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# CLINICAL PSYCHOLOGY IN EUROPE

The Official Academic Journal of the European Association of Clinical Psychology and Psychological Treatment

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Editorial

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# EACLIPT Statement on the Importance of Science and Evidence-Based Treatment for Mental Health

Chantal Martin-Soelch[1], Claudi Bockting[2,3,4], Josefien Breedvelt[5], Lisbeth Frostholm[6,7], Nina Heinrichs[8], Colette Hirsch[9], Agnieszka Popiel[10], Winfried Rief[11]

**[1]** *Department of Psychology, University of Fribourg, Fribourg, Switzerland.* **[2]** *AmsterdamUMC, Department of Psychiatry, Amsterdam Public Health, University of Amsterdam, Amsterdam, The Netherlands.* **[3]** *The Centre for Urban Mental Health, University of Amsterdam, Amsterdam, The Netherlands.* **[4]** *Institute for Advanced Study, University of Amsterdam, Amsterdam, The Netherlands.* **[5]** *Department of Child and Adolescent Psychiatry, Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, United Kingdom.* **[6]** *Department of Clinical Medicine, Aarhus University, Aarhus, Denmark.* **[7]** *Department of Functional Disorders, Aarhus University Hospital, Aarhus, Denmark.* **[8]** *Department of Psychology, Bielefeld University, Bielefeld, Germany.* **[9]** *Department of Psychology, King's College London, London, United Kingdom.* **[10]** *Institute of Psychology, SWPS University, Warsaw, Poland.* **[11]** *Department of Clinical Psychology and Psychotherapy, University of Marburg, Marburg, Germany.*

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**Corresponding Author:** Chantal Martin-Soelch, University of Fribourg, Department of Psychology, Rue P.-A.-de-Faucigny 2, 1700 Fribourg, Switzerland. Phone: +41 26 300 7687. E-mail: chantal.martinsoelch@unifr.ch

The European Association for Clinical Psychology and psychological treatment (EACLIPT) expresses deep concern regarding current trends concerning science, evidence-based treatment, and the potential threats to mental health.

Recent developments have highlighted a troubling trend of undermining and censuring scientific research and evidence-based practices and propagating false information in medical and psychological care. This shift poses significant risks to the well-being of individuals who rely on scientifically validated treatments for their mental health conditions.

It is crucial to ensure that mental health care remains grounded in rigorous scientific evidence to provide the best possible outcomes for those in need.

The spread of false or misleading information can undermine public trust in legitimate medical research and treatments, leading individuals to seek unproven or harmful alternatives. This is especially concerning for mental disorders, where the complexity of conditions and treatments already makes it challenging to identify solid, evidence-based

research. Disinformation can exacerbate these difficulties, creating confusion and skepticism around scientifically validated therapies. Consequently, patients may struggle to access effective care, and healthcare providers may face increased barriers in delivering accurate information and support. Combating disinformation requires robust efforts to promote media literacy, enhance transparency in research, and ensure that credible sources are easily accessible to the public.

We are also deeply concerned about the impact of the current geopolitical situation worldwide on the mental health of individuals. The heightened political tensions, divisive rhetoric, armed conflicts and climate changes have created an environment of uncertainty and stress, which can exacerbate mental health issues.

We call for a renewed commitment to science and the well-being of individuals affected by mental health issues. Together, we can ensure that mental health care remains effective, compassionate, and grounded in the best available evidence. EACLIPT stands in solidarity with mental health professionals and advocates who are working tirelessly to protect and promote evidence-based practices.

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Research Articles

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# The Effect of Depression and Hopelessness on Suicidal Risk in Young People: The Mediating Role of Impulsivity

Anyerson Stiths Gómez-Tabares[1], Olber Eduardo Arango-Tobón[1], César Núñez[2,3], Gastón Adolfo Zapata Lesmes[4]

**[1]** *Faculty of Social Sciences, Health and Wellness, Universidad Católica Luis Amigó, Medellín, Colombia.* **[2]** *Psychology Program, Faculty of Social and Human Sciences, Universidad de Medellín, Medellín, Colombia.* **[3]** *Corporación APICSA, Medellín, Colombia.* **[4]** *Faculty of Social Sciences, Health and Wellness, Universidad Católica Luis Amigó, Manizales, Colombia.*

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**Corresponding Author:** Anyerson Stiths Gómez-Tabares, Faculty of Social Sciences, Health and Wellness, Psychology Program, Universidad Católica Luis Amigó, Tv. 51a #67B 90, Colombia, Medellín, Antioquia. Postal Code 050034. Phone: +57 (604) 4487666. E-mail: anyerspn.gomezta@amigo.edu.co

**Supplementary Materials:** Materials [see Index of Supplementary Materials]

## Abstract

**Background:** Previous studies have documented that depression and hopelessness predict higher suicide risk in young people. However, the psychological mechanisms that may mediate these associations are unknown. The aim of this study was to analyze the effects of depression, hopelessness, and impulsivity on suicidal attempts and risk, and to explore the mediating role of impulsivity in these associations.

**Method:** A total of 1,645 young people participated with a mean age of 21.604 years (*SD* = 3.22) (68.8% female and 31.2% male). A sociodemographic form was applied to explore suicide attempts in the last year (SA), the Plutchik Suicide Risk (SR), Beck Hopelessness (BHS), Barratt Impulsivity (BIS), and Beck Depression Inventory (BDI) scales. Direct correlations were found among BHS, BDI, BIS, SA, and SR.

**Results:** The binary regression model showed that the variables BHS, BDI, and BIS explained between 33% and 49% of the variance of suicidal risk and 16% of the variance of suicide attempts. Structural equation analysis showed that impulsivity mediated the associations between depression, hopelessness, and suicidal risk, on the one hand, and mediated the associations between depression and suicide attempt, on the other hand, whose total direct and indirect effects were statistically significant.

**Conclusion:** The findings emphasize the importance of impulsivity as the mechanism influencing interactions between mood indicators and suicidal behavior in young populations.

## Keywords

suicide, impulsivity, depression, emotions, risk

### Highlights

- Depression and hopelessness have been identified as significant predictors of suicidal behavior in young people.
- The effect of depression and hopelessness on suicidal behavior is mediated by impulsivity.
- The effect of depression, hopelessness, and impulsivity on suicidal behavior showed invariance by sex (male/female).

According to the Global Health Estimates Report (WHO, 2021), suicide is the fourth leading cause of death worldwide in young people aged 15-19 years. Previous attempts have been reported to be the most important risk factor for suicide in the general population. According to the Institute of Legal and Forensic Medicine in Colombia 2,952 suicides were registered, and the annual rate corresponds to 6,16 cases per 100,000 inhabitants in 2022 (National Institute of Legal Medicine and Forensic Sciences, 2023).

Several current systematic reviews have identified a broad set of risk factors associated with suicide, including social isolation, mental disorders, alcohol abuse, family-related events, information processing styles, and deficits in neuropsychological functions (Ati et al., 2021; González Sancho & Picado Cortés, 2020; Hernández-Bello et al., 2020). Nevertheless, the role of personality factors, such as impulsivity, remains under investigation. The current evidence is inconsistent regarding the mediating role of impulsivity among depression, hopelessness, suicide attempts, and suicidal behavior.

Research on cognitive processing has found that hopelessness plays an important role in suicidal risk and behavior and has a mediating role between depressive symptoms and suicide attempts in adults and youth (Choi & Shin, 2023; Dat et al., 2021).

Horwitz et al. (2017) found that hopelessness is a longitudinal predictor of depression in youth at high suicidal risk. Their study suggests that lack of positive expectations is the most significant predictor of depression and future suicidal behavior, as hopelessness magnifies depressive symptoms, which in turn increases the likelihood of suicide, especially when combined with loss of social connectedness and loneliness.

Indeed, negative circumstances related to stressors in various roles, such as family conflicts, lack of support networks, or social pressure, can influence the development of suicidal ideation (Dutton et al., 2013; Puzia et al., 2014). These factors align with Joiner's (2005) theory, which posits that the perception of being a burden to others (e.g., family,

friends, or society) is associated with both an increased risk of suicide and the acquired capability for suicide.

In this context, path analyses proposed by Dat et al. (2021) in a sample of 322 young college students demonstrated that hopelessness functions as a mediator of the effect of self-esteem and social anxiety, intensifying depressive symptoms and suicidal ideation. Additional studies have indicated that hopelessness is a predictor of depression (Choi & Shin, 2023), and both psychological factors would strongly predict suicidal risk in young populations (Gómez-Tabares et al., 2024; Núñez et al., 2023).

Some studies have approached risk factors from a direct effect and mediation approach to suicidal behavior, noting the importance of recognizing the interaction of these elements in the mechanism that predicts suicide. Similarly, Wang et al. (2015) found that hopelessness, depression, and impulsivity contribute significantly to the development of suicidal risk and behavior, but such contribution depends on how these factors interact with each other. In their study, they concluded that hopelessness mediated by the severity of depression has an indirect effect on suicidal ideation because hopelessness is not a direct cause of suicidal behavior and only gains strength when mediated by depressive symptomatology. This mechanism of direct and indirect effects is dependent on high or moderate levels of impulsivity in patients with depression since these patients with greater impulsivity are more likely to increase suicide attempts and display suicidal behavior in general.

Therefore, an important construct in the interaction of suicide risk factors is impulsivity. Current evidence suggests that impulsivity is a significant component of suicidal behavior and plays an important role in the transition from suicidal ideation to suicide attempt (Beach et al., 2022; Cole et al., 2019). Zhang et al. (2022), in a community sample of 480 college students, examined the effect of impulsivity on suicidal ideation by depression. The results indicated that impulsivity had an indirect but mediating effect on depression and concluded that the higher the students' impulsivity, the stronger the predictive effect of depression on suicidal ideation.

Other studies indicate that people with higher impulsivity scores report significantly more suicide attempts than patients with lower impulsivity scores (Mann et al., 1999). However, in a meta-analysis conducted by Anestis et al. (2014), the central role of impulsivity in suicide attempts and risk is questioned, noting that impulsivity is a distal risk factor that modulates the effect of more direct factors such as precipitating experiences that increase suicide in individuals.

Literature has indicated that depression and hopelessness may interact with impulsivity to generate an increased risk for suicidal attempts and behaviors (Arango-Tobón et al., 2021; Dumais et al., 2005; Swann et al., 2008). Arango-Tobón et al. (2021) points out that impulsivity is a mediator between depression and suicidal behavior and acts as a trigger and determinant of suicide in young people.

Given the above, further evidence on the mediating role of impulsivity between depression and hopelessness may generate better assessment processes for the identification of suicidal behaviors and better ways to intervene early in short-term suicide risk indicators during youth. The present study aimed to explore whether impulsivity plays a mediating role between depression and hopelessness concerning suicide attempts and risk. We hypothesized that 1) Both depression and hopelessness have significant direct effects on suicide attempts and risk, but 2) Impulsivity as a mediator between depression and hopelessness amplifies their direct or indirect effects on suicide attempts and risk in young people.

# Method

## Participants

A stratified random probability sampling by academic semesters from three private universities in Manizales and Medellín (Colombia) was used. A total of 2,580 students were invited to participate voluntarily in this study. A total 935 people did not participate in the study for the following reasons: minors (<18 years of age) who did not provide informed parental consent ($n$ = 92), were absent on the day of data collection, or did not want to participate in the study ($n$ = 175), did not complete all the questionnaires administered or left more than five items in a row unanswered in one or more instruments ($n$ = 668).

The main inclusion criterion is that they were young people between the ages of 18 and 30 since the highest suicide rates in Colombia occur among young people aged 18 and 19 (10.43 per 100,000 inhabitants), 20 to 24 (9.98 per 100,000 inhabitants) and 25 to 29 (8.16 per 100,000 inhabitants) (Instituto Nacional de Salud, 2023). In addition, the highest incidence of suicide attempts also occurs in the young population and has increased systematically in the last five years in the cities of Manizales and Medellin, Colombia. Furthermore, the highest incidence of suicide attempts is observed in the young population, with a notable increase over the past five years in the cities of Manizales and Medellín, Colombia.

The final sample consisted of 1,645 young people attending three private universities in two Colombian cities, Manizales ($n$ = 992, 60.3%), and Medellín ($n$ = 653, 39.7%). In terms of sex, 1,131 were women (68.8%) and 514 were men (31.2%). The mean age was 21.604 years ($SD$ = 3.22). Regarding the socioeconomic level, 24.4% belonged to the lower level, 65.5% to the middle level, and 10.2% to the upper level. 62.2% reported not having a partner, 30.9% reported having a partner relationship, 3.5% lived with their partner, 2.1% were married and 0.9% reported no information. Participants from both cities were from urban areas and did not differ in terms of socioeconomic status ($z$ = -0.894, $p$ = .371).

There were no indigenous or rural populations. The results section describes the mental health indicators of the youth reported from the instruments.

## Instruments

### Ad Hoc Sociodemographic Form

This self-administered form collected data on participants' age, sex, place of residence, socioeconomic status, history of suicide attempts, and number of such attempts. The variable corresponding to suicide attempts was obtained from self-reports of at least one attempt in the past year, assessed using a dichotomous response format (yes/no). Responses were coded numerically, assigning a value of 0 to a no response and 1 to a yes response.

### Plutchik Suicide Risk Scale (SR)

It is a Likert-type instrument designed to assess the risk of suicide attempts (Plutchik & Van Praag, 1989). It includes 15 items, each with dichotomous response options (Yes/No). Affirmative responses are scored with one point, resulting in a maximum score of 15. A score above 6 suggests the presence of suicidal risk (Rubio et al., 1998). The scale is frequently used in research with young population in Colombia (Gómez-Tabares, 2020; Gómez-Tabares et al., 2024; Núñez et al., 2023; Suárez-Colorado et al., 2019), demonstrating internal consistency with Cronbach's alpha values above 0.75. For this study, internal consistency between 0.77 (Cronbach's alpha) and 0.82 (McDonald's Omega) was evidenced. Confirmatory factor analysis (CFA) showed that the scale was a good fit for a unidimensional model of suicide risk (GFI = 0.972, AGFI = 0.960, RMSEA = 0.043).

### Beck Hopelessness Scale (BHS)

It is a screening instrument to detect feelings of hopelessness associated with depression and suicide risk. It was developed by Beck et al. (1974) and consists of 20 dichotomous (true/false) items reflecting cognitive and emotional components of hopelessness. Scores range from 0 to 20, with higher scores indicating greater severity of hopelessness. The scale allows the severity of hopelessness to be classified as minimal (0 to 3), mild (4 to 8), moderate (9 to 14), and severe (15 to 20). Validation studies conducted with the Colombian population report a Cronbach's alpha between 0.82 and 0.93, test-retest reliability coefficients between 0.60 and 0.69 (Rueda-Jaimes et al., 2018), and optimal fit for a unidimensional structure (CFI = 0.99, RMSEA = 0.03) (Pineda-Roa et al., 2024). The internal consistency for this study was .84 (Cronbach's alpha) and .88 (McDonald's Omega). Confirmatory factor analysis was also conducted and indicated that the data were consistent with a unidimensional model (GFI = 0.973, AGFI = 0.964, RMSEA = 0.033).

### Beck Depression Inventory (BDI)

It is a 21-item self-report measure designed to assess the severity of depressive symptoms (Beck et al., 1979). It assesses affective, cognitive, physiological, and behavioral aspects of depression. Each item is scored on a scale of 0 to 3, with a total score ranging from 0 to 63. Higher scores indicate greater severity. The inventory allows the classification of depressive symptoms into minimal (0 to 9), mild (10 to 16), moderate (17 to 29), and severe (30 to 63). Studies conducted with university students in Colombia have shown internal consistency with Cronbach's alpha values between 0.88 and 0.92 (Arango-Tobón et al., 2021; Núñez et al., 2023). In this study, internal consistency was 0.89 (Cronbach's alpha) and 0.91 (McDonald's Omega). Confirmatory factor analysis supported a unidimensional structure with good fit indices (GFI = 0.967, AGFI = 0.959, RMSEA = 0.035).

### Barratt Impulsivity Scale, v. 11 (BIS-11)

This is a self-report Likert-type scale designed to assess impulsivity as a behavioral trait (Patton et al., 1995). The linguistic equivalence of the BIS-11 has been demonstrated for use in Spanish-speaking population (Oquendo et al., 2001). The scale consists of 30 items on a 4-point scale (rarely or never, occasionally, often, and always or almost always). Studies conducted with Colombian adolescent and adult populations have demonstrated acceptable internal consistency for the total scale score, reporting Cronbach's alpha values between 0.75 (Urrego Barbosa et al., 2017) and 0.795 (Chachín Pinzón et al., 2019). Additionally, Stanford et al. (2009) highlighted the use of a score of 74 in psychological studies to identify impulsivity. The internal consistency for this study was 0.75 (Cronbach's alpha) and 0.79 (McDonald's omega). Confirmatory factor analysis supported a unidimensional structure with acceptable goodness-of-fit indices (GFI = 0.943, AGFI = 0.931, RMSEA = 0.040).

## Procedure and Ethical Aspects

The recruitment of participants did not involve any specific clinical criterion and was carried out through the modality of subjects available in the classrooms, according to the stratification by academic semester of three university institutions in the cities of Manizales and Medellin, Colombia. After the application of the informed consent form and on a voluntary basis, the young people filled out the instruments manually with pencil and paper.

The study was approved by the Ethics Committee of the Universidad Católica Luis Amigó and the Corporación Coetika, Manizales, Colombia. It was research without risk for the participants (Resolution 8430 of 1993) and was ethically oriented in Law 1090 of the Colombian College of Psychologists regarding the exercise of research. Law 1266 of 2008; Law 1581 of 2012 and Decree 1377 of 2013 regarding the handling of personal data were taken into account when considering the criteria for the collection, handling, and special protection of personal data and the use of information for academic research

purposes. Although the sampling did not include specific clinical criteria, young people who showed an indicator of suicidal risk according to the Plutchik scale were referred to the University Welfare Service for counseling and psychological support.

## Data Analysis

Data analysis was performed using SPSS version 25.0. First, a descriptive analysis of the socio-demographic characteristics of the sample was carried out. The internal consistency of the instruments was confirmed using Cronbach's alpha and McDonald's omega coefficients. The instruments were also tested for fit to a unidimensional structure from confirmatory factor analysis (CFA) (Byrne, 2016). Descriptive and frequency statistics were calculated for the suicide risk, suicide attempt, depression, hopelessness and impulsivity variables. Kolmogorov-Smirnov and chi-squared ($\chi^2$) tests were used to assess the distribution of the data, which showed that they were not normally distributed.

The Mann-Whitney *U* test was used to compare scores for suicide risk and attempt, depression, hopelessness and impulsivity by sex on the one hand, and suicide risk factor on the other. The *p*-value was reported and effect sizes were calculated for these comparisons. The eta-squared ($\eta^2$) was used as a measure of effect size (small (0.01), medium (0.06) and large (0.14) (Fritz et al., 2012). Spearman's rho was used to assess correlations between the variables of depression, hopelessness and impulsivity and suicide risk and attempt.

Two path analysis models were then developed to estimate the standardized direct and indirect effects between the variables. These models were analyzed using generalized least squares. Bootstrapping with a 95% confidence interval was used to estimate total, direct, and standardized indirect effects (Byrne, 2016).

Model fit was assessed by probability $\chi^2$ ($p \geq .05$), $\chi^2/df$ (values < 3), and additional fit indices including comparative fit index (CFI ≥ 0.90), incremental fit index (IFI ≥ 0.90), Tucker-Lewis index (TLI ≥ 0. 90), goodness of fit index (GFI ≥ 0.90), adjusted goodness of fit index (AGFI ≥ 0.90), normed fit index (NFI ≥ 0.90), and root mean square error of approximation (RMSEA ≤ 0.08) (Byrne, 2016; Schermelleh-Engel et al., 2003). Finally, a multigroup analysis was performed to test the invariance of the structural model between sexes (male/female). The ΔCFI criterion was used to assess model equivalence, with a change equal to or less than 0.01 (ΔCFI ≤ 0.01) supporting invariance (Cheung & Rensvold, 2002). Path and multigroup analyses were performed in Amos v. 24.0 software.

# Results

Regarding the most relevant mental health indicators reported, a suicide risk factor was found in 26.7% of the young people and a history of a previous suicide attempt in 13.2%. It was also found that 36% of the young people reported some symptoms of depression

and 27.2% reported indicators of hopelessness (Supplementary Materials, Table 1). We found that women had higher scores than men in suicidal risk and depression. When assessing the effect size of significant sex differences, a small effect size was identified. No differences were found between men and women in suicide attempts, hopelessness, and impulsivity (Supplementary Materials, Table 2).

A comparative analysis of psychological variables as a function of suicide risk and attempt was performed (see Table 1). The young people who presented a suicide risk factor showed higher scores in depression, hopelessness, and impulsivity compared to the group without risk. Additionally, youth who reported any suicide attempt in the last year presented higher scores in suicidal risk, depression, hopelessness, and impulsivity compared to the group with no history of attempts. All differences were statistically significant ($p < .001$).

**Table 1**

*Differences According to Suicide Risk and Attempt and the Variables of Depression, Hopelessness, and Impulsivity*

| Variable | *M* | *SD* | *AR* | *Mdn* | *M* | *SD* | *AR* | *Mdn* | *z* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Without risk** | | | | **With risk** | | | | **Test statistic** | | |
| Suicide attempt | 1.02 | 0.15 | 734.29 | 1.00 | 1.43 | 0.50 | 1065.93 | 1.00 | -21.385 | < .001 | 0.278 |
| Depression | 6.11 | 5.42 | 666.59 | 5.00 | 17.38 | 9.59 | 1251.35 | 17.00 | -22.136 | < .001 | 0.298 |
| Hopelessness | 2.03 | 2.11 | 705.20 | 2.00 | 5.49 | 4.48 | 1145.60 | 4.00 | -16.872 | < .001 | 0.173 |
| Impulsivity | 47.48 | 12.37 | 715.19 | 46.00 | 59.41 | 13.55 | 1118.25 | 60.00 | -15.237 | < .001 | 0.141 |
| | **Without suicide attempt** | | | | **With suicide attempt** | | | | **Test statistic** | | |
| Suicide risk | 3.08 | 2.46 | 733.72 | 3.0 | 7.76 | 2.23 | 1410.53 | 8.0 | -19.683 | < .001 | 0.236 |
| Depression | 8.12 | 7.64 | 772.63 | 6.0 | 15.70 | 10.24 | 1154.44 | 15.0 | -11.050 | < .001 | 0.074 |
| Hopelessness | 2.68 | 2.99 | 789.14 | 2.0 | 4.80 | 4.48 | 1045.85 | 3.0 | -7.519 | < .001 | 0.034 |
| Impulsivity | 49.52 | 13.23 | 785.47 | 48.0 | 58.29 | 14.65 | 1069.99 | 58.0 | -8.223 | < .001 | 0.041 |

*Note.* *M* = Mean; *SD* = Standard Deviation; *Mdn* = Median; *AR* = Average Range; $\eta^2$ = Eta Square.

Table 2 shows the results of the correlational analysis of the various study variables using Spearman's *Rho* coefficient. Suicide risk and attempt correlated directly and significantly ($p < .001$) with depression, hopelessness, and impulsivity.

Table 3 presents two binary logistic regression models using the input method, in order to identify the role of depression, hopelessness, and impulsivity variables on the variance of suicide risk and attempt. The first model used the suicide risk factor and the second the history of a suicide attempt as a dependent variable. Depression, hopelessness, and impulsivity were the independent variables. Both the first model, as assessed by the Hosmer-Lemeshow test ($\chi^2 = 7.830$, $df = 8$, $p = .750$), and the second model ($\chi^2 = 12.744$, $df = 8$, $p = .521$), presented good indicators of goodness of fit.

**Table 2**

*Spearman Correlation Coefficient (Rho) Between Suicide Risk and Attempt and the Variables of Depression, Hopelessness, and Impulsivity*

| Variable | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Suicide risk | – | 0.485** | 0.679** | 0.461** | 0.474** |
| 2. Suicide attempt | | – | 0.273** | 0.185** | 0.203** |
| 3. Depression | | | – | 0.516** | 0.432** |
| 4. Hopelessness | | | | – | 0.362** |
| 5. Impulsivity | | | | | – |

**$p < .001$.

**Table 3**

*Binary Logistic Regression Analysis: Suicide Risk Factor and Suicide Attempt as Dependent Variables*

| | | | | | | | 95% CI for *OR* | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | **β** | ***SE*** | **$\chi^2$ Wald** | ***df*** | ***p*** | ***OR*** | ***LL*** | ***UL*** |
| **Model 1. Suicide risk factor as a dependent variable** | | | | | | | | |
| Depression | 0.153 | 0.012 | 169.694 | 1 | < .001 | 1.166 | 1.139 | 1.193 |
| Hopelessness | 0.130 | 0.027 | 22.395 | 1 | < .001 | 1.138 | 1.079 | 1.201 |
| Impulsivity | 0.036 | 0.006 | 36.967 | 1 | < .001 | 1.036 | 1.025 | 1.048 |
| **Model 2. Suicide attempt history as a dependent variable** | | | | | | | | |
| Depression | 0.069 | 0.011 | 41.677 | 1 | < .001 | 1.072 | 1.050 | 1.095 |
| Hopelessness | 0.006 | 0.025 | 0.065 | 1 | 0.799 | 1.007 | 0.958 | 1.058 |
| Impulsivity | 0.025 | 0.006 | 16.511 | 1 | < .001 | 1.025 | 1.013 | 1.038 |

The first model showed that the independent variables explained between 33% ($R^2$ Cox and Snell = 0.334) and 49% ($R^2$ Nagelkerke = 0.486) of the suicide risk factor and the second model explained between 8% ($R^2$ Cox and Snell = 0.084) and 16% ($R^2$ Nagelkerke = 0.156) of the variation in a suicide attempt.

The odds ratios (*OR*) show how much the probability of belonging to the suicide risk and attempt categories increases according to the variance of the independent variables. In Model 1, depression, hopelessness, and impulsivity increased the suicide risk factor. For Model 2, depression and impulsivity contributed a significant effect that increased the probability of suicide attempts. Hopelessness did not contribute a significant effect on a suicide attempt.

To establish the total, direct and indirect standardized effects of the independent variables on suicide risk and attempt, two structural equation models were estimated using the generalized least squares method (Byrne, 2016). In the first model, the direct ef-

fect of the dependent variables depression, hopelessness, and impulsivity on suicide risk and suicide attempt was estimated, but it did not yield good goodness-of-fit indicators at the $\chi^2$ probability level and the RMSEA indicator, so the model was re-specified to improve goodness-of-fit indicators and establish patterns of association with mediating variables. In Model 2, impulsivity was used as a mediating variable between depression, hopelessness, suicidal risk, and suicide attempts. Additionally, suicide attempt was placed as a mediator between impulsivity and suicidal risk. This model obtained better goodness-of-fit indicators (see Table 4). Additionally, a sex invariance analysis was performed in order to corroborate whether Model 2 is equivalent between males and females (see Table 4).

**Table 4**

*Goodness-of-Fit Statistics of Structural Models for Predicting Suicide Risk and Suicide Attempt*

| | $\chi^2$ | *df* | $\chi^2/df$ | IFI | CFI | NFI | TLI | GFI | AGFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|
| **Model** | | | | | | | | | | |
| Model 1 | 15.618 | 2 | 7.809 | 0.984 | 0.984 | 0.982 | 0.921 | 0.996 | 0.971 | 0.064 |
| Model 2 | 1.010* | 1 | 1.010 | 1.000 | 1.000 | 0.999 | 1.000 | 0.999 | 0.996 | 0.002 |
| **Invariance by sex (male/female) of Model 2** | | | | | | | | | | |
| Without restrictions | 1.020* | 2 | 0.510 | 1.001 | 1.000 | 0.999 | 1.011 | 0.999 | 0.996 | 0.000 |
| Structural weights | 6.933* | 10 | 0.693 | 1.004 | 1.000 | 0.992 | 1.007 | 0.998 | 0.995 | 0.000 |
| Structural covariance | 8.768* | 13 | 0.674 | 1.005 | 1.000 | 0.990 | 1.008 | 0.998 | 0.995 | 0.000 |
| Structural waste | 10.070* | 16 | 0.629 | 1.007 | 1.000 | 0.988 | 1.009 | 0.998 | 0.995 | 0.000 |

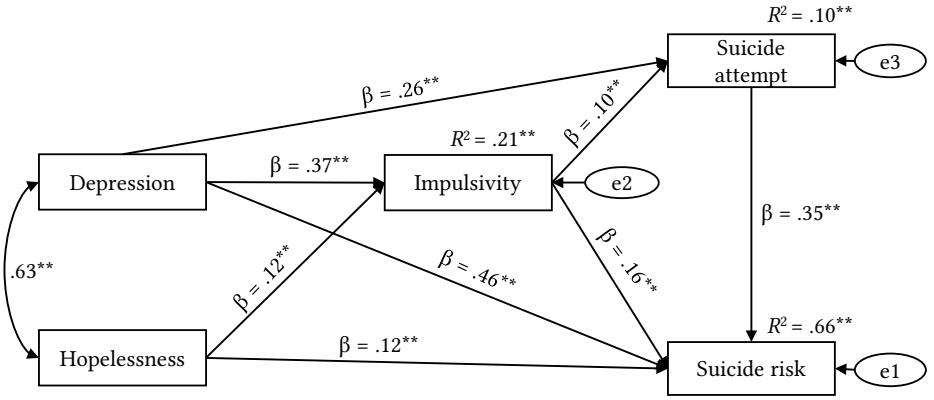
*$p \geq .05$.

Table 4 shows the goodness-of-fit indices of Model 2, with different levels of restriction to assess sex invariance (male/female). When comparing the differences in CFI, values of $\Delta CFI \leq 0.010$ were observed, demonstrating the sex invariance of the proposed model.

Figure 1 shows that the variables: depression, hopelessness, impulsivity, and previous suicide attempt explained 66% ($R^2 = 0.655$, $p < .001$) of the variation in suicidal risk. Depression and impulsivity variables contributed significant effects on suicide attempts ($R^2 = 0.101$, $p < .001$), and depression and hopelessness variables explained 21% ($R^2 = 0.206$, $p < .001$) of the variation in impulsivity. Likewise, it was found that impulsivity mediated the association between depression, hopelessness, and suicidal risk, on the one hand, and mediated the association between depression and suicide attempt, on the other hand, whose total direct and indirect effects were statistically significant ($p < .001$) (see Table 5).

**Figure 1**

*Structural Equation Modeling of Suicide Risk and Attempt and the Mediating Role of Impulsivity*




**$p$ < .001.

**Table 5**

*Standardized Total, Direct and Indirect Effects of Predictor Variables on Response Variables*

| | Impulsivity (Mediator) | | | Suicide attempt (Mediator) | | | Suicide risk | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CI 95% | | | CI 95% | | | CI 95% | |
| **Effect** | **Value β** | ***LL*** | ***UL*** | **Value β** | ***LL*** | ***UL*** | **Value β** | ***LL*** | ***UL*** |
| **Hopelessness** | | | | | | | | | |
| Total | 0.122** | 0.066 | 0.179 | 0.012** | 0.005 | 0.022 | 0.141** | 0.100 | 0.181 |
| Direct | 0.122** | 0.066 | 0.179 | – | – | – | 0.116** | 0.077 | 0.156 |
| Indirect | – | – | – | 0.012** | 0.005 | 0.022 | 0.024** | 0.013 | 0.037 |
| **Depression** | | | | | | | | | |
| Total | 0.367** | 0.311 | 0.420 | 0.297** | 0.241 | 0.351 | 0.621** | 0.582 | 0.659 |
| Direct | 0.367** | 0.311 | 0.420 | 0.260** | 0.199 | 0.320 | 0.458** | 0.416 | 0.499 |
| Indirect | – | – | – | 0.037** | 0.017 | 0.058 | 0.163** | 0.138 | 0.189 |
| **Impulsivity** | | | | | | | | | |
| Total | – | – | – | 0.101** | 0.046 | 0.154 | 0.199** | 0.162 | 0.236 |
| Direct | – | – | – | 0.101** | 0.046 | 0.154 | 0.165** | 0.131 | 0.199 |
| Indirect | – | – | – | – | – | – | 0.035** | 0.016 | 0.054 |
| **Suicide attempt** | | | | | | | | | |
| Total | – | – | – | – | – | – | 0.346** | 0.311 | 0.380 |
| Direct | – | – | – | – | – | – | 0.346** | 0.311 | 0.380 |
| Indirect | – | – | – | – | – | – | – | – | – |

**$p$ < .001.

Table 5 shows the total, direct and indirect standardized effects of the independent, mediating and dependent variables. Depression contributed the largest total effect on impulsivity, suicide attempt, and suicidal risk. Likewise, impulsivity is a mediator between depression and hopelessness, whose indirect effects were significant ($p < .001$). Since all direct and indirect effects are statistically significant, it can be concluded that the mediation effect of the impulsivity and suicide attempt variables is partial.

## Discussion

The aim of the present study was to examine the role of impulsivity relative to depression and hopelessness in suicidal attempts and risk. We hypothesized that 1) depression, hopelessness, and impulsivity have direct effects on suicide risk and attempts, but the mechanism of influence among these predictors may not be the same as when analyzed together, and, therefore, 2) impulsivity may play a mediating role between depression and hopelessness and this role amplifies their direct or indirect effects on suicidal attempts and risk in youth.

According to the results of our study, it is clear that depression, hopelessness, and impulsivity represent significant predictors and have effects on suicidal risk. Regarding our first hypothesis, the analyses suggest that people with greater depressive symptoms, feelings of hopelessness, and impulsivity are at greater risk of attempts and, thus, suicidal risk. These findings are consistent with the results of other studies in which lack of premeditation or difficulties in planning before making decisions, depressive symptoms, and hopelessness have been found to be direct predictors of suicide attempts in young people (Valderrama & Miranda, 2017; Yen et al., 2009).

However, when analyzing the direct effects of depression, hopelessness, and impulsivity on suicidal attempts and risk, the model did not show optimal goodness-of-fit indicators (Model 1, Table 4). These results may indicate that although the existence of different significant predictors of suicidal behavior is clear as suggested by several meta-analyses (Ati et al., 2021; González Sancho & Picado Cortés, 2020; Hernández-Bello et al., 2020), these results may vary when analyzing the mechanisms by which these factors, along with others related to interpersonal functioning, interact (Joiner et al., 2009; O'Connor & Nock, 2014). Specifically, the perception of an inability adequately take responsibility for others, coupled with cognitions associated with dysfunctional affective bonds with other people or the social environment, plays a significant role (Van Orden et al., 2010).

This finding is consistent with Wang et al. (2015), who demonstrated that the interaction between depressive symptoms and impulsivity can significantly predict suicide risk. Furthermore, they found that impulsivity moderated the relationship between depression and suicide risk. In our study, impulsivity showed the strongest clear relationships with suicidal risk ($r = 0.47$) and depression ($r = 0.43$), indicating that people with more severe

depression tend to be more impulsive and have higher suicidal risk. This is consistent with studies that have analyzed risk factors and mediating effects between impulsivity and suicidal risk (Dvorak et al., 2013; Gómez-Tabares et al., 2020).

This mechanism of interaction effects between depressive symptoms, feelings of hopelessness, and impulsivity with respect to suicidal risk and behavior has been addressed in different research (Javdani et al., 2011; Koyama et al., 2020; Liu et al., 2020; Zhang et al., 2022) and indicates that the mediating effect of impulsivity is an important bridge between the relationships of depression and hopelessness. Regarding our second hypothesis, our study confirmed that those participants with higher suicide risk were those in whom depressive symptoms and hopelessness were mediated by impulsivity traits, in other words, impulsivity plays a mediating role between depression and hopelessness, and such a role increases the effect of both predictors on suicide risk.

In addition, it was shown that the proposed model remains invariant when sex differences (male/female) are taken into account, reinforcing the idea that impulsivity is a strong psychological mechanism mediating the interactions between indicators of depression hopelessness, and suicidal behavior in a young population.

Indeed, the results of suicidal ideation have shown significant indirect effects with risk behavior through impulsivity and low desire to live, but not through hopelessness (Smith & Wells, 2023), which leaves an interesting axis of research given that ideation and risk behaviors are associated with each other through impulsivity and desire to live.

Meanwhile, our findings add to the knowledge so far of the mediating effect of impulsivity with respect to depression and hopelessness on suicidal attempts and risk and we can conclude that high levels of trait impulsivity increase the effect of depression and hopelessness on suicidal behavior, which is consistent with empirical evidence from cross-sectional and longitudinal studies where the mediating role of impulsivity on depression and hopelessness has been studied (Arango-Tobón et al., 2021; Wang et al., 2015). On the other hand, we found that impulsivity is also a mediator in the relationships between depression and suicidal attempts, an aspect that is often related to the association of reiterative death ideation and the presence of suicidal attempts (Sohn et al., 2021).

Now, the correlations we found between impulsivity and suicidal intent are low but significant ($r = 0.2$) and may indicate that impulsivity has a direct effect on suicidal intent that consequently generates higher suicide risk in young people. Findings from studies such as that of Zhang et al. (2022) support the conclusion that individuals exhibiting impulsivity traits increase attempts and overall suicidal risk more. Having depressive symptoms and impulsivity traits maximizes the individual or joint effect of depression and hopelessness on suicidal behavior.

Although the data collected allowed us to test the two central hypotheses of our study, it is important to point out some limitations. 1) The cross-sectional design and the unknown predictive validity of the probability of suicide in the sample reduces the

explanatory capacity of our model on the mediating role of impulsivity in populations of young university students. Although there are advances in predictive models related to impulsivity, ideation, and suicidal risk (Beach et al., 2022), new studies that increase the explanatory capacity of statistical models that involve impulsivity as a mediator of suicidal risk are worthwhile. In this regard, it is necessary to consider that the study did not consider specific clinical aspects of physical and mental health as inclusion criteria, which may be expanded for analysis in future studies.

Indeed, as proposed by Joiner (2005), Ma et al. (2016), Baertschi et al. (2017), and Chu et al. (2017), it is also necessary to examine other interpersonal variables to determine whether they moderate or mediate the relationship with suicide risk (Chu et al., 2016; O'Connor & Portzky, 2018). While the study's results show promise in explaining how impulsivity mediates the effect of depression and hopelessness on suicide risk, further exploration of the relationship with interpersonal variables in future studies may enhance the predictive scope for suicidal behavior (Joiner et al., 2009; Puzia et al., 2014).

It is therefore suggested that these findings should be interpreted carefully and that more longitudinal studies are needed to provide predictive evidence of suicide and of the mediating or moderating role of impulsivity. 2) The use of self-report measures to establish depressive symptoms, hopelessness, and impulsivity may represent a bias in the information analyzed since self-reports are based on self-awareness and recall of behavioral patterns related to suicidal attempts and risk. 3) The sample is composed of young university students, and it is not clear that our results can be generalized to other populations, so it is suggested that this study could be replicated in other clinical or non-clinical samples. It would be desirable for future studies to analyze not only trait impulsivity but also impulsivity as a state, in order to analyze the effect that impulsivity as a psychological or neuropsychological characteristic may have on depression and hopelessness. Finally, it is suggested, as proposed by Anvar et al. (2022), to analyze impulsivity in relation to the severity of emotional fluctuation, uncontrollability, dynamic course, and affective and cognitive precursors of suicidal ideation and suicide attempts.

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**Competing Interests:** The authors declare that they have no competing interests.

**Ethics Statement:** The study was approved by the Ethics Committee of the Universidad Católica Luis Amigó (Colombia) in April 2022, through file number 65450. Informed consent was obtained from all participants to participate in this study.

**Reporting Guidelines:** The JARS-Quant guidelines for non-experimental quantitative research were followed in this study.

**Preregistration:** This study is not pre-registered. The study was registered at the Universidad Católica Luis Amigó, Medellín, Colombia [05020299123].

**Data Availability:** Data supporting the conclusions of this study are available upon reasonable request to the corresponding author. Data are not publicly available due to ethical restrictions on informed consent.

## Supplementary Materials

The Supplementary Materials contain the following items (for access, see Gómez-Tabares et al., 2025S):

- Supplementary Table 1: Indicators of mental health events (suicide risk and attempt, depression, hopelessness, and impulsivity)
- Supplementary Table 2: Sex differences in suicide risk and attempt, depression, hopelessness, and impulsivity

### Index of Supplementary Materials

Gómez-Tabares, A. S., Arango-Tobón, O. E., Núñez, C., & Zapata Lesmes, G. A. (2025S). *Supplementary materials to "The effect of depression and hopelessness on suicidal risk in young people: The mediating role of impulsivity"* [Supplementary tables]. PsychOpen GOLD. https://doi.org/10.23668/psycharchives.16212

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# Empirically Informed, Idiographic Networks of Concordant and Discordant Motives: An Experience Sampling Study With Network Analysis in Non-Clinical Participants

Thies Lüdtke [1,2], Fabian Steiner [3], Thomas Berger [3], Stefan Westermann [4]

**[1]** *Department of Human Medicine, MSH Medical School Hamburg, Hamburg, Germany.* **[2]** *Institute of Sustainability Psychology, Leuphana University Lüneburg, Lüneburg, Germany.* **[3]** *Department of Clinical Psychology and Psychotherapy, Institute of Psychology, University of Bern, Bern, Switzerland.* **[4]** *Department of Psychology and Psychotherapy, Witten/Herdecke University, Witten, Germany.*

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**Corresponding Author:** Stefan Westermann, Chair of Clinical Psychology and Psychotherapy, Department of Psychology and Psychotherapy, Witten/Herdecke University, Alfred-Herrhausen-Straße 44, 58455 Witten, Germany. Phone: +49 2302 92 6789. E-mail: Stefan.Westermann@uni-wh.de

**Supplementary Materials:** Materials [see Index of Supplementary Materials]

## Abstract

**Background:** Case formulations and treatment planning mostly rely on self-reports, observations, and third-party reports. We propose that these data sources can be complemented by idiographic networks of motive interactions, which are empirically derived from everyday life using the Experience Sampling Method (ESM). In these networks, positive edges represent concordance of motives whereas negative edges indicate discordance. Based on consistency theory, which states that discordance emerges when the activity of one motive (e.g., 'affiliation') is incompatible with the activity of another motive (e.g., 'autonomy'), we hypothesized that discordance would be associated with subclinical depressive symptoms.

**Method:** Fifty-one undergraduates completed a six-day ESM assessment period with 6 assessments of motive satisfaction per day. Based on the ESM data, idiographic networks of the seven most important motives per person were computed using mlVAR (https://doi.org/10.32614/CRAN.package.mlVAR). We extracted indices of motive dynamics from each person's network, namely the strength of negative edges compared to the overall network

strength as well as the values of the single most negative and positive edges. These indices were then used to predict subclinical depressive symptoms, controlling for overall motive satisfaction.
**Results:** Discordant, conflicting motive relationships made up only 6% of network strengths, indicating high concordance overall. Neither conflict index predicted subclinical depressive symptoms but maximum concordance was associated with lower subclinical depressive symptoms. Motive satisfaction was a significant predictor across models.
**Conclusion:** The applicability and clinical utility of the motive network approach was promising. Insufficient variance due to a healthy sample and the small number of observations limit the interpretability of findings.

## Keywords

consistency theory, approach, avoidance, motive, concordance, conflict

### Highlights

- A novel approach to estimating idiographic networks of motives is introduced.
- Network links between motives indicate discordance (= conflict) or concordance (= compatibility).
- Motive satisfaction and concordance were associated with lower subclinical depressive symptoms.
- Unexpectedly, motive conflicts were not associated with subclinical depressive symptoms.

## Theoretical Background

For decades, therapists have relied on the same data sources for case conceptualization and treatment planning (Eells, 2007), namely questionnaires or clinical interviews, observations (e.g., nonverbal behavior), and information from third parties, such as family members. These data are undoubtedly indispensable but their 'ecological validity', meaning the applicability to real-world situations (Kihlstrom, 2021), can be questioned. One way to supplement traditional methods of case conceptualization is the structured assessment of patients' experiences and behaviors in daily life, a method referred to as the Experience Sampling Method (Larson & Csikszentmihalyi, 2014), which relies on repeated self-report assessments, for example using smartphones. The feasibility of person-specific ESM studies has been demonstrated (Bak et al., 2016; Thonon et al., 2020; Wichers et al., 2016) and the necessary assessment tools (i.e., smartphones) are widely available (VuMa, 2023). Nonetheless, therapists seldom make use of this method beyond paper-pencil diaries in clinical practice, likely due to heavy caseload and lack of financial incentives.

Experience Sampling results in datasets which allow the estimation of both group-based and idiographic (Molenaar, 2004) models. One statistical approach, which is applicable to both types of models, is the so-called network approach (Borgatti et al., 2009),

which has gained popularity within psychological research over the past years (Fried et al., 2017; Robinaugh et al., 2020). In network models, constructs are represented as *nodes* and *edges*. Nodes are the variables of interest, often symptoms (Borsboom, 2017), whereas edges represent statistical relationships between them, computed, for example, as partial correlations. Such networks can take many forms, such as social networks in which nodes represent people (Tabassum et al., 2018) or semantic networks in which nodes represent semantic or lexical units (Christensen & Kenett, 2023). In the present study, nodes represent psychological constructs whereas edges represent the partial correlations between these constructs. One of their major advantages is that networks can be graphically visualized, making them accessible to health professionals and patients alike (Bak et al., 2016). As Bak et al. (2016) phrase it, "discussing ESM results with a patient offers clues as to why and when symptoms vary, given certain stressors and contexts, with clues for protective mechanisms or coping strategies" (p. 8).

Why are ESM-based, idiographic assessments of patients' experiences and behaviors in daily life not already a standard tool for therapists? We argue that – in addition to above-mentioned reasons – the information that is usually assessed in idiographic networks is not useful enough in aiding the conceptualization and individualization of psychotherapy. Although symptom-focused networks help to understand the centrality of certain symptoms and strength of symptom associations (e.g., Beard et al., 2016), they provide limited information about the underlying processes that may have led to their formation or maintenance. Given that psychological interventions are often targeted at mechanisms rather than symptoms (e.g., metacognitive biases; Moritz & Woodward, 2007), symptom networks may have limited clinical utility (current network approaches have other shortcomings, too, such as limited utility in ordinal data, see Borsboom et al., 2021). In line with that, Scholten, Lischetzke, and Glombiewski (2022) recently proposed a combination of functional analytic and experience sampling approaches. Here, we use network theory to assume a motive-focused view that answers questions such as *Does the patient value independence or confirmation by others*, *Does the patient seek intimacy and does she/he receive it*, and most importantly *Do the patient's motivational goals clash*? Against this background (Westermann et al., 2019) we propose that a more instructive source of information for therapists is the interplay of patients' motives in their daily life, particularly when these are in conflict.

The term 'motive' can be conceptualized as an active process that directs attention, cognition, and action (e.g., Schultheiss & Brunstein, 2005). According to Grawe (2004), motives serve as means to satisfy basic needs, such as the need for relatedness or autonomy (Deci & Ryan, 2000), and to protect them from violation. One can distinguish between approach and avoidance motives. Approach motives aim at creating or maintaining appetitive, need-satisfying experiences, such as being liked by others (affiliation). In contrast, avoidance motives are directed towards preventing or ending aversive, need-violating experiences, such as being criticized (self-esteem), that a person wants to avoid

(Coats et al., 1996; Grosse Holtforth, 2008). According to consistency theory, motive satisfaction (i.e., 'congruence'; Grawe, 2004) describes a state in which an approach motive is fulfilled (e.g., experiencing oneself as belonging) or the aversive experience is averted (e.g., avoiding being criticized), whereas motivational incongruence is characterized by the dissatisfaction of one's motive, the latter being associated with mental health issues, such as loneliness (Gable, 2006) or the risk of chronicity of anxiety disorders (Struijs et al., 2018).

When the satisfaction of one motive supports satisfaction of another motive, they are in a concordant relationship with each other. In contrast, a discordant relationship emerges when the satisfaction of one motive reduces the satisfaction of another motive. For example, belonging and being autonomous can be mutually exclusive, as assertive behavior can be accompanied by discontent of others whereas overly cooperative behavior can violate one's self-determination. Such motivational conflicts due to competing motives give rise to what is called 'discordance' within the framework of consistency theory. Discordance, in turn, is hypothesized to function as an 'internal' stressor (similar to cognitive dissonance; Festinger, 1957) that can facilitate the formation and maintenance of psychopathology (Grawe, 2004). In line with this, psychotherapy is accompanied by a reduction of incongruence (e.g., Berking et al., 2003) and psychological conflicts of goals (more broadly defined and not restricted to motives) are inversely associated with psychological well-being (Gray et al., 2017).

We propose that ESM-based measurements of motive satisfaction and conflict are ideally suited to augment established methods of treatment planning because they allow assessing motivational dynamics *in vivo* and in personally relevant situations, unaffected by retrospective recall biases (Ben-Zeev & Young, 2010; Urban et al., 2018). According to our approach, the interplay of motives in daily life can be represented as an idiographic network, in which nodes depict motives and edges constitute concordant (i.e., positive) versus discordant (i.e., negative) relationships between motives, potentially providing information that helps to personalize treatment and improve the therapeutic relationship (Caspar, 1997). Importantly, we propose that motivational conflicts can be empirically assessed even when participants are not able to report those associations in self-reports (e.g., due to a simple lack of explicit representation or due to defense mechanisms in a psychodynamic sense, see Blanco et al., 2023). Table 1 provides an overview of relevant motive-related terms and how they were operationalized in the network methodology.

The clinical utility of motive dynamics is not limited to a certain diagnosis or symptom spectrum (Grosse Holtforth & Grawe, 2004). However, for the first-time validation of the proposed motive network approach, we focus on depressive symptoms. According to the reinforcement theory of depression (Ferster, 1973; Lewinsohn & Graf, 1973; Lewinsohn & Libet, 1972), a low rate of response-contingent positive reinforcement through rewarding activities is a key factor in the development and maintenance of depressive symptoms (Lewinsohn, 1974, p. 151). Within our motive network approach,

**Table 1**

*Motive-Related Terms and Their Network Operationalization*

| Term | Network operationalization |
|---|---|
| Motive | Node |
| (In)congruence | Momentary value of node (0: incongruence, 9: congruence) |
| Motive interaction | Edge |
| Concordant motives (mutualistic interaction of two motives over time) | Positive edge |
| Discordant/conflicting motives (competitive interaction of two motives over time) | Negative edge |
| Concordance / Discordance | Summary statistics of edge weights in the network (e.g., negative edge weights divided by all edge weights; see methods section) |

activities are perceived as rewarding if they satisfy an individual's motives (Brockmeyer et al., 2015), but if the satisfaction of one motive is accompanied by the dissatisfaction of another motive (i.e., motivational discordance), activities may lose their reinforcing properties. Enduring states of conflict due to discordant motives could lead to diminished reinforcement and thus depressive symptoms whereas motivational concordance may be a protective factor.

In sum, we hypothesized that individuals with higher subclinical depressive symptoms would display stronger motive conflicts, operationalized as the proportion of negative edges, as well as the magnitude of the largest negative edge within the individual's network. Relatedly, we hypothesized that concordance, operationalized as the magnitude of the strongest positive edge would be associated with *reduced* subclinical depressive symptoms. We excluded avoidance motives from the analyses because they are empirically associated with psychopathology (Grosse Holtforth, 2008), which may confound analyses.

# Method

## Recruitment

We recruited undergraduate psychology students who were compensated with course credits. Participants were eligible for participation if they were at least 18 years of age

and did not report any mental disorder. The ethics committee of the Faculty of Human Sciences at the University of Bern approved the study (#2016-05-00006).

The present study was part of a larger project (Lüdtke & Westermann, 2023). Sample size considerations were based on recommendations for multilevel modelling (Maas & Hox, 2005) given the nested data structure of repeated measurements within participants. The target sample size was set to $n = 50$ level two cases (i.e., participants) to avoid biased estimates of second-level standard errors (Maas & Hox, 2005). No stopping rule for data collection was applied. Given that our initial power analysis focused on maximizing level two cases, the number of data points within participants (up to 36 assessments) was limited when compared to recommendations for within-person network estimation (Mansueto et al., 2023).

## Procedures

Assessments were conducted between August and November 2016. All participants provided written informed consent prior to participation. The baseline assessment consisted of an online survey as well as a face-to-face meeting. The online survey covered sociodemographic and clinical variables, approach- and avoidance motives, as well as subclinical depressive symptoms (see Baseline Measures section). During the face-to-face meeting, participants received a study smartphone and were instructed to carry it with them for six consecutive days. All functions of the smartphones were disabled except for the ESM survey application 'movisensXS', version 0.8.4211 (movisens GmbH, Germany).

## Measures

### Baseline Measures

The German version of the Depression Anxiety Stress Scales (DASS-21; Nilges & Essau, 2015) was used to measure subclinical depressive symptoms. Participants rated how much each item applied to them over the past week (e.g., "I felt that life was meaningless"), with response options ranging from *not at all* to *very much, or most of the time* on a four-point scale. Internal consistencies ranged from $\alpha = .79$ for the anxiety subscale to $\alpha = .87$ for the depression subscale in the present sample. The DASS-21 can be used both in clinical and non-clinical samples (Antony et al., 1998).

The Inventory of Approach and Avoidance Motivation (IAAM; Grosse Holtforth & Grawe, 2000) measures the importance of motives from *not at all* to *extremely important*. The questionnaire was developed in a 'bottom-up' process based on patients' case formulations (Grosse Holtforth, 2008) covering 14 approach- and nine avoidance motives on 94 items. For approach motives, internal consistencies range from .62 (self-reward) to .90 (affiliation) in psychology students (Grosse Holtforth & Grawe, 2000).

Whereas the IAAM measures motive importance, the incongruence questionnaire (INC; Grosse Holtforth & Grawe, 2003) measures the extent to which motives are

implemented/satisfied in participants' interactions with their environment (recoded to represent the degree of incongruence). Internal consistencies of INC subscales range from .71 to .89 in healthy participants (Grosse Holtforth & Grawe, 2003). For the present study, only approach motives were considered. The short version of the scale (INC-S; Grosse Holtforth & Grawe, 2003) consists of one item per motive and was used in the ESM assessment phase (see ESM Assessments section).

### ESM Assessments

Participants completed six assessments of momentary motive satisfaction per day, for a period of six days, resulting in a maximum of 36 assessments per participant. Entries were defined as missing if they were dismissed, ignored, discontinued, or completed more than 30 minutes after the prompt. Each ESM assessment comprised 36 items. ESM assessments occurred at pseudo-random times between 9:30 a.m. and 9:30 p.m. with a minimum inter-assessment distance of 60 minutes. In addition, we offered the possibility to access the ESM assessment manually in case of a missed prompt. Each ESM assessment took approximately one minute to answer. Participants completed a total of 1,481 assessments, of which 1,406 assessments were prompted by the smartphone (95%), whereas 75 assessments were manually accessed by the participant within 30 minutes after a missed/ignored prompt (5%). Full adherence would have resulted in 36 x 51 = 1,836 datapoints, so 1,481 assessments correspond to 81% adherence. On average, participants responded to a prompt after 301 seconds ($SD$ = 427 seconds, range = 1 to 1761 seconds, Median = 27 seconds). The distribution was skewed with half of the responses occurring within the first 30 seconds after the prompt. Most participants ($n$ = 48; 94%) used the study smartphone for 6 days as intended. After completing the ESM phase, participants returned the study smartphones and completed a debriefing session.

Motive satisfaction was assessed six times per day using the short version of the Incongruence Questionnaire (INC-S; Grosse Holtforth & Grawe, 2003). We made slight adjustments to the INC-S. First, a ten-point Likert scale was administered to allow for a more fine-grained assessment of motive satisfaction while retaining the endpoints of the scale. Second, we adjusted the wording to capture momentary motive satisfaction rather than general motive satisfaction: "*Below you will find a list of different pleasant and unpleasant experiences. Please indicate how sufficiently you have been able to realize the more pleasant ones since the last survey (part 1) and how much the more unpleasant ones apply to you since the last survey (part 2)*" (translated from German). The internal consistency of approach motive satisfaction has been reported as good (.84; Grosse Holtforth & Grawe, 2003) and the correlation between the short and the long version of the INC was high in the present sample ($r$ = .62, $p$ < .001), illustrating the validity of the INC-S in the ESM setting (for both scales, the seven most important motives based on the IAAM were used).

The INC-S was accompanied by a short version of the Positive and Negative Affect Scales (PANAS; Watson et al., 1988), as well as items on the situational context (see Lüdtke & Westermann, 2023). We used only one of the PANAS items in exploratory analyses to examine the effect of momentary motive satisfaction on concurrent sadness, namely "In the present moment, I feel…" with the response options ranging from *unhappy* to *happy* on a seven-point scale.

## Analyses

First, we computed idiographic networks of motive satisfaction separately for each participant. To do so, we identified the seven most important motives that participants endorsed in the IAAM and entered the corresponding INC-S items into a network. Selecting the most important motives per participant ensured that potential motive conflicts were personally relevant and it helped to reduce model complexity (i.e., fewer nodes), which is recommended for low numbers of observations (Mansueto et al., 2023). Conceptually, the resulting networks represented concordant or discordant interactions (i.e., edges) between the satisfaction of idiosyncratically relevant motives (i.e., nodes) within a participant across the ESM period. Hence, a positive edge indicated that the satisfaction of one motive was accompanied by the concomitant satisfaction of another motive, whereas a negative edge indicated that whenever one motive was satisfied, another motive was less satisfied. Network estimation was conducted using the mlVAR package in R, version 0.5.[1] We computed contemporaneous networks, which indicate how the satisfaction of one motive is associated with the satisfaction of another goal at the same time (i.e., partial correlations). The mlVAR package estimates these networks by extracting the residuals of time-lagged temporal models based on non-correlated random effects. Model estimation relied on linear mixed effects (lmer), the contemporaneous network estimation was set to "orthogonal", without prior standardization. Node-specific fit indices provided are presented in the Supplementary Materials.

In the second step of the analysis, we extracted network parameters on motive concordance versus discordance from each model and examined their association with subclinical depressive symptoms on a group level (i.e., between persons). First, we calculated the proportion of negative edges relative to total edge strength in the network, henceforth referred to as *conflict proportion*. To do so, we added up the absolute values of negative edge weights and divided them by the absolute values of all edge weights. The resulting index of discordance can be interpreted as the proportion of conflicting edge strength relative to the overall strength of edges within the network. Additionally, we extracted the strongest negative edge from each network, referred to as *maximum conflict*, as well as the strongest positive edge, referred to as the *maximum concordance*. The ra-

1) CRAN link: http://cran.r-project.org/package=mlVAR Github link (developmental): http://www.github.com/SachaEpskamp/mlVAR

tionale for estimating the *maximum conflict* parameter was that one strong motivational conflict may have detrimental consequences because the conflicting motives cannot both be satisfied at the same time, resulting in over-active motives with ongoing activity and an overall lower level of congruence (e.g., Boudreaux & Ozer, 2013). For example, while autonomy and affiliation are in conflict, the self-esteem motive has fewer opportunities to become satisfied. The rationale for the *maximum concordance* parameter was that one strong concordant relationship between important motives allows for efficient behavior that results in high decreases of incongruence.

Network parameters of motive discordance and concordance were then used to predict subclinical depressive symptoms (DASS-D; Nilges & Essau, 2015) in OLS regression models. Motive satisfaction across the ESM period (INC-S; Grosse Holtforth & Grawe, 2003) was added as a covariate to all models. A check of model assumptions revealed that the outcome was skewed due to a large proportion of participants reporting hardly any subclinical depressive symptoms, and a visual inspection of residuals indicated problems with heteroscedasticity and non-normality. As a log-transformation could not resolve the issue, we resorted to bias-corrected and accelerated (BCa) bootstrap confidence intervals and corresponding *p*-values (based on 5000 samples), which are robust to violations of assumptions, such as non-normality (Field, 2009, p. 163). All tests were two-sided with conventional *p*-values of .05.

Following confirmatory analyses, we conducted an exploratory linear mixed model (LMM) analysis to examine the moment-to-moment effects of motive satisfaction on concurrent mood. LMM allowed us to examine how the level of motive satisfaction, that is (in)congruence, relates to momentary affective states measured concomitantly. Thus, the LMM analyses answered the question whether – within participants – a moment in which motives were more strongly satisfied was associated with better mood as compared to a moment in which motives were less satisfied (and vice versa). LMM analyses account for the clustering of time points nested within individuals (Twisk, 2019, p. 150). The model included a random intercept, and it relied on maximum likelihood estimation. Averaged as well as momentary person-mean-centered motive satisfaction were entered as predictors (a so-called hybrid model; Twisk, 2019, p. 139).

# Results

## Participant Characteristics and Adherence

A priori it was determined that participants with fewer than 12 completed assessments (i.e., 33%) would be excluded from analyses. Out of $n = 55$ participants, four (7%) completed less than 12 timely ESM assessments, leaving $n = 51$ participants. Baseline characteristics are presented in Table 2.

**Table 2**

*Baseline Characteristics (n = 51)*

| Baseline Characteristic | |
|---|---|
| Age; *M* (*SD*) | 21.8 (2.1) |
| Gender; female/male | 45/6 |
| Years of education; *M* (*SD*) | 14.3 (1.8) |
| DASS-21-D; *M* (*SD*) | 1.6 (0.6) |

*Note.* DASS-21-D = DASS-21 depression subscale.

## Importance, Satisfaction and Conflict of Motives

The motives that were most often represented in the idiographic networks were 'confidence' and 'variety' (both part of 43 idiographic networks; 78%), followed by 'intimacy' (76%), 'autonomy' (65%), and 'self-reward' (64%). The 'status' goal was the least prominent, as it was represented only in one idiographic network (2%). The mean-ratings in the IAAM support the importance of the aforementioned motives, with 'self-confidence' receiving the highest average rating ($M$ = 4.28 on the 5-point scale, $SD$ = 0.51), followed by 'autonomy' ($M$ = 4.21, $SD$ = 0.53) and 'intimacy' ($M$ = 4.20, $SD$ = 0.65), whereas 'status' received the lowest rating ($M$ = 2.47, $SD$ = 0.56). Across the ESM period, the motive with the highest grand-mean satisfaction was autonomy ($M$ = 7.18 on the 10-point scale, $SD$ = 1.95), followed by control ($M$ = 7.03, $SD$ = 1.87). However, a variance component analysis ('null model') revealed that participants differed significantly in terms of motive satisfaction across the ESM-period (Wald Z tests: $p$'s < .001). Figure 1 depicts four exemplary idiographic motive networks.

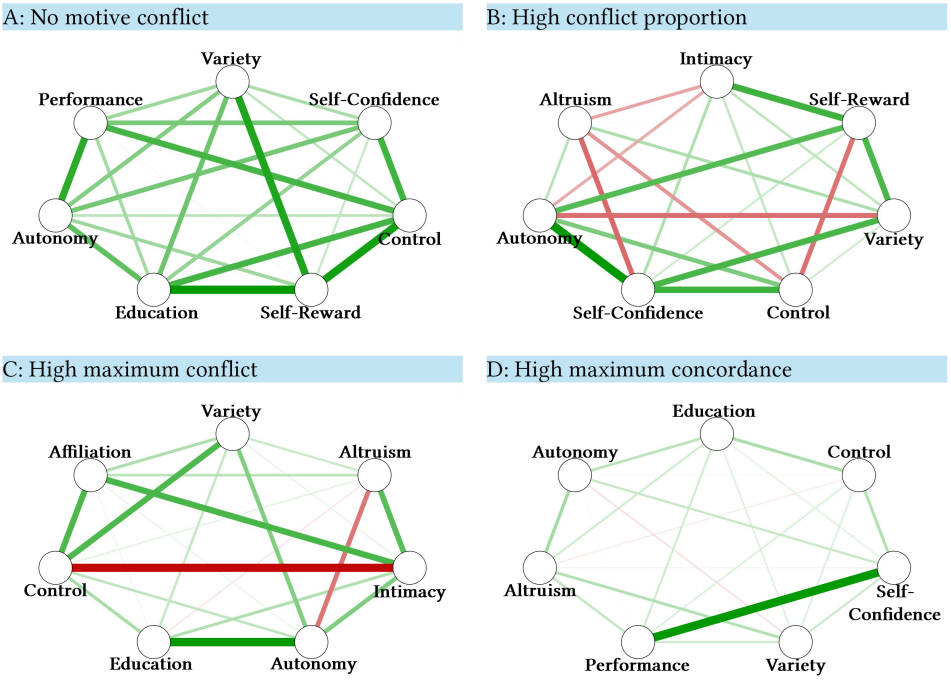
Across the sample, motives were mostly concordant, with an average conflict proportion of 6.2% ($SD$ = 6.7%; range = 0 to 29%). Of note, $n$ = 10 participants showed no conflict at all, and the distribution was skewed due to low values. For maximum conflict, the resulting distribution was skewed towards zero as well, with a mean of $r$ = -.09 ($SD$ = .09; range: 0 to -.33). Exemplary time series of motivational conflict versus cooperation are presented in the Supplementary Materials.

## Associations Between Motive Concordance as Well as Discordance and Subclinical Depressive Symptoms

We conducted three linear regression analyses (see Table 3). The first model examined whether the conflict proportion predicted subclinical depressive symptom severity, whereas the remaining two models examined the effect of the maximum conflict and maximum concordance, respectively. In all models, motive satisfaction was entered as a covariate.

**Figure 1**

*Four Exemplary Idiographic Motive Networks*




*Notes.* Network graphs of four participants are depicted for illustrative purposes. Green lines (i.e., edges) represent concordant relationships between motives whereas red lines represent discordant relationships. The thickness of edges is determined by the strength of the association. Motive network A (Participant 72) depicts uniformly positive edges, indicating no conflict, motive network B (Participant 71) depicts multiple moderately negative edges (29% conflict proportion), motive network C (Participant 41) shows few but strong negative edges (-.33 maximum conflict), and motive network D shows a case of maximum concordance (.61 maximum concordance).

Contrary to our hypotheses, neither conflict proportion nor maximum conflict predicted subclinical depressive symptoms (see Table 3). In contrast, the maximum concordance predicted subclinical depressive symptoms in that higher maximum concordance was associated with reduced subclinical depressive symptoms in models using robust bootstrapping. Motive satisfaction, which was added as a covariate, was a significant predictor of subclinical depressive symptoms across models in that more satisfaction was associated with less subclinical depressive symptoms.

**Table 3**

*Network-Derived Motive Satisfaction, Concordance and Discordance as Predictors of Subclinical Depressive Symptoms*

| Predictor | *b* | *SE* | *t* (*df*) | *p* | Bootstrap 95%-CI; *p* |
|---|---|---|---|---|---|
| Motive satisfaction | -0.139 | 0.059 | 2.358 (48) | .023 | [-0.258, -0.013]; $p$ = .047 |
| Proportion of negative edges | 0.374 | 1.269 | 0.295 (48) | .770 | [-2.341, 3.014]; $p$ = .792 |
| Motive satisfaction | -0.167 | 0.057 | 2.921 (48) | .005 | [-0.286, -0.052]; $p$ = .012 |
| Most negative edge | 0.995 | 0.940 | 1.058 (48) | .295 | [-0.517, 2.405]; $p$ = .198 |
| Motive satisfaction | -0.165 | 0.054 | 3.072 (48) | .003 | [-0.285, -0.051]; $p$ = .008 |
| Most positive edge | -1.136 | 0.643 | 1.765 (48) | .084 | [-2.119, -0.038]; $p$ = .021 |

*Note.* Intercept coefficients not displayed; due to heteroskedasticity and non-normality of residuals, Bootstrap confidence intervals and *p*-values are provided.

## Exploratory Analyses

It was surprising that the maximum concordance was associated with subclinical depressive symptoms whereas the maximum conflict was not. Our conjecture was that the null effects regarding motivational conflict might be related to a lack of discordant motivational relations (and thus variance). When we excluded participants from the analyses who displayed not one subclinical depressive symptom or motive-conflict ($n$ = 15), maximum conflict was associated with subclinical depressive symptoms according to bootstrapping ($b$ = 1.744, 95% Bootstrap-CI [0.054, 3.329]), but not conventional significance testing ($p$ = .131). Tentatively, these findings suggest that a lack of variance may have contributed to null results at least partly and that it may be worthwhile to examine effect of maximum conflict in participants who display more motive conflicts.

Confirmatory analyses indicated that participants with higher average motive satisfaction across the six-day ESM period reported lower subclinical depressive symptoms. Possibly, this effect emerged because motive satisfaction was immediately related to positive mood on a moment-to-moment level. Thus, we examined whether momentary within-person fluctuations of motive satisfaction were associated with contemporaneous affect (i.e., *unhappy* to *happy*) in a LMM analysis. The model controlled for the mean level of motive satisfaction (i.e., a 'hybrid model') to disentangle between- from within-person variance. Results suggested that, on a within-person level, an increase in motive satisfaction predicted more happiness (fixed effect: $b$ = 0.406, $SE$ = .024, $p$ < .001), meaning that when a person felt that their motives were satisfied more than usually, they felt in fact happier.

## Discussion

The present study demonstrated the feasibility and, in part, the clinical utility of a novel network-based approach to quantifying motive concordance and discordance in participants' everyday lives using Experience Sampling. Adherence (81%) was relatively high compared to other ESM studies (e.g., 76.8% in psychosis research; Deakin et al., 2022), and only four participants had to be excluded because of too few assessments. These data suggest that the proposed ESM-based motive network approach could be a feasible tool for therapists to learn about patients' idiographic motivational conflicts in order to aid treatment planning. The clinical utility of the derived indices of concordance and discordance was supported partly, as higher maximum concordance (i.e., strong concordant relationships between at least two motives) and overall motive satisfaction were associated with reduced subclinical depressive symptoms whereas motive conflicts were not.

In terms of validity, the assessment method has proven to be promising because the correlation between trait incongruence assessed via self-report and the average incongruence in daily life was high but not redundant ($r$ = .62). Visual representations of aggregated motive conflict (Figure 1) could serve as valuable sources of information for both therapists and patients. Inter-individual differences in idiographic network composition and everyday-life motive satisfaction support the usefulness of the idiographic approach.

Whereas network-derived concordance may be a protective factor, motivational conflicts showed no associations with subclinical depressive symptoms. It is possible that null effects were the result of the low number of observations within participants (i.e., 36 given full adherence) in combination with a low probability of occurrence of motivational discordance in the healthy student sample. A clinical sample would likely increase the likelihood of detecting more severe motive conflicts, which might be better suited to predict depressive symptoms. For example, edges and centrality strength show stronger correlations between internalizing symptom networks from the same population than between networks from clinical versus non-clinical samples (Funkhouser et al., 2020). Alternatively, when explaining the null finding one has to take into account that incongruence and discordance overlap empirically and theoretically, because discordance actually results in incongruence. Therefore, testing that discordance explains variance in depressive symptoms over and above incongruence is particularly conservative. Finally, an alternative psychological explanation for the null finding is, of course, that the motive conflicts that *are* related to depression are not captured with our network operationalization of motive conflict (e.g., due to motive incongruence not being consciously accessible due to avoidance motives and/or defense mechanisms).

## The Role of Motive Satisfaction

ESM-derived motive satisfaction emerged as a significant predictor of subclinical depressive symptoms across models. Interestingly, exploratory post hoc analyses suggest that momentary fluctuations in approach motive satisfaction were associated with momentary happiness. This result is in line with theoretical accounts of approach and avoidance motivation (Carver & Scheier, 2000), and it adds to findings that a lack of motive satisfaction is associated with reduced well-being, self-esteem, or joie de vivre (Grosse Holtforth & Grawe, 2003) between persons but also on a moment-to-moment level. In addition, this finding provides further evidence for the importance of resource activation in psychotherapy and a salutogenetic perspective on mental health in general (e.g., Munder et al., 2019). Consequently, the clinical utility of the assessment might lie in the identification of how an individual motive network can be driven to more concordance during psychotherapy.

## Limitations and Future Directions

First, the number of observations was low. Even 75 or 100 assessments are associated with low sensitivity (Mansueto et al., 2023), so 36 assessments in the present sample may have been too few to reliably estimate network parameters. However, we have made several design choices that were aimed at reducing the impact of small numbers of observations (Mansueto et al., 2023), namely limiting the number of nodes by selecting the seven most important motives per person, constraining analyses to contemporaneous networks, and using full information maximum likelihood estimation. One might argue that a more robust measure of motive interactions, such as simple correlations between motives, would be more appropriate. We decided against this option because, conceptually, the isolated relationship between two motives is not as informative as the interplay of all motives, which is illustrated by the fact that motivational (in)congruence is assessed using a combination of all approach and avoidance motives, respectively (Grosse Holtforth & Grawe, 2003). Unlike simple correlations, partial correlation networks represent associations between two nodes while controlling for all other information possible (Epskamp & Fried, 2018), which we consider a much more appropriate representation of overall concordance/discordance among motives.

Second, the student sample was educated, healthy, and mostly unaffected by motivational conflict according to our approach, resulting in skewed data and non-normally distributed errors. We addressed these issues with robust bootstrapping procedures but could not overcome the conceptual problem of floor effects. Third, the method of motive networks must be critically discussed. A motive network is based on an individual's transaction with their environment. A conflict between motives might occur due to motive-related conflicts, but also due to challenges imposed by the environment, a skill deficit, or a combination of such factors. In the current study, it is not possible to

partition those sources of variance, and it would be worthwhile to qualitatively assess how conflicts emerged and how they were experienced by participants in future studies.

Fourth, the theoretical framework we drew upon – consistency theory (Grawe, 2004) – is only one amongst many that are capable of informing motive conflicts. In the domain of psychodynamics, there are many theories that address motives and conflicts between motives. For example, the two-polarities model of personality development (Blatt, 2007) assumes two motivational processes: interpersonal relatedness and self-definition. In this model, psychopathology such as a depressive disorder can stem from a too strong focus on one of these processes accompanied by a neglect of the other. However, if one motivational process is active and the other is inactive all the time – in contrast to alternating activity –, there is no variance to be captured as motive conflict in experience sampling data. Thus, the theoretical perspective adopted here, and the resulting operationalization cannot capture the entirety of motive conflicts, limiting the interpretation of the findings. Lastly, the slightly adapted version of the INC-S which we used to assess congruence in daily life was not validated prior to the study.

There are several avenues for future research. First, the convergent validity of motive networks could be assessed using other data sources such as clinical interviews (e.g., OPD; Arbeitskreis zur Operationalisierung Psychodynamischer Diagnostik, 2023). Second, the test-retest reliability could be determined through repeated experience sampling phases (e.g., a month apart). Lastly, the qualitative evaluation of motive networks could be achieved by interviewing participants about their personal motive networks (e.g., individual concordant and conflicting pairs of motives and their face validity for the interviewees).

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**Competing Interests:** We have no conflicts of interest to disclose.

**Ethics Statement:** This study was performed in line with the principles of the Declaration of Helsinki. The ethics committee of the Faculty of Human Sciences at the University of Bern approved the study (#2016-05-00006). All participants provided written informed consent prior to participation.

**Preregistration:** The study was not pre-registered.

**Reporting Guidelines:** The manuscript was prepared in accordance with the JARS-Quant guidelines for quantitative research. An overview of approach motives as well as fit indices of the network's nodes are provided in the Supplementary Materials.

**Data Availability:** The data that support the findings of this study as well as the code are available from the corresponding author, Stefan Westermann, upon reasonable request.

## Supplementary Materials

The supplement contains a table which lists all approach motives that were assessed in the present study including respective Intraclass Correlation Coefficients (ICCs), a table with fit indices for each node of the idiographic network models, as well as a figure with exemplary depictions of congruence of the autonomy and the affiliation motive over time for two participants (for access, see Lüdtke et al., 2025S).

### Index of Supplementary Materials

Lüdtke, T., Steiner, F., Berger, T., & Westermann, S. (2025S). *Supplementary materials to "Empirically informed, idiographic networks of concordant and discordant motives: An experience sampling study with network analysis in non-clinical participants"* [Additional information]. PsychOpen GOLD. https://doi.org/10.23668/psycharchives.16213

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# Associations and Interactions Between Neuroticism, Adverse Life Events and Health Anxiety: Results From a Large Representative Cohort

Thomas Tandrup Lamm [1,2], Mimi Yung Mehlsen [3],

Tina Birgitte Wisbech Carstensen [1,2], Kaare Bro Wellnitz [1,2], Eva Ørnbøl [1,2],

Thomas Meinertz Dantoft [4], Per Fink [1,2], Marie Weinreich Petersen [1,2],

Lisbeth Frostholm [1,2]

**[1]** *Research Clinic for Functional Disorders, Aarhus University Hospital, Aarhus, Denmark.* **[2]** *Department of Clinical Medicine, Aarhus University, Aarhus, Denmark.* **[3]** *Department of Psychology, Aarhus University, Aarhus, Denmark.* **[4]** *Center for Clinical Research and Prevention, Bispebjerg and Frederiksberg Hospital, The Capital Region of Denmark, Denmark.*

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**Corresponding Author:** Thomas Tandrup Lamm, Research Clinic for Functional Disorders, Aarhus University Hospital, Palle Juul-Jensens Boulevard 11, Aarhus N 8200, Denmark. Phone: +0045 61147069. E-mail: THLAMM@rm.dk

**Supplementary Materials:** Materials [see Index of Supplementary Materials]

## Abstract

**Purpose:** Adverse life events and neuroticism have been shown to be associated with health anxiety (HA), but their interaction has not been studied. This study aimed to examine the separate associations as well as the possible interaction effect of neuroticism and adverse life events with HA.

**Method:** Cross-sectional self-report data originated from a representative Danish population cohort (DanFunD) ($N$ = 7,493, 18-72 years, 53% females). Primary measures were HA (Whiteley Index 6 revised), neuroticism (NEO personality Inventory Revised short form), and adverse life events (Cumulative Lifetime Adversity Measure, CLAM). The CLAM was split into illness/death related life events (IDE) and other adverse life events (OAE) to test the specificity of IDEs.

**Results:** Adjusted ordinal logistic regression models showed positive associations with HA for IDEs ($OR$ = 1.05, CI [1.03, 1.08]), OAEs ($OR$ = 1.05, CI [1.03, 1.07]) and neuroticism ($OR$ = 1.08, CI

[1.07, 1.09]). A Wald's test revealed no difference in association with HA for IDEs and OAEs ($p$ = .82). Adjusted models showed an interaction effect for neuroticism*IDEs ($OR$ = 1.002, CI [1.000, 1.004]), but not for neuroticism*OAEs ($OR$ = 0.999, CI [0.996, 1.002]).

**Conclusion:** Associations with HA were found for both adverse life events and neuroticism. Size of association did not differ for IDEs and OAEs. Only IDEs interacted with neuroticism.

## Keywords

health anxiety, neuroticism, adversity, Diathesis Stress Model, cohort study, effect moderation

### Highlights

- Neuroticism and adverse life events are associated with health anxiety.
- No difference in effect size between illness/death and other types of adversity was found.
- Illness/death related adversity interact with neuroticism in their association with health anxiety.
- Interaction between Illness/death related adversity and neuroticism was small.

Health anxiety (HA) refers to the experience of recurrent, excessive preoccupations with bodily symptoms and fear of having a serious illness in spite of relatively sparse evidence of illness (Fink et al., 2004). The term covers both mild and transient health-related worries as well as severe and debilitating HA (Longley et al., 2010). Experiences with HA frequently occur in the general population (Sunderland et al., 2013) and if untreated, severe HA has been shown to persist (Fink et al., 2004; olde Hartman et al., 2009) with dire consequences, such as reduced quality of life, more sick leave, more disability pensions, and increased health expenditure (Eilenberg et al., 2015; Fink et al., 2010).

## Models of Severe Health Anxiety

One foundational model to explain why mental disorders occur is the Diathesis-Stress Model (Monroe & Simons, 1991). This model states that mental disorders develop when a pre-disposed individual (individual specific factors) is exposed to an adequate stressor (environmental specific factors). Some studies have tested this model on disorders such as depression and social anxiety, finding significant interactions between adverse life events and diathesis factors such as neuroticism and genetic profiles (Arnau-Soler et al., 2019; Brown & Rosellini, 2011; Howe et al., 2017).

In relation to HA, elements of the Diathesis-Stress Model are reflected in the Cognitive Model of HA, which is the most widely used etiological model of HA (Salkovskis & Warwick, 2001). Here, adverse life events associated with illness and death are thought to contribute to an individual forming inflexible or negative schematic assumption about health and illness. This predisposes individuals to react in catastrophizing ways to future

health-related stressors, which can ultimately increase the risk of developing the more severe forms of HA.

According to the Cognitive Model of HA, illness/death related life events (IDEs) play a special role in the development of severe HA and should thus have a stronger association with HA than other adverse life events (OAEs) (e.g. social adversity, natural disasters, violence), which may be associated with increased anxiety and distress but are not specifically linked to health related anxiety.

## Experiences With Illness and Death

The association between adverse life events and HA has been examined in several studies, which indicate higher rates of adverse life events among people that report more HA (Mertz et al., 2023; Reiser et al., 2014; Weck et al., 2014). The specificity of IDEs nevertheless remains unclear (Thorgaard et al., 2018). Some studies indicate a degree of specificity for IDEs (Bailer et al., 2014; Sandin et al., 2004), whereas others show that it is adverse life events, irrespective of type, which are associated with HA (Mertz et al., 2023; Reiser et al., 2014; Weck et al., 2014). Some studies have even indicated a lack of association between HA and IDEs (Barsky et al., 1994; Gehrt et al., 2022).

## Neuroticism

While the Cognitive Model of HA emphasizes the role of stress factors, such as IDEs, less emphasis is placed on the role of predisposing/diathesis factors (Salkovskis & Warwick, 2001). Neuroticism is a trait that reflects an individual's largely heritable tendency to experience negative emotions (Barlow et al., 2014). It has been argued that neuroticism acts as a central diathesis factor for mood and anxiety disorders (Barlow et al., 2014), and studies have demonstrated that neuroticism can interact with and amplify the effect of adverse life events in relation to depression and stress (Brown & Rosellini, 2011; Howe et al., 2017). Moderate to large associations have furthermore been found between neuroticism and HA (Cox et al., 2000; Taillefer et al., 2003). However, while there are several studies relating severe HA to neuroticism and various types of adverse life events, no studies have examined if these factors interact in their association with HA, as suggested in the Diathesis-Stress Model.

## Aim of the Current Study

To provide insight into the development of HA, the current study aimed to 1) examine the association between HA, neuroticism, and adverse life events related to illness/death (IDEs) as well as other types of adverse life events (OAEs), and 2) to examine if neuroticism and adverse life events interact in the association with an individual's level of HA.

We hypothesized that: 1) higher levels of neuroticism would be associated with higher levels of HA, 2) higher numbers of adverse life events (both IDEs and OAEs)

would be associated with higher levels of HA, 3) IDEs would be more strongly associated with HA than OAEs, 4) there would be an interaction effect between adverse life events (both IDEs and OAEs) and neuroticism in their association with HA, so that scoring higher on adverse life events would cause the association between neuroticism and HA to be amplified.

# Method

## Design and Participants

Data originates from The Danish study of Functional Disorders (DanFunD), which is a representative Danish general population cohort study (Dantoft et al., 2017). 25,368 adults living in the western part of the Greater Copenhagen area of Denmark were randomly drawn from the Danish Civil Registration System based on social security number and invited to participate in the study. They received the invitation via mail to their postal address. 7,493 participants (29.53% of the invited) were included between 2012 and 2015. Participants were excluded if they were 1) pregnant, 2) not born in Denmark, 3) not Danish citizens. Participants answered a large battery of validated questionnaires, covering a variety of biological, psychological, and social domains and underwent a physical health examination. Only measures of relevance to this study will be described (for all measures, see Dantoft et al., 2017).

All participants gave written informed consent. Ethical approval was granted from the Ethical Committee of Copenhagen County (Ethics Committee: 3-2012-0015) as well as the Danish Data Protection Agency (2012–58- 006, 1–16–02-227-16), and the study was conducted in accordance with the Helsinki II Declaration. The current study was not pre-registered.

## Measures

The following measures were used:

### Dependent Variable

*Health Anxiety* was measured with a revised and abbreviated 6-item version of the Whitely Index (Pilowsky, 1967), called the Whitely Index 6 Revised (WI6-R) (Carstensen, Ørnbøl, Fink, Pedersen, et al., 2020). The WI6-R is a self-report measure, where items are scored on a 0-4 rating scale (from 'Not at all' to 'A great deal'), with a range of 0-24. Higher scores indicate more HA. This measure has been validated in the Danish general population, using the DanFunD Cohort (Carstensen, Ørnbøl, Fink, Pedersen, et al., 2020).

### Independent Variables

*Neuroticism* was measured by the NEO-PI-R short form (sf) (Hansen & Mortensen, 2004). This is an abbreviated version of the Danish 240-item NEO-PI-R. The NEO-PI-Rsf consists of 60 items, which measure the big five traits (neuroticism, conscientiousness, extraversion, agreeableness, openness), though in the current study, only the neuroticism scale was used. In the NEO-PI-Rsf, each trait is measured with 12 items. Answers are given on a 5-point rating scale ('clearly disagree' to 'clearly agree') with a range of 0-48. Higher scores indicate more neuroticism.

The NEO-PI-Rsf has been validated in a sample of the Danish population showing that the instrument has acceptable psychometric properties (Hansen & Mortensen, 2004).

*Adverse life events* were measured using a Danish version of the Cumulative Life-time Adversity Measure (CLAM) (Seery et al., 2010). This version was translated and validated in a Danish sample using the DanFunD cohort (Carstensen, Ørnbøl, Fink, Jørgensen, et al., 2020). The CLAM is a formative instrument that estimates the occurrence of adverse life events throughout the life span via 37 items, which are divided into 7 categories: 1) Own-illness or injury, 2) Loved one's illness or injury, 3) Violence, 4) Bereavement, 5) Social/environmental stress, 6) Relationship stress, 7) Disaster. For each event, three instances of the event and one period can be recorded (from time point A to B). One self-described event can also be recorded. For each item, a score is calculated by adding all recorded instances into a single score (max 4 events per item). Higher scores indicate more adverse life events.

A total score for each category of adverse life events can be formed by combining the scores of items for the specific event category. A total lifetime adversity score can also be constructed by summing the total scores from all event categories. For the current study, an "illness/death related life events" (IDEs) variable was computed by combining the categories: "own-illness or injury", "loved one's illness or injury" and "bereavement" into a single score (13 items, range 0-52). To assess the effect of the remaining adverse life events, an "other adverse life events" (OAEs) variable was computed by combining the remaining CLAM categories, including "violence", "social/environmental stress", "relationship stress", "disaster" (26 items, range 0-104).

### Covariates

Covariates were chosen based on Directed Acyclic Graphs (Moffa et al., 2017). This is further elaborated upon in the following section 'Analysis'. The following covariate measures were used:

*Self-reported social status* was measured with a validated item asking individuals how they would rate their own social position in society on a ranking scale from 1-10, which was scored on an ordinal scale from 1 to 10, with 10 representing the highest possible self-reported social status (Demakakos et al., 2008).

*Physical fitness* was tested using The Danish Step Test (Aadahl et al., 2013), which is a validated measure of cardiorespiratory fitness. The test is conducted by asking participants to step up and down on a step bench for a maximum of 6 minutes following instructions from a computer. Maximal oxygen consumption ($VO_2$max) is estimated based on how long participants can keep up with the pace of instructions and is then calculated based on known principles of the energy costs. Physical fitness was scored from 0-20, where a higher score indicated better physical fitness (Aadahl et al., 2013; Dantoft et al., 2017).

*Sleep problems* were measured using 2 items ("How often do you have problems falling asleep?" and "How often do you wake up too early compared to how long you would like to sleep?"), which have been used in a previous population cohort (Byberg et al., 2012; Dantoft et al., 2017). Both items were scored from 1-4 using the following categories: 1 = "once per month or rarer"; 2 = "two to four times per month"; 3 = "once or more times a week"; 4 = "daily". In the current study, sleep problems were binarily rated as having "sleep problems" if participants scored above 2 on either of the items, and "no sleep problems" if they did not.

## Analysis

Descriptive analyses consisted of counts (%), range, mean (*SD*), or median (IQR) depending on the variables and their empirical degree of skew. Because of long tails on the distribution of IDEs and OAEs, the tails were shortened by reducing all values above a given threshold to the threshold value (IDEs threshold = 10; OAEs threshold = 7).

All hypotheses were analyzed using both crude and adjusted ordinal logistic regression models with HA as an ordered outcome. Hypotheses were tested based on the adjusted estimates as they provide minimally confounded estimates, but crude estimates were also reported to facilitate comparison with other studies.

Adjustment variables were chosen based on Directed Acyclic Graphs (DAGs) (Moffa et al., 2017), and the minimal set of adjustment variables was found using the free online software Daggity (Textor et al., 2016). DAGs were drawn by a subset of the author group (TTL, TC, KBW, MWP, LF) and included neuroticism, IDEs, OAEs, age (in years), physical activity, physical symptoms, sex (male/female), sleep problems, and socio-economic status. The minimal set of adjustment variables consisted of sleep problems, physical activity, and self-reported social status as well as neuroticism, IDEs, and/or OAEs depending on primary predictor. Thus, Hypotheses 1, 2, and 3 were all evaluated based on parameters from the same adjusted ordinal logistic regression analysis. Syntax for the DAGs can be found in Appendix A.

Odds ratio (*OR*) was used as a measure of association, and hypotheses were evaluated at alpha level .05 by interpreting 95% confidence intervals (CI) and whether or not CI overlapped with 1.

Hypotheses 1 and 2 that HA was associated with neuroticism, IDEs, and OAEs were evaluated based on the adjusted CI for the associations of neuroticism, IDEs, or OAEs with HA. *OR* > 1 indicated that higher neuroticism or more IDEs/OAEs were associated with greater odds of HA. Hypothesis 3 that IDEs were more strongly associated with HA than OAEs was evaluated by direction and degree of overlap of the adjusted CIs of IDEs and OAEs and was formally tested using Wald's test. Hypothesis 4 that neuroticism and IDEs or OAEs interacted in the association with HA was tested by adding either neuroticism*IDEs or neuroticism*OAEs to the adjusted model used for Hypotheses 1, 2, and 3.

It was furthermore examined to which degree IDEs had a specific association with HA, or if similar associations could be found in relation to more general measures of anxiety or depression. To do this, supplementary analyses were conducted using the SCL-90 depression and anxiety scales as the dependent variables (description of measures in Appendix B), and IDEs, neuroticism and their interaction as the independent variables. Both crude and adjusted models were estimated, using the same set of covariates as the ordinal logistic regression model predicting HA.

All independent variables and covariates were median centered. Proportional odds assumptions were tested using Brant tests (Brant, 1990). Linearity of continuous covariates was checked by expanding the model with natural cubic splines with five knots at the 5th, 27.5th, 50th, 72.5th, and 95th percentiles, following the recommendations by (Harrell, 2015). All analyses were run in STATA version 18.0 (StataCorp, 2023).

## Results

The studied population consisted of *N* = 7,493 participants aged 18-72, of which 53% were females. Rates of missing data were below 1.7% for all measures with a completion rate of 99.4% for HA, 98.2% for neuroticism, and 98,8% for adverse life events. Further descriptive statistics for the analyzed cohort can be found in Table 1.

Testing Hypotheses 1 and 2, which stated that there would be a positive association between HA and OAEs, IDEs, and neuroticism, revealed a positive association with HA for neuroticism, IDEs, and OAEs. This indicated that having a higher score on these variables was associated with higher odds of reporting more HA (see Table 2). The size of these effects varied. To enhance interpretability, the standard deviation (*SD*) and interquartile range (IQR) were used to estimate the difference in odds of scoring higher on HA between two individuals where one scored one *SD* or quartile above the other on the dependent variables.

For neuroticism, it was estimated based on the adjusted model that an individual scoring one *SD* higher on neuroticism would have 74% higher odds of scoring higher on HA. For IDEs, it was estimated based on the adjusted model that an individual scoring

**Table 1**

*Sample Characteristics*

| Variable | *N* (%) | *M* (*SD*)[a] / Median (IQR)[b] | Range | *N* missing (%) |
|---|---|---|---|---|
| Sex | | | | |
| Males | 3456 (46) | | | |
| Females | 4037 (54) | | | |
| Age[b] | 7493 | 54 (44-63) | 18-72 | |
| Self-rated social status[a] | 7407 | 6.62 (1.40) | 1-10 | 86 (1.15) |
| Sleep problems | | | | 60 (0.80) |
| No | 6371 (86) | | | |
| Yes | 1062 (14) | | | |
| Physical fitness[a] | 6419 | 9.52 (2.73) | 1-19 | 1074 (14.33) |
| Health anxiety[b] | 7454 | 2 (0-5) | 0-24 | 39 (0.52) |
| Neuroticism[a] | 7365 | 16.47 (7.48) | 0-46 | 128 (1.71) |
| Adverse life events, total[b] | 7405 | 5 (3-8) | 0-35 | 88 (1.17) |
| Illness/death related events[b] | 7361 | 4 (2-6) | 0-19 | 132 (1.76) |
| Other adverse life events[b] | 7405 | 1 (0-2) | 0-25 | 88 (1.17) |

*Note.* Mean (standard deviation) or Median (interquartile range) was reported selectively based on the empirical distribution of each variable. For variables that were normally distributed, mean (*SD*) was reported. For variables that were non-normally distributed, median (IQR) was reported. Reporting format is denoted in the superscript.
[a]Mean, *SD*. [b]Median, IQR.

one quartile higher would have a 10% higher odds of scoring higher on HA. For OAEs, this was 5%.

Hypothesis 3 was examined by testing to which degree there was a difference in the strength of the association with HA for the IDEs and OAEs variables. A Wald's test ($\chi^2(1) = 0.05$, $p = .82$) indicated that there was no difference in the effect sizes between IDEs and OAEs and that both variables had similar *OR*s and almost identical CIs (see Table 2).

Testing Hypothesis 4 regarding the interactions between neuroticism and the two types of adverse life events (IDEs and OAEs), a small interaction effect between neuroticism and IDEs in their association with HA was found. No interaction was found for neuroticism and OAEs (see Table 2). This indicates that IDEs amplified the association between neuroticism and HA, rather than the effect of IDEs and neuroticism simply being additive. A more tangible effect size was calculated by using the model parameters to estimate the difference in odds of scoring higher on HA for two individuals where one individual scored one *SD* higher on neuroticism and one quartile higher on IDEs. The

**Table 2**

*Ordinal Logistic Regression Models and Interaction Effects for the Association Between Neuroticism, Adverse Life Events, and Health Anxiety*

| Independent variable | *OR* [95% CI] | *Z* | *p* | *N* |
|---|---|---|---|---|
| Neuroticism, cru | 1.09 [1.09, 1.10] | 31.22 | < 0.01 | 7362 |
| Neuroticism, adj[a] | 1.08 [1.07, 1.09] | 24.24 | < 0.01 | 6169 |
| Illness/death related life events, cru | 1.05 [1.03, 1.07] | 6.59 | < 0.01 | 7348 |
| Illness/death related life events, adj[b] | 1.05 [1.03, 1.07] | 5.74 | < 0.01 | 6169 |
| Other adverse life events, cru | 1.12 [1.10, 1.15] | 11.02 | < 0.01 | 7391 |
| Other adverse life events, adj[c] | 1.05 [1.03, 1.08] | 4.48 | < 0.01 | 6169 |
| Illness/death*neuroticism, cru | 1.002 [1.000, 1.005] | 2.60 | < 0.01 | 7261 |
| Illness/death*neuroticism, adj[d] | 1.002 [1.000, 1.004] | 1.96 | 0.05 | 6169 |
| Other adverse*neuroticism, cru | 1.000 [0.997, 1.002] | 0.08 | 0.93 | 7303 |
| Other adverse*neuroticism, adj[e,f] | 0.999 [0.996, 1.002] | -0.25 | 0.82 | 6169 |

*Note.* Cru = crude; Adj = adjusted; *OR* = odds ratio. *OR* values should be interpreted as the cumulative odds of scoring higher on the WI6-R for each additional point on neuroticism (range: 0-48), Other adverse life events (range: 0-104), Illness/death related life events (range: 0-52). BRANT tests for proportional odds were non-significant in all cases except for the crude model for the interaction between neuroticism and illness/death related life events, where a BRANT test showed a $p = .023$ for the overall model. Nevertheless, variable level tests were all $p > .05$. Consequently, we chose to regard the assumption of proportional odds as sufficiently fulfilled.

[a]illness/death related life events, other adverse life events, physical activity, sleep problems, self-reported social status. [b]neuroticism, other adverse life events, physical activity, sleep problems, self-reported social status. [c]illness/death related life events, neuroticism, physical activity, sleep problems, self-reported social status. [d]other adverse life events, physical activity, sleep problems, self-reported social status. [e]illness/death related life events, physical activity, sleep problems, self-reported social status. [f]Interaction effects in the last four rows are based on ordinal logistic regression models with interaction terms included. To see the estimated parameters of all variables included in these models, see Appendix C.

higher scoring individual was estimated to have a 2% higher odds of scoring higher on HA.

To further ascertain the specificity of the interaction between IDEs and neuroticism for HA, similar ordinal logistic regression models were run with depression and anxiety measures as the outcome instead of HA (see Appendix D). These models indicated that both neuroticism and IDEs were associated with anxiety and depression scores. The effect sizes of the associations were slightly larger for neuroticism than what was found in the model predicting HA, and slightly smaller for IDEs. In contrast to models

predicting HA, no interaction effect was found when predicting anxiety or depression from the interaction between neuroticism and IDEs ($p > .05$).

# Discussion

## Summary of Findings

This population-based study found positive associations between health anxiety and illness/death related life events, other adverse life events, and neuroticism (Hypotheses 1 and 2). It further indicated that illness/death related life events did not have a stronger association with HA than other types of adverse life events (Hypothesis 3). Finally, a small interaction effect was shown for illness/death related life events, which amplified the effect of neuroticism on health anxiety. No such interaction with neuroticism was found for other adverse life events (Hypothesis 4).

## Associations Between Health Anxiety, Adverse Life Events, and Neuroticism

The finding that both neuroticism and adverse life events were positively associated with HA is in line with other studies on the association between HA and different types of adverse life events (Mertz et al., 2023; Reiser et al., 2014; Thorgaard et al., 2018; Weck et al., 2014) and neuroticism (Cox et al., 2000; Taillefer et al., 2003). It should also be noted that the positive associations between neuroticism and adverse life events have been found for other types of mental disorders in previous studies and is thus not likely to be specific to HA (Hogg et al., 2023; Kotov et al., 2010). Similarly, in the current study, IDEs had associations to depression and anxiety which were comparable in size to what was found in relation to HA.

It should also be considered that the estimated effect of neuroticism appeared to be larger than the effects of both OAEs and IDEs. This difference in effect may indicate that dispositional factors could be more strongly associated with the development of HA than adverse life events.

## The Specificity of IDEs

The lack of specificity for IDEs found when testing Hypothesis 3 is in line with the few other studies that have not been able to identify difference in the size of the association with HA for OAEs and IDEs (Barsky et al., 1994; Mertz et al., 2023; Reiser et al., 2014; Weck et al., 2014). This is also reflected in the review by Thorgaard et al. (2018) which showed that several studies demonstrate associations with HA for both event types. The inconsistency of the association between IDEs and HA could be interpreted as

incongruent with the Cognitive Model of HA, which proposes that IDEs should play a specific causal role in the development of severe HA.

## Interactions Between Adverse Life Events and Neuroticism

The current study is the first to test for an interaction effect between neuroticism and adverse life events in relation to HA, finding an interaction between neuroticism and IDEs, which does not appear for the association between neuroticism and OAEs. This appears to be consistent with other studies examining diathesis-stress interactions for other mood and anxiety disorders that have found similar significant interaction effects (Arnau-Soler et al., 2019; Brown & Rosellini, 2011; Howe et al., 2017) and aligns with what would be expected based on the Diathesis-Stress Model. Furthermore, supplementary analyses showed that an interaction between IDEs and neuroticism could not be identified when examining the association with more general depression and anxiety. Thus, the interaction effect between neuroticism and IDEs seemed to only occur in relation to HA.

Importantly, the size of the interaction effect was small. Scoring highly on both neuroticism and IDEs resulted in only 2% higher odds of scoring higher on HA. The size of this association puts the theoretical and clinical implications of this finding into question.

## Implication and Future Work

The results of this study indicate that both diathesis and stress factors are associated with HA, consistent with the Diathesis-Stress Model (Monroe & Simons, 1991), though inconsistent evidence was found for the specificity of IDEs in relation to HA, which is implied in the Cognitive model of HA (Salkovskis & Warwick, 2001).

To more robustly establish the causal role of OAEs, IDEs and neuroticism in relation to HA, future studies should preferably use prospective designs. Current findings do not support the importance of future studies examining IDEs as a separate category instead of measures of cumulative adversity (Seery et al., 2010).

Furthermore, the current model supports the importance of dispositional factors in relation to HA, as neuroticism was shown to have the strongest association with HA. Future theoretical work could focus on integrating these factors in the cognitive model of HA (Salkovskis & Warwick, 2001).

The knowledge about the relative importance of neuroticism and adverse life events could inform clinical work with HA patients and may be integrated in case formulation, psychoeducation or during psychotherapy (Bagby et al., 2016; Buwalda & Bouman, 2008).

### Strengths and Limitations

The strength of the current study is its use of validated self-report measures in a large representative sample of the general population. All analyses are theoretically driven, testing popular models within the field, and the current study is also the first to test the interactions between neuroticism and adverse life events in relation to HA.

The study is limited by its cross-sectional design, which inhibits causal inference (Kraemer et al., 1997). While it is well established that both adverse life events and neuroticism are prospective risk factors for various types of mental disorders (Jeronimus et al., 2016; Li et al., 2016), bi-directional effects have also been shown, where mental disorder can increase both rates of stressful life events (Rnic et al., 2023) and levels of neuroticism (Ormel et al., 2013). The retrospective nature of the CLAM also makes it vulnerable to recall bias, whereby current state effects may modify the reported frequency or significance of past events (Lalande & Bonanno, 2011).

Another limitation is related to the use of a self-reported measure for HA, as distress reported via self-report may not always correspond to actual clinically significant distress (Hedman et al., 2015). Thus, the current findings could be supplemented in future studies using dichotomous classifications of HA set via clinical interviews to better estimate the clinical implication of findings.

Finally, the aggregated adverse life event variables used in the current study (IDEs and OAEs) were created by combining specific subscales from the CLAM for this specific study (Carstensen, Ørnbøl, Fink, Jørgensen, et al., 2020). As such, these subdivisions have not been formally validated. However, as the CLAM is a formative measure, this should not pose a threat to validity.

## Conclusion

Using data from the large representative DanFunD cohort, the current study has found positive associations between health anxiety and neuroticism, illness/death related life events and other adverse life events. The findings show that illness/death related life events did not have a stronger relation to health anxiety than other adverse life events. While a specific interaction effect was found between illness/death related life events and neuroticism in relation to health anxiety, the size of this interaction was small, and the clinical significance of this finding remains unclear.

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**Competing Interests:** The authors have declared that no competing interests exist. Furthermore, the authors have no additional (i.e., non-financial) support to report.

**Ethics Statement:** All participants gave written informed consent. Ethical approval was granted from the Ethical Committee of Copenhagen County (Ethics Committee: 3-2012-0015) as well as the Danish Data Protection Agency (2012–58- 006, 1–16–02-227-16), and the study was conducted in accordance with the Helsinki II Declaration.

**Reporting Guidelines:** The current manuscript was formatted according to the JARS-Quant reporting guidelines for Quantitative Research Designs.

**Preregistration:** The current study was not pre-registered. The current study is not a replication study.

**Data Availability:** All data collected in the current study are confidential, and data can therefore not be made available. The code used for statistical analysis and other study materials can be shared upon reasonable request.

## Supplementary Materials

The Supplementary Materials contain the following items (for access, see Lamm et al., 2025S):

- Appendix A: Syntax of Directed Acyclic Graphs (DAGs)
- Appendix B: Ordinal logistical regression models of the association between neuroticism, adverse life events, and health anxiety with interactions
- Appendix C: Description of measures used in supplementary analyses and descriptive statistics
- Appendix D: Results of supplementary analyses

### Index of Supplementary Materials

Lamm, T. T., Mehlsen, M. Y., Carstensen, T. B. W., Wellnitz, K. B., Ørnbøl, E., Dantoft, T. M., Fink, P., Petersen, M. W., & Frostholm, L. (2025S). *Supplementary materials to "Associations and interactions between neuroticism, adverse life events and health anxiety: Results from a large representative cohort"* [Online appendices]. PsychOpen GOLD. https://doi.org/10.23668/psycharchives.16215

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# Loneliness and Distress in the Aftermath of the COVID-19 Pandemic: A Cross-Sectional Study of German University Students

Joanna J. Hunsmann [1], Florian Weck [1], Julia Wendt [2], Franziska Kühne [1]

**[1]** *Department of Clinical Psychology and Psychotherapy, University of Potsdam, Potsdam, Germany.* **[2]** *Department of Emotion- and Biopsychology, University of Potsdam, Potsdam, Germany.*

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**Corresponding Author:** Joanna J. Hunsmann, Division of Clinical Psychology and Psychological Treatment, LMU Munich, Leopoldstr. 13, 80802 Munich, Germany. Phone: +49 89 - 2180 5199. E-mail: joanna.hunsmann@psy.lmu.de

**Supplementary Materials:** Code, Data, Materials, Preregistration [see Index of Supplementary Materials]

## Abstract

**Background:** Characterized by uncertainty and recurring periods of social isolation, the COVID-19 pandemic resulted in increases of loneliness and distress in young adults, such as university students. Despite the lifting of the last restrictions in Germany in April 2023, the state of mental health in vulnerable groups after the three-year global crisis remains to be investigated. Therefore, we aimed to assess university students' mental health after the pandemic.

**Method:** Between April and July 2023, $N$ = 886 university students throughout Germany participated in a fully anonymous cross-sectional online survey. Psychological distress (BSI; Brief Symptom Inventory), loneliness (LS-SOEP; Loneliness Scale), and emotion regulation strategies (ERQ; Emotion Regulation Questionnaire) were assessed by standardized questionnaires, and mental health was compared to a survey of students in April 2020 ($N$ = 1,062).

**Results:** Unexpectedly, we found higher levels of distress in 2023 than in 2020. Overall, $R^2_{adj}$ = 41% of variance in psychological distress was accounted for in a multiple linear regression, with loneliness emerging as the most important predictor. Additionally, emotion regulation, gender identity, and health behaviors such as keeping daily routines, sufficient sleep, and regular exercise were significant predictors. Analyses of variance (ANOVAs) revealed that students with past or present mental health conditions were significantly lonelier than those without.

**Conclusion:** These findings highlight the ongoing mental health challenges of university students in the aftermath of the COVID-19 pandemic, identifying non-binary and female students, as well as students with current or past mental health conditions as particularly lonely and distressed.

## Keywords

mental health, psychological distress, loneliness, emotion regulation, health behaviors, COVID-19 pandemic, university students

### Highlights

- This study is among the first to investigate post-pandemic mental health in German university students.
- Differences in loneliness were found by gender, with non-binary students particularly affected.
- Students with current or past mental health conditions reported more loneliness and more distress.
- Health behaviors and adaptive emotion regulation predicted better mental health.

Impacting various domains of life, the COVID-19 pandemic has been widely recognized not only as a threat to physical, but also to mental health (Bower et al., 2023; Gruber et al., 2021; World Health Organization, 2020). Across borders, it was accompanied by increases in psychological distress and symptoms of depression and anxiety (Benke et al., 2020; Bower et al., 2023). Characterized by periods of social isolation, the COVID-19 pandemic has also seen a notable rise in loneliness (Ernst et al., 2022). University students, often confronted with financial instability, academic pressures, and instability in social networks, are considered particularly vulnerable to mental health deterioration (Auerbach et al., 2018; Ochnik et al., 2021).

In Germany, university students' mental health was affected by frequently changing study conditions (Matos Fialho et al., 2021). Typically associated with older age, a rise in loneliness in young adults in Germany during the COVID-19 pandemic has been highlighted (Lepinteur et al., 2022; Werner et al., 2021). This is alarming since social contacts are considered especially important in this life phase. Defined as subjective experience of distress resulting from perceived deficiencies in the quantity and quality of social connections (Hawkley & Cacioppo, 2010), loneliness has been tied to a variety of adverse health outcomes (Cacioppo et al., 2010; Hawkley et al., 2009). Early longitudinal studies reported responses of recovery after the lifting of lockdown restrictions, however, levels of loneliness remained notably high (Ahrens et al., 2021; Chandola et al., 2022; Entringer et al., 2020). In Germany, pandemic restrictions (e.g., mask-wearing) were maintained comparatively long, with final regulations ending in early 2023 (Bundesregierung, 2023; see also Appendix A in the Supplementary Materials).

Mauz and colleagues (2023) provide evidence for the deterioration of mental health during later waves of the pandemic, highlighting the negative effect of the war in Ukraine. Given the pandemic duration, added stressors, and the serious threat for mental health given prolonged loneliness, monitoring university students' mental health in the aftermath of the COVID-19 pandemic remains relevant.

During the pandemic, identifying as female (Benke et al., 2020; Lepinteur et al., 2022), younger age (Benke et al., 2020; Bower et al., 2023), and prior mental health conditions (Benke et al., 2020; Bower et al., 2023; Shevlin et al., 2023) were consistently associated with greater distress. Individuals belonging to a risk group for COVID-19 or experiencing lasting consequences (e.g., post-COVID) were more distressed (Houben-Wilke et al., 2022). Meanwhile, in line with recommendations by health organizations (Inter-Agency Standing Committee, 2020), better mental health was associated with behaviors such as keeping daily rhythms, regular physical exercise, healthy nutrition, and sufficient sleep (Mata et al., 2021; Shanahan et al., 2022; Voltmer et al., 2021). Furthermore, adaptive emotion regulation was associated with less distress and loneliness (Ahrens et al., 2021; Preece et al., 2021). Policymakers and university staff would benefit from understanding which students may be particularly burdened after COVID-19.

In this study, we examined German university students' mental health in the aftermath of the COVID-19 pandemic. Specifically, we hypothesized that students would report lower levels of psychological distress in spring 2023, after restrictions ended, compared to the lockdown period in 2020. We expected correlations between psychological distress and loneliness, as well as emotion regulation strategies. We hypothesized that loneliness and emotion regulation strategies would be significant predictors for psychological distress, beyond the impact of person-related factors and health behaviors. Finally, we examined the role of students' prior mental health conditions and hypothesized that students with current or past mental health conditions would report more loneliness, demonstrate less adaptive emotion regulation, and engage less in health-related behaviors compared to others.

# Method

## Procedure

A total of $N = 886$ university students in Germany participated in the cross-sectional online study between April and July 2023. The survey was conducted using the survey tool of the University of Potsdam. Participants were recruited nationally via email through universities' student councils, with requests to spread the survey link among their students, as well as locally at the University of Potsdam via the participant pool of the Cognitive Sciences and by distribution of flyers at key locations on campus during mental health awareness days.

Inclusion criteria were student status, studying in Germany, age 18 and above, and giving informed consent. The latter was obtained from all participants, ensuring thorough understanding of their rights, the study's objectives, risks, and benefits. Abiding by institutional guidelines of the University of Potsdam, data collection maintained complete anonymity, strictly limiting sociodemographic information asked, and adhering rigorously to national and EU data protection laws. Participant characteristics can be found in Table 1.

## Measures

The questionnaire commenced with a brief assessment of sociodemographic variables, namely gender (female, male, non-binary), age (in categories to further ensure anonymity, e.g., 21-25), relationship status, and study term.

### COVID-19-Related Variables

Participants were asked how often they had been infected with the COVID-19 virus and whether they belonged to one of the following three groups, later referred to as COVID-related group status: at-risk for severe infection, having experienced a severe infection, and experiencing lasting effects of a past infection. Participants were also asked about the extent to which they felt burdened by the COVID-19 pandemic, the war in Ukraine, the energy crisis, and the climate crisis. Answers were given on a 5-point Likert scale, ranging from 1 (*not at all*) to 5 (*very strongly*).

### Psychological Distress

Psychological distress was assessed with the German version of the Brief Symptom Inventory (BSI; Derogatis & Melisaratos, 1983; Franke, 2000). Consisting of 53 items, it measures distress on nine dimensions. General psychological distress is indicated by a global score, the General Severity Index (GSI). The instrument uses a 5-point Likert scale, ranging from 0 (*not at all*) to 4 (*extremely*). Higher levels reflect greater distress. To calculate the GSI, the sum of all item scores is divided by 53, the number of items. In the present study, Cronbach's α was .96.

### Loneliness

The German version of the 3-item Loneliness Scale (LS-SOEP; Hawkley et al., 2015; Hughes et al., 2004) was used to assess loneliness, which is derived from the UCLA Loneliness Scale (Russell, 1996). Responses to the items were given on a 5-point Likert scale, ranging from 0 (*never*) to 4 (*very often*). We used the mean value of given responses (Luhmann & Hawkley, 2016), with higher values indicating greater loneliness. In this sample, Cronbach's α was .77.

### Emotion Regulation

Emotion regulation was measured with the German version (Abler & Kessler, 2009) of the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). It contains 10 items that measure how a person deals with positive and negative emotions. The scale *Suppression* consists of six items and the scale *Reappraisal* consists of four items rated from 1 (*strongly disagree*) to 7 (*strongly agree*). In our sample, Cronbach's α was .81 for *Reappraisal* and .75 for *Suppression*.

### Health-Related Behaviors

Six items regarding health behaviors were self-developed by adapting recommendations of the of the Inter-Agency Standing Committee of the United Nations (2020). In line with previous studies during the COVID-19 pandemic, self-reported regularity of exercise, daily living rhythms, sufficient sleep, healthy dietary habits, mindfulness practices, and alcohol consumption were recorded (Chen et al., 2020; Koob et al., 2021; Mata et al., 2021; Petzold et al., 2020). Answers were given on a 4-point scale, ranging from 1 (*disagree*) to 4 (*agree*), with higher values indicating stronger practice of health behaviors (see Appendix C, Supplementary Materials, for full item list).

### Mental Health Conditions

Students were queried regarding prior mental health conditions (1 = *Yes, I am currently undergoing treatment for it*; 2 = *Yes, I received treatment for it in the past*; 3 = *No*). If affirmed, participants were asked to specify whether there had been a worsening of symptoms since the pandemic.

## Comparison Data

To compare post-pandemic levels of psychological distress to students' mental health in the beginning of the COVID-19 pandemic, we used data from a survey conducted at our university in April 2020 (Löscher, 2020). A total of $N$ = 1,062 ($n$ = 706, 66.5% female; $n$ = 345, 32.5% male; $n$ = 11, 1% non-binary) university students in Germany participated in this cross-sectional online survey. Participants were aged 18 to 51 years ($M$ = 24.01; $SD$ = 4.68). The procedure was analog to the assessment detailed for 2023, except for the distribution of flyers on campus.

## Statistical Analysis

All analyses were conducted in R (R Core Team, 2023). There were no missing data. However, for the study term question, some exclusions were made due to non-digit entries (e.g., "bachelor", 23 cases). The level of significance for all analyses was α = .05. Analyses were conducted as previously registered, with minor deviations detailed below due to unmet assumptions (Hunsmann & Kühne, 2023S, March 31). First, we computed

descriptive statistics. In exploratory manner, we examined the correlations between perceived burdens and psychological distress, applying the Bonferroni correction for multiple comparisons (Armstrong, 2014). We also explored differences in loneliness by gender.

Proceeding with our hypotheses, we examined the relationships between psychological distress, loneliness, and emotion regulation strategies, using Spearman's rank correlations due to violations of the assumption of normality. To better understand how distressed students were in the aftermath of the COVID-19 pandemic, we used a Mann-Whitney *U*-test to compare students' levels of psychological distress in both samples. The Mann-Whitney *U*-test was conducted due to violations in the assumptions of equal variances and normality. Effect sizes are reported, with $r = .1$ considered a small, $r = .3$ a moderate, and $r = .5$ a large effect (Cohen, 1988).

Next, we conducted hierarchical multiple regression analyses to predict psychological distress from loneliness and emotion regulation strategies, while controlling for health behaviors and person-related factors. First, we considered a baseline model with health behaviors and person-related factors. In a second step, we added the emotion regulation strategies suppression and reappraisal as predictors. Similarly, we added the predictor loneliness to the baseline model. Finally, we computed a multiple regression model predicting psychological distress from all variables. As the assumption of homoskedasticity was not confirmed for all regression models, we employed heteroskedasticity-consistent, robust estimations using the HC3 method in all regression analyses (Hayes & Cai, 2007; Long & Ervin, 2000; White, 1980). Where the assumption of normality of residuals was violated, we conducted bootstrapped regression analyses with 5000 bootstrap samples to assess the stability of the original regression models' results. If not specified otherwise, the bootstrapped regression analyses supported the initial models.

Finally, we conducted analyses of variance (ANOVAs) to investigate differences in loneliness, emotion regulation strategies, and health behaviors between participants depending on their history of mental health conditions. Post hoc contrasts were computed using the Tukey Honestly Significant Difference (HSD) test. Effect sizes were calculated using omega squared ($\omega^2$) as recommended by Kroes and Finley (2023). Field's (2013) recommendation for interpreting $\omega^2$ was used ($\omega^2 \geq 0.01$ small, $\omega^2 \geq 0.06$ medium, $\omega^2 \geq 0.14$ large).

# Results

## Sample

An overview over sociodemographic information is provided in Table 1, experiences related to the COVID-19 pandemic in Table 2.

**Table 1**

*Sample Characteristics*

| Characteristic | overall *N* = 886 *n* (%) | female *N* = 551 *n* (%) | male *N* = 307 *n* (%) | non-binary *N* = 28 *n* (%) |
|---|---|---|---|---|
| **Age** | | | | |
| 18-20 | 165 (18.6%) | 108 (19.6%) | 51 (16.6%) | 6 (21.4%) |
| 21-25 | 498 (56.2%) | 311 (56.4%) | 171 (55.7%) | 16 (57.1%) |
| 26-30 | 155 (17.5%) | 94 (17.1%) | 57 (18.6%) | 4 (14.3%) |
| 31-35 | 32 (3.6%) | 17 (3.1%) | 15 (4.9%) | 0 (0.0%) |
| 36-40 | 22 (2.5%) | 11 (2.0%) | 10 (3.3%) | 1 (3.6%) |
| 41-45 | 6 (0.7%) | 5 (0.9%) | 1 (0.3%) | 0 (0.0%) |
| 46-50 | 3 (0.3%) | 1 (0.2%) | 2 (0.7%) | 0 (0.0%) |
| 51+ | 5 (0.6%) | 4 (0.7%) | 0 (0.0%) | 1 (3.6%) |
| **Education (in semesters)** | | | | |
| *M* (*SD*) | 6.13 (3.56) | 6.09 (3.43) | 6.25 (3.78) | 5.59 (3.40) |
| Range | 1.00, 24.00 | 1.00, 18.00 | 1.00, 24.00 | 1.00, 14.00 |
| **Marital status** | | | | |
| Divorced | 1 (0.1%) | 1 (0.2%) | 0 (0.0%) | 0 (0.0%) |
| Married | 32 (3.6%) | 27 (4.9%) | 4 (1.3%) | 1 (3.6%) |
| Relationship | 355 (40.1%) | 243 (44.1%) | 103 (33.6%) | 9 (32.1%) |
| Single | 497 (56.1%) | 280 (50.8%) | 200 (65.1%) | 17 (60.7%) |
| Widowed | 1 (0.1%) | 0 (0.0%) | 0 (0.0%) | 1 (3.6%) |
| **Mental health condition** | | | | |
| No | 634 (71.6%) | 383 (69.5%) | 241 (78.5%) | 10 (35.7%) |
| Current | 123 (13.9%) | 88 (16.0%) | 27 (8.8%) | 8 (28.6%) |
| Previous | 129 (14.6%) | 80 (14.5%) | 39 (12.7%) | 10 (35.7%) |

Of those students who had a history of mental health conditions ($n$ = 252; 28.4%), either currently or previously received psychotherapy, 58.3% ($n$ = 147) reported worsening symptoms since the COVID-19 pandemic. Furthermore, 44.5% ($n$ = 394) of participants were classifiable as psychologically distressed.

As can be seen in Figure 1, 10.1% of students reported feeling *strongly* or *very strongly* burdened by the COVID-19 pandemic. In comparison, the percentage of students reporting to feel *strongly* or *very strongly* burdened by the other stressors were 17.6% for the war in Ukraine, 26.9% for the energy crisis, and 45.8% for the climate crisis. Yet, there was a small but significant correlation between students' distress and how burdened they felt by the COVID-19 pandemic ($r$ = .26, $p$ < .001). Likewise, there were small correlations between psychological distress and perceived burdens due to the energy crisis ($r$ = .28,

$p < .001$), the war in Ukraine ($r = .25$, $p < .001$), and the climate crisis ($r = .22$, $p < .001$, Bonferroni correction $p < .0125$).

**Table 2**

*COVID-19-Related Variables*

| Characteristic | *N* = 886, *n* (%) |
|---|---|
| **Number of infections with COVID-19** | |
| 0 | 165 (18.6%) |
| 1 | 450 (50.8%) |
| 2 | 227 (25.6%) |
| 3 | 40 (4.5%) |
| 4 | 4 (0.5%) |
| **At-risk group** | 75 (8.5%) |
| **Severe course** | 65 (7.3%) |
| **Lasting consequences (e.g., post-COVID)** | 84 (9.5%) |

Descriptive statistics for psychological distress, loneliness and emotion regulation are provided in Table 3.

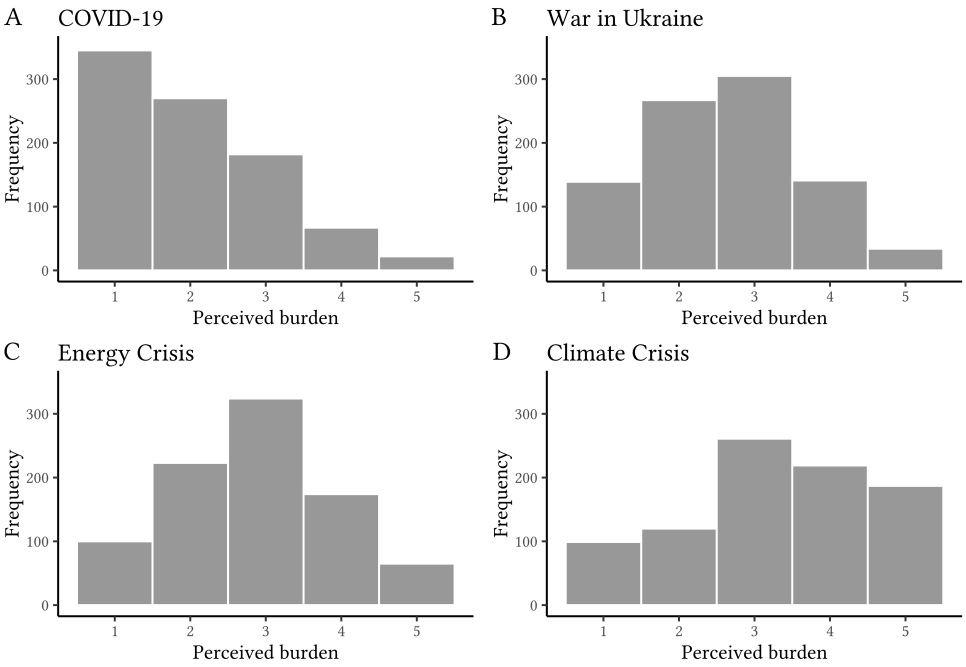
A one-way ANOVA revealed a small yet significant difference in loneliness by gender, $F(2, 883) = 8.37$, $p < .001$, $\omega^2 = .016$, 95% CI [.004, .039]. Post hoc contrasts showed that participants identifying as non-binary were significantly lonelier ($M = 3.5$, $SD = 0.98$) than participants identifying as female ($M = 2.92$, $SD = 0.88$) or male ($M = 2.79$, $SD = 0.96$). As for differences in loneliness by COVID-19 related group status, a *t*-test revealed that participants at risk for a severe course of infection reported significantly higher loneliness ($M = 3.21$, $SD = 0.92$) than participants not belonging to a risk-group ($M = 2.86$, $SD = 0.91$; $t(884) = -3.19$, $p = .001$, $d = 0.39$), and that participants who reported lasting consequences of a past infection reported significantly higher loneliness ($M = 3.09$, $SD = 0.95$) than participants without post-COVID ramifications ($M = 2.87$, $SD = 0.91$), $t(884) = -2.10$, $p = .036$, $d = 0.24$.

## Difference in Psychological Distress

The Mann-Whitney *U*-test revealed a significant difference in psychological distress between students in 2020 and 2023, $U = 332516$, $z = -8.211$, $p < .001$, $r = .19$, with students in 2023 reporting significantly higher distress ($Mdn = 0.74$) than students in 2020 ($Mdn = 0.45$).

**Figure 1**

*Perceived Burdens Due to Current Events*




*Note.* Extent to which participants indicated to feel burdened: 1 = *not at all*, 2 = *slightly*, 3 = *somewhat*, 4 = *strongly*, 5 = *very strongly*.

## Psychological Distress in Relation to Loneliness and Emotion Regulation

There was a large positive correlation between psychological distress and loneliness, $r_s(884) = .56$, $p < .001$. A small negative correlation was found between psychological distress and reappraisal, $r_s(884) = -.18$, $p < .001$, whereas distress and suppression were positively correlated, $r_s(884) = .23$, $p < .001$.

The baseline multiple linear regression model predicting psychological distress from health behaviors and person-related factors was statistically significant, explaining 17% of variance, see Table D1 (Appendix D, Supplementary Materials). Adding the emotion regulation strategies to the baseline model resulted in a statistically significant model explaining 24% of variance in psychological distress, see Table D2 (Appendix D). The model was better than the baseline model, $\Delta R^2 = .066$, $F(2, 866) = 38.5$, $p < .001$. The strategy of suppression predicted higher psychological distress, and the strategy of reappraisal

**Table 3**

*Descriptive Statistics*

| Characteristic | overall N = 886 | Mental health conditions: no n = 634 | current n = 123 | previous n = 129 |
|---|---|---|---|---|
| **Psychological distress (GSI)** | | | | |
| *M* (*SD*) | 0.88 (0.62) | 0.79 (0.57) | 1.17 (0.67) | 1.05 (0.68) |
| Range | 0.00, 3.58 | 0.00, 3.23 | 0.08, 3.58 | 0.04, 3.00 |
| **Loneliness (LS-SOEP)** | | | | |
| *M* (*SD*) | 1.89 (0.92) | 1.77 (0.88) | 2.28 (0.95) | 2.09 (0.93) |
| Range | 0.00, 4.00 | 0.00, 4.00 | 0.00, 4.00 | 0.00, 4.00 |
| **Reappraisal (ERQ)** | | | | |
| *M* (*SD*) | 4.30 (1.08) | 4.32 (1.06) | 4.21 (1.15) | 4.33 (1.08) |
| Range | 1.00, 7.00 | 1.00, 7.00 | 1.50, 6.50 | 1.00, 7.00 |
| **Suppression (ERQ)** | | | | |
| *M* (*SD*) | 3.72 (1.28) | 3.73 (1.27) | 3.85 (1.30) | 3.55 (1.31) |
| Range | 1.00, 7.00 | 1.00, 7.00 | 1.00, 6.75 | 1.00, 6.50 |

*Note.* GSI = General severity index; LS-SOEP = 3-item Loneliness Scale; ERQ = Emotion Regulation Questionnaire.

lower distress. The bootstrapped regression analysis closely aligned with initial model, however, belonging to the age group 36-40 was corrected as a nonsignificant predictor.

Similarly, the predictor loneliness was added to the baseline model, resulting in a statistically significant model accounting for 39% of the variance in psychological distress, see Table D3 (Appendix D). Here, an increase in loneliness was associated with an increase in psychological distress. The model with loneliness was significantly better than the baseline model, $\Delta R^2 = .209$, $F(1, 867) = 301.87$, $p < .001$.

Lastly, an exploratory regression model with all predictors accounted for $R^2 = 41\%$ of variance in psychological distress, see Table 4 (see also Table D4, Appendix D).

While being the strongest of the models predicting distress, it only explained 2% more variance in distress than the model with loneliness (Table D3, Appendix D), $\Delta R^2 = .024$, $F(2, 865) = 17.99$, $p < .001$. This underscores the importance of loneliness as a predictor for distress.

## The Role of Prior Mental Health Conditions

The ANOVA revealed a small effect of prior mental health in loneliness, $F(2, 883) = 20.00$, $p < .001$, $\omega^2 = .041$, 95% CI [.02, .071]. Post hoc comparisons revealed that participants

**Table 4**

*Multiple Regression Analysis: Predictors of Psychological Distress (N = 886)*

| Variable | Standardized β | *SE* | *t* | *p* |
|---|---|---|---|---|
| (Intercept) | | 0.17 | 3.454 | < .001 |
| **Loneliness** | .44 | 0.02 | 13.225 | < .001 |
| **Suppression** | -.10 | 0.02 | -3.407 | < .001 |
| **Reappraisal** | .13 | 0.01 | 4.659 | < .001 |
| **Health behaviors** | | | | |
| Daily structure | -.07 | 0.02 | -2.244 | 0.025 |
| Healthy nutrition | .02 | 0.03 | 0.757 | 0.449 |
| Regular exercise | -.06 | 0.02 | -2.086 | 0.037 |
| Mindfulness practice | .05 | 0.02 | 1.630 | 0.104 |
| Sufficient sleep | -.16 | 0.02 | -5.128 | < .001 |
| Limiting alcohol | -.03 | 0.02 | -1.241 | 0.215 |
| **Age**[a] | | | | |
| 21-25 | -0.02 | 0.04 | -0.708 | 0.479 |
| 26-30 | 0.02 | 0.06 | 0.456 | 0.648 |
| 31-35 | 0.00 | 0.10 | 0.151 | 0.880 |
| 36-40 | -0.04 | 0.11 | -1.420 | 0.156 |
| 41-45 | 0.00 | 0.13 | -0.196 | 0.845 |
| 46-50 | -0.02 | 0.18 | -1.429 | 0.153 |
| 51+ | 0.01 | 0.48 | 0.226 | 0.821 |
| **Gender**[b] | | | | |
| Male | -.13 | 0.04 | -4.564 | < .001 |
| Non-binary | .02 | 0.15 | 0.508 | 0.612 |
| **Therapy**[c] | | | | |
| Current | .08 | 0.06 | 2.654 | 0.008 |
| Previous | .09 | 0.05 | 2.960 | 0.003 |
| $R^2$ ($R^2_{adj}$) | .442 (.409) | | | |
| $F$ | 31.630 | | | |
| $p$ | < .001 | | | |

[a]reference category: 18-20. [b]reference category: female. [c]reference category: no therapy.

with current ($M$ = 3.28, $SD$ = 0.95) and past mental health conditions ($M$ = 3.09, $SD$ = 0.93) were significantly lonelier than those without ($M$ = 2.77, $SD$ = 0.88).

As for differences in emotion regulation by mental health status, no significant difference was found in suppression, $F(2, 883) = 1.78$, $p = .169$. There was also no significant difference in reappraisal, $F(2, 883) = 0.59$, $p = .556$.

As for the overall score regarding health behaviors, there was no significant difference between participants with past, current, or no mental health conditions, $F(2, 883) = 0.57$, $p = .564$. Investigating each behavior individually, we found a small difference in exercising regularly between participants depending on their mental health history, $F(2, 883) = 6.73$, $p = .001$, $\omega^2 = .013$, 95% CI [.002, .033]. Post hoc comparisons revealed that participants with no mental health conditions ($M = 2.9$, $SD = 0.99$) reported to exercise more regularly than participants with current ($M = 2.65$, $SD = 1.05$) or past ($M = 2.6$, $SD = 1.03$) mental health conditions. There was also a small difference in mindfulness practice by mental health group, $F(2, 883) = 11.05$, $p < .001$, $\omega^2 = .022$, 95% CI [.007, .047]. However, participants with no mental health conditions ($M = 1.88$, $SD = 0.9$) reported significantly less mindfulness practice than participants with current ($M = 2.2$, $SD = 0.91$) or past ($M = 2.19$, $SD = 1$) mental health conditions.

## Discussion

Our first hypothesis, anticipating lower psychological distress in 2023 compared to 2020, was not supported. Confirming the second hypothesis, loneliness and emotion regulation emerged as significant predictors for distress. The third hypothesis, positing differences by prior mental health, was only partially confirmed. Comparing levels of psychological distress in a three-year interval, we found that students reported higher distress in 2023 than in 2020, with 44.5% of students psychologically distressed, as compared to 27% in 2020. Certain health behaviors, i.e., keeping regular routines, getting sufficient sleep, and exercising regularly, were associated with lower distress. Identifying as male was associated with lower distress, experiencing past or current mental health conditions with higher distress. Beyond person-related variables and health behaviors, suppression and loneliness were predictive of higher psychological distress, while reappraisal predicted lower distress. Overall, loneliness was the most influential predictor for psychological distress and 41% of variance in distress was explained. Students identifying as non-binary reported the highest levels of loneliness, followed by female students. Students with prior or current mental health conditions reported more loneliness than others. There were no differences in emotion regulation by mental health history. Regarding health-related behaviors, students without prior mental health issues reported to exercise more regularly. However, students with previous and current mental health conditions reported practicing more mindfulness.

Our research design does not allow for causal attributions. However, our results are in line with existing research suggesting a deterioration of mental health in Germany during the later pandemic (Mauz et al., 2023; Walther et al., 2023). A US study highlighted an increase in severe levels of depression, anxiety, and stress among university students compared to previous years (Emmerton et al., 2024). However, the authors report this as part of a longer-term trend and identify academic performance as key stressor alongside

several non-pandemic stressors (Emmerton et al., 2024). Our results might also capture differences in daily stressors, as the 2020 assessment occurred during lockdown and the semester break. Furthermore, global stressors beyond the pandemic must be considered (Mauz et al., 2023). Our exploratory analyses indicate that students in 2023 felt markedly burdened by stressors such as the climate crisis and the war in Ukraine. However, the reliance on self-developed self-report measures is a limitation.

Another limitation of this study lies in the use of a convenience sample. The study may have particularly attracted the interest of students struggling with mental health. However, a similar prevalence of mental disorders has been reported in other studies (e.g., Auerbach et al., 2018). Age distributions in both samples were comparable and in line with nationwide representative surveys (e.g., Statista, 2024). A notable 62% of participants identified as female (67% in 2020) and 3% as non-binary (1% in 2020). As the percentages of female and male students in Germany are approximately equal (Kroher et al., 2023) and since the pandemic had differential effects on male, female, and non-binary individuals (Flor et al., 2022), this limits the generalizability of our findings. Furthermore, demographic variables that may explain differences in mental health were not assessed due to anonymity considerations, thereby limiting comparability. Such variables could be financial status (e.g., Chandola et al., 2022), ethnic minority status (Plenty et al., 2021), and geographical location, as COVID-19 measures varied across regions in Germany. Finally, almost 10% of students reported being impacted by lasting consequences of a prior infection with COVID-19 (see Appendix B, Supplementary Materials).

## The Central Role of Loneliness in Predicting Psychological Distress

Loneliness was the strongest predictor for psychological distress. One explanation is to understand loneliness as a persisting consequence of the pandemic. Werner and colleagues (2021) reported loneliness being highly predictive of mental health issues in a longitudinal study, with loneliness during the pandemic only marginally predicted by pre-pandemic loneliness. Greater loneliness was reported in regions with more pandemic-related restrictions in a Norwegian study among students, however, the study also found that loneliness was linked to time spent on campus and declined again from 2021 to 2022 (Hysing et al., 2023). Conversely, loneliness could stem from existing mental health conditions. Students with diagnosed mental health conditions might struggle to seek social support or engage in fulfilling interactions (Perese & Wolf, 2005). As mental health conditions remain a sensitive topic, they may hesitate to confide in others (Schnyder et al., 2017; Schomerus et al., 2019).

Regarding gender differences in loneliness, our results align with existing findings (Hysing et al., 2023; Werner et al., 2021). A rise in female loneliness during COVID-19 has been linked to declining wellbeing (Lepinteur et al., 2022), likely due to gender gaps in other areas, e.g., finances or caretaking (Flor et al., 2022). However, the 3% non-binary students in our sample reported the highest loneliness. This percentage is in line with

other German and international surveys (e.g., Ipsos, 2021). Transgender and non-binary individuals are more likely to experience discrimination and violence (Aparicio-García et al., 2018), with social support and LGBTQIA+ communities playing a vital role in mitigating negative mental health outcomes (Weinhardt et al., 2019). Thus, they may have been disproportionately affected by social restrictions. Alternatively, loneliness may have been high in this group before the pandemic (Aparicio-García et al., 2018).

Despite the importance of emotion regulation in psychopathology, we found no differences by mental health status. This may reflect the limitations of our narrow assessment, with adaptive emotion regulation increasingly seen as flexible (e.g., Aldao et al., 2015) and influenced by factors like strategy access and emotional awareness (Gratz & Roemer, 2004). In line, cognitive control and flexibility moderated the association between uncertainty intolerance and emotion regulation difficulties in a multi-wave pandemic study, affecting mental health (Godara et al., 2023). Our finding that health behaviors served as adaptive coping strategies generally aligned with previous research (Chen et al., 2020; Mata et al., 2021; Oftedal et al., 2019).

## Conclusion

Psychological distress was high in this university student sample even after the pandemic, with loneliness notably prevalent in the most distressed individuals. This underscores the importance of addressing loneliness in young adults. We also found that adaptive emotion regulation and specific health behaviors, such as adequate sleep, exercise, and maintaining daily routines, were associated with better mental health cross-sectionally. Future research should monitor loneliness among university students longitudinally. Specific interventions could address loneliness (Ma et al., 2020; Masi et al., 2011). Targeted programs in universities would benefit from particularly focusing on non-binary and female students. Counseling services could facilitate support groups and therapy referrals, and universities could expand practical assistance for challenges commonly faced by female students, such as caregiving responsibilities. By addressing mental health openly and fostering support systems, significant strides may be made towards reducing loneliness among university students.

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**Competing Interests:** The authors have declared that no competing interests exist.

**Ethics Statement:** Abiding by institutional guidelines of the University of Potsdam, data collection maintained complete anonymity, strictly limiting sociodemographic information asked. The survey strictly followed the APA Ethical Principals of Psychologists and Code of Conduct (2017) and the ethical guidelines of the Federation of German Psychologist Associations (DGPS, 2022). Informed consent was obtained from all participants, ensuring thorough understanding of their rights, the study's objectives, risks, and benefits.

**Preregistration:** The study and analyses were conducted as previously registered (Hunsmann & Kühne, 2023S, March 31).

**Reporting Guidelines:** JARS-Quant Reporting Standards for Studies Using No Experimental Manipulation

**Data Availability:** The analysis code and data from this study are available on OSF (Hunsmann & Kühne, 2024S), the comparison data is available from the corresponding author upon request. No further materials were used.

## Supplementary Materials

The Supplementary Materials contain the following items:

- *Preregistration* (Hunsmann & Kühne, 2023S)
- *Research data and analysis code* (Hunsmann & Kühne, 2024S)
- *Online appendices* (Hunsmann et al., 2025S):
  - Appendix A: COVID-19 Pandemic Restrictions in Germany
  - Appendix B: Lasting Consequences of Prior COVID-19 Infections
  - Appendix C: Item List of Health Behaviors
  - Appendix D: Regression tables with detailed statistics for multiple regression models: a baseline model, a model with emotion regulation, a model with loneliness, and a model with all predictors

### Index of Supplementary Materials

Hunsmann, J. J., & Kühne, F. (2023S). *University students' mental health in the aftermath of the COVID-19 pandemic* [Preregistration]. OSF Registries. https://doi.org/10.17605/OSF.IO/97WTU

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# Dynamic Complexity of Positive and Negative Affect in NSSI – A Daily Diary Study

Michaela Bruckbauer-Schwed[1,2], Tim Kaiser[3], Marc Keglevic[1], Anton-Rupert Laireiter[2]

**[1]** *Department of Psychiatry, Kardinal Schwarzenberg Klinikum, Schwarzach, Austria.* **[2]** *Department of Psychology, University of Salzburg, Salzburg, Austria.* **[3]** *Department of Methods and Evaluation / Quality Assurance, Free University Berlin, Berlin, Germany.*

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**Corresponding Author:** Michaela Bruckbauer-Schwed, Department of Psychiatry, Kardinal Schwarzenberg Klinikum, Kardinal Schwarzenbergplatz 1, 5620 Schwarzach im Pongau, Austria. Phone number: +436643320183. E-mail: michaela.bruckbauer-schwed@ks-klinikum.at

**Supplementary Materials:** Preregistration [see Index of Supplementary Materials]

## Abstract

**Background:** Non-suicidal self-injury (NSSI) is a major health problem. Functionally, it is related to affect instability and increased affective intensity. The role of negative emotions has already been extensively explored, only few studies have focused on positive emotions. The concept of dynamic complexity (DC) is particularly well suited to differentially analyze the dynamics of affect collected by ecological momentary assessment (EMA). This study examines DC of positive and negative emotions in individuals with and without NSSI history in an EMA setting.

**Method:** Participants from a clinical NSSI group ($n$ = 28) and a comparable clinical non-NSSI control group ($n$ = 33) completed the Positive and Negative Affect Schedule (PANAS) once a day between six to 37 days ($M$ = 15.60, $SD$ = 5.80). DC was calculated for the assessed time-series of daily affect. Additionally, we fitted a linear mixed model to predict positive and negative dynamic complexity with length of stay and group.

**Results:** Compared to controls, individuals with a history of NSSI showed significantly more positive affect and had significantly higher DC in affect in general. No significant difference for negative affect was found.

**Conclusion:** Our results suggest that it is important to assess dynamic emotional patterns and to analyze in detail the role of positive and negative affect in individuals with NSSI in order to better

understand the complex interplay between the different emotional states and to be able to use it for diagnostic purposes and clinical interventions.

## Keywords

non-suicidal self-injury (NSSI), affect instability, positive affect, dynamic complexity, ecological momentary assessment

### Highlights

- The NSSI group showed a higher DC in positive and negative emotions than clinical controls.
- The NSSI group showed higher mean levels of positive emotions than clinical controls.
- Within-person variation in DC explains more variance than survey period or group differences.

Non-suicidal self-injury (NSSI) is a serious psychiatric phenomenon characterized by the direct, intentional destruction of bodily tissues without the intent to die (Nock & Favazza, 2009). It is a growing public health concern worldwide due to its high prevalence rates (Muehlenkamp et al., 2012) and increased emergency department utilization (Olfson et al., 2005). In inpatient samples, 21% of adults report a history of NSSI (Briere & Gil, 1998).

It is now well established from various studies that emotion regulation (Gratz & Roemer, 2008) is one of the most commonly endorsed functions of NSSI. Emotion regulation refers to the methods individuals use to manage their emotions, including determining which emotions they experience, when they occur, and how they are felt and expressed (Gross, 1998). Klonsky (2009) found that 85% of participants engaged in NSSI to alleviate negative emotions, such as sadness, frustration, and pain and reported feeling calm and relieved afterwards. Claes et al. (2010) also found similar results, where participants reported a decrease in negative high arousal emotions, such as anxiety and depression, and an increase in positive-low arousal emotions, such as relief.

In addition to emotion regulation, affect instability also plays an important role in NSSI (Kerr & Muehlenkamp, 2010). Affect instability is defined as rapid and intense mood swings with difficulties in controlling these swings and their outcomes (Marwaha et al., 2014). Many studies (e.g., Peters et al., 2016; Santangelo et al., 2017) reported an increased affect instability in individuals with NSSI compared to controls. Furthermore, affect instability predicts the onset and continuation of non-suicidal self-injury (Peters et al., 2016).

Another aspect of impaired emotion regulation is variability of positive and negative affect. Affect variability pertains to the extent or magnitude of an individual's affective states over a period of time. If someone exhibits higher levels of affective variability, he/she experiences emotions that are more intense and deviate more significantly from

his/her typical affective state (Houben et al., 2015). Ong and Steptoe (2020) reported that greater variability in positive affect increased mortality risk in older adults. Conversely, in younger adults, instability in positive affect was related to better mental health (Spindler et al., 2016). Victor et al. (2021) demonstrated that variability in negative affect was associated with NSSI, suicidal ideation, and suicidal behavior assessed concurrently as well as prospectively.

There is also limited knowledge about changes in emotion dysregulation over the course of inpatient hospitalization. Few studies have examined this issue in adult inpatients. For example, Fowler et al. (2016) found significant improvements in experiential avoidance and emotion dysregulation with large effect sizes following intensive inpatient psychiatric treatment over a period of six to eight weeks.

A common idea in various theoretical models is that individuals engage in NSSI in response to intense emotional distress aiming to regulate or alleviate these distressing states by modifying, reducing, or diverting attention from them in some way (e.g., Nock & Prinstein, 2004; Selby & Joiner, 2009). An approach to explain the development and maintenance of self-injury has been proposed by Nock and Prinstein (2004) with their four-factor model based on learning theory. This functional approach describes four reinforcement processes: automatic negative reinforcement when NSSI is performed to alleviate negative states, automatic positive reinforcement when NSSI is followed by an increase in positive affect, social negative reinforcement when NSSI is performed to reduce or stop interpersonal demands, and social positive reinforcement when NSSI is performed to seek attention or receive help.

Much of the research to date has focused on the negative reinforcements associated with NSSI. Only a few studies have found an association between positive affect and NSSI. Some studies have found an increase in positive affect following NSSI (Jenkins & Schmitz, 2012; Kranzler et al., 2018) However, these self-report and ecological momentary assessment data on positive affect need to be replicated. In addition, motives for engaging in NSSI behaviors seem to include attempts to reduce negative affect and increase positive affect (Claes et al., 2010; Selby et al., 2014). Regarding the four-factor model, Yen et al. (2016) reported that adolescents in psychiatric inpatient settings who endorsed automatic positive reinforcement as a motive for NSSI were more likely to continue with NSSI. Turner et al. (2012) reported that 92% of an adult sample with a history of NSSI engaged in self-injury as a means of generating positive emotions. Other studies have found no support for an increase in positive affect after engaging in NSSI (Armey et al., 2011) and no group differences in positive emotional reactivity in individuals with NSSI compared to controls (Mettler et al., 2021). Jenkins and Schmitz (2012) showed that positive, but not negative affect, was significantly associated with a higher frequency of lifetime NSSI acts in college students.

## Dynamic Complexity (DC)

A growing body of literature investigated the relationship between NSSI and affect with correlational and ANOVA-based analyses (e.g., Victor & Klonsky, 2014). However, no previous study was grounded in a nonlinear-dynamic systems framework where it is important to consider dynamic characteristics (such as fluctuations or critical slowing down) of affect and its relation to NSSI.

According to the synergetic approach to psychology, human change processes are characterized by non-linearity and non-stationarity of their dynamics (Schiepek & Strunk, 2010). When the relationship between input and output of a dynamic system is not directly proportional, the system is considered nonlinear (Stam, 2005). It is typical for nonlinear dynamic systems that, depending on the state of the system, even high levels of negative affect (input) do not lead to non-suicidal self-injury (output). In contrast, when the system is in an unstable state, even minor increases of negative affect can trigger self-injurious behavior. Nonstationarity, on the other hand, denotes changes in descriptive statistics, including (moving) averages and variance, over time. Nonstationarity is consistent with discontinuous phase transitions caused by the nonlinear mechanisms inherent in complex systems. Phase transitions are defined as a change from one pattern to another pattern, caused by internal and external conditions. Almost invariably, phase transitions are preceded and facilitated with critical instabilities (Schiepek & Strunk, 2010).

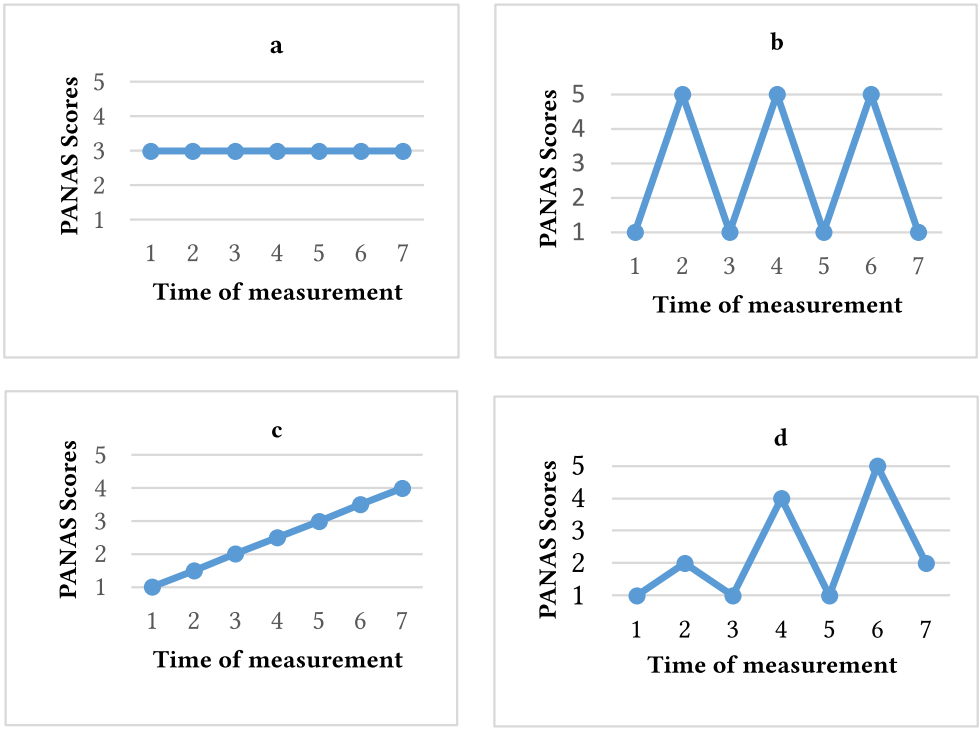
Critical instabilities preceding phase transitions can be assessed with the dynamic complexity (DC), which was developed for short time series typical in psychological research (Schiepek et al., 2014). DC is the product of two parameters, fluctuation (F) and distribution (D). F quantifies the intensity of change with respect to frequency and amplitude of a time-series (Figure 1). F is maximal when the variable in the time-series jumps between the minimum and maximum value as often as possible. D quantifies the scattering of the time-series within the range of possible values. D maximizes when values are irregular and chaotically distributed (for a detailed description and formula, see Schiepek & Strunk, 2010). Consequently, high DC indicates frequent, large, and irregular fluctuations (Olthof et al., 2020).

F and D and their product DC indicate critical instabilities in self-organizing processes and non-stationary phenomena in time series (Schiepek & Strunk, 2010). During periods of fluctuation, the system is destabilized and oscillates between old and new patterns until the system stabilizes in a new state (attractor) and variability decreases (Kelso, 1995; Thelen & Smith, 1994). Typically, DC is computed by looking at a window of data consisting of seven measurement points that are shifted from one day to the next throughout the time series. Applying this procedure produces a time series that includes DC values for each item (Schiepek & Strunk, 2010). A manifestation of nonlinear dynamics and phase transitions is the rise and fall in affect intensity over time. Individuals engaging in NSSI typically show high affective variability (Victor et al., 2021), which

reflects the overall amplitude of affective changes. Affective changes (from positive to negative affective states) can be considered as order transitions. The typical high affect fluctuations in individuals engaging in NSSI could be recognized by the presence of more critical instabilities in their affect data. Therefore, we hypothesize that an order transition phenomenon like affective change is accompanied by phases of critical instabilities (fluctuations in affect) of the time series resulting in an increase of dynamic complexity in individuals with a history of NSSI compared to controls.

**Figure 1**

*Diagrammatic Illustration of Various Modes of Distribution, Fluctuation, and Dynamic Complexity in One Individual*




*Note.* Distribution describes how the time series data is distributed across the scale range, fluctuation: frequency and amplitude of changes in time series, dynamic complexity: multiplicative product of a fluctuation measure and a distribution measure, *b* illustrates the highest fluctuation, while *a* illustrates the lowest one. *c* and *d* illustrate the highest distribution, *a* illustrates the lowest distribution. *b* and *d* show high dynamic complexity, whereas *a* shows low dynamic complexity.

To summarize, research has proposed that NSSI is associated with intense negative affect and affective instability. Although the evidence has highlighted the role of emotion regu-

lation in NSSI through negative reinforcement of aversive affect (e.g., Nock & Prinstein, 2004), some research has examined positively reinforcing effects (e.g., Jenkins & Schmitz, 2012).

## Present Study

Based on the literature described above, the present study is the first to apply the concept of DC to the description and analysis of NSSI. We are particularly interested in the following three hypotheses: First, we expect individuals engaging in NSSI to show a higher DC than controls without a history of NSSI. The resulting high DC in the NSSI group should be represented by frequent, large, and irregular fluctuations in time series. Second, we aim to examine mean levels of positive and negative affect in the NSSI group compared to controls. Previous research mostly focused on the role of negative affect and negative reinforcement in NSSI. Therefore, one could assume that participants with NSSI also show higher negative affect. However, we also wanted to investigate whether positive affect might be present as well. So, investigating DC in affective states that differ between individuals with and without a history of NSSI may be an opportunity to identify potential maintaining or risk factors of NSSI. Third, we investigate whether the average values of dynamic complexity change over time. We assume that the dynamic complexity should decrease during the course of the hospital stay, as therapeutic and pharmacological interventions should lead to the stabilization of the patients.

# Method

## Daily Assessments

Ecological momentary assessment (EMA) enables an assessment of behavior and psychological processes in everyday life. EMA reduces the influence of recall biases, enhances research findings' ecological validity, and tracks changes in intra-individual psychological processes (Stone & Shiffman, 1994). Another advantage of EMA is the distinction between state affect and trait affect.

## Participants

Inclusion criteria were a) suffering from a mental disorder; b) aged between 18 and 65 years; c) having adequate language skills in German to understand and follow instructions and give informed consent; d) non-suicidal self-injury in the last year for the NSSI-group and no such behavior in the control-group. Exclusion criteria were a) acute episodes of psychosis, psychotic or manic episodes, rapid cycling, and acute substance use; b) missing cognitive skills to complete assessment.

61 subjects selected according to the procedure described below met the required criteria, 33 (54.1%) of them did not show NSSI and constitute the control group (22 women,

11 men) with a mean age of 35.0 (*SD* = 10.73) years. In this group, 18 (54.5%) met the diagnostic criteria (ICD-10) of a depressive disorder, ten (30.3%) of an anxiety disorder, two (6.1%) of an obsessive-compulsive disorder, two (6.1%) of a personality disorder (avoidant and dependent personality disorder), and one (3.0%) of insomnia. The NSSI group consisted of 28 (45.9%) participants (26 females, two males) with a mean age of 26.69 (*SD* = 8.73) years. Of these, 12 (42.9%) met ICD-10 criteria for a depressive disorder, eight (28.6%) for a post-traumatic stress disorder, five (17.9%) for a primary diagnosis of borderline personality disorder, and three (10.7%) for an eating disorder. In addition, eight (28.6%) were diagnosed with comorbid borderline personality disorder. The diagnoses were initially assigned by the treating psychiatrist based on the clinical picture and confirmed in a second step by the researcher using the ICD-10 research criteria.

## Procedure

Subjects were recruited from an Austrian adult inpatient psychiatric unit ("Kardinal Schwarzenberg Klinik") located in the southern area of the federal state of Salzburg. Patients meeting inclusion criteria were invited to participate in the study and were informed about the studies' procedure in detail and written informed consent was obtained. Additionally, the phone number was recorded for being able to contact subjects during the study. Prior to commencement, the study procedure was approved by the Ethics Committee of the Province of Salzburg (EC number: 415-E). Only the third hypothesis was preregistered (see Bruckbauer-Schwed et al., 2023S), as the data for the first and second hypotheses had already been analyzed at the time of registration. Data collection started with a general questionnaire asking for age, gender, professional and family status and NSSI. With respect to that, subjects were asked if ever in their lives they had performed any NSSI-behavior; if yes, they were additionally asked about its frequency over their lifetime. Positive and negative affect was recorded by using the Positive and Negative Affective Schedule (PANAS) in an EMA-design over a period of at least six days. Participants received no compensation for their participation.

EMA was initiated by an invitation by a SMS-message. The questionnaire could be retrieved and completed in SoSci Survey (https://www.soscisurvey.de) on the subjects' mobile phones. Due to technical problems, data acquisition had to be changed to the mobile PIEL App (Jessup et al., 2012). With a wake-up function subjects were prompted to answer their questionnaires at 6 p.m. daily taking approximately five minutes to be completed. For assistance participants could contact the researcher at any time during the study period. It was also possible to complete the questionnaire in a paper-pencil-format. Two participants choose this option for some of their entries.

### Positive and Negative Affective Schedule (PANAS)

The Positive and Negative Affective Schedule (PANAS; Watson et al., 1988; German: Krohne et al., 1996) consists of two 10-item scales, one for positive and one for negative affect. Participants rated, how they generally felt during each day with respect to each emotion on a 5-point Likert-like intensity scale (1 = *very slightly/not at all*, 5 = *extremely*). The internal consistency of the PANAS is high, with Cronbach alpha's of 0.90 for positive and 0.87 for negative affect (Watson et al., 1988).

### Statistical Analyses

Dynamic complexity (DC) (Schiepek & Strunk, 2010) was computed for the PANAS´s positive and negative affect subscales. DC is a measure for identifying critical instabilities and fluctuations in short, coarse-grained, time series like those obtained in typical diary studies. It is calculated from two parameters: fluctuation intensity and distribution (see section on DC above). The fluctuation measure is highest when the time series fluctuates widely between its minimum and maximum, while the distribution measure is larger when it takes many different values. Both parameters are then multiplied by each other, resulting in a total dynamic complexity measure. Both parameters were calculated in moving windows. Like other studies using this method (e.g., Schiepek et al., 2014), we chose a moving window size of seven days. To identify local complexity peaks, we calculated the difference between the average and maximum complexity of each PANAS item. Peak complexity values for individual positive and negative affect items were averaged to obtain scale-level peak complexity values. We then used *t*-tests to compare the peak complexity values for the positive and negative affect scales of patients with NSSI to those of controls. Finally, to test whether average dynamic complexity values change over time, we fitted linear mixed models to predict dynamic complexity of the positive and negative affect scales from number of days since admission and group (NSSI vs. controls). Models included random intercepts for each participant and an interaction effect of the group by time. The linear mixed models were included to determine whether there were temporal trends in the development of dynamic complexity. Missing values were imputed using Kalman filter imputation.

## Results

The assessment period for the NSSI group was between 8 and 37 days (*Mdn* = 16.5, *M* = 17.21, *SD* = 5.56) and between 6 and 32 days for the control group (*Mdn* = 14.0, *M* = 14.24, *SD* = 5.73). The frequency of NSSI acts during their lifetime was classified in intervals. Eleven participants indicated more than 60 NSSI acts, three between 31 and 60, seven between 30 and 16, three between six and 15, and four between two and five acts. In the NSSI group, a median number of 2.5 assessments (interquartile range: 5.25) were missing

and had to be imputed. In the control group, a median of 3 assessments (interquartile range: 4) were missing.

On average, patients engaged in NSSI showed significantly higher peak complexity scores than controls (Figure 2). This was true for both positive ($t(44.89) = 2.88$, $p = .006$) and negative affect ($t(57.65) = 2.08$, $p = .042$). The effect sizes of these differences were medium for positive affect ($d = 0.77$, 95% CI [0.23, 1.30]) and medium for negative affect ($d = 0.54$, 95% CI [0.01, 1.06]).

As a robustness analysis, we repeated the comparisons after excluding four patients reporting only between two and five NSSI acts during their lifetime. This led to slightly higher group differences. For positive affect complexity, the difference was significant and large ($t(42.42) = 3.21$, $p = .002$, $d = 0.86$). For negative affect complexity, the difference was significant and medium ($t(56.26) = 2.17$, $p = .034$, $d = 0.56$).

In addition, NSSI patients had higher mean levels of positive affect: the mean PANAS positive affect score in the NSSI group was 2.41 ($SD = 0.34$) compared to 2.16 ($SD = 0.36$) in the non-NSSI group. This difference was significant ($t(55,02) = 2,36$, $p = .022$; $d = .61$). There was no evidence of differences in negative affect: in the NSSI group, the mean PANAS negative emotion score was 2.26 ($SD = 0.41$), compared to a mean of 2.27 ($SD = 0.48$) in the non-NSSI group ($t(58.98) = -0.12$, $p = .906$). Figure 3 shows the distribution of mean-max complexity in positive and negative affect. The NSSI group has higher scores for both positive and negative affect, demonstrating that the NSSI group generally has higher emotionality than the control group.

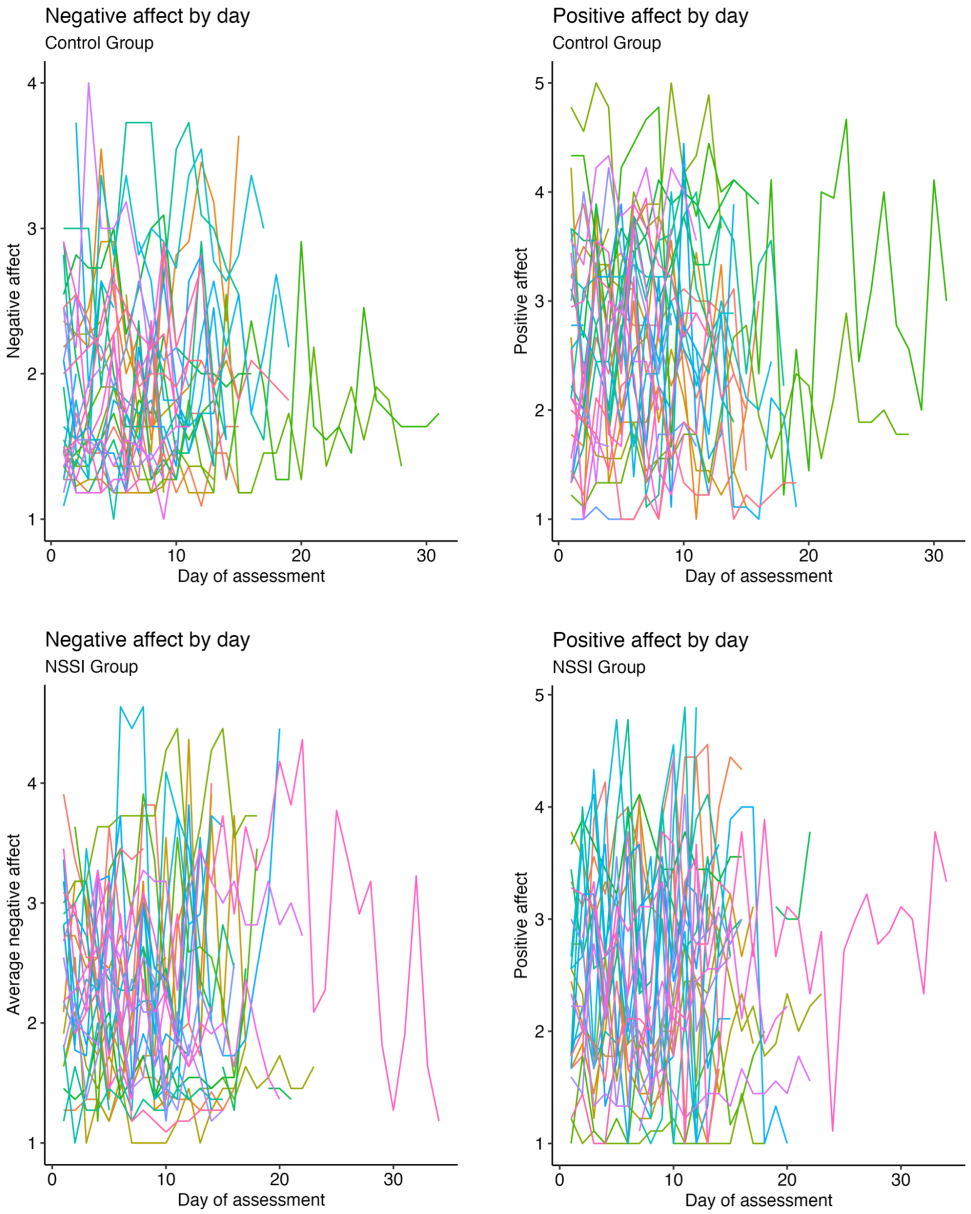
Furthermore, we fitted a linear mixed model to predict positive complexity (= DC of positive affect) from time (in days) and group (NSSI vs. control) as predictors. The model included a random intercept for each participant. The model's total explanatory power was substantial (conditional $R^2 = 0.50$), and the part related to the fixed effects alone (marginal $R^2$) was 0.02.

The second linear mixed model predicted negative complexity (= DC of negative affect) from the same variables as the first model. The total explanatory power was substantial (conditional $R^2 = 0.57$), and the part related to the fixed effects alone (marginal $R^2$) was 0.08. Standardized parameters of the models were obtained by fitting the model on a standardized version of the dataset. 95% Confidence Intervals (CIs) and $p$-values were computed using a Wald $t$-distribution approximation. We did not find an association of length of stay with dynamic complexity. The models are summarized in Table 1 and Table 2.

The average reported NSSI frequency was not related to the average positive affect, $r(26) = -.10$, and the average negative affect, $r(26) = -.04$, both $p > .05$. Similarly, there was no significant correlation between the number of NSSIs and the peak complexity for positive ($r(26) = -.06$) and for negative ($r(26) = .08$) emotions, both $p > .05$.

**Figure 2**

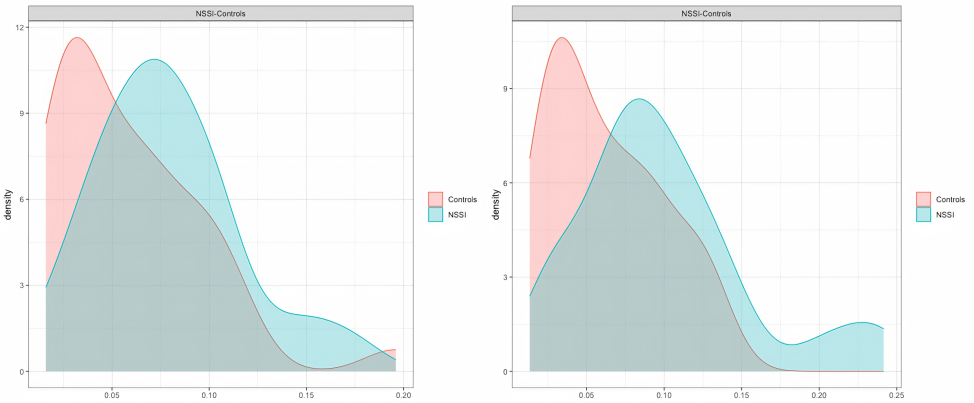
*Raw Affect Scores Over the Period of Assessment for All Participants*




*Note.* Coloured lines represent individual subject's daily affect assessments; x-axis: number of days of assessment; y-axis: affect intensity.

**Figure 3**

*Distribution of Mean Max Complexity*




*Note.* (A) distribution of mean max complexity of positive affect. (B) distribution of mean max complexity of negative affect.

**Table 1**

*Coefficients for the Linear Mixed Model Predicting the Dynamic Complexity of Positive Affect From Time and Group*

| | Estimates | 95% CI | *p* |
|---|---|---|---|
| **Predictors** | | | |
| (Intercept) | 0.03 | 0.02; 0.05 | < .001 |
| Days | -0.00 | -.00; .00 | 0.132 |
| Group [NSSI] | 0.01 | -.01; .03 | .333 |
| Days x Group [NSSI] | 0.00 | -.00; .00 | .616 |
| **Random Effects** | | | |
| $\sigma^2$ | 0.00 | | |
| $\tau_{00\ Code}$ | 0.00 | | |
| ICC | 0.49 | | |
| $N_{Code}$ | 59 | | |
| Observations | 671 | | |
| Marginal $R^2$ | .02 | Conditional $R^2$ | .50 |

*Note.* 95% CI = 95% confidence interval; NSSI = non-suicidal self-injury; $\sigma^2$ = variance of intercepts; $\tau_{00\ Code}$ = standard deviation of intercepts; ICC = intraclass correlation; $N_{Code}$ = number of participants; Marginal $R^2$ = variance explained by fixed effects; Conditional $R^2$ = variance explained by both fixed and random effects.

**Table 2**

*Coefficients for the Linear Mixed Model Predicting the Dynamic Complexity of Negative Affect From Time and Group*

| | Estimates | 95% CI | *p* |
|---|---|---|---|
| **Predictors** | | | |
| (Intercept) | 0.02 | 0.01; 0.03 | < .001 |
| Days | -0.00 | -.00; .00 | 0.141 |
| Group [NSSI] | 0.02 | .00; .04 | .041 |
| Days x Group [NSSI] | 0.00 | -.00; .00 | .274 |
| **Random Effects** | | | |
| $\sigma^2$ | 0.00 | | |
| $\tau_{00\ Code}$ | 0.00 | | |
| ICC | 0.53 | | |
| $N_{Code}$ | 59 | | |
| Observations | 671 | | |
| Marginal $R^2$ | .08 | Conditional $R^2$ | .57 |

*Note.* 95% CI = 95% confidence interval; NSSI = non-suicidal self-injury; $\sigma^2$ = variance of intercepts; $\tau_{00\ Code}$ = standard deviation of intercepts; ICC = intraclass correlation; $N_{Code}$ = number of participants; Marginal $R^2$ = variance explained by fixed effects; Conditional $R^2$ = variance explained by both fixed and random effects.

## Discussion

The current study is, to our knowledge, the first to examine DC and the role of positive affect in NSSI, particularly in an adult clinical sample. Consistent with our first hypothesis, participants in the NSSI group showed higher DC in affect – both positive and negative – than controls. This study impressively demonstrated that only a few days are sufficient to show the typical dynamic pattern of high affect fluctuation in individuals with a history of NSSI. Although NSSI is generally associated with an increase in negative affect in most other studies, in our study individuals with a history of NSSI specifically showed more positive affect than controls. We could not find significant differences in mean levels of negative affect. Previous studies have reported mixed findings regarding positive affect in NSSI (e.g., Armey et al., 2011; Jenkins & Schmitz, 2012). We did not find a significant relationship between change in dynamic complexity of affect and length of inpatient stay in either the NSSI or the control group.

The finding that individuals with a history of NSSI showed increased DC for both positive and negative affect is consistent with previous research showing higher affect variability / instability in the NSSI group compared to controls (Santangelo et al., 2017; Victor et al., 2021). The advantage of using DC instead of, for example, classical variance as a measure of varying degrees of fluctuations is that variance is indifferent to the shape of the time series, unlike F and D, which are influenced by it. Variance specifically

indicates the magnitude of fluctuations without regard to the frequency or sequence of system states. We were also able to show that the NSSI group generally has higher emotionality than the control group. This result is consistent with other studies based on emotional experience (e.g., Victor & Klonsky, 2014). According to the study by Victor and Klonsky (2014), self-injurers show higher negative emotions than non-injurers.

To explain our finding of increased positive affect in our NSSI group, several explanations can be considered: First, some authors emphasize the addictive nature of NSSI (e.g., Buser & Buser, 2013), including compulsivity, loss of control, and continuation despite negative consequences. In this sense, engagement in NSSI may activate the EOS (endogenous opioid system), which contributes to the experience of analgesia by releasing opiates in response to tissue damage. This physiological process can lead to an improvement in mood (Sandman & Touchette, 2002). Second, positive reinforcement is an important general motive for maintaining NSSI, as demonstrated in previous studies (e.g., Selby et al., 2014). Selby et al. (2014) found that more than 50% of their sample reported at least one instance of NSSI for automatic positive reinforcement (APR) reasons, with "satisfaction" as the most frequently endorsed motivation. In addition, self-injurers with APR motives reported more frequent NSSI. Third, we used a psychiatric control group with a higher proportion of depressed patients (54.55% vs. 42.9%). Depressives typically show elevated levels of negative affect compared to non-depressives. Although we did not test this assumption statistically, it is plausible to assume that the higher proportion of depressives in the control group accounts for the lower levels of positive affect in this group. Fourth, 13 (46.43%) participants in the NSSI group met criteria for a borderline personality disorder diagnosis (primary or comorbid). Borderline personality disorder and NSSI overlap in some criteria (e.g. impaired emotion regulation). Therefore, it could also be possible that the group differences are not due to NSSI, but to other psychopathological characteristics. Future studies should definitely investigate this possibility. Furthermore, Stapleton and Wright (2019) reported that psychiatric inpatients diagnosed with borderline personality disorder indicate positive experiences with inpatient care for many reasons: the opportunity to talk to someone and be listened to, time away from everyday life, feeling safe, and gaining control over their recovery. In our opinion, this argument is particularly important for our study, because almost 50% of the NSSI group consisted of patients with borderline personality disorder, while not a single patient in the control group had this diagnosis. It can therefore be assumed that the patients with borderline personality disorder in our study had similar positive experiences during their inpatient stay. The increased level of positive affect found in our NSSI sample could therefore be attributed to this. Finally, we examined whether average dynamic complexity changed over time. The association was not significant. The average length of stay in the psychiatric department of the Kardinal Schwarzenberg Clinic is between 2 and 3 weeks, and the average assessment period was 17 days for the NSSI group and 14 days for the control group. Perhaps the length of stay or assessment period was too short

to detect a change in dynamic complexity over time. Fowler et al. (2016) found significant improvements in experiential avoidance and emotion dysregulation only after 6-8 weeks of intensive inpatient psychiatric treatment.

## Limitations

Our study has several limitations. The first is that our sample size is not very large, which limits generalizability. On the other hand, the results suggest that intra-individual differences in dynamic complexity explain significantly more variance than differences in assessment duration or between-group differences. Future studies with larger samples and, thus, higher power to detect smaller effects, should be done to replicate our findings. A second major limitation is that we made only one measurement per day. Normally, affective changes occur several times per day, especially in emotionally unstable subjects. Consequently, a single assessment per day may not have been sufficient to capture the dynamics of emotional change. Typical ambulatory assessment studies therefore perform several measurements per day. However, this limitation may also be an advantage, as studies have found lower compliance rates in these designs. In their systematic review, Hepp et al. (2020) found an average compliance rate of 64.9% with prompts for more than one daily measurement, while a single daily measurement resulted in an average compliance rate of 78.9%. To minimize the risk of low response rates and early study termination, we chose to use a single measurement per day design. A third possible limitation is that participation in our study was not incentivized. Hepp et al. (2020), in their systematic review of daily life studies of NSSI, found that incentivized studies resulted in higher compliance rates. A fourth limitation is the assessment of the frequency of NSSI. We could only ask our participants for a retrospective estimate of the number of times they had injured themselves in their lifetime. This type of assessment is problematic because individuals may have had difficulties in recalling the exact number of lifetime self-injurious acts. In addition, many members of the NSSI sample have engaged in NSSI continuously over a long period of their lives. In this case, the exact number of NSSI events is likely to be impossible to assess. Due to the lack of compliance, it was not possible to assess individual acts of NSSI during the clinic stay or the survey period. Thus, we could not directly examine associations between acts or attempts of NSSI and affective states. As a result, we could not examine the relationship between emotions and NSSI acts, e.g., whether positive (or negative) affect occurs before or, in the case of a positive act, after an NSSI act. We were unable to assess the effects of the medications that participants received during their stay, as well as the effects of their psychological treatments on their affect fluctuations.

## Conclusion and Implications

The results of our study illustrate that individuals with a history of NSSI show greater dynamic complexity for positive as well as negative affect and higher mean levels of positive affect. Future studies should explicitly consider this possibility and explore the dynamics of positive emotions in the context of NSSI more intensively, especially with larger samples, but also in individual case studies as a second very insightful strategy. The higher variance explained at the individual level suggests that the application of dynamic complexity is more meaningful when considered at the individual case level. Regarding prevention and treatment, future research should also focus on specific patterns of affect dynamics to identify early warning signs of critical instability and order transitions in individuals with a history of NSSI. Knowledge of these phenomena offers the possibility of early intervention in affective change. For example, van de Leemput and colleagues (2014) reported that specific dynamic patterns of emotions are associated with the onset and offset of episodes of major depression. In addition, anticipating and observing order transitions in affect may be useful for clinical assessment of mental disorders and treatment planning (e.g., dialectical behavior therapy (DBT)) to reduce affective instability).

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**Ethics Statement:** This research was approved by the Ethical Committee of the country of Salzburg (EC Number: 415-E/2147). All subjects gave written informed consent in accordance with the Declaration of Helsinki (2013).

**Reporting Guidelines:** JARS-Quant guidelines for quantitative research

**Data Availability:** The data that support the findings of this study are available on request from the corresponding author, Michaela Bruckbauer-Schwed.

## Supplementary Materials

The Supplementary Materials contain the preregistration for the study (for access, see Bruckbauer-Schwed et al., 2023S).

### Index of Supplementary Materials

Bruckbauer-Schwed, M., Kaiser, T., Plöderl, M., & Laireiter, A.-R. (2023S). *Dynamic complexity of positive and negative affects in NSSI – A daily diary study* [Preregistration]. PsychArchives. https://doi.org/10.23668/psycharchives.13937

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