

Contents lists available at ScienceDirect

Journal of Affective Disorders



journal homepage: www.elsevier.com/locate/jad

Suicidal urges and attempted suicide at multiple time scales in borderline personality disorder

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ARTICLE INFO ABSTRACT Keywords: Background: There is strong evidence for an enduring suicidal diathesis among individuals with a history of Suicidal ideation suicide attempts, particularly among people diagnosed with borderline personality disorder (BPD). However, the Ecological momentary assessment progression of suicidal crises among people predisposed to suicidal behavior remains poorly understood. Borderline personality disorder Methods: Via multilevel structural equation modeling we tested the hypothesis that a history of attempted suicide Multilevel structural equation modeling predicts a stronger dynamic link between affect and impulsivity with suicidal ideation (i.e., suicidal urges) both moment-to-moment and day-to-day. 153 patients diagnosed with BPD, 105 of whom had a history of medically serious suicide attempts completed a 21-day ecological momentary assessment protocol (17,926 total assessments). Results: Individuals with higher average levels of negative affect reported more suicidal thoughts. Moments characterized by more negative affect, hostility, impulsivity, and less positive affect were also characterized by elevated suicidal ideation. For hostility and positive affect, these significant links generalized to the daily level. At the same time, for negative affect and hostility the within-person coupling was stronger among attempters in comparison to non-attempters, and these effects did not significantly differ across timescales. Limitations: Follow-up studies replicating our findings of the dysregulation-suicidality nexus in clinically more diverse samples are needed. Conclusions: The diathesis for suicidal behavior manifests in tighter dynamic links between negative affect or hostility and suicidal ideation. Because these within-person links were amplified in attempters compared to nonattempters, differential coupling patterns may index potentially lethal processes that generalize beyond BPD reflecting distinct diathesis components.

Borderline personality disorder (BPD) represents a key vulnerability factor for suicide attempts and death by suicide (Mann et al., 1999). ~9 % of people with a BPD diagnosis die by suicide (Gunderson and Ridolfi, 2001; McGirr et al., 2007) and almost all report chronically elevated levels of suicidal ideation (Zanarini et al., 2016). Comorbid BPD increases the number and lethality of suicide attempts among patients with major depressive disorder (Soloff et al., 2000) or substance use disorder (Oldham, 2006). A higher number of suicide attempts predicts the lethality of suicide attempts (Chesin et al., 2010) and death by suicide (Clark et al., 1989) in BPD, aligning with the general notion that, transdiagnostically, a history of attempted suicide is one of the strongest predictors of future suicidal behavior (O'Connor and Nock, 2014).

However, to date, little is known about how an enduring diathesis for death by suicide manifests in the processes that catalyze suicidal thoughts (Kuehn et al., 2020). Based on a 21-day ambulatory assessment protocol, we investigated whether the suicide diathesis in a high-risk population is expressed in the dynamic coupling of affect and suicidal ideation in people's daily lives. More specifically, we tested whether suicidal urges, defined as within-person links of affect or impulsivity with amplifications of suicidal ideation in daily life, distinguish those with a history of medically serious suicide attempts from nonattempters.

Affective dysregulation is among the most potent indicators of acute suicide risk (Anestis et al., 2014; Galynker et al., 2017; Law et al., 2015),

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https://doi.org/10.1016/j.jad.2023.02.034

Received 15 November 2022; Received in revised form 7 February 2023; Accepted 9 February 2023 Available online 11 February 2023 0165-0327/© 2023 Published by Elsevier B.V. and particularly so in BPD (Linehan et al., 1993; McGirr et al., 2007; Soloff et al., 2005; Wedig et al., 2012; Yen et al., 2004). Although related, there is relatively less evidence for the predictive validity of impulsivity for suicide in BPD as compared to affective responses. Previous work has primarily focused on cross-sectional self-reports of impulsiveness, emphasizing investigation of suicidal risk over the longterm. Conceivably, assessments of impulsive states, in contrast, may uncover more proximal risk factors for suicidal risk as it emerges in daily life (Hadzic et al., 2020; Lucht et al., 2021).

Intense affective experiences, impulsive urges and potentially escalating suicidal thoughts are viewed as temporary deviations from a baseline state, thus waxing and waning and naturally diminishing over time (Rudd et al., 2006; Sperry et al., 2021). Recent work supports this view of suicidal ideation - and thus the risk of attempting suicide - to be highly variable over short periods of time such as days (Coppersmith et al., 2019; Crowe et al., 2019) or even only a few hours (Hallensleben et al., 2017). Similarly, affective states, like hopelessness have been shown to co-occur with momentary changes in suicidal ideation (Kleiman et al., 2017). Positive and negative affective states, however, are hypothesized to be differentially reactive to contextual demands in daily life. Self-reported and observed positive, but not negative, affect follows an endogenous, biologically-driven (i.e., circadian) daily rhythm (e.g., Hasler et al., 2008). In contrast, the negative affective system has been hypothesized to function more reactively, and thus be more variable throughout the day, due to the relative unpredictability of (social) threat (Murray et al., 2002).

Accordingly, these findings, along with a growing recognition that affect dynamics are essential for understanding suicide (Kuehn et al., 2022), necessitate fine-grained, process-based assessments to comprehend how suicidal crises emerge in daily life at time scales that match their rhythmicity and reactivity. Nevertheless, data on the affective signatures specifically associated with suicidal behavior in everyday life are lacking, with most previous studies measuring suicidal ideation over longer intervals (Franklin et al., 2017), and disregarding differential time scales at which the predictive value of short-term warning signs may emerge. Tracking affective processes in people diagnosed with BPD and a history of suicidal behavior over three weeks, Links et al. (2007) found that negative mood intensity was related to daily self-reported suicide ideation, and to the number of suicidal behaviors during the preceding year, while impulsivity was not (see also Mou et al., 2018). Importantly, however, neither study examined whether the differential coupling of affect and suicidal ideation varied as a function of attempt history. It is, therefore, unclear whether these links are reflective of BPD per se, or a more general suicidal diathesis. Moreover, it is yet to be tested whether fluctuations of positive affect may also be considered as suicidogenic, how fluctuations in impulsivity relate to suicidal ideation in daily life, and how the predictive value of affect and impulsivity may vary as a function of time scale.

Suicidal ideation and behaviors precede death by suicide by years, potentially becoming a chronic and habitual response to adverse life events (Mehlum et al., 1994). In early-stage suicidal crisis,¹ where affective disturbance may progress to suicidal ideation (i.e., suicidal urges), people begin to consider suicide, likely as a coping effort to

escape circumstances that are perceived to be intolerable or overwhelmingly painful (Crane et al., 2014; Shneidman, 1998). The persistence of suicidal thinking in high-risk samples may be explained by the notion that suicidal ideation potentially leads to decreases in negative affect or increases in positive affect (Kleiman et al., 2018; Kuehn et al., 2022). From a reinforcement perspective, therefore, the experience of short-term relief, may lead to recurrent, sustained thoughts of suicide (Selby et al., 2007). Evidence from experimental studies builds on this notion of affective reinforcement, finding that suicidal ideation and behaviors are potentially caused by aberrant learning processes and decision-making biases in the face of distress (Dombrovski et al., 2019; McGirr et al., 2012; Millner et al., 2019). Together these studies suggest that in the context of aversive affective experiences the search for alternatives to suicide may be undermined by relief from negative mood after suicidal thoughts. To date, however, there is no prospective evidence that people predisposed to suicidal behavior are more likely to consider suicide when experiencing aversive affective states. Thus, in this study, we tested the hypothesis that among suicide attempters, compared to psychiatric controls, the daily coupling of affective dysregulation and suicidal ideation is stronger. That is, we predicted that among suicide attempters, daily affect/impulsivity and suicidal ideation would be more strongly associated.

We used multilevel structural equation modeling (MSEM) to examine within-person links (i.e., suicidal urges) among affective or impulsive experiences and suicidal ideation, and whether these links are potentiated among suicide attempters. We refer to within-person associations among affect or impulsivity and suicidal ideation as suicidal urges to capture the volatile character of suicidal thoughts and affective experiences across short periods of time (Kaurin et al., 2020; Kleiman et al., 2017), similar to tendencies to act rashly in the context of aversive experiences (e.g., negative urgency; Cyders and Smith, 2008; Tomko et al., 2015). Because there is research to suggest that circadian rhythmicity could reflect an important contributor to fluctuations in affective states, our analyses account for multiple time scales including variability in affect and impulsivity from day to day and across faster time scales within days. This allowed us to test the possibility that day-to-day or more rapid moment-to-moment coupling patterns may reflect distinct diathesis components that differ in their diurnal rhythmicity and contextual reactivity.

Given the high prevalence of serious suicidal thoughts, suicide attempts, and death by suicide in people diagnosed with BPD, we used a case-control design including non-clinical and non-attempter BPD comparison groups to control for psychopathology confounds. BPD offers a particularly informative population for the study of suicidality because it reflects a confluence of internalizing and externalizing psychopathology (Eaton et al., 2011): Diagnostic criteria like affective instability relate more strongly to internalizing, while others, such as marked impulsivity relate more strongly to externalizing forms of psychopathology. Such heterogeneity may imply a higher level of generalizability to other clinical disorders, particularly in comparison to those within which having 'thoughts of death' is itself part of the DSM-5 criteria (e.g., major depressive disorder (MDD); APA, 2013). Stratifying for histories of suicide attempts further allowed us to isolate the characteristics of prior suicide attempts that increase the seriousness of suicidal behavior (Soloff et al., 2000, 2005). Although suicide attempts are not synonymous to death by suicide, individuals with a history of suicide attempts likely share characteristics with those who died by suicide as the lethality of suicide attempts is known to progress with repeated attempts (Malone et al., 1995). Therefore, a history suicide attempts may be studied as an indicator for those at highest risk for death by suicide.

¹ Across a variety of theoretical vantage points, suicidal ideation and behavior is assumed to be best captured by a unidimensional construct, with passive suicidal ideation, active intent, and behavior existing along a continuum (Joiner, 2007; Klonsky and May, 2015; O'Connor, 2011). The term "early suicidal crisis" alludes to its continuous conceptualization, because suicidal ideation precedes a suicide attempt or death by suicide, and it also puts emphasis on the fact that suicidal ideation vs. behavior should be considered to represent distinct stages of the process (Klonsky et al., 2018). We do, however, acknowledge that such an operationalization reflects a rather simplistic account of suicidality. It is likely that multiple pathways underlie superficially similar progressions of cognition and behaviors (Szanto et al., 2018).

1. Method

All study procedures were approved by the Institutional Review Board of the University of Pittsburgh (STUDY19050210).

1.1. Sample

Participants were 153 individuals diagnosed with BPD (M_{age} : 33.62, SD = 9.60; 81 % female). Of these 153 individuals with BPD, n = 105 had a history of suicide attempts (BPD-ATT group) and n = 48 reported no past suicide attempts (BPD-NON group). The average amount of years since the last suicide attempt was \sim 7 years.

Medically significant attempts were defined by a score > 1 on the Beck Lethality Scale (LS; Beck et al., 1975). The LS assigns lethality scores in an ordinal continuum of severity of medical damage. Scores are anchored by descriptions of medical consequences in increasing degrees of severity. For participants with multiple attempts, data for the most serious lifetime attempt were used. As indicated by χ^2 -tests of independence, the distribution of comorbid diagnoses did not differ among clinical groups. Across groups, approximately \approx 83.3–90 % had a major depressive disorder, \approx 37.5–55.7 % had a PTSD, \approx 47.9–52.8 % had a generalized anxiety disorder, and \approx 47.9–58.6 % had an alcohol use disorder (see Table 1).

Male and female subjects between the ages of 18 and 45 years diagnosed with BPD and/or a history of suicide attempts, were recruited from inpatient, outpatient, and non-patient (community) sources. Diagnostic interviews were conducted by Master's-level research clinicians using standardized semi-structured interviews. These included the Structured Clinical Interview for DSM-IV, and the International Personality Disorders Examination (IPDE; First et al., 2007; Loranger et al., 1996). BPD subjects were required to meet diagnostic criteria for BPD (probable or definite) on the IPDE, with a lifetime time frame, and a score of 8 or more (definite) on the Revised Diagnostic Interview for Borderlines, with a 2-year time frame (Zanarini et al., 2016). Diagnoses were confirmed in a consensus conference of raters, using a best estimate process, and all available data. Exclusion criteria included a lifetime (past or current) diagnosis of schizophrenia, delusional (paranoid)

Table 1

socioucinographic, compliance and incline diagnostic data across study group	ciodemographic, compliance and lifetime diagnostic da	ta across study group
------------------------------------------------------------------------------	-------------------------------------------------------	-----------------------

	BPD-ATT	BPD-NON	χ ²	р
	n = 105	n = 48		
Age M (SD)	34.34 (10.63)	32.25 (6.78)		
Gender (% female)	84.5 %	76 %		
Compliance rate	78.08 %	78.15 %		
Clinical diagnoses				
Post-traumatic stress disorder	50.71 %	37.50 %	7.37	.024
Panic disorder	43.57 %	35.42 %	0.97	.613
Obsessive compulsive disorder	23.58 %	20.83 %	0.33	.848
Social phobia	37.15 %	31.25 %	0.81	.666
Generalized anxiety disorder	50.72 %	47.92 %	1.12	.570
Major depressive episode	87.86 %	83.33 %	0.58	.748
Dysthymia	7.86 %	12.50 %	0.24	.625
Bulimia nervosa	17.15 %	8.33 %	1.69	.193
Anorexia nervosa	9.29 %	6.25 %	0.77	.680
Substance use disorder				
Alcohol	56.43 %	47.92 %	2.53	.280
Sedative/anxiolytic	11.43 %	6.25 %	1.49	.474
Cannabis	32.14 %	35.42 %	1.99	.368
Stimulants	7.86 %	8.33 %	0.59	.745
Opioid	17.86 %	12.50 %	0.37	.545
Cocaine	17.14 %	12.50 %	0.80	.671
Hallucinogens	2.86 %	10.42 %	5.59	.060
Poly-substance	7.14 %	6.25 %	2.23	.328

Note. BPD-NON = non-attempters diagnosed with BPD; ATT = attempters diagnosed with BPD; compliance rate refers to the ratio of completed surveys vs. max. Possible number of surveys.

disorder, schizoaffective disorder, any bipolar disorder or psychotic depression, physical disorders or treatments with known psychiatric consequences, or an IQ < 70 by WTAR (Wechsler, 2001).

Suicide attempters had a history of self-injurious acts with the intent to die within a 1-month period prior to completing the study assessments or had a history of a past suicide attempt with strong current suicidal ideation at the time of study enrollment. Suicide attempt history was verified by a psychiatrist using all available information: participant's report, medical records, and collateral information from the treatment team, family, and friends. Significant discrepancies between these sources led to exclusion from the study.

1.2. Ambulatory assessment

Participants completed a 21-day EMA protocol within pre-defined time windows, using the MetricWire Version 4.2.8 (2019) smartphone application, which randomly reminded them to complete surveys via push notifications 6 times per day over a 12-h period. Assessments were aligned with participants' usual waking hours, which they were asked to specify before their enrollment in the study. The random assessments were spaced apart by a minimum of 90 min, and participants were given 60 min to respond to each prompt. Data from this protocol have been, in part, been previously published (Kaurin et al., 2020), but has not been assessed in the context of attempt history and examined interpersonal behavior that was reported during interpersonal situations in an event-contingent manner.

Participants rated the degree to which they felt negative affect (i.e., mean of sad, nervous, guilty, ashamed; $\omega_{within} = 0.80$; $\omega_{between} = 0.94$), hostility (i.e., mean of anger, irritability; $\omega_{within} = 0.78$; $\omega_{between} = 0.93$), and positive affect (i.e., mean of happy, content, excited; $\omega_{within} = 0.74$; $\omega_{between} = 0.84$). Items were derived from the Positive and Negative Affect Schedule (Watson et al., 1988), and read "How ADJECTIVE did you feel right now?". Ratings were made on a scale from 1 ("Not at All") to 5 ("A great deal").

In line with previous work, items from the CAT-PD (Wright and Simms, 2014) were adapted to reflect momentary features of impulsivity (Wright, 2023; Wright and Simms, 2016). To reduce participant burden, only a limited number of items were administered. However, to cover the breadth of the construct, we chose items from several subscales of the disinhibition domain, including irresponsibility ("I said/did things that I wish I hadn't"), non-planfulness ("I acted without thinking"), and risk taking ("I did something risky"). All items were rated based on the same 5-point scale and were averaged to form an impulsivity score ($\omega_{\text{within}} = 0.76$; $\omega_{\text{between}} = 0.95$).

Suicidal ideation was assessed with two dichotomous items (1 = yes, 0 = no; Kaurin et al., 2022; Tsypes et al., 2022) from the Columbia Suicide Severity Rating Scale (Posner et al., 2011): "Have you wished you were dead or wished you could go to sleep and not wake up?", "Have you actually had any thoughts of killing yourself?" (McDonald's $\omega_{within} = 0.82$; $\omega_{between} = 0.92$).

1.3. Data analysis

We used multilevel structural equation modeling (MSEM; Sadikaj et al., 2019), to test whether within-person covariation patterns of affect, hostility and impulsivity with suicidal ideation were stronger among suicide attempters. All models were estimated in Mplus with Bayesian parameter estimation fixed to 10,000 iterations (version 8.4; Muthén and Muthén, 2019).

MSEM can accommodate momentary events nested within days as well as persons, which allows for the decomposition of the total variance into the latent Level 3 (between-person) variance and Levels 2 (*day*; within-person) and 1 (*moment*; within-person) residual variances. The nested data structure allowed us to decompose suicidal ideation as well as hypothesized short-term risk factors into several variance components across different time scales ranging from rapid moment-to-



Fig. 1. Statistical model of suicidal urges, representing the within-person association between affect or impulsivity and suicidal ideation at the momentary (Level 1) and daily level (Level 2), and including the decomposition of observed daily variables into between- (subscript i) and within-person (subscripts t and d) variance. Between-person variance reflects individual differences in the observed variables, and the within-person variance reflects moment-to-moment or day-to-day departures from each individual's mean on these variables. Whereas in unconditional models, suicidal ideation was regressed on affect, hostility and impulsivity, conditional models tested whether variability in random slopes differed across our study groups. Single-headed arrows indicate regression paths. Filled dots represent random effects. Red arrows denote cross-level interactions, that is, changes of the daily or momentary association strength between affect, hostility or impulsivity and suicidal ideation relative to the BPD-NON group, which served as reference group of our dummy coded suicide history variable. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

moment fluctuations to slower day-to-day variability, as well as individual differences in average levels. MSEM also allows for the estimation of random effects (i.e., daily, and momentary intercepts and slopes that vary across individuals).

On 10.8 % of days, participants reported suicidal ideation at least once. More specifically, non-attempters diagnosed with BPD endorsed suicidal ideation on 6.5 %, and suicide attempters on 18.9 % of all study days, corresponding to 2.3 % and 6.8 % for momentary assessments.

Fig. 1 provides a diagram of the models tested. We first tested four independent, *unconditional* models (left side of Fig. 1). In those three-level models, momentary (Level 1) and daily (Level 2) ratings of suicidal ideation were regressed on negative affect, hostility, positive affect, or impulsivity at the within-person level (i.e., the suicidal urge paths in Fig. 1), and the same structure was mirrored at the between-person level. For within-person regressions, we estimated random slopes of suicidal urges, modeling individual differences in the strength of their momentary and daily within-person associations.

Building on those results, we next tested a set of four *conditional* models to examine whether variability in day- and momentary level random slopes differed across groups. For that purpose, we created dummy-coded moderator variables differentiating among non-attempters diagnosed with BPD (BPD-NON), and suicide attempters diagnosed with BPD (BPD-ATT). These grouping variables allowed us first to examine mean-level differences in our predictor variables and suicidal ideation. We also entered grouping variables as cross-level moderators of the paths at each level to test whether a history of suicide attempt was linked to stronger momentary and daily within-person links of affect, hostility or impulsivity and suicidal ideation (i.e., suicidal urges). In these models, the BPD-NON group served as reference group.

The right side of Fig. 1 provides an overview of model paths as they appear in Table 3. To empirically test the divergence of effects across timescales, we tested whether model-wise momentary and daily cross-level moderation coefficients were statistically different from each other.²

Significance for each model parameter was based on 95 % Credibility Intervals (CIs). CIs excluding zero were interpreted to be indicative of a parameter that differed significantly from zero. Sex (0 = female; 1 = male) and age (centered on mean age) were also included as covariates in all models at Level 3, and day number (i.e., day centered on mean of observations) and day of week (weekday vs. weekend) were included as a Level 2 covariates to account for possible change over time and weekly cycles. Along with other parameters not reported in the tables (e.g., residual variances), coefficients for covariates are not depicted in the diagrams, but full specifications and detailed output from all models can be found online at https://osf.io/7mjf6/.

A priori power was estimated using Monte Carlo simulation in Mplus

² As part of this study, another n = 52 healthy controls were recruited in addition to the clinical groups. Thus, all conditional and unconditional model sets were subjected to a sensitivity analysis which included those participants. This analysis did not change the pattern of our results (for details, see htt ps://osf.io/7mjf6/).Healthy controls (M_{age} = 33.77 (8.99); 75 % female; 84.41 % compliance) were recruited through community advertising and the Pitt+Me registry. The Pitt+Me registry is a database of >244,000 individuals willing to consider participation in research studies. The registry's software matches participants, based on their demographics and on their ICD-10 code(s), with studies for which they may be eligible.

8.4, using the final obtained group sizes and assuming an average within-person sample size of N = 20 days of observations. At an alpha level of 0.05, power was 0.81 to detect a within-person association of r = 0.10, power = 0.83 to detect a between-person association of r = 0.21, power = 0.82 to detect group differences in within-person associations (i.e., a cross-level interaction) of d = 0.27 between BPD non-attempters and attempters, and power = 0.81 to detect group differences in within-person associations (i.e., cross-level interaction) of d = 0.32 between BPD-HL and BPD-LL. Thus, we were generally powered to detect small effects for parameters of interest.

2. Results

2.1. Unconditional model set

For all predictors, we found a significant link at the momentary level, whereas for positive affect and hostility further significant links emerged at the daily level. Overall, this pattern confirms our model's ability to capture suicidal urges. Thus, in a given moment (or on a given day, respectively), when individuals experienced higher levels of negative affect or impulsivity, and lower levels of positive affect, they also reported elevated levels of suicidal ideation. At the between-person level, none of our predictors were significantly associated with suicidal ideation. Thus, individuals who tended to experience more negative affect, hostility, impulsivity, or less positive affect on average did not necessarily also experience more suicidal ideation in general (*see Table 2 for details*).

2.2. Conditional model set

No significant differences of the between-person regression coefficient emerged for the BPD-ATT group relative to the BPD-NON, which served as the reference group in this analysis. The absence of a significant regression coefficient for the BPD-ATT group suggests that average daily values of affect and impulsivity were comparable to those in BPD-NON (Table 3). Turning to group differences, adjusted for differences in the predictors, we found that suicidal ideation was significantly elevated in the BPD-ATT relative to the BPD-NON group.

In tests of cross-level interactions (Fig. 2), we found that in comparison to BPD-NON, the momentary, within-person link of negative affect was amplified in BPD-ATT and for hostility a stronger temporal coupling among attempters emerged at the daily level. These effects were indicated by significant regression coefficients for the BPD-ATT group relative to the BPD-NON group. Difference tests of cross-level moderation coefficients did not reach statistical significance,

Table 2

Key unstandardized coefficients from four independent unconditional multilevel structural equation models predicting suicidal ideation from average negative and positive affect, hostility and impulsivity (i.e., model-specific predictors).

	Model-specific predictors			
	Negative affect	Hostility	Positive affect	Impulsivity
	β [CI]	β [CI]	β [CI]	β [CI]
within-person (momentary)	0.03 [0.01; 0.06]	0.01 [0.00; 0.02]	-0.02 [-0.03; -0.01]	0.03 [0.01; 0.05]
within-person (daily)	-0.01 [-0.03; 0.01]	0.02 [0.00; 0.03]	-0.07 [-0.08; -0.05]	0.03 [-0.00; 0.06]
between-person	0.02 [-0.01; 0.05]	0.02 [-0.00; 0.04]	0.01 [-0.01; 0.04]	0.00 [-0.02; 0.02]

Note. N = 153 (between), N = 2993 (daily), N = 17,926 (momentary); 95 % credibility intervals of parameter estimates are in parentheses. Bolded values indicate the credibility interval does not contain zero.

Table 3

Key unstandardized coefficients from four independent conditional multilevel structural equation models (with moderation effects being fixed to equality) predicting suicidal ideation from average negative and positive affect, hostility and impulsivity (i.e., model-specific predictors) across attempters (BPD-ATT) vs. non-attempters (BPD-NON).

	Model-specific predictors			
	Negative affect	Hostility	Positive affect	Impulsivity
	β [CI]	β [CI]	β [CI]	β [CI]
Within-person				
associations				
$Predictor \rightarrow SI$	0.00	-0.01	-0.04	0.02 [-0.04;
(momentary)	[-0.04;	[-0.03;	[-0.04;	0.09]
	0.04]	0.03]	0.09]	
$Predictor \rightarrow SI$	0.01	-0.01	-0.05	0.01 [-0.08;
(daily)	[-0.06;	[-0.05;	[-0.09;	0.11]
	0.06]	0.04]	0.01]	
Between-person associations				
Predictor \rightarrow SI	0.03 [0.00:	0.01	0.02	0.00 [-0.02:
i i cuictor · bi	0.061	[-0.00.	[-0.01.	0.021
	0100]	0.031	0.041	0102]
BPD-ATT \rightarrow	0.17	-0.19	-0.07	0.09 [-0.07:
predictor	[-0.08:	[-0.40:	[-0.29:	0.24]
Freedom	0.401	0.021	0.15]	
BPD-ATT \rightarrow SI	-0.04	-0.02	0.10 [0.03:	-0.00
	[-0.10:	[-0.07:	0.16]	[-0.08:
	0.031	0.041		0.081
Cross-level	-	-		-
interaction				
BPD-ATT \rightarrow	0.03 [0.01;	0.00	-0.01	0.00 [-0.03;
suicidal urge	0.05]	[-0.01;	[-0.02;	0.04]
(momentary)		0.02]	0.01]	
BPD-ATT \rightarrow	0.01	0.03	-0.03	0.03 [-0.02;
suicidal urge	[-0.02;	[0.01;	[-0.05;	0.09]
(daily)	0.04]	0.06]	0.00]	
Difference	0.01	-0.03	0.02	-0.03
parameter	[-0.03;	[-0.06;	[-0.02;	[-0.11;
	0.06]	0.01]	0.06]	0.04]

Note. N = 153 (between), N = 2993 (daily), N = 17,926 (momentary); nonattempters (BPD-NON) group served as reference; positive regression coefficients denote that average momentary or daily values of affect or impulsivity, ideation, or the respective random slope (i.e., suicidal urge) is higher for the comparison group than for the BPD-NON group; a negative regression coefficient means that they are lower; group differences in the average levels of suicidal ideation were adjusted for each of the predictors; \rightarrow indicates regression; model parameter estimates are standardized. 95 % credibility intervals of parameter estimates are in parentheses. Bolded values indicate the credibility interval does not contain zero; SI = suicidal ideation, Suicidal Urge = daily within-person association between affect or impulsivity and suicidal ideation.

suggesting that effects were not divergent across timescales. For positive affect or impulsivity no statistically significant cross-level moderations emerged.

3. Discussion

There is strong evidence for a persistent suicidal diathesis among those with a history of suicide attempts and this vulnerability is pronounced among people diagnosed with BPD. The daily evolution of a suicidal crisis in people at risk for enacting suicidal thoughts, however, remains poorly understood. We estimated both trait-level and dynamic within-person associations of affective and behavioral dysregulation and suicidal ideation in a high-risk population of people diagnosed with BPD that varied in their history of suicide attempts. As expected, in comparison to non-attempters, daily suicidal ideation was elevated among suicide attempters. On average, affect, hostility and impulsivity did not differ between attempters and non-attempters. In line with previous work (Links et al., 2007), at the momentary level, we found significant positive associations of suicidal ideation with negative affect, hostility,



Fig. 2. Unstandardized point estimates of MSEM coefficients predicting suicidal ideation as laid out on the right side of Fig. 1 and detailed in Table 3 across different temporal scales (momentary, daily). Effects of hostility, impulsivity, negative and positive affect were contrasted across suicide attempters (BPD-ATT) with non-attempters (BPD-NON is the reference group). Central dot and horizontal lines denote estimated regression coefficient and 95 % confidence interval.

and impulsivity; we also observed a negative association between ideation and positive affect. This pattern was also observed for the slower day-to-day fluctuations for hostility and positive affect.

Regarding the central hypothesis of this study, we found that among participants who had attempted suicide in the past, the likelihood of more severe suicidal ideation was linked to higher *momentary* withinperson deviations from an individual's average level of negative affect and *daily* within-person deviations from an individual's average levels of hostility. Difference scores of cross-level moderator coefficients further suggested that these divergences across timescales were not statistically significant.

Overall, our findings do not corroborate previous work on the differential circadian rhythmicity of positive and negative affect (Hasler et al., 2008). The finding of significant covariation patterns of negative affect and hostility being equally predictive at slower daily and faster momentary assessment schedules, however, aligns with recent work on the exact timescale of suicidal thoughts (Coppersmith et al., 2022). This work suggests that suicidal desire, relative to more advanced states of suicide risk, such as suicidal intent, tends to have a longer duration of up to 20 h. Thus, daily averages of negative affect and hostility may be a reasonable time scale for our investigations.

Previous work has proposed that the repeated contemplation of suicide may represent a way to cope with negative affect (Kuehn et al., 2022), potentially because other options may not be perceived to be viable (Dombrovski et al., 2019). Our study builds on these findings, suggesting that differential escalatory dynamics are governed by an individual's relative intensity of experienced affect. More precisely, the diathesis for suicidal behavior is expressed in the dynamic processes linking affect and suicidal ideation, particularly for previous attempters. Because we found these within-person links to be significantly amplified in attempters in comparison to non-attempters, all of whom had BPD diagnoses, suicidal urges may demarcate specific, potentially lethal, dynamic processes that generalize beyond BPD.

Regarding impulsivity, our findings align with previous work on the dynamic links of state indices of impulsivity with suicidal behavior (Hadzic et al., 2020). Because impulsivity accelerates the transition from thoughts to action, it has long been seen as a central risk factor for suicidal behavior in all populations (Bryan and Rudd, 2006), and in BPD in particular (Brodsky et al., 2006). In meta-analyses, however, the predictive validity of impulsivity for suicide attempts is paradoxically rather modest (Anestis et al., 2014), with little discriminatory value for the differentiation between attempters and non-attempters (Millner et al., 2020). Likewise, we found that neither momentary nor daily

within-person links between impulsivity and suicidal ideation were related to attempt history. Conceivably, higher momentary levels of affect-related impulsivity (e.g., negative urgency) may more clearly differentiate attempters from non-attempters and future studies are needed to investigate this link (e.g., Millner et al., 2020).

The analyses reported in this study were based on a stringent casecontrol sampling strategy, accounting for the medical seriousness of suicide attempt histories in a sample at heightened risk for suicide. Furthermore, they were based on a priori power calculations, specifically targeting the detection of the hypothesized cross-level interaction effect. Our results were robust to sensitivity analyses, such as the exclusion of HCs from our models due to minimal variability rates in our main outcome (https://osf.io/7mjf6/). On that empirical basis, our study provides new insights into the timing of affect, hostility as well as impulsivity in the clinical recognition of potentially lethal crises in suicide attempters. Given that comorbidity frequencies did not differ across our clinical study groups, along with the fact that significant contrasts of the strengths of suicidal urges emerged between suicide attempters and non-attempters imply that the observed effects may generalize beyond BPD (i.e., BPD is held constant across both groups by our case-control design).

Notwithstanding these strengths of our study design, follow-up studies replicating our findings of the dysregulation-suicidality nexus in clinically more diverse samples are needed. Given the relevance of persistent negative affectivity for the prediction of suicidal behavior, it is important to test whether the diathesis for death by suicide in individuals diagnosed with MDD without a diagnosis of BPD may also be characterized by a stronger momentary coupling between affect and suicidal ideation (Zanarini et al., 2016).

Suicidal thoughts are rare episodic events and even if assessed moment-to-moment during a 21-day EMA protocol with high ecological validity in real-world, every-day contexts and representative, high-risk populations, the base rate of momentary endorsements of suicidal ideation is low (Husky et al., 2014). In our sample, endorsement rates of suicidal ideation were sparse, when considered as a proportion of momentary assessments, which matches previous work (Husky et al., 2014). Thus, the question, however, of how best to conceptualize and assess suicidal ideation and behavior is vital to progress toward a clearer understanding of suicidal phenomena. As discussed by Millner et al. (2020), current measures lack the validity to aid the reliable identification of suicidal thoughts or behaviors (Hom et al., 2016; Plöderl et al., 2011), and often diverse facets of suicidal thoughts are confused into one metric without appropriately evaluating its predictive or construct validity (Millner et al., 2020). Future research, therefore, should dedicate its efforts to more rigorous and transparent practices (Carpenter and Law, 2019) and descriptive work focusing on suicidal thoughts and behaviors and the components postulated to precipitate or covary with these phenomena. By basing our analyses on a well-defined, high-risk sample, adapting an operationalization and measurement of our suicidal ideation on the basis of an established scale, offering a variety of sensitivity analyses to probe the robustness of our findings, and openly sharing our data and code, we do our best to contribute to this endeavor.

Though our study is a first step toward the integration of previous work with real-life experiences of suicidal crises, future studies are needed to help clearly laying out the mechanism through which affective dysregulation is more strongly tied to suicidal ideation in suicide attempters relative to non-attempters, including the illumination of differential time scales more clearly. Possibly, the slower day-to-day fluctuations, in comparison to transient variability in suicidal ideation, could be more tightly linked to hostility and impulsivity, because these tend to occur less frequently and to be more reactive to rare contextual demands in daily life (e.g., interpersonal conflicts). Conceivably, both may be indicative of a reactive behavioral inhibition system responding more dynamically to aversive or ambiguous stimuli. Future studies could test this assumption by simultaneously measuring fluctuations in hostility as well as impulsivity and suicidal ideation as well as limbic, prefrontal, and striatal reward circuitry that regulates behavioral activation and effort-related functions (Berridge and Kringelbach, 2015).

Conceivably, stronger suicidal urges are a product of continuous reinforcement of suicidal thoughts via reductions in negative and elevations of positive affect. It has been argued suicidal thoughts may be protective (i.e., thoughts about suicide regulate affect, which then reduces the likelihood of actual suicidal behaviors; Maltsberger et al., 2010), while others have argued that it could be harmful to attribute positive qualities to suicide (Selby et al., 2007). One alternative explanation may be that aberrant learning processes and related decisionmaking biases for active responses to escape aversive states may moderate the strength of experienced urges. As a first step toward a more mechanistic perspective on the relationship between affect and suicidal ideation, Allen et al. (2022) prospectively observed suicide attempts and found that effects of disinhibition enhanced the within-person coupling between suicide ideation and actual suicide attempts based on data from 30-years of follow-up. Future studies are much needed to assess the affect-regulatory qualities of suicidal thoughts and behaviors. Despite the need for replication, we believe that our study shows the feasibility and challenges of integrating high-frequency monitoring into clinical assessments of suicide risk and safety planning (comparable to ambulatory blood sugar monitoring in diabetes). If collected over reasonable periods, such data may help therapists and patients recognize emotional states as warning signs (Kaurin et al., 2022). Intervention contingencies need to be devised carefully, however, since reinforcement of distress signals with extended contact can have a destabilizing effect in BPD.

Our findings underscore the importance of naturalistic methods to detect acute spikes in suicidality at time scales that match rhythmicity and socio-affectively determined reactivity and extend previous work by translating theoretical and empirical evidence on how risk for death by suicide is expressed/experienced in daily life into plausible interactional models of daily suicidal urges. Differentiating between suicide attempters and non-attempters may elucidate potentially lethal daily links between affective dysregulation and suicidal ideation, that are useful for identifying who and under what circumstances is at the highest risk for dying by suicide.

Role of the funding source

This research was supported by grants from the National Institute of Mental Health (R01MH048463, R01MH100095, R01MH119399, L30MH101760), the University of Pittsburgh's Clinical and Translational Science Institute, which is funded by the National Institutes of Health (NIH) Clinical and Translational Science Award (CTSA) program (UL1TR001857). The CTSA program is led by the NIH's National Center for Advancing Translational Sciences. The opinions expressed are solely those of the authors and not those of the funding source.

CRediT authorship contribution statement

Alexandre Y. Dombrovski, Michael N. Hallquist & Aidan G.C. Wright: Conceptualization, Methodology, Reviewing and Editing; Aleksandra Kaurin: Data curation and analysis, Writing, Original draft preparation, Visualization.

Conflict of interest

None.

Acknowledgements

We are grateful to the patients who took part in this study and to the clinical and research teams who made this work possible.

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