


Research

Exploring self-harm risk vulnerabilities in autism using the ‘thinking patterns profiling model’

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Abstract

Background Autism has been linked to higher rates of self-harm. Research is yet to establish the reason for the association between autism and self-harm as a distress response.

Methods Using the ‘thinking patterns profiling model’, this study explored characteristics associated with self-harm risk in 100 autistic young people. Secondary analysis of routinely collected clinical data was conducted using odds ratios and t-tests.

Results We found the prevalence of reported self-harm risk was 48%. Young people with reported self-harm risks had significantly lower regulation skills ($p \leq 0.01$) and lower social flexibility skills ($p \leq 0.01$) compared to those without reported self-harm risk. For those described as impulsive, mean scores on the following skills were significantly lower: perspective-taking skills ($p \leq 0.01$), flexible thinking for creative problem-solving ($p \leq 0.05$) and sensory tolerating ($p \leq 0.05$). There was no relationship between reported self-harm risk and adverse childhood experiences.

Conclusions These findings suggest that profiling tools such as ‘Thinking Patterns Profiling Model’ can be used to explore unique patterns of vulnerability and resilience related to self-harm risk in autism. The findings suggest that autistic thinking patterns might interplay with other factors (e.g. impulsivity). Patterns are based on each person’s profile across four core skill-sets: regulation, flexible thinking, sensory coherence, and social perspective-taking. These findings motivate a person-centred and profile-informed approach to planning support and adjustments. Further studies are needed to confirm the ways in which mechanisms typically involved in self-harm risk, may interact with core cognitive and affective differences found in autism.

Keywords Thinking patterns · Autism · Self-harm · Sensory · Regulation · Flexible thinking · Perspective-taking · Impulsivity

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1 Introduction

Self-harm is a growing topic of concern because studies show higher rates and earlier onsets [1]. Self-harm is a multi-faceted construct that refers to ‘any act of self-poisoning or self-injury carried out by a person, irrespective of their motivation’ (National Institute for Health and Care Excellence [NICE], 2013). Hargus et al. [2] identified three self-harm risk subgroups: people who think about self-harm without acting; people who harm themselves without any suicidal intent; and people who harm themselves with suicidal intent. Whilst some authors believe the groups form a continuum [2], others maintain that these groups are distinct and require independent lines of enquiry [3]. This is due to significant differences in the prevalence, trajectories and responsiveness to treatments found between suicidal and non-suicidal populations [4]. Nevertheless, there continues to be variation in categorisations used in studies. Depending on the nuances of the topic of interest, researchers choose to subdivide according to intent (e.g. suicidal or non-suicidal), action (e.g. ideation or act), or motivation (e.g. prevailing thoughts, emotions, and experiences). In relation to motivation, self-harm in autistic people can sometimes occur in the context of positive or neutral affect. Harm can sometimes result from acts that are driven by thrill-seeking, risk-taking, sensory-seeking, or by a fascination in a restricted interest [5]. Since the topic of interest in this paper is self-harm as a distress response, no further attention will be paid to self-harm risks that occur in the absence of distress.

There is also some robust evidence for close predictive links between different forms of self-harm. For example, Klonsky et al. [6] identified that attempted suicide may be predicted by acts of non-suicidal self-harm. Also, in a prospective follow-up study, researchers identified that acts of self-harm may be predicted by self-harm ideation [7]. In clinical settings, it is important to identify self-harm risk as early as possible. Interventions can then be delivered, and measures taken, to prevent an escalation of self-harm risk (e.g. from self-harm ideation to acts of self-harm, or from acts of self-harm to suicidal intent). With this in mind, all forms of self-harm have the potential for tragic consequences [8]. Therefore self-harm risk is a complex topic that is worthy of wider investigation. This study focuses on the factors contributing to self-harm as a distress response in autistic people. It pays attention to the factors contributing to the distress, and the skills needed to regulate negative emotion in healthier ways.

Higher rates of self-harm have been reported in autistic populations compared to non-autistic groups. Some studies have shown rates that are three times higher [9] and there may be a degree of under-reporting [10]. Whilst it is difficult to unravel the complex nature of self-harm as a distress response in autism, it seems likely that the following framework might be used as a start-point for understanding self-harm risks for both autistic and non-autistic people. At least two areas of complexity might influence the level of self-harm risk occurring in a person’s life: Firstly, there are within-person factors such as emotional regulation [9, 11], social communication [12, 13], restricted interests and rumination [14], sensory processing, and the need for sameness [15], imagination [16], and impulsivity [13, 17]. Secondly, there are external environmental factors that include adverse experiences relating to family, housing, education, employment, finances, and social contact [18–20]. These within-person and external factors are likely to act in combination and for many people the impact can be compounded by mental health conditions such as anxiety, depression, and eating disorders, known also to be increasingly prevalent in young people [21]. It is feasible that each individual factor might either increase the likelihood of self-harm (i.e. causing a person to be more vulnerable) or decrease the likelihood of self-harm (i.e. causing a person to be more resilient). Links between self-harm and adverse childhood experiences have been found [22, 23]. The term Adverse Childhood Experiences (ACEs) is used to describe any potentially traumatic experience occurring in childhood [24]. A model for understanding complex factor interplay over time, with additional factors relating to motivation (e.g. ruminative processes and social support) and volition (e.g. impulsivity) has been proposed in the Integrated Motivational-Volitional model [25]. Whilst this is a model of suicidal behaviour, the model founders believe that it may also apply to non-suicidal self-harm responses. Research attention has not yet focused on whether this model might help to explain higher rates of self-harm in autistic people.

Reviews have previously indicated the important role of impulsivity in understanding self-harm in young people [26]. It is unsurprising that studies have found an association between self-harm and an in-the-moment urge to react rashly when experiencing negative affect [27, 28]. However, the mechanisms at play between self-harm and impulsivity-versus-deliberation may be more complex. This is pertinent for this study because a high proportion of autistic people have other neuro-developmental differences co-occurring. For example, in a previous study, the prevalence of Attention Deficit Hyperactivity Disorder (ADHD) was 60% in a school-aged population of autistic young people [34], and it is known that impulsivity is a core diagnostic feature of ADHD [29]. Accordingly, support plans might be more accurately targeted when impulsivity is considered alongside other within-person variables, and included in clinical formulations [30].

Some studies have suggested additional vulnerability to self-harm for those described as deliberators or ruminators [31]. Other studies point towards an association between self-harm and trait impulsivity [26]. This may seem contradictory because it suggests that increased self-harm risk vulnerability can be found in people who think too much about consequences, as well as in people who think too little about consequences. When considered alongside a within-person variable such as social functioning, it might be possible to offer a plausible explanation for this apparent contradiction. Those inclined to respond in socially unexpected ways, without thinking about consequences, might have an increased self-harm vulnerability via a mechanism involving impulsivity. In contrast, a mechanism involving deliberation might explain the increased self-harm vulnerability for those inclined to ruminate over every social response that might conceivably result in people perceiving them negatively. As suggested by Larsson et al. [29], impulsivity cannot be viewed as a discrete or stable variable, and it has been shown to decrease with age in a community sample. It might therefore be possible for the same individual to be described as impulsive in childhood, and a ruminator later in life.

When heterogeneous groups of autistic people are studied at a single point in time, important differences in experience may be missed [32, 33]. To develop the most suitable support plans, it is important to understand the individual skills and thinking patterns of autistic people who are at risk of self-harm. Identification of key variables and their influence on patterns of self-harm in autism is important so that clinicians can target support to develop the skills that will decrease a person's vulnerabilities and increase their resilience.

The 'Thinking Patterns Profiling Model' [34, 35] has been developed to identify the skills and thinking patterns of each person who attends for an autism assessment. A unique visual profile can be created for each person at the end of their assessment, and this profile can be used to talk with the individual and their family about autism and what it means for them. It is a personalised profile that highlights strengths as well as potential targets for skill-building and support. It has been designed to help the person, who attended for assessment, to communicate their needs to others. It has been created to help people in post-assessment settings to understand and appreciate the person's strengths and differences more quickly and more easily.

This study was designed to see if the 'Thinking Patterns Profiling Model' could help to identify factors related to autism that may be associated with a parent/caregiver-reported self-harm risk at the time of autism diagnostic assessments in autistic young people aged 4–18 years.

2 Methods

2.1 Study design and setting

This was a cross-sectional study conducted in a large UK based National Health Service (NHS) Trust provider of community and hospital-based mental health services in North-West England.

2.2 Study population

Anonymised data were used for autistic young people who were aged four to eighteen years when they attended autism diagnostic profiling assessments between November 2018 and May 2019. One hundred and forty-six young people accessed the autism diagnostic assessment service in this time period. After excluding those who were not given an autism diagnosis, and those who did not access a full profiling assessment, one hundred young people were included.

2.3 Procedure

Approval for this study was granted by the Research Office of Cheshire and Wirral Partnership NHS Foundation Trust on 11th June 2021. Information analysts from the Trust's Performance and Information Team collated routinely available demographic and diagnostic information from electronic patient records. Each young person was given an identification code. Only anonymised and aggregated data were used for data analysis.

Referral information and information from the pre-assessment questionnaires from home and school (or another setting), were used to pre-populate a semi-automated anonymised electronic dashboard. Assessment appointment information was then transcribed live during each parent/carer interview. The practitioners who gathered this assessment information each had over twenty years clinical experience working with autistic young people and their families. They were able to ensure that complex constructs were accurately captured and verified, through testimonies of everyday

life shared by parents during parent interviews. Data were collated and scored within the semi-automated anonymised electronic dashboards. Based on data from all sources, the young people were identified as with or without reported self-harm risk. The self-harm risk group was further subdivided into those with and without reported impulsivity.

Consistent with the principle that underpins operational research, this study used routinely collected data and transformed it into aggregated information to provide a quantitative real-setting basis for decision-making and improvements in public health [36]. As noted by Harries et al. [36], *'operational research is not an academic exercise, but rather a formal evaluation of public health practice that needs to be firmly integrated and embedded within health service delivery'* (p.98).

2.4 Measures

The following routinely collected data were used to calculate numerical scores for seventeen 'Thinking Patterns Profiling Model' variables (with higher scores indicating higher levels of skill). Scores were calculated for each young person across four core aspects: regulation, flexible thinking, sensory coherence, and social perspective-taking. Please also see Tollerfield et al. [34] for a more detailed review of these constructs and published components of the scoring system [37–41]. As noted by Tollerfield et al. [34], the term 'sensory coherence' is helpful because it emphasises the importance of making sense of sensory details in the context of the whole situation.

Routinely available data sources:

1. The pre-assessment questionnaires included items from a range of published measures, as well as items based on clinical judgement and consensus amongst psychiatrists and speech and language therapists working as part of the diagnostic assessment team. The questionnaires included items from the Empathy Quotient-Systemizing Quotient (EQ-SQ) Child questionnaire [38], the Emotion Dysregulation Inventory [39], the Extreme-Demand-Avoidance questionnaire [40], the Social Communication, Emotional Regulation, and Transactional Support (SCERTS) model [41], and the Flexibility Scale [42].
2. The parent/carer interview was based on the Diagnostic Interview for Social Communication Disorders (DISCO) [42] and extended to include indicators for executive functioning, attention control, impulsivity, and activity levels as well as mood and emotional regulation.
3. Electronic patient records included demographic information, the Care and Risk of Self and Others, and reports based on the Autism Diagnostic Observation Schedule, second edition [ADOS-2] [43]. For some young people, there were also records from appointments with Child and Adolescent Mental Health Services, and from appointments with ADHD team specialists.

Young people were included in the self-harm risk group when there was reported evidence of self-harm related actions (e.g. picking, cutting, head-butting, biting, self-poisoning) or words used with clear intent (e.g. talking about stabbing or cutting whilst holding a sharp object). Young people were not included in the self-harm risk group if they made remarks without any evidence of risk (e.g. reports of young people thinking about suicide all the time whilst stating that they would not ever take action to harm themselves; or stating that they wish they were not here anymore; or asking 'what's the point of it all?'; or saying they want to jump whilst being nowhere near a drop, *and* in the absence of signs of intent). ACEs were identified in line with Felitti et al. [19]: emotional neglect, physical neglect, emotional abuse, physical abuse, sexual abuse, domestic violence, household incarceration, household mental illness, household substance misuse, parental separation. To assess for impulsivity, ACEs, and self-harm risk, parents/carers were also asked direct questions. For example, they were asked 'Would you describe your child as frequently impulsive (i.e. frequently doing things without thinking about the consequences)?'. Since other studies found low agreement between and child-reported and parent-reported concerns [6], it was considered important to use multiple sources to capture all related information.

Whilst psychometric properties have been reported for some of the pre-assessment questionnaires [38–40, 42], the validity and reliability of the composite tool (i.e. the combined set of pre-assessment questionnaires) has not yet been examined. In this study, it is noted that for convenience, numerical scores were calculated for each of the seventeen 'Thinking Patterns Profiling Model' variables. In reality, since the variables in this study are psychological attributes, it is unlikely that they can be quantified or measured precisely using an instrument with equal interval integers. More recently, social science researchers have turned to computer science-based methods to evaluate whether a tool measures what it intends to measure [44]. However, the use of these methods was outside the scope of this present study.

2.5 Data analysis

Patient characteristics were reviewed for the whole group, and for the subgroups with and without reported self-harm risk. The self-harm risk group was further subdivided into those described as impulsive, and those who were not. Characteristics were summarised with frequencies and percentages, and odds ratios were calculated with their 95% confidence intervals. Independent t-tests were used to compare the mean scores between groups for each of the 'Thinking Patterns Profiling Model' variables. Stata Statistical Software [45] was used for all t-tests. The Select Statistical Services online odds ratio confidence interval calculator [46] was used for all odds ratios. P-values ≤ 0.05 were regarded as significant.

2.6 Community involvement

Firstly, the testimonies of autistic people were the driving force behind the conception of the 'Thinking Patterns Profiling Model'. The voices of over one thousand young people and their parents/carers have inspired and influenced its development.

Using this model, individual profiles can be created for each autistic person so that their skills and thinking patterns can be appreciated, and support plans tailored. This is in line with priorities identified in the Autistica Support Plan [47] which outlines what is required to build a proven support systems for autistic people by 2030.

The study conception and design were inspired and informed by personal stories shared with the first author during diagnostic assessment sessions between November 2013 and November 2021. Interpretation of the study findings and final manuscript revisions benefitted from the contribution of experts by experience who attended one of four community involvement sessions in 2021. The following groups were represented: Parents and autistic individuals speaking for themselves; autistic people diagnosed at various ages (e.g. diagnosed aged five and diagnosed aged 40–50 years); autistic people with no other additional neuro-developmental differences and those with suspected or diagnosed ADHD; autistic people with severe learning disabilities and no spoken words; and autistic people with good linguistic and cognitive skills.

3 Results

3.1 Demographics

Of the one hundred autistic young people included in this study, just under half ($n = 48$) had a reported self-harm risk, just under half ($n = 48$) had reported impulsivity, and exactly half ($n = 50$) had co-occurring ADHD. We found no significant differences between the characteristics of the autistic young people with and without reported self-harm risk (Table 1). Notably, the percentage of young people with reported self-harm risk remained at 48% independent of co-occurring ADHD, and independent of learning levels. Prevalence of self-harm risk increased to 54% in those with impulsivity, but this increase was not statistically significant.

We then looked at the subgroup of those with a reported self-harm risk and divided them into those described as impulsive ($n = 26$) and those who were not described as impulsive ($n = 22$) (Table 2). We found much a higher prevalence of impulsivity in those with co-occurring ADHD (83%), and also in those with learning levels described as below age-related expectations (73%). We found that those in this self-harm risk group who were described as impulsive, were more likely to have a diagnosis of ADHD (OR = 15; 95%CI = 3.6–61.8), and they were more likely to have learning levels described as below age-related expectations (OR = 9.6; 95%CI = 2.4–38.1).

Whilst we found no statistically significant differences relating to age, it was noted that the prevalence of reported self-harm risk, increased with each age category from 33% in 4–6 year olds, up to 58% in 14–18 year olds (Table 1). In comparison, the prevalence of impulsivity in those with a reported self-harm risk increased only up to the 11–13 year old category, where it peaked at 70% (Table 2). In the 14–18 year old category it dropped to 33%.

Table 1 Characteristics associated with reported self-harm risk in young autistic people attending autism diagnostic assessment service between November 2018 and May 2019

Characteristics	Total	Reported Self-Harm Risk	OR	95% CI
	N	n (%)		
All autistic young people	100	48 (48)		
Ethnicity				
White British	87	42 (48)	Ref.	–
Missing ^a	13	6 (46)	0.9	0.3–3.0
Gender				
Male	69	30 (44)	Ref.	–
Female	30	17 (57)	1.7	0.7–4.0
Transgender	1	1 (100)	–	
Age in years				
4–6	6	2 (33)	0.7	0.1–4.0
7–10	49	21 (43)	Ref.	–
11–13	19	10 (53)	1.5	0.5–4.3
14–18	26	15 (58)	1.8	0.7–4.8
Attention Deficit Hyperactivity Disorder diagnosis				
No	50	24 (48)	Ref.	–
Yes	50	24 (48)	1.0	0.5–2.2
Index of Multiple Deprivation deciles				
1–2	11	6 (55)	1.3	0.3–5.1
3–4	29	13 (45)	0.9	0.3–2.4
5–6	16	6 (38)	0.6	0.2–2.2
7–8	13	8 (62)	1.7	0.5–6.4
9–10	31	15 (48)	Ref.	–
Number of Adverse Childhood Experiences (ACEs)				
0	47	20 (43)	Ref.	–
1–3	42	22 (52)	1.5	0.6–3.4
4 or more	11	6 (55)	1.6	0.4–6/1
Impulsivity				
No	52	22 (42)	Ref.	–
Yes	48	26 (54)	1.1	0.5–2.4
Learning level				
Below ^b ARE	63	30 (48)	1.0	0.5–2.4
At or above ^b ARE	37	18 (49)	Ref.	–

^aEthnicity not recorded in the electronic patient records

^bARE = Age-Related Expectations

3.2 'Thinking patterns profiling model' variables

Seven of the 'Thinking Patterns Profiling Model' variables were significantly associated with a reported self-harm risk. These included at least one variable from each of the four core aspects: regulation, flexible thinking, sensory coherence, and social perspective-taking. Tables 3 and 4 identify the variables (in bold) with p -values ≤ 0.05 when mean scores were compared.

The mean scores for young people with a reported self-harm risk were significantly lower compared to those with no risk of self-harm on three 'Thinking Patterns Profiling Model' variables: 'mutual-regulation' ($p \leq 0.01$), 'self-regulation' ($p \leq 0.01$) and 'flexible thinking in response to social demands' ($p \leq 0.01$) (Table 3). This difference was also found in the

Table 2 Characteristics associated with reported impulsivity in autistic young people with a reported self-harm risk attending autism diagnostic assessment service between November 2018 and May 2019

Characteristics	Total N	Described as impulsive n (%)	OR	95% CI
All autistic young people with reported self-harm risk	48	26 (54)		
Ethnicity				
White British	42	22 (52)	Ref.	–
Missing ^a	6	4 (67)	1.8	0.3–11.2
Gender				
Male	30	17 (57)	Ref.	–
Female	17	8 (47)	0.7	0.2–2.3
Transgender	1	1 (100)	–	
Age in years				
4–6	2	1 (50)	0.6	0–11.3
7–10	21	13 (62)	Ref.	–
11–13	10	7 (70)	1.4	0.3–7.2
14–18	15	5 (33)	0.3	0.1–1.2
Attention Deficit Hyperactivity Disorder diagnosis				
No	24	6 (25)	Ref.	–
Yes	24	20 (83)	15	3.6–61.8
Index of Multiple Deprivation deciles				
1–2	6	5 (83)	10	0.9–110.3
3–4	13	8 (62)	3.2	0.7–15.1
5–6	6	5 (83)	10	0.9–110.3
7–8	8	3 (38)	1.2	0.2–7.2
9–10	15	5 (33)	Ref.	–
Number of Adverse Childhood Experiences (ACEs)				
0	20	13 (65)	Ref.	–
1–3	22	8 (36)	0.3	0.1–1.1
4 or more	6	5 (83)	2.7	0.3–27.8
Learning level				
Below ^bARE	30	22 (73)	9.6	2.4–38.1
At or above ^b ARE	18	4 (22)	Ref.	–

Bold values are statistically significant ($p \leq 0.01$)

^aEthnicity not recorded in the electronic patient records

^bARE = Age-Related Expectations

self-harm risk subgroups: young people described as impulsive scored significantly lower on the same three variables, when compared to those who were not described as impulsive ($p \leq 0.05$; $p \leq 0.01$; $p \leq 0.01$, respectively) (Table 4).

A different pattern was found with the next three variables in Fig. 1: 'flexible thinking for creative problem-solving', 'over-sensory sensitivity tolerating' and 'affective perspective-taking'. In those with a reported self-harm risk, there was only a significant difference in mean scores for these variables when those with and without impulsivity were compared ($p \leq 0.05$; $p \leq 0.05$; and $p \leq 0.01$, respectively), and not when comparing those with and without a reported self-harm risk. In those who had a reported self-harm risk, the mean scores for those described as impulsive, were lower than the mean scores for those without a reported self-harm risk. Scores for those who were not described as impulsive were significantly higher than these mean scores (Fig. 1).

Table 3 Comparison of 'Thinking Pattern Profiling Model' variables in autistic young people with and without a reported self-harm risk attending autism diagnostic assessment service between November 2018 and May 2019

Measure	Group mean (standard deviation)			Comparing group means T-test P
	Combined	SH + ve	SH-ve	
Cognitive perspective-taking	5.7 (3.6)	6.5 (4)	5.1 (3)	≤ 0.05
Affective perspective-taking	12 (5.8)	(6.1) 13	12 (6)	0.82
Flexible thinking in response to social demands	8.3 (5.6)	6.6 (4.7)	9.9 (5.8)	≤ 0.01
Flexible thinking in creative problem-solving	7 (4)	(3.6) 7	7.1 (4.4)	0.88
Flexible thinking in interests	8.6 (4.6)	8.7 (5)	8.5 (4.2)	0.85
Flexible thinking in Sensory-motor movements	13 (5.1)	14 (5)	13 (5.3)	0.5
Flexible thinking in routines	5.2 (4)	4.8 (4.3)	5.5 (3.7)	0.38
Flexible thinking in physical organisation/order	11 (4.9)	10 (5.1)	11 (4.7)	0.37
Flexible thinking in speech and language	9.8 (3.6)	9.8 (3.9)	9.7 (3.3)	0.87
Over-sensory sensitivity tolerating	36 (11)	34 (11)	37 (12)	0.27
Over-sensory sensitivity refining	6.2 (5.7)	6 (5.5)	6.4 (5.9)	0.73
Under-sensory sensitivity filtering	33 (9.9)	33 (9.8)	33 (10)	0.93
Under-sensory sensitivity registering	23.5 (4.4)	23.9 (4.1)	23.3 (4.6)	0.44
Mutual-regulation (responding)	8 (4.2)	6.8 (3.7)	9 (4.4)	≤ 0.01
Mutual regulation (describing)	15 (5)	15 (5.4)	14 (4.6)	0.73
Self-regulation	13 (8.8)	10 (6.8)	16 (9.6)	≤ 0.01

With the variable, 'cognitive perspective-taking', in those with a reported self-harm risk, there was a significant difference in the mean scores between those with and without impulsivity ($p \leq 0.01$). Young people who were not

Table 4 Comparison of 'Thinking Pattern Profiling Model' variables in autistic young people with reported self-harm risk, with and without reported impulsivity, attending autism diagnostic assessment service between November 2018 and May 2019

Measure	Group mean (standard deviation)			Comparing group means T-test P
	Combined	SH + ve Impulsive	SH + ve Not Impulsive	
Cognitive perspective-taking	6.5 (4)	4.8 (3.3)	8.4 (4)	≤ 0.01
Affective perspective-taking	13 (6.1)	9.8 (4.6)	16 (6.1)	≤ 0.01
Flexible thinking in response to social demands	6.6 (4.7)	4.9 (4)	8.6 (4.8)	≤ 0.01
Flexible thinking in creative problem-solving	7 (3.6)	6 (3.3)	8.1 (3.7)	≤ 0.05
Flexible thinking in interests	8.7 (5)	9.5 (4)	10 (4)	0.26
Flexible thinking in sensory-motor movements	14 (5)	12 (5.3)	14 (5)	0.07
Flexible thinking in routines	4.8 (4.3)	4.8 (3.6)	4.9 (5)	0.96
Flexible thinking in physical organisation/order	10 (5.1)	11 (4.7)	9.8 (5.6)	0.4
Flexible thinking in speech and language	9.8 (3.9)	9.5 (4)	10 (4)	0.58
Over-sensory sensitivity tolerating	34 (11)	31 (10)	38 (11)	≤ 0.05
Over-sensory sensitivity refining	6 (5.5)	5.4 (4.5)	6.7 (6.6)	0.41
Under-sensory sensitivity filtering	33 (9.8)	31 (9.7)	35 (9.5)	0.12
Under-sensory sensitivity registering	23.9 (4.1)	22.9 (4.2)	25 (3.8)	0.07
Mutual-regulation (responding)	6.8 (3.7)	5.8 (3)	8 (4.1)	≤ 0.05
Mutual regulation (describing)	15 (5.4)	14 (4.9)	16 (5.8)	0.12
Self-regulation	10 (6.8)	7.7 (4.3)	10 (6.8)	≤ 0.01

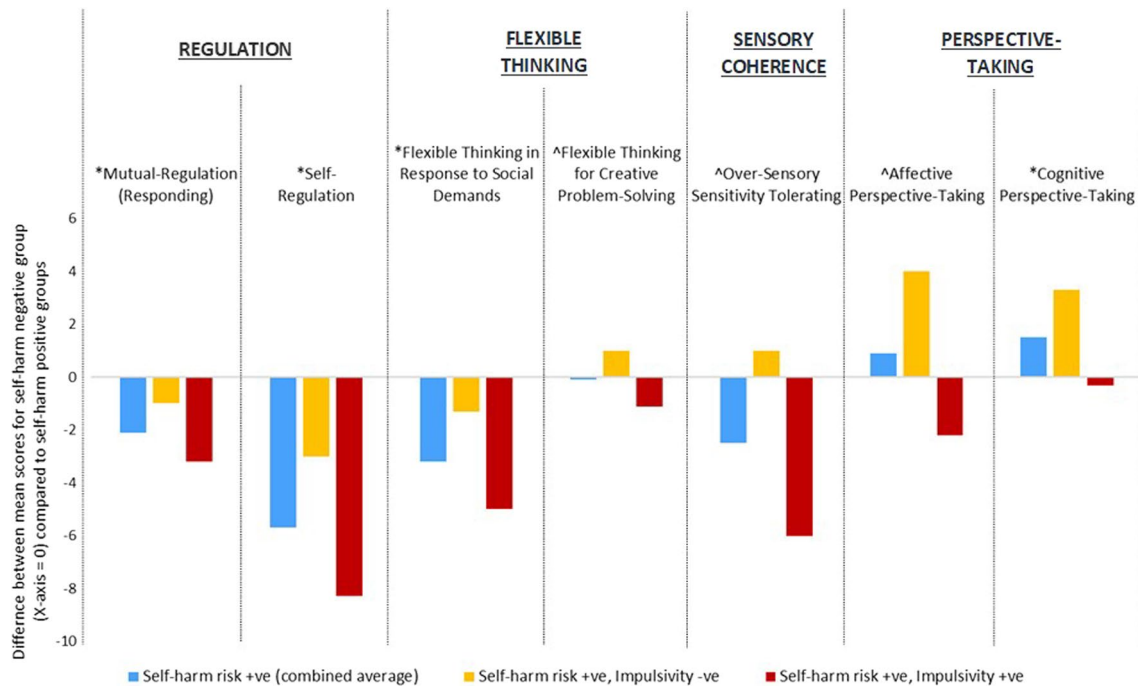


Fig. 1 Comparing group mean scores on statistically significant 'Thinking Patterns Profiling Model' variables for those with/without self-harm risk and those with/without trait impulsivity. * $p < 0.05$; ^ $P < 0.05$ only when comparing the self-harm risk positive sub-group with and without impulsivity

described as impulsive had significantly higher scores. Young people who were described as impulsive had lower scores. This difference was hidden when the groups were analysed together. The composite mean score for the self-harm risk group was significantly higher. Therefore, the lower mean score for those described as impulsive was missed until the impulsivity subgroups were analysed.

4 Discussion

This study aimed to identify which 'Thinking Patterns Profiling Model' variables may be associated with self-harm risks in autism. We found a significant relationship between self-harm risk and the variables 'mutual-regulation', 'self-regulation', 'flexible thinking in response to social demands' and 'cognitive perspective-taking'. However, we also found that other variables were significantly associated when the role of impulsivity was considered: 'flexible thinking for creative problem-solving', 'over-sensory sensitivity tolerating' and 'affective perspective-taking'.

Several limitations should be considered when interpreting these results. Firstly, this is a relatively small sample and only represents those accessing diagnostic assessment services in one geographical area. We do not know if the findings can be generalised beyond this group, to adult populations and to other geographical areas, to other racial/ethnic groups, and to those given an autism diagnosis prior to the age of four years. The skills and thinking patterns of those without autism and those with sub-threshold autism traits is also unknown. Conclusions will need further review since no comparison group was included in this study.

Secondly, there are some measure-related issues. This study used data from routine clinical care. The 'Thinking Patterns Profiling Model' has some clinical utility, and it is strengthened due to clinical triangulation with use of data from pre-assessment information, parent/caregiver interview, direct observation of the young person, electronic records relating to risk, and records relating to other health care appointments (e.g. ADHD and CAMHS appointments). Nevertheless, the validity and reliability of the composite tool has not yet been demonstrated. Finally, as a cross-sectional study, the direction of reported associations cannot be established.

Prevalence of self-harm risk in this study was 48%. For comparison, the rate of self-harm in early identified autistic young people up to seven years old has been reported at 50% [48]. Rates vary widely from 10% to 70% for young

people without intellectual disabilities [49]. Broadly consistent with studies of non-autistic populations [1], the prevalence of self-harm risk was higher in 14–18 year olds compared to 11–13 year olds. In the present study, however, this difference between age categories did not reach statistical significance.

Some studies have shown a link between ACEs and detrimental outcomes such as hospital treated self-harm in adulthood [22] and suicidality in children [23]. In contrast, when all participants met the criteria for an autism diagnosis, we found no significant relationship between the number of ACEs and the percentage of reported self-harm risk. Since there was a non-significant upward trend, we cannot be certain that this result would be replicated with a larger sample size. Regardless of the replicability, it is feasible that the salience of conventional ACEs might differ qualitatively for some autistic people in the context of adversities experienced in everyday life due to core affective and cognitive differences related to autism. This may alter typical relationships between ACEs and self-harm risk.

There are some plausible explanations for an altered relationship between ACEs and self-harm risk. Certain common everyday situations may be experienced as distressing by some autistic people, due to specific sensory, social, or linguistic aspects of the context. For example, the lights, sounds, and complex social-linguistic dynamics of an event might result in debilitating discomfort for some people, whilst others might experience no impact at the same event. Arguably, a person's sensitivity and response to certain types of additional trauma might be heightened in the context of repeated patterns of distress. Self-harm risks might already be elevated due to autistic differences impacting on affect and emotional regulation. For other autistic people, certain features of autism might serve as protective factors against harms related to ACEs. For example, some autistic children may be preoccupied by an interest, activity or sensation and they may be less aware of more subtle malfunctioning social dynamics within a household. Whatever the explanations for each individual, these findings indicate that for autistic people the factors (i.e. internal, external, motivational and volitional) and the trajectories might differ compared to non-autistic populations. This is consistent with the findings and suggestions of others [15].

4.1 The role of impulsivity in self-harm risk

Results from this study implicate the role of impulsivity in self-harm. This is in line with previous studies [17]. Lockwood et al. [28] highlighted impulsivity as a complex and multi-dimensional construct and distinguished between in-the-moment situational impulsivity and impulsivity-versus-deliberation. In the present study, the focus was on the latter which could arguably be referred to as trait impulsivity. Since trait impulsivity is a core indicator in diagnoses of ADHD, it was not surprising to find a strong association between these two variables. However, the findings showed that the prevalence of reported self-harm risk remained constant (48%) in autistic young people with co-occurring ADHD and was only slightly elevated (54%) for autistic young people with impulsivity. The significant role of impulsivity was seen only in the context of certain 'Thinking Patterns Profiling Model' variables. Interestingly, for autistic young people at risk of self-harm, there were some statistically significant differences between the profiles of those described as impulsive, compared to those who were not described as impulsive (i.e. the impulsive group had lower scores in 'flexible thinking for creative problem-solving', 'over-sensory sensitivity' and 'perspective-taking'). This finding supports the idea that there may be more than one mechanism for self-harm vulnerability in autism. It seems feasible that for some autistic young people (particularly those without impulsivity), distress might be linked to high levels of anxiety and a tendency to deliberate or 'over-think' things (e.g. anguishing about the perspectives of others, and about how to solve everyday problems). For others, there might be a tendency to do things without thinking them through, due to trait impulsivity. Although not specifically measured in this study, the role of deliberation or rumination and its relationship with impulsivity has been identified as an important topic [25]. With the highest rates of self-harm and the lowest rates of impulsivity seen in the 14–18 year old category, it is possible that the mechanism might also shift over time (e.g. between impulsivity-driven self-harm and rumination-driven self-harm). Anecdotally, some autistic teenagers with co-occurring ADHD, describe a shift in awareness, with a 'racing mind' (i.e. fast-flowing thoughts and ideas that are difficult to harness), becoming more noticeable to them in adolescence, perhaps due to abating levels of physical activity. Future studies could review trends across larger population samples to explore how patterns of impulsivity, rumination, and self-harm differ over time in neurodiverse populations (i.e. those with and without neuro-developmental differences such as autism and ADHD).

4.2 Regulation skill profiles associated with self-harm risk and impulsivity

In this study, lower regulation skills were significantly associated with a reported self-harm risk, irrespective of impulsivity. This finding was expected, based on previous studies [9, 50]. These results contribute to a growing body of evidence suggesting the importance of delivering targeted interventions and support plans that are designed to build the skills needed for healthy levels of self-regulation (i.e. perceiving, interpreting, and regulating emotion) and mutual-regulation (i.e. expressing emotion to others, and responding to emotional support offered by others).

4.3 Flexible thinking skill profiles associated with self-harm risk and impulsivity

Lower scores for 'flexible thinking in response to social demands' were significantly associated with a reported self-harm risk. This finding is consistent with studies that found an association between self-harm and deficits in social interaction [13] and with social communication [12]. However, the present study provides support for the crucial importance of focusing on the social flexible thinking skills needed for successful social exchanges.

Given the suggested role of anxiety and uncertainty in social inflexibility [51], it may be helpful for interventions to specifically target environmental adjustments that reduce the level of anxiety and unpredictability experienced. Interventions for those who are cognitively and linguistically able, might also specifically target development of sophisticated social communication skills such as compromise and self-advocacy. Without such skills there may be higher risk of relationship breakdown, and social isolation. For some people, this might lead to distress and an increased self-harm risk.

We found statistically significant results for only one of the six non-social flexible thinking skills. Mean scores in 'flexible thinking for creative problem-solving' were significantly higher for those with reported self-harm risk who were not described as impulsive compared to those who were described as impulsive. Seemingly, the mechanism for increased risk might differ for these two subgroups. This would be consistent with the model of suicidal behaviour developed by O'Connor and Kirtley [25].

Assuming that those who were not described as impulsive may be prone to deliberating, this could suggest a self-harm risk vulnerability that is linked to ruminating over all imaginable choices and outcomes. Experts by experience described this as resulting in a sense of 'overload' that can precede self-harm. Links between rumination and suicidality have also been found widely in the literature [52]. Consistent with O'Connor and Kirtley [25], people may be at higher risk of feeling trapped when they are prone to ruminating. This risk may be exacerbated for some autistic people who may be hampered by co-existing autistic differences. For example, autistic thinking patterns may result in a person holding rigid views on certain topics or feeling unable to execute a solution due to additional social or sensory differences.

In contrast, those who were described as impulsive might be prone to increased self-harm risk via a different mechanism. Associations between impulsivity and suicidality have been repeatedly reported in the literature [53]. The self-harm risk might be heightened for autistic people due to prevalence of restricted imagination skills and co-occurring ADHD. Fifty percent of the autistic young people in the present study also had an ADHD diagnosis and we found that there was a significant association between ADHD and impulsivity. Potentially, some of those described as impulsive might also have weak imagination skills. Consequently, some autistic people may struggle to imagine the possible solutions and react impulsively to negative emotions, without first finding help to work through the choices and possible outcomes.

4.4 Sensory coherence profiles associated with self-harm risk and impulsivity

We found no significant difference in over-sensory sensitivity (tolerating) scores when the combined self-harm risk group was compared to those with no reported self-harm risk. However, when the self-harm subgroups were explored, we found that those who were described as impulsive had significantly lower scores on over-sensory sensitivity (tolerating) scores. This may indicate a higher risk of sensory overload for this subgroup. Links between sensory overload, distress, and self-harm have been indicated in other studies [54]. However, we found that the 95% confidence intervals were very wide for over-sensory sensitivity (tolerating), so the present study findings must be interpreted cautiously.

Prevailing literature on self-harm and sensory differences in autism is contradictory. Some studies indicated a possible link between sensory differences and self-harm [15, 55]. Others did not identify sensory aspects as a significant

predictor for self-harm [56]. To date, evidence indicates that if links exist between self-harm and sensory coherence, the exact nature is yet to be determined.

Clinically, the importance of reviewing each person's unique sensory profile is paramount. Different combinations of sensory difference may result in varying levels of vulnerability and resilience. For example, there may be an increased self-harm risk for people who find comfort in a repetitive sensory-seeking response to distress that incidentally also causes bodily harm. In contrast, there may be increased resilience for those who find comfort in a repetitive sensory interest that is positive and constructive (e.g. writing music or computer code).

Sensitivities relating to internal sensations such as pain and emotion may warrant particular attention. Research is now emerging to support the importance of this. A recent study found a link between under-sensitivity to pain and self-harm [57]. Conceivably, there could also be a link between self-harm and reduced ability to register internal sensations associated with emotion which is identified as a component of alexithymia [58]. Costa et al. [59] found that the risk of suicidality was higher for adults with high levels of autistic traits including alexithymia. According with this, the 'Thinking patterns Profiling Model' was updated in 2019 to include a measure for registering of emotion specifically and separate from the score for registering other internal sensations such as pain, temperature, hunger, and thirst.

4.5 Perspective-taking skill profiles associated with impulsivity

We found a significant relationship between differences in cognitive perspective-taking skills when the combined self-harm risk group was compared to those with no reported self-harm risk. When the self-harm subgroups were explored, we found that those who were not described as impulsive had significantly higher scores on both cognitive and affective perspective-taking. A recent study made some comparable findings [60] despite differences in population, setting, and terminology. They found that a certain subgroup (i.e. females who attempted suicide) had higher ability to identify with fictitious characters and higher scores on sensitivity to the suffering of others. Interestingly, in the present study there were a higher number of females in the self-harm group not described as impulsive. However, this result was not statistically significant in this relatively small study sample.

One possible explanation for the link between self-harm and affective perspective-taking is that people with high affective perspective-taking may have sufficient levels of sensitivity and concern for the suffering of others that they would not consider self-harm due to resulting pain for friends and family. As suggested by Zhang et al. [61], people with low affective perspective-taking skills might be at higher risk due to lack of this protective factor.

However, in the present study, higher than average levels of perspective-taking were also associated with self-harm in one of the subgroups (i.e. those who were not described as impulsive). Possibly, heightened sensitivity and heightened concern for the feelings of others might be experienced to the extent that it results in distress. Again, assuming that those not described as impulsive might be prone to ruminating, the self-harm risk might be elevated due to emotional overload.

Finally, lower perspective-taking scores were found for people in the self-harm risk group who were described as impulsive. Perhaps it is unsurprising that the propensity for self-harm might increase due to the combined effect of impulsivity and low perspective-taking skills. Specifically, an impulsive person, who struggles to recognise, interpret, and respond to the thoughts and feelings of others, might easily react in unexpected ways. Without skill-building and support, this might become a repeating pattern that ultimately leads to poorer social outcomes. Congruent with models described by others, self-harm risk, like suicidal risk, might be increased when people have less social support or connection [25, 62].

5 Future directions

Autistic people may have elevated potential vulnerability due to having a powerful concurrence of critical differences. This might have a combined influence that may be greater than the sum of its parts. This potential vulnerability might then be activated in the context of certain experiences related to the environment or co-existing conditions. It is not suggested that the variables identified in this study are unique to autism. Rather, the nature of autism implicates differences of some sort in all four sub-profiles. The interplay between core cognitive, affective, and sensory differences in autism might increase the magnitude of a person's vulnerability or resilience because differences are always widespread across all of the domains. Further exploration will be needed to consider these assertions and ways to prevent the environmental activation of vulnerability. In particular, the perspectives and experiences of those without autism and those with sub-threshold autism traits should be sought.

In the meantime, researchers and clinicians could consider all skills and sub-skills and their interplay in each autistic person's individual experience of overload. Both autism and self-harm risk are complex and heterogenous in nature. Consequently, individually tailored support plans are needed. It seems prudent to consider profiles and sub-profiles at key points in a person's life (e.g. diagnostic assessment, transition from one setting to another, admission to a temporary setting, and annual health checks) so that person-centred therapeutic and environmental interventions can be informed. Further evaluation is needed to check the validity of using tools such as the 'Thinking Patterns Profiling Model' as a vehicle for communicating profiles in a visually clear and time-efficient way. Further research is needed to examine test-retest data, and factors that might impact on these datasets. Further research is also needed to generate empirical evidence to evaluate whether the 'Thinking Patterns Profiling Model' descriptions provide an accurate overview of each unique form of autism. Computer science methods such as data mining might be adopted to explore validity, and machine learning algorithms might have potential to identify data-driven patterns that can be linked to data-driven support plans [44].

6 Conclusion

Profiling models such as the 'Thinking Patterns Profiling Model' can be used to identify factors that may be involved in increased self-harm risk vulnerability found in autism. Patterns and trajectories may differ for autistic populations compared to literature based on general community populations. Some autistic people may experience ACEs, some autistic people may be impulsive, but clinicians have found that all autistic people have differences impacting four core aspects: regulation, flexible thinking, sensory coherence and social perspective-taking [34]. Speculatively, the combined effect of these core variables might help to explain higher rates of self-harm for autistic people. The present study indicated that all autistic young people at risk of self-harm, may have lower skills relating to emotional regulation and social flexibility. In terms of creative problem-solving, perspective-taking, and sensory differences, an autistic young person may have differing patterns of vulnerability that seem to be linked to their level of trait impulsivity-versus-deliberation.

Given the prevalence of self-harm risk and the potential role of impulsivity found in this study, it could be argued that screening for self-harm risk should be included routinely in every diagnostic assessment. When the skills and thinking patterns of autistic people are systematically identified and shared using a one-page visual profiling model such as the 'Thinking Patterns Profiling Model', the risk of missing important clinical information may be reduced. With each sub-profile visually represented alongside additional factors (e.g. self-harm risk, impulsivity, sleep, diet, memory, numeracy, and literacy), it may be possible to see and understand more clearly the potential for variables to influence outcomes in combination. These study findings contribute to the growing interest in finding a comprehensive skills-based model that can be used to understand, plan, and evaluate which strategies and interventions work for a person and why.

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Data availability The dataset generated during the current study was based on routine NHS appointments and is available from the corresponding author on reasonable request.

Code availability Not applicable.

Declarations

Ethics approval and consent to participate This retrospective study was conducted on already available and routinely collected data and was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Research Office of Cheshire and Wirral Partnership NHS Foundation Trust on 11th June 2021.

Consent for publication The study data were obtained via standard service provision, and retrospectively analysed at an aggregated and anonymised level. Informed consent was obtained for all standard clinical service provision in line with NHS policy.

Competing interests The authors declare no competing interests.

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