Studying Personality Pathology with Ecological Momentary Assessment:
Harmonizing Theory and Method

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Abstract

Over the past 20 years, ecological momentary assessment (EMA) has become a vital part of the methods repertoire used to study personality pathology. This is because EMA facilitates modeling (dys)function consistent with clinical theory as an ensemble of contextualized dynamic within-person processes, such as when and how relevant socio-affective responses may become disrupted in daily life. Despite its popularity, there is little systematic work on the conceptual adequacy and cross-study consistency in the design choices and reporting standards of EMA studies on personality disorders. EMA protocol design choices impact the reliability and validity of conclusions, and variability in choices affect replicability and thus credibility of the conclusions drawn. We provide an overview of the core decisions researchers face in designing an EMA study organized around the “three D’s”: *density* (frequency of surveys), *depth* (length of surveys), and *duration* (number of days in a protocol). To identify the typical and range of employed study designs, including what PD researchers view as important and where there are gaps in our knowledge, we reviewed relevant studies published over the years 2000-2021. Of 66 identified unique EMA protocols, studies scheduled ~6.5 assessments per day with an average of ~21 items, lasted for ~13 days, and obtained a compliance of ~75%. Generally, denser studies had less depth and shorter duration days, whereas protocols with longer duration tended to be deeper. We offer recommendations on how valid research on PDs can be organized around these considerations with the goal of reliably uncovering temporal-dynamics in personality (dys)functioning.

Keywords: ecological momentary assessment; ambulatory assessment; within-person processes; personality pathology; dysregulation; personality disorders

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Ecological momentary assessment (EMA) refers to intensive repeated assessment of individuals in naturalistic settings (Moskowitz et al., 2009). Over the past two decades there has been a surge of interest in using EMA to study dynamic processes in daily life across the psychological sciences (Hamaker & Wichers, 2017) including the study of personality pathology (*see supplementary Tables 1-3 for an overview*). EMA affords key benefits, most notably increased ecological validity, reduced retrospective bias, and the ability to sample various points along a process (Shiffman et al., 2008). Thus, EMA allows researchers to better harmonize theory, data acquisition, and statistical models of personality pathology (Hopwood et al., 2021). Reaping these benefits requires making decisions about critical EMA protocol design issues. Here, we introduce an organizing framework for EMA study designs, the “three D’s” (3Ds), which stands for the density, depth, and duration of sampling. Based on a comprehensive literature review, we then discuss relevant considerations when planning and conducting high quality EMA studies on personality (and its) pathology.

The key features of personality and its pathology theoretically involve contextualized dynamic socio-affective processes. Broadly, these processes result in behavioral (in)consistency, such as rigidity (vs. flexibility) and instability (vs. stability) of behavior, considered indicative of personality dysfunction (Leary, 1957). Rigidity and instability can be contrasted by their reference to the psychological context of situations—rigidity is behaving consistently across meaningfully distinct situations, whereas instability is behaving inconsistently across meaningfully similar situations (Shoda et al., 2013). Ultimately excessive (in)consistency may contribute to behavioral patterns that fail to meet the expected situational demands (Hopwood et al., 2021). These concepts are domain neutral and can be applied to different areas of

psychological functioning. They can also enrich recent perspectives on personality traits as density distributions of states (Fleeson, 2001), merging of trait and social-cognitive theory (Fleeson & Jayawickreme, 2015), and functional views on (mal)adaptive personality traits (Wright & Kaurin, 2020).

These generic concepts can be brought to life by considering the cardinal symptoms of various DSM personality disorder (PD) diagnoses. The affective instability criterion of borderline PD (BPD) diagnosis is the quintessential exemplar of a dynamic, contextually catalyzed feature. Affective instability is often expressed in the context of desperate efforts to avoid real or imagined abandonment, illustrating how psychologically meaningful situational features can prompt specific behaviors. Other examples include paranoid PD, describing hostile reactions to perceived attacks, or schizoid PD describing a lack of response when praised.

It is impossible to study these theoretically important processes accurately with cross-sectional or long-term longitudinal methods, which are designed to smooth over the variability across contexts (Reis, 2012). EMA resolves related issues by sampling individuals' thoughts, feelings, and behaviors intensively and repeatedly over time, close to when the processes of interest are occurring (e.g., impulsive responses to emotion; Feil et al., 2020). Sampling intensively and repeatedly can capture variability across situations and along different points of a process so that the process can be modeled directly. Sampling in near-real time mitigates retrospective biases inherent to self-report research facilitating more faithful representations of the process (Trull & Ebner-Priemer, 2013). By sampling behavior as it unfolds in the natural context of an individual's daily life ecological validity is maintained, because the contexts captured via EMA are those that matter to the participant (Shiffman et al., 2008), and not artificially fabricated stressors often found in laboratory research (e.g., bucket of ice-water, e.g., Dang et al., 2020) that have no relevance to personality pathology. For these reasons, capturing

experiences within everyday situations that shape and maintain pathology via intensive longitudinal data aligns closely with how these processes are defined clinically and returns data characterized by enhanced precision and generalizability (Mehl & Conner, 2012).

Targets for EMA in research on personality pathology.

We review several of the most common EMA sampling approaches here as they have been applied to study personality pathology, though these are not intended to be exhaustive. Supplementary Tables 1 to 3 provide an overview of socio-affective processes that have so far been assessed in key EMA studies on PDs.

Description. On the most basic level EMA helps develop descriptive models of how personality pathology manifests. This includes questions about the frequency, intensity, and temporal covariation of specific symptoms as they occur in daily life (e.g., Wright & Simms, 2016). Such information is crucial to decide how best to balance the density and duration of assessments to capture meaningful variation for more explanatory studies moving forward. To illustrate, for many infrequent and episodic phenomena, such as suicidal ideation or hostile aggression (Kaurin et al., 2020; Scott et al., 2017), establishing adequate sampling schedules is challenging because little research has examined the “true” timescale of, for instance, an emergent suicidal crisis, and it is unlikely that the length of a suicidal episode is the same from one individual to another or even from one episode to the next (Kaurin et al., 2022).

EMA has helped characterize the occurrences of several BPD symptoms, such as affective lability (Jahng et al., 2008), rage, interpersonal devaluation, and rejection (Gadassi et al., 2014; Houben et al., 2018), impulsivity (Berenson et al., 2011; Coifman, et al., 2012), as well as other psychological symptoms including psychotic and dissociative symptoms (Glaser et al., 2010; Stiglmayr et al., 2008), quarrelsomeness (Sadikaj et al., 2012), and frequently co-occurring dysfunctional behaviors (e.g., substance use, binge/purge episodes, suicidal ideation; e.g., Kaurin

et al., 2020; Selby et al., 2012). More recently, research has begun investigating the crosscutting dimensions of the DSM-5 PD traits (Wright & Simms, 2016; Roche, 2018) as well as the developmental forms of personality pathology (Vanwoerden et al., 2021) as they manifest from day to day.

Variability. Beyond assessing an individual's average behavior, EMA can quantify variability across time and context, or how much symptoms fluctuate from occasion to occasion. Variability is a defining indicator of the dysfunctional processes presumed to underlie PDs (e.g., emotion dysregulation; Linehan, 1993). General personality pathology is presumably driven, in part, by an unstable self-concept and perception of others, which lead to reactive fluctuations in behavior and affect characterizing pathological personality processes (Bender et al., 2011). Thus, many of the concepts in the DSM-5 Alternative Model of Personality Disorder Criterion A suggest temporally dynamic processes (e.g., alternating between connection and rejection).

Most variability research has focused on BPD, showing, that people diagnosed with BPD relative to non-clinical and clinical controls report significantly greater variability in negative affect, self-esteem, and interpersonal behaviors than non-clinical controls (Ebner- Priemer, 2007; Santangelo et al., 2017; Trull et al., 2008). However, more recent research suggests that even cardinal features of BPD (e.g., affective instability) are transdiagnostic (Santangelo et al., 2014), and that variability in socio-affective processes may represent an indicator of general personality pathology (Ringwald et al., *in press*). Relatedly, Wright and Simms (2016) found that daily expressions of PDs were highly variable across days, such that half the total variability was associated with daily fluctuations. Edershile and Wright (2021) found that grandiose and vulnerable narcissistic states were similarly variable and related to greater baseline-assessed narcissism severity (*see supplementary Table 2 for an overview*).

Variability has been operationalized in different ways across studies. The most

straightforward approach is to calculate the standard deviation (SD) of an individual's time-series of scores. However, some have proposed that a more precise estimate of instability that more closely matches clinical descriptions would be to use the mean square of successive differences (MSSD; Jahng et al., 2008). Though conceptually compelling, two recent studies have called into question the added value of more complex indices of affective dynamics, suggesting that an individual's mean and SD may account for the most variance in affective experiences in daily life (Dejonckheere et al., 2019; Wendt et al., 2019).

If-Then Signatures, Contingencies, and Reactivity. The within-person link between contextual variables and relevant symptoms has variously been interpreted as if-then signatures, situational contingencies, and reactivity (Fournier et al., 2008; Suls & Martin, 2005). Assessing within-person temporal covariation patterns of internal states and plausibly evocative contextual factors directly targets the processes that clinicians have identified as key to symptom shifts among individuals with severe personality pathology (Pincus et al., 2009). Arguably, the most relevant context for the expression of personality pathology is the interpersonal context (Hopwood, 2018; Wright & Ringwald, 2022), and EMA methods are well suited to study the expression of PDs and, for instance, related cognitions (e.g., rumination; Yaroslavsky et al., 2019) or expectancies (e.g., rejection sensitivity; Zeigler-Hill & Abraham, 2006) in such situations. Other constructs, such as urgency, are specifically defined as a contextualized process, and EMA can be used to directly study the within-person link between rash behavior and elevated emotions (Feil et al., 2020). Meaningful variability in the strength of the within-person association has been studied as a function of individual differences in diagnosis, traits, and other person-level characteristics (Lazarus et al., 2018; Sadikaj et al., 2013). As an example, people diagnosed with BPD report more acute changes in negative affect in response to interpersonal challenges than patients with bipolar disorder or depression (Mneimne et al., 2018). EMA further

allows one to evaluate putative etiological and maintenance mechanisms that are associated with various forms of symptom expression such as whether and how long before an event increased negative affect precedes suicidal behavior (Kleiman et al., 2017), and whether suicidal behavior precedes reports of lower levels of negative affect (Kleiman et al., 2018).

However, often the speed of processes may make it difficult to sample the timing of events with enough fidelity to conclusively determine or even directly inform our understanding of their ordering. When processes occur more rapidly than we sample (e.g., behavioral exchanges within a situation when sampling across situations), then the causal processes will be captured by the contemporaneous associations (Granger, 1969). These still reflect dynamic associations because they emerge from the fluctuation of behavior across time, but they will be ambiguous as to causal directionality. When the processes are occurring more slowly than sampling (e.g., stress during the workday leads to self-injury after work) then causal processes can be reflected in lagged associations. Though these give researchers much more purchase on the causal direction, accuracy will be predicated on getting the lag period (i.e., temporal spacing) correct, and incorrectly specifying it can lead to null or opposite associations (Pelz & Lew, 1970). Without a clear understanding of the timescale on which a phenomenon unfolds, examining lagged associations are not inherently any more informative than the contemporaneous associations in intensive longitudinal data.

Assess and model idiosyncrasies in PD manifestation. The increased use of EMA methodology research has been accompanied by calls to use idiographic statistical techniques to develop personalized models of individuals' processes from the many repeated assessments collected (Molenaar, 2004; Wright & Woods, 2020). Using the person as the unit of analysis for psychopathology research may facilitate a bridge across the persistent research-practice divide (Stricker & Goldfried, 2019), as each personalized model invites comprehensive analyses and

interpretations, just as is commonly done in therapy. Individualized models are particularly relevant for complex syndromes such as PDs, which emerge at the confluence of multiple domains of dysfunction (Wright & Woods, 2020). However, despite enthusiasm for their potential clinical utility (Fisher & Boswell, 2016), emerging evidence suggests that clinicians express doubts as to whether idiographic models would provide incremental information over and above insights generated in the therapeutic process (Zimmermann et al., 2019). The quest for tractable idiographic models also encounters conceptual and methodological challenges such as susceptibility to error from a variety of sources, but also the fit between assessment schedules and measurement assumptions inherent to related methodology (Kaurin et al., 2022).

Despite these potential limitations, the symptomatic heterogeneity observed among individuals with the same PD diagnosis has been systematically demonstrated in idiographic models (Kaurin et al., 2022; Woods et al., 2020). This is difficult to ignore and demands further inquiry. At the same time, the personalized approach will only be as good as the data collection protocol and statistical model used.

The “Three D’s” of EMA study design.

Crucial to EMA studies is the selection of a rationale for the sampling schedule. Well-designed EMA studies sample all relevant variables a) at the appropriate frequency to capture the process of interest, b) reliably, and c) for a long enough duration to capture a sufficient number of instances of the target behavior or process. These each correspond to one of the 3Ds of EMA design: *density* (i.e., how frequently surveys are administered), *depth* (i.e., how many constructs and questions per construct), and *duration* (i.e., how many days the study lasts). None of the 3Ds exist in a vacuum and balancing them requires thoughtful consideration. It is immediately intuitive that there is an upper limit on how many questions an individual can be asked to thoughtfully answer each day, which will likely put the needs for depth and density in opposition.

Moreover, when a rare event is the focus of investigation, one should increase duration to ensure sufficient sensitivity to detect the process of interest, but that likely places a limit on density.

The three typical ways for defining sample schedules include *time-* (e.g., hourly), *signal-* (e.g., 6 random times per day), and *event-contingency* (e.g., assessment whenever participants experience a particular event or state). The choice of a particular sampling type and schedule depends on the research question, the prevalence of the behaviors, as well as the intended data analytic strategy once the data are collected. Therefore, *density* is perhaps the most important criterion for the validity of EMA studies. Aspects specific to the density of EMA study designs are 1) the number of assessments per day, 2) the “trigger” or contingency of the assessments, and, eventually, 3) the timing intervals between assessments. Deciding on the number of assessments per day requires careful consideration of the timing of the process of interest (i.e., fitting the temporal dynamics of the processes of interest) while minimizing the expected burden on participants (Hopwood et al., 2021). Without an adequately chosen assessment schedule, process-inherent cycles may be missed, important events excluded, or participant burden artificially increased without clear benefits for the research question (Ebner-Priemer et al., 2007; Hopwood et al., 2021). Because of the unknown time course of many phenomena, high-sampling frequencies are often recommended (Collins & Graham, 2002), which offers little guidance for researchers in designing EMA studies and interpreting results.

The main questions related to *depth* have to do with how many indicators will be needed to reliably assess a given construct as well as how many constructs are needed to validly study a process. The reliability of measurement and the number of constructs that can be assessed are in tension when space is limited. Often researchers turn to single items or very brief forms, which may prove problematic for reliability (Allen et al., 2022). However, traditional measures of personality (pathology) cannot simply be ported downwards to momentary assessments, or at

least the psychometrics may be understandably different (Ringwald, Manuck, et al., *in press*). To illustrate, extraversion combines assertiveness, warmth, and positive emotions at the dispositional level. That is, people who are often assertive are also often warm, but that does not mean that when they are being assertive, they are also being warm. Consequently, typically strong correlations at the person level of assessment are weaker at the momentary level.

Considerations related to *duration* mainly have to do with how many repeated instances of a particular event, behavior, or process will occur for each participant in the protocol. If the focus of the assessment is common or frequent in daily life (e.g., affect, blood pressure) then the duration of the protocol might only need to be relatively brief. However, when behaviors are rare (e.g., suicide attempts), or are constrained to only certain days (e.g., drinking on weekends), then the duration of the protocol may need to be dramatically extended to capture sufficient instances of the behavior for reliable and well-powered investigations.

Many reporting guidelines exist that outline best practices on methodological issues relevant to planning and conducting EMA studies in clinical samples (e.g., Trull & Ebner-Priemer, 2020). Because there is no empirical evidence to support considerations key to the design of EMA studies, decisions are typically made on an ad-hoc and expedient basis such as regarding the perceived feasibility or following decisions made in prior research, with unclear validity and generalizability (Janssens et al., 2018). Relatedly, meta-analytic work has mostly focused on compliance rates (Wrzus & Neubauer, 2022).

Studies that systematically varied the number of assessments per day demonstrated that compliance over 14 days was comparable when answering 3, 6, 9, or 12 prompts per day (Eisele et al., 2020; Stone et al., 2003). The number of questions in EMA studies barely predicted differences in compliance (Hasselhorn et al., 2021; Jones et al., 2019). Although some counterevidence exists (Eisele et al., 2020; Morren et al., 2009), that evidence is weak. For

example, Eisele and colleagues (2020) showed that doubling a questionnaire from 30 to 60 items reduced compliance from 89% to 84% for a typical participant. Also, as assessment days increased within studies, typically over more than one week, compliance tended to decline over time (Rintala et al., 2019).

Beyond considerations about the precision of gathered data, much less is known about how EMA study design choices influence the *validity* of the resultant data. It may be that although participants continue to respond to EMAs, their responses are less valid over time as they increasingly “automate” their responses to the same EMA survey. One recent study showed small but significant effects of survey length on participant reported carelessness in responding (Eisele et al., 2020). Participant carelessness could be especially pernicious because it could either decrease *or* increase correlations among items depending on the nature of the carelessness (King et al., 2018). One often mentioned threat to validity is *reactivity*, the possibility that the research methods themselves affect the behavior under study, and thus distort study findings along with their implications (Clifford et al., 2007; McCambridge & Kypri, 2011). Recent evidence suggests a link between the frequency of assessment and reactivity (McCarthy et al., 2015), and that dampening of self-reports reflects over-reporting in initial interviews rather than later reactivity to assessments (Shrout et al., 2018). However, outside of some treatment studies that investigate the effect of monitoring on treatment outcome, many represent secondary analyses of idiosyncratic data sets that do not systematically vary relevant assessment procedures (e.g., Arslan et al., 2021). As a result, the conditions under which reactivity is invoked, or other ways in which participants' responses may change in more intense study designs, is still a matter of speculation.

The Present Review

It remains an open question as to how much consensus there is in the design of EMA

studies on personality pathology. The decisions researchers make when designing an EMA study can have a dramatic impact on the resulting data structure. However, the actual expected impacts are poorly understood, based on unsystematic inquiry, generally confounded with substantive study considerations, and limited to investigations of single outcomes. Systematically studying patterns of typical research practices is relevant to understand what personality pathology researchers think is important in terms of constructs and their timing, but also where there may be gaps or missing information in the literature.

We integrated and organized recommendations from various guidelines and related research on PDs into a 3D framework as outlined above (i.e., *density*, *depth*, *duration*) to provide recommendations on how valid research on personality pathology can be organized around these considerations. For that purpose, we reviewed relevant studies using EMA in PD research published from 2000 through 2021 and summarized our literature review along the 3Ds. We have organized our results using three broad categories – namely BPD, other PDs, and developmental forms of PDs; *see* supplementary Tables 1-3 – to illustrate the distribution of relevant studies on constructs beyond BPD. Because we were primarily interested in EMA protocol features, secondary data analyses were only included if additional analyses revealed a critical aspect of the EMA protocol not presented in the main paper. Despite our best attempts to include as much of the relevant literature as possible, this review and the accompanying database are not exhaustive, but can easily be built upon to include more recent studies moving forward. All data reported in our analyses and references for studies included in our review are publicly available and can be found via <https://osf.io/xn4jf/>.

Method

We identified relevant studies via a search through PubMed and PsychINFO databases using the following keywords: “ecological momentary,” “experience sampling,” “ambulatory

assessment*,” “momentary assessment*,” “EMA,” “ESM” in combination with “personality pathology*” and “personality disorder” and “maladaptive personality”. To be included in the review, the study had to: (1) report empirical data, (2) comprise of >1 assessment per day, except if assessments occurred over an extended period such as in Wright & Simms (2016), and (3) have been published between 2000 and 2021 (the last search conducted was in December 2021). All publications resulting from the search were checked regarding inclusion criteria by at least two independent coders.

Coding of relevant Studies. We used the 3D framework as a coding scheme to assess the relevant information from each study, in addition to the sample types and sizes, as well as sampling schedules and key study variables.

Density was coded as the number of scheduled assessments per day, intervals between assessments, as well as the resultant compliance rate. Compliance was only calculated for signal- and time-based designs, because for event-contingent EMA studies, the maximal number of daily prompts is not fixed. In instances where the maximum number was variable due to participants’ daily routine (e.g., Ebner-Priemer et al., 2007), we reported the average number of diary entries in our supplementary tables. *Depth* was coded as the number of items per assessment and the time (minutes) it took participants to finish a single query. *Duration* was coded as the number of days the EMA protocol lasted.

Results

We identified 105 publications that met the inclusion criteria outlined above. Many of these publications were secondary data analyses, resulting in 61 unique EMA protocols. Of these distinctive publications, only 14 focused on other personality pathology features (Table S2), and only $n=5$ assessed relevant processes in youth samples (Table S3). Of these 61 unique studies, $n=42$ (~69%) contained at least one clinical subsample, with $n=6$ (~10%) specified as inpatient,

and $n=12$ (~20%) as outpatient samples. Sample sizes ranged from as little as 2 participants (Roche et al., 2014) to 396 (Edershile et al., 2019), with sample sizes varying as a function of study target (BPD: $M=103.56$, $SD=59.50$; OPD: $M=214.79$, $SD=120.20$; Youth: $M=93.80$, $SD=44.52$). Most studies used signal-contingent sampling ($n=50$, ~82%), followed by a combination of signal- with event-contingent sampling ($n=8$, ~13%), purely event-contingent designs ($n=5$, ~8%), time-contingent sampling ($n=4$, ~7%). Signal-contingent protocols were mostly chosen for reasons of decreased reactivity or enhanced variability in the assessed contexts (e.g., Chaudhury et al., 2017), whereas event-contingent sampling protocols were most often used for the study of specific, rare, or irregular behaviors (suicidal ideation, substance use, interpersonal interactions).

Density. Compliance rates for signal- and time-based designs were only provided in 43 (of 54 signal- and time-contingent) studies and were highly similar across all three target populations (BPD: 76.11%; $SD=10.97$, range: 57%-95%; OPD: 69.39%; $SD=8.51$, range: 52%-77%; Youth: 79.56%; $SD=16.38$, range: 51.5%-91%). The total number of assessments ranged between 2-12 ($M=6.76$, $SD=2.53$) in recent studies on BPD, between 1-8 ($M=5.67$, $SD=2$) across studies on other personality pathology, and between 3-10 ($M=5.60$, $SD=2.70$) in youth samples. Overall, researchers typically did not justify their chosen time-based designs. Compared to average numbers of emitted queries, less is known about the variability in (exact) time intervals between consecutive signals. Exact between-signal intervals were only reported in $n=3$ studies and varied between 10 minutes (Ebner-Priemer et al., 2007a) and 4.01h (Scott et al., 2017). In other studies, the minimum amount of time between two signals was described (e.g., 90 min; Vize et al., 2021) or the time-frame, within which a signal was emitted (e.g., 2hr time-blocks over 12h; Andrewes et al., 2017).

Depth. Recent EMA studies on personality pathology typically covered topics related to

1) interpersonal or 2) affective processes, 3) specific PD symptoms (e.g., impulsivity, dissociation, rumination) or 4) covarying behaviors (e.g., substance use, suicidal ideation). Most studies reported the number of items that were administered in total (with varying degrees of clarity). In BPD samples, the total number of items per query ranged between 1 and 48 ($M=17.54$, $SD=13.25$). In studies focusing on other PD items ranged from 14 to 100 ($M=33$, $SD=26.43$) per assessment, whereas in studies based on youth samples the range was 4-38, with an average of 19.67 ($SD=14.28$). Few studies reported how long it took participants to complete individual assessments. For those who did ($n=7$), the average time was $M=6.14$ ($SD=3.24$, range: 2~10) minutes.

Duration of ambulatory assessments. Protocols mostly followed participants over the course of several weeks, with an average of $M=12.56$ ($SD=13.48$, range: 1-100) days across all sample types (BPD: $M=11.25$, $SD=8.48$, range: 1-28; other PD: $M=19.92$, $SD=26.05$, range: 4-100; youth PD: $M=8.33$, $SD=4.93$, range: 4-15). Overall, studies that lasted longer, tended to use less dense ($r(49)=-.49$, $p<.001$), but deeper ($r(62)=.51$, $p=p<.001$) EMA protocols, and thus deeper assessments tended to be less frequently emitted ($r(47)=-.39$, $p=.005$).

Discussion

High quality EMA study design balances many inferential and scientific benefits against many more decisions researchers must make. The goal of the present review was to systematically review commonly implemented designs across EMA studies on personality pathology to illustrate what researchers currently focus on, along with potential gaps or missing information in the literature.

Our review suggests that researchers want to design studies that maximize the value of the resultant data, yet collect data as efficiently as possible (i.e., as much data with as few prompts). Researchers tended to give deeper surveys less frequently, and more frequent surveys over

shorter periods of time. Highly dense assessments were conducted only for a day or two (Ebner-Priemer et al., 2015), whereas longer duration studies used fewer assessments, and sometimes only one, assessment per day (Wright & Simms, 2016). No study included in this review combined an intense daily assessment schedule with a long duration study period, and therefore no empirical evidence exists to illustrate how more demanding designs interfere with the quality of the data assessed.

As outlined above, brief, and dense protocols have furthered our understanding of the average levels of relevant behaviors, their variability, and plausibly evocative contextual factors. The high percentage of studies with dense assessment schedules, particularly in BPD samples, speaks to the notion that most researchers investigated affective instability, which necessitates more assessments per day to reliably track the ups and downs of emotions within a day. However, there was much variability in the time-frame researchers used to assess “momentary” constructs such as affect, and few of the reviewed studies provided a conceptually motivated rationale for the chosen time-based design (*see also* Singh & Björling, 2019), nor a power analysis to justify specific sampling densities. Moreover, studies that did provide a power analysis (e.g., Chapman et al., 2009; Kaurin et al., 2020; Vize et al., 2021), differed in their computational approach.

If provided, sampling rationales were typically related to the type of assessment schedules, but not the expected timing of the process of interest. When continuous processes were studied, often a time-contingent or signal-contingent schedule has been used (e.g., affect, self-esteem), whereas discrete events have typically been studied using an event-contingent design (e.g., social interactions, alcohol consumption). Though these distinctions have often been strongly suggested, it is not clear that they result in qualitative differences in data structure (Himmelstein et al., 2019). More importantly, the empirical determination of time-based designs requires further clarification as current studies leave open what, for instance, the prototypical

stress response looks like right after a stressor exposure.

There is some evidence to suggest that short intervals between assessments of 15 or 30 minutes tap a process specific to affective instability in BPD, whereas longer intervals (i.e., $\geq 2h$) may miss relevant processes (Ebner-Priemer et al., 2015). Plausibly due to their implications on sampling density, these suggestions were rarely followed or cited (Houben et al., 2017; Vansteelandt et al., 2017), suggesting that the prioritization of one type of protocol over the other is likely driven by considerations regarding study demand characteristics, rather than systematic evidence that informs the fit between theory and method. Resolving the question on resolution has (at least) three important implications for the field moving forward. First, knowledge of the average shape in the time course of relevant processes in daily life could help formalizing causal/functional relationships between specific events/contexts and relevant intraindividual processes at any given time point. Second, knowledge on inter-individual variability in the temporal resolution of relevant processes may also help optimizing the design of relevant interventions, such as those that induce mood changes or aid the management of severe states of tension. Third, tracking down the appropriate length of time intervals when studying processes key to personality pathology is necessary to reliably track processes that are presumed to follow different temporal trajectories from what are otherwise contemporaneous assessments on the same schedule. For example, although alcohol use is thought to be preceded by changes in thoughts and emotions (such as cravings for alcohol or positive affect), even regularly drinking participants report alcohol use on only 31% of days (Dora et al., 2022), while cravings and affect can fluctuate multiple times within a day. Figure 1 provides an illustration with real data collected across 21 days, 6 times per day, for an individual who reported 29 episodes of suicidal ideation over three weeks. Balancing timing issues is especially challenging with studies on personality pathology, where the factors that may trigger or influence key symptoms (e.g., mood, social

context, or suicidal ideation) fluctuate on diverse timescales.

Beyond pressing issues related to the temporal resolution of relevant processes, currently employed designs have also kept us from understanding relatively extreme and rare events. For example, one recent meta-analysis involving participant level data from 22 studies which collected data on suicidal thoughts and behaviors (collected over 3 to 196 days, $M = 19.37$, median = 14) indicated that although suicidal thoughts were endorsed in around 22% of EMAs, suicidal behaviors were only observed in two studies, making them too rare to be included in analyses (Kuehn et al., *under review*). Thus, although frequent daily assessments help capturing short-term dynamics of suicidal thinking, when administered over a relatively short period, researchers may likely miss high-risk time windows within which suicidal thoughts might escalate into attempts. Similarly, brief protocols also offer little in the way of illustrating periodical shifts in processes central to personality pathology (e.g., exacerbating symptoms from week to week), and how those might be preceded by warning signs. Identifying therapeutically relevant warning signs before shifts in key symptoms are observable, makes momentary assessments over an extended period (in which clinical change is likely) indispensable (Helmich et al., 2021).

Relatedly, tracking changes in socio-affective dynamic patterns across development and their predictive validity for psychopathology (Houben & Kuppens, 2020; Kaurin et al., 2022) requires studies of longer duration, or at least designs that include repeated EMA periods. Our review suggests that only a small subset of studies focused on early forms of PDs. There is evidence to suggest that disrupted interpersonal processes in youth, particularly among peers, may be uniquely associated with increased vulnerability for personality pathology later in life (Stepp, Lazarus, & Byrd, 2016). What is missing from the related set of literature, however, is work that samples trait vulnerabilities in youth across relevant daily contexts. Assessing PD

symptoms in daily interpersonal situations is key to inform etiological models of youth personality pathology, enhance our understanding of proximal risk, and delineate dynamic processes affecting PD symptom expression in daily life, pointing to potential intervention targets.

Recommendations

Most consistently across studies, researchers reported the number of prompts per day, the duration of protocol (in days), and the broad item domains, but less so the number of items employed. However, beyond those general parameters tracking down the exact specifics of each study was nearly impossible. For instance, we noticed that many EMA studies on personality pathology lack details about the practicalities of data collection, such as how participants were instructed. Apart from limiting the possibilities to replicate research findings, such information is essential to derive firm conclusions on what practices are effective with this participant group and the phenomena clinically relevant to them. It is plausible to assume that studies with low compliance rates or other methodological limitations are less likely to be published, and thus included in meta-analytic overviews (Wrzus & Neubauer, 2022). In the reviewed studies, researchers rarely provided detailed descriptions of how raw data were prepared for focal data analyses, which would carry important information about the selection of participants in the final sample. Relatedly, the ways in which compliance was defined varied across studies, and of the 61 unique datasets, only $n=42$ provided a measure of compliance. This notion extends to the question of how effective and useful incentive structures and monitoring schemes (e.g., weekly calls) may look like. Information about how participants were incentivized to participate was difficult to extract from the reviewed studies for instance due to diverging definitions. Thus, information about an optimal ratio between completed prompts and monetary compensation is lacking, as well as how it might differ as a function of target group (e.g., community vs. clinical

sample; youth vs. adult participants).

Therefore, to increase the comparability of EMA studies on personality pathology, allow further investigation of design and sample effects in studies employing repeated momentary assessments, and fine tune best practices recommendations, we have compiled a checklist on how to report on EMA studies for researchers to use that is organized around recommendations of *density*, *depth*, and *duration* (Figure 2). We encourage researchers to be open and transparent by reporting all steps and choices that were made in the research process. Optimally, future studies would publish a paper that describes the EMA protocol in detail, so that secondary data analyses may reference that paper when turning to specifics of the study design. If there are space limitations in the manuscript, we encourage researchers to provide information about project details in supplemental information files that can be stored on <https://osf.io> or similar platforms and can be referred to in the manuscript.

EMA studies constitute a viable research paradigm for the study of personality pathology. With careful planning and documentation of study designs and incentives tailored to the research area and target sample, high quality of data can usually be obtained.

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Figure 1. Suicidal ideation, negative affect, and impulsivity fluctuate at different timescales.

Figure 2. Minimum number of necessary parameters to consider when planning and reporting EMA studies on personality pathology.

Table S1

Overview of Ecological Momentary Assessment Studies including Samples with a Borderline Personality Disorder (BPD) Diagnosis.

#	study	sample	sample type	assessment schedule	key variables	depth		density		duration no. days
						no. items	survey time	no. prompts; time b/w prompts	M of reports; % compliance	
1	Ammerman et al., 2017	BPD=51	community	S	NA, self-injurious thoughts & behaviors, impulsivity, aggression	15	N/A	4/day; variable, within one of four 3hr time slots	N/A	7
2	Berenson et al., 2011	BPD=41 HC=38	community	S	perceived rejection, rage feelings	8	N/A	5/day; depending on waking hrs	73%	21
3	Chapman et al., 2009	high BPD=30 low BPD= 39	UGS	S	PA, NA, emotion suppression & observation, impulsive behavior, urges	48	N/A	8/day; 60-90 mins; over 12hrs	80.93%	4
4	Chaudhury et al., 2017	BPD=50	clinical	S	PA, NA, stressors, coping strategies	38	N/A	6/day; 2.1h b/w prompts	69%	7
5	Coifman et al., 2012	BPD=65 HC=61	community	S	PA, NA, interpersonal experiences & stress, impulsivity	29	5–10 mins	5/day; N/A	71%	21
6	Dawood et al., 2019	40 (75% AD, 60% BPD, 40% MDD)	clinical (outpatient)	S & EC after interactions ≥ 3 mins	momentary affect experience (valence and arousal)	2	N/A	R: 6/day; variable over 12hrs EC: min. 6 interactions/day on average	R: 72.32% EC: 5.18 interactions/day	21
7	Ebner-Priemer et al., 2015 sample 1	BPD=50 HC=48	clinical (inpatient, outpatient)	S	primary and secondary emotions (PA, NA), distress	12	N/A	every 15 mins (+/- 5 mins) during waking hours	N/A	1
	Ebner-Priemer et al., 2015 sample 2	BPD=42 HC=23	clinical (waitlist)		mood, distress	6		every 60 mins (+/- 10 mins) during waking hours		4
	Ebner-Priemer et al., 2015 sample 3	BPD=43 HC=21	clinical (inpatient, outpatient), community		primary and secondary emotions (PA, NA), distress	12		every 15 mins (+/- 5 mins) during waking hours		1

8	Ebner-Priemer et al., 2007a ¹	BPD=50 HC=50	clinical	S	affect, intensity of affect, distress	11	N/A	every 10–20 mins over 24hrs	BPD: 52.3 HC: 55.9	1
9	Gadassi et al., 2014 ²	BPD=57 APD=43 HC=53	clinical	S	PA, NA, isolation, rejection, shame, dissociation, social proximity	31	5–10 mins	5/day; N/A	73.57	21
10	Glaser et al., 2010	BPD=56 CPD=38 PSY=81 HC=49	clinical (inpatient, outpatient), community	S	PA, NA, stress, psychotic experiences	19	N/A	10/day; over 15 hrs	BPD: 70% PSY: 65% CPD: 73% HC: 85%	6
11	Hawkins, et al., 2014 ³	BPD=86 no BPD=195	community, clinical	T	BPD symptoms	2	N/A	5/day; 3hrs	62%	14
12	Heiland et al., 2021	BPD=50 non-BPD=49	UGS	S & EC after experiencing an emotion	affect, perceived distress tolerance, willpower	R: 17 EC: N/A	N/A	R: 7/day; variable over 12hrs EC: unlimited	R: 75.34% EC: 97.1% of all data came from random prompts	7
13	Houben & Kuppens, 2020	202	UGS	S	PA, NA	8	N/A	10/day; variable over 12hrs	86.78%	7
14	Houben et al., 2016 ⁴	BPD=30 HC=28	clinical (inpatient), community	S	valence of affective experience	1	N/A	10/day; variable over 13hrs	BPD: 65.80% HC: 84.24%	8
15	Kaurin et al., 2020 ⁵	BPD=153 HC=52	clinical (inpatient, outpatient), community	S	PA, NA impulsivity, suicidal ideation	26	N/A	6/day; variable over 12hrs	70%	21
16	Kockler et al., 2017	BPD=43 PTSD=28 BN=29 HC=28	clinical (inpatient, outpatient), community	S	PA, NA	1–4	N/A	every 15 mins. (+/- 1 min) during waking hrs	N/A	1
17	Köhling et al., 2016	MDD/ BPD=20 MDD=21	clinical (inpatient)	S	PA, NA, reactivity, events	20	N/A	5/day; adjusted to therapy schedules	MDD + BPD: 94.8% MDD: 93.9%	7

Secondary data analyses:

¹ Ebner-Priemer et al., 2015 (sample 1); Ebner-Priemer et al., 2006, 2007b, 2008; Ebner-Priemer & Sawitzki, 2007; Reisch et al., 2008

² Berenson et al., 2011; Coifman et al., 2012; Snir et al., 2015; Zaki et al., 2013

³ Law et al., 2016

⁴ Houben et al., 2018

⁵ Kaurin et al., 2021b; Kaurin et al., 2020c; Ringwald et al., 2020; Tsypes et al., 2022

18	Lane et al., 2016 ⁶	BPD=56 COM=60	clinical (inpatient, outpatient), community	S & EC after cigarette/ alcohol consumption or NSSI	NA, alcohol craving, alcohol consumption, social interactions, impulsivity, interpersonal conflict	R: 31; EC: 1 + follow- up	N/A	R: 6/day; 60 mins to other random prompt, 30 mins from any scheduled assessment EC: unlimited, events followed up at 30, 60, 120, and 180 mins	R: 90.26% of random prompts; EC: 92.95% of follow-up prompts	21
19	Lazarus et al., 2018 ⁷	BPD=33 other PD=68	clinical (outpatient)	EC after social interaction	PA, NA, interactions, perceived rejection, acceptance	100	N/A	unlimited	58.96	21
20	Lieb et al., 2004	BPD=23 HC=24	clinical (inpatient)	S	cortisol (saliva samples), engagement in activity, smoking	2	N/A	7/day; variable over 2hrs	N/A	3
21	Links et al., 2007 ⁸	BPD with a history of suicidal behavior=82	clinical (outpatient)	S	mood, situational specifics, substance use	26	N/A	6/day; once in every 160 min block over 16hrs	58.1%	21
22	Miskewicz et al., 2015	BPD=187 COM=95	community	T	BPD symptoms, situational triggers	19	N/A	5/day; 3hrs	overall: 63% BPD: 58% NBPD: 65%	14
23	Mneimne et al., 2018	BPD=38 MDD=15 BD=14 HC=62	clinical (outpatient), community	T	PA, NA, interpersonal challenges	12	N/A	5/day; 3hrs	63%	14
24	Mou et al., 2018	N=35 (BPD=11)	clinical (inpatient)	S	NA, suicidal thinking	13	N/A	4/day; N/A	57%	2–46 (8.8)
25	Moukhtarian et al., 2020	BPD=19 ADHD=28 BPD+ ADHD=22 HC= 29	clinical (outpatient), community	S	PA, NA, mind wandering	7	max. 2 mins	8/day; variable, 65 mins–135 mins over 10hrs	74.8%	5
26	Pearson et al., 2017	females with BPD features=133	community, UGS	S & EC after eating disorder behavior	NA, stressful events, eating disorder behavior	~47	N/A	6/day; every 2– 3hrs during waking hrs	R: 75% EC: 86%	14

Secondary data analyses:

⁶ Carpenter et al., 2019; Carpenter et al., 2017; Fleming et al., 2021; Hepp et al., 2018; Napolitano et al., 2021

⁷ Kaurin et al., 2020b; Ringwald et al., 2022; Woods et al., 2020

⁸ Links et al., 2008; Nisenbaum et al., 2010

27	Rizk et al., 2019	females with BPD and history of suicidal behavior=38	clinical	S	suicidal ideation	9	N/A	6/day; variable over 2hrs	N/A	7
28	Russel et al., 2007 ⁹	BPD=38 HC=44	clinical, community	EC after interactions ≥ 5 mins	affect, interpersonal behavior	21	N/A	max. 10 interactions	HC: 128.36 BPD: 91.16	20
29	Santangelo et al., 2020a	BPD=119	clinical (waitlist)	S	self-esteem, affective state, dysfunctional behaviors	9–10	N/A	12/day; every 60 mins (+/- 10 mins)	84.86%	4
30	Santangelo et al., 2020b	BPD-REM=35 BPD=60 HC=60	clinical (waitlist), community	S	affective instability, instability of self-esteem	8	N/A	12/day; 60 mins (+/- 10 mins)	BPD: 88% BPD-REM: 91% HC: 85%	4
31	Santangelo et al., 2017 ¹⁰	BPD=60 HC=60	clinical (waitlist), community	S	self-esteem instability, affective instability, association with psychopathology	6	N/A	12/day; 60 mins (+/- 10 mins)	BDP: 88% HC: 91%	4
32	Santangelo et al., 2014 ¹¹	BPD=43 PTSD=28 BN=20 HC=28	clinical (inpatient, outpatient), community	S	affective instability	4–6	N/A	N/A; every 15 mins (+/- 1 min)	BPD: 57.91 BN+PTSD: 57.75 PTSD: 58.50 BN: 56.70 HC: 56.68	1
33	Scala et al., 2018 ¹²	BPD=36 any AD=18	clinical	S	self-injurious urges, distressing or negative affect, identity disturbance	6–7	N/A	6/day; once in 2hrs	74%	21
34	Scott et al., 2017	117	community	S	NA, perceived rejection and criticism, aggressive urges and behaviors, victimization	~11	N/A	6/day; 4.01hrs	76%	21
35	Selby & Joiner, 2013	behaviorally dysregulated participants=47	community, UGS	S	emotion, rumination, dysregulated behaviors	21	< 3 mins	5/day; every 2-3hrs	92%	14

Secondary data analyses:

⁹ Kopala-Sibley et al., 2012; Sadikaj et al., 2010, 2013

¹⁰ Santangelo et al., 2018

¹¹ Ebner-Priemer et al., 2015 (Sample 3); Santangelo et al., 2016 (Sample 1)

¹² Ellison et al., 2020

36	Selby et al., 2012	women with BN=133 women with BN+BPD=25	community	S & EC after eating disordered or self- destructive behavior	emotion dysregulation, emotional variability, dysregulated behavior	43	11.92 min (SD= 65.21)	6/day; N/A; unlimited	N/A; Binges: BN+BPD: .61; BN: .61 Vomiting episodes: BN+BPD: .83; BN: .78	14
37	Solhan et al., 2009	BPD=58 MDD/DT=42	clinical (outpatient)	S	PA, NA	31	N/A	6/day; variable	91.82%	28
38	Stepp et al., 2009 ¹³	BPD=43 other PD=46 no PD=23	clinical (outpatient)	T	social interaction, emotional responses	37	N/A	2/day; N/A	BPD: 4.62 other PD: 3.73 no PD: 5.46	7
39	Stiglmayr et al., 2008 ¹⁴	BPD=51 MDD=25 AD=26 HC=40	clinical (inpatient, outpatient), community	S	dissociative symptoms, subjective ratings of stress	22	N/A	N/A; every 60 mins (+/- 5 mins)	BPD: 26.3 MD: 23.5 AD: 24.5 HC: 26.0	2
40	Stiglmayr et al., 2005	BPD=63 HC=40	clinical (inpatient, outpatient), community	S	aversive tension	1 + brief follow up	N/A	every hour during waking hrs	BPD: 25.90 HC: 25.88	2
41	Trull et al., 2008 ¹⁵	BPD=34 MDD/DT=26	clinical (outpatient)	S	affective instability, emotion regulation	37	N/A	6/day; at least 20 mins	BDP: 90% MDD/DT: 90%	28
42	Vansteelandt et al., 2017 ¹⁶	BPD=32	clinical (inpatient)	S	PA, NA	5	N/A	10/day; 80 mins (SD=35 mins)	63%	8
43	Wolff et al., 2007	BPD=30 HC=28	clinical (outpatient), community	S	aversive tension, emotion identifying	5–7	N/A	N/A; every hour	BPD: 14.03 HC: 13.86	1
44	Yaroslavsky et al., 2019	females, sample enriched for BPD features=121	UGS	S	NA, rumination, negative interpersonal events	~27	N/A	5/day; variable over 12hrs	78%	27

Secondary data analyses:

¹³ Stepp et al., 2011

¹⁴ Santangelo et al., 2016 (Sample 2)

¹⁵ Harpøth et al., 2020; Hepp et al., 2016; Hepp et al., 2017, 2020; Jahng et al., 2011; Scheiderer et al., 2016; Tomko et al., 2014, 2015

¹⁶ Vansteelandt et al., 2020

45	Zachringer et al., 2019	females with at least 5 BPD criteria=26	clinical	S	NA, dissociation	7	N/A	12/day; approx. 1hr over 13hrs	T0: 69.21% T1: 63.87%	2 x 4 (T0, T1)
46	Zaki et al., 2013	BPD=38 HC=42	community	S	PA, NA, NSSI	17	N/A	5/day; N/A	overall: 72% BPD: 72% HC: 72%	21

M = mean; BPD = Borderline Personality Disorder; S = signal-contingent; T = time-contingent; EC = event-contingent; NA = negative affect; N/A = not available in original work; HC = healthy controls; PA = positive affect; AD = anxiety disorder; MDD = Major Depressive Disorder; APD = avoidant personality disorder; CPD = Cluster C PD; PSY = psychotic disorder; PTSD = posttraumatic stress disorder; BN = bulimia nervosa; COM = community control participants; NSSI = non-suicidal self-injury; BD = bipolar disorder; ADHD = attention deficit hyperactivity disorder; REM = in remission; BD = bipolar disorder; DT = dysthymia; UGS = undergraduate students.

Table S2

Overview of Ecological Momentary Assessment Studies including Samples with any Personality Disorder Diagnosis.

#	study	sample	sample type	assessment schedule	key variables	depth		density		duration
						no. items	survey time	no. prompts; time b/w prompts	M of reports; % compliance	no. days
1	Edershile & Wright, 2021 sample 2 ¹⁷	N=330	UGS	S	narcissistic grandiosity and vulnerability	8	3–5 mins	5/day; variable, min. 90 mins	73%	10
	Edershile & Wright, 2021 sample 3	N=261	community					7/day; variable, min. 90 mins	77%	10
2	Edershile et al., 2019 sample 1 ¹⁸	N=396	UGS	S	PA, NA, narcissistic grandiosity, narcissistic vulnerability, dominant and affiliative behavior during social interactions, self-esteem	24	N/A		52%	
	Edershile et al., 2019 sample 2	N=288	UGS	S, EC after social interactions (min. 4/day)		24		6/day; variable, min. 90 mins	R: 68% EC: 43.66	7
	Edershile et al., 2019 sample 3 ¹⁹	N=231	UGS	S		31			77%	
3	Farmer et al., 2004	PD=57 no PD=41		S	PA, NA	20	N/A	8/day; variable within 105 mins	66% (at least two thirds of 32 prompts)	4
4	Roche et al., 2013	N=184	UGS	EC after interactions ≥5 mins	interpersonal behavior & perceptions	14	N/A	max. 8 interactions	41.1	7
5	Roche et al., 2014	N=2 (couple)	clinical (outpatient), community	EC after interactions ≥5 mins	interpersonal behavior & perceptions	27	N/A	unlimited	husband: 6.5 wife: 6.19	21

Secondary data analyses:

¹⁷ Vize et al., 2021a (Sample 3)

¹⁸ Vize et al., 2021a (Sample 2)

¹⁹ Edershile & Wright, 2021 (Sample 1)

6	South & Miller, 2014 ²⁰	N=78	UGS	S	daily stress, cognitive appraisals, affect, situational variables	~24	N/A	5/day; variable over 12hrs; min. 20 mins	70.10%	7
7	Vize et al., 2021a sample 1 ²¹	N=297	community	S	PA, NA, warm-cold self and other ratings, dominant-submissive self and other ratings, empathy, loneliness	11–23	N/A	6/day; min. 90 mins	N/A	14–21
	Vize et al., 2021a sample 4	N=342	community			11–19		7/day		10
8	Wright & Simms, 2016 ²²	PD=101	clinical	S	daily PD manifestations	75	N/A	1/day; variable	89.5	100
9	Wright et al., 2017	N=102	clinical (inpatient)	EC	NA, interpersonal perceptions and behavior	100	N/A	N/A	3 interactions per day, 57.6	21

Note. N/A = not available in original work; M = mean; UGS = undergraduate students; COM = community members; NPD = narcissistic personality disorder; PA = positive affect; NA = negative affect; S = signal-contingent; EC = event-contingent; PD = personality disorder.

Secondary data analyses:

²⁰ Jarnecke et al., 2017

²¹ Vize et al., 2021b

²² Dotterer et al., 2020; Sharpe et al., 2021; Wright et al., 2015a; Wright et al., 2019; Wright et al., 2015b

Table S3

Overview of Ecological Momentary Assessment Studies including Youth Samples with a (Borderline) Personality Disorder Diagnosis.

#	study	sample	sample type	assessment schedule	key variables	depth		density		duration
						no. items	survey time	no. prompts; time b/w prompts	M of reports; % compliance	no. days
1	Andrewes et al., 2017a ²³	BPD=107 first-presentation 15–25 years	clinical (outpatient)	S	PA, NA, self-injurious thoughts, NSSI	12	max. 8 mins	6/day; variable, within 2hr time-blocks over 12h	51.56%	6
2	Briones-Buixassa et al., 2021	BPD=22 NSSI=19 HC=23 18–33 years	clinical, UGS, community	S, EC after NSSI episode	NA, interpersonal conflicts, NSSI	4–6	N/A	R: 3/day EC: unlimited	overall: 79.9% HC: 99.9% NSSI: 60.53% BPD: 73.7%	15
3	Scott et al., 2015	girls with BPD-symptoms=89	community	S	shame, anger	4	N/A	4/day; variable	86.31%	7
4	Selby et al., 2021	self-injuring young adults=47 15–21 years	community, clinical (outpatient)	S, EC after NSSI thought or behavior	NA, rumination, dysregulated behaviors	32	3–5 mins	5/day; variable within 90 mins	N/A	14
5	Vanwoerden et al., 2021	parents & their high risk BPD-children=162 10–14 years	clinical (outpatient)	S	(in)validating parent behavior, perceived helpfulness of these behaviors	26	N/A	10/day; N/A	dyads: 1.44 conflicts; 90%	4
	children				BPD symptoms, perceived parental support	27–38			91%	

Note. N/A = not available in original work; M = mean; HC = healthy controls; BPD = individuals meeting diagnostic criteria for Borderline Personality Disorder; PA = positive affect; NA = negative affect; S = signal-contingent; EC = event-contingent; NSSI = non-suicidal self-injury; PTSD = posttraumatic stress disorder, BN = bulimia nervosa; PD = panic disorder; MDD = major depressive disorder; UGS = undergraduate students.

Secondary data analyses:

²³ Andrewes et al., 2017b

Table 4

Associations among the 3 Ds across Tables 1-3.

	BPD (Table 1)			OPD (Table 2)			Youth PD (Table 3)			overall		
	density	depth	duration	density	depth	duration	density	depth	duration	density	depth	duration
density	1			1			1			1		
depth	-.38 (.020)	1		-.02 (.003)	1		.58 (.303)	1		-.38 (.005)	1	
duration	-.50 (.002)	.40 (.005)	1	-.88 (.004)	.59 (.053)	1	-.72 (.171)	.02 (.969)	1	-.49 (.000)	.50 (.000)	1

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