Psychological Medicine (2009), **39**, 1533–1547. © 2009 Cambridge University Press
doi:10.1017/S0033291708004947 Printed in the United Kingdom

ORIGINAL ARTICLE

Experience sampling research in psychopathology: opening the black box of daily life

I. Myin-Germeys[1,2,3]*, M. Oorschot[1]†, D. Collip[1]†, J. Lataster[1]†, P. Delespaul[1] and J. van Os[1,4]

[1] *Department of Psychiatry and Neuropsychology, South Limburg Mental Health Research and Teaching Network, EURON, Maastricht University, Maastricht, The Netherlands*
[2] *Section Social Cognition, Mondriaan Zorggroep, Heerlen, The Netherlands*
[3] *School of Psychological Sciences, University of Manchester, UK*
[4] *Division of Psychological Medicine, Institute of Psychiatry, London, UK*

A growing body of research suggests that momentary assessment technologies that sample experiences in the context of daily life constitute a useful and productive approach in the study of behavioural phenotypes and a powerful addition to mainstream cross-sectional research paradigms. Momentary assessment strategies for psychopathology are described, together with a comprehensive review of research findings illustrating the added value of daily life research for the study of (1) phenomenology, (2) aetiology, (3) psychological models, (4) biological mechanisms, (5) treatment and (6) gene–environment interactions in psychopathology. Overall, this review shows that variability over time and dynamic patterns of reactivity to the environment are essential features of psychopathological experiences that need to be captured for a better understanding of their phenomenology and underlying mechanisms. The Experience Sampling Method (ESM) allows us to capture the film rather than a snapshot of daily life reality of patients, fuelling new research into the gene–environment–experience interplay underlying psychopathology and its treatment.

Received 17 April 2008; Revised 16 October 2008; Accepted 8 November 2008; First published online 12 February 2009

Key words: Daily life, ESM, momentary assessment, psychopathology, structured diary method.

Introduction

There is an expanding interest in research with a specific focus on the experience of psychopathology in the realm of daily life. Developments in several scientific disciplines have fuelled the need for a momentary, daily life approach. In epidemiology, focus is shifting from observations of the macro-environment to the more detailed study of the micro-environment (McGrath, 2007). In psychology, there is an increased awareness that psychological models of psychopathology are essentially dynamic over time, requiring multiple assessments (Bentall, 2003). Cognitive science has focused on experiences as being embodied and situated, providing a powerful rationale for investigating experiences in the context in which they are occurring (Robbins & Aydede, 2008). Finally, there is a growing need to ecologically validate experimental and laboratory findings (Koren *et al*. 2006). The study of persons in the context of normal daily life may provide a powerful and necessary addition to more conventional and cross-sectional research strategies in psychopathology (Table 1). The current paper provides a review of momentary assessment studies in psychopathology, with a focus on (1) phenomenology, (2) underlying mechanisms and aetiology, (3) dynamic psychological models, (4) biological mechanisms, (5) the application to treatment research and (6) gene–environment interactions.

Momentary assessment strategies

Momentary assessment strategies that are used most frequently are the Experience Sampling Method (ESM) (Delespaul, 1995; Hektner *et al*. 2007) and the Ecological Momentary Assessment (Stone & Shiffman, 1994; Shiffman *et al*. 2008) (both methods hereafter called the ESM). The ESM is a structured diary method in which subjects are asked in normal daily life to report their thoughts, feelings and symptoms, and also the context (e.g. location, company, activity) and the appraisal of the context. Both open-ended questions and self-report Likert scales have been used. The reports typically have to be filled out several times a day (Fig. 1) during several consecutive days, either at random unpredictable moments, signalled by a beeper or alternatively, triggered by an event of interest (e.g.

* Address for correspondence: Dr I. Myin-Germeys, Department of Psychiatry and Neuropsychology, Maastricht University, PO Box 616 (VIJV), 6200 MD Maastricht, The Netherlands.
(Email: i.germeys@sp.unimaas.nl)
† These authors contributed equally to this work.

Table 1. *The pros and cons of the Experience Sampling Method* (*ESM*) (*see also Fig. 1*)

Advantages
(1) It is an assessment in the moment, which makes it less vulnerable to recall bias.
(2) It is an assessment in the real world, not in the laboratory, thus improving ecological validity.
(3) It yields multiple assessments including assessments of context, constituting an excellent tool to study the interaction with contextual features.
(4) Unconscious processes may be made explicit in the data.
(5) The longitudinal character of the data allows investigating variation over time.
(6) New statistical approaches such as multi-level and mixed-effects models allow analysing the unbalanced hierarchic ESM data sets with variation at the level of the subject and at the level of the moment (Schwartz & Stone, 1998; Hedeker *et al*. 2008).
Limitations
(1) The ESM is time-consuming and demanding for participants.
(2) Although the ESM has a longitudinal structure, most of the effects will not last over beeps and therefore still require cross-sectional analyses. Shortening the time intervals between beeps may be one way to adapt the design to the temporal dynamics of the processes of interest (Ebner-Priemer & Sawitzki, 2007). However, this may increase the intrusiveness of the method, possibly resulting in induced rather than recorded experiences.
(3) The ESM could easily induce experiences. Researchers should carefully construct the ESM questionnaire and balance the number of reports to avoid reactivity to the method.
(4) Compliance with the research protocol is not guaranteed because subjects are conducting the study during the course of everyday life, without the presence of the researcher. This is particularly true for ESM studies using a paper-and-pencil approach instead of electronic diaries. Some authors have put doubt on the reliability and subject compliance in paper-and-pencil ESM studies, favouring the use of electronic devices (Stone *et al*. 2002, 2003; Broderick *et al*. 2003). However, two recent studies have suggested acceptable compliance rates (>80%) in paper diary methods yielding similar findings to electronic diaries (Jacobs *et al*. 2005; Green *et al*. 2006).

when someone is in contact with other people). In the paper-and-pencil version, subjects carry a digital wristwatch and a set of questionnaires collated in a booklet for each day. More recently, software packages have been developed for running these studies on palmtop computers (Schärer *et al*. 2002; Kimhy *et al*. 2006; Le *et al*. 2006; Granholm *et al*. 2008), providing equivalent results (Gwaltney *et al*. 2008).

Thought sampling is another quantitative method sampling daily life experiences, specifically quantifying characteristics of thinking (Hurlburt, 1990, 1997). Other ambulatory assessment technologies include instruments monitoring real-time biological phenomena (Fahrenberg & Myrtek, 1996, 2001) and end-of-day diaries, such as the ChronoRecord (Bauer *et al*. 2008), requiring one report a day for a number of days. As the current review aimed to investigate severe mental illness in terms of momentary mental processes in interaction with contextual features, only ESM studies are included that assess momentary self-reports at least twice a day.

Method

This review includes all ESM studies in psychopathology published since 1992, when the book *The Experience of Psychopathology: Investigating Mental Disorders in their Natural Settings* (de Vries, 1992) was published. The database PubMed was screened for published studies between 1992 and 2008 using the keywords 'experience sampling method*', 'momentary assessment*' and 'ecological momentary assessment*'. Abstracts were screened and articles were selected that used the actual ecological momentary assessment or the ESM to study psychopathology with the exclusion of chronic pain and addiction. In addition, a first- and last-author bibliographical search was conducted for all papers resulting from the first search. Finally, several general ESM review papers were screened for papers on ESM and psychopathology (Moskowitz & Young, 2006; Shiffman *et al*. 2008; www.ambulatory-assessment.org).

Phenomenology

The ESM enables a more detailed understanding of psychiatric phenomenology. When are psychiatric symptoms present? Do they fluctuate over time? How do they impact on daily functioning and what contextual conditions trigger, accompany or follow symptoms in the flow of daily life? This knowledge would allow for a better understanding of the phenomena,

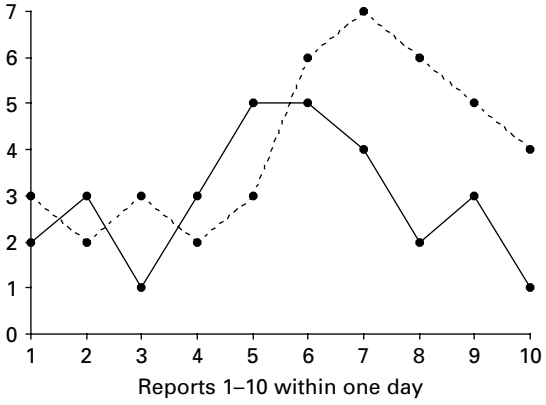

Fig. 1. The Experience Sampling Method (ESM) provides multiple observations within one person, enabling researchers to investigate variation over time and patterns of covariation between different variables, e.g. variables *y* (—●—) and *z* (- -●- -).

the underlying mechanisms, but also of the targets for treatment.

Affective disorders

Disturbed mood is the most prominent feature of mood disorders. However, there is little systematic information on how depression alters the dynamics of mood states in daily life. Peeters *et al*. (2006) found a more pronounced diurnal rhythm and more variability from moment to moment of negative affect in depressed patients compared to controls. Moreover, depressive persons exhibited increasing positive affect levels over the day with a later acrophase relative to healthy controls. This was replicated in a study investigating diurnal mood variation in depression in non-clinical individuals (Murray, 2007). However, in this study the circadian function of positive affect was attenuated in the depressed group.

Depressed patients were found to experience lower levels of momentary quality of life that were mediated by momentary experiences of positive and negative affect, physical complaints and enjoyment of activities (Barge-Schaapveld *et al*. 1999). Depression also had an effect on work performance with significant decrements in task focus and productivity, equivalent to about 2.3 days of sickness per month (Wang *et al*. 2004).

The ESM has also been used to study depression in children and adolescents (Axelson *et al*. 2003). One study reported more caffeine use and sleep problems in youth with major depression compared to healthy youngsters (Whalen *et al*. 2008). Youngsters with a depressive disposition were more likely to smoke, have the urge to smoke, and drink alcohol (Whalen *et al*. 2001). Depressive symptoms and problem behaviour have also been related to intense and labile emotions and less effective emotion regulation in adolescents (Silk *et al*. 2003).

Only two studies used the ESM to investigate bipolar disorder. It was shown that patients with bipolar disorder spent more time in passive leisure activities and were more often alone at home compared to controls (Havermans *et al*. 2007). Mean levels of self-esteem and affect were not abnormal in remitted bipolar patients. However, bipolar patients showed strong fluctuations in both affect and self-esteem (Knowles *et al*. 2007). The ESM thus allowed for a better understanding of dynamic mood changes over time and the situational determinants thereof.

Psychotic disorders

The phenomenology of positive symptoms of psychosis has been investigated extensively with the ESM. Delespaul *et al*. (2002) revealed that, contrary to what was expected, visual hallucinations in daily life were reported most frequently whereas auditory hallucinations were experienced with a higher intensity. The intensity of hallucinatory experiences was influenced by several contextual moderators, including social context and activity level (Delespaul *et al*. 2002). Delusional moments were found to be present only one-third of the time and were accompanied by high negative and low positive affect. They were also found to be influenced by social factors and activity level (Myin-Germeys *et al*. 2001*a*). The importance of the dynamics of social context was emphasized by another ESM study (Verdoux *et al*. 2003*b*), showing that dynamic changes in social company were even stronger predictors of psychotic experiences in persons at risk for psychosis than social contact *per se*. These data thus show that psychosis is driven by subtle person–environment interactions in the stream of daily life.

Negative symptoms of psychotic disorders have also been studied using the ESM. Myin-Germeys *et al*. (2000) studied flat affect in daily life and found schizophrenia patients to be more emotionally active and responsive than is assumed using behavioural and external observations. A study on anhedonia showed that schizophrenia patients displayed a deficit in anticipatory pleasure (pleasure related to future events) but not in consummatory pleasure (pleasure when directly engaging in an activity) (Gard *et al*. 2007). Furthermore, social anhedonia was characterized by increased time spent alone, a greater preference for solitude and less positive affect (Brown *et al*. 2007). Psychosis-prone individuals were not

more socially withdrawn, depressed or anxious in general. However, they spent more time doing nothing and reported higher levels of depression and anxiety in specific environmental or social situations (Husky *et al*. 2004). ESM data may thus provide a better insight into the true nature of the phenomena as they unfold in daily life.

Anxiety disorders

Only a few studies have been conducted in the area of anxiety disorders, a domain in which situational triggers are often of importance in eliciting symptoms. Dijkman-Caes *et al*. (1993) compared behavioural aspects of panic disorder patients with and without agoraphobia and, contrary to expectation, found no difference between groups regarding the amount of time spent in public places. Panic subjects with agoraphobia did, however, spend significantly more time at home and with their families than did panic patients without agoraphobia and normal controls. Kenardy *et al*. (1992) found that the prediction of panic was a significant precursor of an actual panic attack, but not the level of anxiety, threat or experience of control. Expectation of panic attacks was also associated with panic occurrence, as well as elevated sense of danger, helplessness, avoidance and catastrophic thoughts (Kenardy & Taylor, 1999). Expected panic attacks did not differ from unexpected attacks in the experience of the actual attack but, rather, levels of distress and arousal preceding the attack were higher in expected panic attacks.

De Beurs *et al*. (1992) demonstrated that self-monitored incidence of panic attacks was lower than incidence rates obtained through retrospective estimation. Similarly, in patients diagnosed with obsessive–compulsive disorder (OCD), retrospective recall as opposed to ecological momentary assessment led to overestimation of symptom covariation with non-symptomatic variables such as stress and loneliness (Gloster *et al*. 2008). These findings challenge current diagnostic conceptualizations of panic disorder subtypes based on retrospective reports and call for more momentary research in the study of anxiety disorders and OCD.

Eating disorders

The feasibility and validity of using a momentary approach to test models of eating disordered behaviour have been demonstrated (Stein & Corte, 2003; Engel *et al*. 2005), emphasizing the importance of proximal antecedents (Smyth *et al*. 2001). Negative affect, and more specifically anger, in addition to low positive affect and dissociative experiences were found to precede a binge in the flow of daily life in both bulimia nervosa and binge eating disorder (Greeno *et al*. 2000; Alpers & Tuschen-Caffier, 2001; Steiger *et al*. 2005; Engel *et al*. 2007; Smyth *et al*. 2007; Stein *et al*. 2007; Wonderlich *et al*. 2007*a*). Of note, several studies in patient samples and one in a student sample (Wegner *et al*. 2002) found a deterioration of mood and self-perception after a binge, showing that binge eating may not be effective for regulating mood and self-perception (Steiger *et al*. 1999, 2005; Wegner *et al*. 2002; Engelberg *et al*. 2007; Hilbert & Tuschen-Caffier, 2007; Stein *et al*. 2007). Smyth *et al*. (2007), however, reported an increase in positive affect and a decrease in negative affect and anger after binge or vomit episodes in bulimia patients. A study that differentiated between the consequences of binging and purging behaviour reported a return to pre-binge mood state levels after purging but an increase in negative affect after binging. This study underlined that not the amount of negative mood but rather the association between negative mood and the desire to eat is specific for bulimia (Alpers & Tuschen-Caffier, 2001). Binge episodes were found to be preceded by poorer than average self-concepts, poorer than average social experiences (Steiger *et al*. 2005, 1999) and potent family hassles (Okon *et al*. 2003). Bulimic individuals also showed larger increases in self-criticism following negative social interactions, suggesting a hypersensitivity to social interactions in bulimia (Steiger *et al*. 1999). Finally, dietary restraint has been shown to precede binge cravings whereas elevated binge cravings seem to predict actual binge episodes (Steiger *et al*. 1999; Engelberg *et al*. 2005). This association, however, was not revealed in impulsive binge eaters (Steiger *et al*. 1999).

Two studies used ESM data to validate different subtypes of bulimia nervosa by examining differences in disordered eating behaviour and patterns of affect. Wonderlich *et al*. (2007*a*) found increased levels of binging and purging on a daily basis in the interpersonal-emotional subtype, whereas Myers *et al*. (2006) related multi-impulsive bulimia to increased impulsive and self-damaging behaviour but not to differences in eating behaviour compared to other subtypes of bulimia. It has also been shown that previous experience of childhood maltreatment may impact on mood and eating behaviours in bulimia nervosa (Wonderlich *et al*. 2007*b*). Sexual abuse was related to increased purging and self-destructive behaviours whereas emotional abuse was related more specifically to anger. It is important to understand this heterogeneity in bulimia nervosa in tailoring treatments to the styles and needs of different patients.

ESM studies on anorexia nervosa are less numerous. One case study (Vansteelandt *et al*. 2004) revealed

that a tendency to be physically active is related to emotional experiences and weight preoccupation in anorexia nervosa. A larger ESM study (Vansteelandt *et al*. 2007) indicated that lower body mass index was associated with higher levels of both the urge to be physically active and physical activity itself. In addition, self-discrepant beliefs may lead to affective lability in patients with anorexia nervosa, which in turn may lead to more restrictive behaviour and rituals. Both affect lability and restrictive behaviour were significantly exacerbated by stressful events (Engel *et al*. 2005).

Attention deficit hyperactivity disorder (*ADHD*)

An ESM study on ADHD in adults revealed that the two ADHD symptom dimensions in adults were differentially associated with daily experiences (Knouse *et al*. 2008). Inattentive symptoms were positively associated with indices of general distress, whereas hyperactive-impulsive symptoms were unrelated to overall affective states and self-reported concentration problems but were associated with reduced sensitivity to contextual factors in perceptions of situations. Another study in children with ADHD and their mothers revealed that the preparatory tasks of daily living are especially challenging and linked disproportionately to child behaviour problems, parent negative affect and contentious interactions (Whalen *et al*. 2002, 2006*a*). Mornings and weekends were found to be particularly challenging for ADHD children and their parents. Mothers of children with ADHD were found to have lower parenting esteem and elevated levels of anger in the company of their children (Whalen *et al*. 2006*b*). A study investigating the effects of nicotine suggested that smokers with ADHD experience nicotine-related reductions in ADHD symptoms during daily life (Gehricke *et al*. 2006).

Pervasive developmental disorder

Only one study used the ESM to investigate autism spectrum disorders. In 1994, the inner experiences of three persons with Asperger syndrome were investigated using the ESM. Two persons reported inner experiences whereas one was not able to report any inner experience. Thoughts were exclusively reported as images with almost no other features of inner experience (Hurlburt *et al*. 1994).

Borderline personality disorder (*BPD*)

Given the dynamic and reactive pattern of symptoms in BPD, the ESM is an attractive method for investigating its phenomenology. Borderline patients were found to report a higher frequency and increased intensity of negative affect (Stein, 1996; Ebner-Priemer *et al*. 2007; Russell *et al*. 2007; Glaser *et al*. 2008) (Fig. 2), a lower frequency and decreased intensity of positive affect (Ebner-Priemer *et al*. 2007; Glaser *et al*. 2008), increased levels of aversive tension (Stiglmayr *et al*. 2005), and increased (Russell *et al*. 2007; Reisch *et al*. 2008) and persistent (Ebner-Priemer *et al*. 2008) anxiety and sadness in comparison to control subjects. In addition, increased levels of intra-individual variability and short-term fluctuations in overall affect valence (Stein, 1996; Ebner-Priemer *et al*. 2007; Russell *et al*. 2007; Trull *et al*. 2008), more instability on successive scores for hostility, fear and sadness (Trull *et al*. 2008) and oscillation between these (Ebner-Priemer *et al*. 2008; Reisch *et al*. 2008) were found to be important factors of the emotional dysregulation in BPD patients. Affective instability was also found to be associated with the experience of stress in the flow of daily life (Glaser *et al*. 2008), as were increased levels of dissociation (Stiglmayr *et al*. 2008). BPD patients have, furthermore, been characterized by a pattern of negative recall (Ebner-Priemer *et al*. 2006). High levels of negative mood intensity were significantly related to impulsivity, self-reported suicidal ideation and suicidal behaviours over the past year in patients with BPD (Links *et al*. 2007, 2008). Event-contingent recording research in BPD patients has revealed that their interpersonal behaviour is characterized by a tendency to jump between the pursuit and avoidance of interpersonal connectedness (Russell *et al*. 2007). These results ecologically validate the incorporation of affective and interpersonal instability and stress reactive symptoms in the diagnosis of BPD.

Phenomenology: conclusion

These data show that one of the most central characteristics of almost all symptoms observed in patients with severe psychiatric disorders is meaningful and widespread variation over time. Understanding this variation and the determinants thereof, both internal and situational, is therefore important for the diagnosis and treatment of these symptoms. Cross-sectional instruments are unable to assess this variation. As a consequence, data obtained with these instruments may not be linearly related to ESM findings.

Aetiology

Momentary assessment strategies may also constitute a powerful tool to examine underlying mechanisms relating to the onset and maintenance of psychopathology, especially when these mechanisms involve changes with regard to how persons react to or behave in certain situations or environments.

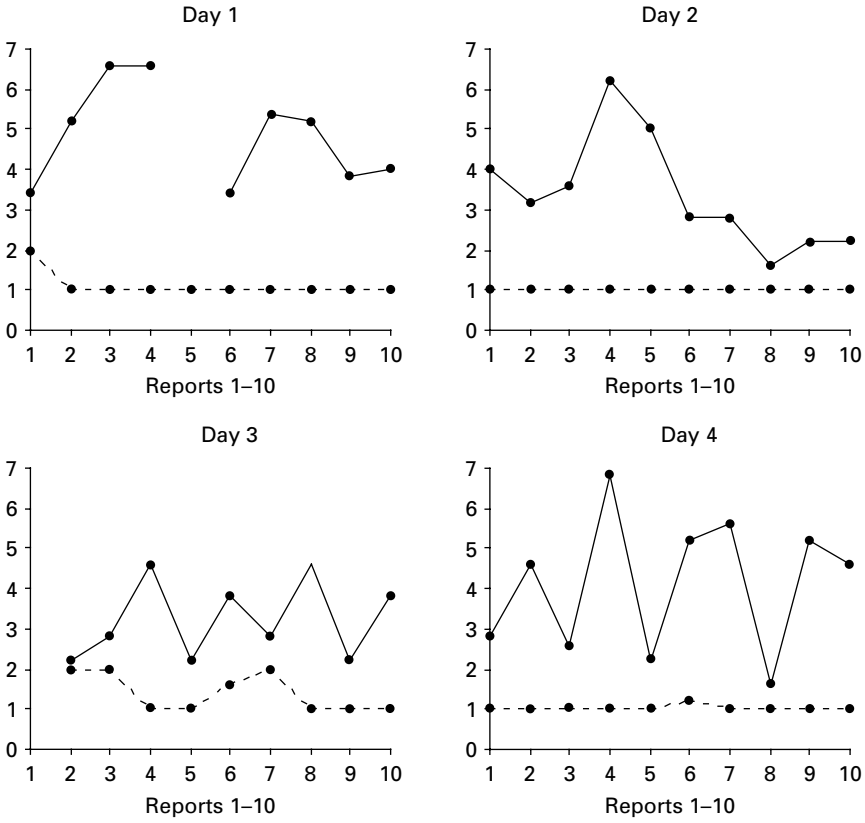

Fig. 2. Real-life data from one patient with borderline personality disorder (—●—) and one control subject (- -●- -) retrieved from the study of Glaser *et al.* (2008), showing differences between the two in level of negative affect and variability over time.

Stress

Stress has been postulated to play a role in all major psychiatric illnesses. Whereas previous research mainly focused on major life events, there is increasing evidence that the minor life events or daily hassles may be more powerful predictors of psychological symptoms (Monroe, 1983) and of subjective distress (Marco & Suls, 1993). The ESM is a useful tool to study subjective appraisals of stressful events that occur in the context of daily life, in addition to the emotional and symptomatic reactions to these events, thus providing information on the stress–person interplay.

Stress sensitivity in daily life has been investigated extensively in relation to psychosis. It has been demonstrated that small stressors predict increased emotional reactions in persons with an increased liability to psychosis (Myin-Germeys *et al*. 2001*b*; Lataster *et al*. 2008), which was more pronounced in females (Myin-Germeys *et al*. 2004). These subjects also show continuous variation in the intensity of subtle psychotic experiences associated with minor stresses in the flow of daily life (Myin-Germeys *et al*. 2005*a*). Furthermore, it has been demonstrated in two independent samples that altered stress sensitivity is independent of neurocognitive impairments, another well-known vulnerability marker for psychosis (Morrens *et al*. 2007; Myin-Germeys *et al*. 2002). It is thus hypothesized that altered stress sensitivity is an independent 'affective' pathway to psychosis, possibly underlying the dimension of positive symptoms (Myin-Germeys & van Os, 2007). This affective pathway may partly result from a sensitization process by which previous exposures to severe stress, such as life events (Myin-Germeys *et al*. 2003*a*), increase the sensitivity to small stresses in daily life, thus giving rise to a lasting behavioural liability (Collip *et al*. 2008).

In affective disorders it was found that patients with current major depression experienced fewer positive events but the same amount of negative events compared to controls, although both events were rated as more stressful (Peeters *et al*. 2003*b*). Patients with remitted bipolar disorder, however, reported similar frequencies of daily hassles compared to controls and experienced these events as equally stressful. Higher levels of depression and more previous depressive episodes in the remitted bipolar patients predicted more stressful appraisals of daily events (Havermans *et al*. 2007). The results in the bipolar and depressed

https://doi.org/10.1017/S0033291708004947 Published online by Cambridge University Press

group were compared to similar data collected in patients with psychosis. Depressed patients showed a larger increase in negative affect, bipolar patients a larger decrease in positive affect, and psychotic patients both larger increases in negative and larger decreases in positive affect compared to controls (Myin-Germeys *et al*. 2003*b*). These findings show that emotional reactivity to daily stress may constitute part of the underlying vulnerability for severe mental illness, which is most pronounced in subjects suffering from psychosis.

Cannabis use

Cannabis use has been associated with psychosis. Verdoux *et al*. (2003*a*) found, in undergraduate students, that cannabis immediately increased the intensity of psychosis and decreased feelings of pleasure, especially in participants with high vulnerability for psychosis. Henquet *et al*. (unpublished observations) extended the finding that cannabis increases hallucinatory experiences to patients with psychosis. However, they found that patients are also more sensitive to the mood-enhancing effects of cannabis. Both studies found no evidence for the self-medication hypothesis because cannabis use was not predicted by previous mood or intensity of psychosis. Tournier *et al*. (2003) reported that cannabis use did not modify the level of state anxiety in daily life and, similarly, that the likelihood of using cannabis was not influenced by state anxiety. These findings provide a better insight into the motives for and the mechanisms of cannabis use, yielding essential information for the design and improvement of treatment strategies.

Aetiology: conclusion

Some of the mechanisms underlying psychopathology may be found in the dynamic interplay between the environment and the person. The longitudinal character of the data and the assessment of both experiences and environmental features enable the investigation of subtle person–environment interplays that subjects are not always consciously aware of.

Psychological models

Psychological models generally assume dynamic interactions between different constructs. However, most research is based on cross-sectional assessments. The longitudinal character of the ESM enables the study of dynamic patterns over time, thus capturing the film rather than a snapshot of daily life reality. Psychological modelling in daily life is still in its early stages but it seems a promising approach.

Psychological processes in paranoia

A recent psychological model states that persecutory delusions (e.g. the experience that someone wants to harm you) serve as a defence against low self-esteem, although studies investigating the relationship between paranoia and self-esteem level revealed inconsistent results (Bentall *et al*. 2001). A recent ESM study, however, examined the temporal relationship between paranoid experiences and both self-esteem level and variability in individuals with variable levels of paranoia (Thewissen *et al*. 2008). Both lower self-esteem level and higher self-esteem variability were associated with higher levels of paranoia. Moreover, a temporal association between a decrease in momentary self-esteem and an increase in momentary paranoia was found. The use of the ESM, therefore, offers a plausible and intriguing explanation for the inconsistent results on the relationship between self-esteem level and paranoia, indicating that not self-esteem level *per se* but rather fluctuations in self-esteem may induce paranoia (Thewissen *et al*. 2008).

Psychological processes in depression

The helplessness–hopelessness theory of anxiety and depression describes, in addition to the depressogenic attributional style (i.e. attributing negative events to stable and global causes), the cognitive aetiology of anxiety and the co-occurrence of both mood states. According to the theory, both anxiety and depression are characterized by helplessness (i.e. attributing that events are uncontrollable) but only depression is characterized by hopelessness (i.e. attributing that negative outcomes will be stable and global) (Alloy *et al*. 1988). The ESM was used in analogue student samples to investigate the helplessness–hopelessness theory (Swendsen, 1997, 1998; Swendsen & Compagnone, 2000). Attributional style in daily life did not explain mood fluctuations but was associated with the incidence of causal attributions and perception of controllability. Although the studies provided evidence that specific causal attributions of stability and globality about negative events explain fluctuations in depressed mood, there was no support for the relationship between uncontrollability attributions and anxious mood within the flow of daily life.

Coping

Coping is related to how people deal with the problems in their daily life (Lazarus & DeLongis, 1983) and, as such, seems well suited for in-depth study with the ESM. However, relating the psychological concept of coping to real-life behaviour is complicated (Stone *et al*. 1998; Marco *et al*. 1999). Only one study

https://doi.org/10.1017/S0033291708004947 Published online by Cambridge University Press

investigated ESM measures of coping in relation to psychopathology. In this study, in a sample of patients with psychotic disorder, symptomatic coping, defined as going along with the content of psychotic symptoms (e.g. carrying out hallucinatory commands), was compared to other, non-symptomatic forms of coping. It was shown that symptomatic coping, measured by semi-structured interview, was negatively associated with ESM measures of coping in daily life whereas non-symptomatic coping was positively associated with ESM measures of coping in daily life. In addition, it was suggested that effective coping may be associated with the tendency to develop conscious appraisals of distress associated with psychotic symptoms (Lardinois *et al*. 2007).

Treatment

Momentary assessment strategies may also have clear advantages in clinical psychopharmacology and treatment studies because they provide more accurate information retrieval and have superior ecological validity (Moskowitz & Young, 2006). Furthermore, the collection of many data points reduces random error variance and increases sensitivity to detect change. In addition, daily diary methods may have added value for the assessment of medical adherence, especially in children and adolescents (Quittner *et al*. 2008). Despite these clear advantages, there are few studies applying the ESM to investigate treatment effects in psychopathology. Barge-Schaapveld *et al*. (1995) showed that clinical improvement was reflected in increased household activities, less passive leisure time and increased positive and decreased negative affect. After antidepressant treatment, responders, in contrast to non-responders, displayed a significant increase in activity level (Raoux *et al*. 1994). In a study of imipramine (a tricyclic antidepressant agent) treatment on momentary quality of life, it was shown that the treatment condition did not change overall levels of quality of life but stabilized quality of life and decreased the level of inactivity (Barge-Schaapveld & Nicolson, 2002). Treatment also decreased sensitivity to stress and, more specifically, increased reward experience (Wichers *et al*. 2008*a*). Response to treatment in depression may thus be conditional on restoration of hedonic capacity.

These studies show how the ESM may provide more fine-grained information with regard to treatment effects and adherence and more insight into the psychological mechanisms underlying response to treatment. Furthermore, studies performed in patients with generalized anxiety disorder and social phobia have shown computer-assisted ambulatory treatment to increase cost-effectiveness of cognitive behavioural therapy, while being efficient in reducing symptom levels (Newman *et al*. 1997, 1999; Anderson *et al*. 2004; Przeworski & Newman, 2004).

Biological mechanisms

Momentary assessment strategies may also be useful for understanding variation in biological mechanisms as they play out in the flow of daily life. The current review focuses on papers that combine biological assessments with self-reports of subjective experiences in the flow of daily life in patients with severe mental illness.

Stress and the hypothalamic–pituitary–adrenal (HPA) axis

Stress responsivity is associated with HPA axis activity and the hormone cortisol (O'Connor *et al*. 2000) and dysfunction of the system has been associated with various psychopathologies (Watson & Mackin, 2006; Connan *et al*. 2007; Thompson *et al*. 2007). Laboratory cortisol assessments fail to capture the complete dynamics of the cortisol pattern and, more importantly, cannot link the response to true ecological processes such as experiencing stress in the realm of daily life. As cortisol can be validly extracted from saliva (Kirschbaum & Hellhammer, 1993), it is well suited to be assessed using the ESM.

Thus far, only a small number of ESM studies have used the method of saliva sampling to investigate HPA axis activity in psychopathology (Peeters *et al*. 2003*a*, 2004; Lieb *et al*. 2004; Stetler *et al*. 2004; Stetler & Miller, 2005; Steptoe *et al*. 2007). In patients with major depressive disorder, the HPA axis response to negative daily events and mood changes was blunted (Peeters *et al*. 2003*a*). Erratic cortisol secretion was particularly present in out-patients with severe and recurrent forms of depression (Peeters *et al*. 2004). Stetler & Miller (2005) found that a blunted cortisol response to awakening in depressed individuals might be due to a disruption of the regulatory influences of psychosocial factors and sleep patterns. Such daily activities, or 'zeitgebers', such as waking, eating or psychosocial factors were unrelated to cortisol secretion in depressed participants, suggesting a possible underlying mechanism of circadian disturbances in depression (Stetler *et al*. 2004). Furthermore, in a twin study, it was found that probands of co-twins with lifetime depression displayed a different diurnal cortisol profile than those without, suggesting that altered HPA axis functioning is an indicator of depression liability (Wichers *et al*. 2008*c*). In patients diagnosed with BPD, ambulatory salivary cortisol measurements have suggested increased HPA axis

activity, with higher total cortisol in response to awakening and higher total daily cortisol levels (Lieb *et al*. 2004).

Searching for biological markers

The ESM might be helpful to investigate biological markers for psychiatric disorders, by linking laboratory data to self-report assessments obtained in daily life.

Marcelis *et al*. (2003) examined the relationship between cerebral tissue alterations and the experience of stress in the natural environment. Subjective stress experience was associated with increased levels of cerebrospinal fluid and reduced white-matter volumes in patients with psychosis (Marcelis *et al*. 2003). Another study in psychosis demonstrated that dopamine release induced by a physical stressor in the laboratory was associated with psychotic reactivity to daily life stress in first-degree relatives of patients with psychosis (Myin-Germeys *et al*. 2005*b*). In depression, prefrontal cortex electroencephalography (PFC EEG) was combined with a momentary assessment study, showing that specific symptoms of depression such as rumination and self-esteem were uniquely associated with patterns of PFC EEG alpha activity (Putnam & McSweeney, 2008). In another study on depression, diminished late pupil dilation to negative words in a laboratory setting was found to be associated with higher levels of negative affect and lower levels of positive affect in the daily life of depressed children (Silk *et al*. 2007). Daily life research may thus drive the study of biological markers by improving our understanding of associated behavioural phenotypes.

Gene–environment interactions (G×E)

Finally, the ESM may be a useful tool in the rapidly developing field of the study of G × E in psychopathology, according to which susceptibility genes may amplify the risk for an individual to react with psychopathology in response to environmental pathogens. Moffitt *et al*. (2005) suggested a prospective collection of cumulative, repeated measures of proximal rather than distal environmental risk factors to optimize the environmental risk measurement in gene–environment research. ESM technology may be well placed to implement this methodological improvement.

Thus far, very few studies have used the ESM to study G × E in psychopathology. One study in psychosis investigated whether emotional reactivity to stress was mediated by the catechol-*O*-methyltransferase (COMT) Val158Met genotype. This study showed that patients with the Met/Met genotype showed the largest increase in psychotic symptoms and negative emotions in response to daily stressors, thus providing evidence for G × E mechanisms in the formation of psychotic symptoms (van Winkel *et al*. 2008). A second study in a general population sample found opposite results, with Val/Val carriers displaying more feelings of paranoia in response to stress (Simons *et al*. 2008). A final study in patients with psychosis demonstrated that the COMT Val carriers, but not subjects with the Met/Met genotype, reported an increase in hallucinations in response to cannabis use (Henquet *et al*. 2008).

One other study used the ESM to study G × E in depression. In a general population twin study, it was demonstrated that probands whose co-twins were diagnosed with lifetime depression showed a stronger mood bias to stress than those with co-twins without such a diagnosis, thus providing evidence that the genetic liability to depression is in part expressed as the tendency to display negative affect in response to minor stressors in daily life (Wichers *et al*. 2007*b*). Of interest, however, the experience of positive affect associated with stress attenuated this endophenotypic expression of genetic vulnerability for depression (Wichers *et al*. 2007*a*). Similarly, positive affect decreased genetic moderation by a polymorphism in the gene encoding the brain-derived neurotrophic factor (BDNF; a factor known to be associated with stress-related behaviour) of the negative affect response to social stress (Wichers *et al*. 2008*b*).

These initial studies show the feasibility and power of ESM data for high-quality G × E studies examining the immediate effect of risk exposure conditional on genetic vulnerability for psychopathology in general as well as conditional on specific susceptibility polymorphisms.

Conclusion

This review has shown that variability over time and the dynamic interplay with the environment are essential features of psychopathological experiences that need to be captured for a better understanding of their phenomenology and underlying mechanisms. As variability is very difficult to assess with traditional instruments, the findings of ESM studies are a fundamental extension to cross-sectional data. The ESM has also been shown to contribute to a better understanding of the interplay between psychopathological experiences and environmental features, particularly because most of these interaction patterns are subtle and not consciously appraised.

Together, the data from the ESM literature suggest that the study of the variability and the dynamic patterns of reactivity of experiences, as they unfold

https://doi.org/10.1017/S0033291708004947 Published online by Cambridge University Press

in daily life, may accelerate our understanding of psychological and biological mechanisms underlying psychopathology. In addition, it may foster new research into treatment response and prove to be essential in the rapidly developing field of gene–environment interactions. The ESM enables capturing the film rather than the snapshot of daily life reality.

Declaration of Interest

None.

References

Alloy LB, Abramson LY, Metalsky GI, Hartlage S (1988). The hopelessness theory of depression: attributional aspects. *British Journal of Clinical Psychology* **27**, 5–21.

Alpers GW, Tuschen-Caffier B (2001). Negative feelings and the desire to eat in bulimia nervosa. *Eating Behaviors* **2**, 339–352.

Anderson P, Jacobs C, Rothbaum BO (2004). Computer-supported cognitive behavioral treatment of anxiety disorders. *Journal of Clinical Psychology* **60**, 253–267.

Axelson DA, Bertocci MA, Lewin DS, Trubnick LS, Birmaher B, Williamson DE, Ryan ND, Dahl RE (2003). Measuring mood and complex behavior in natural environments: use of ecological momentary assessment in pediatric affective disorders. *Journal of Child and Adolescent Psychopharmacology* **13**, 253–266.

Barge-Schaapveld DQ, Nicolson NA (2002). Effects of antidepressant treatment on the quality of daily life: an experience sampling study. *Journal of Clinical Psychiatry* **63**, 477–485.

Barge-Schaapveld DQ, Nicolson NA, Berkhof J, deVries MW (1999). Quality of life in depression: daily life determinants and variability. *Psychiatry Research* **88**, 173–189.

Barge-Schaapveld DQ, Nicolson NA, van der Hoop RG, De Vries MW (1995). Changes in daily life experience associated with clinical improvement in depression. *Journal of Affective Disorders* **34**, 139–154.

Bauer M, Wilson T, Neuhaus K, Sasse J, Pfennig A, Lewitzka U, Grof P, Glenn T, Rasgon N, Bschor T, Whybrow PC (2008). Self-reporting software for bipolar disorder: validation of ChronoRecord by patients with mania. *Psychiatry Research* **159**, 359–366.

Bentall R (2003). *Madness Explained: Psychosis and Human Nature*. Penguin Books: London.

Bentall RP, Corcoran R, Howard R, Blackwood N, Kinderman P (2001). Persecutory delusions: a review and theoretical integration. *Clinical Psychology Review* **21**, 1143–1192.

Broderick JE, Schwartz JE, Shiffman S, Hufford MR, Stone AA (2003). Signaling does not adequately improve diary compliance. *Annals of Behavioral Medicine* **26**, 139–148.

Brown LH, Silvia PJ, Myin-Germeys I, Kwapil TR (2007). When the need to belong goes wrong: the expression of social anhedonia and social anxiety in daily life. *Psychological Science* **18**, 778–782.

Collip D, Myin-Germeys I, Van Os J (2008). Does the concept of 'sensitization' provide a plausible mechanism for the putative link between the environment and schizophrenia? *Schizophrenia Bulletin* **34**, 220–225.

Connan F, Lightman SL, Landau S, Wheeler M, Treasure J, Campbell IC (2007). An investigation of hypothalamic-pituitary-adrenal axis hyperactivity in anorexia nervosa: the role of CRH and AVP. *Journal of Psychiatric Research* **41**, 131–143.

de Beurs E, Lange A, Van Dyck R (1992). Self-monitoring of panic attacks and retrospective estimates of panic: discordant findings. *Behaviour Research and Therapy* **30**, 411–413.

Delespaul P, deVries M, van Os J (2002). Determinants of occurrence and recovery from hallucinations in daily life. *Social Psychiatry and Psychiatric Epidemiology* **37**, 97–104.

Delespaul PAEG (1995). *Assessing Schizophrenia in Daily Life*. University of Maastricht: Maastricht.

de Vries MW (ed.) (1992). *The Experience of Psychopathology: Investigating Mental Disorders in their Natural Settings*. Cambridge University Press: Cambridge.

Dijkman-Caes CI, de Vries MW, Kraan HF, Volovics A (1993). Agoraphobic behavior in daily life: effects of social roles and demographic characteristics. *Psychological Reports* **72**, 1283–1293.

Ebner-Priemer UW, Kuo J, Kleindienst N, Welch SS, Reisch T, Reinhard I, Lieb K, Linehan MM, Bohus M (2007). State affective instability in borderline personality disorder assessed by ambulatory monitoring. *Psychological Medicine* **37**, 961–970.

Ebner-Priemer UW, Kuo J, Schlotz W, Kleindienst N, Rosenthal MZ, Detterer L, Linehan MM, Bohus M (2008). Distress and affective dysregulation in patients with borderline personality disorder: a psychophysiological ambulatory monitoring study. *Journal of Nervous and Mental Disease* **196**, 314–320.

Ebner-Priemer UW, Kuo J, Welch SS, Thielgen T, Witte S, Bohus M, Linehan MM (2006). A valence-dependent group-specific recall bias of retrospective self-reports: a study of borderline personality disorder in everyday life. *Journal of Nervous and Mental Disease* **194**, 774–779.

Ebner-Priemer UW, Sawitzki G (2007). Ambulatory assessment of affective instability in borderline personality disorder: the effect of the sampling frequency. *European Journal of Psychological Assessment* **23**, 238–247.

Engel SG, Boseck JJ, Crosby RD, Wonderlich SA, Mitchell JE, Smyth J, Miltenberger R, Steiger H (2007). The relationship of momentary anger and impulsivity to bulimic behavior. *Behaviour Research and Therapy* **45**, 437–447.

Engel SG, Wonderlich SA, Crosby RD, Wright TL, Mitchell JE, Crow SJ, Venegoni EE (2005). A study of patients with anorexia nervosa using ecologic momentary assessment. *International Journal of Eating Disorders* **38**, 335–339.

Engelberg MJ, Gauvin L, Steiger H (2005). A naturalistic evaluation of the relation between dietary restraint, the urge to binge, and actual binge eating: a clarification. *International Journal of Eating Disorders* **38**, 355–360.

Engelberg MJ, Steiger H, Gauvin L, Wonderlich SA (2007). Binge antecedents in bulimic syndromes: an examination of dissociation and negative affect. *International Journal of Eating Disorders* **40**, 531–536.

Fahrenberg J, Myrtek M (1996). *Ambulatory Assessment. Computer-Assisted Psychological and Psychophysiological Methods in Monitoring and Field Studies*. Hogrefe & Huber: Seattle, WA.

Fahrenberg J, Myrtek M (2001). *Progress in Ambulatory Assessment: Computer-Assisted Psychological and Psychophysiological Methods in Monitoring and Field Studies*. Hogrefe & Huber Publishers: Kirkland, WA.

Gard DE, Kring AM, Gard MG, Horan WP, Green MF (2007). Anhedonia in schizophrenia: distinctions between anticipatory and consummatory pleasure. *Schizophrenia Research* **93**, 253–260.

Gehricke JG, Whalen CK, Jamner LD, Wigal TL, Steinhoff K (2006). The reinforcing effects of nicotine and stimulant medication in the everyday lives of adult smokers with ADHD: a preliminary examination. *Nicotine and Tobacco Research* **8**, 37–47.

Glaser JP, Van Os J, Mengelers R, Myin-Germeys I (2008). A momentary assessment study of the reputed emotional phenotype associated with borderline personality disorder. *Psychological Medicine* **38**, 1231–1239.

Gloster AT, Richard DC, Himle J, Koch E, Anson H, Lokers L, Thornton J (2008). Accuracy of retrospective memory and covariation estimation in patients with obsessive-compulsive disorder. *Behaviour Research and Therapy* **46**, 642–655.

Granholm E, Loh C, Swendsen J (2008). Feasibility and validity of computerized ecological momentary assessment in schizophrenia. *Schizophrenia Bulletin* **34**, 507–514.

Green AS, Rafaeli E, Bolger N, Shrout PE, Reis HT (2006). Paper or plastic? Data equivalence in paper and electronic diaries. *Psychological Methods* **11**, 87–105.

Greeno CG, Wing RR, Shiffman S (2000). Binge antecedents in obese women with and without binge eating disorder. *Journal of Consulting and Clinical Psychology* **68**, 95–102.

Gwaltney CJ, Shields AL, Shiffman S (2008). Equivalence of electronic and paper-and-pencil administration of patient-reported outcome measures: a meta-analytic review. *Value in Health* **11**, 322–333.

Havermans R, Nicolson NA, Devries MW (2007). Daily hassles, uplifts, and time use in individuals with bipolar disorder in remission. *Journal of Nervous and Mental Disease* **195**, 745–751.

Hedeker D, Mermelstein RJ, Demirtas H (2008). An application of a mixed-effects location scale model for analysis of Ecological Momentary Assessment (EMA) data. *Biometrics* **64**, 627–634.

Hektner JM, Schmidt JA, Csikszentmihalyi M (2007). *Experience Sampling Method: Measuring the Quality of Everyday Life*. Sage Publications: London.

Henquet C, Rosa A, Delespaul P, Papiol S, Fananas L, van Os J, Myin-Germeys I (2008). COMT Val(158)Met moderation of cannabis-induced psychosis: a momentary assessment study of 'switching on' hallucinations in the flow of daily life. *Acta Psychiatrica Scandinavica*. Published online: 18 September 2008. doi:10.1111/j.1600-0447.2008.01265.x.

Hilbert A, Tuschen-Caffier B (2007). Maintenance of binge eating through negative mood: a naturalistic comparison of binge eating disorder and bulimia nervosa. *International Journal of Eating Disorders* **40**, 521–530.

Hurlburt RT (1990). *Sampling Normal and Schizophrenic Inner Experience*. Plenum Press: New York.

Hurlburt RT (1997). Randomly sampling thinking in the natural environment. *Journal of Consulting and Clinical Psychology* **65**, 941–949.

Hurlburt RT, Happe F, Frith U (1994). Sampling the form of inner experience in three adults with Asperger syndrome. *Psychological Medicine* **24**, 385–395.

Husky MM, Grondin OS, Swendsen JD (2004). The relation between social behavior and negative affect in psychosis-prone individuals: an experience sampling investigation. *European Psychiatry* **19**, 1–7.

Jacobs N, Nicolson NA, Derom C, Delespaul P, van Os J, Myin-Germeys I (2005). Electronic monitoring of salivary cortisol sampling compliance in daily life. *Life Sciences* **76**, 2431–2443.

Kenardy J, Fried L, Kraemer HC, Taylor CB (1992). Psychological precursors of panic attacks. *British Journal of Psychiatry* **160**, 668–673.

Kenardy J, Taylor CB (1999). Expected versus unexpected panic attacks: a naturalistic prospective study. *Journal of Anxiety Disorders* **13**, 435–445.

Kimhy D, Delespaul P, Corcoran C, Ahn H, Yale S, Malaspina D (2006). Computerized experience sampling method (ESMc): assessing feasibility and validity among individuals with schizophrenia. *Journal of Psychiatric Research* **40**, 221–230.

Kirschbaum C, Hellhammer DH (1993). Salivary cortisol in psychoneuroendocrine research: recent developments and applications. *Psychoneuroendocrinology* **19**, 313–333.

Knouse LE, Mitchell JT, Brown LH, Silvia PJ, Kane MJ, Myin-Germeys I, Kwapil TR (2008). The expression of adult ADHD symptoms in daily life: an application of experience sampling methodology. *Journal of Attention Disorders* **11**, 652–663.

Knowles R, Tai S, Jones SH, Highfield J, Morriss R, Bentall RP (2007). Stability of self-esteem in bipolar disorder: comparisons among remitted bipolar patients, remitted unipolar patients and healthy controls. *Bipolar Disorders* **9**, 490–495.

Koren D, Seidman LJ, Goldsmith M, Harvey PD (2006). Real-world cognitive – and metacognitive – dysfunction in schizophrenia: a new approach for measuring (and remediating) more 'right stuff'. *Schizophrenia Bulletin* **32**, 310–326.

Lardinois M, Myin-Germeys I, Bak M, Mengelers R, van Os J, Delespaul PA (2007). The dynamics of symptomatic and non-symptomatic coping with psychotic

symptoms in the flow of daily life. *Acta Psychiatrica Scandinavica* **116**, 71–75.

Lataster T, Wichers M, Jacobs N, Mengelers R, Derom C, Thiery E, Van Os J, Myin-Germeys I (2008). Does reactivity to stress cosegregate with subclinical psychosis? A general population twin study. *Acta Psychiatrica Scandinavica* **119**, 45–53.

Lazarus RS, DeLongis A (1983). Psychological stress and coping in aging. *The American Psychologist* **38**, 245–254.

Le B, Choi HN, Beal DJ (2006). Pocket-sized psychology studies: exploring daily diary software for palm pilots. *Behavior Research Methods* **38**, 325–332.

Lieb K, Rexhausen JE, Kahl KG, Schweiger U, Philipsen A, Hellhammer DH, Bohus M (2004). Increased diurnal salivary cortisol in women with borderline personality disorder. *Journal of Psychiatric Research* **38**, 559–565.

Links PS, Eynan R, Heisel MJ, Barr A, Korzekwa M, McMain S, Ball JS (2007). Affective instability and suicidal ideation and behavior in patients with borderline personality disorder. *Journal of Personality Disorders* **21**, 72–86.

Links PS, Eynan R, Heisel MJ, Nisenbaum R (2008). Elements of affective instability associated with suicidal behaviour in patients with borderline personality disorder. *Canadian Journal of Psychiatry* **53**, 112–116.

Marcelis M, Myin-Germeys I, Suckling J, Woodruff P, Hofman P, Bullmore E, Delespaul P, van Os J (2003). Cerebral tissue alterations and daily life stress experience in psychosis. *Acta Psychiatrica Scandinavica* **107**, 54–59.

Marco C, Suls J (1993). Daily stress and the trajectory of mood: spillover, response assimilation, contrast, and chronic negative affectivity. *Journal of Personality and Social Psychology* **64**, 1053–1063.

Marco CA, Neale JM, Schwartz JE, Shiffman S, Stone AA (1999). Coping with daily events and short-term mood changes: an unexpected failure to observe effects of coping. *Journal of Consulting and Clinical Psychology* **67**, 755–764.

McGrath JJ (2007). The surprisingly rich contours of schizophrenia epidemiology. *Archives of General Psychiatry* **64**, 14–16.

Moffitt TE, Caspi A, Rutter M (2005). Strategy for investigating interactions between measured genes and measured environments. *Archives of General Psychiatry* **62**, 473–481.

Monroe SM (1983). Major and minor life events as predictors of psychological distress: further issues and findings. *Journal of Behavioral Medicine* **6**, 189–205.

Morrens M, Krabbendam L, Bak M, Delespaul P, Mengelers R, Sabbe B, Hulstijn W, van Os J, Myin-Germeys I (2007). The relationship between cognitive dysfunction and stress sensitivity in schizophrenia: a replication study. *Social Psychiatry and Psychiatric Epidemiology* **42**, 284–287.

Moskowitz DS, Young SN (2006). Ecological momentary assessment: what it is and why it is a method of the future in clinical psychopharmacology. *Journal of Psychiatry and Neuroscience* **31**, 13–20.

Murray G (2007). Diurnal mood variation in depression: a signal of disturbed circadian function? *Journal of Affective Disorders* **102**, 47–53.

Myers TC, Wonderlich SA, Crosby R, Mitchell JE, Steffen KJ, Smyth J, Miltenberger R (2006). Is multi-impulsive bulimia a distinct type of bulimia nervosa: psychopathology and EMA findings. *International Journal of Eating Disorders* **39**, 655–661.

Myin-Germeys I, Delespaul PA, deVries MW (2000). Schizophrenia patients are more emotionally active than is assumed based on their behavior. *Schizophrenia Bulletin* **26**, 847–854.

Myin-Germeys I, Delespaul P, van Os J (2005*a*). Behavioural sensitization to daily life stress in psychosis. *Psychological Medicine* **35**, 733–741.

Myin-Germeys I, Krabbendam L, Delespaul P, van Os J (2003*a*). Do life events have their effect on psychosis by influencing the emotional reactivity to daily life stress? *Psychological Medicine* **33**, 327–333.

Myin-Germeys I, Krabbendam L, Delespaul PA, van Os J (2004). Sex differences in emotional reactivity to daily life stress in psychosis. *Journal of Clinical Psychiatry* **65**, 805–809.

Myin-Germeys I, Krabbendam L, Jolles J, Delespaul PA, van Os J (2002). Are cognitive impairments associated with sensitivity to stress in schizophrenia? An experience sampling study. *American Journal of Psychiatry* **159**, 443–449.

Myin-Germeys I, Marcelis M, Krabbendam L, Delespaul P, van Os J (2005*b*). Subtle fluctuations in psychotic phenomena as functional states of abnormal dopamine reactivity in individuals at risk. *Biological Psychiatry* **58**, 105–110.

Myin-Germeys I, Nicolson NA, Delespaul PA (2001*a*). The context of delusional experiences in the daily life of patients with schizophrenia. *Psychological Medicine* **31**, 489–498.

Myin-Germeys I, Peeters F, Havermans R, Nicolson NA, DeVries MW, Delespaul P, Van Os J (2003*b*). Emotional reactivity to daily life stress in psychosis and affective disorder: an experience sampling study. *Acta Psychiatrica Scandinavica* **107**, 124–131.

Myin-Germeys I, van Os J (2007). Stress-reactivity in psychosis: evidence for an affective pathway to psychosis. *Clinical Psychology Review* **27**, 409–424.

Myin-Germeys I, van Os J, Schwartz JE, Stone AA, Delespaul PA (2001*b*). Emotional reactivity to daily life stress in psychosis. *Archives of General Psychiatry* **58**, 1137–1144.

Newman MG, Consoli AJ, Taylor CB (1999). A palmtop computer program for the treatment of generalized anxiety disorder. *Behavior Modification* **23**, 597–619.

Newman MG, Kenardy J, Herman S, Taylor CB (1997). Comparison of palmtop-computer-assisted brief cognitive-behavioral treatment to cognitive-behavioral treatment for panic disorder. *Journal of Consulting and Clinical Psychology* **65**, 178–183.

O'Connor TM, O'Halloran DJ, Shanahan F (2000). The stress response and the hypothalamic-pituitary-adrenal axis: from molecule to melancholia. *Quarterly Journal of Medicine* **93**, 323–333.

Okon DM, Greene AL, Smith JE (2003). Family interactions predict intraindividual symptom variation for adolescents

with bulimia. *International Journal of Eating Disorders* **34**, 450–457.

Peeters F, Berkhof J, Delespaul P, Rottenberg J, Nicolson NA (2006). Diurnal mood variation in major depressive disorder. *Emotion* **6**, 383–391.

Peeters F, Nicholson NA, Berkhof J (2003*a*). Cortisol responses to daily events in major depressive disorder. *Psychosomatic Medicine* **65**, 836–841.

Peeters F, Nicolson NA, Berkhof J (2004). Levels and variability of daily life cortisol secretion in major depression. *Psychiatry Research* **126**, 1–13.

Peeters F, Nicolson NA, Berkhof J, Delespaul P, deVries M (2003*b*). Effects of daily events on mood states in major depressive disorder. *Journal of Abnormal Psychology* **112**, 203–211.

Przeworski A, Newman MG (2004). Palmtop computer-assisted group therapy for social phobia. *Journal of Clinical Psychology* **60**, 179–188.

Putnam KM, McSweeney LB (2008). Depressive symptoms and baseline prefrontal EEG alpha activity: a study utilizing Ecological Momentary Assessment. *Biological Psychology* **77**, 237–240.

Quittner AL, Modi AC, Lemanek KL, Ievers-Landis CE, Rapoff MA (2008). Evidence-based assessment of adherence to medical treatments in pediatric psychology. *Journal of Pediatric Psychology* **33**, 916–936.

Raoux N, Benoit O, Dantchev N, Denise P, Franc B, Allilaire JF, Widlocher D (1994). Circadian pattern of motor activity in major depressed patients undergoing antidepressant therapy: relationship between actigraphic measures and clinical course. *Psychiatry Research* **52**, 85–98.

Reisch T, Ebner-Priemer UW, Tschacher W, Bohus M, Linehan MM (2008). Sequences of emotions in patients with borderline personality disorder. *Acta Psychiatrica Scandinavica* **118**, 42–48.

Robbins P, Aydede M (2008). *The Cambridge Handbook of Situated Cognition*. Cambridge University Press: Cambridge.

Russell JJ, Moskowitz DS, Zuroff DC, Sookman D, Paris J (2007). Stability and variability of affective experience and interpersonal behavior in borderline personality disorder. *Journal of Abnormal Psychology* **116**, 578–588.

Schärer LO, Hartweg V, Hoern M, Graesslin Y, Strobl N, Frey S, Biedermann C, Walser S, Walden J (2002). Electronic diary for bipolar patients. *Neuropsychobiology* **46** (Suppl. 1), 10–12.

Schwartz JE, Stone AA (1998). Strategies for analyzing ecological momentary assessment data. *Health Psychology* **17**, 6–16.

Shiffman S, Stone AA, Hufford MR (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology* **4**, 1–32.

Silk JS, Dahl RE, Ryan ND, Forbes EE, Axelson DA, Birmaher B, Siegle GJ (2007). Pupillary reactivity to emotional information in child and adolescent depression: links to clinical and ecological measures. *American Journal of Psychiatry* **164**, 1873–1880.

Silk JS, Steinberg L, Morris AS (2003). Adolescents' emotion regulation in daily life: links to depressive symptoms and problem behavior. *Child Development* **74**, 1869–1880.

Simons C, Wichers M, Derom C, Thiery E, Myin-Germeys I, Krabbendam L, van Os J (2008). Subtle gene–environment interactions driving paranoia in daily life. *Genes, Brain, and Behavior*. Published online: 21 August 2008. doi:10.1111/j.1601-183X.2008.00434.x.

Smyth J, Wonderlich S, Crosby R, Miltenberger R, Mitchell J, Rorty M (2001). The use of ecological momentary assessment approaches in eating disorder research. *International Journal of Eating Disorders* **30**, 83–95.

Smyth JM, Wonderlich SA, Heron KE, Sliwinski MJ, Crosby RD, Mitchell JE, Engel SG (2007). Daily and momentary mood and stress are associated with binge eating and vomiting in bulimia nervosa patients in the natural environment. *Journal of Consulting and Clinical Psychology* **75**, 629–638.

Steiger H, Gauvin L, Engelberg MJ, Ying Kin NM, Israel M, Wonderlich SA, Richardson J (2005). Mood- and restraint-based antecedents to binge episodes in bulimia nervosa: possible influences of the serotonin system. *Psychological Medicine* **35**, 1553–1562.

Steiger H, Gauvin L, Jabalpurwala S, Seguin JR, Stotland S (1999). Hypersensitivity to social interactions in bulimic syndromes: relationship to binge eating. *Journal of Consulting and Clinical Psychology* **67**, 765–775.

Stein KF (1996). Affect instability in adults with a borderline personality disorder. *Archives of Psychiatric Nursing* **10**, 32–40.

Stein KF, Corte CM (2003). Ecologic momentary assessment of eating-disordered behaviors. *International Journal of Eating Disorders* **34**, 349–360.

Stein RI, Kenardy J, Wiseman CV, Dounchis JZ, Arnow BA, Wilfley DE (2007). What's driving the binge in binge eating disorder? A prospective examination of precursors and consequences. *International Journal of Eating Disorders* **40**, 195–203.

Steptoe A, Gibson L, Hamer M, Wardle J (2007). Neuroendocrine and cardiovascular correlates of positive affect measured by ecological momentary assessment and by questionnaire. *Psychoneuroendocrinology* **32**, 56–64.

Stetler C, Dickerson SS, Miller GE (2004). Uncoupling of social zeitgebers and diurnal cortisol secretion in clinical depression. *Psychoneuroendocrinology* **29**, 1250–1259.

Stetler C, Miller GE (2005). Blunted cortisol response to awakening in mild to moderate depression: regulatory influences of sleep patterns and social contacts. *Journal of Abnormal Psychology* **114**, 697–705.

Stiglmayr CE, Ebner-Priemer UW, Bretz J, Behm R, Mohse M, Lammers CH, Anghelescu IG, Schmahl C, Schlotz W, Kleindienst N, Bohus M (2008). Dissociative symptoms are positively related to stress in borderline personality disorder. *Acta Psychiatrica Scandinavica* **117**, 139–147.

Stiglmayr CE, Grathwol T, Linehan MM, Ihorst G, Fahrenberg J, Bohus M (2005). Aversive tension in patients with borderline personality disorder: a computer-based controlled field study. *Acta Psychiatrica Scandinavica* **111**, 372–379.

Stone AA, Schwartz JE, Neale JM, Shiffman S, Marco CA, Hickcox M, Paty J, Porter LS, Cruise LJ (1998). A comparison of coping assessed by ecological momentary assessment and retrospective recall. *Journal of Personality and Social Psychology* **74**, 1670–1680.

Stone AA, Shiffman S (1994). Ecological momentary assessment (EMA) in behavioral medicine. *Annals of Behavioral Medicine* **16**, 199–202.

Stone AA, Shiffman S, Schwartz JE, Broderick JE, Hufford MR (2002). Patient non-compliance with paper diaries. *British Medical Journal* **324**, 1193–1194.

Stone AA, Shiffman S, Schwartz JE, Broderick JE, Hufford MR (2003). Patient compliance with paper and electronic diaries. *Controlled Clinical Trials* **24**, 182–199.

Swendsen J (1997). Anxiety, depression and their comorbidity: an experience sampling test of the helplessness-hopelessness theory. *Cognitive Therapy and Research* **21**, 97–114.

Swendsen J (1998). The helplessness-hopelessness theory and daily mood experience: an idiographic and cross-situational perspective. *Journal of Personality and Social Psychology* **74**, 1398–1408.

Swendsen JD, Compagnone P (2000). The expression of cognitive vulnerabilities for depression in daily life: a French–American study. *European Psychiatry* **15** (Suppl. 1), 22–28.

Thewissen V, Bentall RP, Lecomte T, van Os J, Myin-Germeys I (2008). Fluctuations in self-esteem and paranoia in the context of daily life. *Journal of Abnormal Psychology* **117**, 143–153.

Thompson KN, Phillips LJ, Komesaroff P, Yuen HP, Wood SJ, Pantelis C, Velakoulis D, Yung AR, McGorry PD (2007). Stress and HPA-axis functioning in young people at ultra high risk for psychosis. *Journal of Psychiatric Research* **41**, 561–569.

Tournier M, Sorbara F, Gindre C, Swendsen JD, Verdoux H (2003). Cannabis use and anxiety in daily life: a naturalistic investigation in a non-clinical population. *Psychiatry Research* **118**, 1–8.

Trull TJ, Solhan MB, Tragesser SL, Jahng S, Wood PK, Piasecki TM, Watson D (2008). Affective instability: measuring a core feature of borderline personality disorder with ecological momentary assessment. *Journal of Abnormal Psychology* **117**, 647–661.

van Winkel R, Henquet C, Rosa A, Papiol S, Faňanás L, De Hert M, Peuskens J, van Os J, Myin-Germeys I (2008). Evidence that the COMTVal158Met polymorphism moderates sensitivity to stress in psychosis: an experience-sampling study. *American Journal of Medical Genetics. Part B, Neuropsychiatric Genetics* **147B**, 10–17.

Vansteelandt K, Pieters G, Vandereycken W, Claes L, Probst M, Van Mechelen I (2004). Hyperactivity in anorexia nervosa: a case study using experience sampling methodology. *Eating Behaviors* **5**, 67–74.

Vansteelandt K, Rijmen F, Pieters G, Probst M, Vanderlinden J (2007). Drive for thinness, affect regulation and physical activity in eating disorders: a daily life study. *Behaviour Research and Therapy* **45**, 1717–1734.

Verdoux H, Gindre C, Sorbara F, Tournier M, Swendsen JD (2003*a*). Effects of cannabis and psychosis vulnerability in daily life: an experience sampling test study. *Psychological Medicine* **33**, 23–32.

Verdoux H, Husky M, Tournier M, Sorbara F, Swendsen JD (2003*b*). Social environments and daily life occurrence of psychotic symptoms – an experience sampling test in a non-clinical population. *Social Psychiatry and Psychiatric Epidemiology* **38**, 654–661.

Wang PS, Beck AL, Berglund P, McKenas DK, Pronk NP, Simon GE, Kessler RC (2004). Effects of major depression on moment-in-time work performance. *American Journal of Psychiatry* **161**, 1885–1891.

Watson S, Mackin P (2006). HPA axis function in mood disorders. *Psychiatry* **5**, 166–170.

Wegner KE, Smyth JM, Crosby RD, Wittrock D, Wonderlich SA, Mitchell JE (2002). An evaluation of the relationship between mood and binge eating in the natural environment using ecological momentary assessment. *International Journal of Eating Disorders* **32**, 352–361.

Whalen CK, Henker B, Ishikawa SS, Jamner LD, Floro JN, Johnston JA, Swindle R (2006*a*). An electronic diary study of contextual triggers and ADHD: get ready, get set, get mad. *Journal of the American Academy of Child and Adolescent Psychiatry* **45**, 166–174.

Whalen CK, Henker B, Jamner LD, Ishikawa SS, Floro JN, Swindle R, Perwien AR, Johnston JA (2006*b*). Toward mapping daily challenges of living with ADHD: maternal and child perspectives using electronic diaries. *Journal of Abnormal Child Psychology* **34**, 115–130.

Whalen CK, Jamner LD, Henker B, Delfino RJ (2001). Smoking and moods in adolescents with depressive and aggressive dispositions: evidence from surveys and electronic diaries. *Health Psychology* **20**, 99–111.

Whalen CK, Jamner LD, Henker B, Delfino RJ, Lozano JM (2002). The ADHD spectrum and everyday life: experience sampling of adolescent moods, activities, smoking, and drinking. *Child Development* **73**, 209–227.

Whalen DJ, Silk JS, Semel M, Forbes EE, Ryan ND, Axelson DA, Birmaher B, Dahl RE (2008). Caffeine consumption, sleep, and affect in the natural environments of depressed youth and healthy controls. *Journal of Pediatric Psychology* **33**, 358–367.

Wichers M, Barge-Schaapveld DQCM, Nicolson NA, Peeters F, de Vries M, Mengelers R, van Os J (2008*a*). Reduced stress-sensitivity or increased reward experience: the psychological mechanism of response to antidepressant medication. *Neuropsychopharmacology*. Published online: 21 May 2008. doi:10.1038/npp.2008.66.

Wichers M, Kenis G, Jacobs N, Myin-Germeys I, Schruers K, Mengelers R, Delespaul P, Derom C, Vlietinck R, van Os J (2008*b*). The psychology of psychiatric genetics: evidence that positive emotions in females moderate genetic sensitivity to social stress associated with the BDNF Val-sup-6-sup-6Met polymorphism. *Journal of Abnormal Psychology* **117**, 699–704.

Wichers M, Myin-Germeys I, Jacobs N, Peeters F, Kenis G, Derom C, Vlietinck R, Delespaul P, van Os J (2007*a*). Evidence that moment-to-moment variation in positive emotions buffer genetic risk for depression: a momentary assessment twin study. *Acta Psychiatrica Scandinavica* **115**, 451–457.

Wichers M, Myin-Germeys I, Jacobs N, Peeters F, Kenis G, Derom C, Vlietinck R, Delespaul P, van Os J (2007*b*). Genetic risk of depression and stress-induced negative affect in daily life. *British Journal of Psychiatry* **191**, 218–223.

Wichers MC, Myin-Germeys I, Jacobs N, Kenis G, Derom C, Vlietinck R, Delespaul P, Mengelers R, Peeters F, Nicolson N, Van Os J (2008*c*). Susceptibility to depression expressed as alterations in cortisol day curve: a cross-twin, cross-trait study. *Psychosomatic Medicine* **70**, 314–318.

Wonderlich SA, Crosby RD, Engel SG, Mitchell JE, Smyth J, Miltenberger R (2007*a*). Personality-based clusters in bulimia nervosa: differences in clinical variables and ecological momentary assessment. *Journal of Personality Disorders* **21**, 340–357.

Wonderlich SA, Rosenfeldt S, Crosby RD, Mitchell JE, Engel SG, Smyth J, Miltenberger R (2007*b*). The effects of childhood trauma on daily mood lability and comorbid psychopathology in bulimia nervosa. *Journal of Traumatic Stress* **20**, 77–87.