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Published in:
Current Opinion in Behavioral Sciences

DOI:
10.1016/j.cobeha.2020.11.005

Publication date:
2021

Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in Behavioral Sciences

Psychopathology and positive emotions in daily life

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In this short review, we describe recent trends from Ecological Momentary Assessment (EMA) research investigating positive affect (PA) in relation to mood disorders. Aside from notable exceptions (e.g. mania), most mood disorders involve relatively lower levels of PA in daily life, often combined with a larger level of variability in PA. In reaction to positive events, studies show a puzzling 'mood brightening' effect in individuals with mood disorder symptoms that suggests hyper responsiveness to real-life rewards. Studies into anhedonia (i.e. lack of, or lower levels of PA) suggest that high-arousal PA and anticipatory PA are potential targets for intervention. Despite PA-focused EMA-interventions bear promises of greater therapeutic effectiveness, so far, these promises have not materialized yet.

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Current Opinion in Behavioral Sciences 2020, **39**:10–18

This review comes from a themed issue on **Positive Affect**

Edited by **Gilles Pourtois**, **Disa Sauter**, **Blair Saunders** and **Henk van Steenbergen**

https://doi.org/10.1016/j.cobeha.2020.11.005

Introduction

In mood disorders feelings or emotions are distorted or inconsistent with its context to such an extent that it interferes with one's ability to function [1]. Mood disorders include Bipolar Disorder, Dysthymia, Cyclothymic Disorder, Premenstrual Dysphoric Disorder, and Major Depressive Disorder (MDD), and affect approximately 10% of the population each year [2,3]. Research on affective psychopathology is predominantly focused on stress and Negative Affect (NA). In recent years, however, there has been increasing attention and recognition that rewarding experiences and Positive Affect (PA), or the lack thereof (i.e. anhedonia), is at least equally important for the understanding, treatment of, and recovery from, mood disorders.

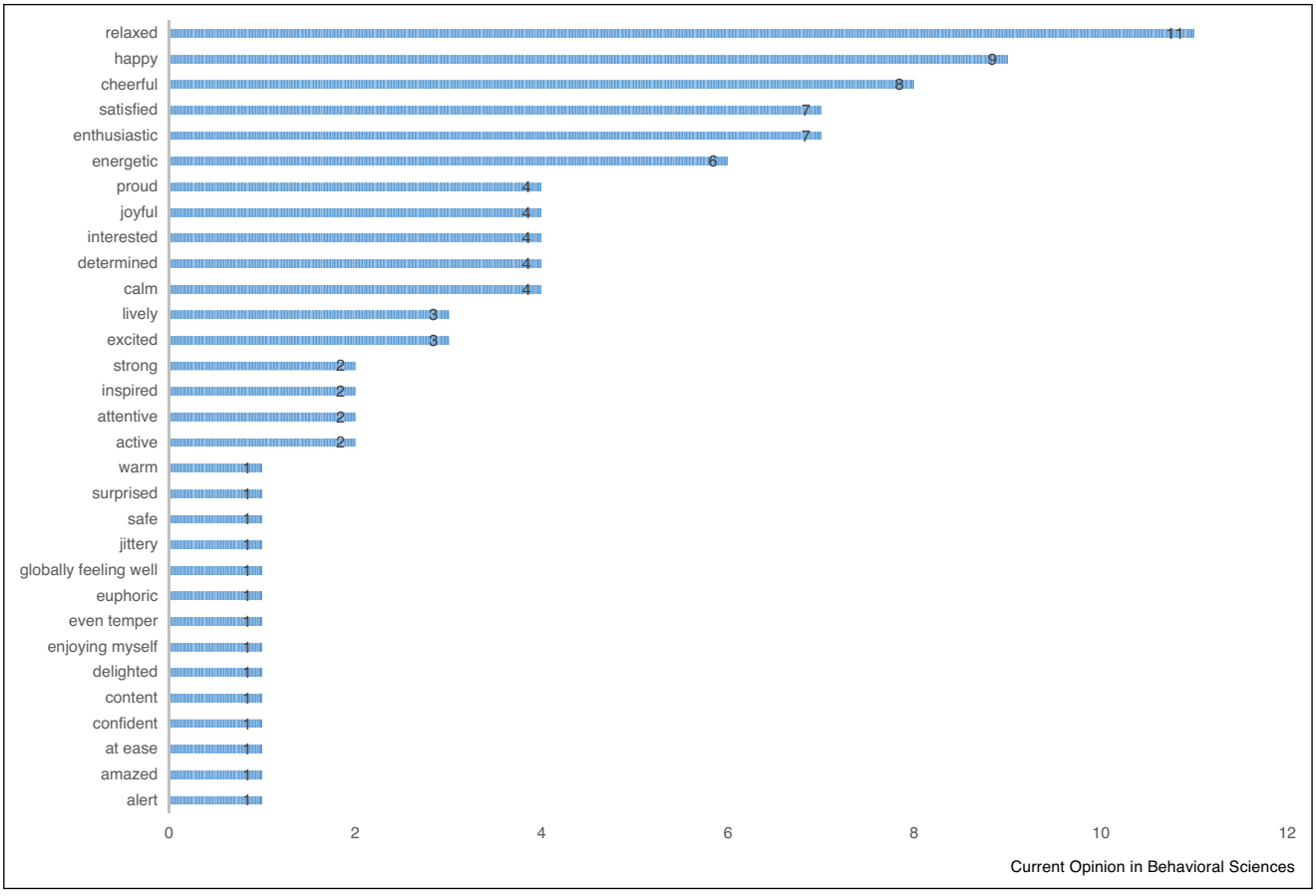
PA generally refers to the experience of pleasurable emotions, such as happiness, relaxation, enthusiasm, and joy, and varies over time as a function of subjectively appraised context [4,5]. When it comes to understanding the nature of PA in the context of people's daily life, Ecological Momentary Assessment (EMA) studies have examined the level of PA, its fluctuations, and interaction with contexts in both healthy and clinical populations. EMA is a structured diary technique to sample subjective experiences, behavior and context in the flow of daily life, typically using smartphone technology. Its naturalistic approach ensures ecologically valid data (i.e. generalizable to real-life), Participants typically fill out structured diaries multiple times a day (e.g. five times a day), that are assessed at fixed or random time points, and across multiple consecutives days (e.g. for 30 days). The high frequency in longitudinal sampling enables researchers to shed light on the nature of mood disorders on the micro-level. For example, to what extent depression is linked to PA changes across minutes or hours, and the extent to which these short-term changes in PA co-vary with behavior or other contextual factors over time. In addition, compared to retrospective questionnaires that asks patients to report on symptoms during the past weeks or months, the frequent sampling in EMA studies reduces recall bias. In that sense, EMA methods can not only validate diagnostic criteria in daily life, but also go beyond by providing novel insights into the micro-processes and mechanisms of mood disorders.

In what follows, we review some of the most important advancements of EMA research in PA and psychopathology over the last five years.

Positive Affect (PA) in daily life

In EMA studies, PA is typically operationalized as the mean of a set of adjective rating scales. For example, participants are asked 'How do you feel at the moment?' followed by the adjectives 'relaxed', 'happy', and 'cheerful' and a slider-scale anchored with 'not at all' (outer left) and 'very much' (outer right). Often, but not always, the set of affective items is based on the Positive Affect and Negative Affect Schedule [6], or is based on circumplex models of affect [7,8] with the selection made to balance high and low arousal items [9]. The most frequently used adjectives used to describe PA in EMA research in relation to mood disorders over the last two years are feeling relaxed, happy, and cheerful (see Figure 1).

Figure 1



The Ecological Momentary Assessments (EMA) items used to assess Positive Affect, extracted from 17 EMA studies that reported on PA and mood disorders between 2018 and June 2020. Number on the X-axis reflects number of studies that used the EMA-item dipicted on the Y-axis. We searched in Web of Science (WoS) Core Collection electronic database for English-language papers published between 2018 and June 2020 using the following key terms: 'positive emotion*' OR 'positive affect*' OR 'positive mood*' OR pleasur* OR well?being OR eudaimon*; and 'Mood disorder*' OR 'Affect* disorder*' OR 'Bipolar*' OR 'Bipolar Disorder*' OR Depress* OR 'Major Depressive Disorder' OR MDD OR anhedoni*; and 'Experience sampling' OR 'Ecological Momentary Assessment*' OR 'Experience Sampling Method' OR 'structured diary method*' OR 'intensive longitudinal assessment*' OR 'real-time data capture stud*' OR 'event sampl*' OR 'beeper stud*' OR 'ambulatory stud*' in title, abstract, author keywords, and Keywords Plus. From the 90 articles, 24 were marked as relevant because they (1) explicitly or implicitly handled the subject of positive affect or anhedonia; (2) had a focus on mental health or mood disorder, and (3) used EMA. We excluded studies that focused on (1) genetics, or neurological underpinnings; (2) methodological studies; and (3) studies that did not report on PA items, leaving 17 recent EMA studies for extraction of PA items.

EMA studies have linked compromised mental health and mood disorders to various alterations in PA functioning, such as reduced PA complexity and PA flexibility in daily life [10], blunted PA reactivity to daily life stress ([11]) and reduced expectations of future PA (Note: when having a history of depression, but not bipolar disorder; [12]). The most robust finding, however, is the consistent link between lower psychological wellbeing or increased mood disorder symptomatology and lower mean levels of PA [10,12,13,14,15,16,17••,18,20]. One exception should be noted though, namely in the manic phases of bipolar disorder, which manifests as (too) high levels of PA.

PA dynamics in mood disorders

In addition to the robust link between mood disorders and lower mean level is PA in daily life, EMA researchers explored the link between mood disorders and the dynamic nature of PA. PA dynamics are quantitative descriptions of PA summarizing how PA unfolds and fluctuates over time. For example, emotional variability, operationalized as the average within-person variance in affect or average within-person Standard Deviation (SD) in affect, summarizes the dispersion in PA levels. In addition, there are more complex affective dynamics such as inertia (i.e. auto-correlation or auto-regression coefficient; summarizes how self-predictive affect is over time),

and the Mean Successive Squared Difference (MSSD; summarizes how unstable affect is over time). For a visual illustration of these dynamics, see Figure 2.

Recent EMA studies report paradoxical results in this respect. Whereas some studies found no association between PA dynamics and mood disorders [14,17••], others have linked symptoms of mood disorders and low psychological well-being to greater variability in PA ([15] in high-arousal PA; first study of [16,19,21••]), and/or more inert PA [16,22,23]. In the meta-analyses on the relation between affect dynamics and psychological well-being, lower well-being was characterized by both greater variability and inertia irrespective of ESM time frame [16]. However, this inertia-variability paradox is resolved when taking the overlap among the mean, variability, and inertia into account (i.e. by controlling for one or the other). Indeed, although PA dynamics are interrelated, the differences between groups in the level of variability (e.g. variance) and the level of inertia (e.g. autocorrelation) in PA are typically examined in isolation. EMA research on negative affect and wellbeing suggests that, when adjusted for the overlap, inertia adds little predictive value in the prediction of mood disorders over and above the lower level of PA and larger spread in PA levels ([24,25•,26]; see also Figure 2).

In people with bipolar disorder, after controlling for differences in individuals' mean PA, variability in PA still provides unique and additional information [19,21••]. However, over-and-above the PA mean and variability, the auto-correlation of PA (inertia) likely adds limited information in predicting psychological health [25•].

Real-life reward responsiveness and mood brightening

The Emotion Context Insensitivity theory and positive attenuation hypothesis predict attenuated emotional reactivity to positive emotional stimuli in the daily lives of depressed individuals [27]. In line with this hypothesis and theory, depression is consistently associated with reduced reward responsiveness in experimental studies and neurological studies in the laboratory [28–31]. In stark contrast, results from EMA studies show either no differences in depressed individuals' reward responsiveness, or evidence for the opposite: a 'mood brightening effect', defined as a greater improvement in the mood of depressed individuals in the hours after they report having experienced a positive event.[3]

The first report of the mood brightening effect concerned a larger decrease in NA and larger increase in PA after positive events in depressed versus non-depressed individuals [32]. Most EMA studies thereafter predominantly focused on the brightening in NA (e.g. Ref. [33]). Although in stark contrast to theory and empirical results from the laboratory, the mood brightening effect in PA seems robust and, compared to anxiety, specific to depression — with more severely depressed individuals showing greater brightening [34•]. Interestingly, anticipating next-day positive events seem to produce similar mood brightening effects [35].

So far, several factors have been excluded as the driving force behind the mood brightening effect [36]. First, the scarcity in positive events that is often observed in depressed patients (i.e. contrast hypothesis). Second, the lower threshold to appraise positive events as positive and, third, floor effects in PA that may create relatively larger room for improvement in the PA of depressed individuals Perhaps, emotion regulation might (partly) explain mood brightening effects. For NA, depressed individuals' tendency to ruminate (i.e. focused attention to negative events and moods) might be lowered by the experience of a positive event to an extent that they ruminate less than controls, and the subsequent lower level of NA presents itself as a mood brightening effect [33].

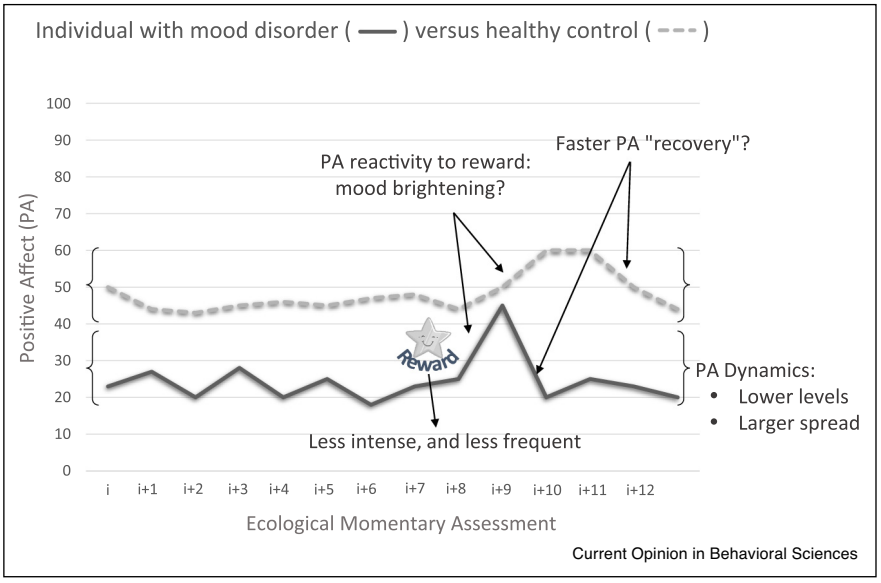
Another explanation for the discrepancy between theory and EMA results on reward responsiveness could be that PA reactivity to the self-reported pleasantness of an event is a suboptimal operationalization. Bakker *et al.* [37] argued that experimental tasks and behavioral activation therapy typically involve approach-based rewards, suggesting that situations in which one can encounter relatively many rewards (e.g. engaging with friends, working or being physically active; hereafter 'active behavior') is a better operationalization or translation of rewards in daily life than (pleasantness ratings of) positive events. Remarkably, when operationalizing reward responsiveness in daily life as PA reactivity to active behavior, in line with theory, the authors indeed observe a blunted reward responsiveness in individuals with depressive symptoms. However, the new operationalization is still awaiting replication. Heininga *et al.* [14] explored both operationalizations of reward responsiveness in the daily lives of depressed patients and healthy controls, but found no difference between both groups in PA reactivity to positive events, nor in PA reactivity to active behavior.

Anhedonia in daily life

To better understand PA in mood disorders, it may also be useful to shift the focus from syndromes to symptoms [38]. Anhedonia is one of the two core symptoms of depression and is clinically understood as 'a markedly diminished interest or pleasure in all, or almost all,

[3] It should be noted that one recent EMA study reported reduced reward responsiveness in depressed individuals, but, instead of the change in PA after pleasant activities or events, reward responsiveness was operationalized as the pleasantness rating of daily activities [61], better known as appraisal.

Figure 2



Hypothetical example of how PA unfolds over time in individuals with mood disorder versus healthy controls. Based on individual patient data from Heininga *et al.* [14].

activities of the day' during the past two weeks [1]. Based on advances in neurology and experimental psychology, anhedonia is now understood as impairments in the ability to experience reward (i.e. deficit in 'liking'; consummatory anhedonia), pursue reward (i.e. deficit in 'wanting'; anticipatory anhedonia) and/or learn about reward ([39–42]; but see Ref.: [43]).

With regard to 'liking' in daily life, anhedonia is linked to lower appraisal of positive events (i.e. positive events are rated less pleasurable; [15]; but see Ref.: [20]), fewer positive event experiences [20], and lower levels of PA in daily life [14,15,20,44]. Beyond these descriptive statistics, anhedonic versus non-anhedonic individuals also show differences in their associations between events and PA over time. Consummatory high-arousal PA (e.g. feeling 'energetic', 'enthusiastic', and 'cheerful') might be of special interest to better understand anhedonia, as individuals with anhedonia show 'mood brightening' in high-arousal PA but not low-arousal PA [15], and show a diminished favorable impact on affective experiences in individuals with anhedonia [44]. That is, compared to healthy controls, high-arousal PA in individuals with anhedonia is typically followed by a greater increase in NA and stress, and a greater decrease in PA and physical activity approximately six hours later (see Figure 3).

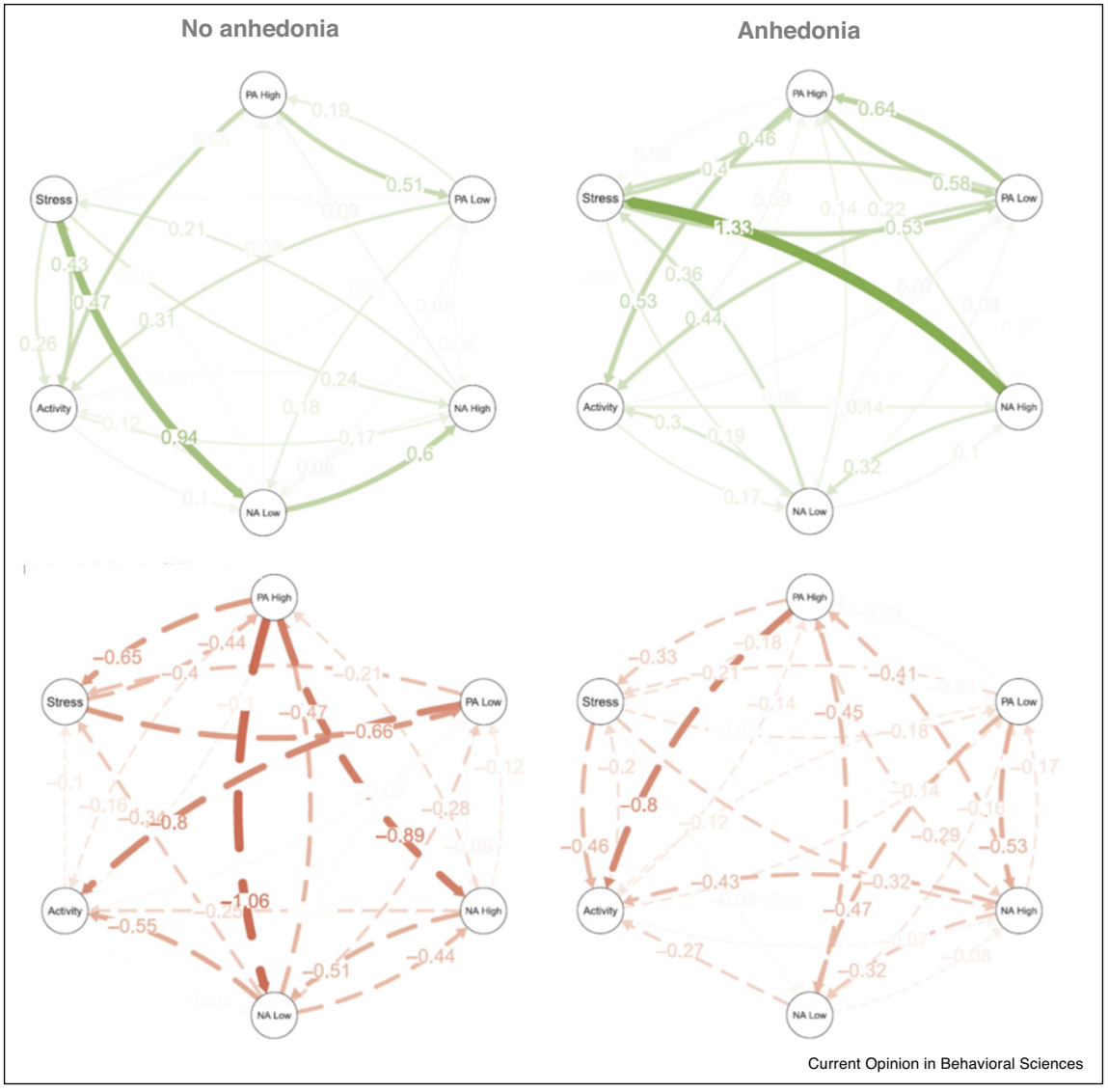
With regard to 'wanting', EMA studies suggest that alterations in motivation and anticipation might also be a vulnerability marker for mood disorders. For example, low PA in anhedonia is associated with lower levels of motivation six hours later [45], and the results suggest that individuals with anhedonia are at risk for a negative spiral of low PA and low motivation. Furthermore, depressive symptoms are also linked to diminished anticipatory pleasure experiences [46•], and a weaker link between anticipatory pleasure and active behavior [37]. Together, these EMA advances suggest that, in addition to a lower mean level of PA, individuals with depressive symptoms are less able or less motivated to modify their daily behaviors as a function of reward anticipation.

With regard to deficits in reward learning in the daily lives of individuals with anhedonia, advances show that the EMA timeframe is key. Without conscious processing, individuals learn about the reward value of each context and activity by creating associations with co-occurring rewarding experiences such as PA. These implicit associations, in turn, increase the likelihood that individuals engage in similar contexts and activities semi-randomly assessed approximately 90 min later and the next day [47]. However, such associative learning effects were not replicated when using a short-term retrospective ESM design with fixed beeps approximately six hours apart [48]. More EMA research is thus needed to determine the optimal design to investigate reward learning in daily life.

PA-focused daily life interventions

Given that the one-size-fits-all treatment approach is not always effective, EMA Interventions (EMIs) have been put forward as a promising tool to personalize affective disorder treatments and improve their effectiveness (e.g. Refs. [49–52]). So far, three EMIs have been developed that focus on PA and (symptoms of) mood disorders.

Figure 3

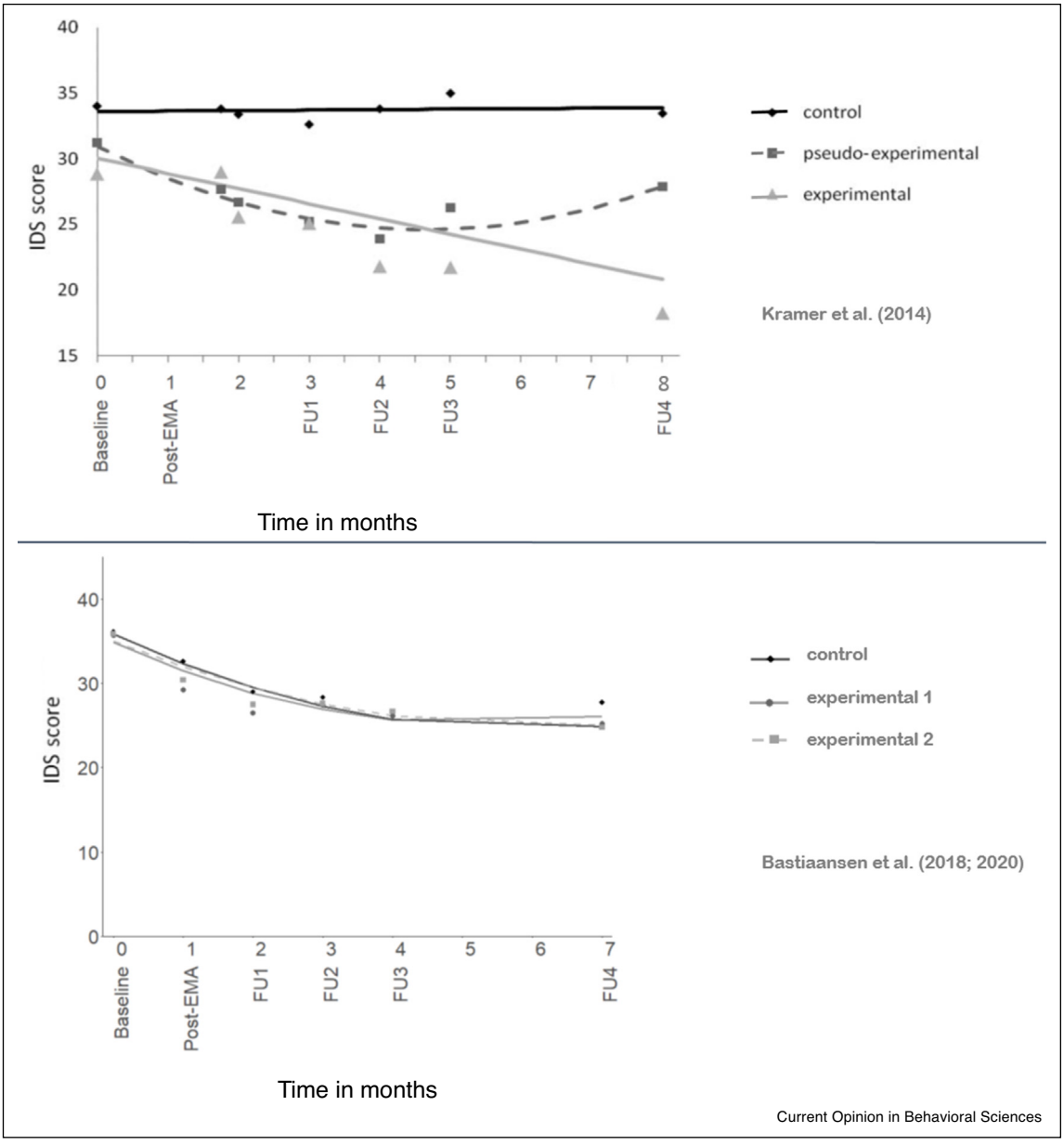


Adapted from Figure 2 of Bos *et al.* [44]. Networks of anhedonic and non-anhedonic individuals showing the strength of the IRF associations estimated through automated impulse response function analysis (IRF). Green (solid) arrows indicate positive associations between variables; red (dashed) arrows negative ones. The stronger a particular association, the thicker and brighter the color of the arrow.

In the first Randomized Controlled Trials (RCT) ESM-I study, depressive symptoms were effectively reduced by six weekly sessions of ESM-based PA-feedback [53]. The feedback purely descriptive, for example, graphically showing patients' own level of PA across different situations. A follow-up study revealed that the decrease in depressive symptoms was preceded by a decrease in sedentary behaviors and an increase in physical activity and social behaviors [54], suggesting that lifestyle changes may be part of the remedy. It should be noted though that, although patients' depressive complaints reduced according to the Hamilton Depression Rating Scale and the Inventory of Depressive Symptoms, according to the EMA assessments, patients' momentary levels of PA did not change during the intervention [55].

Next, beyond mere descriptive feedback, van Roekel *et al.* [20,56,57] showed that evaluative feedback in the form of ESM-based recommendations on how to change one's lifestyle might be a more effective way to reduce depressive symptoms – at least in a sub clinical sample. Albeit effect sizes were small, and participants showed no marked decrease in depressive symptoms according to the Patient Health Questionnaire, self-monitoring in

Figure 4



Upper part: adapted Figure 3b from Kramer *et al.* [53]. Lower part: adapted Figure 2 from Appendix D from Bastiaansen *et al.* [60••]. Plots show predicted lines plotted across time (intention-to-treat analysis). IDS = Inventory of Depressive Symptomatology. Post-EMA = assessment in the week after the 28-day intervention period. FU = Follow Up assessment. In the study of Bastiaansen *et al.* [60••], during the 28-day intervention period, patients received weekly feedback on either positive affect and activities (Do-module; experimental 1) or negative affect and thinking patterns (Think-module; experimental 2).

combination with specific recommendations for lifestyle changes effectively increased participants' PA levels throughout daily life, suggesting evaluative feedback may also be an effective way to augment the efficacy of regular depression treatment. In line with these findings, indeed, recent advances on Behavioral Activation treatments suggest that these treatments may work by targeting (low) reward responsiveness directly [42,58].

Finally, Bastiaansen *et al.* [59,60••] translated these findings to clinical practice by providing both descriptive and evaluative Behavioral Activation based feedback on patients' PA, but found no evidence for improvements compared to patients' PA who followed treatment as usual, nor evidence for an increase in EMI-specific empowerment or social functioning of patients. When comparing the study of Bastiaansen *et al.* to the study of

Kramer *et al.* (Figure 4), the largest difference is in the control groups of both studies (i.e. treatment as usual). Whereas in Kramer's study the treatment as usual was medication which only marginally improved patients moods, in the study of Bastiaansen *et al.*, treatment as usual consisted of medication combined with psychotherapy which was more effective in improving patients' moods in the control group. Although the PA-focused EMI did not go beyond the efficacy of medication and psychotherapy, Bastiaansen *et al.*, conclude that it may be worthwhile to investigate whether EMIs can be blended with routine mental health services as they have the potential to make psychotherapy treatments more time-efficient for therapists without sacrificing efficacy.

Conclusions

Recent advances in the field of Positive Affective (PA) and mood disorders in daily life suggest that people with mood disorders typically experience relatively lower levels of PA in daily life, possibly combined with a reduced anticipatory PA, and moment-to-moment variability in PA in bipolar disorder. Future EMA studies into mood disorders may benefit from incorporating both consummatory PA (as experienced in-the-moment) and anticipatory PA (looking forward to future activities or contexts). Social contexts, stress and motivation seem closely related to PA in the daily lives of individuals with anhedonia, and unravelling its underlying mechanisms may be an important next step in fine-tuning treatments for mood disorder.

Evidence from laboratory settings versus EMA appears paradoxical, as laboratory studies show blunted reward responses in depression, whereas EMA studies show evidence for the opposite (i.e. a 'PA brightening effect' in response to positive events). To reconcile both strands of literature, future studies may benefit from a more in-depth analysis into the type of positive events, as well as the operationalizations of reward responsiveness in daily life. For example, by exploring possible relevant differences in the types of positive events (e.g. intrapersonal/interpersonal events, or social/non-social events), and PA reactivity to positive events active behavior, while also including reward-related laboratory test batteries in the same EMA study participants. That way, reward responsiveness in daily life could be 'calibrated' by comparing correlational patterns. Another promising direction for future research would be to investigate the moderating effects of PA regulation strategies on PA brightening after positive events and/or active behavior.

Although the promised therapeutic efficacy of EMIs has not fully materialized (yet), PA-focused EMIs that aim to alter behavior in daily life seem a cost-effective and easily accessible alternative for patients who cannot receive standard Behavioral Activation therapy, or not yet. Furthermore, EMIs may help to understand the mechanisms that underlie behavioral change in Behavioral Activation treatment. There are indications that future PA-focused EMIs may be most effective when targeting both consummatory and anticipatory PA as well as the strength of the connection between both, and involve a type of evaluative feedback which is preferably integrated with face-to-face therapist guidance sessions.

Conflict of interest statement

Nothing declared.

CRediT authorship contribution statement

Vera E Heininga: Conceptualization, Investigation, Visualization, Data curation, Writing - original draft, Writing - review & editing. **Peter Kuppens:** Conceptualization, Writing - review & editing.

Acknowledgement

This work was supported by the C1 grant by the KU Leuven Research Council (C14/19/054).

References and recommended reading

Papers of particular interest, published within the period of review, have been highlighted as

- • of special interest
- •• of outstanding interest

1. American Psychiatric Association: *Diagnostic and Statistical Manual of Mental Disorders*. edn 5. 2013 http://dx.doi.org/10.1176/appi.books.9780890425596.
2. Kessler RC, Berglund P, Chiu WT, Demler O, Heeringa S, Hiripi E, Jin R, Pennell B-E, Walters EE, Zaslavsky A, Zheng H: **The US National Comorbidity Survey Replication (NCS-R): design and field procedures**. *Int J Methods Psychiatric Res* 2004, **13**:69-92 http://dx.doi.org/10.1002/mpr.167.
3. National Institute of Mental Health (NIMH): **Any mood disorder [Statistics on Mental Health Information]**. *Any Mood Disord* 2020 https://www.nimh.nih.gov/health/statistics/any-mood-disorder.shtml#part_155955.
4. Carver CS: *Control Processes, Priority Management, and Affective Dynamics: Emotion Review*. 2015 http://dx.doi.org/10.1177/1754073915590616.
5. Frijda NH, Mesquita B: **The social roles and functions of emotions**. *Emotion and Culture: Empirical Studies of Mutual Influence*. American Psychological Association; 1994:51-87 http://dx.doi.org/10.1037/10152-002.
6. Watson D, Clark LA, Tellegen A: **Development and validation of brief measures of positive and negative affect: the PANAS scales**. *J Pers Soc Psychol* 1988, **54**:1063-1070 http://dx.doi.org/10.1037/0022-3514.54.6.1063.
7. Feldman Barrett L, Russell JA: **Independence and bipolarity in the structure of current affect**. *J Pers Soc Psychol* 1998, **74**:967-984 http://dx.doi.org/10.1037/0022-3514.74.4.967.
8. Yik MSM, Russell JA, Barrett LF: **Structure of self-reported current affect: integration and beyond**. *J Pers Soc Psychol* 1999, **77**:600.
9. Russell JA: **A circumplex model of affect**. *J Pers Soc Psychol* 1980, **39**:1161-1178 http://dx.doi.org/10.1037/h0077714.
10. Dejonckheere E, Mestdagh M, Houben M, Erbas Y, Pe M, Koval P, Brose A, Bastian B, Kuppens P: **The bipolarity of affect and depressive symptoms**. *J Pers Soc Psychol* 2018, **114**:323-341 http://dx.doi.org/10.1037/pspp0000186 AMER PSYCHOLOGICAL ASSOC.

11. Booij SH, Snippe E, Jeronimus BF, Wichers M, Wigman JTW: **Affective reactivity to daily life stress: relationship to positive psychotic and depressive symptoms in a general population sample**. *J Affect Disord* 2018, **225**:474-481 http://dx.doi.org/10.1016/j.jad.2017.08.051Bos ELSEVIER SCIENCE BV.

12. Thompson RJ, Spectre AS, Insel P, Mennin D, Gotlib IH, Gruber J: **Positive and negative affective forecasting in remitted individuals with bipolar I disorder, and major depressive disorder, and healthy controls**. *Cognit Ther Res* 2017, **41**:673-685 http://dx.doi.org/10.1007/s10608-017-9840-2.

13. Bakker JM, Goossens L, Kumar P, Lange IMJ, Michielse S, Schruers K, Bastiaansen JA, Lieverse R, Marcelis M, van Amelsvoort T *et al.*: **From laboratory to life: associating brain reward processing with real-life motivated behaviour and symptoms of depression in non-help-seeking young adults**. *Psychol Med* 2019, **49**:2441-2451 http://dx.doi.org/10.1017/S0033291718003446 CAMBRIDGE UNIV PRESS.

14. Heininga VE, Dejonckheere E, Houben M, Obbels J, Sienaert P, Leroy B, van Roy J, Kuppens P: **The dynamical signature of anhedonia in major depressive disorder: positive emotion dynamics, reactivity, and recovery**. *BMC Psychiatry* 2019, **19** http://dx.doi.org/10.1186/s12888-018-1983-5 BMC.

15. Heininga VE, van Roekel E, Ahles JJ, Oldehinkel AJ, Mezulis AH: **Positive affective functioning in anhedonic individuals' daily life anything but flat and blunted**. *J Affect Disord* 2017, **218**:437-445 http://dx.doi.org/10.1016/j.jad.2017.04.029.

16. Houben M, Van Den Noortgate W, Kuppens P: **The relation between short-term emotion dynamics and psychological well-being: a meta-analysis**. *Psychol Bull* 2015, **141**:901-930 http://dx.doi.org/10.1037/a0038822.

17. •• Nelson J, Klumparendt A, Doebler P, Ehring T: **Everyday emotional dynamics in major depression**. *Emotion* 2020, **20**:179-191 http://dx.doi.org/10.1037/emo0000541 AMER PSYCHOLOGICAL ASSOC.

Investigates the everyday PA dynamics of depressed individuals (e.g. inertia, context insensitivity, and variability), and shows no differences in the dynamics of PA between depressed and healthy subjects.

18. Sperry SH, Barrantes-Vidal N, Kwapil TR: **The association of affective temperaments and bipolar spectrum psychopathology: an experience sampling study**. *Motiv Emot* 2018, **42**:126-136 http://dx.doi.org/10.1007/s11031-017-9652-4 SPRINGER/PLENUM PUBLISHERS.

19. Sperry SH, Kwapil TR: **Affective dynamics in bipolar spectrum psychopathology: modeling inertia, reactivity, variability, and instability in daily life**. *J Affect Disord* 2019, **251**:195-204 http://dx.doi.org/10.1016/j.jad.2019.01.053 ELSEVIER SCIENCE BV.

20. van Roekel E, Bennik EC, Bastiaansen JA, Verhagen M, Ormel J, Engels RCME, Oldehinkel AJ: **Depressive symptoms and the experience of pleasure in daily life: an exploration of associations in early and late adolescence**. *J Abnorm Child Psychol* 2016, **44**:999-1009 http://dx.doi.org/10.1007/s10802-015-0090-z.

21. •• Sperry SH, Walsh MA, Kwapil TR: **Emotion dynamics concurrently and prospectively predict mood psychopathology**. *J Affect Disord* 2020, **261**:67-75 http://dx.doi.org/10.1016/j.jad.2019.09.076 ELSEVIER.

Shows that, after controlling for differences in individuals' mean PA, variability in PA still provides unique and additional information in people with bipolar disorder.

22. Kiekens G, Hasking P, Nock MK, Boyes M, Kirtley O, Bruffaerts R, Myin-Germeys I, Claes L: **Fluctuations in affective states and self-efficacy to resist non-suicidal self-injury as real-time predictors of non-suicidal self-injurious thoughts and behaviors**. *Front Psychiatry* 2020, **11** http://dx.doi.org/10.3389/fpsyt.2020.00214 FRONTIERS MEDIA SA.

23. Koval P, Sütterlin S, Kuppens P: **Emotional inertia is associated with lower well-being when controlling for differences in emotional context**. *Front Psychol* 2015, **6**:1997 http://dx.doi.org/10.3389/fpsyg.2015.01997.

24. Bos EH, de Jonge P, Cox RFA: **Affective variability in depression: revisiting the inertia-instability paradox**. *Br J Psychol (London, England: 1953)* 2019, **110**:814-827 http://dx.doi.org/10.1111/bjop.12372.

25. • Dejonckheere E, Mestdagh M, Houben M, Rutten I, Sels L, Kuppens P, Tuerlinckx F: **Complex affect dynamics add limited information to the prediction of psychological well-being**. *Nat Hum Behav* 2019, **3**:478-491 http://dx.doi.org/10.1038/s41562-019-0555-0.

Following Koval *et al.* [13] (Emotion, 13, 1132) and Bos *et al.* [24] (British Journal of Psychology, 110, 814–827) who did similar analyses with regard to NA, this study shows that mood disorders may not be linked to greater variability in PA *per se*, as it often disappears after controlling for differences in mean PA.

26. Koval P, Pe ML, Meers K, Kuppens P: **Affect dynamics in relation to depressive symptoms: variable, unstable or inert?** *Emotion (Washington, D.C.)* 2013, **13**:1132-1141 http://dx.doi.org/10.1037/a0033579.

27. Rottenberg J, Gross JJ, Gotlib IH: **Emotion context insensitivity in major depressive disorder**. *J Abnorm Psychol* 2005, **114**:627-639 http://dx.doi.org/10.1037/0021-843X.114.4.627.

28. Bylsma LM, Morris BH, Rottenberg J: **A meta-analysis of emotional reactivity in major depressive disorder**. *Clin Psychol Rev* 2008, **28**:676-691 http://dx.doi.org/10.1016/j.cpr.2007.10.001.

29. Forbes EE, Dahl RE: **Research review: altered reward function in adolescent depression: what, when and how?: reward function and adolescent depression**. *J Child Psychol Psychiatry* 2012, **53**:3-15 http://dx.doi.org/10.1111/j.1469-7610.2011.02477.x.

30. Keren H, O'Callaghan G, Vidal-Ribas P, Buzzell GA, Brotman MA, Leibenluft E, Pan PM, Meffert L, Kaiser A, Wolke S *et al.*: **Reward processing in depression: a conceptual and meta-analytic review across fMRI and EEG studies**. *Am J Psychiatry* 2018, **175**:1111-1120 http://dx.doi.org/10.1176/appi.ajp.2018.17101124.

31. Rottenberg J, Hindash AC: **Emerging evidence for emotion context insensitivity in depression**. *Curr Opin Psychol* 2015, **4**:1-5 http://dx.doi.org/10.1016/j.copsyc.2014.12.025.

32. Peeters F, Nicolson NA, Berkhof J, Delespaul P, deVries M: **Effects of daily events on mood states in major depressive disorder**. *J Abnorm Psychol* 2003, **112**:203-211 http://dx.doi.org/10.1037/0021-843X.112.2.203.

33. Panaite V, Koval P, Dejonckheere E, Kuppens P: **Emotion regulation and mood brightening in daily life vary with depressive symptom levels**. *Cognit Emot* 2019, **33**:1291-1301 http://dx.doi.org/10.1080/02699931.2018.1543180.

34. • Khazanov GK, Ruscio AM, Swendsen J: **The "Brightening" effect: reactions to positive events in the daily lives of individuals with major depressive disorder and generalized anxiety disorder**. *Behav Ther* 2019, **50**:270-284 http://dx.doi.org/10.1016/j.beth.2018.05.008 ELSEVIER INC.

An in-depth study of the puzzling 'Brightening' effect, as well as an analysis of the extent of spill-over to other domains of psychological functioning.

35. Starr LR, Hershenberg R: **Depressive symptoms and the anticipation and experience of uplifting events in everyday life**. *J Clin Psychol* 2017, **73**:1442-1461 http://dx.doi.org/10.1002/jclp.22447.

36. Bylsma LM, Taylor-Clift A, Rottenberg J: **Emotional reactivity to daily events in major and minor depression**. *J Abnorm Psychol* 2011, **120**:155-167 http://dx.doi.org/10.1037/a0021662.

37. Bakker JM, Goossens L, Lange I, Michielse S, Schruers K, Lieverse R, Marcelis M, van Amelsvoort T, van Os J, Myin-Germeys I, Wichers M: **Real-life validation of reduced reward processing in emerging adults with depressive symptoms**. *J Abnorm Psychol* 2017, **126**:713-725 http://dx.doi.org/10.1037/abn0000294.

38. Fried EI, Nesse RM: **Depression is not a consistent syndrome: an investigation of unique symptom patterns in the STARD study**. *J Affect Disord* 2015, **172**:96-102 http://dx.doi.org/10.1016/j.jad.2014.10.010.

39. Berridge KC, Robinson TE, Aldridge JW: **Dissecting components of reward: 'liking', 'wanting', and learning**. *Curr Opin Pharmacol* 2009, **9**:65-73 http://dx.doi.org/10.1016/j.coph.2008.12.014.

40. Rømer Thomsen K, Whybrow PC, Kringelbach ML: **Reconceptualizing anhedonia: novel perspectives on balancing the pleasure networks in the human brain**. *Front Behav Neurosci* 2015, **9** http://dx.doi.org/10.3389/fnbeh.2015.00049.

41. Treadway MT, Zald DH: **Reconsidering anhedonia in depression: lessons from translational neuroscience**. *Neurosci Biobehav Rev* 2011, **35**:537-555 http://dx.doi.org/10.1016/j.neubiorev.2010.06.006.

42. Pizzagalli DA: **Depression, stress, and anhedonia: toward a synthesis and integrated model**. *Annu Rev Clin Psychol* 2014, **10**:393-423 http://dx.doi.org/10.1146/annurev-clinpsy-050212-185606.

43. De Fruyt J, Sabbe B, Demyttenaere K: **Anhedonia in depressive disorder: a narrative review**. *Psychopathology* 2020:1-8 http://dx.doi.org/10.1159/000508773.

44. Bos FM, Blaauw FJ, Snippe E, van der Krieke L, de Jonge P, Wichers M: **Exploring the emotional dynamics of subclinically depressed individuals with and without anhedonia: an experience sampling study**. *J Affect Disord* 2018, **228**:186-193 http://dx.doi.org/10.1016/j.jad.2017.12.017.

45. van Roekel E, Heininga VE, Vrijen C, Snippe E, Oldehinkel AJ: **Reciprocal associations between positive emotions and motivation in daily life: network analyses in anhedonic individuals and healthy controls**. *Emotion* 2019, **19**:292-300 http://dx.doi.org/10.1037/emo0000424.

46. • Li X, Zhang Y, Huang Z-J, Chen X-L, Yuan F-H, Sun X-J: **Diminished anticipatory and consummatory pleasure in dysphoria: evidence from an experience sampling study**. *Front Psychol* 2019, **10** http://dx.doi.org/10.3389/fpsyg.2019.02124 FRONTIERS MEDIA SA.
One of the first studies to investigate both consummatory and anticipatory PA in daily life in individuals with depressive symptoms.

47. Wichers M, Kasanova Z, Bakker JM, Thiery E, Derom C, Jacobs N, van Os J: **From affective experience to motivated action: tracking reward-seeking and punishment-avoidant behaviour in real-life**. *PLoS One* 2015, **10**:e0129722 http://dx.doi.org/10.1371/journal.pone.0129722.

48. Heininga VE, van Roekel E, Wichers M, Oldehinkel AJ: **Reward and punishment learning in daily life: a replication study**. *PLoS One* 2017, **12**:e0180753 http://dx.doi.org/10.1371/journal.pone.0180753.

49. Colombo D, Fernández-Álvarez J, Patané A, Semonella M, Kwiatkowska M, García-Palacios A, Cipresso P, Riva G, Botella C: **Current state and future directions of technology-based ecological momentary assessment and intervention for major depressive disorder: a systematic review**. *J Clin Med* 2019, **8**:465 http://dx.doi.org/10.3390/jcm8040465.

50. Dubad M, Winsper C, Meyer C, Livanou M, Marwaha S: **A systematic review of the psychometric properties, usability and clinical impacts of mobile mood-monitoring applications in young people**. *Psychol Med* 2018, **48**:208-228 http://dx.doi.org/10.1017/S0033291717001659.

51. Linardon J, Cuijpers P, Carlbring P, Messer M, Fuller-Tyszkiewicz M: **The efficacy of app-supported smartphone interventions for mental health problems: a meta-analysis of randomized controlled trials**. *World Psychiatry* 2019, **18**:325-336 http://dx.doi.org/10.1002/wps.20673.

52. Myin-Germeys I, Kasanova Z, Vaessen T, Vachon H, Kirtley O, Viechtbauer W, Reininghaus U: **Experience sampling methodology in mental health research: new insights and technical developments**. *World Psychiatry* 2018, **17**:123-132 http://dx.doi.org/10.1002/wps.20513.

53. Kramer I, Simons CJP, Hartmann JA, Menne-Lothmann C, Viechtbauer W, Peeters F, Schruers K, van Bemmel AL, Myin-Germeys I, Delespaul P *et al.*: **A therapeutic application of the experience sampling method in the treatment of depression: a randomized controlled trial**. *World Psychiatry* 2014, **13**:68-77 http://dx.doi.org/10.1002/wps.20090.

54. Snippe E, Jeronimus BF, aan het Rot M, Bos EH, de Jonge P, Wichers M: **The reciprocity of prosocial behavior and positive affect in daily life**. *J Pers* 2018, **86**:139-146 http://dx.doi.org/10.1111/jopy.12299 WILEY.

55. Hartmann JA, Wichers M, Menne-Lothmann C, Kramer I, Viechtbauer W, Peeters F, Schruers KRJ, van Bemmel AL, Myin-Germeys I, Delespaul P *et al.*: **Experience sampling-based personalized feedback and positive affect: a randomized controlled trial in depressed patients**. *PLoS One* 2015, **10**:e0128095 http://dx.doi.org/10.1371/journal.pone.0128095.

56. Van Roekel E, Vrijen C, Heininga VE, Masselink M, Bos EH, Oldehinkel AJ: **An exploratory randomized controlled trial of personalized lifestyle advice and tandem skydives as a means to reduce anhedonia**. *Behav Ther* 2017, **48**:76-96 http://dx.doi.org/10.1016/j.beth.2016.09.009.

57. van Roekel E, Masselink M, Vrijen C, Heininga VE, Bak T, Nederhof E, Oldehinkel AJ: **Study protocol for a randomized controlled trial to explore the effects of personalized lifestyle advices and tandem skydives on pleasure in anhedonic young adults**. *BMC Psychiatry* 2016, **16**:182 http://dx.doi.org/10.1186/s12888-016-0880-z.

58. Forbes CN: **New directions in behavioral activation: using findings from basic science and translational neuroscience to inform the exploration of potential mechanisms of change**. *Clin Psychol Rev* 2020, **79**:101860 http://dx.doi.org/10.1016/j.cpr.2020.101860.

59. Bastiaansen JA, Meurs M, Stelwagen R, Wunderink L, Schoevers RA, Wichers M, Oldehinkel AJ: **Self-monitoring and personalized feedback based on the experiencing sampling method as a tool to boost depression treatment: a protocol of a pragmatic randomized controlled trial (ZELF-i)**. *BMC Psychiatry* 2018, **18** http://dx.doi.org/10.1186/s12888-018-1847-z BMC.

60. •• Bastiaansen JA, Ornée DA, Meurs M, Oldehinkel A: **An evaluation of the efficacy of two add-on ecological momentary intervention modules for depression in a pragmatic randomized controlled trial (ZELF-i) [Preprint]**. *PsyArXiv* 2020 http://dx.doi.org/10.31234/osf.io/8jfgc.
Randomized Controlled Trial of an EMI that targets both of depression's core symptoms: depressed mood and anhedonia, and examines the effects of EMA-monitoring and personalized feedback on depressive complaints in clinical practice beyond treatment as usual.

61. Wu H, Mata J, Furman DJ, Whitmer AJ, Gotlib IH, Thompson RJ: **Anticipatory and consummatory pleasure and displeasure in major depressive disorder: an experience sampling study**. *J Abnorm Psychol* 2017, **126**:149-159 http://dx.doi.org/10.1037/abn0000244.