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Research paper

Impulsivity as a predictor of self-harm onset and maintenance in young adolescents: a longitudinal prospective study

Joanna Lockwood[a,b,c,d,*], Ellen Townsend[b,c], David Daley[a,d], Kapil Sayal[a,c]

[a] Division of Psychiatry & Applied Psychology, School of Medicine, University of Nottingham, UK & Centre for ADHD and Neurodevelopmental Disorders Across the Lifespan, Institute of Mental Health, University of Nottingham, UK
[b] Self-Harm Research Group, School of Psychology, University of Nottingham, UK
[c] Centre for Mood Disorders, Institute of Mental Health, University of Nottingham, UK
[d] NIHR MindTech MedTech Co-operative, Institute of Mental Health, University of Nottingham, UK

A B S T R A C T

Background: Rates of self-harm in young adolescents are increasing and self-harm typically emerges at this developmental stage. Greater specificity of impulsivity as a multifaceted construct is enabling investigation of links between individual impulsivity facets and self-harm outcomes. However, studies have yet to adequately explore these associations in young adolescents, and prospective relationships between multidimensional impulsivity and self-harm in younger adolescents remain untested. This study investigates unidimensional facets of impulsivity as risk-factors for the emergence and maintenance of self-harm, specifically within young community-based adolescents.

Methods: A school-based sample of 594 adolescents (aged 13-15 years) provided data at two time points, 12 weeks apart. Logistic regression analyses determined associations between impulsivity-related facets (as delineated by the UPPS-P scale) and self-harm outcomes over time.

Results: Overall, 23.6% of young people reported lifetime self-harm. A higher tendency towards Sensation Seeking was associated with self-harm onset over the study-period (OR 1.19, 95% CI 1.017-1.401). Deficits in Premeditation predicted maintained (versus remitted) self-harm behaviour during this time (OR 1.16, 95% CI 1.013-1.328). Negative Urgency was a significant cross-sectional correlate, but did not offer prospective predictive utility.

Limitations: The study relied on self-report. Interpretations are cautious given low incidence of self-harm outcomes over the course of the study.

Conclusions: Separate pathways to impulsive behaviour describe the psychological context in which self-harm starts and develops in young people. Findings support differential treatment targets and developmentally-focused early intervention. The predictive utility of impulsivity was inconsistent between cross-sectional and longitudinal analyses, underlining the role for temporality in the establishment of risk of self-harm.

1. Introduction

Self-harm is a prevalent behaviour in adolescence - a developmental period corresponding to huge social, psychological, biological and neurodevelopmental growth (Sawyer et al., 2018). Community-based studies world-wide have reported lifetime rates of adolescent self-harm at around 17-18% (Muehlenkamp et al., 2012; Swannell et al., 2014) with rates comparable regardless of whether classification of behaviour explicitly excludes suicidal intent i.e. non-suicidal self-injury or NSSI (Muehlenkamp et al., 2012). Self-harm is defined here as any act of self-poisoning or self-injury irrespective of motivation or suicidal intent (Kapur et al., 2013), given the recognition that self-harm behaviour often involves multiple, changing or ambivalent motivations (Hawton et al., 2010); and suicidal intent is most accurately described as dimensional (Orlando et al., 2015).

Work to clarify the psychological mechanisms that contribute to onset and continued engagement in self-harm is theoretically best focused in early adolescence given that the behaviour commonly emerges at around age 12 to 14 years (Nock, 2010). In addition, recent evidence from primary care data, which has charted an increase in self-harm across adolescence, revealed the sharpest rise occurring in adolescent girls under 16 years of age (Morgan et al., 2017). Young adolescents (aged 12-14 years) are also those least likely to seek formal support for their self-harm, with community-based cases of self-harm outnumbering hospital presentations by up to 20 times (Geulayov et al., 2017). Research involving early adolescent samples is thus well placed to elucidate target opportunities for early intervention and prevention work in a high-risk group. An overreliance on cross-sectional designs in the literature has however hampered the empirical establishment of factors that might predict risk for first-time and continued engagement in self-harm. Notably, evidence from the wider field of suicidology has shown correlates established in associative studies to be poor predictors of behaviour over time (Franklin et al., 2017).

* Correspondence to: Joanna Lockwood, Division of Psychiatry & Applied Psychology, Institute of Mental Health, University of Nottingham Innovation Park, Triumph Road, Nottingham, NG7 2TU.
E-mail address: Joanna.lockwood@nottingham.ac.uk (J. Lockwood).

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1.1. Trait impulsivity and self-harm

Trait impulsivity is a multidimensional construct consistently associated with self-harm (Hamza et al., 2015; Lockwood et al., 2017). Increasingly, research is utilising the organisational structure of the UPPS-P impulsivity scale (Cyders and Smith, 2008; Whiteside and Lynam, 2001) to clarify the relationship between trait impulsivity and self-harm. The UPPS-P sets out five pathways to impulsive behaviour: Negative Urgency (NUR) - the tendency to act rashly when feeling extreme negative emotion; Positive Urgency (PUR) - the tendency to act rashly when feeling extreme positive emotion; (lack of) Perseverance (LPS) - the tendency to give up when a task becomes difficult or boring; (lack of) Premeditation (LPM) - the tendency to act without due regard to the consequences of behaviour; and Sensation-Seeking (SS) - the tendency to seek out novel, thrilling or risky situations. Widespread adoption of the UPPS-P multidimensional model is bringing methodological consistency, and driving more precise empirical tests of the influence of trait impulsivity on complex behavioural outcomes, including self-harm (Smith et al., 2007).

While the evidence base for UPPS-P facets as cross-sectional correlates of self-harm in *young* adolescents has yet to be established, accumulating findings in mid to late adolescent groups (Lockwood et al., 2017) suggest that, compared with those with no history of self-harm, adolescents with a lifetime history are best characterised by Negative Urgency. That is to say, adolescent self-harm is most likely to relate to impulsivity that occurs in response to intense negative emotion. Importantly, this relationship has been shown to hold over and above the influence of other emotion-related correlates (Glenn and Klonsky, 2010, 2011) and so it is rash response to emotion – rather than emotionality per se – that appears problematic. In parallel with broader affect-regulation models of NSSI (Chapman et al., 2006; Klonsky, 2009), Negative Urgency is theorised to operate as part of an affect-regulation strategy, in which rash impulsive acts (such as self-harm) provide immediate relief or distraction from heightened emotional arousal (Cyders, 2008). Hence a disposition towards Negative Urgency could theoretically indicate a vulnerability to initial engagement in self-harm. Indeed, the first onset of a number of problem behaviours in youth which may operate within a negative reinforcement affect-regulation cycle, such as problem drinking, eating disorders, smoking, drug use or gambling, are predicted by Negative Urgency (Pearson et al., 2012; Settles et al., 2014; Smith, 2016).

To our knowledge, only one study to date has tested the utility of Negative Urgency in predicting the onset of self-harm in adolescence. Riley and colleagues (2015) found that Negative Urgency scores at baseline uniquely among UPPS-P facets predicted the onset of self-harm behaviour nine months later in a female-only sample of university students aged 18-19 years (Riley et al., 2015). In addition, a deficit in Perseverance, but not Negative Urgency or any other UPPS-P facet, predicted the maintenance of self-harm over the course of the study. These findings suggest that while emotion-relevant impulsivity, operating via negative reinforcement, may confer a broad risk for initial self-harm engagement, these processes may alter or become less critical once self-harm is established as a behavioural response. At this point, non-emotion based facets of impulsivity may play a greater role in the persistence or development of behaviour. Riley and colleagues (2015) suggest that individuals who lack perseverance (i.e. who tend to quit tasks when they become difficult or challenging) may be more likely to maintain self-harm because they are less able to resist urges, or to recruit and stick with alternative strategies. Arguably, a failure to recruit adequate deliberation before acting may also serve to maintain a behavioural course of action.

The prospective evidence is not always consistent however. In a longitudinal study with undergraduates, Glenn & Klonsky (2011) found no prospective association between any impulsivity facet and continued self-harm over a one-year study period. Null findings have also yielded from other studies which have examined impulsivity (by UPPS-P, or other measures) as a prospective predictor of self-harm (Garisch and Wilson, 2015; O'Connor et al., 2009a; Peterson and Fischer, 2012). Importantly, impulsivity facets had demonstrated cross-sectional correlations with self-harm in three of these prospective studies (Garisch and Wilson, 2015; Glenn and Klonsky, 2011; Peterson and Fischer, 2012).

No community-based study to date has examined the prospective utility of impulsivity in predicting self-harm onset or maintenance in young adolescents (13-15 years) using the multidimensional UPPS-P tool. Such work is an essential step in unpicking mixed prospective findings, and crucially within a sample at increased risk for first onset. Impulsivity is not an immutable trait, and UPPS-P traits (Negative and Positive Urgency, and Sensation Seeking) have been shown to peak in early to mid-adolescence (Littlefield et al., 2016). An examination of impulsivity and self-harm at an early developmental stage at which normative levels of impulsivity are heightened is contextually necessary.

Specifically, the current study examines the prospective association between separate UPPS-P facets at baseline and the first emergence or maintenance of self-harm over a 12-week follow-up period. This duration provides a time-frame short enough for clinical relevance given that clinical decisions are often made in terms of hours, days, or weeks (Glenn and Nock, 2014), but long enough to allow for the onset or maintenance of self-harm behaviour. Short follow-up designs are underrepresented in the self-harm/suicidality literature (Franklin et al., 2017). Primarily, we anticipated that (1) UPPS-P facets, and Negative Urgency in particular, will independently predict those who self-harm for the first time during the course of the study relative to those with no history of self-harm and (2) UPPS-P facets will independently predict those who maintain their self-harm behaviour over the course of the study relative to those with remitted self-harm. As the clarification of short-term prospective predictors of self-harm behaviour, beyond simple associative studies, has been identified as a critical research priority (Glenn and Nock, 2014), a secondary aim was to establish whether cross-sectional correlates of self-harm established amongst baseline measures, were the same as risk factors identified prospectively.

2. Methods

The study ran from October 2016 until February 2017. Schools in the East Midlands of England were approached and, following meetings with interested schools, three were selected to provide a geographical spread of urban and rural areas. Participants were students in Years 9 and/or 10 (aged 13-15 years). Year groups were selected as representing a developmental stage at which self-harm behaviours are likely to emerge but avoiding year groups with high academic burden. Mean eligibility for free school meals across schools, as a proxy for socio-economic status (SES), was 12.4% indicating that the sample was representative of nationally reported proportions (12.9%) for secondary schools (Department for Education, 2017). Opt-out consent was obtained from parents. Ethical approval was obtained from the Division of Psychiatry and Applied Psychology Research Ethics sub-committee at the University of Nottingham. School assemblies or tutor sessions held before data collection, described the study and were an opportunity to reinforce key messages around confidentiality and participant rights. Reminder messages including an opportunity to withdraw consent were distributed one week before baseline and follow-up data collection. Full details of the study process, recruitment and attrition are included in diagram 1 and have been reported as part of a wider study examining the impact of self-harm research participation (Lockwood et al., 2018).

2.1. Materials and measures

The SHIP-SHAPE school survey is a paper-based self-report questionnaire that captures demographic information (age, sex, and

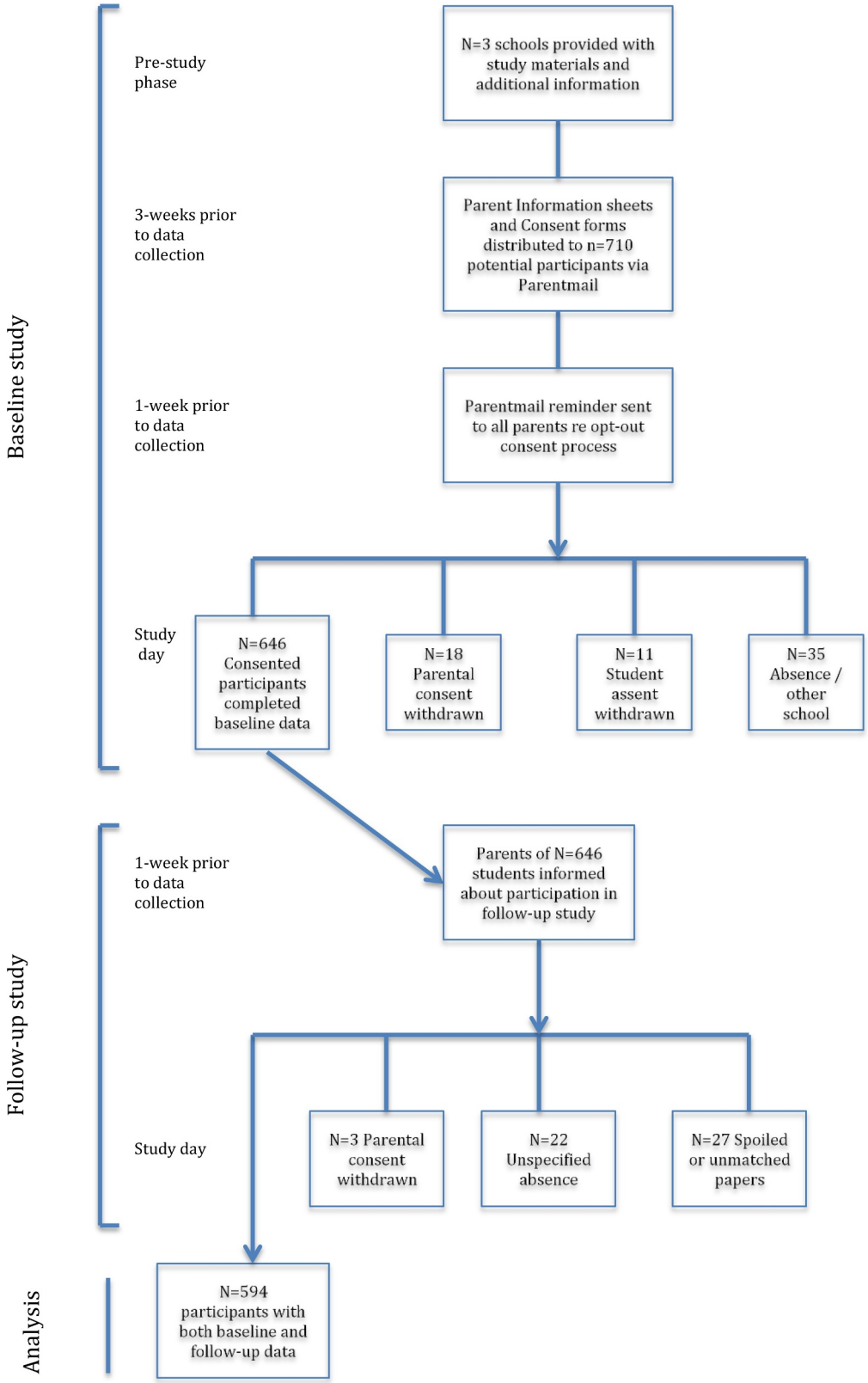

Diagram 1. Flow diagram of the SHIP-SHAPE study process and recruitment

ethnicity) alongside psychological measures and questions about self-harm status.

The UPPS-P scale (Cyders and Smith, 2008; Whiteside and Lynam, 2001) assesses five distinct personality-based traits that lead to impulsive behaviour. The UPPS-P is comprised of 59 items rated on a 4-point scale from 1 (agree strongly) to 4 (disagree strongly). Responses refer to behaviour that occurs generally or within a particular context, e.g. "When I feel rejected…" The scale demonstrates good internal consistency and reliability (Cyders et al., 2007) . A brief version of the UPPS-P has been developed to reduce participant burden and was used

in this study. The 20-item short form **SUPPS-P** (Cyders et al., 2014) consists of four items per subscale. Items included are based on those with the highest item-total correlations on the original subscales. Tests of the SUPPS-P in adolescent samples have shown it to retain the psychometric properties of the full scale and to be a valid and reliable alternative to the full UPPS-P for non-clinical samples (Cyders et al., 2014). Internal consistencies for baseline data were acceptable to good: NUR (.74); LPS (.74); LPM (.83); SS (.69); PUR (.82).

The Difficulties in Emotion Regulation Scale (DERS; Gratz and Roemer, 2004) is a 36 item self-report questionnaire designed to assess clinically relevant emotion dysregulation, and normative development. Responses refer to behaviour that occurs generally, or within the context of distress. DERS assesses emotion dysregulation across six subscales. Item scores are summed to give a subscale score and Total score with higher scores indicating greater emotion dysregulation. The measure has demonstrated good reliability and validity with adolescent samples (Neumann et al., 2010). The 18 item short-form **DERS-SF** (Kaufman et al., 2015) was used in this study. It has been validated in adolescent and adult samples and demonstrates comparable or better psychometric properties than the original scale (Kaufman et al., 2015). In the present study internal consistency scores were good (α = .89).

The Positive Affect and Negative Affect Schedule-Short Form (I-PANAS-SF; Thompson, 2007) assesses recent (past week) positive affect (PA) and negative affect (NA) at baseline and follow-up. The short-form includes five items for each affect scale rated on a 5-point scale from 1 = not at all to 5 = extremely. Mood scores in each scale are summed to give a Total PA and Total NA score. The scale is an internationally reliable and validated psychometric assessment of affect (Karim, 2011; Thompson, 2007). In the current study alphas were acceptable: NA (α = .78); PA (α = .70).

The Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983) assesses depressive and anxiety symptomatology experienced across the previous week in a 14-item scale (7 depressive and 7 anxious items). HADS has demonstrated good validity and reliability with community-based adolescents (White et al., 1999). Subscale score are summed with higher scores indicating increased symptomatology. Due to an administrative error in one school, analyses are based on six items per subscale. Here, internal consistency was good for anxiety (α = .83) and acceptable for depression (α = .75).

Questions about self-harm behaviour Participants were provided with a definition of self-harm based on NICE (National Institute for Health and Care Excellence) guidelines ((NICE), 2004) "Self-harm is hurting yourself on purpose such as cutting, hitting, biting, burning or self-poisoning such as swallowing too many pills or other dangerous substances, no matter what the reason. Self-harm is not hurting yourself by accident." Participants were asked one question modified from the Lifestyle and Coping Questionnaire (LCQ; Madge et al., 2008) developed for use in the Child and Adolescent Self-Harm in Europe (CASE) study (Madge et al., 2008): "Have you ever on purpose harmed yourself in some way (e.g. cutting, hitting, biting or swallowing things)?" Participants were also asked to describe their most recent incident of self-harm. This enabled classification of reported self-harm to be verified in accordance with CASE study definitions (Madge et al., 2008). However, in some cases, young people chose not to provide an answer to this question, stating they preferred not to say, or couldn't remember. All indications of self-harm were therefore accepted with or without a definition. To establish temporal dimensions, participants were asked to indicate how recently they had last self-harmed. Options comprised: Over a year ago / in the last six months / in the last 2 months / in the last 4 weeks / Not relevant. These criteria were selected in line with previous studies which have examined self-harm over lifetime and more recent timeframes (Glenn and Klonsky, 2010; Rawlings et al., 2015). Research suggests that young people are at increased risk for repeat self-harm in the immediate months following self-harm (Chitsabesan et al., 2003). As such, additional weighting was given to recent timeframes (past 6 months, 2 months, 1 month). Finally, as an additional index of premeditation, participants were asked to indicate the typical length of time between first having an urge to self-harm and completing the act. Response options were: less than 10 minutes / 10-30 minutes / 30-60 minutes / 1-3 hours / 3-6 hours / 6-12 hours / more than one day / not relevant.

2.2. Procedure

To ensure the SHIP-SHAPE school survey was understandable and acceptable for young respondents a youth advisory panel was established to provide advice on the design, content and delivery of the survey in a school setting. The panel comprised young people aged 15 years with lived experience of self-harm who were taking part in a 10-week therapy programme. They understood that participation in the panel was not related to their therapy and were provided with a £10 shopping voucher as a thank you for their time.

On data collection day, consented students were provided with an Information Sheet, assent form and envelope. Study procedures were explained by the researcher (in person or by video) or by school tutors using provided scripts. Participants were asked to devise a unique and memorable ID code (based on initials and date of birth) and to include this on their survey script. To be able to link survey responses of concern to participants, students were asked to write this ID code on a named assent form and envelope, and then to seal the form inside the envelope. Sealed envelopes and surveys were collected and stored separately. Following survey completion, students were invited to engage with the back page of the survey, which included jokes/cartoons and spaces to colour/doodle. All participants were provided with a resource sheet detailing sources of support. Data collection took place during designated lesson time. Survey completion took around 20 minutes. All responses were scrutinised within 24 hours according to the study safeguarding protocol.

2.3. Analyses

Analyses were performed using the IBM Statistical Package for the Social Sciences (SPSS) version 24.0 for Windows. As < 3% of the total data for each scale was missing and was Missing Completely at Random (Little's MCAR test $chi2 = 228.376$, $p > .05$), analyses proceeded using pairwise deletion. Univariable and multivariable logistic regression analyses and Man-Whitney U Tests examined associations between variables and self-harm outcomes. To account for the influence of age, Year Group (which remained stable across time points) was included as a categorical proxy for age in regression analyses. To predict onset of behaviour, participants were identified who indicated no self-harm history at baseline but endorsed self-harm engagement 12 weeks later. Univariable analyses established if baseline variables predicted first-time self-harm relative to no-self-harm. Multivariable analysis established if variables were independently predictive. Significant univariable predictors and UPPS-P facets were entered simultaneously into the multivariable model. Participants endorsing maintained self-harm were those who reported a lifetime incidence of self-harm at baseline and then reported further self-harm during the study period i.e. endorsed past 4 weeks; past 2 months. Participants who endorsed remitted self-harm indicated that they last self-harmed over a year ago, at either baseline or follow-up. For twenty participants who indicated self-harm at both time points it was not possible to ascertain if the behaviour was repeated during the study period. These participants were excluded from this analysis. Univariable multinomial logistic regression models determined if baseline variables predicted maintained self-harm compared to those with no or remitted self-harm. Multivariable analyses established independent predictive utility. All predictor variables were entered simultaneously into multivariable models. To assess the cross-sectional relationship between UPPS-P facets (and other mood-based correlates) and lifetime self-harm, univariable and multivariable logistic regression analyses were performed with self-harm dichotomised

into no self-harm (0) and self-harm (1). For multivariable analyses, SUPPS-P facets, age and sex were entered in step one; remaining mood-related covariates were included in step two to see if their inclusion reduced the influence of impulsivity facets on lifetime self-harm. The Sidak correction was applied for multiple comparisons in univariable analyses. This approach is recommended as it takes into account correlations between variables. Because of the small sample sizes of some analyses and the exploratory nature of the study, uncorrected p-values are presented, with results which fall above the Sidak corrected p-value highlighted.

3. Results

3.1. Study completion rates and baseline characteristics

Comparison of the 594 participants who completed baseline and follow-up surveys (completers) with the 52 (non-completers) who were lost to follow-up revealed no differences in sex, year group, ethnicity, impulsivity, emotion dysregulation, negative affect, anxiety symptomatology, lifetime self-harm or thoughts of self-harm. However, attrition rates differed by school setting. Non-completers also had lower positive affect and higher depressive symptomatology than completers at baseline ($p < .05$).

Table 1 presents key demographic and variable data associated with the sample as a whole and according to lifetime self-harm status. The total number of young people completing the survey at baseline was 646 of whom 594 (92%) completed the survey for a second time 12 weeks later (average length to follow-up 12.1 weeks, SD1.15). Respondents were spread across schools (165:214:215). Main analyses focus on the 594 participants for whom longitudinal data were available and self-harm status over the study period could be established. The ethnicity of the sample was predominantly white (85%). The majority of students were aged 13-14 years (94%). Overall, 23.6% of participants endorsed lifetime self-harm. Girls were more than two times more likely to endorse self-harm than boys. Around half of participants who reported self-harm (47.6%) indicated acting within 10 minutes of first having the urge to self-harm, with 68.9% suggesting they would typically act within an hour of first thought.

Univariable logistic regression analyses using cross-sectional data revealed that three impulsivity subscales (Negative and Positive Urgency and (lack of) Premeditation) were related to increased risk of lifetime self-harm. Risk of self-harm increased by 64.4% for each one unit rise in Negative Urgency; and by 33.5% and 29.0% respectively with unit rises in Positive Urgency and (lack of) Premeditation. In addition, those who self-harmed had higher levels of depressive and anxiety symptomatology, emotion dysregulation, and negative affect, and lower positive affect compared to those without lived experience. Among impulsivity facets, only Negative Urgency retained a significant independent predictive contribution in a multivariable model. Anxiety symptomatology and emotion dysregulation also remained significant independent predictors.

3.2. Characteristics of participants reporting self-harm over the study period

Table 2 presents demographic and variable data associated with self-harm status over the study period. The majority of participants (83.2%; n = 494) did not self-harm during the 12 week study period. However, 55 young people (9.3%) indicated repeating self-harm during this time. An additional 25 (4.2%) reported a first incidence of self-harm between baseline and follow-up. In total, 31% of those indicating thoughts of self-harm at baseline reported an act of self-harm 12 weeks later.

3.3. Is onset of self-harm predicted by baseline impulsivity?

Those reporting self-harm for the first time during the course of the study ($n = 25$) had higher levels of Sensation Seeking at baseline than those without a history of self-harm. Specifically, a higher tendency towards rash risk-taking and novelty-seeking increased the likelihood of first-time self-harm by 19.3% ($p = .030$). Negative Urgency was not a significant predictor of self-harm onset compared with no self-harm, nor were any other SUPPS-P variables. However, those with first time

Table 1
Demographic data and variables associated with the sample as a whole and by lifetime self-harm status at baseline

	All students n = 594 n(%) or median (IQR)	Lifetime self-harm n = 137 (23.6%) n(%) or median (IQR)	univariable logistic regression OR(95% CI)	*p value*	multivariable logistic regression aOR(95% CI)	*p value*
Year group						
Year 9	410 (69.0)	87 (65.3)				
Year 10	184 (31.0)	50 (36.5)	0.74 (0.49-1.11)	p = 0.140	0.71 (0.39-1.27)	p = 0.24
Sex						
Male	299 (50.3)	48 (35.0)				
Female	278 (46.8)	82 (59.8)	2.22(1.48-3.31)	p < .0001**	1.210 (0.67-2.17)	p = 0.52
Study variables *median (IQR)*						
Negative Urgency	9 (4)	11(4)	1.64 (1.49-1.81)	p < .0001**	1.28 (1.13-1.46)	p < .0001**
(lack of) Perseverance	9 (4)	9 (4)	0.94 (0.87-1.02)	p = 0.119	0.98 (0.88-1.11)	p = 0.98
(lack of) Premeditation	9 (3.75)	10 (4)	1.29 (1.19-1.40)	p < .0001**	1.09 (0.96-1.23)	p = 0.17
Sensation-Seeking	11 (4.25)	11 (5)	1.01 (0.95-1.08)	p = 0.712	1.02 (0.92-1.14)	p = 0.77
Positive Urgency	7 (4)	9 (4)	1.34 (1.24-1.44)	p < .0001**	1.06 (0.95-1.18)	p = 0.32
Anxiety symptoms	6(5)	10 (6)	1.13 (1.02-1.29)	p < .0001**	1.13 (1.02-1.29)	p = 0.032*
Depression symptoms	3(3)	5 (4)	1.07 (0.93-1.22)	p < .0001**	1.07 (0.93-1.22)	p = 0.33
Emotion dysregulation (Total score)	40.00 (18)	53.50 (21.75)	1.04 (1.01-1.07)	p < .0001**	1.04 (1.01-1.07)	p = 0.016*
Positive Affect (Total score)	17 (4)	16.50 (5)	1.08 (0.98-1.19)	p = 0.007**	1.08 (0.98-1.19)	p = 0.12
Negative Affect (Total score)	12 (4)	15 (6)	1.10 (0.99-1.23)	p < .0001**	1.10 (0.98-1.23)	p = 0.08

Note: Sex reference category = boys. Year group reference category = Year 9. Significance *p < .05, **p < .01. Anxious and Depressive symptomatology (HADS); Emotion dysregulation (DERS); Positive and Negative Affect (iPANAS); Negative Urgency, lack of Perseverance, lack of Premeditation, Sensation-Seeking, Positive Urgency (SUPPS-P).Univariable analyses: Odds Ratios (OR) represent the increase in likelihood of reporting lifetime self-harm relative to no self-harm per one unit rise in predictor variable. Sex and age were included as covariates. Two variables (lack of Perseverance; Sensation Seeking) do not survive Sidak correction for multiple comparisons at p < .004. Multivariable analyses: adjusted odds ratios (aOR) represent the increase in likelihood of reporting lifetime self-harm relative to no self-harm per one unit rise in predictor variable, adjusting for the effects of all other variables. Three variables retain individual predictive utility. In sensitivity analyses emotion dysregulation retained a weak significance for girls only in multivariable analyses (*aOR 1.052, 95% CI 1.010-1.096, p = .015*).

Table 2
Descriptive statistics of demographic data and non-parametric tests examining differences between psychological variables and self-harm status over the study.

	Never self-harm (N) (n = 413)	self-harm onset (O) (n = 25)	self-harm maintained (M) (n = 55)	self-harm remitted (R) (n = 81)	*Pairwise comparison 1*	*Pairwise comparison 2*	*Pairwise comparison 3*
Year group	n(%)	n(%)	n(%)	n(%)			
Year 9 (13-14 yrs)	289 (69.9)	18 (72.0)	33 (60.0)	53 (65.4)			
Year 10 (14-15 yrs)	124 (30.1)	7 (28.0)	22 (40.0)	28 (34.6)			
Sex							
Male	229 (55.4)	14 (56.0)	13 (23.6)	37 (45.7)			
Female	175 (42.4)	11 (44)	37(67.2)	42 (51.9)			
Study variables	median (IQR)				Man-Whitney U (r2)		
NUR	8 (4)	8 (2.5)	11 (4)	11 (3)		R > N p < .0001 (0.10)	
LPS	9 (4)	9.5 (5.5)	9 (3)	9 (3)			
LPM	8 (3)	9 (4)	10 (4)	9 (3)		R > N p < 0.14 (0.01)	M > R p = .028 (0.05)
SS	11 (5)	13 (3)	11 (4.5)	11 (4)	0 > N p = .008 (0.01)		
PUR	7 (3)	8 (5)	9 (5)	8 (4.75)		R > N p < .0001 (0.04)	
ANX	5(3)	6 (4)	10 (5)	7 (6)		R > N p < .0001 (0.05)	M > R p < .0001 (0.13)
DEP	3(3)	3 (3.5)	5.50 (3.5)	4 (3)		R > N p < .0001 (0.03)	M > R p < .0001 (0.10)
EMOT	37.0 (13)	46.0(20.0)	55.0 (20)	44 (19.5)	0 > N p = .011 (0.02)	R > N p < .0001 (0.05)	M > R p < .0001 (0.13)
PA	18 (5)	18 (5)	15 (5)	13 (5)			
NA	11(3)	12 (5.5)	17 (3.5)	17 (4.75)		R > N p < .0001 (0.04)	M > R p < .0001 (0.16)

Note: N = participant did not report a history of self-harm over the course of the study; O = first time self-harm over the course of the study; M = maintained self-harm over the course of the study; R = no self-harm reported in the last year. Man-Whitney U tests the difference between the distributions of scores for comparison groups. r^2 is a measure of effect. Comparison 1 = (no SH v onset); comparison 2 = (remitted SH v no SH); comparison 3 = (maintained SH v remitted SH). NUR (Negative Urgency); LPS (lack of Perseverance); LPM (lack of Premeditation); SS (Sensation Seeking); PUR (Positive Urgency); ANX (Anxiety symptomatology); DEP (Depressive symptomatology); EMOT (Emotion dysregulation); PA (Positive Affect); NA (Negative Affect).

Table 3
Univariable and multivariable logistic regressions examining associations between baseline UPPS-P facets, additional covariates, and onset of self-harm relative to no self-harm over the study period

	Onset of self-harm v. no self-harm between baseline and follow-up univariable analysis (crude OR)			multivariable analysis (adjusted OR)		
	OR	*95% CI*	*p value*	*OR*	*95% CI*	*p value*
Negative Urgency	1.13	.958 -1.337	0.137	1.00	0.819 - 1.229	0.975
(lack of) Perseverance	1.02	.869 -1.184	0.855	1.09	0.910 - 1.302	0.353
(lack of) Premeditation	1.16	.986 - 1.369	0.073	1.02	0.832 - 1.254	0.841
Sensation-Seeking	1.19	1.017 -1.401	0.030*	1.19	0.994 - 1.422	0.059
Positive Urgency	1.13	.967 -1.314	0.116	1.09	0.903 - 1.308	0.436
Anxious symptomatology	1.09	.961 - 1.242	0.178	-	-	-
Depressive symptomatology	1.16	.991 -1.355	0.064	-	-	-
Emotion dysregulation	1.04	1.010 -1.077	0.010*	1.05	1.008 - 1.093	0.019
Positive Affect	0.99	.886 - 1.114	0.910	-	-	-
Negative Affect	1.10	.971 -1.242	0.136	-	-	-

Note: *Significant at p < .05. No variables survive Sidak correction at p < .004.
Univariable model: Crude OR shows the increase in likelihood of onset of SH between baseline and follow-up per one unit rise in predictor variable. Sex and age were included as covariates.
Multivariable model: Adjusted ORs describe the increase risk of self-harm onset over and above the influence of other variables in the full model. Only impulsivity facets and significant univariable predictors were included in the multivariable model. First-time self-harm (n = 25) and No-self-harm (n = 380). Emotion dysregulation retained a significant independent influence on self-harm onset. However, the multivariable model overall was not significant $\chi 2$ (14) 14.262, p < .072 (Nagelkerke .097). In sensitivity analyses three variables were significant univariable predictors of onset for girls: (lack of) Premeditation *OR 1.436, 95%CI 1.113-1.853, p = .005*; emotion dysregulation *OR 1.049, 95%CI 1.000-1.101, p = .048* and Negative affect *OR 1.200, 95%CI 1.015-1.418, p = .033*.

self-harm were more likely to have difficulties in regulating emotion than those that did not self-harm. In multivariable analyses, emotion dysregulation retained an independent predictive utility, but Sensation Seeking did not (*p = .059*). However, overall the multivariable model was not significant (Table 3).

3.4. Is maintained self-harm behaviour predicted by baseline impulsivity?

Among those with a history of self-harm, (lack of) Premeditation was the only impulsivity facet to predict the maintenance of self-harm over the study period. Hence, lower deliberation increased the odds of maintained self-harm compared with remitted self-harm by 16% per one-unit rise. In addition, those maintaining self-harm behaviour had more depressive and anxiety symptomatology, greater negative affect, and more difficulties in regulating their emotions than those who had not self-harmed in over a year. Positive affect had a protective influence decreasing the likelihood that those with a past history of self-harm would maintain their behaviour. Those with remitted self-harm were distinguished from those who had never self-harmed by negative affect, depressive and anxiety symptoms and emotion dysregulation. Negative Urgency and Positive Urgency also differentiated between these groups. However, no SUPPS-P facets, or any other variable, distinguished those

Table 4
Univariable and multivariable multinomial logistic regressions predicting maintained self-harm, remitted self-harm and no self-harm from baseline SUPPS-P facets and additional covariates

	Remitted v. no SH						Maintained v. Remitted SH					
	univariable analysis (crude OR)			multivariable analysis (adjusted OR)			univariable analysis (crude OR)			multivariable analysis (adjusted OR)		
	OR	*95% CI*	*p value*	*OR*	*95% CI*	*p value*	*OR*	*95% CI*	*p value*	*OR*	*95% CI*	*p value*
NUR	1.455	1.308-1.619	<.0001	1.344	1.171 - 1.542	<.0001*	1.108	.959-1.282	0.164	0.888	0.724 - 1.091	0.250
LPS	0.927	.843 - 1.020	0.120	0.985	0.872 - 1.114	0.815	1.071	.934 -1.228	0.327	1.101	0.913 - 1.327	0.315
LPM	1.124	1.020 - 1.239	0.019 ł	0.998	0.876 - 1.136	0.971	1.160	1.013 - 1.328	0.005 ł	1.012	0.839 - 1.219	0.903
SS	1.026	.941 - 1.120	0.558	1.016	0.909 - 1.136	0.780	0.979	0.863 - 1.110	0.739	1.116	0.942 - 1.321	0.204 ł
PUR	1.235	1.130 - 1.349	<.0001	1.057	0.945 - 1.183	0.334	1.112	0.988 - 1.253	0.079	1.099	0.940 - 1.284	0.237
ANX	1.246	1.156 - 1.342	<.0001	1.079	0.952 - 1.223	0.236	1.231	1.114 - 1.360	<.0001	1.075	0.894 - 1.294	0.442
DEP	1.201	1.091 - 1.322	<.0001	0.990	0.855 - 1.148	0.899	1.273	1.125 - 1.442	<.0001 ł	1.157	0.943 - 1.421	0.163
EMOT	1.059	1.038 - 1.081	<.0001	1.012	0.979 -1.047	0.478	1.051	1.024 - 1.079	<.0001	1.023	0.976 - 2.073	0.340
PA	0.976	.913 - 1.045	0.489	1.011	0.914 -1.118	0.836	0.905	0.825 - .993	0.035	0.991	0.848 - 1.158	0.908
NA	1.202	1.115 - 1.297	<.0001	1.010	0.897 - 1.137	0.872	1.258	1.136 - 1.392	<.0001	1.103	0.926 - 1.314	0.273

Note: Univariable models: Crude OR shows the increase in likelihood of onset of SH between baseline and follow-up per one unit rise in predictor variable. Sex and age were included as covariates.
NUR (Negative Urgency); LPS (lack of Perseverance); LPM (lack of Premeditation); SS (Sensation Seeking); PUR (Positive Urgency); ANX (Anxiety symptomatology); DEP (Depressive symptomatology); EMOT (Emotion dysregulation); PA (Positive Affect); NA (Negative Affect). SH = self-harm. Remitted v no SH: Four variables do not survive Sidak correction for multiple comparisons at $p < .004$ (LPS; LPM; SS; PA). Maintained v Remitted SH; six variables do not survive correction for multiple comparisons at $p < .004$ (NUR; LPS, LPM; SS; PUR; PA). Multivariable models: Adjusted ORs describe the increase risk of self-harm onset over and above the influence of other variables in the full model. *Negative Urgency retains significance (aOR) in multivariable analyses. Maintained self-harm (n = 45), Remitted self-harm (n = 73) and no self-harm (n = 367).
Model diagnostics: $\chi 2$ (24) 657.831, $p < .0001$, (Nagelkerke 0.38). ł Significant variable in sensitivity analyses for girls only ($p < .005$),

with persistent self-harm over the study period from those whose behaviour had remitted, when analysed in the context of the other predictive variables (see Table 4).

Although the main reported findings adjusted for the influence of sex, additional multivariable analyses were conducted separately for boys and girls to examine if the relationship between self-harm status, SUPPS factors, or additional covariates differed according to sex. Results were substantively in line with those reported overall. Of note however, some associations relating to emotion-based correlates or impulsivity were demonstrated in girls but not boys. Specifically, emotion dysregulation was a significant multivariable predictor of lifetime self-harm for girls only. First onset of self-harm was predicted by emotion dysregulation and (lack of) Premeditation for girls, but not boys. Contrary to the main findings, Sensation Seeking did not hold predictive utility for either sex. Repeated (versus remitted) self-harm over the study was associated with higher Premeditation, depressive symptomatology and increased Sensation Seeking in girls.

4. Discussion

This research examines the association between unidimensional impulsivity facets (SUPPS-P) and first onset and maintenance of self-harm in a young adolescent sample. It significantly contributes to an emerging body of longitudinal work by establishing facets of impulsivity as prospective risk factors for self-harm, providing a specific focus on young adolescent samples. This is essential and timely given that early adolescence reflects the developmental stage at which first initiation of self-harm is most relevant (Nock, 2010) and that rates of self-harm are rising in this group (Morgan et al., 2017). Findings support a differential – and clinically relevant – relationship between unidimensional impulsivity facets and self-harm outcomes over time. Evidence that Sensation Seeking is associated with self-harm onset in a young sample is a novel and developmentally important advancement.

4.1. Main findings

Just one facet of impulsivity – Sensation Seeking – predicted new onset of self-harm in a small number of study participants. Contrary to previous findings (Riley et al., 2015) self-harm onset was not associated with Negative Urgency. The discrepancy may reflect a developmental difference between the young age of this sample (mostly 13-14 years) for whom the first onset of behaviour appears to relate to rash (but not emotional) risk-taking, and older samples for whom rash reactivity to negative affect was related to initial behaviour (Riley et al., 2015). Arguably, onset at a later developmental stage may be driven by a different set of factors. Indeed, evidence has shown other distinctions, such as greater severity of self-harm, in those with earlier onset (Ammerman et al., 2018). Sensation Seeking is purported to influence behavioural enactment through a positive reinforcement process (Berg et al., 2015b), but its mechanism of action may relate not just to a propensity to seek out fun and exhilaration, but to a high tolerance of associated risks, a high threshold for fear, or perhaps to valuing the reward of the activity as greater than any risk. It is also argued that sensation seekers may have an “optimistic bias” (Weinstein, 1980) and may consider themselves to be less at risk of negative consequences from action than others. Previous cross-sectional findings using a short form of UPPS (Glenn & Klonsky, 2010) have demonstrated that college students who self-injure have higher Sensation Seeking than those who do not. In addition, adolescent risk-seeking, but not novel experience-seeking was shown to be predictive of NSSI in an undergraduate sample (Knorr et al., 2013) and this component of the trait may be a particular marker of risk. However, low frequency of self-harm (1-2 incidences), which is the behavioural pattern predominantly endorsed by early adolescents (Bjarehed et al., 2012), is also purported to relate to experimentation and novelty (Klonsky and Olino, 2008). Future research that considers how young adolescents appraise self-harm and the likely sequelae may be informative. The present prospective findings thus extend the cross-sectional evidence base to provide a (tentative) indication of temporal context for Sensation Seeking in the emergence of self-harm in a school sample. An important caveat is that the effect size for the influence of Sensation Seeking on self-harm onset was small and not retained within multivariable examination. As such findings should be interpreted with caution. Given that Sensation Seeking is a trait that peaks in early adolescence (Steinberg, 2008) there is theoretical merit in further examining putative relationships between onset of self-harm and this trait within a larger young adolescent sample. It is possible that Sensation Seeking is heightened in males (Cross et al., 2013) – a finding replicated in the present sample where more boys than girls reported initial onset of behaviour. Notably, additional sensitivity analyses did not find a significant effect of Sensation Seeking for boys or girls however. In fact, these analyses tentatively suggested that the context to female, but not male, first engagement in self-harm may relate to

difficulties managing low mood, and an immature impulse control system related to low premeditation. Given that the sensitivity analyses were based on small split sample sizes, it is possible that there was insufficient power to detect effects. The interplay between SUPPS-P facets, sex and initial engagement in self-harm warrants examination in a larger sample.

In terms of the maintenance of behaviour over time, (lack of) Premeditation was the only impulsivity facet to distinguish between those with remitted self-harm and those repeating self-harm over the study period, i.e. it told us something about contemporaneous risk. Poor premeditation reflects a reduced cognitive capability to plan ahead and foresee the negative consequences of behaviour, or perhaps to let awareness of those consequences inhibit behaviour. Hence treatment efforts which target these cognitive deficits and in which young people explore their responses to potential negative consequences of action may be useful in helping to break the cycle of self-harm repetition. Indeed, evidence suggests that therapeutic goal-oriented approaches which tackle cognitions (e.g. CBT/DBT-A) are helpful in young adults aged 18 years and over (Hawton et al., 2016), and may warrant further examination in younger adolescent groups (Hawton et al., 2015). Again, sensitivity analyses (which found that (lack of) Premeditation predicted maintained behaviour for girls, but not boys, would tentatively suggest that such approaches may hold particular benefit for girls. Previous examinations in clinical samples have pointed to a relationship between poor premeditation (non-planning impulsiveness) and repeated/habitual self-injury over occasional self-injury (Gatta et al., 2016) such that inadequate reflection may serve to maintain ongoing risk where behaviour is established. Our findings extend this analysis to a young community-based context (i.e. underscores that vulnerability spans categories of psychopathology). Notably, this vulnerability stands up to prospective scrutiny. That Negative Urgency did not distinguish between maintained and remitted self-harm is also consistent with the view that once such an ongoing pattern of behaviour is established, urgency facets may offer less clinically relevant targets for intervention than cognitive deficits (Glenn and Klonsky, 2010; Riley et al., 2015). Contrary to previous findings (Riley et al., 2015), (lack of) Perseverance was not an important facet in the maintenance of self-harm. Low perseverance reflects cognitive difficulties maintaining focus on a course of action and links between self-harm and deficits in perseverance in older adolescent groups might relate to difficulties in carrying out alternative strategies or maintaining a decision to stop self-harm (Glenn and Klonsky, 2010). Arguably in a younger adolescent sample for whom self-harm behaviour is still becoming established, facets relating to the cessation of behaviour may not yet be influential factors.

Given the lack of association between Negative Urgency and first incidence or maintenance of self-harm in our sample, it could follow that onset in younger adolescence may not necessarily function as an impulsivity driven affect-regulatory device, nor does a propensity to act rashly in response to heightened affect contribute to ongoing risk. Yet, other affect-related facets (e.g. emotion dysregulation, anxiety and depressive symptomatology) were significant prospective predictors, suggesting that difficulties with mood and the *regulation* of emotion are important components of risk. Moreover, our cross-sectional findings indicated that Negative Urgency, Emotion Dysregulation and Anxiety were significant independent predictors of lifetime self-harm in a young sample. These findings are consistent with previous evidence in older community and treatment-seeking populations showing links between affect-based reactivity and self-injury (Herpertz et al., 1997; Janis and Nock, 2009; Peterson and Fischer, 2012) and other emotion-related constructs such as alexithymia (Garisch and Wilson, 2015; Gatta et al., 2016). Further research beyond associative studies, is needed to clarify when the relationship between emotion-driven impulsivity and self-harm is expressed, and how this relates to broader affect-regulation functions of self-harm. Given the consistent relevance of difficulties in the *cognitive management* of emotion in self-harm demonstrated here and in the wider literature, and that problems of affect regulation may be exaggerated by deficits in cognitive control mechanisms (Herpertz et al., 1997) there is merit in examining the transaction between impulsivity facets and variance in the cognitive management of that emotional context, and broader cognitive processing, when modelling risk. Discrepancies between performance-based impulsivity measures (which measure the variability in cognitive processes that contribute to an impulsive behaviour at the time of measurement) and self-report data are widely reported (e.g. Janis & Nock, 2009) and it is recognised that these constructs may represent disparate aspects of impulsivity (Cyders and Coskunpinar, 2011). Nonetheless, exploring the transaction between underlying (trait) vulnerabilities and context-specific situational factors (e.g. behaviour within a cognitive-emotional context) that may moderate its expression, may help to clarify not just who is at risk, but when that risk is expressed.

In terms of other key findings, the prevalence of life-time self-harm (23.6%) was higher than reported in other community-based school samples e.g. 18.1% reported by Geulayov et al (2015). However, comparable, and even higher rates have been reported (Baetens et al., 2011; Cerutti et al., 2011; Garisch and Wilson, 2015).Variability in self-report estimates could reflect cross-cultural differences, or artefacts of study measurement. Our findings echo current hospital data which point to increasing levels of overt self-harm in younger samples (Geulayov, et al 2015). Around half the young people reporting lifetime self-harm indicated they typically acted within *ten minutes* of first thinking about self-harm. A short response latency between initial thought and self-harm within an hour has previously been reported (e.g.O'Connor et al., 2009b). The increased likelihood of behavioural enaction within such a short timeframe underscores the challenging but critical necessity of keeping young people *visibly* safe in moments of overt distress. For example, classroom time-out procedures may offer breathing space, but inadvertently afford an opportunity for self-harm in vulnerable students. More work is needed to unpick the notion of premeditation and its association with a complex behavioural outcome such as self-harm. That impulsivity is an important proximal risk-factor in the progression towards a self-harm act was demonstrated recently using novel card-sort task and sequential analysis techniques (CaTs; Townsend et al., 2016).Adolescents, asked to identify the factors leading up to and following a self-harm act, identified the item “I did it on impulse – without planning” as the only immediate precursor to both a first and most recent episode of self-harm. Notably, this item blurs the distinction between trait-based low deliberation and an impulsive state-based act. Further work is needed to clarify how these state/trait processes are implicated in the progression towards a self-harm episode. Nonetheless, the present findings underscore that self-harm is often an unpremeditated act.

4.2. Methodological issues

In terms of strengths, this longitudinal study had a large sample (n = 594) and an even distribution of male and female participants, which offered a comprehensive picture of community-based self-harm in young adolescents. The retention rate (92%) compares very well with other school-based longitudinal studies (Hasking et al., 2015). The study used established measures with good reliability/validity. The involvement of a youth advisory panel was an additional strength.

In terms of limitations, the study relied on self-report, which, in addition to potential response/recall bias, precludes the clarification or corroboration of responses. Work with young or vulnerable participants may benefit from approaches in which interpretations can be substantiated or clarified. Given links between impulsivity and psychopathology (Berg et al., 2015a; Janis and Nock, 2009) it is possible that associations between impulsivity facets and self-harm outcomes may differ in clinical/treatment-seeking versus normative populations. Examinations which distinguish youth on the basis of clinical profile (e.g. frequency/severity/treatment-seeking) may further clarify the nature of

impulsive self-harm. In particular, while the purposely adopted 12-week timeframe may arguably be too short to allow the natural course of self-harm to play out within a normative population, it is also possible that self-harm repetition over this time frame would be identified in a clinical sample. The measurement approach to capturing self-harm data, which asked participants to indicate recent self-harm in terms of 4 weeks, past 2 months and past 6 months, was insufficient in certain cases to identify all incidents of self-harm occurring between baseline and follow-up (a 12-week period). A more suitable approach would have been to ask participants at follow-up if they had self-harmed since the baseline assessment. The brief SUPPS-P scale was sufficiently specified to detect distinct pathways to self-harm and brought the advantage of minimal time burden. However, the full UPPS-P scale may provide a more detailed picture of associations.

4.3. Clinical and research implications

The findings, albeit based on small effect sizes, tentatively indicate putative individual markers of risk for onset and for maintenance of self-harm in early adolescents. Discussion of appropriate approaches to risk-taking and seeking stimulation may be beneficial for young adolescents as part of universal preventative approaches targeting healthy decision-making. Tackling cognitive deficits which underpin the maintenance of established self-harm are a potential clinical treatment focus for on-going risk profiles. Therapeutic approaches (such as CBT/DBT-A/MBT) which explore outcomes of rash action, tackle risk-cognitions and highlight workable goals may have merit. This study provides an important comparison between cross-sectional correlates and prospective risk-factors within the same sample. Findings underline that the emotional context of impulsive self-harm (of relevance in cross-sectional analysis) is insufficient in explaining the full picture of risk for young adolescents where behaviour is first emerging or maintained. As previous evidence supporting the role of Negative Urgency in self-harm has focused on older adolescent groups, this may represent an important developmental distinction. Further tests of the incremental predictive utility of SUPPS-P facets are needed to support theoretical understanding. Such work should consider how sex or clinical presentation influence outcomes.

5. Conclusion

This study examined unidimensional facets of impulsivity as short-term risk-factors for the emergence and maintenance of self-harm in young school-based adolescents and revealed a differential pattern of association. Findings confirm the discriminative utility of the SUPPS-P measure and make a major contribution to the literature investigating how risk-factors for self-harm/suicide which are established as cross-sectional correlates of behaviour, stand up to scrutiny within prospective designs.

Contributors

JL conceptualised the study, performed the analysis, and drafted the initial manuscript. ET, DD, and KS were involved in designing the study and editing the manuscript. All authors read and approved the final manuscript.

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Declaration of Competing Interest

None.

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Supplementary materials

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