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Research paper

Cognitive-emotional networks in students with and without a history of non-suicidal self-injury

Thomas Duncan-Plummer [a], Penelope Hasking [a,b,*], Kate Tonta [a,b,c], Mark Boyes [a,b]

[a] School of Population Health, Faculty of Health Sciences, Curtin University, Perth, Australia
[b] Curtin enAble Institute, Faculty of Health Sciences, Curtin University, Perth, Australia
[c] Centre for Clinical Interventions, Perth, Australia

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ABSTRACT

Background: Contemporary models of non-suicidal self-injury (NSSI) suggest that emotional vulnerabilities, negative self-schemas, and beliefs about NSSI work together to differentiate students who self-injure from those who do not. However, it is unclear how these mechanisms are differentially related among students with and without a history of NSSI. Considering this, we used a network analysis approach to explore how students with and without a history of NSSI vary in processing their emotional experiences in relation to their self-concepts and beliefs about NSSI.

Method: A sample of 480 university students (M_{age} = 21.18, SD = 2.43; 73.5 % female) completed self-report measures about their perceived emotional experiences (e.g., emotional reactivity, emotion regulation difficulties), self-concepts (e.g., self-esteem, self-efficacy), and NSSI.

Results: A network comparison test revealed that students with a history of NSSI perceived themselves to have difficulties regulating particularly intense, unwanted negative emotions. In light of this, students with a history of NSSI expected some benefits of NSSI (e.g., emotion regulation) regardless of potential barriers (e.g., pain). Conversely, for students without a history of NSSI, expecting NSSI to have aversive outcomes was tied to expecting NSSI to have few benefits.

Limitations: The cross-sectional design limits inferences to be made about the network structures.

Conclusions: Students with and without a history of NSSI appear to differ in their cognitive processing of negative emotions and strategies used to deal with these emotions.

1. Introduction

Non-suicidal self-injury (NSSI) is self-inflicted damage to one's body tissue (e.g., cutting, burning, and hitting oneself) without suicidal intent (International Society for the Study of Self Injury [ISSS], 2018). Approximately 11.5 % of young adults in the general population and 20.2 % of university students are likely to report a history of NSSI (Swannell et al., 2014). Although individuals typically first engage in NSSI during adolescence (Plener et al., 2015), there is another peak onset period during emerging adulthood which often coincides with university studies and associated life-stressors (Gandhi et al., 2017). Although NSSI is not characterised by suicidal intent, it frequently co-occurs with suicidal behaviour (Voss et al., 2020) and is a strong predictor of future suicide attempts (Ribeiro et al., 2016). Furthermore, individuals who engage in NSSI are often stigmatised (Staniland et al., 2020) and are prone to experience more stressful life-events in the future (Baetens et al., 2021). To better support individuals who engage in NSSI, it is critical to understand why some individuals are more likely to self-injure than others.

Individuals who engage in NSSI often report that NSSI helps them regulate their emotions (Taylor et al., 2018). Some individuals may use NSSI to distract themselves from suicidal urges (Paul et al., 2015) and to avoid unwanted negative emotions which are perceived as intense, pervasive, and difficult to manage (Chapman et al., 2006; Nock et al., 2008; Selby and Joiner, 2009). Individuals may also self-injure to communicate emotional distress and seek help from others, or to punish themselves (Nock and Prinstein, 2004; Taylor et al., 2018). Through recurring use of NSSI, a positive feedback loop may emerge where the emotion regulation benefits become more apparent, accessible, and habituated, which may lead to further NSSI engagement in a repetitive

* Corresponding author.
E-mail address: penelope.hasking@curtin.edu.au (P. Hasking).

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cycle (Chapman et al., 2006; Hooley and Franklin, 2018).

Contemporary models of NSSI integrate emotional processing and social-cognitive theory to explain why some individuals are more likely to self-injure than others (Hasking et al., 2017; Hooley and Franklin, 2018). According to the Cognitive-Emotional Model of NSSI (Hasking et al., 2017), individuals are more likely to self-injure if they are highly reactive to negative emotions, experience difficulties regulating these emotions (e.g., perceive having few strategies to deal with their emotions), and have learned to expect that NSSI is an effective strategy to regulate these emotions. Conversely, individuals who believe that they can tolerate distress, resist the urge to self-injure, and use other strategies to manage their emotions (e.g., cognitive reappraisal) are less likely to self-injure (Hasking et al., 2017). According to the Benefits and Barriers Model (Hooley and Franklin, 2018), individuals who view themselves positively and perceive NSSI to be a painful, unhelpful, and aversive behaviour are less likely to see NSSI as a beneficial way to cope with negative emotions, and are therefore less likely to self-injure. In contrast, individuals who criticise themselves for failing to meet high standards and experience low self-esteem are more likely to self-injure (Gyori and Balazs, 2021).

In line with these perspectives, individuals with a history of NSSI generally report higher trait negative and lower trait positive affect (Burke et al., 2018), more emotional reactivity (Nock et al., 2008), greater psychological distress and difficulties managing negative emotions (Richmond et al., 2017; Wolff et al., 2019), negative self-schemas (Forrester et al., 2017), and expectations that NSSI will be an effective emotion regulation strategy which is difficult to resist under stress (Hasking and Boyes, 2018). However, most of the research referring to the Cognitive-Emotional Model of NSSI focuses on relationships between only a few of these key factors in isolation (e.g., NSSI outcome-expectancies and emotion regulation, Hird et al., 2022; negative self-schemas; Taylor et al., 2019). This leaves an incomplete picture of how these constructs operate together, and their relative importance for students with and without a history of NSSI. Considering this, it may be necessary to take a broader approach to understand how cognitive-emotional processing may differ between students with and without a history of NSSI.

A novel way to explore complex cognitive-emotional relationships implicated in NSSI would be to arrange them in a psychological network. Psychological networks are typically used to visualise relationships between symptoms of a disorder, which can be analysed graphically to identify important symptoms which may theoretically maintain the disorder (Borsboom and Cramer, 2013). Networks may also comprise broader constructs implicated in psychopathologies (Jones et al., 2017), and can be applied to characteristics of behaviors such as NSSI (e.g., Buelens et al., 2020). Networks may be particularly useful for exploring integrative frameworks similar to the Cognitive-Emotional Model of NSSI (e.g., Heeren and McNally, 2016), and have been used to assess mechanisms of eating disorders (e.g., Levinson et al., 2017) and borderline personality disorder (e.g., Richetin et al., 2017).

A network of cognitive-emotional mechanisms involved in NSSI could be represented by a constellation of circles (*nodes*) connected to other nodes by lines which reflect a partial correlation between two nodes (*edges*). More specifically, emotional reactivity, positive and negative affect, psychological distress, emotion regulation difficulties and strategies, distress tolerance, self-schemas (e.g., self-efficacy, perfectionism), and NSSI outcome expectancies could all be represented as nodes related to each other via edges. This allows for a more comprehensive representation of cognitive-emotional constructs linked to NSSI than looking at individual factors alone. Once the network is constructed, the relative strength of each edge can be assessed by looking at the *edge-weights,* which are the partial correlation coefficients between two nodes (e.g., emotional reactivity and negative affect) after accounting for their relationships with all other nodes. If a node is strongly connected to other nodes in the network, it has high *strength-centrality* (Barrat et al., 2004). Theoretically, this suggests that it plays an important role in the network, and that it may be worth investigating its potential as a target in treatment (see Borsboom, 2017; Elliott et al., 2020). Therefore, identifying meaningful edges and central nodes in the networks could help us understand the relative importance of cognitive, emotional, and self-schemas linked to NSSI.

Although existing models of NSSI outline a role for cognitive-emotional constructs in NSSI, less is known about how the interactions between these constructs may differentiate individuals with and without a history of NSSI. Networks composed of the same nodes can also be compared across different samples (e.g., students with and without a history of NSSI) to identify the varying interconnectivity of nodes between groups (van Borkulo et al., 2022). Considering this, a network comparison test would be useful for considering how emotional constructs associated with NSSI (e.g., emotional reactivity) may differentially relate to specific difficulties with emotion regulation (e.g., limited strategies for regulating emotions) or specific emotion regulation strategies (e.g., reappraisal) in people with and without a history of NSSI. For example, perhaps individuals who have self-injured perceive limited access to strategies for regulating their emotions primarily as a function of emotional reactivity, whereas those without a history of self-injury may find it harder to access strategies as a function of psychological distress. This insight would be more useful than simply knowing to what degree an individual is emotionally reactive, distressed, and has difficulties regulating their emotions. Thus, a network analysis allows us to understand nuances in cognitive-emotional processes linked to NSSI so that better support can be provided for students who may self-injure. Using the Cognitive-Emotional Model of NSSI to inform which NSSI-related constructs to include in the networks, we aimed to explore how these constructs may differentially relate among students with and without a history of NSSI through testing for invariance between cognitive-emotional networks among students with and without a history of NSSI.

2. Methods

2.1. Participants and procedure

The Human Research Ethics Committee at Curtin University approved the data collection procedures and recruitment strategies used in this study. We invited Australian university students (specifically students with and without a history of NSSI) to participate in an online survey using social-media advertisements and the undergraduate research pool. Information regarding the study was communicated to students through an online information sheet before they consented to participate. The survey took 45–60 min to finish. For their participation, students were rewarded course credit or placed in a draw to win either an iPad or one of ten $25 vouchers. Participants were provided information about how to access mental-health resources after completing the survey.

The final sample comprised 480 Australian university students aged 18–41 years ($M_{age} = 21.18$, $SD = 2.43$, 73.5 % identified as female). The majority (76.9 %) of participants were born in Australia. Two-hundred participants (41.7 %) reported a history of NSSI. Approximately 113 participants reported engaging in NSSI within the last 12 months, and 48.7 % of these participants reported having self-injured five or more times during this period. Cutting was the most commonly reported primary method of NSSI (49.5 %), followed by severe scratching (12.2 %) and hitting oneself (11.6 %). Mean age of NSSI onset was 13.7 years, $SD = 3.05$.

2.2. Measures

Table 1 contains key details about the measures used in this study. A more in-depth description of these measures is located in the Supplementary Materials.

Table 1
Measures of variables comprising cognitive-emotional networks in students with and without NSSI.

Measure	Description	Scoring	Total score/subscales	Psychometrics	α
Inventory of Statements about Self-Injury (ISAS; Klonsky and Glenn, 2009).	Measures NSSI history, primary method of NSSI, age of NSSI onset, NSSI frequency in the last year.	NSSI history coded as 0 = No NSSI history, 1 = NSSI History. Frequency is measured on a six-point scale (1 = *none* to 6 = *five or more times*).	–	Good test-retest reliability over four weeks ($r = 0.85$) and one year ($r = 0.68$; Glenn and Klonsky, 2011).	–
Non-Suicidal Self-Injury Expectancies Questionnaire (NEQ; Hasking and Boyes, 2018).	Measures outcome expectancies participants may have about engaging in NSSI (regardless of whether they had engaged in NSSI).	20 items where higher scores on a four-point scale (1 = *extremely unlikely* to 4 = *extremely likely*) indicate greater perceived likelihood of outcome occurring after self-injuring.	Affect Regulation (OE_REG), Communication (OE_COM), Negative Self-Beliefs (OE_SEL), Pain (OE_PAI), Negative Social Outcomes (OE_NES).	Sound internal consistency (α = 0.71–0.86) and construct validity among university students (Hasking and Boyes, 2018).	0.70–0.87
Adapted Self-Efficacy to Avoid Suicidal Action Scale (Czyz et al., 2014).	Measures participants' self-efficacy to resist NSSI (regardless of whether they had engaged in NSSI).	Six items where higher scores on a six-point scale (1 = *very uncertain* to 6 = *very certain*) indicate greater self-efficacy to resist NSSI.	Total score (SERS)	Excellent internal consistency (α = 0.92; Hasking and Rose, 2016).	0.94
General Self-Efficacy Scale (GSE; Schwarzer and Jerusalem, 1995).	Measures participants' perceived general capacity to accomplish goals and manage life difficulties.	10 items where higher scores on a four-point scale (1 = *not at all true* to 4 = *exactly true*) indicate greater general self-efficacy.	Total score (GSE)	Good internal consistency (α = 0.85) and construct validity with other measures of self-efficacy (Scherbaum et al., 2006).	0.90
Rosenberg Self-Esteem Scale (RSE; Rosenberg, 1965).	Measures participants' self-esteem.	10 items where higher scores on a four-point scale (1 = *strongly agree* to 4 = *strongly disagree*) indicate a more positive perception of oneself.	Total score (SE)	Excellent internal consistency (α = 0.90) and construct validity with other self-esteem measures in university student samples (Robins et al., 2001).	0.92
Clinical Perfectionism Questionnaire (CPQ; Fairburn et al., 2003).	Measures participants' perceived level of clinical perfectionism (i.e., overdependence of self-worth on meeting high standards).	12 items (e.g., "Have you felt a failure as a person because you have not succeeded in meeting your goals?") where higher scores on a four-point scale (1 = *not at all* to 4 = *all of the time*) indicate higher levels of clinical perfectionism. Negative coded items were removed (see Supplementary Materials).	Total score (CP)	Sound internal consistency (α = 0.78) and construct validity with other perfectionism measures (Howell et al., 2020), as well as good four-month test-retest reliability (Dickie et al., 2012).	0.81
Depression Anxiety Stress Scales (DASS-21; Lovibond and Lovibond, 1995).	Measures participants' perceived psychological distress (symptoms of depression, anxiety, and stress) over the past week.	21 items, where higher scores on a four-point scale (0 = *never* to 3 = *almost always*) indicate greater psychological distress.	Total Score (DASS)	Excellent internal consistency (α = 0.93; Henry and Crawford, 2005), and construct validity in university students (e.g., Osman et al., 2012).	0.93
Distress Tolerance Scale (DTS; Simons and Gaher, 2005).	Measures a participant's perceived tolerance to distressing emotional states.	15 items (e.g., "Feeling distressed or upset is unbearable to me"), where higher scores on a five-point scale (1 = *strongly agree* to 5 = *strongly disagree*) indicate greater distress tolerance.	Tolerance (DTS_Tolerance), Appraisal (DTS_Appraisal), Absorption (DTS_Absoprtion), Regulation (DTS_Regulation).	Sound internal consistency (α = 0.76–0.86), construct validity, and discriminative validity (Brown et al., 2022b).	0.76–0.86
Positive and Negative Affect Schedule (PANAS; Watson et al., 1988).	Measures the extent to which a participant generally experiences positive and negative affect.	10 items for positive affect (e.g., "Joyous") and 10 items for negative affect (e.g., "Guilty"), where higher scores on a five-point scale (1 = *very slightly or not at all* to 5 = *extremely*) indicate greater levels of positive or negative affect, respectively.	Positive Affect (PA) and Negative Affect (NA).	Good internal consistency (positive affect, α = 0.89; negative affect, α = 0.85) and construct validity with other affect measures (Crawford and Henry, 2004).	0.91–0.91
Emotional Reactivity Scale (ERS; Nock et al., 2008)	Measures participants' perceived emotional reactivity (i.e., experience of emotional sensitivity, intensity, and persistence).	21 items (e.g., "My feelings get hurt easily"), where higher scores on a five-point scale (0 = *not at all like me* to 4 = *completely like me*) indicate greater emotional reactivity.	Total score (EREACT)	Excellent internal consistency (α = 0.96) and demonstrated construct validity (see Nock et al., 2008).	0.96
Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski and Kraaij, 2007)	Measures participants' self-reported use of nine cognitive emotion regulation strategies during distressing events.	36 items, (e.g., "I think I have to accept the situation"), where higher scores on a five-point scale (1 = almost never to 5 = almost always) denote greater use of that strategy.	Self-blame (SBlame), Acceptance (Accept), Focus on thought/ rumination (Rumina), Positive refocusing (Refocu), Refocus on planning (Plann), Positive reappraisal (Reappr), Putting into perspective (Perspe), Catastrophizing (Catastr), and Blaming others (BlameOt).	Demonstrated sound validity and reliability (e.g., Garnefski and Kraaij, 2007).	0.67–0.89

(*continued on next page*)

Table 1 (*continued*)

Measure	Description	Scoring	Total score/subscales	Psychometrics	α
Difficulties with Emotion Regulation Scale (DERS; Gratz and Roemer, 2004).	Measures participants' perceived emotion regulation difficulties experienced under distress.	36 items, (e.g., "When I'm upset, I believe that there is nothing I can do to make myself feel better"), where higher scores on a five-point scale (1 = *almost never* to 5 = *almost always*) indicate greater emotion regulation difficulty in that domain.	Non-acceptance of emotional responses (DERSNA), Difficulties engaging in goal-directed behaviour (DERSGD), Impulse control difficulties (DERSIC), Lack of emotional awareness (DERSEA), Limited access to emotion regulation strategies (DERSELS), Lack of emotional clarity (DERSEC).	Good internal consistency across each subscale (α = 0.80–0.89; Gratz and Roemer, 2004).	0.84–0.93
Brief Experiential Avoidance Questionnaire (BEAQ; Gámez et al., 2014)	Measures participants' tendency to avoid undesirable emotions (e.g., suppressing emotions, avoiding tasks). Shortened version of the Multidimensional Experiential Avoidance Questionnaire (Gámez et al., 2011).	15 items (e.g., "I go out of my way to avoid uncomfortable situations", where higher scores on a six-point scale (1 = *not at all* to 6 = *all of the time*) denote greater levels of experiential avoidance.)	Total score (ExpAvoid).	Sound internal consistency (α = 0.86) and construct validity with other measures of avoidance (Gámez et al., 2014).	0.90

Note. Column α = Cronbach's alpha in the present study. Names of scales and subscales in brackets represent node names in the networks of students with and without a history of NSSI. More details about these measures (e.g., example items for each subscale) can be found in the Supplementary Materials.

2.3. Data analysis

We used the *estimateNetwork* function via the *bootnet* package (Epskamp et al., 2018) in R v4.1.2 to estimate regularised partial correlation networks (using the default "*EBICglasso*" model) for both individuals with and without a history of NSSI separately. We ran the standard *bootnet* procedure to assess the edge-weight accuracy of each network, which utilised non-parametric bootstrapping involving 2500 bootstrap samples. We also used *bootnet* to estimate strength-centrality using case-drop bootstrapping with 1000 bootstrap samples, to test for significant differences in strength-centrality and edge-weights within each network, and to measure strength-centrality stability for each of the networks (see Epskamp et al., 2018). Finally, we used the *NetworkComparisonTest* package (van Borkulo et al., 2022) with 1000 iterations to compare the global strength and structure of each network, and to test for edge-weight and centrality differences between the networks at both α = 0.05 and with a Holm-Bonferroni correction for multiple testing.

3. Results

3.1. Preliminary analysis

Descriptive statistics, bivariate correlations, and independent samples *t*-tests for each node for students with and without a history of self-injury are in the Supplementary Materials. Several nodes were strongly correlated (e.g., negative affect and psychological distress), though not to the extent that they were measuring identical constructs ($r < 0.80$; see Tabachnick and Fidell, 2013). Favouring specificity in line with the Cognitive-Emotional Model of NSSI, we decided not to sum these measures into composite nodes (see McNally, 2021 for a discussion).

3.2. Network analysis

3.2.1. Network visualisation

The cognitive-emotional networks of individuals with and without a history of NSSI are presented in Fig. 1. Both networks were visualised using the *qgraph* package (Epskamp et al., 2012). Weaker edge-weights are represented by thin, faint lines between nodes, and stronger edge-weights are represented by thicker, bolder lines between nodes. Blue lines represent positive edges, and red lines represent negative edges. We fixed the average layout of both networks using the *averageLayout* function to ease interpretation of edge differences, and curved the edges to minimise potential overlaps between edges and nodes. Edge weights in the network of students without a history of NSSI ranged from −0.001 (*self-blame — absorption*) to 0.38 (*tolerance — absorption*). Edge-weights in the network of students with a history of NSSI ranged from 0.002 (*catastrophizing — non-acceptance of emotional responses*) to 0.46 (*tolerance — absorption*).

3.2.2. Edge-weight accuracy and centrality stability

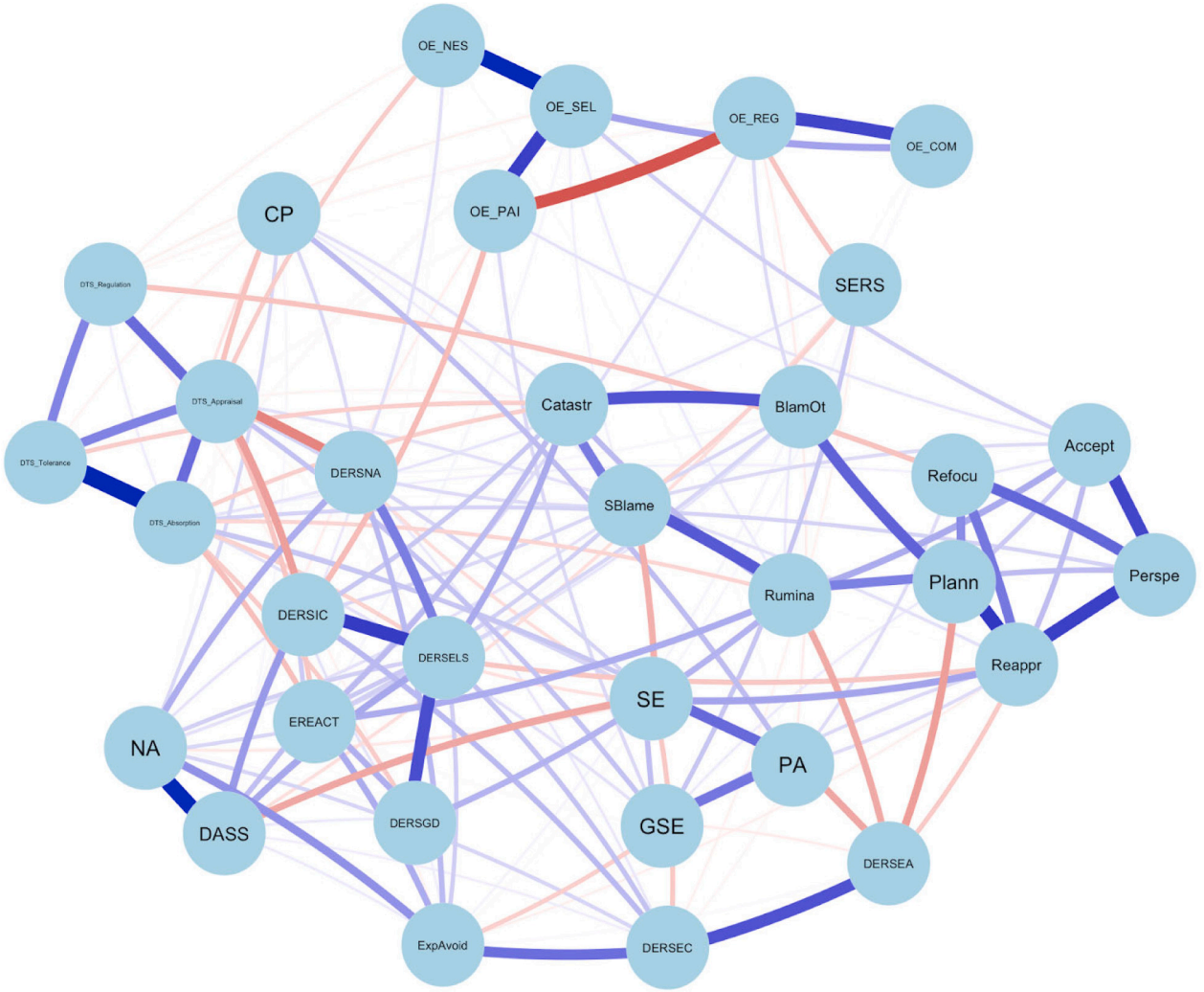
Non-parametric bootstrap analysis results for the cognitive-emotional networks of students with and without a history of NSSI are included in the Supplementary Materials. Most of the bootstrapped confidence intervals were small to moderate, with only some degree of overlap. Although several edge-weights were significantly different from most others edges (e.g., *pain-expectancy — affect regulation expectancy* for students without a history of NSSI), some edges that appeared relatively strong were not significantly different to most other edges in the network (e.g., *perfectionism — positive affect* for students without a history of NSSI). Therefore, the order of edge-weight estimates can be interpreted with some confidence, but caution should still be taken when interpreting visually weaker edges. Centrality stability was adequate for the network of students without a history of NSSI (*CS* = 0.52) but below the preferred cut-off of 0.5 (Epskamp et al., 2018) for the network of students with a history of NSSI (*CS* = 0.36).

3.2.3. Network density and average absolute edge-weights

As per Burger et al. (2022), we computed each network's density by dividing the number of detected edges in the network by the number of observable edges in a fully connected network. Density was similar for both the network of students without NSSI history (0.32, 169 edges/528 edges) and with NSSI history (0.31, 162 edges/528 edges). Mean absolute edge-weights were also similar for networks of students without NSSI history (0.016) and with NSSI history (0.017).

3.2.4. Node centrality

Strength-centrality plots for both networks are included in Supplementary Material. Correlations between standard deviations and strength-centrality coefficients of each node were small and non-significant for the networks of students with NSSI history ($r = 0.15$, $p = .41$) and without NSSI history ($r = 0.23$, $p = .19$), suggesting it is unlikely that differential variability between nodes accounted for centrality differences. The three most central nodes in the network of students without NSSI history were *limited access to emotion regulation strategies*, *appraisal*, and *positive reappraisal*. Although these nodes were not significantly stronger than each other (see Supplementary Material), they were significantly more central than most other nodes in the network. The most central nodes in the network of students with NSSI history were *limited access to emotion regulation strategies, self-esteem, and refocus on planning*. The *limited emotion regulation strategies* node was



Students Without a History of NSSI

Non-suicidal self-injury outcome expectancies
OE_REG = Affect regulation expectancy
OE_COM = Communication expectancy
OE_SEL = Negative self-beliefs expectancy
OE_PAI = Pain expectancy
OE_NES = Negative social outcomes expectancy

Self-schemas
SERS = Self-efficacy to resist non-suicidal self-injury
GSE = General self-efficacy
SE = Self-esteem
CP = Perfectionism

Distress and distress tolerance
DASS = Psychological distress
DTS_Tolerance = Tolerance
DTS_Appraisal = Appraisal
DTS_Absorption = Absorption
DTS_Regulation = Regulation

Emotional experience
PA = Positive affect
NA = Negative affect
EREACT = Emotional reactivity
ExpAvoid = Experiential avoidance

Cognitive emotion regulation strategies
SBlame = Self-blame
Accept = Acceptance
Rumina = Focus on thought/rumination
Reflect = Positive refocusing
Plann = Refocus on planning
Reappr = Positive reappraisal
Perspe = Putting into perspective
Catastr = Catastrophizing
BlameOt = Blaming others

Difficulties with emotion regulation
DERSNA = Non-acceptance of emotional responses
DERSGD = Difficulties engaging in goal-directed behaviour
DERSIC = Difficulties with impulse control
DERSEA = Lack of emotional awareness
DERSEC = Lack of emotional clarity
DERSELS = Limited access to emotion regulation strategies

Fig. 1. Cognitive-emotional networks in students with and without a history of NSSI.
Note. Regularised partial correlation networks comprising cognitive-emotional constructs linked to NSSI. Layouts were fixed to the average layout of both networks. Edges were curved slightly to minimise overlap between edges and nodes. The legend describes node names and corresponding constructs. Details about edge-weight differences can be found in the Supplementary Materials.

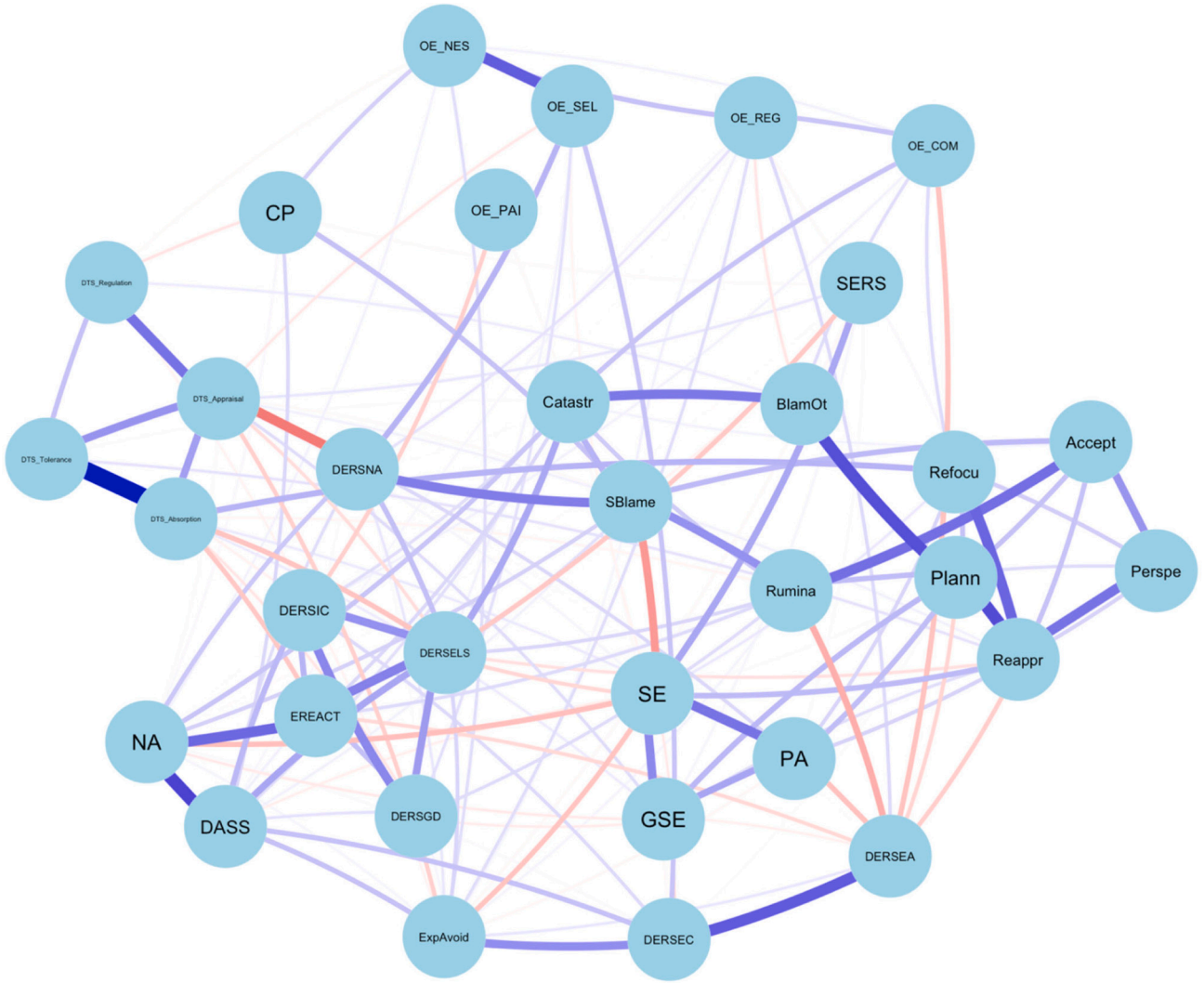


Fig. 1. (*continued*).

Students With a History of NSSI

Non-suicidal self-injury outcome expectancies
OE_REG = Affect regulation expectancy
OE_COM = Communication expectancy
OE_SEL = Negative self-beliefs expectancy
OE_PAI = Pain expectancy
OE_NES = Negative social outcomes expectancy

Self-schemas
SERS = Self-efficacy to resist non-suicidal self-injury
GSE = General self-efficacy
SE = Self-esteem
CP = Perfectionism

Distress and distress tolerance
DASS = Psychological distress
DTS_Tolerance = Tolerance
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Emotional experience
PA = Positive affect
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DERSIC = Difficulties with impulse control
DERSEA = Lack of emotional awareness
DERSEC = Lack of emotional clarity
DERSELS = Limited access to emotion regulation strategies

Table 2
Ten largest significant edge-weight differences between cognitive-emotional networks of students with and without a history of NSSI.

Edge	Edge Weights		E (Δ_r)
	No NSSI	NSSI	
Pain expectancy — negative-self beliefs expectancy	0.28	–	0.28****
Pain expectancy — affect regulation expectancy	−0.25	–	0.25***
Emotional reactivity — negative affect	0.06	0.26	0.20**
Non-acceptance of emotional responses — self-blame	0.05	0.22	0.17**
Difficulties with impulse control — difficulties with goal-directed behaviour	0.04	0.21	0.17*
Affect regulation expectancy — communication expectancy	0.27	0.10	0.17*
Difficulties with impulse control — appraisal	−0.14	–	0.14**
Emotional reactivity — limited strategies	0.08	0.22	0.13*
Non-acceptance of emotional responses — negative-self beliefs expectancy	–	0.13	0.13**
Emotional reactivity — experiential avoidance	0.12	–	0.12*

Note. Edge-weights are partial correlations. – = Partial correlation not detected in regularised network. * = $p < .05$, ** = $p < .01$, *** = $p < .001$, **** = Holm-Bonferroni corrected $p < .001$. No NSSI = No NSSI History. NSSI = NSSI History.

significantly more central than all nodes except for *self-esteem*. However, *self-esteem* and *refocus on planning* were not significantly stronger than other central nodes, such as *appraisal*, *positive reappraisal*, *self-blame* and *psychological distress*.

3.2.5. Network comparison test

The cognitive-emotional networks of students with and without a history of NSSI had invariant global strength (combined edge-weights of each network; $S = 0.56$, $p = .62$). However, an omnibus test of invariance in network structure indicated that at least one edge was significantly different between the two networks, $M = 0.28$, $p = .008$. Given this variance in network structure, we performed an exploratory post hoc analysis of individual edge-weight differences across the networks. Several edge-weights significantly differed ($\alpha = 0.05$) between the networks of students with and without a history of NSSI, with the largest differences observed for the edges: *pain expectancy — negative-self beliefs expectancy* ($E = 0.28$, $p < .001$; weaker for NSSI), *pain expectancy — affect regulation expectancy* ($E = 0.25$, $p = .001$; weaker for NSSI), *emotional reactivity — negative affect* ($E = 0.20$, $p = .004$; stronger for NSSI), *self-blame — non-acceptance of emotional response* ($E = 0.17$, $p = .01$; stronger for NSSI), and *difficulties with goal-directed behaviour — difficulties with impulse control* ($E = 0.17$, $p = .03$; stronger for NSSI). After applying a Holm-Bonferroni correction, only the *pain expectancy — negative-self expectancy* edge was significantly different between the two networks; the edge was undetected in the network of students with a history of NSSI. Table 2 contains the 10 largest significant edge-weight differences and corresponding edge-weights between networks of students with and without NSSI history. All significant ($\alpha = 0.05$) edge-weight differences are presented in the Supplementary Materials. Regarding centrality differences, *self-blame*, *self-esteem* and *putting into perspective* were significantly ($\alpha = 0.05$) more central in the network of students with a history of NSSI, while the *pain expectancy* was significantly less central to the network of students with NSSI history (Holm-Bonferroni corrected $p < .001$).

4. Discussion

The purpose of this study was to compare cognitive-emotional networks of students with and without a history of NSSI. Although the overall level of interconnectivity was similar for both networks, structural differences between the networks indicate that students with a history of NSSI may perceive themselves to have difficulties regulating particularly intense and unwanted negative emotions. Furthermore, students without a history of NSSI who viewed NSSI as an aversive behaviour also expected it to be unhelpful, while students with a history of NSSI generally expected NSSI to have some benefits regardless of potential negative outcomes such as pain. These findings have implications for understanding how students with and without a history of NSSI vary in processing emotional experiences in relation to their self-concepts and NSSI-specific cognitions.

Consistent with previous research (e.g., Nock et al., 2008), students with a history of NSSI perceived themselves to be more reactive to negative emotions. The present study builds on this by demonstrating that, after accounting for other key factors in the model, perceived emotional reactivity was more strongly linked to negative affect and limited perceived access to emotion regulation strategies among students with a history of NSSI. Contrasting theoretical models outlining a role for experiential avoidance in NSSI (e.g., Chapman et al., 2006), experiencing negative emotions more intensely was not associated with a greater tendency to avoid the emotions among students with NSSI history. Furthermore, students with a history of NSSI reported more entwined difficulties with managing impulses and goal-directed behaviour under distress. Together, this may suggest that when experiencing intense negative emotions, students with a history of NSSI might find it difficult to access effective strategies to manage or avoid their emotions. This challenges the idea that individuals with greater emotional reactivity turn to avoidance strategies to regulate more intense emotions (cf. Chapman et al., 2006), and more closely aligns with research implicating limited perceived access to effective emotion regulation strategies among individuals who self-injure (e.g., Wolff et al., 2019). Considering this, and that the perception of limited emotion regulation strategies was central to the networks, it appears that perceived limited access to strategies for regulating intense negative emotions, not necessarily the use of avoidance strategies in particular, may be more useful for understanding NSSI in this context.

Another difference across the networks for students with and without a history of NSSI was the experience of blaming oneself for and finding it difficult to accept negative emotional responses. For students with a history of self-injury, there were stronger links between seeing negative emotions as unacceptable, blaming oneself for having negative emotions, and expecting to feel bad about oneself for engaging in NSSI regardless of whether it was expected to be painful. Furthermore, self-blame and self-esteem were more central and interconnected with difficulties regulating emotions for students with a history of NSSI. Together, this may be tapping into perceptions of shame and self-criticism surrounding negative emotional experiences and the use of NSSI among students who have self-injured (see Brown et al., 2022a). Students with a history of NSSI may have a tendency to blame themselves for experiencing negative emotions which are perceived as unacceptable, and may also feel shameful for using NSSI to deal with these emotions.

Arguably, in finding it difficult to deal with intense negative emotions, students with a history of NSSI endorsed NSSI as an effective emotion regulation strategy. Furthermore, students with a history of NSSI generally expected NSSI to help them regulate their emotions and communicate with others regardless of whether they thought NSSI would be painful or that they would feel badly about themselves for self-injuring. This differs from students without a history of self-injury, who generally expected NSSI to be both a poor emotion regulation and communication strategy with negative personal consequences, perhaps because they also expected NSSI to be painful and self-deprecating. This may suggest that individuals without a history of NSSI have a more generalized perception of NSSI as an unhelpful and self-punitive behaviour associated with physical pain, whereas individuals who have self-injured are able to identify positive aspects of NSSI (e.g.,

emotion regulation, communication) despite some negative personal and social consequences. It is possible that for those who have never self-injured, expecting NSSI to be painful and aversive could act as a barrier to perceiving the emotion regulation benefits of self-injury (Hooley and Franklin, 2018). However, students with a history of NSSI may 'overcome' these barriers to access the emotion regulation benefits of NSSI when dealing with particularly intense, unwanted, negative emotions given limited perceived access to other emotion regulation strategies.

4.1. Theoretical and clinical implications

Theoretically, the present study provides some support for the Cognitive Emotional Model of NSSI, in that students with and without a history of NSSI appear to process their emotions differently in tandem with their beliefs about NSSI. Furthermore, the findings suggest it may be worth further exploring the Benefits and Barriers conceptualisation of NSSI, in that pain may operate as a barrier to perceiving emotion regulation benefits of NSSI, which seems to be overcome by students with NSSI history. Generally, limited perceived access to strategies for dealing with intense emotions should be considered as an important factor, especially in that it may play a more important role in NSSI than use of specific avoidance strategies. Finally, in efforts to support students with a history of NSSI, it may be helpful to consider experiences of self-blame, shame, and stigma surrounding negative emotionality and NSSI, as well as acknowledge the ambivalence that may arise in expecting both benefits and negative consequences of NSSI (see Gray et al., 2021).

4.2. Limitations and future research

Given that this research was exploratory and included several comparisons, most of the findings presented should be used to guide future research rather than make clinical judgments. The correlational design and use of cross-sectional data means that it is not possible to infer causality or the temporal order of relationships between the cognitive-emotional constructs presented in the networks. This raises the question of whether differences between the networks preceded self-injury, or emerged as a result of self-injury. Researchers should assess cognitive-emotional differences associated with NSSI longitudinally, and further investigate how students who have self-injured perceive and modify their emotion regulation strategies in real-time when faced with more intense negative emotions or beliefs that they are unable to cope with their emotions. It may also be worth focussing on the interplay between shameful, self-critical beliefs about emotions and emotion-regulation strategies to better understand the experience of students who self-injure. Although the network comparison test is generally robust to variations in sample size between networks (van Borkulo et al., 2022), it is possible that some edges were not detected in the network of students with a history of NSSI due to fewer participants relative to the network of students without a history of NSSI. Conversely, conceptual overlap between nodes may have over-inflated centrality estimates of like-constructs (e.g., distress tolerance appraisal) relative to other important but conceptually distinct factors (see Fried and Cramer, 2017). Finally, as the centrality stability coefficient for the network of students with a history of NSSI was below the recommended cut-off, it is unclear if the network would be replicated accurately in other samples (Epskamp et al., 2018). Therefore, it would be useful to replicate this study in a larger group of individuals, including non-student samples, to see if similar patterns are observed before making clinical judgments.

4.3. Conclusion

Students who have self-injured may perceive themselves to have a limited capacity to regulate intense negative emotions which may be appraised as shameful to experience. In light of this, students with a history of NSSI may expect NSSI to provide emotion regulation benefits despite negative personal consequences such as pain, whereas students who have never self-injured generally perceive NSSI to be both unhelpful and aversive. Therefore, it may be useful to further investigate the appraisal of and access to strategies for regulating intense, negative, self-conscious emotions to better understand NSSI, and to acknowledge that students with a lived experience of NSSI are likely to perceive some benefits of self-injury regardless of its potential negative outcomes.

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CRediT authorship contribution statement

All authors were involved in conceptualising the research project. Thomas Duncan-Plummer conducted the network analysis and prepared the initial manuscript. Penelope Hasking, Mark Boyes, and Kate Tonta collected the data used for the analysis, contributed to interpreting the data, and edited/revised subsequent versions of the manuscript.

Conflict of interest

The authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2023.02.054.

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