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Phenotyping suicidal ideation and behavior: Comparing clinical characteristics and future suicide attempts between suicidal subtypes in two clinical samples

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Abstract

Objectives: To further validate the concept of suicidal subtypes distinguished by indicators of suicidal thinking and behavior with regard to clinical characteristics and past and future suicide attempts.

Methods: Psychiatric inpatients were assessed (study 1: ecological momentary assessments in 74 depressed inpatients with suicidal ideation; study 2: clinical assessments in 224 inpatients after a suicide attempt and over a 12-month follow-up period). Subtypes were identified using latent profile analysis (based on indicators of real-time suicide ideation) and latent class analysis (based on features of past suicide ideation and suicide attempt characteristics). Comparisons between subtypes included clinical characteristics (depression, suicidal ideation, trait impulsivity, childhood trauma) as well as past (study 1) and future (study 2) suicide attempts.

Results: Suicidal subtypes emerged that are characterized by suicidal ideation means and stability and features of past suicidal behavior (four in study 1, three in study 2). The subtypes differed in terms of depression/suicidal ideation, but not in terms of trait impulsivity/childhood trauma. Although not significant, the subtypes "high-stable" and "low-moderate stable" reported multiple re-attempts more frequently during follow-up than the "low-stable" subtype in study 2.

Conclusion: Differences in clinical variables (and by trend in future suicide attempts) clearly point to the clinical relevance of suicidal subtypes (with variability of suicidal thoughts playing a particularly important role).

KEYWORDS
assessment, depression, real-time monitoring, suicidal thoughts/suicidal behavior

1 | BACKGROUND

Although the prevention of suicides is among the major goals of international and national public health plans, the prediction and prevention of suicidal thoughts and behaviors (STBs) still remains challenging (Glenn & Nock, 2014; Mou et al., 2020). Several recommendations for suicide research, such as focusing on short-term changes in suicidal ideation (SI) and related risk factors using ecological momentary assessments (EMA) or focusing on clinically significant suicidal subtypes independent from underlying psychiatric conditions, have been made to improve the prevention of STBs (Ballard et al., 2021; Franklin et al., 2017; Mou et al., 2020).

Bernanke et al. (2017) introduced the idea of two major subtypes of people at risk of suicide characterized by distinct suicidal thinking patterns that differ in terms of stress-responsiveness, risk factors, and underlying pathophysiological processes and their impact on the relation between contextual factors, for example, life-stressors, and features of suicidal behavior (SB), such as the lethality of the method used (Bernanke et al., 2017). One subtype, the *stress responsive type* is characterized by sudden and more fluctuating SI after stressful life-events, less planned SB, childhood trauma, impulsivity and aggression (at trait level), and potentiated cortisol response/hypothalamic-pituitary-adrenal (HPA) axis dysfunction. The other subtype, the *non-stress responsive type*, is characterized by persistent and more severe SI, worse depression, more planned SB, and better cognitive control.

Longitudinal studies investigating the trajectories of SI over several months generally support the idea of SI subtypes that differ with respect to the level and persistence of SI. More intense SI and more stable SI were associated with more severe depression (Kohler-Forsberg et al., 2017), greater risk for rehospitalization and further suicide attempts (Czyz & King, 2015), and greater emotion dysregulation (Wolff et al., 2018).

Two recent EMA studies have additionally supported the idea of different SI patterns specifically defined by SI variability. Kleiman et al. identified five phenotypes that differed with respect to mean and variability of real-time SI (Kleiman et al., 2018). Oquendo et al. further demonstrated that higher SI variability is associated with physical abuse in childhood, lifetime aggression, and trait impulsivity (2020). Interestingly, SI variability appeared to be trait-like over the study period of 2 years in depressed individuals.

The available evidence regarding suicidal subtypes and the specific role of SI variability highlight the importance of assessing individual SI patterns and trajectories in clinical settings. Yet, only few studies have shed light on the specific associations of suicidal subtypes with clinical characteristics, or examined the clinical importance of these with regard to the nature of past SB and the occurrence of future SB in detail. The present examination aims to fill this gap and investigates the presence of suicidal subtypes as proposed by Bernanke et al. (2017) in two clinical samples with different risk profiles using a longitudinal approach with different temporal resolution.

1.1 | Aims of the study

Our first aim was to examine SI subtypes in real-time using EMA data collected in a sample of psychiatric inpatients with past or present SI (lower risk sample). We assessed whether the emerging subtypes differed in terms of SB history, trait impulsivity, childhood trauma, and clinical characteristics (level of depression and SI). Based on previous findings (Bernanke et al., 2017; Kleiman et al., 2018), we expected to identify SI patterns showing at least two major subtypes differing in SI variability. We hypothesized that trait impulsivity is heightened and the experience of childhood trauma is more likely in those subtypes with highly variable SI, thereby indicating a consistency with the proposed *stress-responsive type*. Similarly, we also expected subtypes with more persistent and more severe SI (i.e., less variability and higher mean) to report higher levels of past SI and depression and thus fall into the category of the *non-stress-responsive type*. With regard to suicide history, we had no specific hypotheses. Second, we aimed to identify suicidal subtypes in a sample of psychiatric inpatients with a history of suicide attempt (high-risk sample) based on features of past STBs. Again, we expected to identify at least two major subtypes that differ in terms of intensity and persistence of SI and attempt characteristics (i.e., higher degrees of planning and more lethal methods in subtypes with more severe and more persistent SI, reflecting the *non-stress-responsive type*) and clinical variables (trait impulsivity, depression, SI severity, experience of childhood trauma). Employing a longitudinal design, we additionally examined whether the number of suicide reattempts differed between suicidal subtypes during the 12-month follow-up period and explanatorily examined SI severity and persistence stability.

2 | METHOD

2.1 | Study 1

2.1.1 | Sample

Between September 2015 and August 2017, 74 psychiatric inpatients with a primary diagnosis of a unipolar depressive disorder and current or lifetime SI were included in the study. A descriptive overview of the sample is provided in Table 1. All participants provided written informed consent and the ethics committee approved the protocol (388-13-16122013, Leipzig University).

2.1.2 | Assessments

All participants took part in a 6-day ecological momentary assessment period (EMA) with 10 signal-contingent assessments per day (occurring randomly between 8:00 am and 7:50 pm with a minimum interval of 30 min between prompts). EMAs were carried out with lent Android smartphones and movisensXS©. Compliance with the

TABLE 1 Descriptive characteristics of the study samples

	Study 1 *n* = 74	Study 2 *n* = 224
Age in years		
Mean (SD)	37.6 (14.3)	37.3 (14.3)
Range	18–85	18–81
Sex, female	*n* (%)	*n* (%)
	53 (71.6%)	126 (56.3%)
Highest school degree	*n* (%)	*n* (valid %)
No degree	1 (1.3)	11 (5.1)
Middle school	31 (41.9)	70 (32.3)
High school diploma	24 (32.5)	31 (14.3)
College degree	17 (23.0)	23 (10.6)
Vocational training	n.a.	71 (32.6)
Other	1 (1.3)	11 (5.1)
Missings	0	7
Diagnoses category according to ICD-10, currently[a]	*n* (%)	*n* (valid %)
F0: Organic mental disorders	0	1 (0.6)
F1: Mental and behavioral d. due to psychoactive substance use	7 (9.6)	6 (3.4)
F2: Schizophrenia, schizotypal and delusional d.	0	2 (1.2)
F3: Affective d.	74 (100.0)	110 (64.0)
F4: Neurotic, stress-related and somatoform d.	7 (9.8)	31 (18.0)
F5: Behavioral syndromes associated with physiological disturbances and physical factors	1 (1.4)	n.a.
F6: D. of adult personality and behavior	n.a.	21 (12.2)
F7: Mental retardation	0	0
F8: D. of psychological development	0	1 (0.6)
F9: Unspecified mental d.	0	0
Missings	0	52

Abbreviations: d, disorders; n.a, not assessed.

[a]In study 1, all present diagnoses were recorded (except personality disorders), therefore multiple answers occur; in study 2, only the primary diagnosis was recorded.

EMA assessment was excellent (89.7%) resulting in 4.022 valid assessments. At each prompt, momentary active SI was rated with two items from "0" (not at all) to "4" (very much (e.g., "At this moment I think about taking my life.") (Forkmann et al., 2018). The baseline assessment history of suicide attempts was assessed via the Suicide Behaviors Questionnaire—Revised (SBQ-R Glaesmer et al., 2017; Osman et al., 2001). Suicidal ideation and depression levels were assessed with the Beck Scale for Suicide Ideation (BSS; Beck & Steer, 1993; Kliem & Brähler, 2015) and the Rasch-based Depression Screening (DESC-I; Forkmann et al., 2009; Forkmann et al., 2011), with higher scores indicating higher levels of the respective construct. The Childhood Trauma Screener (CTS; Glaesmer et al., 2013; Grabe et al., 2012), a short version of the Childhood Trauma Questionnaire (CTQ; Bernstein et al., 2003) was applied to assess experiences of maltreatment during childhood. The used items as well as the prevalence of the different kinds of child maltreatment can be found in the Supplementary Online Material (SOM-Table S1). The Barratt Impulsiveness Scale version 11 (BIS-11; (Meule et al., 2011; Patton et al., 1995)) was used to assess trait impulsivity.

2.1.3 | Statistical analysis

The following variables were calculated across all EMA prompts (allowing ≤15 missing values per person) for each participant: root mean squared successive differences (RMSSD) indicating point-to-point variability in SI (Neumann et al., 1941; Woyshville et al., 1999), mean SI, maximum value of SI, and the percentage of SI ratings >0. All

variables were standardized using z-transformation. Patterns of SI were identified using latent profile analyses conducted in R using the packages "mclust" (Scrucca et al., 2016) and "tidyLPA" (Rosenberg et al., 2018). Latent profile analyses is a categorical latent variable approach that focuses on identifying latent subpopulations within a population based on a certain set of variables (Spurk et al., 2020). To allow meaningful interpretation of the patterns, models with two to five distinct subtypes were specified with equal variances, co-variances fixed to 0, and cases per pattern ≥5. Several criteria were evaluated to determine the final number of profiles. A good solution was supposed to show high average probability for pattern membership, entropy ≥0.80 indicating preciseness of classification, sample size adjusted Bayesian information criterion (SABIC), as small as possible indicating model fit, bootstrapped likelihood ratio test (BLRT) close to 0, and significant ($p < 0.01$) posterior probability with a high maximum and minimum close to maximum (Stanley et al., 2017; Tein et al., 2013).

Analysis of variances and χ^2-tests were conducted to examine if the SI subtypes differ with respect to history of suicide attempt, level of SI and depression, childhood trauma, and trait impulsivity. For the analyses of variances, *p*-values for post-hoc analyses were adjusted using Games-Howell correction.

2.2 | Study 2

2.2.1 | Sample

308 psychiatric inpatients were recruited in 13 psychiatric hospitals upon admission for severe SI or a recent suicide attempt (Forkmann et al., 2020). Of those, participants with a lifetime history of at least one suicide attempt were included in the present analysis ($n = 224$), of these, $n = 66$ (29.5%) were in inpatient treatment for acute SI and $n = 158$ (70.5) for a suicide attempt. A descriptive overview of the sample can be found in Table 1. Three follow-up interviews took place (after 6, 9, and 12 months; participation rate $T^1 = 69.2\%$, $T^2 = 61.7\%$, $T^3 = 50.3\%$). All participants gave written informed consent. The study was approved by the local ethics committees (EK 310/13, RWTH Aachen University; 4909-14, Ruhr University Bochum; 042-1427012014, Leipzig University).

2.2.2 | Assessment

Number and characteristics of previous suicide attempts were assessed using the German *Self-Injurious Thoughts and Behaviors Interview* (SITBI-G; Fischer et al., 2014; Nock et al., 2007) and the *Suicide Attempt Self-Injury Interview* (SASII; Linehan et al., 2006). Information on the average intensity of SI and persistence of SI were used (SITBI-G, referring to the worst period of lifetime SI) for the present analysis. SASII-based interviewer ratings of lethality and impulsivity of the most recent attempt were included. Several self-report questionnaires were applied to assess SI (BSS), depression (DESC-I), childhood trauma (CTS), and trait impulsivity (BIS-11). SITBI and SASII were re-assessed at each follow-up (referring to the respective follow-up interval). Thirty-five of the interviewed participants reported at least one reattempt occurring over the course of the 12-month follow-up period.

2.2.3 | Statistical analysis

For each participant, the following variables served as indicator variables in the latent class analysis: average intensity and persistence of worst lifetime SI, impulsivity and medical lethality of most recent SA (see Table 3 for rating scales). Missing values were deleted listwise. Phenotypes characterized by these features were identified using latent class analyses conducted in R using the package "poLCA" (Linzer & Lewis, 2011). Latent class analyses allows to specify a multidimensional discrete latent variable based on a cross-classification of two more observed categorical variables (Schreiber, 2017). We evaluated several criteria for determining the number of subtypes (Zhang et al., 2018): a good solution was defined as one that showed the lowest Bayesian information criterion (BIC) and SABIC values (indicating model fit), the highest relative entropy (indicating preciseness of classification), and demonstrated good interpretability. Differences between the final classes were examined using χ^2-tests (categories with missing cells or too few cases were excluded from the analysis). If the subtypes differed with regard to current SI and depression, trait impulsivity, childhood trauma, or reattempts, χ^2-tests and analysis of variances were conducted. For the analyses of variances, *p*-values for post-hoc analyses were adjusted using Games-Howell correction. Intensity and persistence of SI assessed at the follow-ups were visually plotted to inspect trajectories over time for participants with complete data sets (using "ggplot2" package in R).

3 | RESULTS

3.1 | Study 1: SI subtypes in the lower risk sample

3.1.1 | Latent profile analysis of real-time SI

Taking all evaluated criteria for model fit into account, the four subtypes solution seemed the best choice as it demonstrated the highest entropy in combination with a significant BLRT and the second lowest SABIC of all tested models (see SOM-Table S2).

3.1.2 | SI subtypes

The four subtypes did not differ in mean age ($F(73,3) = 0.189$, n.s). ANOVAs demonstrated that significant differences characterize the four subtypes in terms of mean and variability of real-time SI during the observation period (see Table 2). Those subtypes are defined as follows: (1) low mean and low variability ("low-stable"), (2) high mean and high variability ("high-unstable"), (3) low mean and moderate

TABLE 2 Differences between suicidal ideation (SI) subtypes in indicator variables and clinical characteristics ($N = 74$)

Subtype (mean—variability)	1 ($n = 34$) low-stable	2 ($n = 17$) high-unstable	3 ($n = 12$) low- moderately stable	4 ($n = 11$) moderate-unstable	Test statistic	p
Indicators of real-time suicide ideation (SI)						
Max SI	1.77	6.88	4.33	4.18	$F = 54.666$	**<0.001**
Mean SI	0.04	3.57	0.72	1.44	$F = 169.069$	**<0.001**
% Present SI	2.95	94.16	33.20	69.2	$F = 684.497$	**<0.001**
RMSSD	0.24	1.70	1.13	1.41	$F = 38.478$	**<0.001**
Clinical characteristics						
Suicide ideation (sum BSS)[a]	4.7	18.3	7.0	11.3	$F = 13.437$	**0.000**
Depression (sum DESC)[a]	23.0	30.0	25.6	29.1	$F = 75.53$	**0.000**
Childhood trauma (sum CTS)	10.8	11.6	11.6	11.5	$F = 0.149$	0.930
Trait impulsivity (sum BIS-11)	66.3	70.4	64.1	66.0	$F = 0.979$	0.408
	N (%)	**N (%)**	**N (%)**	**N (%)**		
History of suicide attempt	32%,4% ($n = 11$)	41.2% ($n = 7$)	41.7% ($n = 5$)	36.4% ($n = 4$)	$X^2 = 1.066$	0.801

Note: To enable interpretation, raw-scores are displayed. Bold values indicate significance or significance by trend.

Abbreviations: CTS, Childhood Trauma Screener; DESC, Rasch based Depression Screening.

[a]Sig. group differences (Games-Howell-corrected) BSS: P1 < P2 ($p < 0.001$), P2 > P3 ($p < 0.001$); DESC: P1 < P2 ($p = 0.001$), P2 > P4 ($p = 0.023$); because of cell frequencies <5 X^2 tests were exact tests according Fisher.

variability ("low-moderately stable"), and (4) moderate mean and high variability ("moderate-unstable"). Remarkably, participants in subtype 1 reported SI in only roughly 3% of real-time assessments. Figure S1 (see Supplementary Material) shows the individual trajectories of real-time SI over the observation period according to subtype membership.

3.1.3 | Differences in clinical features and past SB

Significant differences were only observed in baseline SI and depression levels (see Table 2). Subtypes 2 and 4, defined by high SI variability, were assumed to represent the *stress-responsive type*. Yet, neither subtype indicated the presence of greater childhood trauma or trait impulsivity in comparison to other subtypes. There was no subtype characterized by high mean SI and low SI variability that corresponded with the previously defined *non stress-responsive type*. Subtype 2 did however show the highest real-time SI on average, and participants included in this subtype reported the highest previous levels of SI and depression (significantly differing from participants in subtypes 1 and 3).

The percentage of persons with a history of a suicide attempt did not differ significantly between the subtypes.

3.2 | Study 2: SI/SB subtypes in the high-risk sample

3.2.1 | Latent class analysis

According to the BIC, SABIC, and relative entropy for models with two to five classes, three or four of the subtypes we identified appeared most suited for describing distinguishable classes (see SOM-Table S3). After inspecting these solutions, we favored that of defining three subtypes to enhance their interpretability.

3.2.2 | Differences in features of past SI and SB between the subtypes

The three subtypes showed no differences in mean age ($F(1,220) = 1.952$, n.s.) or regarding sex ($\chi^2(2) = 2.070$, n.s.). As Table 3 displays, the three subtypes differed significantly with regard to the indicator variables, and they can be characterized according to the severity and persistence of past SI. Subtype 1, "high-stable," was assumed to resemble the *non-stress-responsive type* whereas subtype 3, "low-unstable," appeared to be consistent with the *stress-responsive type*. In line with our assumptions, the attempt characteristics were different between the subtypes. Notably, a relevant proportion of participants across all subtypes described their most recent suicide attempt as having been impulsive with intense emotion (25%, 41% and 57.2%, respectively).

3.2.3 | Differences in clinical characteristics and future SB between the three SI/SB subtypes

Table 4 demonstrates that current depression and SI levels differed significantly between the subtypes. Specifically, subtype 1 ("high-stable") had significantly higher depression scores and SI than subtype 3 ("low-unstable"). Participants' depression levels were also significantly higher in "subtype 2 ("low-stable") compared to subtype

TABLE 3 Differences between suicidal ideation (SI)/suicidal behavior (SB) subtypes in indicator variables ($N = 224$)

Subtype (mean – stability)	1 ($n = 68$) High-stable %	2 ($n = 37$) Low-stable %	3 ($n = 115$) Low-unstable %	Test statistic	p
Intensity of worst SI (lifetime; SITBI)				$X^2 = 42.166$	**0.000**
Rather low	2.9	12.8	15.4		
Moderate	26.5	71.8	33.3		
Rather strong	55.9	0.0	40.2		
Intense	13.2	15.4	10.2		
Persistence of SI (lifetime; SITBI)				$X^2 = 206.699$	**0.000**
Few seconds	5.9	0.0	32.5		
Few minutes	7.4	15.4	14.5		
15–59 min	10.3	0.0	48.7		
<1 day	5.9	38.5	2.6		
1–2 days	17.6	35.9	0.0		
2 days	52.9	10.3	0.0		
Impulsivity of last SA				$X^2 = 128.817$	**0.000**
Elaborate plan	8.8	0	0		
Planned, resisted for days	32.4	0	3.4		
Planned, resisted <1 day	22.1	17.9	0		
Unplanned, resisted for days	0	25.6	3.4		
Unplanned, resisted <1 day	2.9	10.3	9.4		
Impulsive	5.9	0	22.2		
Impulsive with intense emotion	25	41	57.2		
Lethality of last SA				$X^2 = 48.866$	**0.000**
Very low	4.4	7.7	8.5		
Low	0	25.6	10.3		
Moderate	27.9	35.9	38.5		
High	20.6	0	14.5		
Very high	30.9	0	10.3		
Extremely high	11.8	17.9	7.7		

Note: Bold values indicate significance or significance by trend.

3. Apart from that, there were no significant differences in trait impulsivity or childhood trauma (see Table 4) between the subtypes.

The number of suicide attempts (i.e. single reattempts vs. multiple reattempts) in the follow-up period was different by trend between the three subtypes. In subtype 2 ("low-stable"), single reattempts were more frequent than in the other subtypes. The comparison between 0 versus ≥1 re-attempt was not significant between the subtypes ($X^2(2) = 2.356$, n.s.). (see Table 4).

Figure S2 (see Supplementary Material) displays the individual trajectories of SI intensity and persistence ratings during the follow-up. Data is only graphically shown when participants took part in every follow-up (T1, T2, and T3, $n = 42$). The majority of SI trajectories of SI did not appear stable in either subtype. Instead, a considerable amount of within-person variability is visible.

4 | DISCUSSION

Focusing on suicidal subtypes has been among the most recent directions to enhance our understanding of STBs (Mou et al., 2020). The present examination sheds further light on suicidal subtypes with three main findings. (1) Suicidal subtypes differing with regard to mean and stability of SI and features of past SB could be identified in both studies. Suicidal ideation variability, in particular, appears to be a clinical feature that helps to phenotype persons experiencing STBs. (2) As hypothesized, the identified subtypes differed in some of the clinical variables under study (i.e. depression and SI). They did not however fully resemble the two suicidal subtypes proposed by Bernanke et al. (2017) across both studies (e.g. with regard to number and features of subtypes, trait impulsivity, or the experience of

TABLE 4 Differences in clinical characteristics and future reattempts between the suicidal ideation (SI)/suicidal behavior (SB) phenotypes

Phenotype	1 (n = 68) High-stable Sum	2 (n = 37) Low-stable Sum	3 (n = 115) Low-unstable Sum	Test statistic	p
Suicide ideation (BSS)[a]	19.6	16.1	12.6	F = 11.962	**0.000**
Depression (DESC)[a]	29.1	29.2	24.8	F = 7.963	**0.000**
Childhood trauma (CTS)	13.1	12.7	11.7	F = 1.767	0.173
Impulsivity (BIS-11)					
Non-planning	13.7	14.2	12.8	F = 2.565	0.079
Motor	11.6	11.5	12.1	F = 0.788	0.456
Attention	12.1	12.6	12.0	F = 0.418	0.659
	N (%)	**N (%)**	**N (%)**		
Suicide attempt during 12-month follow-up				X^2 = 8.733	**0.057**
1	4 (5.9)	8 (20.3)	7 (6.0)		
≥ 2	7 (10.3)	1 (2.6)	8 (6.8)		

Note: BSS: C1 > C3 ($p < 0.001$); DESC: C1 > C3 ($p = 0.001$), C2 > C3 ($p < 0.01$). Participation at Follow-ups: T1 69.2%, T2 62.1% and T3 50.4%, no significant differences in participation rate between phenotypes; full follow-up data is available for n = 42 participants (18.6%); because of cell frequencies <5 X^2 tests were exact tests according Fisher. Bold values indicate significance or significance by trend.

Abbreviation: DESC, Rasch based Depression Screening

[a]Sig. group differences (Games-Howell-corrected).

childhood trauma). (3) Most importantly, subtype membership was by trend associated with number of re-attempts during the 12-month follow-up period in study 2. Following is a more detailed critical discussion of the studies' results.

We identified four subtypes characterized by differences in mean and variability in real-time SI. This finding partially supports the definitions of distinct suicidal thinking patterns (Bernanke et al., 2017) and replicates the results of a former EMA study that identified five patterns (Kleiman et al., 2018). Regarding the assumed heightened experience of childhood trauma and trait impulsivity in subtypes assumed to represent the *stress-responsive* subtype, we failed to fully confirm our hypothesis that subtypes featuring a high SI variability (i.e. subtypes 2 and 4) show higher levels in these two areas than other subtypes. As stated before, the *non-stress responsive* subtype did not clearly emerge in our analysis. That said, the participants in subtype 2 that demonstrated the highest average real-time SI during the observation period (albeit with high variability as well) did report the highest levels of depression and previous SI, a finding that did partly confirm our assumptions. We speculate that differences in SI mean and variability might be more pronounced if the EMA observation period was more extended (to capture more stress-inducing experiences) as increases in SI have been found to be linked to stressors in persons with high variability (Oquendo et al., 2020). Further, it must be acknowledged that the sample was rather homogenous in that it consisted only of inpatients with unipolar depression, something which possibly diminished the statistical power and thus led to a blunted distinguishing effect of indicators of real-time SI. In terms of clinical relevance, the four subtypes did not differ significantly in terms of suicide attempt history. In subtype 1 (reporting the lowest level of SI), fewer attempts were reported, indicating a slight tendency that the other subtypes had higher odds for SB in the past. This is in line with studies showing that both brief and fleeting episodes of SI (Wilcox et al., 2010) as well as more persistent episodes of SI (Nock et al., 2018) can increase the risk for suicide attempts.

Overall, the results from study 2 were more straightforward. Of the three emerging subtypes distinguished by indicators of past SI and SB, subtypes 1 ("high-stable") and 3 ("low-unstable") resembled the non-stress-responsive and the stress-responsive type, respectively (Bernanke et al., 2017). In line with our hypothesis, subtype 1 ("high-stable") was characterized by higher and more persistent SI in the past as well as more planned and highly lethal SB in comparison to subtype 3 (characterized by lower level of mean SI persisting for shorter time-intervals, and more impulsive SB rated with mixed lethality levels). Moreover, participants in subtype 1 ("high-stable") reported significantly higher depression and SI levels at baseline. Notably, there were no associations between subtypes and trait impulsivity and childhood trauma. Visually, the individual trajectories of SI intensity and persistence assessed during the follow-up intervals did not appear stable. Instead the ratings demonstrated considerable within-person variability in all subtypes, contradicting the trait-like manner of SI variability found by others (Oquendo et al., 2020). Two aspects limit the explanatory power of our findings however. (1) Relying on interview data gathered retrospectively about STBs might have biased the results. (2) Rather than directly assessing SI variability we asked about the usual persistence of suicidal thoughts (ranging from a few seconds to a few days). In our view, the most important finding for clinical practice is the difference

by trend between the subtypes with respect to re-attempts during the 12-month follow-up period: while more participants in subtype 2 ("low-stable") reported single re-attempts, multiple re-attempts were more frequent in subtypes 1 and 3, suggesting a heightened risk for repeated SB in the future. A recent EMA study also demonstrated that SI variability (particularly probability of acute change) predicted suicide attempts two to 4 weeks after hospital discharge (Wang et al., 2021). Our findings imply that in longer follow-up intervals more variable as well as more persistent SI increase the risk for repeated suicide attempts, although the base rate for SB as well as the participation rate at follow-up was considerably higher in the Wang et al. study (2021).

4.1 | Strengths and limitations

The application of an EMA approach in study 1 and the inclusion of prospective data on SB in study 2 are the major strengths of the present examination. However, the length and context of the EMA interval (6-day assessment during inpatient stay) limits the external validity because we might not have captured any stressor-related experiences. Retrospective ratings of STBs might have affected the results in study 2. The absence of physiological markers of stress responsivity or emotional reactivity hinders the full examination of the processes and pathways leading to SB outlined by Bernanke et al. (2017).

In line with recent studies, SI variability in combination with average SI level distinguished suicidal subtypes in psychiatric inpatients with heightened suicide risk (Czyz & King, 2015; Kohler-Forsberg et al., 2017; Oquendo et al., 2020). That said, our findings imply that not all persons experiencing STBs fit easily into one of the two major subtype categories. Pathways to SB might be even more distinct between individuals, and subordinate subtypes with finer nuances should be taken into account as has already been suggested by others (Kleiman et al., 2018). Taken together, the link between trait impulsivity, childhood trauma, SI variability, and SB did not appear in our findings as hypothesized. We can only speculate as to whether this may be due to methodological aspects of the studies or whether it is more a reflection of general controversies, for example, concerning the role of impulsivity. While the association of childhood trauma and the occurrence of STBs has been reported by several studies (Angelakis et al., 2019, Martin et al., 2016), the role trait impulsivity has been controversially debated (Anestis et al., 2014; Paashaus et al., 2021).

Clinically, this implies that the inclusion of features of past or present SI variability in the assessment of STBs might help in evaluating individual suicide risk. Unfortunately, we cannot draw conclusions on the specific pathways and processes leading to the occurrence of SB at this point. Future studies (preferably in larger clinical samples) must be conducted to shed more light on the specific relationships between suicidal subtypes, stress responsivity, clinical variables assessed at state and trait-level and, most importantly, a prospective behavioral outcome.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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