Word Count: abstract 181; body 4174
Tables: 2; Figures: 2

Associations between self-harm and distinct types of impulsivity

Authors' version of manuscript, Psych Res 2017

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ABSTRACT

Objective: Self-harm is common and is of considerable public health concern. There is an ongoing debate regarding how self-harm should be classified. The aim of this study was to characterize associations between self-harm and impulsivity, including from the perspective of formal mental disorders and neuropsychological functioning.

Method: Total 333 adults (mean [SD] age 22.6 (3.6) years, 61% male) were recruited from the general community, and undertook detailed clinical and cognitive assessments. History of self-harm was quantified using the Self-Harm Inventory (SHI), which asks about 22 self-harm behaviors (classic self-harm behaviors as well as broader types of behavior that may be relevant, such as engaging in emotionally abusive relationships). Principal components analysis was used to identify latent dimensions of self-harming behaviors. Relationships between self-harm dimensions and other measures were characterized using ordinary least squares regression.

Results: Principal Components Analysis yielded a three factor solution, corresponding to self-injurious self-harm (e.g. cutting, overdoses, burning), interpersonal related self-harm (e.g. engaging in emotionally or sexually abusive relationships), and reckless self-harm (e.g. losing one's job deliberately, driving recklessly, abusing alcohol). Regression modelling showed that all three dimensions of self-harm were associated with lower quality of life. Classic and interpersonal self-harm dimensions were associated with impulse control disorders (ICDs) whereas reckless self-harm was associated with other mainstream mental disorders besides ICDs.

Only interpersonal self-harm was significantly associated with other impulsive measures (less risk adjustment on the Cambridge Gambling Task).

Conclusions: This study suggests the existence of three distinct subtypes or 'latent factors' of self-harm: all three appear clinically important in that they are linked with worse quality of life. Clinicians should screen for impulse control disorders in people presenting with self-harm, especially when it is self-injurious or involves interpersonal harm. Our findings militate against self-harm being broadly associated with impulsive personality and cognitive measures, at least in people recruited from a non-clinical / non-treatment setting. If future nosological revisions and treatment trials focus on self-injurious self-harm alone, they may overlook other aspects of self-harm that are also functionally impairing.

Keywords: impulsivity; suicidality; impulsive; cognition

1. INTRODUCTION

Self-harm can be defined as behaviors that are undertaken to damage oneself, irrespective of intention (National Institute for Health and Care Excellence, UK, 2013). Some researchers distinguish non-suicidal self-injury from suicidal self-injury. Far from being limited only to people with formal mental disorders, self-harm behaviors – when defined broadly – are relatively frequent in the general population. Studies in community adolescent populations have reported lifetime prevalence of self-harm (broadly defined) to be up to 17% (Sansone & Sansone, 2010) while studies in child and adult clinical populations report rates as high as 82.4% (Nock & Prinstein, 2004; Selby et al., 2012). Variation in lifetime prevalence of self-harm likely reflects different operationalizations: broader definitions (including self-harm related thoughts as well as behaviors; Sansone & Sansone, 2010), through to relatively narrow/specific definitions (e.g. the concept of 'Non-Suicidal Self Injury Disorder'; Selby et al., 2012). In a cross-sectional assessment of adolescents from 11 European countries (~12,000 participants), the overall lifetime prevalence of self-injurious behavior was 27.6% (Brunner et al., 2014). The public health importance of self-harm is considerable due to its association with increased risk of subsequent suicide (Hawton & Harriss, 2007).

Self-harm is listed explicitly amongst the diagnostic criteria for borderline personality disorder (DSM-5; American Psychiatric Association, 2013), but is also associated with a range of other mental health disorders while not being listed amongst the diagnostic criteria. Self-harm is not unique to borderline personality disorder: elevated rates of self-harm have been found – for example – in depression, substance use (and substance use disorders), anxiety disorders and

problem gambling (Hawton & Harriss, 2007; Sansone et al., 2013; Plener et al., 2015). Psychiatric disorders are exceedingly common among people who present to medical settings with self-harm. For example, in a sample of people who presented to a general hospital with self-harm, 92% had one or more underlying mental disorder, the most common types being mood, substance use, and anxiety disorders; co-presentation with these disorders was more commonplace than co-presentation with personality disorder (Haw et al., 2001).

The issue is timely because self-harm, despite not being a new phenomenon, has now emerged as a candidate mental disorder for the first time. The Diagnostic and Statistical Manual Version 5 (DSM-5) (American Psychiatric Association, 2013) has highlighted 'non-suicidal self-injury' (NSSI) as a condition in need of further study (Zetterqvist, 2015). Some argue that the evidence for this concept is questionable, due to the dichotomy between 'non-suicidal' and 'suicidal' self-injury being invalid (Kapur et al., 2013). Also, because self-harm occurs across a range of mental disorders, it may be better to consider whether distinct types of self-harm exist along a continuum, rather than categorically. Exploration of potential dimensions of self-harm, along with the relative strength of associations between dimensions of self-harm, mental disorders, and personality plus neuropsychological measures of impulsivity, is clinically important. Treatment trials for self-harm tend to focus on self-injury, but other types of self-harm may be important (such as engaging in emotionally abusive relationships, or driving recklessly). Identification of self-harm dimensions and clinical correlates could help to identify key targets for screening and intervention, and also potentially inform the debate about psychiatric screening in clinical practice. For example, in our experience, clinicians typically screen for mainstream

mental disorders in people who present with self-harm, but may not screen for impulse control disorders.

One important concept of relevance to self-harm is 'impulsivity', which refers to actions that are unduly hasty, risky, and ultimately damaging to the individual (Daruna & Barnes, 1993). 'Impulsive' self-harm is listed amongst the diagnostic criteria for borderline personality disorder (American Psychiatric Association, 2013). Some self-harm can be viewed as impulsive in that it can be risky and ultimately damaging, undertaken without forethought. Iimpulsivity can be explored in terms of overt behaviors (such as self-harm, or intake of substances), categorical mental disorders (such as presence or absence of attention-deficit hyperactivity disorder [ADHD], gambling disorder, substance use disorder), dimensional psychopathology (rates of ADHD-like symptoms, or problem gambling), or personality (e.g. the Barratt Impulsiveness Questionnaire). Impulsivity can also be measured using neuropsychological tests, such as in terms of failure to suppress pre-potent responses (response inhibition), or risky decision-making on gambling tasks (for example, preference for more immediate gratification to the detriment of longer-term outcomes) (Grant & Chamberlain, 2014).

Multiple studies have explored manifestations of different types of impulsivity in people with self-harm. In an online sample of 1350 university students, affective impulsivity – defined using latent modelling – was identified as a general risk factor for self-harm but this association was no longer statistically significant after adjusting for affective symptoms. Latent cognitive impulsivity did not show a significant relationship with self-harm in this study (Rawlings et al., 2015). In 181 people with suicidality presenting to the emergency department, surprisingly those

with recent self-harm showed lower attentional impulsivity, on the Barratt Impulsivity Questionnaire, versus those without recent self-harm (Randall et al., 2014). In 64 adolescents with lifetime history of self-injury, versus 30 controls without such a history, those with history of self-injury scored higher on a self-report item asking whether they failed to think before acting, leading to getting into trouble (Janis & Nock, 2009). However, groups did not differ significantly on impulsive errors (commission errors) on a continuous performance task, nor in terms of decision-making on the Iowa Gambling Task. The same authors also compared 20 adult women with recent self-injury versus 20 controls on these neuropsychological tasks, plus a delay discounting task, and the Barratt Impulsivity Questionnaire (Janis & Nock, 2009). They found that people with recent self-injury had significantly higher Barratt scores, but did not differ significantly from the controls on the neurocognitive tasks. In another study, 54 adolescents with a history of self-harm did not differ significantly from controls (n=57) in terms of Iowa Gambling Task performance (Oldershaw et al., 2009). There was tentative evidence for relatively worse decision-making performance in people who recently self-harmed versus people who self-harmed in the past, but the global task measure was not significant. In summary, available studies exploring impulsivity in people with a history of self-harm has yielded mixed results, with the majority of studies not reporting a clear cut positive relationship between self-harm (mostly self-injury) and impulsivity.

Potential limitations of existing studies exploring relationships between self-harm and different types of impulsivity included relatively small sample sizes, inclusion of some measurements of impulsivity but not others within a given study (especially failure to assess occurrence of impulse control disorders or ADHD), treating self-harm as a binary entity (rather than in terms of

potential dimensions or subtypes), and use of cognitive tasks that may not fully have captured underlying cognitive dysfunction. For example, commission errors on continuous performance tasks do constitute a measure of impulsivity, but may be relatively insensitive to pathology compared to tasks that use dynamic tracking algorithms to estimate the ability of a given individual to suppress a 'pre-potent' response.

Aims of the study

To address the above limitations, we recruited a sample of non-treatment seeking adults and quantified a broad range of behaviors related to self-harm, using the 22 item Self-Harm Inventory (SHI) (Sansone & Sansone, 2010). We used Principal Components Analysis to identify latent dimensions of self-harm from the SHI, and explored the relationships between dimensions of self-harm behaviors and specific measures of impulsivity (impulse control disorders, personality measures, and cognition). These levels of impulsivity are complementary, capturing current symptomatology, predisposition (trait personality) as well as objective computerized measures linked to the integrity of fronto-striatal circuitry in the brain. We hypothesized that there would be two distinct subtypes of self-harm: classic 'self-injurious' self-harm (such as cutting, burning, and taking overdoses), and self-harm potentially involving others (such as engaging in destructive relationships, deliberately losing one's job, and driving recklessly). We hypothesized that both types of self-harm would be significantly and positively associated with impulsive symptoms (impulse control disorders), and impulsive cognitive functioning (risky decision-making on a gambling task, and stop-signal impairment on a stop-signal task).

2. METHODS

2.1 Subjects

Three-hundred and thirty-three subjects aged 18-29 years were recruited using media advertisements in two major US cities (adverts in bulletin boards, newspapers, and flyers, asking for people to take part in a research study exploring impulsivity). Subjects were excluded if they were unable to understand and undertake the assessments. The only inclusion criterion, beyond age, was gambling at least occasionally (defined as five or more times in the preceding year); this criterion was used because the research was part of a broader project, funded to explore gambling behaviors in younger people. This approach also allowed us to recruit a somewhat enriched sample with regards to impulsive tendencies. Prior to participation, a complete description of the study was provided, and individuals provided written informed consent.

2.2 Assessments

Subjects participated in detailed demographic, clinical and cognitive assessment. Self-harm was assessed using the previously validated Self-Harm Inventory (Sansone & Sansone, 2010), which is a 22-item self-report questionnaire, covering a range of lifetime self-harm behaviors and thoughts. This inventory yields a total score out of 22, with higher scores being indicative of more serious self-harm. In previous work, a cut off of 5 or more was indicative of borderline personality disorder, and had good psychometric properties when compared to structured clinical

interviews (Sansone & Sansone, 2010). The inventory also correlates significantly with healthcare utilization (Sansone et al., 2008), and compares favorably when viewed against other scales in terms of the range of thoughts/behaviors considered, psychometric properties, and ability to score over range of severities (Latimer et al., 2012).

Occurrence of psychiatric disorders was evaluated using the Mini International Neuropsychiatric Inventory (MINI) (Sheehan et al., 1998) and the Minnesota Impulse Disorder Inventory (MIDI) (Grant, 2008). The MINI identifies standard psychiatric disorders (e.g. depression, bipolar disorder, psychosis, anxiety disorders, obsessive-compulsive disorder) while the MIDI identifies impulse control disorders (kleptomania, compulsive sexual disorder, trichotillomania, intermittent explosive disorder, skin-picking disorder, compulsive buying disorder, pyromania, binge-eating disorder). The MINI has excellent psychometric properties including interrater reliability (majority of kappa values 0.9 or higher; Sheehan et al., 1998); the MIDI has excellent sensitivity and specificity (interrater reliability has not been assessed) (Grant et al., 2005).

The Adult ADHD Self-Report Scale (ASRS v1.1) was used to quantify ADHD symptomatology (Kessler et al., 2005), and the Structured Clinical Inventory for Gambling Disorder symptomatology (SCI-GD) (Grant et al., 2015). Cronbach's alpha for the ASRS has been reported to be good-excellent (~0.88) while inter-rater reliability for the SCI-GD is excellent (overall Kappa close to 1) (Adler et al., 2006; Grant et al., 2004). Quality of life was quantified using the Quality of Life Inventory (QOLI; Cronbach's alpha ~0.81) (Frisch & Cornell, 1993), self-esteem with the Rosenberg Self Esteem Scale (RSE; Cronbach's alpha ~0.8) (Rosenberg, 1965), and emotional dysregulation with the Difficulties with Emotion Regulation Scale (DERS;

Cronbach's alpha 0.7-0.8) (Fowler et al., 2014). Self-esteem is often low in people who self-harm, whereas difficulties with emotional regulation could contribute to self-harm by acting as a trigger. The Barratt Impulsiveness questionnaire was used to quantify impulsive personality traits (Cronbach's alpha ~ 0.8; Patton et al., 1995). Individuals were also asked about how often they consume alcohol (number of times alcohol consumed per week), and number of cigarette packs consumed per day (packs per day equivalent).

Cognitive testing was undertaken using two tests from the Cambridge Neuropsychological Test Automated Battery (CANTABeclipse, version 3, Cambridge Cognition Ltd, UK), which are particularly relevant for impulsivity. The Stop-Signal task was used to measure response inhibition, and the Cambridge Gambling test to measure different aspects of decision-making. On the Stop-Signal task, a series of directional arrows were presented on the computer screen one per time, and volunteers made quick responses depending on the direction of arrows using a button box. Whenever a 'stop-signal' occurred (an auditory 'beep'), subjects attempted to inhibit/suppress their motor response for the given trial. By varying the time between presentation of the arrow and the stop-signal, the task calculated the stop-signal reaction time – a measure of time taken to suppress a response that would normally be made. The stop-signal reaction time is the key measure of inhibitory control (longer equals worse inhibitory control); median response times were also recorded (a measure of general response latency unrelated to inhibitory control).

On the Cambridge Gamble Task (CGT), ten boxes were shown per trial, some blue and some red, with a token having been hidden behind one of these. The participant selected the color of

box they believed a token was hidden behind (blue or red), and then decided how many points to gamble. By sampling subjects' gambling behaviors across a range of risk levels, the task provided overall scores relating to the proportion of points gambled, the proportion of points when a rational color choice was made, and the extent to which subjects changed amount gambled depending on risk (risk adjustment).

2.3 Statistical approach

Data were analyzed using SPSS version 22. All available data were entered into the statistical analyses. SHI items were entered into Principal Components Analysis (PCA), using Varimax rotation, to identify latent subtypes of self-harm (latent factors); the optimal model was selected based on inspection of the Scree Plot. Latent factor scores for each participant were extracted using method 'regression'. Linear regression was then used to examine whether the following clinical (including impulsive) measures were significantly associated with latent factors: age, gender, presence of one or more MINI mental disorders, presence of one or more MIDI mental disorders, Barratt Impulsiveness total score, quality of life, difficulties with emotional regulation (DERS) total score, Rosenberg Self-Esteem Inventory (RSI) total score ASRS total score (Part A), Stop-Signal Reaction Times (SSRTs), quality of decision-making, and overall proportion of points gambled. For regression, the stepwise method of variable entry was used, which follows an iterative process of adding and removing variables in order to arrive at a model of best fit. This approach was preferred in view of the possibility of independent variables correlating with each other. To assess for model assumptions, we examined collinearity statistics (variance

inflation factor), condition index for model dimensions, Durbin-Watson, and whether distributions of residuals conformed to normal distributions. Statistical significance was defined as $p<0.05$ two-tailed.

3. RESULTS

An overview of the demographic, clinical, and cognitive characteristics of the total sample is given in **Table 1**. The mean (standard deviation, SD) Self-harm Inventory total score in the sample was 1.64 (2.45), range 0-16 (maximum possible 22). The distribution of total scores is indicated in **Supplementary Online Figure 1**. 52.9% of individuals endorsed non-zero scores on the instrument. Across the sample, 10.5% had total Self-Harm Inventory scores of five or more, which would be indicative of borderline personality disorder. The percentage of the sample endorsing the different items of the Self-Harm inventory are shown in **Figure 1**. The top-five most commonly endorsed types of self-harm were (in order of descending frequency) abusing alcohol, being promiscuous, engaging in emotionally abusive relationships, driving recklessly, and cutting one's self. In people without any identified mental disorders (N=193), the mean self-harm score was 1.08 (1.75), range 0-9, and 48% of these individuals with no identified mental disorders endorsed a history of self-harm.

* TABLE 1 AND FIGURE 1 AROUND HERE PLEASE *

Table 1. Characteristics of the study sample.

Variable	Mean (SD) or N [%]
Demographic measures	
Age, years	22.56 (3.61)
Gender, N [%] male	203 [61%]
Quality of life	45.69 (12.57)
Education level, N [%]	
Less than high school	9 [2.7%]
High school graduate	23 [6.9%]
Some college	203 [61.0%]
College graduate	68 [20.4%]
Completed training beyond college	30 [9.0%]
Sexual orientation, N [%]	
Asexual	1 [0.3%]
Heterosexual	298 [89.5%]
Homosexual	19 [5.7%]
Bisexual	12 [3.6%]
Other	3 [0.9%]
Rosenberg Self-Esteem score	21.5 (6.46)
Difficulties with Emotional Regulation score	73.36 (19.12)
Substance use	
Alcohol consumption, times/week	1.39 (1.37)
Nicotine consumption, packs per day	0.12 (0.29)
Presence of formal mental disorders	
Any MINI disorder current, N [%]	123 [36.9%]
Any MIDI disorder current, N [%]	33 [10.2%]
Dimensional measures of impulsive psychopathology	
ADHD total score	8.95 (4.69)
Gambling symptoms (SCI-GD total)	1.44 (2.18)
Questionnaire measures of impulsivity	
Barratt Impulsiveness	

Attention	16.87 (4.16)
Motor	23.83 (4.89)
Non-planning	24.00 (5.45)
Cognitive functioning	
SST Median 'Go' Reaction Time	510.46 (188.65)
SST SSRT	182.75 (65.55)
CGT Overall proportion bet	0.54 (0.14)
CGT Overall proportion of rational decisions	0.95 (0.08)
CGT Risk adjustment	1.48 (1.26)

Note: occasionally, one or more measures were incomplete for some subjects, hence total N may not be 333. ADHD = attention-deficit hyperactivity disorder. SCI-GD = structured interview for gambling disorder. SST = Stop-Signal Test. SSRT = Stop-Signal Reaction Time. CGT = Cambridge Gamble Task.

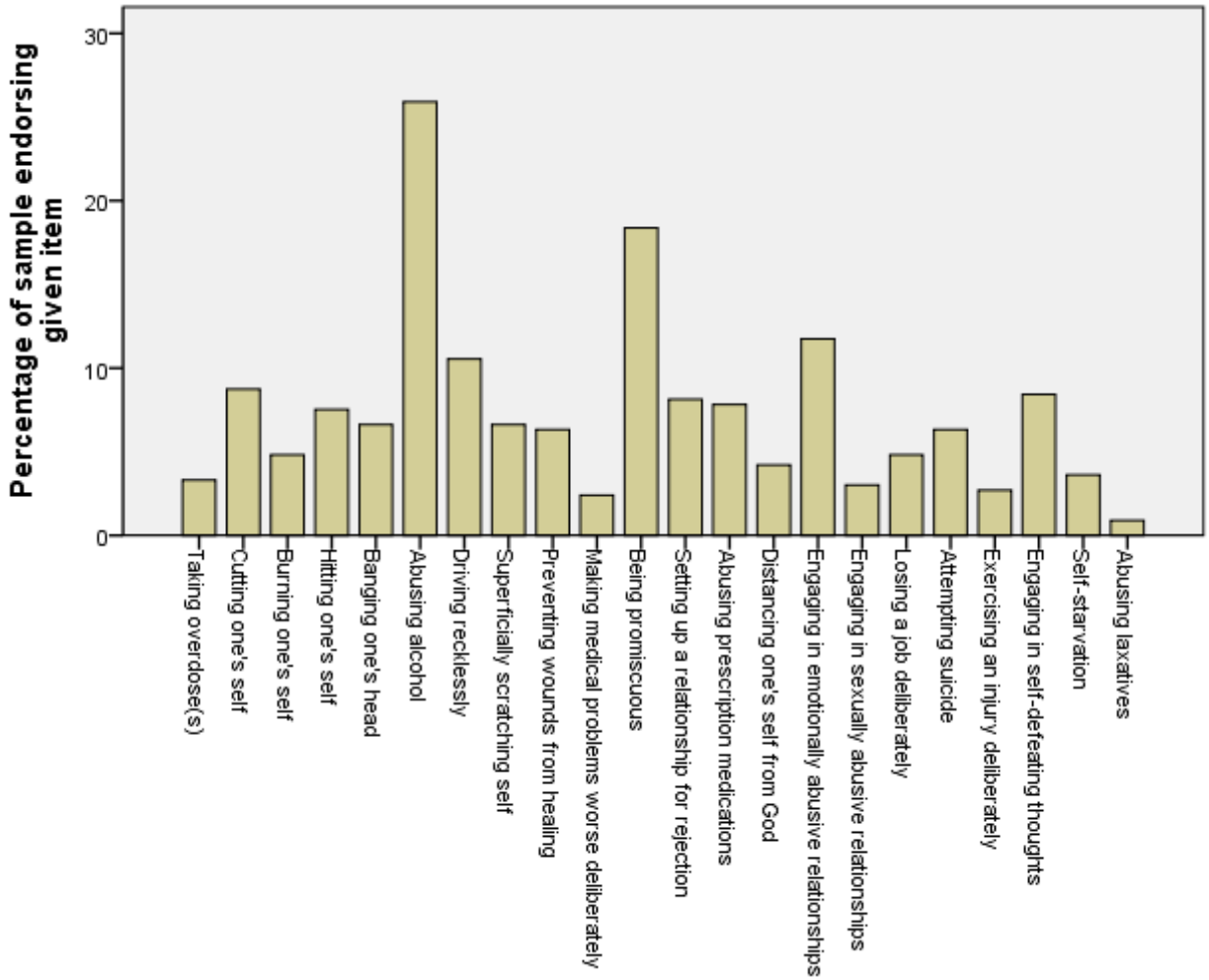

Figure 1. Percentage of subjects in the sample who endorsed individual forms of self-harm as measured by the Self-Harm Inventory items.

The scree plot from the Principal Component Analysis across all SHI items is shown in Figure 2, inspection of which yielded a three factor solution, which accounted for 35% of the variance. The loading of individual SHI items on each factor is shown in Table 2; it can be seen that factor 1 related to classic measures of self-harm (e.g. burning, overdose, cutting) and therefore was labelled "classic self-harm"; factor 2 related mostly to interpersonal dynamics (e.g. engaging in emotionally abusive relationships) and was labelled "interpersonal self-harm"; and factor 3 related mainly to reckless behavior (e.g. driving recklessly, abusing alcohol, or losing a job deliberately), and so was referred to as "reckless self-harm".

Figure 2. Scree Plot for Principal Components Analysis (PCA) across all individual SHI items. A three factor solution was selected based on the plot.

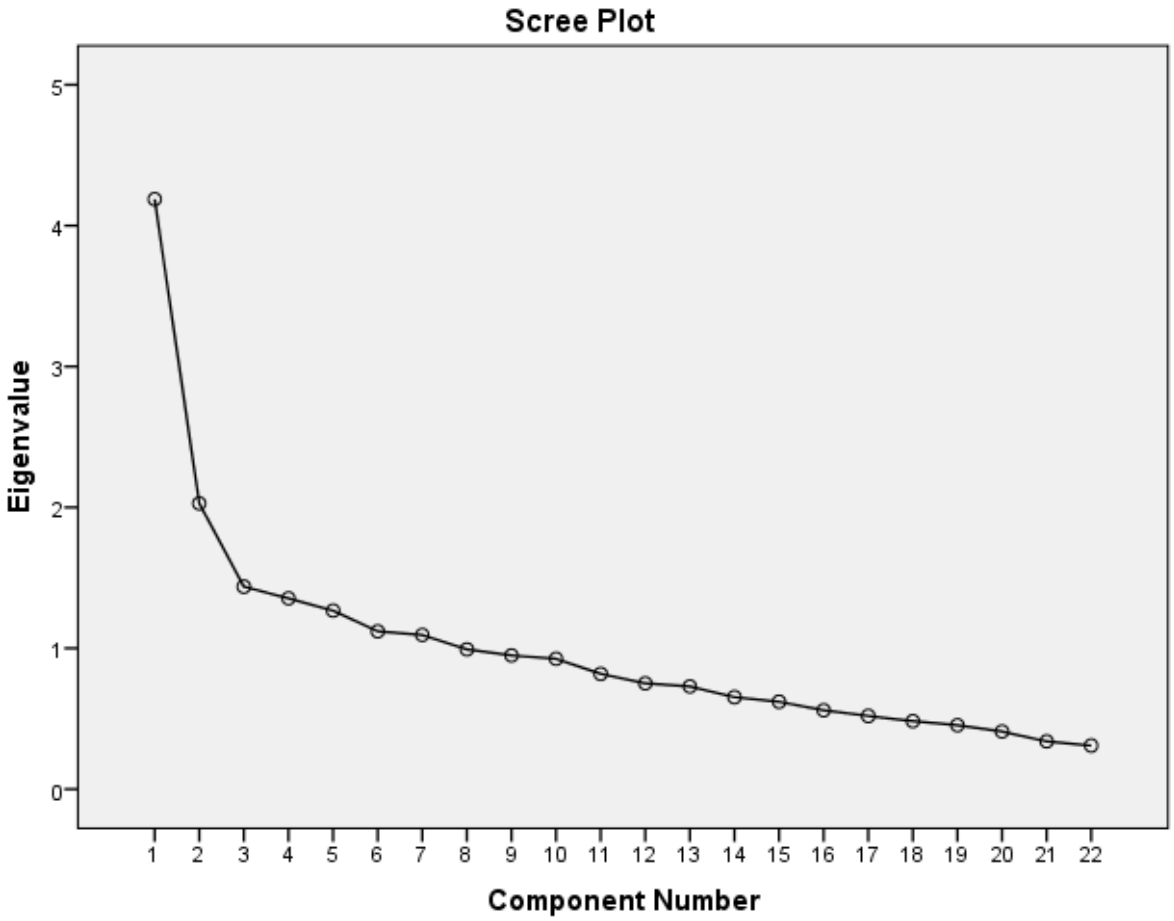

Table 2. Results of rotated component matrix, showing loading of individuals from the SHI on the three latent forms of self-harm, thresholded at r ≥ 0.4.

	Factor		
	1	2	3
Hitting one's self	.649		
Superficially scratching self	.635		
Preventing wounds from healing	.612		
Banging one's head	.529		
Cutting one's self	.516		
Taking overdose(s)	.490		
Burning one's self	.414		
Setting up a relationship for rejection		.763	
Engaging in emotionally abusive relationships		.680	
Distancing one's self from God		.655	
Engaging in self-defeating thoughts		.542	
Engaging in sexually abusive relationships		.494	
Self-starvation		.452	
Losing a job deliberately			.637
Being promiscuous			.609
Driving recklessly			.556
Abusing alcohol			.423

Regression yielded a statistically significant model for classical self-harm (ANOVA F=8.011, $p<0.001$; R square = 0.048). Higher classic self-harm was predicted by lower quality of life (standardized beta=-0.164, t=-2.934, p=0.004) and by higher occurrence of one or more impulse control disorders (standardized beta=0.117, t=2.095, p=0.037). The beta for the model constant was 0.559. Regression also yielded a statistically significant model for interpersonal self-harm (F=14.022, $p<0.001$; R square = 0.118). Higher interpersonal self-harm was predicted by lower quality of life (standardized beta = -0.207, t=-3.789, $p<0.001$), higher occurrence of one or more

impulse control disorders (standardized beta = 0.165, t=3.041, p=0.003), and by less risk adjustment on the Cambridge Gamble Task (standardized beta = -0.143, t=-2.670, p=0.008). The beta for the model constant was 0.867. The regression model for reckless self-harm was also significant (F=15.086, p<0.001; R square = 0.087). Higher reckless self-harm was predicted by and by lower quality of life (standardized beta=-0.128, t=-2.278, p=0.023) and by occurrence of one or more MINI mental disorders (standardized beta=0.231, t=4.114, p<0.001). The beta for the constant term was 0.290.

4. DISCUSSION

This study explored potential latent dimensions of self-harm (candidate subtypes) in non-treatment seeking young adults, using an instrument assessing a broad range of behaviors (22 behaviors). We also incorporated a broad range of impulsive measures, including relating to occurrence of psychiatric disorders, personality, and cognition. The mean total self-harm score of our sample was 1.64 (standard deviation 2.45), which is reasonably comparable to the mean score of 2.3 (2.5) reported in a previous sample of control participants recruited from a variety of medical settings (Sansone et al., 1998). Principal Components Analysis identified three underlying dimensions of self-harm: self-injurious, interpersonal, and reckless self-harm respectively. Higher scores on all three dimensions of self-harm were individually associated with lower quality of life. Only interpersonal self-harm was significantly associated with neuropsychological abnormalities, namely less adjustment as a function of risk on the decision-

making task. Self-injurious and interpersonal self-harm were associated with higher risk of one or more impulse control disorders (ICDs), whereas reckless self-harm was associated with other mental disorders besides ICDs.

Lower quality of life emerged as a significant statistical predictor for all three dimensions of self-harm, indicating the likely untoward cumulative clinical impact of self-harm. The raw mean quality of life t-score was 49.4 in those with no history of self-harm, which is in the mid-normal quality of life range versus normative data (Frisch & Cornell, 1993). A raw self-harm score of two or more was sufficient to bring the mean quality of life down to 43.0 or below (poor quality of life), while a raw mean score of six or more was sufficient to bring mean quality of life down to 37.0 or below (very low quality of life). These findings highlight the particularly strong relationship between self-harm and worse quality of life, emphasizing the need to detect and treat self-harm early on. Our data indicate that interventions capable of stemming the development of new or additional forms of self-harm are likely to have knock on benefits for quality of life. Most self-harm research to date has focused mainly on self-injurious behaviors: our findings suggest that studying other aspects of self-harm in the same setting may be clinically valuable, because these too are linked with worse quality of life.

Higher self-injurious and interpersonal self-harm scores were significantly associated with having one or more impulse control disorders (ICDs, measured using the MIDI), whereas higher reckless self-harm was not. At the same time, higher reckless self-harm scores were associated with having one or more mainstream mental disorders besides ICDs, whereas higher self-injurious and interpersonal self-harm scores were not. In our experience, clinicians tend to screen for mainstream mental disorders (e.g. depression, alcohol use disorder; MINI) in people presenting with self-harm, but ICDs tend to be overlooked. Our finding that ICDs were more predictive of dimensions of self-injurious and interpersonal self-harm than mainstream mental disorders highlights the importance of careful screening for these conditions in clinical practice. It is surprising that self-injurious self-harm was not significantly associated with mainstream mental disorders; however, this may just reflect a stronger relationship with other types of self-harm, which would potentially wash out this association due to the data approach treating the three types of self-harm as being orthogonal. We did not identify a significant relationship between the three self-harm dimensions and ADHD symptom total scores (ADHD is not assessed by the MIDI). In a systematic review, ADHD was found to be a risk factor for self-harm (Allely, 2014). This discrepancy may be due to our method of assessing ADHD symptoms, which relied on a self-report instrument rather than involving the type of detailed psychiatric assessment necessary for confirming such a diagnosis.

It is potentially informative to consider these results alongside previous research findings. When a cross-sectional assessment of adolescents from 11 European countries was undertaken, comprising ~12,000 individuals, depression and anxiety were found to be significantly

associated with self-harm (Brunner et al., 2014). In internal medicine outpatients, self-harm scores correlated significantly with externalized aggressive behavior (Sansone et al., 2013). Across studies, researchers have highlighted higher scores of depression as having an association with self-harm, along with alcohol/drug use (Plener et al., 2015). There was a positive relationship between self-harm and both alcohol and nicotine consumption in college students (Andersson et al., 2013), while a sample of 20,000 young adults followed longitudinally found that high alcohol use was a particularly strong risk factor for engaging in repeated self-harm (Martiniuk et al., 2015). Using data from the US National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), self-harm was significantly associated with various forms of psychopathologies, substance use disorders, and violent behaviors (Vaughn et al., 2015). Research also suggests that self-harm is increased in the context of impulse control disorders such as intermittent explosive disorder, especially when comorbid with personality disorders (Jenkins et al., 2015).

Contrary to our *a priori* expectations, we did not generally identify any significant associations between self-harm and Barratt impulsiveness scores nor between self-harm and performance on the Stop-Signal and Cambridge Gamble Tasks. The only exception to this was that less risk adjustment on the Cambridge Gamble Task was associated with higher scores on the interpersonal self-harm dimension. Barratt impulsiveness was previously found to be significantly elevated in individuals with a history of self-harm (e.g. Janis & Nock, 2009). Reasons for the discrepancy from the current findings are unclear; one possibility is that the relationship between self-harm and Barratt impulsiveness is lost when variation in other

parameters is controlled for (as was the case using the current statistical approach). It also remains possible that there is a relationship between self-harm and Barratt impulsiveness, but that it is subtle or with relatively small effect size, as compared to the impact of other variables such as occurrence of mental disorders.

Multiple previous studies have found no significant decision-making abnormalities in people with a history of self-harm versus controls, using the Iowa Gambling test (Janis & Nock, 2009; Oldershaw et al., 2009; McCloskey et al., 2012). The Iowa Gambling test is conceptually related to the Cambridge Gamble Task, although the latter seeks to decompose different aspects of decision-making and is less contingent on trial-by-trial learning. In previous work, self-harm was not associated with increased errors of commission on a continuous performance task, which is conceptually related to the Stop-Signal Task; nor was self-harm associated with abnormalities in delay discounting (another type of impulsivity, arguably only indirectly captured by the tasks we used herein) (Janis & Nock, 2009). Three prior studies exploring Stop-Signal Task performance in people who self-harm found no significant deficits versus controls overall (Glenn & Klonsky, 2010; Fikke et al., 2011; Allen & Hooley, 2015). Interestingly, the Allen & Hooley study (2015) found that inhibitory control was impacted by emotional valence of stimuli: self-injuring individuals showed worse inhibition relating to images with negative emotional content, and better than expected inhibition relating to images that were self-harm related. Our data confirm that self-harm does not appear to be associated with generalized impairment in decision-making or response inhibition, except for less risk-adjustment being linked with higher interpersonal self-harm.

Limitations

Several potential limitations should be considered regarding the current study. Our statistical approach means that more subtle relationships between clinical variables and self-harm dimensions (small effect sizes) may have been overlooked, in view of the sample size. Ideally the findings would in future be replicated in a larger sample. Our study cannot demonstrate causality between variables. We did not measure all possible cognitive domains germane to impulsivity – for example, we did not measure delay discounting directly. The statistical approach allowed for those variables most robustly associated with self-harm scores to be identified; lack of significant association does not necessarily mean that a given variable is not relevant when attempting to understand self-harm – for example, subtler relationships with small effect size may have been overlooked. While we screened for antisocial personality disorder (part of the MINI assessment) and borderline personality disorder (inferred using total Self-Harm Inventory score of 5 or more), we did not screen for other personality disorders in this study. Because we conducted our study in non-treatment seeking adults aged 18-29 years, it remains to be confirmed whether the findings generalize to other settings. Lastly, we identified underlying dimensions of self-harm using a broad instrument capturing 22 types of behavior; our definition of self-harm is thus very distinct from the typical definitions used in the literature, such as the concept of 'non-suicidal self-injury [NSSI] disorder', listed as a disorder in need of further research in DSM-5, which is narrower in scope and therefore may be more valuable clinically (Nock, 2009). Future work could evaluate relationships between NSSI disorder and self-harm scores on the Self Harm Inventory.

Summary and implications

Self-harm deserves research and clinical attention due to the significant association, found here, with lower quality of life. We propose that focusing only on self-injurious self-harm, as much existing literature discussed above has done, may overlook important treatment targets – our data suggest the existence of three latent dimensions of self-harm: self-injurious, interpersonal, and reckless types. Given that self-harm cuts across a multitude of disorders, we recommend that objective measures of self-harm be included in clinical trials in general, to address whether (for example) treating depression that includes self-harm results in improvement in both symptom types; and if so, which subtype of self-harm is improved. The lack of significant association between self-harm, select impulsive neurocognitive deficits, and Barratt impulsiveness scores militates against self-harm, operationalized in broad terms, representing a discrete 'disorder of impulsivity' in its own right. Nonetheless, clinicians should be careful to screen for impulse control disorders, as well as mainstream mental disorders, when evaluating individuals with self-harm. More research is needed to study whether risk of repeat self-harm, or worsening of self-harm, can be mitigated by interventions with a view to maximizing affected individuals' quality of life. Another key area of investigation is into the validity and utility of narrower clinical definitions of self-harm disorders, such as the DSM-5 concept of 'non-suicidal self-injury [NSSI] disorder'. This diagnostic label focuses on self-injury whereas other aspects of self-harm (besides self-injury) are also likely to be clinically impairing, based on our findings. Future work could also utilize other data analytic approaches than were used here, such as network modelling, or latent variable analysis with structural modelling.

Disclosures and Acknowledgements

This research was supported by a grant from the National Center for Responsible Gaming to Dr. Grant, by a grant from the Academy of Medical Sciences to Dr. Chamberlain, and by a Wellcome Trust Intermediate Clinical Fellowship to Dr. Chamberlain (Reference 110049/Z/15/Z).

Dr. Chamberlain consults for Cambridge Cognition. Dr. Grant has received research grants from NIMH, National Center for Responsible Gaming, and Forest and Roche Pharmaceuticals Dr. Grant receives yearly compensation from Springer Publishing for acting as Editor-in-Chief of the Journal of Gambling Studies and has received royalties from Oxford University Press, American Psychiatric Publishing, Inc., Norton Press, and McGraw Hill. The other authors have no disclosures.

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Table 1. Characteristics of the study sample.

Variable	Mean (SD) or N [%]
Demographic measures	
Age, years	22.56 (3.61)
Gender, N [%] male	203 [61%]
Quality of life	45.69 (12.57)
Education level, N [%]	
Less than high school	9 [2.7%]
High school graduate	23 [6.9%]
Some college	203 [61.0%]
College graduate	68 [20.4%]
Completed training beyond college	30 [9.0%]
Sexual orientation, N [%]	
Asexual	1 [0.3%]
Heterosexual	298 [89.5%]
Homosexual	19 [5.7%]
Bisexual	12 [3.6%]
Other	3 [0.9%]
Rosenberg Self-Esteem score	21.5 (6.46)
Difficulties with Emotional Regulation score	73.36 (19.12)
Substance use	
Alcohol consumption, times/week	1.39 (1.37)
Nicotine consumption, packs per day	0.12 (0.29)
Presence of formal mental disorders	
Any MINI disorder current, N [%]	123 [36.9%]
Any MIDI disorder current, N [%]	33 [10.2%]
Dimensional measures of impulsive psychopathology	
ADHD total score	8.95 (4.69)
Gambling symptoms (SCI-GD total)	1.44 (2.18)
Questionnaire measures of impulsivity	
Barratt Impulsiveness	
Attention	16.87 (4.16)
Motor	23.83 (4.89)
Non-planning	24.00 (5.45)

Cognitive functioning	
SST Median 'Go' Reaction Time	510.46 (188.65)
SST SSRT	182.75 (65.55)
CGT Overall proportion bet	0.54 (0.14)
CGT Overall proportion of rational decisions	0.95 (0.08)
CGT Risk adjustment	1.48 (1.26)

Note: occasionally, one or more measures were incomplete for some subjects, hence total N may not be 333. ADHD = attention-deficit hyperactivity disorder. SCI-GD = structured interview for gambling disorder. SST = Stop-Signal Test. SSRT = Stop-Signal Reaction Time. CGT = Cambridge Gamble Task.

Table 2. Results of rotated component matrix, showing loading of individuals from the SHI on the three latent forms of self-harm, thresholded at $r \geq 0.4$.

	Factor		
	1	2	3
Hitting one's self	.649		
Superficially scratching self	.635		
Preventing wounds from healing	.612		
Banging one's head	.529		
Cutting one's self	.516		
Taking overdose(s)	.490		
Burning one's self	.414		
Setting up a relationship for rejection		.763	
Engaging in emotionally abusive relationships		.680	
Distancing one's self from God		.655	
Engaging in self-defeating thoughts		.542	
Engaging in sexually abusive relationships		.494	
Self-starvation		.452	
Losing a job deliberately			.637
Being promiscuous			.609
Driving recklessly			.556
Abusing alcohol			.423

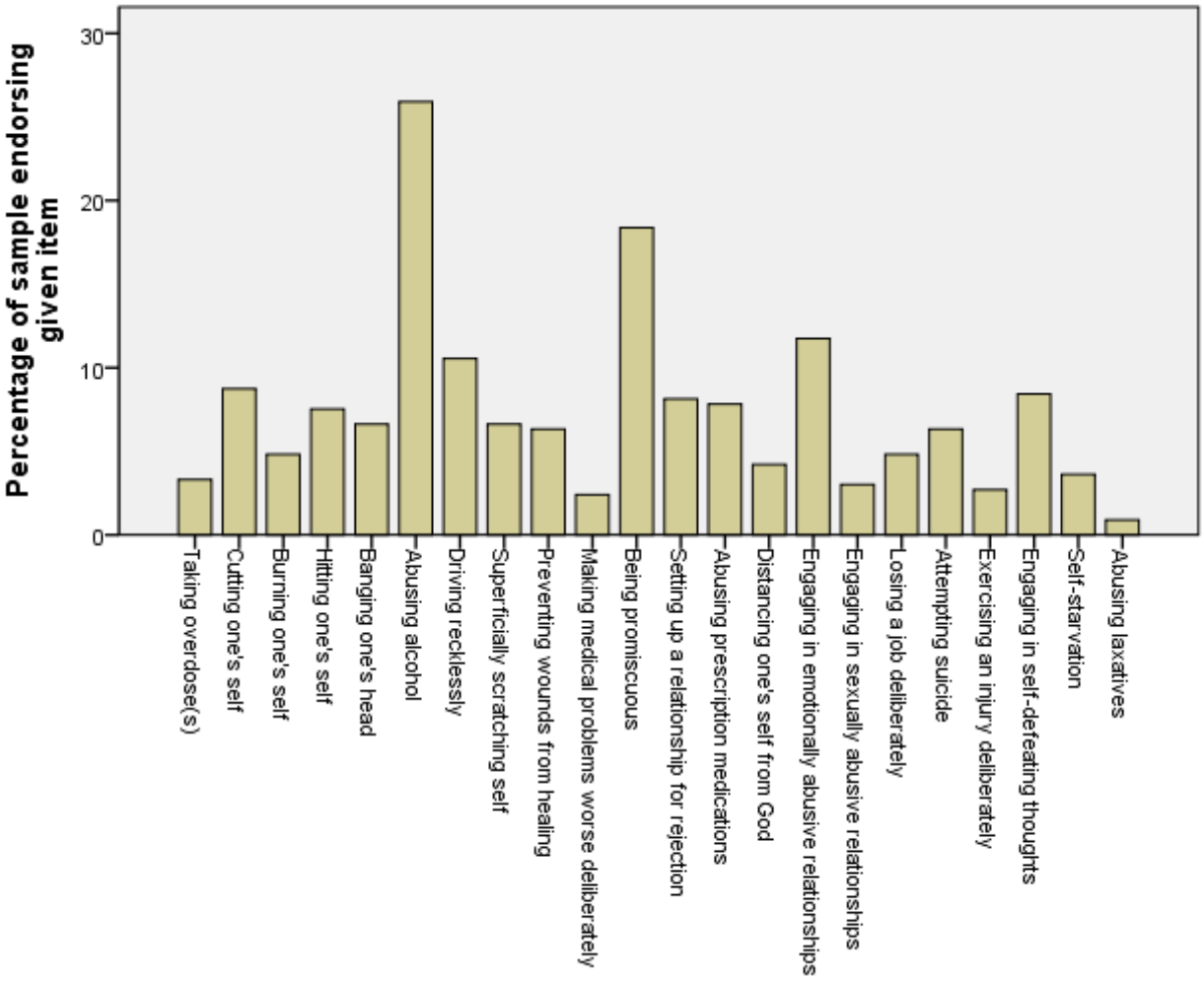
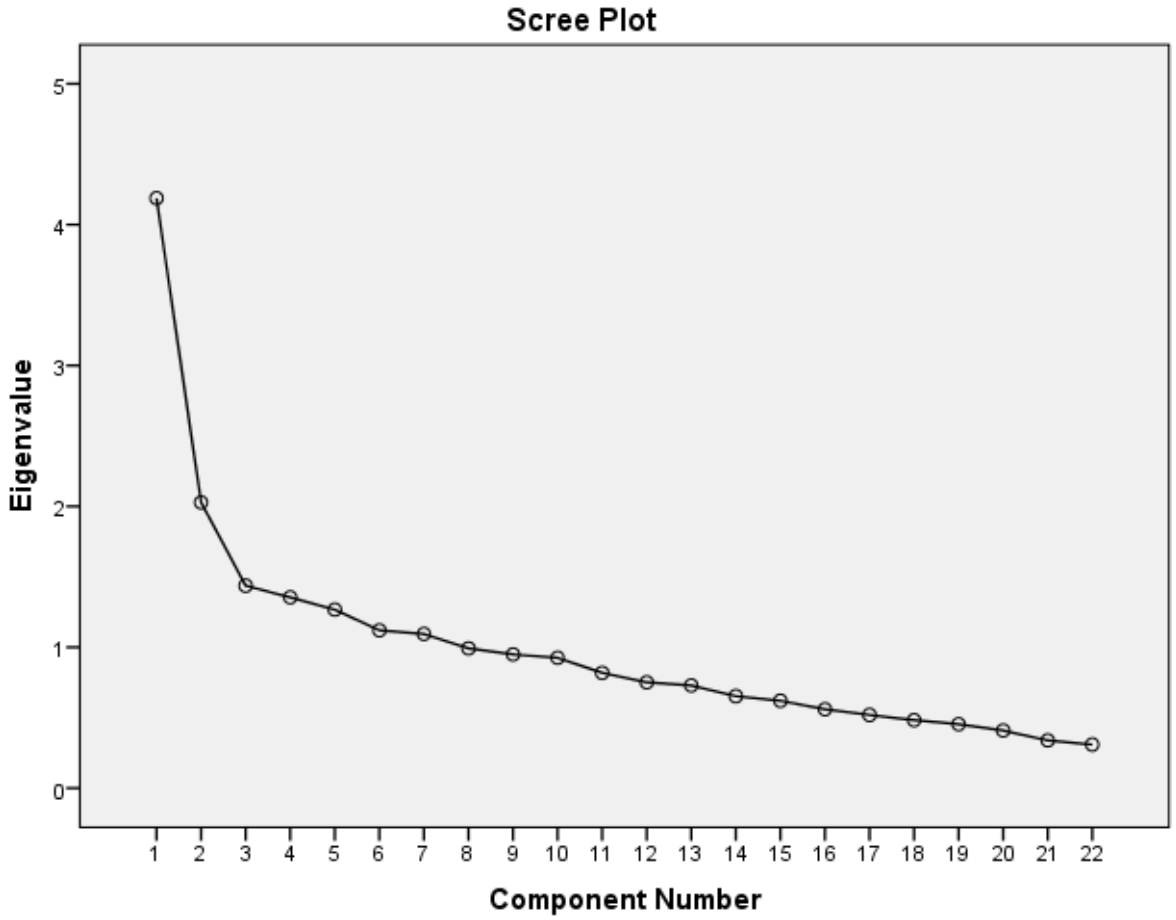


Figure 1. Percentage of subjects in the sample who endorsed individual forms of self-harm as measured by the Self-Harm Inventory items.

Figure 2. Scree Plot for Principal Components Analysis (PCA) across all individual SHI items. A three factor solution was selected based on the plot.



Associations between self-harm and distinct types of impulsivity

Supplementary Online File

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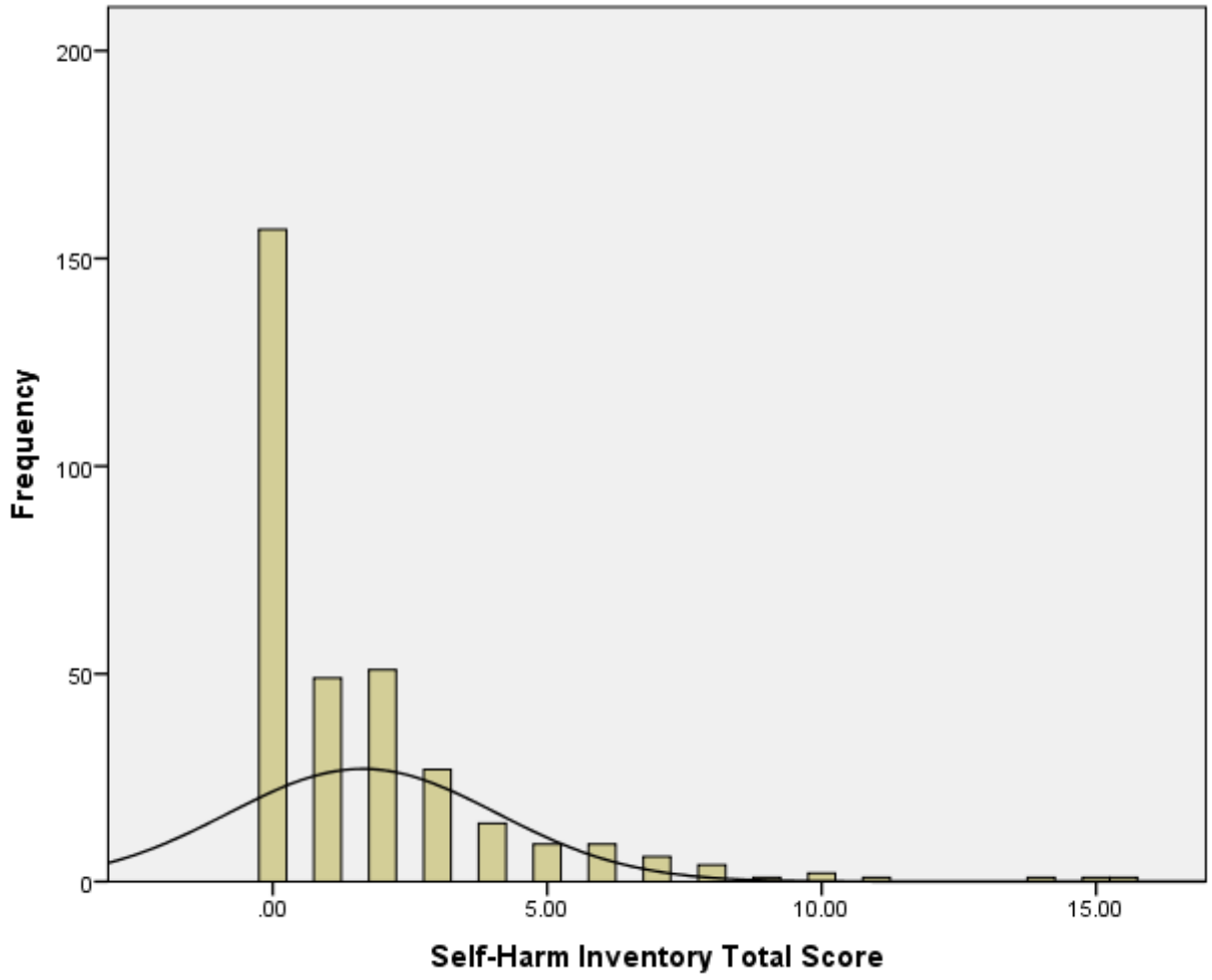

Supplementary Online Figure 1. Histogram showing the distribution of Self-Harm Inventory total scores in the sample.