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Ecological Momentary Assessment of Mood Disorders and Mood Dysregulation

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In this review, we discuss ecological momentary assessment (EMA) studies on mood disorders and mood dysregulation, illustrating 6 major benefits of the EMA approach to clinical assessment: (a) Real-time assessments increase accuracy and minimize retrospective bias; (b) repeated assessments can reveal dynamic processes; (c) multimodal assessments can integrate psychological, physiological, and behavioral data; (d) setting- or context-specific relationships of symptoms or behaviors can be identified; (e) interactive feedback can be provided in real time; and (f) assessments in real-life situations enhance generalizability. In the context of mood disorders and mood dysregulation, we demonstrate that EMA can address specific research questions better than laboratory or questionnaire studies. However, before clinicians and researchers can fully realize these benefits, sets of standardized e-diary questionnaires and time sampling protocols must be developed that are reliable, valid, and sensitive to change.

Keywords: ecological momentary assessment, ambulatory assessment, bipolar disorder, major depression, borderline personality disorder

Ecological momentary assessment (EMA) has received increasing interest in recent years, as evidenced by publications in some of the most highly regarded scientific journals (e.g., Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004, 2006; Mehl, Vazire, Ramirez-Esparza, Slatcher, & Pennebaker, 2007). Two issues have fostered this developing interest. First, findings concerning memory heuristics have demonstrated that gathering information retrospectively is a highly dubious methodology. Second, clinical psychologists and psychiatric researchers now recognize that many symptoms of psychopathology are dynamic; they ebb and flow over time. Fortunately, both of these challenges can be addressed using EMA.

Most methods of assessment in clinical psychology and psychiatry rely on retrospective self-reports of patients' symptoms, including clinical interviews, structured interviews, end-of-day paper diaries, and questionnaires. For all these methods, behavioral, emotional, or cognitive symptoms must be recalled from a patient's memory. The time interval between the original event or experience and the recall differs depending on the assessment method used. For example, paper diaries targeting mood and behaviors often involve relatively short recall periods like 24 hours, whereas personality disorder interviews assess predominant symptoms over the last 2 to 5 years (e.g., Loranger, 1999). Some mental health researchers primarily use biological or psychophysiological measures (e.g., functional brain imaging, heart rate). However, even in these cases, structured interviews are necessary for patient classification, and therefore the assessment still hinges on the accuracy of retrospectively recalled symptoms.

Experimental data, autobiographical studies, and investigations of daily life have all demonstrated that retrospection is subject to multiple systematic distortions (Fahrenberg, Myrtek, Pawlik, & Perrez, 2007; Stone & Broderick, 2007) because recall is often based on biased storage and recollection of memories (Fredrickson, 2000). Multiple memory heuristics have been identified, such as the *affective valence effect*, the *mood congruent memory effect*, and the *duration neglect,* all of which not only increase inaccuracy but also introduce systematic errors (for a detailed discussion, see Ebner-Priemer & Trull, 2009). As a consequence, the U.S. Food and Drug Administration (FDA; 2006) recently issued preliminary guidance for the pharmaceutical industry, noting that real-time data are desirable:

> PRO [Patient-reported outcome] instruments that require patients to rely on memory, especially if they must recall over a period of time, or to average their response over a period of time may threaten the accuracy of the PRO data. It is usually better to construct items that ask patients to describe their current state than to ask them to compare their current state with an earlier period or to attempt to average their experiences over a period of time. (FDA, 2006, p. 11)

Perhaps because cross-sectional and retrospective reports cannot precisely assess time-dependent processes, clinical psychology has largely neglected the dynamics of symptoms (Ebner-Priemer, Eid, Kleindienst, Trull, & Stabenow, 2009). This neglect is unfortunate,

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as there are psychological disorders characterized by core features that by definition involve instability over time (American Psychiatric Association, 2000), like bipolar disorder or borderline personality disorder (BPD). Whereas the average level of symptoms may seem sufficient for deciding to increase or decrease medication dosages, in clinical assessment and psychological treatment we seek to understand the circumstances under which symptoms may occur, be exacerbated, or abate. Depressive symptoms, for example, may be triggered by specific stimuli, whether external (e.g., environmental cues) or internal (e.g., cognitive biases). Investigating these dynamic patterns of reactivity is necessary to understand etiology and improve treatment.

The method of choice to study dynamic processes and to circumvent retrospective biases is EMA. Different terms have been used for this kind of assessment methodology, including *ambulatory assessment* (Fahrenberg et al., 2007), *ecological momentary assessment* (Stone, Shiffman, Schwartz, Broderick, & Hufford, 2002), *experience sampling method* (Csikszentmihalyi & Larson, 1987), or *real-time data capture* (Stone & Broderick, 2007). Even though the terms differ, contemporary versions of these approaches have in common the use of computer-assisted methodology to assess self-reported symptoms, behaviors, or physiological processes while the participant undergoes normal daily activities. To simplify matters we use the term EMA throughout this article.

In this review, we discuss EMA studies on mood disorders and mood dysregulation and illustrate six major benefits of the EMA approach to clinical assessment: (a) Real-time assessment increases accuracy and reduces retrospective bias; (b) repeated assessments allow us to study dynamic processes; (c) multimodal assessment can integrate psychological, physiological, and behavioral data; (d) setting- or context-specific relationships can be revealed; (e) interactive feedback can be provided in real time; and (f) the assessment in real-life situations enhances generalizability. Our review is structured according to these six major benefits. Each section presents relevant empirical studies on bipolar disorder, depression, and borderline personality, if available, as well as implications for clinical assessment.

Review Strategies

To identify relevant EMA studies on mood and mood dysregulation, we screened PsycINFO, PubMed, and MEDLINE search results as well as bibliographies on EMA published at www.ambulatory-assessment.org (the website of the Society for Ambulatory Assessment, which links extensive bibliographies on EMA studies) for studies published up to early 2009 on bipolar disorder, depression, and BPD. Keywords included *ambulatory assessment*, *ambulatory monitoring*, *ecological momentary assessment*, *experience sampling method*, *electronic diary*, *computer-assisted diary*, *electronic momentary assessment*, *ecological validity*, *hand-held computer*, *accelerometry*, and the names of several ambulatory physiological data recorders (see Ebner-Priemer & Kubiak, 2007, for an overview of the latter). Abstracts were examined, and articles were selected that employed EMA to study adult participants with mood disorders or mood regulation difficulties. We did not include studies that assessed mood symptoms in healthy subjects or student populations only. Finally, it is noteworthy that we did not specifically target articles that involved only saliva cortisol assessments in mood disorders. These studies are reviewed elsewhere (e.g., de Kloet, Joels, & Holsboer, 2005).

Real-Time Assessment to Increase Accuracy and Minimize Retrospective Bias

A major advantage of real-time assessment afforded by EMA is that it reduces biases known to plague retrospective reporting and reconstruction of past events and experiences. Such biases have been demonstrated in a variety of empirical studies.

BPD. Ebner-Priemer et al. (2006) compared retrospective and momentary ratings of specific emotions in 50 patients with BPD and 50 healthy control participants using EMA over a 24-hr period. Results revealed a different overall recall pattern in healthy control participants and in those with BPD. BPD patients' recall pattern was characterized by retrospective underestimation of emotions with positive valence and retrospective overestimation of emotions with negative valence. In contrast, healthy control participants' recall pattern was characterized by retrospective overestimation of emotions with positive valence and retrospective underestimation of emotions with negative valence.

Stone, Broderick, Shiffman, and Schwartz (2004) reported that in patients with chronic pain, retrospective measures assessing *change scores* are inherently unreliable. The basic idea was that estimating one average value from memory might be more reliable than estimating two values and calculating the difference. Accordingly, retrospective distortion of mean values (Week 1, Week 2) was lower than retrospective distortion of the change score (change between average pain in Week 1 and average pain in Week 2). As a follow up, Ebner-Priemer, Bohus, and Kuo (2007) hypothesized less accuracy in retrospective ratings of instability, conceptualized as a complex series of changes scores, compared to the retrospective rating of a mean value. The authors investigated correlations between EMA data and expert interview ratings for two BPD criteria: inappropriate anger and affective instability. As hypothesized, the assessments of the affective instability criterion (EMA data and expert interview ratings) showed no association. In contrast, there was a significant correlation between mean EMA ratings of anger and expert ratings for the criterion inappropriate anger. The former finding is consistent with that of Links, Heisel, and Garland (2003), who reported no correlation between mood instability assessed with questionnaires and EMA indices of mood instability in patients with recurrent suicidal behavior.

Depression. Turning to EMA studies of depression, Ben-Zeev, Young, and Madsen (2009) compared average momentary affect reports to retrospective summaries of the same period of time. Both groups, depressed participants and nonclinical control participants, retrospectively exaggerated positive and negative affect. However, depressed individuals showed more absolute inaccuracy in their recall of negative affect. To maximize accuracy in measurement of affect in clinical settings, Ben-Zeev et al. recommended to supplement retrospective self-reports with measures of most recent affective states.

Interestingly, there is some evidence that EMA can increase the accuracy of estimates on economic effects of major depression. Such estimates are usually based only on days missed from work. Wang et al. (2004) investigated work performance using EMA in 105 airline reservation agents and 181 telephone customer service representatives, many of whom were depressed. Depressed

patients, although attending work, reported impaired performance and reduced work productivity in their diaries. This finding suggests that studies focusing only on the number of days missed from work may significantly underestimate the economic effects of depression. Similarly, Mokros (1993) reported differences between depressive symptoms as assessed by clinical interview and by EMA. In the clinical interview, every depressed participant reported prominent and persistent sadness. However, EMA revealed that more than 40% of the depressed participants reported sadness at a similar rate as the healthy control participants. Although intriguing, conclusions must be qualified because the methods not only differed between real-time versus retrospective ratings but also between self-reports (EMA) and ratings by the clinician (interview).

Assessment implications. EMA is a real-time assessment method that reduces retrospective biases. There is preliminary evidence that the length of the recall interval determines the amount of discrepancy between real-time and retrospective reports. Broderick et al. (2008) reported data showing that an increase in the recall period from 1 day to 7 days was accompanied by a monotonic increase in recalled reports of pain, even though real-time pain ratings (EMA) did not increase over time. Therefore, the length of the recall interval should be as short as possible to gather meaningful and reliable data, if it is not possible to collect data in real time.

We are, of course, assuming that real-time measures are more accurate than retrospective ratings, as they reduce retrospective distortions and provide an assessment with greater time-resolution (sampling frequency). As is true for any other measure, however, the accuracy of real-time measures must be shown to be valid as well, ideally compared to a third, criterion variable (true value). Unfortunately, gold standards do not currently exist in psychopathology. It is in fact possible that, in some cases, increasing the time resolution of assessment may lead to lower accuracy. Consider the case of estimating the mean duration of a hypomanic episode. A retrospective rating might lead to an imprecise estimation ("about two weeks") compared to an electronic diary assessment that queried about hypomanic symptoms once per day. The EMA estimate in this case might identify that the patient's symptoms lasted only 5 days, not 2 weeks. However, increasing the sampling frequency to every hour per day might produce multiple assessment points without certain hypomanic symptoms inside a longer episode of hypomania. This might lead to the conclusion that a person had multiple hypomanic episodes within one day, separated by hours without certain symptoms.

Although hypothetical, this example demonstrates that increasing the sampling frequency does not always increase accuracy in some situations. It is crucial that one's sampling frequency and strategy match the construct of interest. For example, because mood is continuously experienced, higher temporal resolution (several times per day) is desirable (vs. sampling one time per day). Other symptoms of mood disorder may not be subject to change as frequently (e.g., low self-esteem), and daily assessment might be preferred. In addition, some experiences may be relatively infrequent such that event-based sampling makes the most sense (e.g., suicidal ideation). Finally, more studies investigating the relationship between length of the recall interval and the amount of discrepancy between real-time and retrospective reports in mood disorders are needed, as well as investigations of how recall bias might change over the course of treatment (presumably due to symptom improvement).

Studying Dynamic Processes Using Repeated Assessments

BPD. One of the hallmark features of BPD is affective instability. There is even some evidence that affective instability might influence all BPD symptoms (e.g., Tragesser, Solhan, Schwartz-Mette, & Trull, 2007). Although for decades affective instability in BPD was mainly assessed by retrospective questionnaires or interviews, the last few years have witnessed a wealth of studies targeting affective instability using EMA technology. EMA allows for a more precise description of the ebb and flow of affective states and, ultimately, for modeling instability by analyzing repeatedly assessed affective states.

Trull et al. (2008) used EMA to characterize affective instability in 34 outpatients with BPD and 26 outpatients with current depressive disorder. Participants carried electronic diaries for approximately one month and were randomly prompted to rate their mood state up to six times a day. Results indicated that BPD patients displayed significantly more variability over time in their positive and negative affect scores than did patients with depressive disorders. Using multilevel modeling of instability (Jahng, Wood, & Trull, 2008), investigators found significantly more instability on successive scores (i.e., changes from one assessment to the next) for hostility, fear, and sadness.

Similarly, Ebner-Priemer, Welch, et al. (2007) reported heightened affective instability for both emotional valence and distress in 50 female patients with BPD compared to 50 healthy control participants. Patients were prompted to rate their affective state every 10 to 20 min during a 24-hr period using electronic diaries. Additionally, Ebner-Priemer, Welch, et al. were able to identify a specific pattern of instability characterized by sudden large decreases in valence. BPD patients took less time to fluctuate from a very positive mood state to a negative mood state. Within a 15-min period, on average, 48% of the declines from a very positive mood state across BPD patients were so large as to switch valence to a negative mood state. In contrast, this was observed in only 9% of the healthy control participants. This finding is consistent with the clinical impression that BPD patients may often appear to abruptly experience a negative mood state.

These studies (Ebner-Priemer et al., 2009; Ebner-Priemer, Kuo, et al., 2007; Jahng et al., 2008; Trull et al., 2008) all share the view that instability is a process characterized by multiple components (i.e., amplitude, frequency, temporal dependency). When investigating affective instability and other dynamic processes in psychopathology, it is important that all of these components are both considered and integrated into the research question itself, the assessment or sampling method, and the data analytic strategy. For further discussion and recommendations for the investigation and analysis of unstable and dynamic processes see Ebner-Priemer et al. (2009).

Russell, Moskowitz, Zuroff, Sookman, and Paris (2007) conducted the first study on the variability of interpersonal behavior in BPD patients. They assessed mood and social interaction behaviors using event-contingent recording in 38 BPD patients and 44 healthy control participants over a 20-day period. Participants were asked to rate items concerning interpersonal behavior following a social interaction (i.e., a predefined event) of at least 5 min. The

BPD group reported heightened intraindividual variability for dominant, agreeable, and quarrelsome behavior.

Stiglmayr, Gratwohl, Linehan, Fahrenberg, and Bohus (2005) assessed specific components of instability in 63 women with BPD and 40 healthy control participants. For 2 consecutive days, participants were asked at hourly intervals to record their current state of aversive tension as well as to record events which might have led to increases in aversive inner tension. In BPD patients, compared to control participants, ratings of aversive tension were significantly higher, the rate of increase in tension was markedly more rapid, and states of aversive tension persisted for a longer period of time. Among BPD participants, experiences of rejection, being alone, and failure accounted for 39% of all events preceding states of high aversive tension.

Reisch, Ebner-Priemer, Tschacher, Bohus, and Linehan (2008) investigated sequences of emotions in BPD, focusing on the activation, persistence, and down-regulation of emotions. Fifty BPD patients and 50 healthy control participants monitored their perceived emotions by using a hand-held computer system for a 24-hr period in a daily life setting. Sequences of emotions in BPD, compared to healthy control participants, were characterized by persistence of sadness and anxiety, as well as emotional oscillating between anxiety, sadness, and anger.

Bipolar disorder. Bipolar disorder is another disorder characterized by cyclic patterns of mood. Manic–depressive cycles have been documented with prospective paper–pencil diary sheets for more than a century. For example, the classic psychiatry textbook by Kraepelin published in 1913 contains nine colored pages, all of them showing time sequence plots of manic–depressive states. There are many benefits of long-term monitoring of patients with bipolar disorders, including the ability to identify environmental and psychological triggers, track treatment response, identify early worsening of symptomatology, and promote patients' insight into their disease as well as to improve adherence to treatment (Baldassano, 2005).

Whereas most of the methods of long-term monitoring in bipolar disorder are still paper-and-pencil based, software is now available for this purpose and is currently used worldwide in multiple projects. ChronoRecord is a noncommercial Internet-based data entry system for patients with bipolar disorder (Bauer, Grof, Rasgon, Bschor, et al., 2006; Bauer, Grof, et al., 2005). This system is used to assess manic–depressive states, sleep, and medication once a day, as well as to track symptoms over several months. Even though end-of-the-day diaries can be somewhat problematic because of the biased retrospective recall of symptoms mentioned earlier, once-a-day assessment is the traditional assessment time frame in bipolar disorder because mood shifts are most often characterized by a relatively slow change from manic to depressive states and vice versa. Typically, there are no multiple switches within one day in Bipolar I or Bipolar II disorders, justifying once-a-day assessment.

Bauer and colleagues validated ChronoRecord by comparing clinician ratings on the Hamilton Depression Rating Scale (Bauer et al., 2004) and the Young Mania Rating Scale (Bauer et al., 2008) with the automated daily self-reporting by patients with bipolar disorder. These analyses indicated good to excellent agreement between self ratings and clinician ratings. Furthermore, the authors investigated whether the computerized tool itself may bias generalizability, as education or age may influence participation in such a computerized study. A comparison of the demographic data of samples assessed with computerized assessment or traditional paper–pencil assessment did not reveal any evidence for bias (Bauer, Rasgon, et al., 2005).

One of the goals of the ChronoRecord project is the early recognition of the prodromal symptoms of bipolar disorder, which may help to prevent relapses if combined with a patient action plan. As sleep disturbance is a frequent warning sign of both mania and depression, Bauer, Grof, Rasgon, Bschor, et al. (2006) collected mood, sleep, and bed rest data from 59 outpatients with bipolar disorder over nearly 6 months. In a sizable subsample of their patients, the researchers found a significant inverse correlation between sleep or bed rest and change in mood, using a time latency of 1 day. Specifically, sleep loss was followed by a shift toward hypomania/mania on the next day or sleep gain was followed by a shift toward depression on the next day. Even though this relationship was not found in all patients, these sleep findings appear promising for informing both therapeutic interventions and prevention efforts.

The definition of the minimum length of hypomanic episodes has been debated in the scientific community (e.g., Benazzi, 2001). Using over 20,000 daily mood ratings from patients with Bipolar I and Bipolar II disorder assessed by the ChronoRecord system, Bauer, Grof, Rasgon, Marsh, et al. (2006) demonstrated that lowering the criterion threshold from 4 days to 2 days for an episode of hypomania tremendously changed the diagnostic profiles. Decreasing the time interval doubled the mean percentage of days in a hypomanic episode for each patient and also doubled the number of patients with a hypomanic episode. Similar findings were revealed when studying the duration of brief depressive episodes (Bauer et al., 2007). It is interesting that empirically varying duration thresholds may remarkably influence classification, yet the criteria of the *Diagnostic and Statistic Manual of Mental Disorders* (4th ed.; *DSM–IV*) are still based largely on clinical judgment. With the exception of the ChronoRecord data set for bipolar disorder, we are not aware of other data sets that are available to evaluate how changing time duration thresholds for symptoms changes the picture of the disorder.

Depression. In depression, many symptoms are thought to be stable, and traditional assessment approaches, like questionnaires, assume this to be the case. However, when "stable" symptoms are assessed repeatedly over time with EMA, these symptoms may show significant within-subject variability (e.g., see Trull et al., 2008, p. 658). An instructive example is the study by Barge-Schaapveld, Nicolson, Berkof, and deVries (1999), which investigated quality of life in depressed subjects. Repeated assessments (10 times a day for 6 days) revealed heightened variability of quality of life in depressed participants compared to nondepressed participants. Multilevel regression analyses uncovered several significant situational determinants of quality of life, including enjoyment of current activities, current complaints, and mood. Interestingly, the heightened variability of quality of life decreased during psychopharmacological treatment (Barge-Schaapveld & Nicolson, 2002).

Chepenik et al. (2006) compared daily diary data from elderly primary care patients with major depression, elderly primary care patients with other depressive disorders, and an elderly normal volunteer comparison group. Findings revealed significant day-to-day variability in negative affect in patients with major depression.

Mixed-effects analyses demonstrated that patients with other depressive disorders exhibited heightened negative affective responses to negative events at levels greater than those in normal subjects and patients with major depression. This study demonstrated that diary methods may capture characteristics of late-life depression previously not identified with assessment methods that have lower time resolution.

Assessment implications. Data gathered using EMA enable us to study symptom variability and instability over time as well as the dynamic interplay between the environment, personal experiences, and psychopathological symptoms. Clinical disorders defined by unstable or cyclic patterns of mood, like BPD or bipolar disorder, are therefore especially well-suited for studies using EMA. In addition, some symptoms thought to be relatively stable (e.g., depressive affect) may actually show a significant amount of variability over time when assessed by time-sensitive methods like EMA (Barge-Schaapveld, Nicolson, van der Hoop, & deVries, 1995; Trull et al., 2008).

When investigating time-dependent processes, two issues are of most importance: First, the data analytic strategy must account for temporal dependencies, a topic which has been discussed in detail elsewhere (Ebner-Priemer et al., 2009; Jahng et al., 2008; Trull et al., 2008). Second, the time-based design must fit the temporal dynamics of the processes of interest (Ebner-Priemer & Sawitzki, 2007). To illustrate, imagine a patient whose affect changes every other day from euthymia to depression or vice versa. This patient's affect might be labeled as unstable, if affect is assessed once per day for 14 days. However, we might conclude the patient's affect is stable if we assessed affect every 30 min during waking hours within a single day. Having a too high or too low a sampling frequency may obscure the true process.

Multimodal Assessment of Self-Report, Physiology, and Behavior

Although researchers and clinicians agree that the assessment of clinical symptoms should include measurements of physiological changes, subjective experience, and behavior, physiological measurements of psychopathological symptoms are fairly rare (Ebner-Priemer & Trull, 2009; Lang, 1993). This neglect may be explained in part by the frequent disagreement between physiological indices and self-reported symptoms, as well as by the disagreement within different physiological indices themselves (Rachman & Hodgson, 1974). Instead of investigating and probing the cause of these converse findings in psychological, physiological, and behavioral variables, researchers, unfortunately, seem to have simply avoided incorporating physiological and behavioral assessments with traditional self-reports.

This neglect is not limited to physiological assessment but also to the measurement of behavioral activity. This, perhaps, is even more surprising, given that psychology is often defined as the science of behavior (Baumeister, Vohs, & Funder, 2007). Altered physical activity is ubiquitous across psychiatric disorders. For example, Tryon (2006) delineated as many as 48 psychiatric disorders which involve increased or decreased activity according to the *DSM–IV*. However, studies assessing behavioral activity in psychiatric disorders are uncommon (Bussmann, Ebner-Priemer, & Fahrenberg, 2009), with the exception of studies that rely on retrospective self-report of behavior.

BPD. Emotional dysregulation has been hypothesized as the core feature of BPD (Linehan, 1993). In addition to self-reports of affective states using EMA, this core feature has been assessed through physiological indices of altered affective regulation and experience in everyday life. For example, Lieb et al. (2004) studied the hypothalamic–pituitary–adrenal (HPA) axis in 23 unmedicated female patients with BPD and 24 matched healthy control participants. Salivary cortisol was collected from all participants during everyday life conditions in response to reminders provided by portable minicomputers. Samples were obtained on 3 consecutive days every 2 hr for 14 consecutive hr after awakening. Patients with BPD displayed significantly higher salivary cortisol levels than healthy control participants, which is consistent with the observed affective hyperreactivity in this population. In another study, Ebner-Priemer, Welch, et al. (2007) used 24-hr psychophysiological ambulatory monitoring to investigate the frequency and intensity of self-reported emotions and cardiovascular indices of emotions during everyday life in 50 patients with BPD and 50 healthy control participants. BPD patients reported more negative emotions and fewer positive emotions. Further, a subgroup of nonmedicated BPD patients manifested higher values of additional heart rate (i.e., heart rate increases corrected for physical activity), an index validated as a physiological indicator of emotional reactivity (Myrtek, 2004). Therefore, both studies (Ebner-Priemer, Welch, et al., 2007; Lieb et al., 2004) reported psychophysiological indices of emotional hyperreactivity in BPD participants during everyday life, a result that has rarely been found in laboratory studies (see Ebner-Priemer, Welch, et al., 2007, for an overview).

The behavioral activity of BPD patients in everyday life has also been examined. In an earlier investigation using structured interviews, Albrecht and Porzig (2003) found that BPD patients reported heightened physical activity during episodes of distress. Ebner-Priemer et al. (2008) attempted to replicate this finding using a 24-hr ambulatory monitoring by repeatedly assessing psychological distress and physical activity. Multilevel analyses revealed no relation between physical activity and distress. However, these conflicting findings may be due to the different methodologies. Whereas the study of Ebner-Priemer et al. (2008) utilized objective measures of physical activity and real-time data capture, the Albrecht and Porzig findings are based on recalled subjective information about physical activity.

Depression. Concerning depression, psychomotor retardation or agitation are criteria for a major depressive episode (American Psychiatric Association, 2000). Schrijvers, Hulstijn, and Sabbe (2008) reviewed psychomotor symptoms in depression and identified 13 studies investigating gross motor activity in daily life using actometers or accelerometry. Although only one study examined psychomotor agitation, many studies reported on 24-hr actometric measurements of limb or horizontal movements to assess psychomotor retardation. For example Volkers et al. (2003) reported lower motor activity level during wake time and a higher motor activity level and a decreased immobility during sleep in 67 unmedicated depressed patients.

Electronic mobile devices are not only capable of capturing physical activity in everyday life but also of combining the assessment with a variety of physiological variables and environmental parameters. Armitage et al. (2004) assessed both physical activity and bright light exposure in 59 outpatients with major depression and 41 healthy control participants. The major depression group

evidenced reduced bright light exposure and altered circadian rhythms in physical activity, especially smaller day–night differences in physical activity. Armitage et al. explained their findings in terms of altered exposure to *zeitgebers* (time cues) in major depression, highlighting that the master circadian clock is strongly driven by light.

Stetler and Miller (2005) combined the assessment of self-reports via EMA with the assessment of the cortisol awakening response. They hypothesized a loss of internal and external regulatory control over HPA axis functioning during depression. Thirty-seven depressed women completed electronic diaries so that researchers could assess the cortisol awakening response (CAR), sleep, and social contacts. Stetler and Miller demonstrated that psychosocial factors contribute to a normal CAR, but their regulatory influence may become disrupted during mild to moderate clinical depression.

Lemke, Broderick, Zeitelberger, and Hartmann (1997) also combined psychological and behavioral parameters in an investigation of 16 unipolar depressed inpatients over 3 days. They assessed physical activity using actometers as well as subjectively experienced intensity of symptoms in the morning and evening. Patients reported feeling significantly less active, less awake, and more depressed in the morning compared to the evening. Diurnal variations of symptoms were reflected by actigraphically measured motor activity, which was negatively correlated with subjectively experienced symptom intensity. A final example of combining subjective reports of mood and daily activities by cell phone combined with actigraphy is a report by Axelson et al. (2003) illustrating in several single cases that EMA can track treatment effects like improvements in mood and social interaction.

Bipolar disorder. Jones, Hare, and Evershed (2005) assessed physical activity in bipolar disorder. The authors found less stable and more variable circadian activity pattern in bipolar patients during subsyndromal periods (i.e., patients were not in an active phase of illness). To derive an index for the variability of circadian activity, the authors first computed an average score of activity for every hour and then calculated the ratio between mean successive differences of activity and the standard deviation of activity. As theoretical models describe disruption of circadian rhythms as a vulnerability factor, this study highlights the need for psychological interventions addressing circadian stability in bipolar patients during subsyndromal periods.

Assessment implications. Combining multiple methods of data collection is not a unique attribute of EMA, but many EMA studies demonstrate that it is possible to study both physiological and behavioral components of psychological disorders in everyday life. Even though obtaining physiological measures in relevant situations outside the laboratory is challenging, progress in biosensor technology has led to compact, portable, and unobtrusive recording systems that allow naturalistic assessment. Of utmost importance in psychophysiological ambulatory assessment is the control for confounding variables like physical activity or breathing pattern. Whereas the reliability of standard physiological data assessment, like heart rate, is usually high, the validity of these assessments depends heavily on the control of confounding variables. Consider the physiological activation in two patients, each of whom argues with her therapist. Although one argues while sitting in a chair during a session, the other argues as she is pacing in the therapy room. Modern, sophisticated computer processing enables the control of confounding variables in cases like these outside the laboratory, disentangling emotional activation from the activation of physical effort (Myrtek, 2004; see for reviews, Haynes & Yoshioka, 2007; Houtveen & de Geus, 2009) and thus increasing validity. However, because the correlation between self-report and direct measurement of either physiological state or behavioral activity is typically low, we do want to emphasize that considering self-reports of physiological or behavioral parameters as valid measures of the physiological or behavioral process itself may be misleading (Baumeister et al., 2007; Bussmann et al., 2009; Fahrenberg et al., 2007).

The Investigation of Setting- or Context-Specific Relationships

Traditional assessment approaches, like symptom questionnaires or interviews, are limited in their ability to reveal context-sensitive information because they do not assess the context itself. For example, symptoms of depression are usually assessed for a period of time (like the last week) but not in specific situations (e.g., while alone, while with friends, while with a romantic partner). Repeated assessments in EMA, however, provide the opportunity to conduct context-sensitive assessment and analyses. One of the earliest examples of a context-sensitive study was conducted by Delespaul and deVries (1987), who investigated setting-specific symptomatology in a mixed sample of patients with mental illness and nonpsychiatric control participants. As expected, psychopathological symptoms were influenced by social environments such as being alone, at home, or in society at large, but contrary to other studies that emphasized the social isolation of such individuals, the chronically mentally ill participants reported feeling better away from home and among people than did control participants.

BPD. Stiglmayr et al. (2008) provided an instructive example for a context-sensitive assessment in BPD. According to *DSM–IV*, dissociative symptoms in BPD occur in response to extreme stress. Therefore, it is expected that dissociative symptoms in BPD would be present during states of high stress but not during calm or relaxed states. To investigate this, Stiglmayr et al. assessed dissociative symptoms and subjective ratings of stress every 60 min for 48 hr in 51 BPD patients, 51 clinical control participants (major depression, $n = 25$; panic disorder, $n = 26$), and 40 healthy control participants. As hypothesized, the increase in dissociation in relation to stress was more pronounced in BPD patients compared to those in the clinical and healthy control groups, consistent with the clinical description in *DSM–IV*. However, BPD patients did report significant dissociative experience during moderate stress states as well.

Glaser, van Os, Mengelers, and Myin-Germeys (2007) also investigated how BPD patients react to stressful situations. Perceived subjective stress associated with daily events and emotional reactivity were assessed using EMA in 44 BPD patients, 42 patients with psychotic disorder, and 49 healthy control participants. Results revealed that BPD participants reported significantly more emotional reactivity to daily life stress compared to both patients with psychosis and healthy control participants, as evidenced by a larger increase in negative affect and a larger decrease in positive affect following the experience of stress.

Depression. Concerning depression, a straightforward example of a context-sensitive analysis is the assessments of symptoms in relation to the time of day. This has been investigated multiple times in patients with major depressive disorder, concerning diurnal variation of mood. For example, Peeters, Berkhof, Delespaul, Rottenberg, and Nicolson (2006) examined reports of positive affect and negative affect over 6 days (10 prompts per day) from 47 depressed outpatients and 39 healthy control participants. Relative to healthy control participants, depressed individuals exhibited increasing positive affect levels during the day with a later peak, whereas depressed persons' negative affect exhibited a more pronounced peak in the morning compared to the healthy individuals'.

Myin-Germeys and colleagues have conducted multiple studies on stress reactivity in clinical disorders over the last decade (for an overview see Oorschot, Kwapil, Delespaul, & Myin-Germeys, 2009, in this special section). For example, Myin-Germeys et al. (2003) investigated emotional reactivity to small disturbances in daily life in patients with nonaffective psychosis ($n = 42$), bipolar disorder ($n = 38$), major depression ($n = 46$), and 49 healthy control participants. Multilevel regression analyses revealed an increase in negative affect in major depression, a decrease in positive affect in bipolar disorder, and both an increase in negative affect and a decrease in positive affect in nonaffective psychosis in association with the subjectively stressful situations, compared to the control participants.

Using a similar research design in a genetically informative sample, Wichers et al. (2007b) investigated whether the propensity to experience negative affect in response to daily life stressors may be an important depression endophenotype. They used EMA to collect multiple appraisals of daily life event-related stress and negative affect in 279 female twin pairs. Interestingly, participants whose cotwins were diagnosed with lifetime depression showed a larger mood response to stress than those with cotwins without such a diagnosis. As this effect was independent of probands' current depressive symptoms and was to a greater extent present in monozygotic twins than in dizygotic twins, it suggests that this tendency may represent a depression endophenotype. Using a similar sample, Wichers et al. (2007a) reported that positive emotions buffer genetic risk for depression.

Assessment implications. Even though several EMA studies reveal context-dependent symptomatology, standard assessment tools in psychopathology still rely on time frames in their instructions (e.g., over the last 2 weeks) rather than on contexts. Thus, it is unclear whether certain symptoms are elicited by, maintained by, or the result of specific events or contexts. Although EMA is well-suited for context-sensitive assessment and analysis, the quality of findings, again, depends on the time sampling strategy used. Whereas situations or contexts with a sufficient base rate are not problematic, rare situations or events might be better studied with retrospective assessments. For example, if the research question focuses on differences in self-esteem between situations associated with a suicide attempt and other situations, EMA may not be useful or efficient. It might take months before a suicide attempt is made, even in a sample of individuals prone to attempts. Despite these limitations, EMA studies have been successfully used to assess not only situational aspects and their influence on daily experience but also appraisals of the situation, ongoing coping behavior, and its influence on symptomatology (Havermans, Nicolson, & deVries, 2007; Tennen, Affleck, & Zautra, 2006; Voelkl & Mathieu, 1993).

Interactive Assessment With EMA

Interactive assessment indicates that the answer given to a current question affects future questions, beeps/prompts, or feedback (Fahrenberg, 1996). A simple form of interactive EMA is branching, mainly used to reduce patients' assessment burden. For example, symptoms related to self-injurious behavior might be assessed only when this behavior actually occurs. However, branching can have drawbacks. Stiglmayr et al. (2005) sought to investigate whether decreases in aversive tension states were a result of self-injuring behavior. To limit patients' burden, the electronic diaries were programmed to present questions about self-injurious behavior when the level of aversive tension dropped a predefined amount within 2 hr. Later, the authors became interested in whether aversive tension is always reduced following self-injurious behavior. Unfortunately, this question could not be answered because self-injurious behavior was queried only during decreases of aversive tension and not during increases. The lesson to be learned is that one must carefully consider whether branching may limit additional data analyses.

A second form of interactive EMA is EMA with individually tailored moment-specific feedback. Solzbacher, Böttger, Memmesheimer, Mussgay, and Rüddel (2007) used EMA to investigate affective dysregulation in patients with chronic posttraumatic stress disorder, bulimia nervosa, and BPD. Using a cell phone, patients rated perceived level of emotions and distress at four randomly selected times throughout the day for more than 3 weeks. When patients reported high levels of distress, they automatically received a reminder on how to regulate their distress. An additional prompt investigated the usefulness of this advice. The authors reported encouraging preliminary findings of this ongoing study.

In a single case study, Hareva, Okada, Kitawaki, and Oka (2009) added a real-time advice function and real-time reporting function as a supportive intervention to an EMA system. In a patient with depressive disorder, the compliance rate was high and a stabilizing trend for psychopathological symptoms was observed after the patient applied the real-time advice.

Assessment implications. Individually tailored moment-specific feedback with EMA is a promising treatment (and perhaps prevention) approach. Unlike many other forms of intervention, behavior can be modified as it is occurring in everyday life. Thus, the problem of implementing and generalizing behavior learned in treatment sessions to everyday life, an issue for most forms of psychological treatment, is minimized. However, as is clear from above, EMA with interactive feedback targeting mood disorders, and other disorders as well, is still in its infancy.

The Assessment in Real-Life Situations to Enhance Generalizability

An obvious advantage of EMA is the assessment of people in their natural environments; symptoms are studied where patients suffer from them—in everyday life. Therefore, EMA renders experimental symptom induction unnecessary, improving construct, ecological, and external validity. Obviously, the most convincing way to demonstrate that a laboratory symptom induction is valid is

to compare these symptoms with symptoms assessed outside the laboratory. However, sometimes findings differ between real life and the laboratory.

BPD. BPD laboratory studies have largely failed to find a consistent psychophysiological pattern of affective dysregulation. However, psychophysiological indices of affective dysregulation have been observed successfully in EMA studies (Ebner-Priemer et al., 2008; Ebner-Priemer, Welch, et al., 2007; Lieb et al., 2004). It seems reasonable to speculate that the affect induction methods used in laboratory studies were insufficient to evoke affective dysregulation that is characteristic of BPD, and more personally relevant provoking stimuli are necessary in laboratory studies.

Depression. In studies of depression there are further examples where laboratory and EMA investigations do not come to the same conclusions. One example is the study of Conrad, Wilhelm, Roth, Spiegel, and Taylor (2008). These investigators did not find group differences between depressed and nondepressed participants with elevated risk for cardiovascular disease regarding cortisol and heart rate variability in everyday life, even though the effects for physical activity and breathing pattern were rigorously controlled. Interestingly, the same research group found group differences in an earlier study in a laboratory stress task (Taylor et al., 2006). Therefore, the authors concluded that findings may vary by situation (laboratory stress testing vs. measurement in everyday life).

Other disciplines also offer examples showing that phenomena outside the laboratory may be different. The office hypertension or white coat effect, which refers to the finding that blood pressure readings made by a physician in a clinic or in the laboratory setting are higher than those recorded in 24-hr ambulatory blood pressure assessment, has been replicated in hundreds of studies. The implication is that hundreds of thousands of people may have been misdiagnosed, and possibly mistreated, because of the white coat effect (Hansen, Jeppesen, Rasmussen, Ibsen, & Torp-Pedersen, 2006). This serves as an instructive example of how risky it can be to generalize solely on the basis of laboratory experiments or findings in artificial situations. As clinical researchers, we might also ask ourselves whether the lack of data from daily life experience of patients may hinder progress in our discipline as well.

Assessment implications. Studies demonstrating improved construct, ecological, and external validity in EMA studies compared to laboratory studies are rare. Although it is tempting to assume that assessing symptoms in everyday life is the most valid method, validity must be demonstrated empirically. The superior validity of everyday life assessment in EMA will be demonstrated through comparisons to other important external criteria. The task for future research will be to identify relevant external validators for our constructs and to conduct studies that evaluate the construct validity of EMA data. Finally, even within an EMA approach, it is important to remember that inadequate item selection or inappropriate matching between sampling design and the construct of interest can also threaten validity.

EMA to Assess and Predict Treatment Progress

Strictly speaking, "EMA to assess and predict treatment progress" is not an advantage of EMA. However, assessing and predicting treatment progress is one way to address the construct validity issue as mentioned above. In theory, EMA should lead to "better" predictions regarding treatment progress, recovery, and relapse compared to retrospective questionnaires; EMA avoids retrospective biases and does assess behavior in everyday life. There are now some treatment studies that deal with the topic of the added value of EMA, though sometimes not explicitly.

Depression. Targeting depression, Lenderking et al. (2008) conducted a randomized, open-label study to investigate if an antidepressant response can be detected more rapidly with daily assessment than with standard weekly assessment approaches. Consistent with their hypothesis, survival analyses revealed that daily diaries detected therapeutic effects more quickly than did standard weekly clinic assessments, across most outcome measures. In addition to supporting the validity of EMA, these findings raise the possibility that drug and placebo effects might be easier to separate using daily diary assessment.

In a study by Gunthert, Cohen, Butler, and Beck (2005), outpatients with depression and/or anxiety diagnoses completed daily assessments of stressors and associated appraisals, negative cognitions, coping strategies, and negative mood for 1 week. The investigators found that the patients' initial ability to cope with daily stress was associated with rates of improvement in cognitive therapy. In a recent study from this team, Cohen et al. (2008) demonstrated that negative affect "spillover" from one day to the next was negatively associated with early treatment response in cognitive therapy.

Barge-Schaapveld and Nicolson (2002) used EMA to assess effects of antidepressant treatment on the quality of daily life and related aspects of daily life experience in patients with major depression. Patients were randomly assigned to imipramine (n = 32) or placebo (n = 31) conditions. EMA monitoring revealed the effects of depression and antidepressant treatment on well-being, mood states, physical complaint, pleasure from activities, and activities themselves. Effects such as these are difficult to identify using non-time-sensitive assessment strategies. Another potential benefit of EMA was revealed in that only a small percentage of patients who showed an increase in specific physical complaints in EMA responses ended up reporting these as side effects to their general practitioner. For example, increased dizziness was reported by 35 patients using EMA, whereas only seven patients reported increased dizziness to their general practitioner. Importantly, EMA-reported side effects of medication were associated with decrements in quality of life, and patients who showed strong associations between side effects and decrements in quality of life were overrepresented among subsequent treatment dropouts.

Volkers et al. (2002) evaluated the effects of antidepressants on 24-hr motor activity in 52 inpatients with major depression. Motor activity was monitored by wrist-actigraphy during a medication-free period and after 4 weeks of treatment. Interestingly, the authors found asynchronous treatment effects, as clinical ratings of psychomotor retardation were not temporally related to changes in activity pattern over treatment as assessed by wrist-actigraphy. Again, this highlights the importance of assessing behavioral and activity patterns directly when possible and not solely through self-reports.

In a pilot study, Stanley, Fairweather, and Hindmarch (1999) demonstrated that activity measured by continuous actigraphy over 10 days was reduced in a depressed patient group receiving dothiepin compared to a group receiving fluoxetine. Importantly, the presumably treatment-induced augmentation of early morning

inertia was already apparent during the first 10 days of treatment, which is clearly before positive treatment effects usually begin for this kind of medication. Having negative side effects, like inertia, before positive treatment effects take place, may threaten medication compliance.

Winkler et al. (2005) investigated participants with seasonal affective disorders in the beginning and at the end of bright light therapy. Compared to healthy control participants, patients evidenced disturbed activity patterns and circadian rhythms as measured by actigraphy during everyday life. Bright light therapy normalized the altered activity pattern. Raoux, Benoit, Dantchev, and Denise (1994) investigated 24-hr motor activity in 26 inpatients with major depression at treatment onset and again after 4 weeks of antidepressant therapy. Diurnal hypoactivity and reduced 24-hr rhythm amplitude were found at treatment onset. Activity level increased significantly on discharge, suggesting positive medication effects on depression.

Conclusion

In this review, we highlighted multiple times that the assessment method itself tremendously affects our perspective on the nature of mood symptoms. Consider a retrospective depression questionnaire that sums up the level of symptoms experienced over the last 7 days. Using this kind of retrospective questionnaire, we will likely conceptualize depression as a mostly stable and context-independent disorder. However, using EMA, we may discover that depressive symptoms actually fluctuate within each day, showing a significant degree of variability both within and across days. We may also observe that certain external and internal events trigger depressive mood, like interpersonal conflict or thoughts of feeling rejected. Such triggers are important starting points both for understanding the etiology and maintenance of depression as well as for informing potential interventions to relieve depression. In addition to facilitating the assessment of dynamic processes and context-specific relationships in real time, multimodal assessment, interactive feedback in real time, and the assessment in real life are advantageous features of EMA. Some even consider EMA to be the gold standard of assessment of everyday life experience (Kahneman et al., 2004).

Although promising, EMA is not yet a standard clinical assessment tool for mood disorders and mood dysregulation for at least two major reasons. First, if clinicians want to assess symptoms in depressive disorders, they can choose from a wealth of state and trait questionnaires or perhaps retrospective clinical interviews. However, if they want to study depressive symptoms using EMA, there is no standard protocol or set of items to choose from. Researchers are confronted with constructing their own electronic diary (e-diary) questionnaire. Second, even though EMA might seem to enjoy enhanced reliability and validity over traditional measures, by providing more ecologically valid assessment and by limiting retrospective distortions, this must be demonstrated empirically. In order to address these concerns, we encourage the development and use of standardized e-diary questionnaires for a variety of clinical conditions so that comparisons across studies can be made.

Unfortunately, the process of developing an e-diary questionnaire and protocol presents additional challenges beyond those faced in developing a trait questionnaire. Specifically, there is an important additional dimension to consider: time. Clinical researchers not only have to select items but also to designate appropriate time sampling strategies. Therefore, a future challenge within EMA research on mood disorders and mood dysregulation is to develop standardized e-diary questionnaires, including standard sets of items for specific mood disorders and syndromes with proven reliability, validity, and sensitivity to change, as well as appropriate time sampling strategies for these standard sets of items which fit the temporal dynamics of the processes of interest. Aside from one article about the structural validity, sensitivity to change, and reliability of a short scale to measure basic dimensions of mood (Wilhelm & Schoebi, 2007), there appears to be little guidance on how to calculate the psychometric properties of EMA data. How best to determine an appropriate time sampling protocol is discussed elsewhere (Ebner-Priemer & Sawitzki, 2007).

It is important to acknowledge that EMA has its limitations, too. First, as mentioned above, standardized item sets with proven psychometric criteria are currently not available (see Haynes & Yoshioka, 2007, for an excellent methodological review on this topic). Second, experimental control of confounding variables is limited, but statistical control has been successfully used by self-reports of context information and by assessing various confounding effects like temperature, physical activity, and breathing pattern (Bussmann et al., 2009; Houtveen & de Geus, 2009). Third, data analysis in EMA can be complex, but there is more and more literature demonstrating how hierarchical structure, in which multiple assessment points are nested within subjects, can be modeled (Bolger, Davis, & Rafaeli, 2003; Jahng et al., 2008; Schwartz & Stone, 2007; Walls & Schafer, 2006; Wilhelm, 2001). There are also articles on design issues (Fahrenberg & Myrtek, 2001; Piasecki, Hufford, Solhan, & Trull, 2007; Shiffman, 2007). Fourth, there is a prevailing concern that patients may either break or sell their EMA devices (e.g., for alcohol or drugs). Even though there is limited evidence for such problems in published articles, we recommend using cheap devices and providing study reimbursement after receiving back EMA devices. Similarly, there is good evidence that EMA can be used with so-called "difficult" patients, like those with BPD or psychosis. Patient compliance in EMA is usually very good, with rates up to 90% or more (Ebner-Priemer & Sawitzki, 2007; Hufford, 2007; Mehl et al., 2007). Concerning reactivity, studies have not found much evidence for this influence on EMA reports (Lenderking et al., 2008; Mehl et al., 2007; Stone et al., 2003). However, both issues depend on the time sampling strategy used. Increasing the number and frequency of the assessment points markedly will increase patient assessment burden and may ultimately reduce compliance and increase reactivity. Fifth, the use of mobile devices currently is more expensive than traditional questionnaire approaches to data collection. However, mobile devices are becoming cheaper, and there is no need to transform the data from paper into electronic form, a task that can be both expensive and subject to error (for an overview on affordable hardware and software solutions, see Ebner-Priemer & Kubiak, 2007).

We view EMA and laboratory experiments not as fundamentally opposed alternatives but instead as complementary approaches. EMA can address specific research questions that might not be investigated sufficiently using only laboratory or questionnaire studies. On the other hand, laboratory experiments allow concise testing of hypotheses under the most stringent methodical isolation

of the phenomena. Combined research strategies can lead us beyond the perennial struggle of internal versus external/ecological validity (Fahrenberg et al., 2007). For example, Putnam and McSweeney (2007) demonstrated in depressed patients that lower bilateral prefrontal cortex activity assessed by electroencephalography in the laboratory predicted higher levels of rumination in everyday life. Similarly, Silk et al. (2007) demonstrated in children with major depression that papillary reactivity to emotional information in the laboratory is associated with higher levels of negative affect in the natural environment. Forbes et al. (2009) investigated adolescents with major depressive disorder and adolescents with no psychiatric disorders using a functional magnetic resonance imaging guessing task. Results supported models of altered reward processing and indicate that depressed adolescents' brain response to monetary reward is related to their affective experience in everyday life. We applaud this new wave of studies combining EMA with laboratory approaches and challenge more investigators to follow suit.

The effort to implement EMA as a standard assessment tool in clinical practice is still in its infancy. In addition to standardized sets of reliable and valid items for different disorders, it would be ideal to develop and implement EMA software that can be uploaded to patients' own mobile phones, reducing the costs of EMA, and data programs that can quickly analyze and print (or send electronically) the relevant information reported by the patient. Fortunately, several research groups are working on these applications. This would result in a possible scenario wherein a new patient's phone number would be assigned to a computer system, which would send disorder-specific questions wirelessly at predetermined time intervals. At the next treatment session (or even earlier), the therapist would receive a one-page symptom chart, describing the intensity, frequency, instability of symptoms, and relations to contextual triggers. This could serve as a starting point for further assessment, treatment planning, and treatment intervention. Fortunately, compliance in EMA studies appears to be fairly good. Our own experience suggests that compliance is heavily influenced by the interest which researchers show to the personal problems of mental health patients in their everyday life. Therefore, we would expect similar if not higher rates of compliance in everyday clinical practice.

In summary, our review of EMA studies of mood disorder and mood dysregulation highlighted several desirable features, like real-time assessment, assessment of dynamic process, multimodal assessments, assessment of context-specific relationships, interactive feedback, assessment in real life, and assessing and predicting treatment response. However, before clinicians and researchers can fully profit from these benefits, a set of standardized e-diary questionnaires including time sampling protocols with proven reliability, validity, and sensitivity to change have to be developed. Fortunately, we are aware of research groups that are conducting the studies that will lay the foundation necessary to achieve these goals.

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