished data) used an enhanced electronic diary to improve the recognition of hypoglycemia in people with type 1 diabetes mellitus with impaired awareness of hypoglycemia (Graveling & Frier, 2010). Patients were "beeped" several times a day in a signal-contingent fashion for 2 weeks to complete momentary symptom reports and a simple choice reaction task implemented within the diary. Upon completing the task, they were prompted to estimate their performance and received immediate feedback on their actual performance. The underlying rationale was to help the patient notice subtle decrements in cognitive performance, which are common early signs of falling blood glucose levels. Figure 20.1 shows the trajectories of the perception of low blood glucose levels over the course of the 2-week study compared with the results from controls who also used an electronic diary without the cognitive task and feedback. The EMA intervention was associated with more accurate cognitive performance estimations (not shown) and with an improvement in the recognition of hypoglycemic events.

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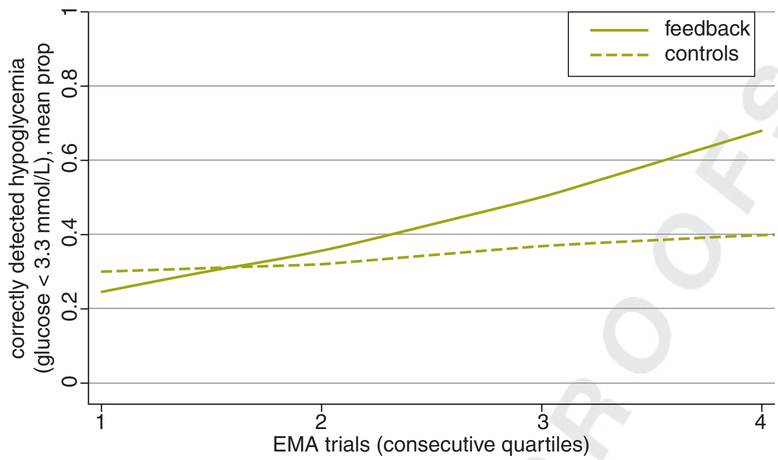

Figure 20.1 Example of an intervention building on EMA: $N = 59$ type 1 diabetes patients received cognitive performance feedback on a reaction choice task implemented within an electronic diary to improve the recognition of low blood glucose levels. Figure shows the detection of low blood glucose levels over time in this feedback group vs. controls who used EMA without feedback ($N = 69$).

A second example of EMA enhanced with an intervention component applies EMA to modify emotion regulation: Huffziger, Ebner-Priemer, Koudela, Reinhard, and Kuehner (2012) tested whether EMA can be used to induce distinct modes of emotion regulation in healthy participants focusing on functional and dysfunctional ways of ruminative thinking (cf. Watkins, 2008). They successfully instructed participants with messages displayed on the diary's screen to adopt a distanced (non-self-immersed), reflective perspective when (re)thinking about past events. This perspective is generally considered to be a more functional form of rumination as compared to rumination characterized by a high emotional involvement and self-immersion (cf. Kross, Ayduk, & Mischel, 2005). This approach may prove to be a promising tool for the prevention of depression or the modification of dysfunctional emotion regulation in other (somatic) disorders.

In a recent review, Heron and Smyth (2010) coined the term of *ecological momentary interventions* for treatment options building on EMA. They summarized several studies that document the feasibility and benefits of such an approach in fields as different as weight management, eating behaviors, or smoking cessation. With ever-improving platforms for electronic diaries, such as Internet-enabled smartphones (Kubiak & Krog, 2012), further novel options unfold by adding server-based applications or remote individual counseling and feedback in a telemedicine-like approach. First findings in this line of research are promising. For instance, Sorbi et al. (2007) successfully used mobile counseling in people with migraines where the patients completed EMA-style electronic diaries that were linked to server-based individual feedback.

Conclusions

In this chapter, we gave a brief overview on applications of EMA in behavioral medicine. EMA has evolved to become the gold standard for the assessment of in situ self-reports. This holds for self-reported symptoms or psychological variables, as well as self-reported behaviors. Recent technological developments, such as EMA implemented on smartphones, make the method much more accessible for researchers and clinicians. Combined with other sources of data, such as in situ physiological monitoring or behavioral observation via audio recordings, EMA will offer new opportunities linking self-reported experience to context. Finally, ecological momentary interventions are a promising development for clinical behavioral medicine, with its full potential and challenges yet to be fully explored.

Suggested Further Readings

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