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Self-Harming Behaviour in Young Adults in the Context of Cloninger's Psychobiological Model of Temperament

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Abstract: Self-harming behaviour, a maladaptive coping strategy employed in response to psychological distress, predominantly manifests during adolescence and early adulthood, and poses serious consequences for both physical and mental health. Its high risk and escalating prevalence have directed scholarly attention toward elucidating factors that contribute to its onset and persistence within the repertoire of maladaptive responses to stress and emotionally charged situations. One important avenue of investigation concerns the personality characteristics of individuals who engage in self-harm, particularly their stable, genetically influenced traits that may increase vulnerability to such behaviour. The present study aims to: (1) examine the association between self-harming behavior and temperament dimensions as conceptualized by R. C. Cloninger's psychobiological model of personality (novelty seeking, harm avoidance, reward dependence, and persistence), grounded in genetic variations influencing the activity of specific neurotransmitters (dopamine, serotonin, and norepinephrine); and (2) evaluate the predictive utility of these temperament traits for self-harming behavior. The study sample comprised 589 individuals aged 18–30 years ($M = 22.04$; $SD = 3.145$), of whom 301 (51.1%) were female. The prevalence of self-harming behaviour within the sample was 55%. Correlational analyses revealed statistically significant ($p < .001$) positive associations between self-harm and the traits of novelty seeking and harm avoidance, alongside statistically significant ($p < .001$) negative associations with reward dependence and persistence. Subsequent linear regression identified three temperament traits—excluding persistence—as significant predictors of self-harming behaviour, collectively explaining 10.3% of its variance. Genetically influenced alterations in the activity and levels of serotonin, dopamine, and norepinephrine—reflected in specific temperament traits—not only elevate the risk of self-harming behaviour but also correlate with other psychiatric disorders comorbid with self-harm. These findings underscore the potential benefit of therapeutic interventions targeting atypical neurotransmitter functioning to mitigate the adverse consequences of self-harming behavior.

Keywords: self-harm; temperament; neurotransmitters; young adulthood; predictive modelling.

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1. Introduction

Self-harming behaviour represents a significant psychopathological risk, occurring predominantly among adolescents and young adults (Peterson et al., 2008). Its prevalence has risen over recent decades (Reinhardt et al., 2022) and is associated with various forms of self-inflicted injury that carry severe clinical implications for both the physical and psychological well-being of young individuals. The increasing severity of this phenomenon has prompted, among other developments, a proposal by the American Psychiatric Association to include self-harm as a formal diagnosis in the Diagnostic and Statistical Manual of Mental Disorders (APA, 2013). However, this process remains ongoing, and no definitive consensus has been reached regarding the precise definition of self-harming behaviour. In light of empirical findings on the scope, nature, and prevalence of different forms of self-harm (Hawton et al., 2012; Demuth & Demuthova, 2019; Demuthova, 2023), self-harm is conceptualised in this study as any act deliberately intended to cause injury or pain to oneself (whether physical and/or psychological) to any degree—including extreme manifestations such as suicidal behaviour. This includes various forms of repeated physical and psychological self-injurious behaviour where the distinguishing feature between self-harm and related behaviours (e.g., body piercing, tattooing, or risk-taking behaviours undertaken for social gain) lies in the underlying motivation—specifically, the intent to inflict pain or suffering on oneself.

Current research on self-harming behaviour encompasses a broad spectrum of questions aimed at clarifying why, and under what conditions, self-harm emerges and is maintained as part of an individual's maladaptive repertoire for coping with psychological stress. One of the key areas that may enhance our understanding of why some adolescents and young adults resort to self-harm in distressing situations is the study of personality traits among individuals who engage in such behaviour. To date, most research in this area has focused on traits within the Five-Factor Model (FFM), with self-harm being associated with elevated neuroticism and openness to experience, and lower levels of agreeableness, conscientiousness, and extraversion (Mullins-Sweatt et al., 2013; Allroggen et al., 2014; Jiao et al., 2022). Associations have also been reported with psychoticism (Carli et al., 2010) and antagonism (Evans and Simms, 2019; Acosta et al., 2020). However, in the context of the core features of self-harming behaviour, additional personality characteristics may appear particularly relevant. Self-harm is frequently characterised by impulsivity (McHugh et al., 2019; Cassels et al., 2020), in combination with the addictive nature of the behaviour (Matera et al., 2021) and a tendency toward increasing frequency and intensity of self-injurious acts, or the pursuit of novel forms of self-harm. The impulsive, compulsive, and addictive dimensions of self-harm are the focus of a growing body of current research (see, for example, Elango et al., 2025). These characteristics reflect specific patterns of central nervous system reactivity (e.g., reward circuitry) and are more closely aligned with temperament-based personality traits.

2. Literature Review

The association between central nervous system (CNS) activity and self-harming behaviour has been demonstrated by several findings from previous research. For example, as Guerdjikova et al. (2014) state, dysregulation of endogenous opioids, monoamines, and glutamate neurotransmitter systems represents one of the neurobiological mechanisms involved in both the development and maintenance of self-harming behaviours. At the functional level, disrupted connectivity has been observed between the dorsal striatum, ventromedial prefrontal cortex, insula, and parietal operculum cortex—regions known to modulate emotional inhibition, pain processing, and reward mechanisms in individuals who engage in self-harm (Case et al., 2021). It has also been shown that individuals who engage in self-harming behaviour exhibit significantly altered levels of cerebrospinal fluid (CSF) beta-endorphin and met-enkephalin compared to individuals without such behaviour (Stanley et al., 2010). Beta-endorphins are known for their analgesic properties and play a key role in reward-related behaviour (Piloizzi et al., 2020), while enkephalin is highly expressed within the brain's reward circuits and regulates neurotransmission in ways that influence reward processing

and reinforcement (Rysztak & Jutkiewicz, 2022). (For a more detailed overview of the neurobiological basis of self-harming behaviour, see Westlund Schreiner et al., 2015).

A more integrative understanding of the mechanisms underlying self-harming behaviour in the context of CNS functioning is offered by C. R. Cloninger's biopsychosocial model of personality. According to Cloninger (1987, 1993), personality is structured through four dimensions of temperament and three dimensions of character. While character dimensions are shaped by learning and mature later in development, temperament dimensions—novelty seeking, harm avoidance, reward dependence, and persistence—are genetically determined and become evident early in life. These dimensions reflect core behavioural dynamics: behavioural activation (novelty seeking), behavioural inhibition (harm avoidance), maintenance (reward dependence), and endurance (persistence) (Tomita et al., 2000). A particularly compelling aspect of Cloninger's model is the hypothesised association between specific temperament traits and distinct neurotransmitters: novelty seeking with dopamine, harm avoidance with serotonin, and reward dependence with norepinephrine (APA Dictionary of Psychology, 2025). The dimension of persistence was identified later in Cloninger's research—initially included under reward dependence—(Cloninger, 1994; Stallings et al., 1996). Its underlying brain systems are believed to involve the lateral orbital and medial prefrontal cortex, as well as the ventral striatum (Gusnard et al., 2003), although this neuroanatomical mapping still requires empirical confirmation (Gillespie et al., 2003). A central premise of Cloninger's theory is that individual predispositions toward specific behavioural tendencies, as reflected in temperament traits, are genetically encoded and rooted in distinct neurochemical and neural activation patterns.

Novelty seeking, harm avoidance, reward dependence, and persistence are personality traits closely linked to the features of self-harming behavior. Self-harm, as a maladaptive coping strategy in response to psychological distress, becomes relatively rapidly reinforced through the brain's reward system, as it provides immediate distraction from psychological problems.

The physical pain involved in self-harm serves as a substitute for emotional pain, which lies beyond the individual's control, thereby resulting in temporary yet highly effective relief (Victor et al., 2012). In this process, both mechanisms of positive reinforcement (gaining control over the situation and pain) and negative reinforcement (relief from unwanted emotions) operate simultaneously. These mechanisms, in addition to activating the brain's reward system, also influence the temperament dimension of persistence—a trait that reflects a person's tendency to persevere in the face of frustration and fatigue (Cloninger et al., 1993), and to maintain behaviours that have previously been rewarded or associated with relief from negative stimuli). It can therefore be assumed that individuals with elevated levels of reward dependence (and persistence) are more likely to engage in repeated self-harm, and to do so to a greater extent, than those with low levels of these traits.

At the same time, the occurrence of self-injury as a coping strategy indicates not only the absence (or inability to use) more adaptive strategies, but also a strong tendency to avoid distressing emotions or other psychological difficulties (so-called "experiential avoidance"), even at the cost of self-harm (Nielsen et al., 2017). The attempt to escape psychological distress and the reluctance to address it despite negative consequences may be related in particular to high levels of the temperament trait of harm avoidance.

Cautiousness and vigilance naturally prevent most individuals from attempting highly risky and maladaptive forms of coping, such as self-harm. Conversely, individuals with a prominent temperament trait of novelty seeking are typically characterised by exploratory excitability (a drive for novel experiences) and impulsiveness (i.e., careless decision-making) (Bidwell et al., 2015). Therefore, high levels of novelty seeking may potentially increase the likelihood of self-harming behaviour.

3. Research Problem and Research Questions

The associations between individual temperament traits arising from neurobiological specificities and self-harming behaviour suggest that Cloninger's theory of temperament may offer not only a significant contribution to understanding the potential mechanisms underlying the emergence and maintenance of self-harm within the repertoire of maladaptive coping strategies for psychological distress, but—due to its biochemical foundations—also present an additional level of potential intervention in the domain of self-harming behaviour through the regulation of neurotransmitter levels. Research findings, however, do not allow for a definitive conclusion regarding whether and how R. C. Cloninger's temperament traits are associated with self-harming behaviour. Only a limited number of studies have addressed this issue, and their results remain inconclusive. For instance, Gomez-Exposito et al. (2016) reported higher levels of reward dependence among individuals who engage in self-harm, whereas other studies have found no significant relationship between self-harm and reward dependence (Ohmann et al., 2008; Hefti et al., 2013). In the domain of novelty seeking, a positive correlation with self-harming behaviour has been confirmed (Lüdtke et al., 2017). While lower levels of harm avoidance are theoretically predicted among self-harming individuals, empirical findings tend to indicate the opposite trend (Korner et al., 2007; Buelens et al., 2020). Persistence is the least studied of the temperament traits, with existing data suggesting lower levels (contrary to theoretical expectations) among self-harming individuals (Kim et al., 2022). It is important to note that most of these findings are based on research conducted within clinical populations, predominantly psychiatric patients, in whom various mental disorders may significantly influence the results. Data drawn from the general (non-clinical) population are nearly non-existent.

The primary aim of this study is to explore the relationship between the temperament traits defined by R. C. Cloninger's psychobiological model of personality and the occurrence of self-harming behaviour in a general population sample of young adults. Additionally, the study seeks to examine the potential predictive power of individual temperament traits with regard to the prevalence of self-harm. Young adulthood (ages 18–30) was selected as the target developmental period because self-harming behaviour still occurs with substantial prevalence in this age group (with only about 7% of participants who reported self-harm during adolescence reporting no further self-harm in young adulthood – Moran et al., 2012), while at the same time, personality temperament traits are sufficiently stabilised to represent enduring individual characteristics.

Given the inconclusive data resulting from previous studies, an exploratory research design was chosen, and the following research questions were formulated:

RQ1: Is there a statistically significant correlation between the temperament traits of Cloninger's psychobiological model of personality (novelty seeking, harm avoidance, reward dependence, and persistence) and the level of self-harming behaviour?

RQ2: What is the predictive value of the temperament traits defined by Cloninger's psychobiological model of personality (novelty seeking, harm avoidance, reward dependence, and persistence) with respect to the occurrence of self-harming behaviour?

4. Methodology

4.1. Measures

To assess the extent of self-harming behaviour, a modified version of the Self-Harm Inventory (SHI; Sansone & Sansone, 2010) was used with the authors' permission. The original version of the inventory captures the presence of this behaviour through twenty-two distinct forms of self-harm. The items measuring the forms of self-harm are preceded by the phrase "Have you ever intentionally, deliberately caused yourself harm..." followed by the different forms of self-harm: "cut yourself, burned yourself, hit yourself, scratched yourself", etc. Based on previous research (see Demuthova & Demuth, 2020), two additional, frequently occurring forms of self-harm were added to the questionnaire ("intentionally lacked sleep with the intention of harming myself"

and “intentionally overexercised with the intention of harming myself”), and one item (“lost a job on purpose”) was removed from the original version of the questionnaire, as it was not found to be characteristic of the age group under study. The frequency of occurrence of all twenty-three forms of self-harm was measured using a 4-point Likert-type scale (ranging from 0 = never to 3 = often). The overall level of self-harming behaviour was calculated based on the total SHI score, which ranged from 0 to 69 points. The modified version of the SHI demonstrated excellent internal consistency, with a Cronbach’s alpha of .915.

Temperament traits from Cloninger’s psychobiological model of personality (novelty seeking, harm avoidance, reward dependence, and persistence) were assessed, with the author’s permission, using the Reduced Temperament and Character Inventory (TCI-56; Adan et al., 2009). This abbreviated version of the Temperament and Character Inventory (TCI), originally developed by R. C. Cloninger (1994), demonstrates good psychometric properties, with the authors reporting internal consistency ranging from .69 for novelty seeking (lowest) to .80 for reward dependence (highest) (Adan et al., 2009). Linguistic adaptation of the instrument was ensured using the translation and back-translation method, followed by expert review.

4.2. Data Collection and Ethical Approval

Data collection was conducted using a combination of convenience sampling and snowball sampling methods. The process took place between April and July 2025 and was carried out in both paper-based and electronic formats. Participants were informed about the aim of the study and were given the opportunity to decline participation when approached or to withdraw from the study at any stage without consequences. Participation was anonymous.

The research protocol was approved by the Ethical Review Committee for Scientific Research of the Faculty of Arts at the University of Ss. Cyril and Methodius in Trnava, Slovakia (Approval ID: UCM-FF-EK 6/2023) and concurrently approved by the Slovak Research and Development Agency of the Ministry of Education, Research, Development and Youth of the Slovak Republic. In light of the sensitive nature of the topic of self-harming behaviour, each participant was offered the possibility of subsequent psychological support or intervention.

4.3. Subjects

The inclusion criteria for participation were willingness to complete the questionnaires and age within the young adulthood range (18–30 years). A total of 597 participants took part in the study; eight (1.34%) were excluded due to missing data. The final sample consisted of 589 participants aged between 18 and 30 years ($M = 22.04$; $SD = 3.145$), including 301 women (51.1%), 285 men (48.4%), and three (0.5%) non-binary young adults.

4.4 Data Analysis

Data analysis was performed using the IBM Statistical Package for the Social Sciences (SPSS), version 29.0.2.0. The normality of the distribution of the studied variables (self-harm, novelty seeking, harm avoidance, reward dependence, persistence) was tested using the Shapiro–Wilk test. The correlations between self-harming behaviour and the individual temperament traits defined in Cloninger’s psychobiological model of personality were assessed using Spearman’s nonparametric correlation. The potential of temperament traits to predict self-harming behaviour was tested using hierarchical linear regression analysis, employing the Forward method. The statistical significance level was set at $\alpha = 0.05$.

5. Results

5.1. Descriptive Analysis of Variables

Basic descriptive statistics for the studied variables (self-harm, novelty seeking, harm avoidance, reward dependence, persistence) are presented in Table 1.

Table 1. Descriptive Statistics for Temperament Traits and Self-Harm

		Novelty Seeking	Harm Avoidance	Persistence	Reward Dependence	Self-Harm
N	Valid	589	589	589	589	589
	Missing	0	0	0	0	0
Mean		21.5093	25.1002	25.7980	26.2343	6.1443
Median		21.0000	25.0000	26.0000	26.0000	3.0000
Std. Deviation		4.51814	5.51761	5.38247	5.79492	8.68073
Skewness		.327	.062	-.082	.010	2.325
Kurtosis		.190	-.383	-.236	-.703	5.852
Minimum		10.00	11.00	8.00	10.00	.00
Maximum		37.00	40.00	38.00	39.00	51.00

As part of the descriptive analysis, a normality test was conducted to examine the distribution of the observed variables. According to the results of the Shapiro–Wilk test (see Table 2), none of the variables demonstrated a normal distribution.

Table 2. Results of the Shapiro–Wilk Test of Normality

	Statistic	df	Sig.
Novelty Seeking	.988	589	<.001
Harm Avoidance	.993	589	.012
Persistence	.993	589	.009
Reward Dependence	.987	589	<.001
Self-Harm	.707	589	<.001

In light of the results of the Shapiro–Wilk test, non-parametric tests were used for the subsequent statistical analyses.

5.2. Research Question 1

Research Question 1 examined whether there is a statistically significant correlation between the temperament traits defined in Cloninger's psychobiological model of personality (novelty seeking, harm avoidance, reward dependence, persistence) and the level of self-harming behaviour. To explore the associations between temperament traits and self-harm, Spearman's non-parametric correlation test was employed. The results are presented in Table 3.

Table 3. Correlations between Self-Harm and Temperament Traits (Spearman's rho Correlation Coefficients)

Self-Harm		
Novelty Seeking	Correlation Coefficient	.211**
	Sig. (2-tailed)	<.001
	N	589
Harm Avoidance	Correlation Coefficient	.258**
	Sig. (2-tailed)	<.001
	N	589
Persistence	Correlation Coefficient	-.164**
	Sig. (2-tailed)	<.001
	N	589
Reward Dependence	Correlation Coefficient	-.137**
	Sig. (2-tailed)	<.001
	N	589

Note: ** $p < .001$

The results of the Spearman correlation indicate that all four temperament traits are statistically significantly associated with the occurrence of self-harming behaviour. For two variables (novelty seeking and harm avoidance), a weak positive correlation was observed (i.e.,

higher scores on these temperament traits are associated with a higher incidence of self-harm). In contrast, for reward dependence and persistence, the relationship was negative (i.e., lower scores on these traits are associated with a higher incidence of self-harming behaviour).

5.3. Research Question 2

Research Question 2 investigated the predictive power of temperament traits derived from Cloninger's psychobiological model of personality (novelty seeking, harm avoidance, reward dependence, and persistence) in relation to the occurrence of self-harming behaviour. In light of the statistically significant correlations identified between self-harming behaviour and all temperament traits delineated by Cloninger's model (see Table 3), all four variables—novelty seeking, harm avoidance, reward dependence, and persistence—were deemed appropriate for inclusion in the subsequent regression analysis aimed at assessing their individual predictive power.

The findings of the linear regression analysis conducted using the forward stepwise method are presented in Tables 4 and 5.

Table 4. Regression Models Predicting the Occurrence of Self-Harming Behaviour

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,228 ^a	,052	,050	8,45931
2	,307 ^b	,094	,091	8,27469
3	,321 ^c	,103	,098	8,24250

a. Predictors: (Constant), novelty seeking
b. Predictors: (Constant), novelty seeking, harm avoidance
c. Predictors: (Constant), novelty seeking, harm avoidance, reward dependence

Table 5. ANOVA Results Testing the Significance of the Regression Models

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2303,009	1	2303,009	32,183	<,001 ^b
	Residual	42005,724	587	71,560		
	Total	44308,733	588			
2	Regression	4185,003	2	2092,502	30,561	<,001 ^c
	Residual	40123,730	586	68,471		
	Total	44308,733	588			
3	Regression	4564,516	3	1521,505	22,395	<,001 ^d
	Residual	39744,218	585	67,939		
	Total	44308,733	588			

- a. Dependent Variable: self-harm
b. Predictors: (Constant), novelty seeking
c. Predictors: (Constant), novelty seeking, harm avoidance
d. Predictors: (Constant), novelty seeking, harm avoidance, reward dependence

Regression analysis included three out of four temperament variables in the predictive models. Based on the values obtained for the trait persistence ($t = 0.665$; $p = 0.506$), it can be concluded that this variable does not significantly predict self-harming behaviour and was therefore excluded from the predictive models.

The strongest predictor of self-harming behaviour is novelty seeking, followed by harm avoidance, while the weakest predictive power is shown by reward dependence. The results of the F test (Table 5) indicate that all three models statistically significantly predict ($p < 0.05$) the dependent variable self-harming behaviour.

However, it is also evident that all three variables together (Model 3) explain only 10.3% of the variance in the occurrence of self-harming behaviour (Table 4), which highlights the multi-etiological nature of this risk behaviour.

6. Discussion

6.1. Descriptive Analysis – Data Overview

The data obtained from the general population in the analysed research sample (RS), regarding the levels of individual temperament traits, correspond closely with data from the validation study of the TCI-56 conducted on a non-clinical adult sample (NCS) (Adan et al., 2009), with mean scores as follows: harm avoidance RS = 25.10 vs NCS = 25.24; novelty seeking RS = 21.51 vs NCS = 22.26; reward dependence RS = 26.23 vs NCS = 28.30; and persistence RS = 25.80 vs NCS = 26.29. A greater deviation is observed only in reward dependence, where our research sample showed lower values. However, in general, it can be assumed that the examined temperament variables do not reflect an atypical sample, and the results can be compared with other similar studies.

Regarding self-harming behaviour, it is not possible to directly assess the absolute score, because the original SHI questionnaire (Sansone & Sansone, 2010) was modified. However, if we accept the assumption that self-harm occurs recurrently (i.e., participants in the modified questionnaire indicate frequent engagement in one or more forms of self-harming behaviour), individuals can be classified within the self-harming group. Consequently, the data can be assessed with regard to the prevalence of self-harming behaviour. Using a cut-off score of 3 (the threshold at which the raw score in the modified SHI questionnaire classifies the participant as belonging to the self-harming group), it can be stated that the prevalence of self-harming behaviour in the research sample reached 55%. This value is higher than that recorded by the same method in previous studies (45.2%) among adolescent populations (see Demuthova & Demuth, 2020). This fact should therefore be considered when interpreting the results.

6.2. Bivariate Analysis – Research Question 1

Spearman's correlation analysis revealed that all four temperament traits from Cloninger's psychobiological model of personality (novelty seeking, harm avoidance, reward dependence, persistence) are statistically significantly associated with the level of self-harming behaviour.

Specifically, harm avoidance exhibited a positive correlation, indicating that higher levels of this trait predict increased frequency of self-harming behaviour. Moreover, harm avoidance demonstrated the strongest association with self-harming behaviour among the temperament traits (Spearman's $\rho = 0.258$). Although this finding may appear counterintuitive at first—given that individuals who self-harm do so deliberately, which might suggest lower harm avoidance levels—a deeper exploration of the motivations and mechanisms underlying self-harming behaviour clarifies this relationship. Self-harming behaviour functions as a means for individuals to avoid psychological pain and distress. Those who engage in self-harm report that inflicting physical pain provides temporary relief from psychological pain, overwhelming negative emotions, and suffering (see, e.g., Franklin et al., 2013; Klonsky et al., 2014). The psychological burden experienced by these individuals is so intense that they resort to extreme strategies such as self-harm to avoid or alleviate it. Consequently, the higher the harm avoidance, the greater the need to escape psychological or emotional pain, and the higher the likelihood of engaging in self-harming behaviour.

In Cloninger's model, harm avoidance is closely linked to serotonin function, which is involved not only in behavioural inhibition but also in processes including impulsivity, suicidal ideation, mood regulation, and anxiety (Delvecchio et al., 2016). Elevated harm avoidance is associated with reduced serotonin levels (Wu et al., 2010). Multiple studies have reported decreased serotonin levels (or functional variations in its transporter, leading to lower serotonin reuptake) among individuals who self-harm (Wilcox et al., 2012; Hankin et al., 2015; Gao et al., 2021). Reduced serotonin is implicated in increased impulsivity and aggression (da Cunha-Bang et al., 2023), contributing to impulsive behaviours (such as selecting maladaptive coping mechanisms like self-harm), impulsive decision-making (e.g., favouring immediate relief over delayed one), and

heightened aggression (often internalised as self-directed aggression manifested through self-harming behaviour). Furthermore, low serotonin levels are closely associated with various psychiatric conditions including depression, anxiety, schizophrenia, obsessive-compulsive disorder, and addiction (De Deurwaerdère & Giovanni, 2020). In this context, self-harming behaviour is a common coping strategy used to manage intense negative emotions associated with these disorders; it serves purposes such as stress reduction, emotional regulation, coping with trauma (Mughal et al., 2023), and avoidance of suicidal acts (Kraus et al., 2020). Psychiatric disorders linked to serotonin deficiency are frequently comorbid with self-harming behaviour (Sadath et al., 2023).

Novelty seeking is closely associated with the brain's behavioural activation system, which is primarily modulated by the neurotransmitter dopamine. This association is based on the premise that exposure to novel stimuli elicits excitation of dopaminergic neurons, thereby activating brain regions that receive dopaminergic input. Furthermore, dopamine facilitates exploratory behaviour in unfamiliar environments (Costa et al., 2014). Self-harming behaviour can be classified as a high-risk activity, typically avoided by psychologically healthy individuals due to its inherent dangers. Nevertheless, individuals exhibiting a heightened tendency to seek novel and intense stimuli may demonstrate a greater propensity to engage in atypical (i.e., novel) behavioural responses when confronted with psychological distress. Moreover, when such behaviour is reinforced through negative reinforcement mechanisms—for instance, by alleviating stress or emotional tension, substituting psychological pain, or averting more severe outcomes such as suicidal acts—it activates the brain's reward system, which is intrinsically linked to dopaminergic circuits. Minassian et al. (2022) state that novelty seeking predicts abnormalities in brain reward circuitry and ultimately the risk of addiction, which helps explain another typical feature of self-harming behaviour—namely, its rapid and enduring integration into the repertoire of maladaptive coping strategies employed to manage psychological distress. A positive correlation between self-harming behaviour and the novelty seeking trait from Cloninger's personality model, or its elevated levels in individuals who self-harm, has been confirmed by other scientific studies as well (see e.g., Tschan et al., 2017; Bae et al., 2020; Kim et al., 2022).

Self-harming behaviour, as a maladaptive mechanism for regulating psychological distress, tends to develop and become reinforced with relative expediency—largely due to the strong influence of negative reinforcement, such as the reduction of aversive affective states, internal tension, anxiety, and other distressing experiences. Its engagement with the brain's reward circuitry is mediated not only via dopaminergic activity but also through norepinephrine, which is synthesised from dopamine (Peng et al., 2025). Cloninger (1987) hypothesised that the temperament trait reward dependence is related to individual differences in norepinephrine functioning, a premise that has been empirically corroborated by a number of subsequent studies (e.g., Ham et al., 2005; Narita et al., 2015). From this perspective, one might anticipate elevated levels of reward dependence among individuals who engage in self-harming behaviours, or a positive correlation between reward dependence and self-harm propensity. However, our findings—as well as those of previous research (e.g., Gomez-Exposito et al., 2016)—reveal a statistically significant ($p < .001$), yet negative, association between reward dependence and self-harming behaviour. This result can be interpreted in light of the conceptualisation of Cloninger's temperament trait reward dependence, which is characteristic of individuals who are emotionally responsive, sentimental, eager to assist others, and highly sensitive to social reinforcement cues (Cloninger et al., 1996). This trait is particularly associated with responsiveness to social rewards, promoting behaviours that are reinforced through positive social feedback, such as approval, affection, and expressions of appreciation from others. However, self-harming behaviour typically elicits negative social responses—it remains a stigmatised and taboo phenomenon, surrounded by widespread misconceptions and prejudices. Even among significant others and close social circles, where one might otherwise expect empathy and support, self-harm is frequently met with negative emotional reactions such as confusion, fear, concern or even rejection. Moreover, research has shown that even mental health professionals may misunderstand or stigmatise individuals who engage in self-harm,

contributing to their social alienation (Pompili et al., 2005). Despite these negative social responses, individuals who self-harm often continue to engage in this behaviour—either because they are not sensitive to these social cues, or because they are socially detached, emotionally cool, practical, and tough-minded (Cloninger et al., 1996) – the traits typically associated with low reward dependence. These tendencies are consistent with findings from previous studies that have also reported lower levels of reward dependence among individuals who engage in self-harming behaviour (Chapman et al., 2009; Islam et al., 2015).

Analogous to reward dependence, the trait of persistence also demonstrated a negative correlation with self-harming behaviour, indicating that lower levels of persistence are associated with a higher frequency of such behaviours. R. C. Cloninger characterises persistence as a trait that motivates individuals to continue engaging in activities even when desirable results occur only infrequently (Cloninger et al., 1996). High levels of persistence are typically found in individuals who are persevering, ambitious, and perfectionistic (Cloninger et al., 2012). These characteristics, however, do not clearly imply what level of persistence can be expected in individuals who engage in self-harming behaviour. On the one hand, these individuals persist in self-harming even though it is a maladaptive strategy, which might suggest higher levels of persistence. On the other hand, existing research has consistently shown that their reward dependence is low, indicating that they are unlikely to adjust their behaviour in response to positive reinforcement. This, in turn, would support the assumption that their levels of persistence are also low. Our findings confirmed that elevated levels of self-harming behaviour are associated with lower levels of persistence. Based on Cloninger's model (Cloninger et al., 1993), such individuals are characterised as changeable, indecisive, and easily discouraged—traits that can contribute to underachievement in contexts where rewards are intermittent or delayed (Cloninger et al., 2012). While one possible explanation for this pattern lies in their concurrently low reward dependence, an alternative interpretation is that low persistence may reflect a general preference for coping strategies that offer immediate and predictable relief (such as self-harming behaviour), rather than those that require sustained effort, emotional investment, and deferred outcomes (such as psychotherapeutic intervention). Low levels of persistence among individuals who self-harm have also been reported in other studies (see e.g., Riley et al., 2015; Kim et al., 2022).

6.3. Multivariate Analysis – Research Question 2

Research Question 2 examined the predictive capacity of the temperament traits from Cloninger's psychobiological model of personality—namely novelty seeking, harm avoidance, reward dependence, and persistence—in relation to the occurrence of self-harming behaviour.

The first key finding from the linear regression analysis was that only three temperament traits—novelty seeking, harm avoidance, and reward dependence—proved to be statistically significant predictors of self-harming behaviour; the trait persistence was excluded from the final predictive model. Notably, persistence was incorporated into Cloninger's model at a later stage (Stallings et al., 1996) and was originally conceptualised as a component of reward dependence. This conceptual linkage is also reflected in our findings, in which both persistence and reward dependence—unlike novelty seeking and harm avoidance—were negatively correlated with self-harming behaviour. There is ongoing academic debate regarding the psychometric validity and structural reliability of persistence as a distinct temperament dimension, with some studies suggesting that it may lack the robustness demonstrated by other traits in the model (see e.g., Brandström et al., 1998; Pélioso & Lépine, 2000). It is therefore plausible that, within our research sample, persistence did not emerge as a sufficiently strong predictor independently—and once reward dependence (its theoretical precursor) was included in the regression model, persistence no longer contributed meaningfully to the overall explanatory power of the model for the dependent variable self-harming behaviour.

The second important finding relates to the sequence in which the independent variables were entered into the predictive model. As illustrated in Table 4, novelty seeking emerged as the

most significant predictor of self-harming behaviour, followed by harm avoidance and, lastly, reward dependence. Interestingly, although harm avoidance showed the strongest bivariate correlation with self-harming behaviour (Spearman's $\rho = .258$, see Table 3), its predictive strength within the regression model was lower than that of novelty seeking. This suggests that the tendency to pursue novel and stimulating experiences appears to be a more crucial factor in explaining why individuals initiate self-harming behaviour as a coping strategy. Importantly, novelty seeking is also recognised as a core dimension of the broader construct of impulsivity. Impulsivity is commonly defined as a predisposition towards rapid, unplanned responses to internal or external stimuli without adequate consideration of the potential negative consequences (Mitchell & Potenza, 2014). It is also a well-established characteristic of individuals who engage in self-harming behaviour (Lynam et al., 2011; Cassels et al., 2022).

A third noteworthy finding pertains to the observation that the three temperament traits identified as statistically significant predictors of self-harming behaviour collectively account for only 10.3% of the variance in the occurrence of this high-risk behaviour (see Table 4). Although such relatively low values of explained variance are common in the field of social sciences, the results clearly indicate that a substantial portion of the variability in self-harming behaviour within our sample is attributable to factors beyond temperament-related characteristics. Nonetheless, it is essential to emphasise that the neurobiological foundations of temperament traits—namely, deviations in the levels and activity of specific neurotransmitters—are demonstrably linked to, or implicated in, a range of other mental health conditions. For example, reduced or impaired serotonergic activity is considered a central mechanism in the pathogenesis of depression and anxiety (Balaman et al., 2023), both of which are frequently reported as comorbidities in individuals who engage in self-harming behaviours (Jiao et al., 2022; Zhao & Zhou, 2024). Likewise, dysregulation of the dopaminergic system has been associated with the development of bipolar affective disorders (Ashok et al., 2017) as well as with various forms of addiction (Wise & Jordan, 2021), both of which are also prevalent among individuals who self-harm (Zhong et al., 2024; Guo et al., 2023). In a similar vein, norepinephrine plays a pivotal role in the aetiology of anxiety disorders and post-traumatic stress disorder (Ressler & Nemeroff, 2001), which likewise exhibit heightened prevalence in self-harming populations (Seong et al., 2024). Taken together, these associations suggest that although temperament traits may not exert a primary or dominant influence on self-harming behaviour, they may nonetheless serve as indicators of specific patterns of central nervous system functioning—patterns that may exert a broader influence, extending not only to the emergence of self-harming behaviour, but also to a wider spectrum of mental health diagnoses.

From a theoretical perspective, the identified behavioural pattern illustrates how Cloninger's dimensions interact to create vulnerability for self-harm: individuals high in novelty seeking may be driven towards risky, maladaptive coping strategies, while high harm avoidance magnifies their urge to escape negative affect at all costs, and low reward dependence diminishes the likelihood that positive social bonds can buffer against self-harming impulses. Importantly, persistence did not emerge as a predictor, which aligns with debates about its psychometric independence but also suggests that the motivational dynamics of self-harm are less about perseverance and more about the immediate regulation of affect. These findings provide new support for the explanatory power of Cloninger's model in accounting not only for normative personality development but also for maladaptive coping behaviours with neurobiological roots.

6.4. Limitations and Suggestions for Further Study

The findings of the conducted analyses should be interpreted in light of several limitations inherent to the present study. First, the biological basis (i.e., deviations in the levels and activity of specific neurotransmitters) of the temperament traits examined was derived from the theory and empirical research constituting Cloninger's psychobiological model of personality. As such, the study relies on the validity of these findings, while the biological correlates themselves were not empirically verified within the present research.

Another limitation pertains to the research sample. Although the sample was relatively large (589 participants), it does not represent a nationally representative selection of the population of young adults. The use of convenience sampling in combination with the snowball method may have resulted in a sample with certain specific characteristics. This is partially indicated by the elevated prevalence of self-harming behaviour (55%) compared to a study that employed the same methodology on a comparable but larger sample (see Demuthova & Demuth, 2020). It is therefore possible that the present sample included a disproportionately high number of individuals experiencing psychological difficulties, with a greater tendency toward maladaptive coping mechanisms. For future research, it would be beneficial to collect data using methods that ensure the representativeness of the sample for the given age cohort, employing random sampling procedures. Such an approach would enhance the generalisability of the findings.

The chosen age range of young adulthood also potentially entails certain limitations. Although Cloninger's theory itself assumes that temperament traits are genetically determined and already manifest early in life (Cloninger, 1993), it is also important to acknowledge that some key regions of the central nervous system continue to mature into early adulthood. The differentiation and development of synaptic connections in the prefrontal cortex—a brain area critical for cognitive control, decision-making, planning, behavioural regulation, and impulse suppression (Hathaway & Newton, 2023)—extend into the third decade of life (Kolk & Rakic, 2022). Consequently, it is possible that elevated impulsivity (in the form of high levels of novelty seeking) may be age-related and might not be present to the same extent in later stages of life. In this context, it is also reasonable to consider that persistence, as a trait reflecting a certain level of resilience, goal-directedness, and self-control, may have been excluded from the predictive model precisely because its developmental trajectory might not yet be complete. Studies examining the neurobiological localisation of the temperament trait persistence suggest that it is linked to specific areas in the lateral orbital and medial prefrontal cortex (see, e.g., Gusnard et al., 2003). From this perspective, it would be beneficial to examine how individual temperament traits are associated with self-harming behaviour in older age groups, and whether persistence might acquire greater predictive significance in later developmental periods.

Although three out of the four temperament traits proved to be statistically significant predictors of self-harming behaviour, a limitation of this finding lies in the relatively low percentage of explained variance in the occurrence of self-harm (10.3%) based on these three variables. This suggests that future research in this area should focus on identifying additional variables that could more robustly account for the occurrence of self-harm. In this regard, special attention should be paid to exploring those potential causes or contributing factors that are also linked to deviations in the levels or activity of serotonin, dopamine, and noradrenaline, as this would also allow for the identification of their interrelationships and interactions. It is possible that temperament traits do not directly influence self-harming behaviour, but that both temperament traits and a wide range of mental disorders represent consequences of atypical neurotransmitter levels. Therefore, it would be of particular interest to investigate potential mediating or moderating effects of various variables. In this respect, future research could be extended to include clinical populations as well.

In addition to the aforementioned limitations indicating possible methodological improvements for future research, there is also scope for exploring various variables whose potential effects on the relationship between the level of self-harming behavior among young adults and the temperament characteristics defined by Cloninger's psychobiological model were not examined in the present study. Based on several existing research findings, it is evident that self-harming behavior—which can, in certain respects, be understood as aggression directed toward oneself—may be associated with internalizing tendencies more typical of the female gender (see e.g., Victor et al., 2018; Moloney et al., 2024). In this regard, moderation analyses could yield valuable future insights, particularly when combined with research focusing on other relevant variables (such as psychological distress, emotion dysregulation, and impulsivity; see e.g., Lutz et al., 2023) that may exert a moderating influence on the relationships under investigation.

6.5. Practical Implications

The findings of the present study provide several relevant implications for clinical practice, prevention strategies, and psychoeducational interventions targeting young adults at risk of self-harming behaviour. The demonstrated association between self-harm and specific temperament traits—particularly novelty seeking, harm avoidance, and reward dependence—suggests that early psychological screening tools integrating temperament profiling could contribute to the identification of individuals with an elevated risk of engaging in self-harm. Such screening may be especially valuable in high-stress environments (e.g., universities, crisis centres, youth outreach services), where elevated impulsivity and emotional dysregulation frequently manifest. Furthermore, tailoring psychoeducational programmes to address maladaptive coping styles associated with these temperament dimensions (e.g., promoting distress tolerance, impulse control, and emotional regulation strategies) could enhance their preventive efficacy.

The biological underpinnings of temperament traits, as outlined in Cloninger's psychobiological model of personality, also offer important guidance for clinical interventions. As deviations in serotonergic, dopaminergic, and noradrenergic activity have been implicated not only in temperament profiles but also in comorbid psychiatric conditions frequently co-occurring with self-harm (e.g., depression, anxiety, bipolar disorder, and substance use disorders), a more integrative, neurobiologically informed treatment approach may prove beneficial. Specifically, interdisciplinary interventions that combine psychotherapeutic techniques with psychopharmacological support targeting atypical neurotransmitter functioning could address both self-harming behaviours and their common comorbidities more effectively. As a good example is the role of selective serotonin reuptake inhibitors (SSRIs), which are commonly used in the treatment of emotional dysregulation and mood disorders and have been successfully used for the treatment of self-harm as well (Sørensen et al. 2022; Chen et al. 2025). In sum, the findings underscore the relevance of incorporating temperament assessment and neurobiological markers into individualised treatment planning and highlight the potential for targeted, multi-level prevention and intervention strategies.

In clinical contexts, temperament profiling could also enrich early risk assessment by identifying individuals with combinations of high novelty seeking, high harm avoidance, and low reward dependence as being at heightened risk for self-harming behaviour. Such profiles may inform personalised interventions that integrate impulse-control training (see e.g., Bjureberg et al., 2025), distress tolerance, and social reinforcement strategies (Schwartz-Mette et al., 2019). Educationally, these insights could guide the design of preventive programmes in schools and universities, where psychoeducation about coping mechanisms can be tailored to personality-based vulnerabilities. For example, individuals high in novelty seeking might benefit from structured opportunities for safe stimulation and novelty (e.g., creative outlets, physical challenges), while those with high harm avoidance could be supported through emotion regulation training and anxiety management. Finally, the association between temperament and neurotransmitter systems highlights the potential value of integrative treatment models combining psychotherapeutic and aforementioned psychopharmacological approaches, where addressing atypical serotonergic, dopaminergic, or noradrenergic functioning may reduce both self-harming behaviour and its frequent psychiatric comorbidities.

7. Conclusion

The present study contributes to the growing body of research on self-harming behaviour by demonstrating the predictive role of temperament traits as conceptualised in Cloninger's psychobiological model of personality. The findings indicate that high novelty seeking and harm avoidance, combined with low reward dependence, constitute a significant vulnerability profile for self-harming behaviour, whereas persistence did not emerge as a relevant predictor. These results

highlight the importance of considering temperament-based predispositions when seeking to understand the mechanisms underlying maladaptive coping in adolescence and young adulthood.

At the same time, the explanatory power of the model accounted for only a modest portion of the variance (10.3%), emphasising that self-harming behaviour is a multifaceted phenomenon influenced by a wide array of psychological, social, and environmental factors beyond temperament alone. This limitation underscores the need for more comprehensive research integrating personality traits with additional variables, such as family dynamics, trauma history, or peer influences. Furthermore, the non-representative sample restricts the generalisability of the results, suggesting caution in extending conclusions to broader populations.

Despite these limitations, the study offers meaningful theoretical and practical insights. It underscores the clinical utility of temperament profiling in early risk detection and highlights avenues for more targeted interventions in both clinical and educational contexts. By situating self-harming behaviour within a neurobiologically grounded personality framework, the research deepens our understanding of its origins while also pointing toward integrative strategies for prevention and treatment.

The presented conclusions highlight the necessity of examining the issue of self-harming behavior from multiple perspectives and emphasize the importance of investigating additional aspects that may contribute to a deeper understanding of the occurrence of this highly risky and destructive behavior.

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References

- Acosta, M., Pirani, S., Garcia, A., Wainwright, K., & Osman, A. (2020). Evaluation of the psychometric properties of the Multidimensional Revenge Attitudes Inventory-21. *Psychological Assessment*, 32(12), 1172–1183. <https://doi.org/10.1037/pas0000951>
- Adan, A., Serra-Grabulosa, J. M., Caci, H., & Natale, V. (2009). A reduced temperament and character inventory (TCI-56): Psychometric properties in a non-clinical sample. *Personality and Individual Differences*, 46(7), 687–692. <https://doi.org/10.1016/j.paid.2009.01.023>
- Allroggen, M., Kleinrahm, R., Rau, T. A., Weninger, L., Ludolph, A. G., & Plener, P. L. (2014). Nonsuicidal self-injury and its relation to personality traits in medical students. *The Journal of Nervous and Mental Disease*, 202(4), 300–304. <https://doi.org/10.1097/NMD.0000000000000122>
- APA (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Association. <https://doi.org/10.1176/appi.books.9780890425596>
- APA Dictionary of Psychology. (2025). <https://dictionary.apa.org/cloningers-psychobiological-model-of-personality>
- Ashok, A. H., Marques, T. R., Jauhar, S., Nour, M. M., Goodwin, G. M., Young, A. H., & Howes, O. D. (2017). The dopamine hypothesis of bipolar affective disorder: The state of the art and implications for treatment. *Molecular Psychiatry*, 22(5), 666–679. <https://doi.org/10.1038/mp.2017.16>
- Bae, Y., Seong, Y., Kim, S. H., & Kim, S. (2020). Clinical characteristics of non-suicidal self-injury and suicide attempts among psychiatric patients in Korea: A retrospective chart review. *Psychiatry Investigation*, 17(4), 320–330. <https://doi.org/10.30773/pi.2019.0269>
- Bidwell, L. C., Knopik, V. S., Audrain-McGovern, J., Glynn, T. R., Spillane, N. S., Ray, L. A., Riggs, N. R., Guillot, C. R., Pang, R. D., & Leventhal, A. M. (2015). Novelty seeking as a phenotypic marker of adolescent substance use. *Substance Abuse: Research and Treatment*, 9(Suppl 1), 1–10. <https://doi.org/10.4137/SART.S22440>

- Bjureberg, J., Ojala, O., Rasmusson, B., Malmgren, J., Hellner, C., Sampaio, F., & Flygare, O. (2025). Cost-effectiveness of internet-delivered emotion regulation therapy for adolescents with nonsuicidal self-injury: Within-trial analysis of a randomized controlled trial. *JMIR Mental Health*, 12, e74303. <https://doi.org/10.2196/74303>
- Brändström, S., Schlette, P., Przybeck, T. R., Lundberg, M., Forsgren, T., Sigvardsson, S., Nylander, P. O., Nilsson, L. G., Cloninger, R. C., & Adolfsson, R. (1998). Swedish normative data on personality using the Temperament and Character Inventory. *Comprehensive Psychiatry*, 39(3), 122–128. [https://doi.org/10.1016/S0010-440X\(98\)90070-0](https://doi.org/10.1016/S0010-440X(98)90070-0)
- Buelens, T., Luyckx, K., Verschueren, M., Schoevaerts, K., Dierckx, E., Depestele, L., & Claes, L. (2020). Temperament and character traits of female eating disorder patients with(out) non-suicidal self-injury. *Journal of Clinical Medicine*, 9(4), 1207. <https://doi.org/10.3390/jcm9041207>
- Carli, V., Jovanović, N., Podlessek, A., Roy, A., Rihmer, Z., Maggi, S., Marusic, D., Cesaro, C., Marusic, A., & Sarchiapone, M. (2010). The role of impulsivity in self-mutilators, suicide ideators and suicide attempters: A study of 1265 male incarcerated individuals. *Journal of Affective Disorders*, 123(1–3), 116–122. <https://doi.org/10.1016/j.jad.2010.02.119>
- Case, J., Mattoni, M., & Olino, T. M. (2021). Examining the neurobiology of non-suicidal self-injury in children and adolescents: The role of reward responsivity. *Journal of Clinical Medicine*, 10(16), 3561. <https://doi.org/10.3390/jcm10163561>
- Cassels, M., Neufeld, S., van Harmelen, A. L., Goodyer, I., & Wilkinson, P. (2022). Prospective pathways from impulsivity to non-suicidal self-injury among youth. *Archives of Suicide Research*, 26(2), 534–547. <https://doi.org/10.1080/13811118.2020.1811180>
- Chapman, A. L., Derbidge, C. M., Cooney, E., Hong, P. Y., & Linehan, M. M. (2009). Temperament as a prospective predictor of self-injury among patients with borderline personality disorder. *Journal of Personality Disorders*, 23(2), 122–140. <https://doi.org/10.1521/pedi.2009.23.2.122>
- Chen, X., Dong, Y., Ye, M., Wang, X., Yan, J., Yao, Y., Qi, Z., Qian, C., & Liu, Z. (2025). Comparative efficacy and acceptability of psychotherapeutic, pharmacological, and combination treatments for non-suicidal self-injury in children and adolescents: A systematic review and network meta-analysis. *BMC Psychiatry*, 25(1), 328. <https://doi.org/10.1186/s12888-025-06735-1>
- Cloninger, C. R. (1987). A systematic method for clinical description and classification of personality variants: A proposal. *Archives of General Psychiatry*, 44(6), 573–588. <https://doi.org/10.1001/archpsyc.1987.01800180093014>
- Cloninger, C. R., Svrakic, D. M., & Przybeck, T. R. (1993). A psychobiological model of temperament and character. *Archives of General Psychiatry*, 50(12), 975–990. <https://doi.org/10.1001/archpsyc.1993.01820240059008>
- Cloninger, C. R., Przybeck, T. R., Svrakic, D. M., & Wetzel, R. D. (1994). *The Temperament and Character Inventory (TCI): A guide to its development and use*. Center for Psychobiology of Personality, Washington University.
- Cloninger, C. R., Sigvardsson, S., & Bohman, M. (1996). Type I and type II alcoholism: An update. *Alcohol Health and Research World*, 20(1), 18–23.
- Cloninger, C. R., Zohar, A. H., Hirschmann, S., & Dahan, D. (2012). The psychological costs and benefits of being highly persistent: Personality profiles distinguish mood disorders from anxiety disorders. *Journal of Affective Disorders*, 136(3), 758–766. <https://doi.org/10.1016/j.jad.2011.09.046>
- Costa, V. D., Tran, V. L., Turchi, J., & Averbeck, B. B. (2014). Dopamine modulates novelty seeking behavior during decision making. *Behavioral Neuroscience*, 128(5), 556–566. <https://doi.org/10.1037/a0037128>
- da Cunha-Bang, S., Frokjaer, V. G., Mc Mahon, B., Jensen, P. S., Svarer, C., & Knudsen, G. M. (2023). The association between brain serotonin transporter binding and impulsivity and

- aggression in healthy individuals. *Journal of Psychiatric Research*, 165, 1–6. <https://doi.org/10.1016/j.jpsychires.2023.06.023>
- De Deurwaerdère, P., & Di Giovanni, G. (2020). Serotonin in health and disease. *International Journal of Molecular Sciences*, 21(10), 3500. <https://doi.org/10.3390/ijms21103500>
- Delvecchio, G., Bellani, M., Altamura, A. C., & Brambilla, P. (2016). The association between the serotonin and dopamine neurotransmitters and personality traits. *Epidemiology and Psychiatric Sciences*, 25(2), 109–112. <https://doi.org/10.1017/S2045796015001146>
- Demuth, A., & Demuthova, S. (2019). Forms of deliberate self-harm and their prevalence in adolescence. In *Proceedings of the International Conference on Research in Psychology* (pp. 23–38). Diamond Scientific Publication. <https://doi.org/10.33422/icrconf.2019.03.140>
- Demuthova, S. (2023). *Self-Harming Behavior in Adolescent Age*. Peter Lang.
- Demuthova, S., & Demuth, A. (2020). Self-harm in adolescence as maladaptive coping. *BRAIN: Broad Research in Artificial Intelligence and Neuroscience*, 11(2), 37–47. <https://doi.org/10.18662/brain/11.2Sup1/92>
- Elango, S. C., Sharma, E., & Roopesh, B. N. (2025). Impulsive-addictive-compulsive types of non-suicidal self-injury: A case series. *Indian Journal of Psychological Medicine*. Advance online publication. <https://doi.org/10.1177/02537176241300760>
- Evans, C. M., & Simms, L. J. (2019). The latent structure of self-harm. *Journal of Abnormal Psychology*, 128(1), 12–24. <https://doi.org/10.1037/abn0000398>
- Franklin, J. C., Puzia, M. E., Lee, K. M., Lee, G. E., Hanna, E. K., Spring, V. L., & Prinstein, M. J. (2013). The nature of pain offset relief in nonsuicidal self-injury: A laboratory study. *Clinical Psychological Science*, 1(2), 110–119. <https://doi.org/10.1177/2167702612474440>
- Gao, Y., Xiong, Y., Liu, X., & Wang, H. (2021). The effects of childhood maltreatment on non-suicidal self-injury in male adolescents: The moderating roles of the monoamine oxidase A (MAOA) gene and the catechol-O-methyltransferase (COMT) gene. *International Journal of Environmental Research and Public Health*, 18(5), 2598. <https://doi.org/10.3390/ijerph18052598>
- Gillespie, N. A., Cloninger, C. R., Heath, A. C., & Martin, N. G. (2003). The genetic and environmental relationship between Cloninger's dimensions of temperament and character. *Personality and Individual Differences*, 35(8), 1931–1946. [https://doi.org/10.1016/S0191-8869\(03\)00042-4](https://doi.org/10.1016/S0191-8869(03)00042-4)
- Gómez-Expósito, A., Wolz, I., Fagundo, A. B., Granero, R., Steward, T., Jiménez-Murcia, S., Agüera, Z., & Fernández-Aranda, F. (2016). Correlates of non-suicidal self-injury and suicide attempts in bulimic spectrum disorders. *Frontiers in Psychology*, 7, 1244. <https://doi.org/10.3389/fpsyg.2016.01244>
- Guerdjikova, A. I., Gwizdowski, I. S., McElroy, S. L., McCullumsmith, C., & Suppes, P. (2014). Treating nonsuicidal self-injury. *Current Treatment Options in Psychiatry*, 1(4), 325–334. <https://doi.org/10.1007/s4001-014-0028-z>
- Guo, Z., Liu, Y., Wang, C., Li, S., Yu, L., Wu, W., You, X., Zhang, Y., Teng, Z., & Zeng, Y. (2023). Exploring the association of addiction-related genetic factors with non-suicidal self-injury in adolescents. *Frontiers in Psychiatry*, 14, 1126615. <https://doi.org/10.3389/fpsyg.2023.1126615>
- Gusnard, D. A., Ollinger, J. M., Shulman, G. L., Cloninger, C. R., Price, J. L., Van Essen, D. C., & Raichle, M. E. (2003). Persistence and brain circuitry. *Proceedings of the National Academy of Sciences of the United States of America*, 100(6), 3479–3484. <https://doi.org/10.1073/pnas.0538050100>
- Ham, B. J., Choi, M. J., Lee, H. J., Kang, R. H., & Lee, M. S. (2005). Reward dependence is related to norepinephrine transporter T-182C gene polymorphism in a Korean population. *Psychiatric genetics*, 15(2), 145–147. <https://doi.org/10.1097/00041444-200506000-00012>
- Hankin, B. L., Barrocas, A. L., Young, J. F., Haberstick, B., & Smolen, A. (2015). 5-HTTLPR × interpersonal stress interaction and nonsuicidal self-injury in general community sample of youth. *Psychiatry research*, 225(3), 609–612. <https://doi.org/10.1016/j.psychres.2014.11.037>

- Hathaway, W. R., & Newton, B. W. (2023, May 29). Neuroanatomy, prefrontal cortex. In *StatPearls*. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK499919/>
- Hawton, K., Saunders, K. E. A., & O'Connor, R. C. (2012). Self-harm and suicide in adolescents. *The Lancet*, 379(9834), 2373–2382. [https://doi.org/10.1016/S0140-6736\(12\)60322-5](https://doi.org/10.1016/S0140-6736(12)60322-5)
- Hefti, S., In-Albon, T., Schmeck, K., & Schmid, M. (2013). Temperaments-und Charaktereigenschaften und selbstverletzendes Verhalten bei Jugendlichen. *Nervenheilkunde*, 32(01/02), 45–53. <https://doi.org/10.1055/s-0038-1628479>
- Islam, M. A., Steiger, H., Jimenez-Murcia, S., Israel, M., Granero, R., Agüera, Z., Castro, R., Sánchez, I., Riesco, N., Menchón, J. M., & Fernández-Aranda, F. (2015). Non-suicidal Self-injury in Different Eating Disorder Types: Relevance of Personality Traits and Gender. *European eating disorders review : the journal of the Eating Disorders Association*, 23(6), 553–560. <https://doi.org/10.1002/erv.2374>
- Jiao, T., Guo, S., Zhang, Y., Li, Y., Xie, X., Ma, Y., Chen, R., Yu, Y., & Tang, J. (2022). Associations of depressive and anxiety symptoms with non-suicidal self-injury and suicidal attempt among Chinese adolescents: The mediation role of sleep quality. *Frontiers in psychiatry*, 13, 1018525. <https://doi.org/10.3389/fpsyt.2022.1018525>
- Kim, K., Park, Y., Choi, J., Kim, D., & Kim, E. (2022). Temperament and Character of High Suicide Risk Group Among Psychiatric Patients. *Psychiatry investigation*, 19(8), 654–660. <https://doi.org/10.30773/pi.2021.0281>
- Klonsky, E. D., Victor, S. E., & Saffer, B. Y. (2014). Nonsuicidal self-injury: What we know, and what we need to know. *The Canadian Journal of Psychiatry / La Revue canadienne de psychiatrie*, 59(11), 565–568. <https://doi.org/10.1177/070674371405901101>
- Kolk, S. M., & Rakic, P. (2022). Development of the prefrontal cortex. *Neuropsychopharmacology : official publication of the American College of Neuropsychopharmacology*, 47(1), 41–57. <https://doi.org/10.1038/s41386-021-01137-9>
- Korner, A., Gerull, F., Stevenson, J., & Meares, R. (2007). Harm avoidance, self-harm, psychic pain, and the borderline personality: life in a "haunted house". *Comprehensive psychiatry*, 48(3), 303–308. <https://doi.org/10.1016/j.comppsy.2007.01.001>
- Kraus, L., Schmid, M., & In-Albon, T. (2020). Anti-suicide function of nonsuicidal self-injury in female inpatient adolescents. *Frontiers in Psychiatry*, 11, 490. <https://doi.org/10.3389/fpsyt.2020.00490>
- Lutz, N. M., Neufeld, S. A. S., Hook, R. W., Jones, P. B., Bullmore, E. T., Goodyer, I. M., Ford, T. J., Chamberlain, S. R., & Wilkinson, P. O. (2023). Why Is Non-suicidal Self-injury More Common in Women? Mediation and Moderation Analyses of Psychological Distress, Emotion Dysregulation, and Impulsivity. *Archives of suicide research : official journal of the International Academy for Suicide Research*, 27(3), 905–921. <https://doi.org/10.1080/13811118.2022.2084004>
- Lüdtke, J., Weizenegger, B., Rauber, R., Contin, B., In-Albon, T., & Schmid, M. (2017). The influence of personality traits and emotional and behavioral problems on repetitive nonsuicidal self-injury in a school sample. *Comprehensive Psychiatry*, 74, 214–223. <https://doi.org/10.1016/j.comppsy.2017.02.005>
- Lynam, D. R., Miller, J. D., Miller, D. J., Bornovalova, M. A., & Lejuez, C. W. (2011). Testing the relations between impulsivity-related traits, suicidality, and nonsuicidal self-injury: A test of the incremental validity of the UPPS model. *Personality Disorders: Theory, Research, and Treatment*, 2(2), 151–160. <https://doi.org/10.1037/a0019978>
- Matera, E., Margari, M., Serra, M., Petruzzelli, M. G., Gabellone, A., Piarulli, F. M., Pugliese, A., Tassiello, A. R., Croce, F., Renna, C., & Margari, A. (2021). Non-suicidal self-injury: An observational study in a sample of adolescents and young adults. *Brain Sciences*, 11(8), 974. <https://doi.org/10.3390/brainsci11080974>

- McHugh, C. M., Chun Lee, R. S., Hermens, D. F., Corderoy, A., Large, M., & Hickie, I. B. (2019). Impulsivity in the self-harm and suicidal behavior of young people: A systematic review and meta-analysis. *Journal of Psychiatric Research*, 116, 51–60. <https://doi.org/10.1016/j.jpsychires.2019.05.012>
- Minassian, A., Kelsoe, J. R., Miranda, A., Young, J. W., & Perry, W. (2022). The relationship between novelty-seeking traits and behavior: Establishing construct validity for the human behavioral pattern monitor. *Psychiatry Research*, 316, 114776. <https://doi.org/10.1016/j.psychres.2022.114776>
- Mitchell, M. R., & Potenza, M. N. (2014). Addictions and personality traits: Impulsivity and related constructs. *Current Behavioral Neuroscience Reports*, 1(1), 1–12. <https://doi.org/10.1007/s40473-013-0001-y>
- Moloney, F., Amini, J., Sinyor, M., Schaffer, A., Lanctôt, K. L., & Mitchell, R. H. B. (2024). Sex Differences in the Global Prevalence of Nonsuicidal Self-Injury in Adolescents: A Meta-Analysis. *JAMA network open*, 7(6), e2415436. <https://doi.org/10.1001/jamanetworkopen.2024.15436>
- Moran, P., Coffey, C., Romaniuk, H., Olsson, C., Borschmann, R., Carlin, J. B., & Patton, G. C. (2012). The natural history of self-harm from adolescence to young adulthood: A population-based cohort study. *The Lancet*, 379(9812), 236–243. [https://doi.org/10.1016/S0140-6736\(11\)61141-0](https://doi.org/10.1016/S0140-6736(11)61141-0)
- Mughal, F., Chew-Graham, C. A., Babatunde, O. O., Saunders, B., Meki, A., & Dikomitis, L. (2023). The functions of self-harm in young people and their perspectives about future general practitioner-led care: A qualitative study. *Health expectations : an international journal of public participation in health care and health policy*, 26(3), 1180–1188. <https://doi.org/10.1111/hex.13733>
- Mullins-Sweatt, S. N., Lengel, G. J., & Grant, D. M. (2013). Non-suicidal self-injury: The contribution of general personality functioning. *Personality and Mental Health*, 7(1), 56–68. <https://doi.org/10.1002/pmh.1211>
- Narita, S., Iwahashi, K., Nagahori, K., Numajiri, M., Yoshihara, E., Ohtani, N., & Ishigooka, J. (2015). Analysis of association between norepinephrine transporter gene polymorphisms and personality traits of NEO-FFI in a Japanese population. *Psychiatry Investigation*, 12(3), 381–387. <https://doi.org/10.4306/pi.2015.12.3.381>
- Nielsen, E., Sayal, K., & Townsend, E. (2017). Functional coping dynamics and experiential avoidance in a community sample with no self-injury vs. non-suicidal self-injury only vs. those with both non-suicidal self-injury and suicidal behaviour. *International Journal of Environmental Research and Public Health*, 14(6), 575. <https://doi.org/10.3390/ijerph14060575>
- Ohmann, S., Schuch, B., König, M., Blaas, S., Fliri, C., & Popow, C. (2008). Self-injurious behavior in adolescent girls: Association with psychopathology and neuropsychological functions. *Psychopathology*, 41(4), 226–235. <https://doi.org/10.1159/000125556>
- Pélissolo, A., & Lépine, J. P. (2000). Normative data and factor structure of the Temperament and Character Inventory (TCI) in the French version. *Psychiatry Research*, 94(1), 67–76. [https://doi.org/10.1016/s0165-1781\(00\)00127-x](https://doi.org/10.1016/s0165-1781(00)00127-x)
- Peng, Z., Jia, Q., Mao, J., Luo, X., Huang, A., Zheng, H., Jiang, S., Ma, Q., Ma, C., & Yi, Q. (2025). Neurotransmitters crosstalk and regulation in the reward circuit of subjects with behavioral addiction. *Frontiers in Psychiatry*, 15, 1439727. <https://doi.org/10.3389/fpsyt.2024.1439727>
- Peterson, J., Freedenthal, S., Sheldon, C., & Andersen, R. (2008). Nonsuicidal self-injury in adolescents. *Psychiatry (Edgmont)*, 5(11), 20–26.
- Pilozzi, A., Carro, C., & Huang, X. (2020). Roles of β -endorphin in stress, behavior, neuroinflammation, and brain energy metabolism. *International Journal of Molecular Sciences*, 22(1), 338. <https://doi.org/10.3390/ijms22010338>

- Pompili, M., Girardi, P., Ruberto, A., Kotzalidis, G. D., & Tatarelli, R. (2005). Emergency staff reactions to suicidal and self-harming patients. *European Journal of Emergency Medicine*, 12(4), 169–178. <https://doi.org/10.1097/00063110-200508000-00005>
- Reinhardt, M., Rice, K. G., Durán, B. S., & Kökönyei, G. (2022). A person-centered approach to adolescent nonsuicidal self-injury: Predictors and correlates in a community sample. *Journal of Youth and Adolescence*, 51(9), 1760–1773. <https://doi.org/10.1007/s10964-022-01628-y>
- Ressler, K. J., & Nemeroff, C. B. (2001). Role of norepinephrine in the pathophysiology of neuropsychiatric disorders. *CNS Spectrums*, 6(8), 663–670. <https://doi.org/10.1017/s1092852900001358>
- Riley, E. N., Combs, J. L., Jordan, C. E., & Smith, G. T. (2015). Negative urgency and lack of perseverance: Identification of differential pathways of onset and maintenance risk in the longitudinal prediction of nonsuicidal self-injury. *Behavior Therapy*, 46(4), 439–448. <https://doi.org/10.1016/j.beth.2015.03.002>
- Rysztak, L. G., & Jutkiewicz, E. M. (2022). The role of enkephalinergic systems in substance use disorders. *Frontiers in Systems Neuroscience*, 16, 932546. <https://doi.org/10.3389/fnsys.2022.932546>
- Sadath, A., Troya, M. I., Nicholson, S., Cully, G., Leahy, D., Ramos Costa, A. P., Benson, R., Corcoran, P., Griffin, E., Phillip, E., Cassidy, E., Jeffers, A., Shiely, F., Alberdi-Páramo, Í., Kavalidou, K., & Arensman, E. (2023). Physical and mental illness comorbidity among individuals with frequent self-harm episodes: A mixed-methods study. *Frontiers in Psychiatry*, 14, 1121313. <https://doi.org/10.3389/fpsyt.2023.1121313>
- Sansone, R. A., & Sansone, L. A. (2010). Measuring self-harm behavior with the self-harm inventory. *Psychiatry (Edgmont)*, 7(4), 16–20.
- Schwartz-Mette, R. A., & Lawrence, H. R. (2019). Peer socialization of non-suicidal self-injury in adolescents' close friendships. *Journal of Abnormal Child Psychology*, 47(11), 1851–1862. <https://doi.org/10.1007/s10802-019-00569-8>
- Seong, E., Lee, K. H., Lee, J. S., Kim, S., Seo, D. G., Yoo, J. H., Han, D. H., Hwang, H., Choi, C. H., & Kim, J. W. (2024). Depression and posttraumatic stress disorder in adolescents with nonsuicidal self-injury: Comparisons of the psychological correlates and suicidal presentations across diagnostic subgroups. *BMC Psychiatry*, 24(1), 138. <https://doi.org/10.1186/s12888-024-05533-5>
- Sørensen, J. Ø., Rasmussen, A., Roesbjerg, T., Verhulst, F. C., & Pagsberg, A. K. (2022). Suicidality and self-injury with selective serotonin reuptake inhibitors in youth: Occurrence, predictors and timing. *Acta Psychiatrica Scandinavica*, 145(2), 209–222. <https://doi.org/10.1111/acps.13360>
- Stallings, M. C., Hewitt, J. K., Cloninger, C. R., Heath, A. C., & Eaves, L. J. (1996). Genetic and environmental structure of the Tridimensional Personality Questionnaire: Three or four temperament dimensions? *Journal of Personality and Social Psychology*, 70(1), 127–140. <https://doi.org/10.1037//0022-3514.70.1.127>
- Stanley, B., Sher, L., Wilson, S., Ekman, R., Huang, Y. Y., & Mann, J. J. (2010). Non-suicidal self-injurious behavior, endogenous opioids and monoamine neurotransmitters. *Journal of Affective Disorders*, 124(1–2), 134–140. <https://doi.org/10.1016/j.jad.2009.10.028>
- Tomita, T., Aoyama, H., Kitamura, T., Sekiguchi, C., Murai, T., & Matsuda, T. (2000). Factor structure of psychobiological seven-factor model of personality: A model revision. *Personality and Individual Differences*, 29(4), 709–727. [https://doi.org/10.1016/S0191-8869\(99\)00227-5](https://doi.org/10.1016/S0191-8869(99)00227-5)
- Tschan, T., Peter-Ruf, C., Schmid, M., & In-Albon, T. (2017). Temperament and character traits in female adolescents with nonsuicidal self-injury disorder with and without comorbid borderline personality disorder. *Child and Adolescent Psychiatry and Mental Health*, 11, 4. <https://doi.org/10.1186/s13034-016-0142-3>

- Victor, S. E., Glenn, C. R., & Klonsky, E. D. (2012). Is non-suicidal self-injury an "addiction"? A comparison of craving in substance use and non-suicidal self-injury. *Psychiatry research*, 197(1-2), 73–77. <https://doi.org/10.1016/j.psychres.2011.12.011>
- Victor, S. E., Muehlenkamp, J. J., Hayes, N. A., Lengel, G. J., Styer, D. M., & Washburn, J. J. (2018). Characterizing gender differences in nonsuicidal self-injury: Evidence from a large clinical sample of adolescents and adults. *Comprehensive psychiatry*, 82, 53–60. <https://doi.org/10.1016/j.comppsy.2018.01.009>
- Westlund Schreiner, M., Klimes-Dougan, B., Begnel, E. D., & Cullen, K. R. (2015). Conceptualizing the neurobiology of non-suicidal self-injury from the perspective of the Research Domain Criteria Project. *Neuroscience and Biobehavioral Reviews*, 57, 381–391. <https://doi.org/10.1016/j.neubiorev.2015.09.011>
- Wilcox, H. C., Arria, A. M., Caldeira, K. M., Vincent, K. B., Pinchevsky, G. M., & O'Grady, K. E. (2012). Longitudinal predictors of past-year non-suicidal self-injury and motives among college students. *Psychological Medicine*, 42(4), 717–726. <https://doi.org/10.1017/S0033291711001814>
- Wise, R. A., & Jordan, C. J. (2021). Dopamine, behavior, and addiction. *Journal of Biomedical Science*, 28(1), 83. <https://doi.org/10.1186/s12929-021-00779-7>
- Wu, I. T., Lee, I. H., Yeh, T. L., Chen, K. C., Chen, P. S., Yao, W. J., & Yang, Y. K. (2010). The association between the harm avoidance subscale of the Tridimensional Personality Questionnaire and serotonin transporter availability in the brainstem of male volunteers. *Psychiatry Research*, 181(3), 241–244. <https://doi.org/10.1016/j.psychresns.2009.10.005>
- Zhao, H., & Zhou, A. (2024). Longitudinal relations between non-suicidal self-injury and both depression and anxiety among senior high school adolescents: A cross-lagged panel network analysis. *PeerJ*, 12, e18134. <https://doi.org/10.7717/peerj.18134>
- Zhong, R., Wang, Z., Zhu, Y., Wu, X., Wang, X., Wu, H., Zhou, J., Li, X., Xu, G., Pan, M., Chen, Z., Li, W., Jiao, Z., Li, M., Zhang, Y., Chen, J., Chen, X., Li, N., Sun, J., ... Fang, Y. (2024). Prevalence and correlates of non-suicidal self-injury among patients with bipolar disorder: A multicenter study across China. *Journal of Affective Disorders*, 367, 333–341. <https://doi.org/10.1016/j.jad.2024.08.231>