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Context matters for affective chronometry

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The emergence of mobile technology has resulted in an explosion of research tracking individuals' everyday emotions using ecological momentary assessment (EMA), and has yielded a cornucopia of metrics to capture the temporal features of affect (hereafter affective dynamics). Dejonckheere, Mestdagh and colleagues conducted a timely and thoughtful meta-analysis to address which EMA metrics best predict psychopathology and well-being, and concluded that affective dynamics capture a negligible amount of variance in emotional well-being over and above mean levels of positive and negative affect[1]. Here we argue that context matters: the authors' conclusion should be considered within the broader field of affective science examining the affective dynamics of subjective, physiological and neural responses surrounding affectively meaningful events. Although mean levels of affect collected at random may strongly correlate with depression and well-being, probing the recovery function of responses following discrete affective perturbations unveils unique insights into affective function and dysfunction, and may be more sensitive to the integrity and well-being of a system than its mean levels.

Dejonckheere, Mestdagh and colleague's recent Letter[1] is a welcome and rigorous addition to the EMA literature. Combining 15 studies totalling over 1,700 participants, the authors examined 16 metrics of affect to determine their contributions to psychological well-being (life satisfaction) and symptoms of psychopathology (depression and borderline personality disorder). The authors report that mean levels of self-reported positive and negative affect account for the lion's share of variance in emotional well-being. Measures of affective dynamics, save for affect variability (standard deviation), explained very little of the remaining variance in well-being or psychopathology. The authors conclude that current affective science using EMA cannot conclusively identify specific affect dynamic parameters (other than the mean) that predict psychological well-being or depression. Critically, however, they acknowledge the possibility that anchoring EMA measurements to meaningful emotional contexts may lead to a different conclusion.

It is this conclusion that we contend warrants further consideration. The extant literature has already established a meaningful role for context in affect dynamics by linking measurement of recovery to affectively meaningful events. Temporal dynamics measured during the recovery period—that is, during the time it takes a system to return to baseline following a perturbation—reveals the integrity of many systems: from zooplankton to economic markets, from tropical forests to human emotional and physical health[2]. Similarly, beyond characterizing fluctuations in naturally occurring affect, we contend that probing humans' recovery function following discrete emotional provocations provides important insight into the dynamics underlying affective function and dysfunction.

For instance, an extensive literature links depression to hypothalamic–pituitary–adrenal (HPA) axis dysregulation. Following stressful events, the HPA system becomes engaged and prolonged HPA axis recovery has been associated with chronic stress and health problems[3]. Although depressed and non-depressed individuals may show similar overall baseline levels of the stress hormone cortisol following a laboratory-induced stressor, cortisol recovery (≥25 min after stressor offset) is poorer in individuals with depression[4]. In other words, a temporally specific window of response to a provocation best differentiates individuals with depression (above baseline differences). Further underscoring the relative independence of daily (unanchored) versus event-related (anchored) fluctuations in the HPA axis, total cortisol following laboratory stress only shares 7.2% of variance with total diurnal cortisol[5]. Thus, event-locked changes in stress hormones are robustly linked to well-being, and cannot be accounted for by unanchored, diurnal levels.

In addition to hormonal fluctuations, the steepness of the recovery function of physiological, behavioural and subjective responses to aversive events uniquely predicts individual differences in psychological well-being. Early EMA research demonstrated that when performing poorly, it was the sustained self-reported depressive symptoms (over periods of days, rather than immediately) that were most associated with cognitive styles linked to risk for depression following mid-term exam feedback[6]. Furthermore, in rodent, non-human primate and human models of anxiety, the duration of freezing (a metric of poor recovery) when encountering a perceived threat is linked to a risk of developing clinical anxiety[7]. Relatedly, purpose in life, a facet of psychological well-being, is associated with faster recovery from negative emotional provocations as indexed by smaller magnitudes of the startle eye-blink reflex following (1,900 ms after, but not during) negative-picture processing[8]. Likewise, conscientiousness, a personality trait linked to mental health outcomes and longevity, is associated with a faster return to baseline several seconds following negative-stimulus processing as indexed by the duration of corrugator supercilii facial electromyography activation (the muscles comprising the furrowing of the brow)—with no such association during the reactivity epoch[9].

Beyond recovery from negative affect, persistence of responses to positive events is linked to psychopathology: short-lived responses to positive events (over timescales of seconds to minutes) is linked to a depressogenic affective style, as measured by self-report[10] and peripheral physiology[11]. Married individuals who have experienced long-lasting marital strain, a risk factor for depression, exhibit short-lived facial electromyography responses to positive pictures (over 8 s)—yet show no differences in initial reactivity. Relatedly, we have found that the capacity to maintain striatal engagement (a brain region implicated in reward processing and learning) in response to positively valenced stimuli (over ~40 min) is associated

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with lower depression[12] and higher psychological (eudaimonic) well-being, and lower total cortisol output[13]—whereas the mean level of striatal engagement is not. It is critical to note that in the above-reviewed work indicating that psychological function was linked to the decay (as opposed to the initial reactivity) of affective, physiological and neural responses, simply averaging across time would have obscured the specific contribution of each metric.

Nonetheless, we agree with the authors' underscoring of parsimony in predictive models: emotion researchers investigating the affective mechanisms that underlie individual differences in psychological functioning must consider the mean level of the predictor of interest first—and only then test whether more complex dynamic measures account for additional variance. In a way, the finding that the mean of several measures of one's self-reported state is the best approximation of one's self-reported trait is perhaps not surprising; self-reported states are probably not independent of trait-like dispositions[14]. This point was also demonstrated recently in the field of personality psychology[15].

The evidence discussed above stemmed from studies that often sampled affective reactions in systems exhibiting intrinsically faster temporal resolution than is typically obtained in EMA studies. However, EMA sampling at finer temporal scales following affectively salient events may also capture the recovery function in subjective experience; the ideal temporal resolution for subjective reactions remains to be determined. Moving forward, we hope that affective scientists do not throw the affective dynamics baby out with the bathwater, but instead disentangle how and when time-varying metrics of self-reported affect, physiology and biological processes add substantial explanatory power above and beyond mean levels in those systems. Doing so will require not only reports of field-based, naturalistic functions in everyday life, but also anchoring assessments to the context of the individual, and empirically induced affective changes. Only then will we be able to determine the level of complexity required to uncover the unique contributions of affect dynamics to psychopathology and well-being.

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References

1. Dejonckheere, E. et al. Complex affect dynamics add limited information to the prediction of psychological well-being. *Nat. Hum. Behav.* **3**, 478–491 (2019).
2. Scheffer, M. et al. Quantifying resilience of humans and other animals. *Proc. Natl Acad. Sci. USA* **115**, 11883–11890 (2018).
3. McEwen, B. S. & Wingfield, J. C. The concept of allostasis in biology and biomedicine. *Horm. Behav.* **43**, 2–15 (2003).
4. Burke, H. M., Davis, M. C., Otte, C. & Mohr, D. C. Depression and cortisol responses to psychological stress: a meta-analysis. *Psychoneuroendocrinology* **30**, 846–856 (2005).
5. Kidd, T., Carvalho, L. A. & Steptoe, A. The relationship between cortisol responses to laboratory stress and cortisol profiles in daily life. *Biol. Psychol.* **99**, 34–40 (2014).
6. Metalsky, G. I., Joiner, T. E., Hardin, T. S. & Abramson, L. Y. Depressive reactions to failure in a naturalistic setting: a test of the hopelessness and self-esteem theories of depression. *J. Abnorm. Psychol.* **102**, 101–109 (1993).
7. Fox, A. S. & Kalin, N. H. A translational neuroscience approach to understanding the development of social anxiety disorder and its pathophysiology. *Am. J. Psychiat.* **171**, 1162–1173 (2014).
8. Schaefer, S. M. et al. Purpose in life predicts better emotional recovery from negative stimuli. *PLoS ONE* **8**, e80329 (2013).
9. Javaras, K. N. et al. Conscientiousness predicts greater recovery from negative emotion. *Emotion* **12**, 875–881 (2012).
10. McMakin, D. L., Santiago, C. D. & Shirk, S. R. The time course of positive and negative emotion in dysphoria. *J. Posit. Psychol.* **4**, 182–192 (2009).
11. Lapate, R. C. et al. Prolonged marital stress is associated with short-lived responses to positive stimuli. *Psychophysiology* **51**, 499–509 (2014).
12. Heller, A. S. et al. Reduced capacity to sustain positive emotion in major depression reflects diminished maintenance of fronto-striatal brain activation. *Proc. Natl Acad. Sci. USA* **106**, 22445–22450 (2009).
13. Heller, A. S. et al. Sustained striatal activity predicts eudaimonic well-being and cortisol output. *Psychol. Sci.* **24**, 2191–2200 (2013).
14. Dohrenwend, B. P., Link, B. G., Kern, R., Shrout, P. E. & Markowitz, J. Measuring life events: the problem of variability within event categories. *Stress Med.* **6**, 179–187 (1990).
15. Finnigan, K. M. & Vazire, S. The incremental validity of average state self-reports over global self-reports of personality. *J. Pers. Soc. Psychol.* **115**, 321–337 (2018).

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