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Affective Dynamics in Psychopathology

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Abstract

We discuss three varieties of affective dynamics (*affective instability*, *emotional inertia*, and *emotional differentiation*). In each case, we suggest how these affective dynamics should be operationalized and measured in daily life using time-intensive methods, like ecological momentary assessment or ambulatory assessment, and recommend time-sensitive analyses that take into account not only the variability but also the temporal dependency of reports. Studies that explore how these affective dynamics are associated with psychological disorders and symptoms are reviewed, and we emphasize that these affective processes are within a nexus of other components of emotion regulation.

Keywords

affective dynamics; affective instability; emotional differentiation; emotional inertia

Optimal mental health is not simply a function of experiencing more positive than negative affect, on average. Such a static view of emotional experience ignores the moment-to-moment ebb and flow of affect that can be influenced by various factors both internal (e.g., cognitive, biological) and external (e.g., events) to the person. Emotional experience is dynamic, not static, and methods that provide multiple microassessments of emotional experience across time and situations can shed light on the dynamic nature of various

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affective processes that are theorized to be central to the development and course of psychopathology. In this review, we focus on three varieties of affective dynamics that have been used in investigations of psychopathology: affective instability, inertia, and emotional differentiation. Although other features of affective dynamics have been studied (e.g., variability; Wichers, Wigman, & Myin-Germeys, 2015), we focus on these three because they truly capture moment-to-moment change and can be estimated based on repeated assessments of momentary affect.

Unfortunately, dynamic affective processes have historically been neglected in psychopathology research (Ebner-Priemer & Trull, 2011), and in behavioral science more generally (Molenaar & Campbell, 2009). This is not surprising because monitoring and analyzing dynamic processes can be challenging. However, both traditional assessment methods (e.g. retrospective questionnaires) and classical statistical indices (e.g., group means) are (a) not well suited for fully capturing within-person processes over time and (b) introduce biases into measurement. For example, retrospective questionnaires or interviews require respondents to speculate about their affective dynamics. Questions like “Do you often change from your usual mood to feeling irritable, very depressed, or very nervous?” require individuals to estimate baselines (what is typical), aggregate over time, and average over different emotions. It is perhaps not surprising that associations between prospectively monitored affective changes and retrospective ratings of these changes are usually weak (Links, Heisel, & Garland, 2003; Solhan, Trull, Jahng, & Wood, 2009).

To investigate affective dynamics precisely, it is essential to use time-sensitive assessment and analyses. Ideally, investigators will use technology (e.g., e-diaries, smartphones) that repeatedly assesses affect with accurate time-stamping. Assessment occasions may be either event-contingent, at random intervals, or a combination of both (Trull & Ebner-Priemer, 2013). Crucially, assessments should occur at a timescale that is appropriate to the affective processes of interest (Bolger, Davis, & Rafaeli, 2003; Hollenstein, 2015). Given that this may not always be known, sampling affect at the highest possible frequency (without overburdening participants) may be advisable (Bolger et al., 2003; Ebner-Priemer & Sawitzki, 2007). However, even an appropriate sampling protocol does not, in and of itself, guarantee a precise and accurate picture of affective dynamics. It is also necessary to use appropriate analytic techniques that fully capture the dynamic nature of affective processes.

Perhaps the most egregious example of using inappropriate summary indices to capture a dynamic process is the use of the standard deviation (or equivalently, a variance) as a proxy for affective instability. A standard deviation is not time-sensitive because it does not account for moment-to-moment changes in affect (Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009; Ebner-Priemer et al., 2007). An often used example (Ebner-Priemer et al., 2009) may help to illustrate the problem: Imagine being on vacation at two different locations (A, B) for 2 weeks each. Location A alternates between rain and sunshine every other day, whereas location B’s weather is more stable, with 1 week of pure sunshine and 1 week of continuous rain. Even though we would label the weather of Location B as more stable than in Location A, the standard deviation would be the same. Therefore, several authors argue for differentiating between variability and instability on a theoretical basis (Ebner-Priemer et al., 2009; Ebner-Priemer et al., 2007; Jahng et al., 2011; Koval, Pe, Meers,

& Kuppens, 2013; Trull et al., 2008). Variability is the general dispersion of scores, whereas instability comprises two components: variability and temporal dependency (Jahng et al., 2011; Koval et al., 2013; Trull et al., 2008). Instability can be measured using a single index that considers both variability and temporal dependency (e.g., the squared successive difference [SSD]; Jahng, Wood, & Trull, 2008) or by examining these two components separately. This idea of decomposing responses into their multiple sources of variance across repeated measurements, whether it be systematic ordering across time or across different affective subscales, is a critical point of overlap in the three indices that we review. Such an approach enables more precise and theoretically meaningful measurement of the various dynamic processes that researchers are interested in.

Affective Instability

Conceptualization

As mentioned, *affective instability* is most often conceptualized as the combination of variability and temporal dependency (Ebner-Priemer et al., 2007; Trull et al., 2008). Whereas variability (i.e., the within-person *SD*) reflects the overall amplitude of affective changes (i.e., how much affect deviates around its mean level), temporal dependency (i.e., the within-person autocorrelation) reflects the moment-to-moment consistency of affect across adjacent measurements.

Measurement

Accordingly, only indices which consider variability and temporal dependency should be used for analyzing instability. Multilevel models of *SSDs* (squared successive differences) and *PACs* (probability of acute changes) have been proposed in this regard (Jahng et al., 2008), as well as aggregated point-by-point changes (Santangelo et al., 2014).

Associations with Psychopathology

Most research on affective instability and psychopathology focuses on borderline personality disorder (BPD). Although a number of other mood and anxiety disorders are conceptualized as disorders of distress or emotion dysregulation, BPD is the only disorder for which affective instability is a specific diagnostic criterion (American Psychiatric Association [APA], 2013). Studies of affective instability using e-diaries and time-sensitive statistics have consistently found heightened affective instability in patients with BPD (Ebner-Priemer et al., 2007; Santangelo, Bohus, & Ebner-Priemer, 2012; Santangelo et al., 2014; Trull et al., 2008). However, most psychological disorders show some kind of altered affective experience, deficient emotion regulation, or dysfunctional behavior to regulate emotions. Therefore, affective instability has also been investigated in diagnostic groups not directly characterized by affective instability as a criterion or major symptom. For instance, heightened instability has been reported in patients with anxiety disorders (Pfaltz, Michael, Grossman, Margraf, & Wilhelm, 2010), bipolar disorder (Jones, Hare, & Evershed, 2005), bulimia nervosa (Anestis et al., 2010; Selby et al., 2012; Vansteelandt, Probst, & Pieters, 2013), major depression (MDD; Thompson et al., 2012), and posttraumatic stress disorder (Kashdan, Uswatte, Steger, & Julian, 2006). Recently, Santangelo et al. (2014) investigated the specificity of affective instability among patients with BPD. Surprisingly, patients with

posttraumatic stress disorder and patients with bulimia nervosa showed similarly heightened instability of affect (emotional valence and distress) as patients with BPD.

On a methodological level, Santangelo et al. (2014) argue that three main topics regarding affective instability are understudied and should be considered to more fully characterize instability and differentiate affective processes between disorders. First, events and triggers of emotional episodes are rarely assessed. However, they are likely to differ between disorders. Tempting food might trigger affective processes in patients with eating disorders, but not in patients with PTSD, whereas for traumatic memories the opposite pattern might be expected. Second, the appraisal of events and the metacognitions of the associated affective processes have been largely neglected in psychopathology research (but see Thompson et al., 2012). Third, it might be helpful to investigate subcomponents of dynamic processes. Several theoretical models of affective dysregulation specify distinct subcomponents, like Linehan's (1993) biosocial theory (including sensitivity to emotional stimuli, responses to emotional stimuli, and return to baseline). Sophisticated theoretical and statistical models have been developed, which make these subcomponents accessible to research (Kuppens, Oravecz, & Tuerlinckx, 2010). A consideration of subcomponents might also be more powerful in differentiating various psychopathological disorders with altered affective dynamics, compared to more global indices of affective instability.

Although BPD and MDD patients both display heightened affective instability relative to controls, instability is more extreme in BPD than MDD (Trull et al., 2008). Regarding the first subcomponent, BPD patients show higher levels of variability than individuals with MDD (Trull et al., 2008), perhaps reflecting greater reactivity to external events. This may (partly) account for the greater affective instability associated with BPD. Yet, the other subcomponent of instability may also play a role. Whereas depression is characterized by heightened temporal dependency of affect (i.e., a high autocorrelation), this is not typical for BPD (Houben, van den Noortgate, & Kuppens, in press). Because temporal dependency is inversely related to instability (Jahng et al., 2008), greater temporal dependency may contribute to relatively lower levels of instability observed among MDD versus BPD patients. Therefore, it is important to distinguish between variability and temporal dependency because differences in affective instability may be driven primarily by one of these subcomponents (Koval et al., 2013; Wang, Hamaker, & Bergeman, 2012).

Recommendations

Like Ebner-Priemer et al. (2009), we recommend before starting a study to clarify: (a) if the temporal order of symptoms or features is relevant for the research question posed; (b) which data acquisition method is best suited to the research question (e.g., e-diaries or a laboratory approach); (c) what is an appropriate sampling frequency, taking into account that an accelerated process in general needs a higher sampling frequency; and (d) what is the best statistical index to model the instability under investigation. Adding the level (mean) of the variable of interest as a covariate might be appropriate, as interactions between instability and level have been observed (Ebner-Priemer et al., 2009). Only the assessment of within-subject regulatory processes will enable us to consider psychopathology in terms of dysregulation and dysfunction of the fundamental aspects of behavior and affect, and

ultimately enable us to investigate and compare the fundamental psychological dimensions that cut across traditional disorders.

Emotional Inertia

Conceptualization

Parallel to the research on affective instability, a number of studies have examined individual differences specifically focusing on the temporal dependency component of affective dynamics. Greater temporal dependency of affect over time reflects a tendency for affect to be highly predictable from moment-to-moment. Given that an important function of affect is to change in response to fluctuating environmental demands (Kashdan & Rottenberg, 2010), greater temporal dependency of affect can be considered to reflect affective inflexibility or resistance to change (Hollenstein, 2015). Therefore, this feature of affective dynamics has been labeled *emotional inertia* (Cook et al., 1995; Kuppens, Allen, & Sheeber, 2010; Suls, Green, & Hillis, 1998).

Measurement

Emotional inertia can be estimated as the within-person autocorrelation of affect assessed repeatedly over time. This involves calculating the correlation between affect at time *t* and affect at time *t-1* for each individual and, in a second step, correlating these within-person autocorrelations with between-person measures of well-being or psychopathology (e.g., Koval et al., 2013). However, it is more common to simultaneously model emotional inertia at the within-person level and estimate how it is associated with measures of well-being or psychopathology at the between-person level, using a multilevel autoregressive model. Here, the within-person autoregressive slope (i.e., affect at time *t-1* predicting affect at time *t*) is estimated at Level 1 and allowed to vary randomly across individuals at Level 2, where individual differences in emotional inertia can be related to person-level covariates (e.g., Kuppens, Oravecz et al., 2010; Suls et al., 1998). An additional consideration when studying inertia is that a person's autoregressive slope may be influenced by time trends. These can be readily removed by including a predictor representing the linear effect of time at the within-person level of the model. Furthermore, as mentioned before, researchers should carefully consider the timescale at which affect is assessed when interpreting their findings, as emotional inertia may show different relationships with measures of well-being and psychopathology at various time-scales (Koval et al., 2013).

Associations With Psychopathology

A number of studies have linked heightened inertia, particularly of negative affect (NA), with indicators of increased vulnerability to depression, such as neuroticism (Suls et al., 1998), low self-esteem (Kuppens, Allen, et al., 2010), trait rumination (Koval, Kuppens, Allen, & Sheeber, 2012), subclinical depressive symptoms (Brose, Schmiedek, Koval, & Kuppens, 2015; Koval et al., 2013), and the 5-HTTLPR polymorphism (Kuppens, van Roekel, Verhagen, & Engels, 2015). A direct link between emotional inertia and future onset of MDD has also been demonstrated (Kuppens et al., 2012; van de Leemput et al., 2014). In fact, Kuppens et al. (2012) found that heightened inertia prospectively predicted the development of MDD among adolescents even after adjusting for several known depression

risk factors, including mean levels of NA and gender. However, whether or not emotional inertia remains elevated among individuals currently in an MDD episode remains unclear (cf. Kuppens, Allen, et al., 2010 vs. Thompson et al., 2012). Nevertheless, heightened temporal dependency or inertia of NA appears to represent an "early warning signal" of an imminent transition into MDD (van de Leemput et al., 2014). This illustrates the utility of properly capturing affective dynamics in terms of diagnosis and early intervention of mental disorders such as depression.

Recommendations

To advance our understanding of emotional inertia future studies should: (a) investigate whether higher levels of inertia are also evident in other forms of psychopathology that are considered to involve alterations in emotional intensity (e.g., antisocial personality disorder), frequency (e.g., autism spectrum disorder), or duration (e.g., specific phobias; Gross & Jazaieri, 2014); (b) examine individual/group differences in inertia in response to the same sequence of emotion-eliciting stimuli in the lab (Koval et al., 2013) in order to clarify whether inertia reflects altered responding versus differential exposure to events; (c) measure inertia of various emotional response components (feelings, behavior, physiology) in the same participants and examine their relations with psychopathology; and (d) assess the longer term consequences of emotional inertia, including the possibility that increases or decreases in emotional inertia may predict future psychopathology (van de Leemput et al., 2014).

Emotional Differentiation

Conceptualization

Another form of affective dynamics is *emotional differentiation* (also referred to as *emotional granularity*; Barrett, 2004). Emotional differentiation refers to an individual's ability to distinguish between different forms of affective experience (e.g., sadness, anger, fear; Barrett, Gross, Christensen, & Benvenuto, 2001). In other words, it is the complexity of emotional experience, with more differentiated emotional experience suggesting a greater ability to make subtle distinctions among emotional states as they are experienced. This is in contrast to *emotional clarity*, which refers to an individual's *perceived* ability to differentiate between emotions (Mayer & Gaschke, 1988; Salovey, Mayer, Goldman, Turvey, & Palfai, 1995). Emotional clarity invokes metaemotional knowledge of whether and how one makes distinctions among emotions (see Salovey et al., 1995), and it can be influenced by a variety of factors (Boden, Thompson, Dizen, Berenbaum, & Baker, 2013). In contrast, emotional differentiation is more narrowly defined and reflects the application of this knowledge while experiencing emotions. Interestingly, evidence suggests that emotional clarity and emotional differentiation, studied in real life using EMA, are at best only weakly related (Boden et al., 2013).

Emotion differentiation is considered an essential component of the emotion regulation process for several reasons (Carpenter & Trull, 2013). First, reliably and accurately identifying one's emotions is important because effective emotion regulation relies on selecting a strategy that is appropriate for the specific emotion one is currently experiencing

(Barrett et al., 2001). Second, to the degree that one can reliably differentiate among emotions as they are experienced, it is less likely that emotional experience will be labeled globally (all bad/negative; all good/positive). Such polarized experience maps onto a number of constructs related to psychopathology, including cognitive biases like all-or-none thinking, splitting, affective instability, poor social functioning, impulsive behaviors, and substance use, as we discuss next.

Measurement

Historically, emotional differentiation has been assessed indirectly by measuring individuals' concurrent experiences of several emotions and statistically estimating the overlap between these different emotion ratings. This avoids the perceptual biases associated with global retrospective reports. A variety of methods have been employed to estimate the degree of emotional differentiation, including: (a) calculating the average bivariate correlation between a set of affective items across an individual's series of repeated assessments (Barrett et al., 2001; Zaki, Coifman, Rafaeli, Berenson, & Downey, 2013); (b) calculating an intraclass correlation (ICC) of an item set across time (Kashdan, Ferssizidis, Collins, & Muraven, 2010; Pond et al., 2012; Tugade, Fredrickson, & Barrett, 2004); and (c) calculating an ICC for each measurement occasion across different affect subscales (Lane & Trull, in press; Tomko et al., in press).

To date, almost all investigations, regardless of their methodology, have created aggregate (i.e., global) measures of differentiation and subsequently drawn inferences about more dynamic, in-the-moment experiences. In contrast, Tomko et al. (in press) were the first to provide a method for calculating differentiation at the level of experience and utilize it to predict dynamic outcomes. This approach represents a significant advance in the study of emotional differentiation as it allows researchers to begin hypothesizing about and directly testing the various time courses in which these dynamic processes unfold. Furthermore, a measure of emotional differentiation at the level of momentary experience more closely operationalizes the process as it was originally theorized (see Barrett et al., 2001), as opposed to treating it as a stable between-person characteristic or trait. This again diverges from the concept of emotional clarity, which is typically thought of as a stable between-person individual difference that is intended to be measured cross-sectionally (Boden et al., 2013).

Associations With Psychopathology

Using Barrett et al.'s (2001) average pair-wise correlation method, Decker, Turk, Hess, and Murray (2008) reported that those with generalized anxiety disorder were not significantly different on either negative or positive emotion differentiation indices than controls based on daily emotion ratings. Using the same method, however, Demiralp et al. (2012) found that individuals with MDD showed lower negative emotion differentiation than controls, but did not differ in terms of positive emotion differentiation. Similarly, Kimhy et al. (2014) reported that individuals with schizophrenia obtained significantly lower scores on an overall emotion differentiation index (negative and positive) but did not differ from healthy controls for negative emotional differentiation.

Zaki et al. (2013) found that those with BPD exhibited less negative emotional differentiation than controls, and additionally, BPD individuals high in rumination and high in negative emotional differentiation were less likely to report nonsuicidal self-injury (NSSI) acts or urges, while those lower in negative emotional differentiation were more likely to report NSSI urges and acts. Similarly, Wolff, Stiglmayr, Bretz, Lammers, and Auckenthaler (2007) found that BPD individuals displayed less emotional differentiation than healthy controls, and the degree of differentiation was positively associated with feelings of aversive tension in BPD individuals but not in control individuals.

Kashdan et al. (2010) studied the relation between negative emotional differentiation and alcohol use in underage social drinkers. Emotion differentiation scores for each individual were calculated using an average intraclass correlation coefficient (Shrout & Fleiss, 1979; Tugade et al., 2004). Results indicated negative emotion differentiation moderated the relation between predrinking NA level and alcohol consumption; those with poorer negative emotional differentiation scores were more likely to binge drink in the face of strong predrink NA. Using the same method Pond et al. (2012) found that, across three studies, individuals with higher levels of emotional differentiation had fewer aggressive tendencies when they reported being angry. Finally, Tomko et al. (in press), using occasion-level ICCs of emotional differentiation, found that greater momentary differentiation and greater average daily differentiation predicted lower momentary reports of impulsivity, but a more global 28-day measure of negative differentiation did not. It is worthwhile to note that almost all of the reviewed studies adjust for intensity of experienced affect in estimating the association between emotional differentiation and various outcomes, making it unlikely that observed differences between clinical and healthy individuals is driven solely by clinical individuals' more extreme affective experiences.

Recommendations

The method used to operationalize emotional differentiation depends crucially on the research question. When differentiation as a stable individual difference is of interest (e.g., group differences in personality/traits) measures designed specifically for that purpose are available (Kang & Shaver, 2004). The between-person differentiation estimates generated from diary and EMA data, like those reviewed before, may also serve as useful proxies for such investigations, but we note that there are substantial precision and bias limitations when using these methods (Lane & Trull, in press). Average interitem correlations are less desirable than between-person ICCs, as the prior is a special case of the latter in which the assumptions rarely hold. In both cases differentiation estimates confound systematic variability across different affective items with other systematic variability from other sources, such as time of day, day of week, and other emotion-evoking events that are not part of the theoretical composition of emotional differentiation. These methods do not treat the time-intensive data in a way that appreciates the temporal dependencies that are a part of it. As such, when time-intensive data are collected we recommend the recent methods developed by Lane, Trull, and colleagues (Lane & Trull, in press; Tomko et al., in press) for investigating both between-person, static differences, and within-person, dynamic changes.

General Discussion

This review of affective dynamics and psychopathology reveals consistent relations between affective instability and a wide range of disorders, between emotion inertia and poorer functioning (primarily increased vulnerability to depression), and between negative emotional (un)differentiation and disorders and features of emotional dysregulation and distress. Unfortunately, efforts to develop new classifications of psychopathology based on dimensions of observable behavior and neurobiological measures (e.g., the NIH initiative RDoC; Cuthbert & Insel, 2013), often ignore the fact that human emotions and behavior are dynamic processes that unfold over time in everyday life, and therefore may miss a fundamental aspect of psychopathology.

Several implications from this review are evident. First, the best method for exploring affective dynamics is a time-intensive assessment, either in the laboratory or in the real world. Furthermore, the data collected using these methods must be analyzed using techniques that reflect the time-sensitive ebb and flow of affect. As we discussed, variance indices must be supplemented with measures of temporal dependence (e.g., inertia) in order to provide a complete and accurate picture of how affect unfolds in daily life. Second, affective dynamics should be assessed within each individual (i.e., intraindividual) and can be viewed in varying time frames (i.e., momentary, daily, weekly). At a more molecular level, one can examine the momentary differentiation of affective experience. Instability, inertia, and emotional differentiation can be indexed at daily and weekly levels as well. However, unless one is testing specific hypotheses regarding the periodicity of these indices, we recommend not extending beyond a daily level when examining associations with psychopathology. A larger time frame is less likely to capture the ebb and flow of affect and to reveal the association with psychopathology and its features. Third, as one is focusing on affective dynamics, it is important to recognize that these also play an important but not exclusive role in the process of emotion (dys)regulation (Carpenter & Trull, 2013). The experience of affect is also interpreted in certain, sometimes idiosyncratic ways, and the way in which one responds to this experience will also be influenced by one’s ability to use adaptive coping strategies in the face of strong emotional experience.

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