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Predicting suicidal ideation by interpersonal variables, hopelessness and depression in real-time. An ecological momentary assessment study in psychiatric inpatients with depression

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ABSTRACT

Objective: To extend evidence on the short-term variability of passive and active suicidal ideation (SI) and the association with suggested proximal risk factors such as interpersonal variables (perceived burdensomeness [PB], thwarted belongingness [TB], hopelessness, and depression) in real-time.
Methods: This is an observational study using a prospective design applying ecological momentary assessments (EMA). Eligible for study inclusion were inpatients with unipolar depression, current or lifetime suicidal ideation, and fluent German. Over six days, 74 participants rated their momentary level of passive and active SI, PB, TB, depressiveness, and hopelessness up to 10 times per day on smartphones. Data was collected from August 2015 to July 2017. Compliance was excellent (89.7%).
Results: Mean squared successive differences supported temporal instability for all variables. According intra-class correlations, between 25% and 47% of variance was accounted for by within-person variability. Multilevel analysis demonstrated significant positive associations between hopelessness, depressiveness, PB, and TB with passive SI. Prospectively, hopelessness and PB remained predictors of passive SI. For active SI, hopelessness, depression, PB, and TB were significantly associated cross-sectionally. Prospectively, hopelessness, PB, and the interaction PBxTB predicted active SI. All models were controlled for previous level of SI.
Conclusions: This study provides further evidence on the short-term variability of SI in very short time frames implying the need of assessing SI repeatedly in clinical and research settings. The associations between interpersonal variables and passive and active SI were only partial in line with assumptions of the Interpersonal Theory of Suicide. Overall, the effects were small warranting further investigation.
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1. Introduction

The major public health problem and personal tragedy of suicide is accompanied by a lack of empirical evidence regarding the short-term prediction of suicidal ideation (SI) and suicidal behavior (SB) [1], i.e. the processes leading to SI and SB in time frames of hours or days (proximal risk factors) [2,3]. Variables such as depressiveness, hopelessness, rage, anger, anxiety, and sleeping problems were identified as variables elevating suicide risk and increasing SI in the short-term while findings seem to be most robust for depressiveness and hopelessness [4–9].

Yet, a recent meta-analysis has concluded that the prediction of imminent suicide risk has not substantially improved over the past 50 years and pointed out the need of assessing suicidal phenomena repeatedly [3], e.g. because SI has been shown to fluctuate considerably [10,11]. Although it has not been established yet in detail, which factors determine the individuals' transition from suicidal thoughts to suicidal actions, the presence of SI is a major risk factor for the emergence of actual SB. Consequently, understanding the development of SI, the role of proximal risk factors and monitoring its course over time is an important part of suicide prevention. Studies applying ecological momentary

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assessments (EMA) allow examining variables of interest in real time, and in participants' natural environment [12,13] and are a very promising approach in suicide research [1,14].

1.1. The interpersonal theory of suicide

The Interpersonal Theory of Suicide (IPTS) posits two interpersonal factors that lead to suicidal desire: thwarted belongingness (TB) and perceived burdensomeness (PB) [15]. TB describes the unmet need of being socially integrated, and PB reflects the perception of being a burden on others. The sole presence of one of these factors causes passive SI (i.e., having death wishes such as "I wish I was dead."), whereas the simultaneous presence of PB and TB (i.e., a two-way interaction) in connection with hopelessness regarding their decrease is assumed to lead to active SI (i.e., experiencing a desire to engage in suicidal behaviors such as "I want to kill myself.") [16]. TB and PB are assumed to be dynamic and, thus, modifiable cognitive-affective states [15,16]. According available empirical evidence, the strongest support has been found for the effect of PB and for the interaction of PB and TB on SI, while the association between TB and SI showed to be less consistent [17,18]. However, only very few studies have tested the main as well as the interaction effects of PB and TB proposed by the IPTS, have applied prospective designs, or have specifically focused on individuals at elevated risk for suicide [17,18].

1.2. EMA studies on SI

Very few studies have examined SI and its risk factors employing EMA so far [19,20] revealing a predictive effect for negative affective states on SI [6,21,22]. Regarding the short-term variability of SI, Kleiman et al. (2017) have reported substantial variability in SI within a time frame of four to eight hours demonstrating that a considerable amount of variation (33%–47%) in SI is attributable to within-person variance [10]. A preliminary analysis (N = 20) of the present study has also demonstrated considerable fluctuations in SI within an even shorter time frame of 30 min up to two hours [11]. Variables discussed at proximal risk factors (hopelessness, PB, and TB) were as well subject to considerable within-person fluctuation and co-occurred with SI in cross-sectional multi-level analyses. However, in prospective multi-level analyses, neither hopelessness nor PB, or TB predicted short-term changes in SI when controlling for SI at the previous measurement occasion [10]. A recent daily diary study also demonstrated concurrent associations between SI and interpersonal variables and hopelessness and provided initial support for prospective associations between the interaction of interpersonal variables and SI [23].

1.3. Aims

Our study aims to further investigate the short-term variability of SI. In addition, we examined cross-sectional as well as prospective associations between SI and variables suggested as proximal risk factors by the IPTS (i.e. PB and TB, [15]) accounting for well-established risk factors of SI such as depressiveness (i.e. sad mood) and hopelessness [4,6,9]. We conducted an EMA study in a sample of psychiatric inpatients with unipolar depression, where we expected SI to occur frequently [24].

In order to extend current evidence and examine the assumptions of the ITPS more stringently [16,20], we 1) applied a high-frequency sampling scheme (10 signals per day within a time frame of 12 hours), 2) assessed all variables of interest with two items (ensuring reliable assessment) [25], 3) distinguished between passive and active SI, and 4) included the interaction between PB and TB in our analyses.

2. Method

2.1. Procedure

Eligible patients in three German psychiatric hospitals were approached and informed about the study by a research assistant (N = 196). Informed consent was provided by those who were willing to participate (N = 92). Of those, 17 (18%) were excluded because they did not meet the inclusion criteria (i.e. primary diagnosis of unipolar depression, current or life-time SI, age $\geq$18 years, fluent in German). Patients were further excluded if they had a bipolar affective disorder, psychotic symptoms, substance addiction in the past year, or an IQ below 85 according to a language based intelligence test [26]. Four participants from the pilot phase were additionally included in the study resulting in N = 79 patients.

Every participant received 10€ for compensation and additional 40€ if having completed at least 80% of the EMA prompts. All study procedures were approved by the Ethical Review Board of the Medical Faculty of University of Leipzig (No: 388-13-16122013).

2.2. Participants

Five of the included participants (6%) did not finish the EMA assessment due to high strain (n = 3) or unexpectedly early discharge from hospital (n = 2). Thus, data of 74 participants (collected 8/2015 to 7/2017) were analyzed (N = 69 with major depression, N = 5 with dysthymia). Age was between 18 and 85 years (M = 37.6, SD = 14.3), N = 53 (71.6%) of the participants were female and N = 24 (33.8%) reported one or more prior suicide attempts.

2.3. Assessments

2.3.1. Baseline

Participants underwent a structured clinical interview (SCID-I) [27] to ensure diagnosis of depression.

2.3.2. EMA

EMA data collection was conducted via movisensXS [28] on Android smartphones that were lent to the participants. Participants were signaled 10 times per day on six consecutive days; signals occurred randomly between 8:00 a.m. and 7:50 p.m. with a minimum interval of 30 minutes between prompts (i.e. signal-contingent). At every prompt, participants were asked to rate their momentary level of passive (*Life is not worth living for me.; There are more reasons to die than to live for me.*) and active SI (*I think about taking my life., I want to die.*), depression (*I feel sad., . . . downhearted.*), hopelessness (*My future seems dark to me., I might as well give up because there is nothing I can do about making things better for myself.*), PB (*I feel useless., . . . like a burden for others.*), TB (*I feel lonely., . . . like I do not belong.*). Each construct was measured with two items using a 5-point Likert scale (*1 – not at all* to *5 – extremely*) resulting in sum scores (ranging from 2 to 10) with higher values indicating a higher level of the respective construct.

EMA items were taken from existing EMA instruments (e.g., German PANAS-X [29]), selected from relevant self-report instruments considering item-total correlation, item content and wording (e.g., the Interpersonal Needs Questionnaire (INQ) [30,31], the German Beck Hopelessness Scale (BHS) [32], the Paykel Suicide Scale (PSI) [33], the Modified Scale for Suicidal Ideation (MSSI) [34], the German Beck Scale for Suicide Ideation (BSS) [35]), or were newly developed. In a second step, item wording was adjusted to be as brief as possible and to refer to the actual moment. Confirmatory factor analysis on the within-person

covariance matrix supported the factorial validity of the item set with depression, hopelessness, PB, TB, passive and active SI reflecting different latent constructs. Reliabilities were excellent on the person-level ($\omega \geq .90$) and good at the prompt-level ($\omega \geq .70$) for all constructs considered in the analysis. Convergent validity was indicated by positive correlations (all $r \geq .55$) between mean EMA scores and sum scores of self-report questionnaires filled in after the EMA assessment measuring the same construct (i.e., INQ, BHS, BSS and the Rasch-based Depression Screening (DESC) [36]) [25].

2.4. Data analysis

The dataset consisted of 60 (assessments on level 1) * 74 (persons on level 2) = 4,440 observations. Participants completed 89.7% of the EMA assessments on average (Min = 75%, Max = 100%), resulting in 4,295 valid observations. Due to the nested structure of the data, we conducted multilevel analyses using the statistical software HLM [37]. Figures were created by using R, ggplot2 package [38,39].

In a first step, we calculated the intercept-only model for both outcomes (passive and active SI) and intra-class correlations (ICC) as an indicator of the proportion of variance explained by the different levels [40]. To further describe variability across time, we calculated Mean Squared Successive Differences (MSSD). The MSSD is a sum score of the squared differences between two measurement occasions in time series and thus represents point-to-point variability with higher values indicating higher fluctuation [41].

Secondly, we computed a baseline model for both outcome variables. The baseline models contained the time lagged SI (passive or active) at level 1 to account for autocorrelation of SI in all further models. These models were used as reference models to evaluate the incremental value of the level 1 predictors using a *Quasi* R^2 measure indicating the change of the outcome's residual variance when adding the model's level 1 predictors [40,42]. We used the R^2 (S&B) formula [43], as this can be applied to models containing random slopes [44].

Thirdly, two models were fitted for passive SI (model 1 with cross-sectional predictors at level 1, model 2 with time-lagged predictors at level 1) and four for active SI (model 3a and 3b with cross-sectional predictors at level 1, model 4a and 4b with time-lagged predictors at level 1, the latter including the interaction term PBxTB). Besides the recommendation to generally allow random slopes in the model where applicable [45], we conducted deviance tests for all models revealing better fit for the random slopes models in comparison to the more restrictive random intercept model. Yet, because we were primarily interested in the fixed effects, random effects are not reported in the paper besides the estimated percentage of slope coefficients that are positive [40].

All models were estimated by means of restricted maximum likelihood estimation (REML), as our number of level 2 units is relatively small [42] and the predictor variables were person-mean centered in all analyses, as we were particularly interested in within-person relationships [46]. In models 2 and 4, predictors were time lagged to the previous measurement occasion (t-1). In doing so, the last value per day was not lagged to avoid obtaining "between-days" lags. Our analyses were sufficiently powered to detect moderate to large effects on the observational level (level 1) [47].

3. Results

3.1. Short-term variability

Across all assessments, the proportion of SI nonzero ratings was 64.3% for passive SI and 38.9% for active SI. Two participants (3%) did not report any SI and 13 participants (18%) did not report any active SI. ICCs indicate that in hopelessness and passive SI around 25% of the variance is accounted for by within-person variability. For active SI, TB, PB, and depressiveness, between 36% and 47% of variance is due to within-person variability according ICCs (see Table 1). Mean MSSD values illustrate that there was on average considerable moment-to-moment variability in all constructs. Yet, MSSDs showed a wide range, indicating that this variability differed substantially between individuals (see Table 1). In Fig. 1, heat maps visually illustrate individual moment-to-moment variability for SI and the risk factors.

3.2. Multilevel analyses

3.2.1. Outcome passive SI

Depressiveness, hopelessness, PB, and TB are significantly positively associated with passive SI, beyond the effects of time lagged passive SI (model 1). For the majority of participants (71–97%), the associations between predictors in model 1 and passive SI were positive (see ratio of slopes > 0 in Table 2).

In model 2, the levels of hopelessness, PB, and passive SI at t-1 significantly positively predicted passive SI at time t. Contrary to our expectations, time lagged TB and depressiveness did not predict passive SI at time t, which was accompanied by lower ratios of positive slopes (60% for depressiveness and 50% for TB).

3.2.2. Outcome active SI

When considering the main and interaction effects of the interpersonal variables cross-sectionally (model 3a and 3b), depressiveness, hopelessness, TB, and PB were positively significantly associated with active SI (co-occurred). For TB and PB, between 64 and 70% of participants showed positive associations with active SI (see Table 3).

Table 1
Descriptive statistics and variability indices of the EMA scales.

Construct and items	Mean	SD	Min	Max	Mean MSSD	SD MSSD	Min_{MSSD}	Max_{MSSD}	ICC
Depressiveness	5.88	1.81	2.28	9.54	3.58	2.39	.53	12.08	0.53
Perceived burdensomeness	5.41	2.08	2.12	9.78	2.60	1.89	.15	8.47	0.66
Thwarted belongingness	5.13	1.95	2.02	9.87	3.52	2.62	.03	11.79	0.57
Hopelessness	5.50	2.25	2.02	9.97	2.00	1.58	.03	6.71	0.74
Passive suicidal ideation	4.54	2.25	2.00	9.64	1.95	2.02	.00	9.05	0.75
Active suicidal ideation	3.18	1.50	2.00	8.06	1.39	2.10	.00	12.83	0.64

Note: SD = standard deviation, Min = minimum, Max, = maximum, MSSD = mean squared successive difference, ICC = intraclass correlation; all constructs were measured with two items resulting in a sum score from 2 to 10;
Data in this table was presented in Forkmann et al. (in press)[25], as part of a large psychometric analysis of the EMA item set used in this study.

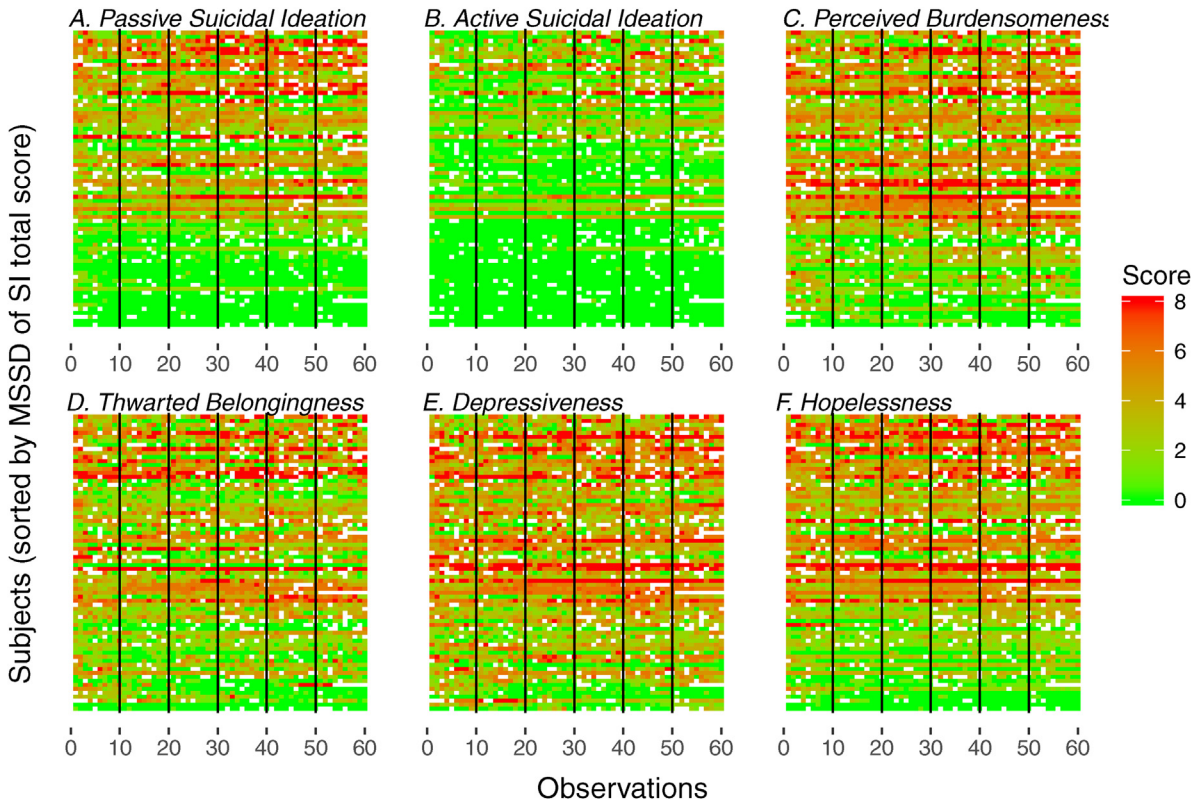

Fig. 1. Heat maps of momentary ratings of suicidal ideation and risk factors across observations and participants.
Note: The ratings of momentary SI and the considered risk factors are coded by color. Green (light gray) indicates low and red (dark gray) indicates high momentary levels of the respective construct. Missing observations are not colored.
In each heat map, one row represents one participant and each square represents one momentary rating (interval between ratings ranged from 30 minutes to few hours). On the x-axis, vertical lines separate the days (day 1 to 6) of the assessment. On the y-axis, participants are sorted by their MSSD in overall suicidal ideation (including passive and active suicidal ideation) with higher MSSD values in the upper part of the heat maps and lower MSSD values in the lower part. In Fig. 1A and 1B (passive and active suicidal ideation), the lower part of the figures is dominated by green (light gray), indicating the absences or very low levels of suicidal ideation. For active suicidal ideation, yellow (middle gray) and red shades (dark gray) are rare in comparison with the other variables. With this exception, the momentary ratings of all depicted variables varied within participants and across time as indicated by color changes within rows.

In the prospective models 4a and 4b, TB did not predict active SI, while hopelessness, PB, and the interaction of PB and TB at t-1 significantly predicted active SI (see Table 3).

4. Discussion

4.1. Short-term variability of SI

The results further demonstrated that SI as well as the risk factors under study (i.e., PB, TB, hopelessness, and depressiveness) are subject to considerable within-person variability over short time periods [10,11]. It is noteworthy that these fluctuations appeared in very short time frames (i.e., intervals of 30 minutes up to few hours) in our study. This finding clearly supports the necessity of assessing SI repeatedly and in real-time to obtain ecologically valid insights in the onset and course of SI [1,14].

4.2. Real-time associations between SI and interpersonal variables

As expected, according to the IPTS [16] and previous evidence from other, mostly cross-sectional, studies [17,18], PB and TB showed positive concurrent associations with passive SI beyond the effect of hopelessness and depressiveness, generally supporting the pathway to passive SI specified in the IPTS. Yet in the prospective analyses, we found an association between PB and passive SI only. For active SI, a different picture emerged: PB, TB, depressiveness, and hopelessness co-occurred with active SI, while the interaction term of PB and TB was not significant in the cross-sectional model. Interestingly, hopelessness and PB as well as the interaction term significantly predicted active SI prospectively (models 4a and 4b). The effect of the interaction appeared to be small, which is in line with meta-analytic evidence from cross-sectional studies showing that the effect of the two-way interaction between PB and TB is relatively weak in comparison to the mostly moderately sized main effects of PB and TB [18]. Additional support for the concurrent and prospective value of the interaction between PB and TB was provided by a recent daily diary study [23]. Hence, the divergence between cross-sectional and prospective analysis in our study might be a result of the limited power to detect small effects and the lower base rate of active SI (compared to passive SI) in the investigated sample.

The finding that PB seems to be a more valid predictor for SI than TB is well-known from a number of previous studies with cross-sectional designs [48–52] and is also in line with meta-analytic evidence showing that PB is a more robust prospective predictor of suicidal thoughts [18]. Using an EMA approach, Kleiman et al. [10] have found concurrent associations between the interpersonal variables, hopelessness, and SI, but could not demonstrate any prospective associations when accounting for the autocorrelation of SI., Our study further supports initial evidence for the prospective value of the interpersonal variables [23] and provides partial evidence for the assumptions of the IPTS employing prospective analysis (especially regarding the link between PB and SI). The rather small effects found in our study, however, cast doubt on the clinical utility of the results as has been

Table 2
Parameter estimates for multilevel models with passive suicidal ideation as outcome variable (models 1 and 2).

	Fixed effects					Random effects
Model	Est.	95% CI (Est.)	SE	t(df)	p	Slopes > 0[1]
Predictors						
Baseline model						
Intercept	2.52	2.01–3.03	0.26	9.72(73)	<.001	
Passive suicidal ideation (t-1)	0.40	.34–.46	0.03	13.54(73)	<.001	98%
Model 1						
Intercept	2.52	2.01–3.03	0.26	9.72(73)	<.001	
Depressiveness	0.07	.03–.11	0.02	3.68(73)	<.001	73%
Hopelessness	0.41	.35–.47	0.03	13.49(73)	<.001	97%
PB	0.09	.05–.13	0.02	3.68(73)	<.001	72%
TB	0.04	.00–.08	0.02	2.51(73)	.014	71%
Passive suicidal ideation (t-1)	0.15	.11–.19	0.02	7.04(73)	<.001	88%
Quasi R^2: Predictors of model 1 account for 9.8% of residual variance in passive suicidal ideation at level 1[2]						
Model 2						
Intercept	2.52	2.07–2.97	0.23	9.72(73)	<.001	
Depressiveness (t-1)	0.03	−.01–.07	0.02	1.31(73)	.195	60%
Hopelessness (t-1)	0.08	.02–.14	0.03	2.79(73)	.007	73%
PB (t-1)	0.09	.03–.15	0.03	3.41(73)	.001	73%
TB (t-1)	0.00	−.03–.04	0.02	−0.01(73)	.990	50%
Passive suicidal ideation(t-1)	0.26	.20–.32	0.03	7.88(73)	<.001	92%
Quasi R^2: Predictors of model 2 account for 1.4% of residual variance in passive suicidal ideation at level 1[2]						

Notes: N (Level 2) = 74. N (Level 1) = 4295. All level-1 predictors were person-mean centered. Est. = Estimate (unstandardized regression coefficient). 95% CI (Est.) = 95% confidence interval for Est. SE = standard error. [1] Based on the assumptions of normally distributed slope coefficients, this value indicates the estimated percentage of slope coefficients that are positive[36].
[2]Quasi R^2 indicates the change of the residual variance in passive suicidal ideation when adding the models' level 1 predictors compared to the baseline models[40].

previously discussed [3,18] and point out that the postulates of the IPTS might not fully capture the variety of individual influences and trajectories of SI.

4.3. Real-time associations between hopelessness, depression, and SI

Notably, hopelessness had the most robust and largest effect on SI across all cross-sectional and prospective models. The importance of hopelessness as a risk factor for suicidality (especially for SI) has previously been demonstrated in a multitude of studies assessing hopelessness via questionnaires [7,8,53,54]. For state hopelessness assessed in real-time, findings are inconclusive: While Kleiman et al. [11] found hopelessness being associated with concurrent and subsequent SI (which did not hold when controlling for preceding SI, however), others [6] could not detect a relation between hopelessness and subsequent SI (when accounting for preceding SI). Despite the specific role of hopelessness *about* PB and TB in the IPTS [16], this aspect has been fairly neglected by the majority of studies examining the IPTS including our own [18]. In light of the relevance of general hopelessness in our results we would strongly recommend to include hopelessness regarding the changeability of PB and TB in future investigations. The effect of depressiveness on SI was less robust in our study: While depressiveness was associated with SI in all our cross-sectional analyses, it had no predictive effect in the prospective analyses contradicting previous studies [6,55]. However, these studies slightly differed from ours in terms of methodology (items, EMA assessment).

4.4. Strengths and limitations

To the best of our knowledge, this is the first EMA-study that distinguishes between passive and active SI, allowing for empirically testing specific IPTS assumptions [10,16,18]. Besides other notable strengths (excellent compliance, assessing all variables with two reliable and valid EMA items [25]), our findings should be considered in the context of several limitations. We examined a rather homogeneous sample of depressed inpatients, and active SI was reported by 61 of 74 participants (82%). Moreover, only 46.7% of eligible inpatients consented to participate in the study further limiting the generalizability of our findings. While our findings can be integrated in the available empirical evidence on short-term variability of SI and its risk factors [19,20,23] and the IPTS [10,18,23], further research in other clinical and non-clinical populations is needed to underpin the generaliziability of the findings. Although suicide research needs new and objective ways of measuring suicide risk (e.g., indirect measures of suicide-related variables as well as behavioral proxies [1,18]), we only used self-reports. Because data on the temporal course of SI and its risk factors is still scarce [19,20], it is also unclear if our sampling strategy fits the dynamics of its natural course [12,56]. Moreover, it remains unclear whether a satisfactory operationalization of the IPTS constructs has already been attained by the available instruments and items such as the INQ [31]. While, overall, our EMA items showed good reliability and convergent validity with the commonly used INQ [25], psychometric limitations of this operationalization apply to our study as well potentially limiting the ability to draw conclusions on the validity of the IPTS [18].

4.5. Conclusion

One of the strongest clinical implications of this study is the need to assess SI and its risk factors repeatedly in short time frames of hours and days (as has been recommended before) [1,14]). Future studies might extend observations to longer periods of several weeks to gain more insight in the individual occurrence, course, and decline of SI [25,56]. Although we could identify variables that predicted changes in SI prospectively, the effects generally appear to be small and only partially in line with

Table 3
Parameter estimates for multilevel models with active suicidal ideation as outcome variable (models 3 and 4).

	Fixed effects					Random effects
Model Predictors	Est.	95% CI (Est.)	SE	t(df)	p	Slopes > 0[1]
Baseline model						
Intercept	1.16	.83–1.49	0.17	6.76(73)	<.001	
Active suicidal ideation (t-1)	0.39	.31–.47	0.04	10.19(73)	<.001	95%
Model 3a						
Intercept	1.16	.83–1.49	0.17	6.76(73)	<.001	
Depressiveness	0.09	.05–.13	0.02	5.19(73)	<.001	79%
Hopelessness	0.14	.10–.18	0.02	5.77(73)	<.001	81%
PB	0.05	.01–.09	0.02	2.76(73)	.007	70%
TB	0.03	−.01–.07	0.02	2.02(73)	.047	64%
Active suicidal ideation (t-1)	0.24	.18–.30	0.03	7.18(73)	<.001	88%
Quasi R^2: Predictors of model 3 account for 8.9% of residual variance in active suicidal ideation at level 1[2]						
Model 3b						
Intercept	1.16	.83–1.49	0.17	6.75(73)	<.001	
Depressiveness	0.09	.05–.13	0.02	5.42(73)	<.001	79%
Hopelessness	0.14	.10–.18	0.02	5.70(73)	<.001	80%
PB	0.03	−.03–.09	0.03	1.01(73)	.283	57%
TB	0.02	−.02–.06	0.02	0.80(73)	.428	56%
PBxTB	0.01	−.01–.03	0.01	1.42(73)	.159	59%
Active suicidal ideation (t-1)	0.23	.15–.31	0.04	6.70(73)	<.001	86%
Quasi R^2: Predictors of model 4 account for 9.2 % of residual variance in active suicidal ideation at level 1[2]						
Model 4a						
Intercept	1.16	.83–1.49	0.17	6.76(73)	<.001	
Depressiveness (t-1)	0.01	−.01–.03	0.01	1.00(73)	.321	62%
Hopelessness (t-1)	0.05	.01–.09	0.02	2.28(73)	.025	67%
PB (t-1)	0.04	.00–.08	0.02	2.11(73)	.038	65%
TB (t-1)	−0.01	−.03–.01	0.01	−0.77(73)	.444	41%
Active suicidal ideation (t-1)	0.32	.24–.40	0.04	8.84(73)	<.001	93%
Quasi R^2: Predictors of model 5 account for 1.2% of residual variance in active suicidal ideation at level 1[2]						
Model 4b						
Intercept	1.16	.83–1.49	0.17	6.76(71)	<.001	
Depressiveness (t-1)	0.01	−.01–.03	0.01	1.18(73)	.242	62%
Hopelessness (t-1)	0.05	.01–.09	0.02	2.38(73)	.020	68%
PB (t-1)	−0.01	−.05–.03	0.02	−0.28(73)	.781	48%
TB (t-1)	−0.06	−.10–(−.02)	0.02	−2.78(73)	.007	28%
PBxTB (t-1)	0.01	.01–.01	0.00	2.61(73)	.011	70%
Active suicidal ideation (t-1)	0.32	.24–.40	0.04	8.50(73)	<.001	92%
Quasi R^2: Predictors of model 6 account for 1.7% of residual variance in active suicidal ideation at level 1[2]						

Notes: N (Level 2) = 74. N (Level 1) = 4295. All level-1 predictors were person-mean centered. Est. = Estimate (unstandardized regression coefficient). 95% CI (Est.) = 95% confidence interval for Est. SE = standard error.
[1]Based on the assumptions of normally distributed slope coefficients, this value indicates the estimated percentage of slope coefficients that are positive.[36]
[2]Quasi R^2 indicates the change of the residual variance in active suicidal ideation when adding the models' level 1 predictors compared to the baseline models.[40]

theoretical assumptions warranting further investigation. It might be useful to focus specifically on person-level or cross-level effects or to conduct subgroup analyses (i.e., differentiate between persons experiencing passive and active SI or persons with and without suicide attempt history). Because of the low base rate of persons experiencing active SI and with a history of suicide attempt(s), such analyses were not possible in our study for reasons of power. More complex models such as the Integrated Motivational-Volitional model of suicidal behavior [57] that include more variables that serve as moderator or mediator in the development of SB might also lead to larger effects because of the combination of several predictors.

Potential conflicts of interest

None.

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