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The 10-year trajectory of aggressive behaviours in autistic individuals

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Abstract

Background Aggressive behaviours are common in people with neurodevelopmental conditions, contributing to poorer quality of life and placement breakdown. However, there is limited empirical research documenting the prevalence and persistence of aggressive behaviours in autism. In this longitudinal study, aggressive behaviours were investigated in a sample of autistic individuals over 10 years.

Methods Caregivers of autistic individuals, both with and without intellectual disability, completed questionnaires relating to the presence of aggressive behaviours at *T1* [*N* = 229, mean age in years 11.8, standard deviation (SD) 5.9], *T2* (*T1* + 3 years, *N* = 81, mean age in years 15.1, SD 5.9) and *T3* (*T1* + 10 years, *N* = 54, mean age in years 24.5, SD 8.1). Analyses examined the presence and persistence of aggressive behaviours and the predictive value of established correlates of aggression.

Results Aggressive behaviours were common at baseline (61.6%) but only persistent in 30% of the sample over 10 years. Higher composite scores of overactivity and impulsivity at *T1* were significantly associated with the persistence of aggressive behaviours at *T2* ($P = 0.027$) and *T3* ($P = 0.012$) with medium effect size.

Conclusions Aggressive behaviours are common in autism, but reduce with age. Behavioural correlates of attention deficit hyperactivity disorder (ADHD) predict the presence and persistence of aggressive behaviour and as such may be useful clinical indicators to direct proactive intervention resources to ameliorate aggressive behaviours.

Keywords aggressive behaviours, autism, impulsivity, overactivity, persistence, prevalence

Background

The term 'aggressive behaviours' is a broad term that encompasses behaviours that inflict social, emotional and physical harm (Farmer & Aman 2011). In this context, the term is not intended to imply that the person showing the behaviour is intending to hurt another person, but simply that these kinds of behaviours have the potential to cause harm. Physical aggression is common and predicts deleterious outcomes for individuals with neurodevelopmental conditions such as autism (Fitzpatrick *et al.* 2016), including an increased likelihood of admission to residential facilities, physical abuse from caregivers, caregiver burnout, isolation and lower quality of life (Lakin 1983; Stormshak *et al.* 1999; Stith *et al.* 2009;

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Hodgetts *et al.* 2013). Whilst reasonably common in neurotypical preschool children (~10%), aggressive behaviours rarely persist into later childhood or adolescence, except in a small minority of male children (Broidy *et al.* 2003; Tremblay *et al.* 2004; Alink *et al.* 2006). Given the clinical significance of aggressive behaviours, it is surprising that there is little consensus on prevalence in autism. Estimates range from 10% to 71.5% (Hartley *et al.* 2008; Farmer & Aman 2011; Kanne & Mazurek 2011; Simó-Pinatella *et al.* 2019), with differences in the recruitment, assessment and age of participants contributing to the variability in estimates.

In other neurodevelopmental conditions, aggressive behaviours are reported to emerge in childhood, peak in adolescence and have a fragmented decline with age (Davies & Oliver 2013). In longitudinal studies, aggressive behaviours have a linear trajectory, persisting in 69% of children with intellectual disability (ID) over 15–18 months (Davies & Oliver 2016), 67% of children with tuberous sclerosis complex (TSC) over 3 years (Wilde *et al.* 2018) and 69% of individuals with fragile X syndrome over 8 years (Crawford *et al.* 2019). Importantly, in all three studies, overactivity and/or impulsivity were associated with the persistence of aggressive behaviours. Taken together, these findings suggest that aggressive behaviours are persistent in most individuals with neurodevelopmental conditions, with some associations with specific behavioural risk markers. However, to date, all studies of aggressive behaviours in autism have been cross-sectional. Prospective longitudinal cohort studies are required to delineate the presence and persistence of aggressive behaviours in autism.

Importantly, function-based assessments and interventions to reduce aggressive behaviours in autism have been implemented effectively (Matson *et al.* 2010). However, as with function-based interventions for all behaviours that challenge, these interventions would arguably be easier to implement earlier in an individual's life, when the scale of the aggressive behaviour is easier to manage and the behaviour is less well embedded in the person's behavioural repertoire (Oliver 1995; Davies & Oliver 2016). Data from longitudinal cohorts should therefore be harnessed to describe access to clinical interventions for aggressive behaviours and to identify behavioural correlates (characteristics associated with aggressive behaviours at a *single* timepoint) and risk markers (characteristics associated with the *persistence* of aggressive behaviours) over time. The identification of such risk markers would allow services to strategically target proactive support to those people for whom aggressive behaviours are most likely to be persistent.

There is some limited evidence for demographic and behavioural characteristics associated with aggressive behaviours in autism at a single timepoint. These correlates include age, informant-reported autism characteristics and the presence of self-injury (Dominick *et al.* 2007; Kanne & Mazurek 2011). However, understanding of risk markers for aggressive behaviours in autism is less well developed. In addition to the clinical value of risk markers for prioritisation of essential service provision, they also have scientific value in revealing underlying mechanisms that confer risk for aggressive behaviours. For example, it has been suggested that compromised behavioural inhibition, the inability to modify or terminate ongoing behaviour, accounts for invariance in behaviours in autism (Turner 1999; Oliver & Richards 2015) and those with an ID (Davies & Oliver 2013). Behavioural correlates of attention deficit hyperactivity disorder (ADHD) indicative of compromised inhibition (overactivity and impulsivity) have been associated with the presence and persistence of self-injury in autistic individuals and the presence of aggression in individuals with TSC (Richards *et al.* 2012; Wilde *et al.* 2018; Laverty *et al.* 2020). The association between impulsivity and aggressive behaviours is also noted more broadly across research exploring these characteristics with typically developing participants (Bresin 2019), suggesting that these associations appear to be independent of the sample characteristics. Thus, the risk markers of overactivity and impulsivity allude to a cognitive mechanism underlying these behaviours. It is plausible that, as with self-injury, the presence and trajectory of aggressive behaviours are determined by an inability to modify or terminate a pre-potent response initiated at a lower threshold (such as in response to an environmental antecedent) due to compromised behavioural inhibition. Delineating correlates and risk markers associated with the presence of aggressive behaviours would refine existing models and implicate potential causal mechanisms that are driving aggressive behaviours.

In summary, aggressive behaviours are highly deleterious, with significant social, emotional and financial costs. A paucity of research has delineated the prevalence of aggressive behaviours in autism, and critically, no study to date has examined the *incidence* and *persistence* of these behaviours. Whilst some cross-sectional research supports associations between behavioural characteristics and the presence of aggressive behaviours in other neurodevelopmental conditions, no data exist evaluating the presence or stability of these associations over time in autism. Therefore, data were collected to identify the prevalence of, and behavioural risk markers for, aggressive behaviours in autism at three timepoints over 10 years. The present study has the following aims:

1 to delineate the prevalence, incidence and persistence of aggressive behaviours in a community sample of autistic people with an ID;
2 to investigate demographic (age, gender, ability, mobility and speech) and behavioural variables (mood, activity, repetitive behaviours and social communication) associated with the presence of aggressive behaviours at *T1*, *T2* (+3 years) and *T3* (+10 years);
3 to evaluate the value of behavioural variables (mood, activity, repetitive behaviours and social communication) collected at *T1* to predict the presence of aggressive behaviours at *T2* and *T3*; and
4 to explore change over time for behavioural correlates of persistent aggressive behaviours.

Methods

Participants

Parents and carers of autistic individuals were recruited in the UK via the National Autistic Society. At *T1*, 48% of participants' scores were categorised as 'not able' or 'partly able' on The Wessex, suggesting that these individuals likely also had an ID (The Wessex was used as a proxy estimate of level of ability within the current study to identify individuals with an associated ID; the self-help sub-scale within this measure is calculated by summing three items regarding independent washing, dressing and feeding ability). All participants who consented to future contact were invited to take part 3 years later [time 2 (*T2*)] and 10 years later at time 3 (*T3*). Self-injury data have been reported for this cohort at *T1*, *T2* and *T3* (Laverty *et al.* 2020).

Data exclusions and missing data

Given the longitudinal design of the current study, a stringent process of data handling specifically with reference to missing data was followed.

Firstly, data exclusions were considered in line with broad criteria deemed necessary to qualify for the current research study. Autistic participants were excluded if (1) they were under the age of 4 at *T1* as some informant measures were not appropriate for younger children, (2) they did not have a confirmed diagnosis of autism by a relevant professional, (3) they had an additional diagnosis of a co-occurring genetic syndrome, (4) they had incomplete scores on the Challenging Behaviour Questionnaire (Hyman *et al.* 2002) or (5) they scored below the autism threshold on an autism screening tool, the Social Communication Questionnaire (SCQ; Berument *et al.* 1999), at more than one of the three timepoints. Thus, casewise deletions were as follows: $n = 59$ at *T1*, $n = 20$ at *T2* and $n = 18$ at *T3*. Table 1 describes the characteristics of participants included at each timepoint. Informant-reported levels of education and household income from the *T3* sample can also be seen in Table S1.

Next, detailed retention and attrition analyses were conducted (see Tables S2 and S3 for further details) to ensure that participants who participated at *T2* and *T3* were representative of the original sample. Analyses showed that those that took part at *T2* did not significantly differ from those that declined to take part on demographic or behavioural variables collected at *T1*. Participants who participated at *T3* were significantly younger at *T1* than those that declined to take part. Participants at *T3* also reported significantly higher repetitive, compulsive and restricted preference behaviour scores at *T1* than those that declined to take part. There were no other differences on demographic or behavioural variables. This suggests that whilst the samples were broadly comparable, data were not missing at random, and therefore, statistical imputation of missing data was not implemented. Given the clinical novelty and

Table 1 Demographic and behavioural characteristics of participants at each timepoint

		T1 (*N* = 229)	*T2*(*N* = 81)	*T3* (*N* = 54)
Age	Median (IQR)	10.0 (6.5)	15.0 (7)	23.0 (7)
Gender	% male (*N*)	85.2 (195)	85.2 (69)	85.2 (46)
Ability	% not able (*N*)	9.2 (21)	8.6 (7)	3.7 (2)
	% partially able (*N*)	38.9 (89)	25.9 (21)	25.9 (14)
	% able (*N*)	52.0 (119)	63.0 (51)	70.4 (38)
Mobility	% mobile (*N*)	96.1 (220)	100.0 (81)	96.3 (52)
Speech	% verbal (*N*)	87.3 (200)	90.1 (73)	90.7 (49)
Mood total score	Median (IQR)	33.0 (10)	34.0 (11.8)	36.5 (11)
Activity total score	Median (IQR)	39.0 (30)	37.0 (32)	22.0 (26.5)
TAQ impulsivity	Median (IQR)	18.0 (11)	16.0 (13)	12.0 (11.3)
TAQ overactivity	Median (IQR)	16.0 (17.8)	15.0 (17.5)	7.0 (16)
Repetitive behaviour total score	Median (IQR)	24.0 (22)	22 (20)	33.0 (26.5)
RBQ compulsive behaviour	Median (IQR)	6.0 (11)	6.0 (9)	6.0 (8.3)
RBQ insistence on sameness	Median (IQR)	4.0 (6)	3.0 (4.5)	3.0 (4.3)
SCQ total score	Median (IQR)	26.0 (10.8)	19.0 (10.5)	18.0 (11.3)

IQR, interquartile range; RBQ, Repetitive Behaviour Questionnaire; SCQ, Social Communication Questionnaire; TAQ, The Activity Questionnaire.

importance of the research, a pairwise deletion approach was adopted for the majority of statistical analyses such that participants were excluded from each analysis for which they had missing data, but included in any analyses for which they had the required data to maximise power. For the latent growth curve analysis, the default behaviour within the lavaan statistical package of listwise deletion was employed [analysis conducted using R software for statistical computing (version 3.5) operating the 'lavaan' package (Rosseel 2012)]. We report the number of missing datum points for each analysis throughout the results section within the associated table.

Procedure

At all timepoints, packs containing an invitation letter and questionnaire access information were sent to all parents and carers. To avoid priming, the study was described as investigating behaviours associated with autism. Using unique identifiers, parents and carers completed appropriate consent forms, before being directed through each measure. Individualised feedback reports were sent to everyone that took part. Ethical approval for this study was obtained from the ethical review committee at Coventry University, and written informed consent was obtained from all participants.

Measures

All measures were selected as appropriate for use as informant report tools for people with neurodevelopmental conditions *and* ID. This was essential given the high co-occurrence of autism and ID (Matson & Shoemaker 2009) and the under-representation of people with ID in autism research (Russell *et al.* 2019). A demographic questionnaire was utilised to collect information on participant age, gender, mobility, verbal ability and diagnostic status. A service receipt subsection was added at *T3* to give participants an opportunity to retrospectively detail clinical services for aggressive behaviours that they had accessed over the 10-year period.

The Wessex (Kushlick *et al.* 1973) assessed adaptive functioning with five sub-scales: *continence*, *mobility*, *self-help skills*, *speech* and *literacy*, with higher scores indicating higher ability. For the purpose of this study, the *self-help* sub-scale was used to calculate degree of adaptive behaviour that is considered an appropriate proxy measure of intellectual functioning given this cannot be measured through any single

questionnaire (Kushlick *et al.* 1973; Palmer & Jenkins 1982; Oliver *et al.* 2012). Responses to items on *speech* and *mobility* were used to further describe the sample. The Wessex has modest inter-rater reliability at sub-scale level $\kappa = 0.62$ and 0.54 for overall classification and item-level reliability, respectively (Kushlick *et al.* 1973; Palmer & Jenkins 1982).

The Mood, Interest and Pleasure Questionnaire (MIPQ; Ross & Oliver 2003; Oliver *et al.* 2021) measured affect. It comprises 12 items, forming two sub-scales: *mood*, and *interest and pleasure*. Higher scores indicate lower affect. MIPQ has good internal consistency (α total = 0.88, mood = 0.79, interest and pleasure = 0.87), test–retest (0.97) and inter-rater reliability (0.85).

The Activity Questionnaire (TAQ; Burbidge *et al.* 2010; Oliver *et al.* 2021) assessed impulsivity and overactivity. It has 18 items forming three sub-scales: *overactivity*, *impulsivity* and *impulsive speech*. A total score reflecting overactivity/impulsivity can be calculated, which is pro-rated according to the participant's mobility and verbal ability. Higher scores indicate higher levels of behavioural correlates of ADHD. Item-level inter-rater reliability ranges from 0.60 to 0.90 (mean 0.75) with assessments of internal consistency showing that all sub-scales correlate to a moderate degree ($\alpha = 0.67–0.94$; Oliver *et al.* 2019).

The SCQ (Berument *et al.* 1999) assessed behaviours associated with autism. It is a non-diagnostic screening tool based on the Autism Diagnostic Interview (ADI; Lord *et al.* 1994) and assesses developmental history (Lord *et al.* 1994). It consists of 40 items forming three sub-scales: *communication*, *social interaction* and *repetitive and stereotyped patterns of behaviour*. Psychometric investigations show good concurrent validity with the ADI (Lord *et al.* 1994) and good internal consistency ($\alpha = 0.90$ for the total scale). The authors identify a cut-off score of 15 as indicative of autism (Berument *et al.* 1999). However, it is argued that this threshold should not be rigid and can vary upon individual characteristics. Thus, because all participants had a clinical diagnosis of autism, participants were only excluded if they scored below the SCQ cut-off at more than one timepoint.

The Challenging Behaviour Questionnaire (Hyman *et al.* 2002; Oliver *et al.* 2021) assessed the presence of challenging behaviour over the past month, including the presence of aggressive behaviours and self-injury. Questionnaires are phrased in a dichotomous way to allow for the persistence, absence, incidence or remission to be derived. Psychometric investigations reveal good inter-rater reliability (reliability coefficients ranging from 0.46 to 0.72; Hyman *et al.* 2002). The prevalence of aggressive behaviours was derived from this measure.

The Repetitive Behaviour Questionnaire (RBQ; Moss *et al.* 2009; Oliver *et al.* 2021) measured frequency and severity of repetitive behaviour on a Likert scale. It comprises five sub-scales: *stereotyped behaviour*, *compulsive behaviour*, *insistence on sameness*, *restricted preferences* and *repetitive speech*. Higher scores indicate higher frequency of repetitive behaviour. Analysis of psychometric properties shows good inter-rater reliability coefficients (0.46–0.80), test–retest reliability (0.61–0.93) and internal consistency (0.50–0.78). Concurrent validity and content validity between the RBQ and the repetitive behaviour sub-scale of the Autism Screening Questionnaire are good (0.6; $P < 0.001$).

Data analysis

Data were tested for normality using Kolmogorov–Smirnov tests. Because of the dataset significantly deviating from normal distributions ($P < 0.05$), non-parametric analyses were employed. McNemar analyses were conducted to assess the persistence of aggressive behaviours from *T1–T2*, *T2–T3* and *T1–T3*. Chi-squared analyses were conducted to assess service use between those presenting with aggressive behaviours at *T3* and those who did not. Kruskal–Wallis analyses were used to evaluate putative demographic and behavioural risk markers associated with aggressive behaviours. For these analyses, participants were split into absent (aggressive behaviours absent at both timepoints), transient (aggressive behaviours absent at either timepoint) and persistent (aggressive behaviours present at both timepoints) groups. To summarise data collected at each of the three timepoints and clearly depict behavioural characteristics that cross-sectionally and longitudinally predicted aggressive behaviours, standardised effect sizes for correlates and risk markers were calculated. *Z* scores were extracted, with *r* statistics then used to calculate effect sizes for continuous data (Fritz *et al.* 2012).

Effect sizes were interpreted with Cohen's *d*; 0.5 indicates a large effect, 0.3 medium effect and 0.1 small effect (this is considered an appropriately cautious way of interpreting effect sizes with non-parametric data; McGrath & Meyer 2006; Fritz *et al.* 2012). Finally, latent growth curves were employed to evaluate change over time for behavioural variables associated with persistent aggressive behaviours from prior statistical tests. This analysis was conducted using R software for statistical computing (version 3.5) operating the 'lavaan' package (Rosseel 2012).

Results

Prevalence, incidence and persistence of aggressive behaviours

In order to address the first aim of the study, the prevalence, incidence and persistence of aggressive behaviours in the current community sample of autistic people with an ID were explored. The prevalence of aggressive behaviours at *T1* was 61.6%, 45.7% at *T2* and 22.2% at *T3*, indicating a gradual decline in the prevalence over 10 years. Participants were then grouped into four categories to explore incidence and persistence across time: absent, remission, incidence and persistent. Incidence rates remained consistently stable between all timepoints: *T1–T2* – 9%, *T2–T3* – 7% and *T1–T3* – 7%. McNemar analysis was employed to explore significant differences between groups (Table 2). Analysis revealed no statistically significant change in aggressive behaviours between *T1–T2* and *T2–T3*. A significant change in aggressive behaviours was observed between *T1* and *T3* ($P = 0.003$), a period of 10 years, whereby aggressive behaviours remitted in 70% of individuals and remained persistent for 30% of participants.

To explore any effects of service use upon change in aggressive behaviours between *T1* and *T3*, chi-squared analyses were calculated (Table 3). Participants were split into three groups whereby incidence and remission groups were combined because of small *n*: absent (aggressive behaviours were absent across the two timepoints being explored), transient (aggressive behaviours were either present or absent at one of the two timepoints being explored) or persistent (aggressive behaviours were present across the two timepoints being explored). Results show that there were significant differences between those with absent, transient and persistent aggressive behaviours regarding access to social workers ($\chi^2(2) = 6.068$, $P = 0.048$). *Post hoc* analysis showed that those with persistent aggressive behaviours accessed social workers more than both the absent and transient groups ($P < 0.02$).

In summary, aggressive behaviours were present in 67% of autistic participants at *T1*, with a significant reduction in behaviour over 10 years. Those with persistent aggressive behaviours were significantly more likely to have interacted with social workers, although there were no other differences regarding service use.

Table 2 Percentage (*N*) of participants showing remission, incidence, persistent or absent aggression across timepoints

	Absent (absent at both timepoints)	Remission (behaviour transitions from present to absent)	Incidence (behaviour transitions from absent to present)	Persistent (present at both timepoints)	*P* (two-tailed)	Remission in participants with aggression	Persistence in participants with aggression
T1–T2[†] (3 years)	37 (29)	19 (15)	9 (7)	37 (30)	0.134	33 (15)	67 (30)
T2–T3[‡] (7 years)	53 (20)	24 (9)	7 (3)	16 (6)	0.146	60 (9)	40 (6)
T1–T3[§] (10 years)	43 (23)	35 (19)	7 (4)	15 (8)	0.003*	70 (19)	30 (8)

*$P < 0.05$.
[†]$N = 81$.
[‡]$N = 38$.
[§]$N = 54$.

Table 3 Number and percentage of autistic individuals accessing services and chi-squared analysis[†]

	Absent (no aggressive behaviours at *T1* or *T3*) (*N* = 23)	Transient (aggressive behaviours at either *T1* or *T3*) (*N* = 23)	Persistent (aggressive behaviours at *T1* and *T3*) (*N* = 8)	Chi-squared test		
				χ^2	df	*P* value
GP	21 (91%)	20 (87%)	8 (100%)	1.217	2	0.544
Psychiatrist	7 (30%)	9 (39%)	6 (75%)	4.926	2	0.085
Clinical psychologist	6 (26%)	10 (43%)	1 (13%)	3.181	2	0.204
Occupational therapist	5 (22%)	7 (30%)	4 (50%)	2.286	2	0.319
Speech and language therapist	8 (35%)	9 (39%)	4 (50%)	0.579	2	0.749
Support group	6 (26%)	8 (35%)	3 (38%)	0.561	2	0.755
Social worker[‡]	12 (52%)	13 (57%)	8 (100%)	6.068	2	0.048*
Nurse	5 (22%)	7 (30%)	4 (50%)	2.286	2	0.319
Paediatrician	3 (13%)	8 (35%)	2 (25%)	2.978	2	0.226

*$P < 0.05$.
[†]All 54 participants were included within this analysis because of no missing data at *T3*.
[‡]*Post hoc* analysis showed that the persistent group accessed social workers more than the absent group.
GP, general practitioner.

Cross-sectional analysis of demographic and behavioural variables associated with the presence of aggressive behaviours

To assess cross-sectional correlates associated with the presence of aggressive behaviours, analyses explored demographic and behavioural variables associated with the presence of aggressive behaviours at *T1*, *T2* and *T3* in turn. Participants were grouped based upon the presence or absence of aggressive behaviours (see Tables S4–S6 for full analyses outcomes at each timepoint). Significant differences were found between the groups, with those showing aggressive behaviours having significantly lower ability scores at both *T2* [$\chi^2(2, N = 81) = 0.042$, $P = 0.030$ (for this statistic, Fisher's exact score is reported as an alternate to chi-squared as 50% of cells have a count of less than 5)] and *T3* [$\chi^2(2, N = 54) = 7.269$ $P = 0.046$] with a large effect size. There were no other significant differences at any of the timepoints for the demographic measures collected.

Various behavioural variables were associated with the presence of aggressive behaviours at each of the three timepoints. Results are summarised in Table 4, which presents effect sizes (R interpreted with Cohen's *d*; see the supporting information for full analyses outcomes at each timepoint). At *T1*, lower mood and higher repetitive behaviour total scores were significantly associated with aggressive behaviours with small effect. Higher total activity score, impulsivity and overactivity were also significantly associated with aggressive behaviours at *T1*, with a medium effect size. At *T2*, higher total activity score and impulsivity were the only behavioural variables significantly associated with aggressive behaviours, with a small and medium effect size, respectively. Finally, at *T3*, higher repetitive behaviour total score, social interaction and insistence on sameness were significantly associated with aggressive behaviours with a small effect. Total activity score, impulsivity and overactivity were also significantly associated with aggressive behaviours at *T3*, with a large effect size.

In summary, analyses revealed demographic and behavioural variables that were associated with the presence of aggressive behaviours at each of the three timepoints. Two behavioural variables (total activity score and impulsivity) were significantly associated with aggressive behaviours at all three timepoints.

Longitudinal risk markers for the presence of aggressive behaviours

To evaluate putative longitudinal risk markers for aggressive behaviours, analyses explored

Table 4 Effect sizes for cross-sectional and longitudinal behavioural risk markers of aggressive behaviours over 10 years[†]

	Cross-sectional correlates			Longitudinal risk markers		
Behavioural variables	**Time 1 (2007) (*N* = 229)**	**Time 2 (2010) (*N* = 81)**	**Time 3 (2017) (*N* = 54)**	***T1–T2* (3 years) (*N* = 81)**	***T2–T3* (7 years) (*N* = 38)**	***T1–T3* (10 years) (*N* = 54)**
Mood, Interest and Pleasure Questionnaire (MIPQ)						
MIPQ total score	O	O	O	O	O	O
Mood	+	O	O	O	O	O
Interest and pleasure	O	O	O	O	O	O
The Activity Questionnaire (TAQ)						
TAQ total score	++	+	+++	++	+++	++
Impulsivity	++	++	+++	+++	+++	O
Overactivity	++	O	+++	O	O	++
Impulsive speech	+	O	O	O	O	O
Repetitive Behaviour Questionnaire (RBQ)						
RBQ total score	+	O	++	O	O	O
Compulsive behaviour	O	O	O	O	O	O
Insistence on sameness	O	O	++	O	O	O
Stereotyped behaviour	O	O	O	O	O	O
Social Communication Questionnaire (SCQ)						
SCQ total score	O	O	O	O	O	O
Communication	O	O	O	O	O	O
Social interaction	O	O	O	O	O	O
Repetitive behaviour	O	O	++	O	O	O

Effect sizes are R interpreted with Cohen's *d* ('O', none; '+', small; '++', medium; '+++', large).
[†]All participants were included within these analyses because of no missing data.

demographic and behavioural variables associated with the presence of aggressive behaviours over time. Kruskal–Wallis analyses were employed to identify significant differences between groups. This analysis was repeated across all timepoints *T1–T2*, *T2–T3* and *T1–T3* and is summarised in Table 4 (see Tables S4–S6 for full analyses outcomes at each timepoint).

Significant differences were identified on measures of total activity, *T1–T2* {[$\chi^2(2) = 7.229$, $P = 0.027$]}, *T2–T3* {[$\chi^2(2) = 8.759$, $P = 0.013$]} and *T1–T3* {[$\chi^2(2) = 8.808$, $P = 0.012$]}; impulsivity, *T1–T2* {[$\chi^2(2) = 12.047$, $P = 0.002$]} and *T2–T3* {[$\chi^2(2) = 10.229$, $P = 0.006$]}; and overactivity, *T1–T3* {[$\chi^2(2) = 8.752$, $P = 0.013$]}. Pairwise *post hoc* analysis corrected for multiple comparisons revealed significant differences between scores in the absent and persistent aggressive behaviour groups, with the persistent group scoring significantly higher on measures of overactivity and impulsivity. Analysis also revealed one significant difference between the absent and transient groups, with higher overactivity scores obtained by the transient group at *T1–T3*. No other significant differences were found for any other demographic or behavioural variables.

In summary, analyses suggested a stable profile of behavioural characteristics associated with aggressive behaviours. Overactivity was the strongest single behavioural variable, predicting aggressive behaviours over both 3 and 7 years to a large effect size. Consistent with cross-sectional analysis, total activity score comprising both overactivity and impulsivity was the only behavioural characteristic to be significantly associated with persistent aggressive behaviours across all three timepoints. The composite of overactivity and impulsivity significantly predicted the presence of aggressive behaviours over 10 years.

Exploring behavioural variables changing over time

In order to address aim 4 and explore change over time in variables associated with persistent aggressive

behaviours, latent growth curve analysis was employed. Given their significance in the prior analysis, the total overactivity and impulsivity composite score (TAQ) collected across the three timepoints was entered into the model to assess group-level change over time. Model fit was evaluated using the chi-squared statistic, standardised root-mean-square residual (SRMR), the root-mean-square error of approximation (RMSEA) and the comparative fit index (CFI). Good fit is generally assumed by (1) a non-significant chi-squared value, (2) values smaller than 0.8 for the SRMR, (3) values greater than 0.95 for the CFI and (4) an RMSEA that is acceptable at <0.08 and good at <0.05 (Hu & Bentler 1999; Maronna *et al.* 2006). Upon inspection, most model fit indices suggested that the model produced was deemed to be of good fit (see Table S7 for details).

Given the model fitted the data well, further exploration was undertaken (see Fig. 1 for model and trajectories). The mean value of the intercept for TAQ variability was significant (i_TAQ = 39.630, $P > 0.01$, $SE = 0.524$), indicating that it was reliably different from zero. The mean value of the slope for TAQ was significant and negative (s_TAQ = −4.931, $P > 0.01$, $SE = 0.261$), suggesting that across time,

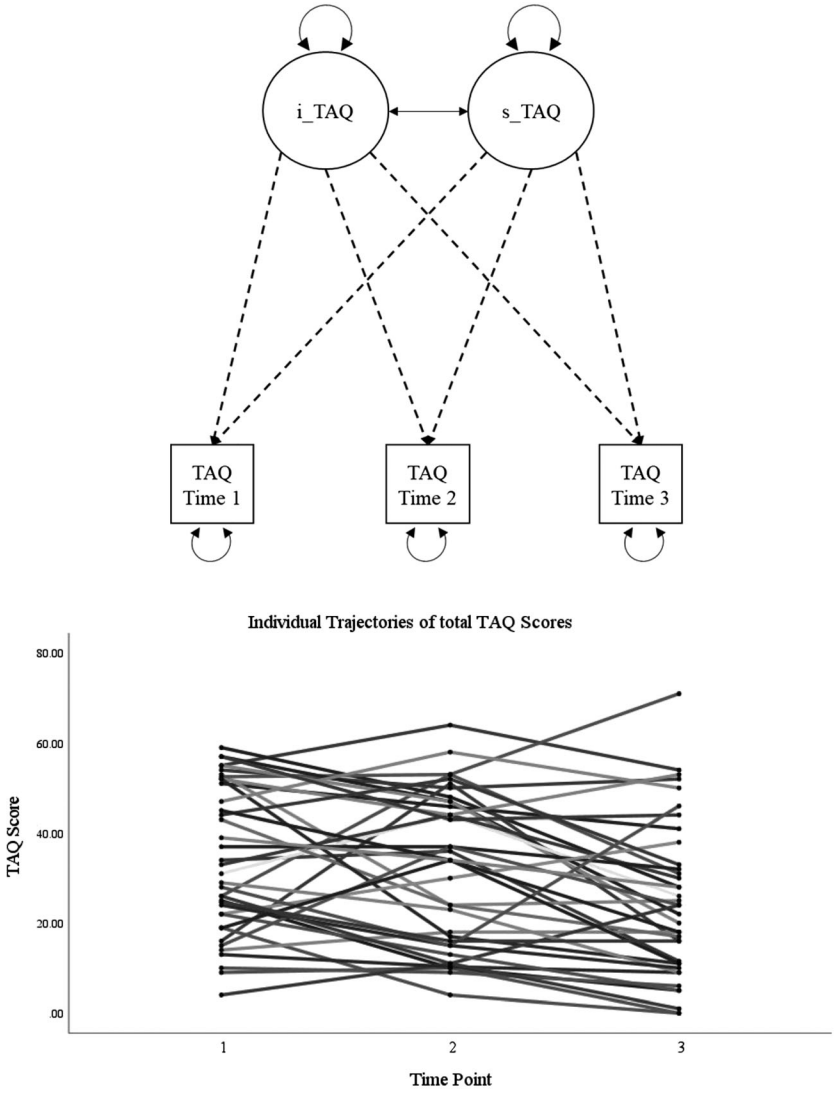

FIGURE 1. Latent growth curve model and growth curve trajectory plot for The Activity Questionnaire (TAQ) scores over time, with each line representing an individual's growth. Data for 54 participants for whom there were three individual time points of data were included within these analyses.

TAQ scores decrease. The variance component of the intercept was significant (i_TAQ = −4.931, $P = 0.029$, $SE = 0.524$), suggesting between-subject variability in intercept values at the first timepoint. Neither the variance component for the slope ($P = 0.070$) nor the covariance between the intercept and slope components ($P = 0.125$) was significant, suggesting that there was no between variation in the rate of change.

In summary, the analysis presents a latent growth curve model indicating the change in TAQ scores over time. TAQ scores decreased over time, whilst maintaining their between-subject variability suggesting meaningfully different trajectories for different individuals.

Summary of results

To summarise, aggressive behaviours were present in 67% of autistic participants at *T1*, with a significant reduction in behaviour over 10 years. Those with persistent aggressive behaviours were significantly more likely to have interacted with social workers, although there were no other differences regarding service use. Two behavioural variables (total activity score and impulsivity) were significantly associated with aggressive behaviours at all three timepoints. There appeared to be a stable profile of behavioural characteristics associated with aggressive behaviours, with overactivity the strongest single behavioural variable, predicting aggressive behaviours over both 3 and 7 years to a large effect size. Total activity score comprising both overactivity and impulsivity was the only behavioural characteristic to be significantly associated with persistent aggressive behaviours across all three timepoints. These activity scores did appear to decrease over time whilst maintaining their between-subject variability suggesting meaningfully different trajectories for different individuals.

Discussion

This was the first study to investigate the prevalence and persistence of aggressive behaviours in a sample of autistic individuals over a 10-year period. The use of robust, validated measures at each timepoint supports the validity and reliability of conclusions. The combined consideration of both a clinical diagnosis and scores above the threshold on an autism screening tool strengthens the internal validity of findings. The use of novel and stringent data analysis techniques allowed for robust examination of the longitudinal data, with previously unreported findings described.

The results show that aggressive behaviours were present in 61.6% of autistic participants at *T1*, with a significant reduction over the 10-year period. The reported prevalence of aggressive behaviours in this sample is similar to previous studies (68%; Kanne & Mazurek 2011), with the novel longitudinal analysis demonstrating persistence of aggressive behaviours over 10 years in 30% of individuals. Significant reductions in aggressive behaviours suggest a divergent trajectory in autism compared with other neurodevelopmental conditions, including TSC, fragile X and ID samples where aggressive behaviours were reported to be persistent in 67% and 69% of individuals, respectively (Davies & Oliver 2016; Wilde *et al.* 2018; Crawford *et al.* 2019). Age-related decline in autism characteristics (such as stereotyped behaviour, insistence on sameness and repetitive language), and other behaviours such as self-injury, are reported for autistic individuals over the lifespan (Woodman *et al.* 2015; Laverty *et al.* 2020), and therefore, the current findings converge with a global age-related decline in some behavioural characteristics for *some* autistic individuals. However, whilst overall prevalence of aggressive behaviours decreased over time, it should be noted that the prevalence of persistent aggressive behaviours over 10 years was still considerably higher than the baseline prevalence reported in neurotypical individuals (~10%) (Broidy *et al.* 2003). Therefore, the persistence of aggressive behaviours for a minority of individuals supports arguments advocating proactive interventions to reduce aggressive behaviours and prevent negative impacts on quality of life.

Notably, aggressive behaviours were associated with lower ability scores at *T2* and *T3*, highlighting an area of potential risk and unmet need in service provision for autistic individuals with an ID. More broadly, there is a notable under-representation of autistic individuals and co-occurring ID in autism research (Martino & Schormans 2018), with 94% of individuals that participated in studies in autism-specific journals having intellectual functioning in the 'average' range (Russell

et al. 2019). This is in contrast with evidence suggesting that up to 55% of autistic individuals have an associated ID (Charman *et al.* 2011). This lack of representation may partly be due to additional practical considerations for research with individuals with autism and ID, such as the adaptation of measures that in turn may compromise validity of conclusions (Visser *et al.* 2017), or complex ethical considerations around obtaining informed consent (Simmons & Watson 2015). Yet these additional considerations are not a reasonable or acceptable justification for the disparity. It is of the upmost importance that future research addresses this disparity and creates a more inclusive and representative evidence base to drive support around aggressive behaviours for autistic individuals with an ID.

When examining the *behavioural* characteristics associated with the presence and persistence of aggressive behaviour, analyses revealed significant differences in profiles. Higher scores in behavioural correlates of ADHD (overactivity, impulsivity and composite activity) were associated both cross-sectionally *and* longitudinally with persistent aggressive behaviours. Results draw parallels with models of impaired inhibition used to further understand the development and maintenance of other clinically relevant behaviours such as self-injury (Schmitt *et al.* 2018; Laverty *et al.* 2020), providing indirect evidence of compromised behavioural inhibition as a risk marker for aggressive behaviours. These 'challenging behaviours' are typically conceptualised as operant behaviours that are constrained by environmental and sensory contingencies such as access to attention or tangibles and escape from demands (Matson & Lovullo 2008; Embregts *et al.* 2009). However, the identification of behavioural correlates of ADHD as risk markers for aggressive behaviours reveals a putative cognitive driver on this operant paradigm. Individuals with poorer executive functioning may be more likely to respond to environmental or sensory antecedents at a lower threshold and less able to terminate this response once it has been initiated (Dalley & Robbins 2017). Therefore, behavioural correlates of ADHD likely predict more frequent, severe and persistent aggression, as they do self-injurious behaviour (Richards *et al.* 2016; Laverty *et al.* 2020). Taken together, these studies indicate that potential interventions for both self-injurious and aggressive behaviours could include supports for executive functioning in individuals who display 'at-risk' characteristics of overactivity and impulsivity.

Latent growth curve analysis allowed for further exploration of behavioural correlates of ADHD, the only behavioural variable shown to be associated with aggressive behaviours at every timepoint both cross-sectionally and longitudinally. Such analysis allows for unique exploration of change over time for unobservable constructs and is being more widely adopted within psychological sciences as a preferable analysis technique (Marsh & Hau 2007). Exploration of the model revealed not only that the approach fitted the data well but also that total activity scores decreased over time, much like aggressive behaviours within our sample. This concomitant decrease in both rates of aggressive behaviours and behaviours shown to be associated with aggressive behaviours over time is aligned with previous reports (Tremblay 2000). However, the driver of this change is still unclear and the sample size for such analyses is moderate. Therefore, future studies should directly address the link between the decline in aggressive behaviours and decreasing total activity scores to determine if one construct is driving the change in the other or if a third underlying variable is affecting change in both characteristics. This would highlight opportunities for clinicians to intervene and facilitate these decreases over time in order to alleviate aggressive behaviours, and their deleterious consequences, in autism.

Importantly, the results also have implications for improving our initial understanding of the types of services autistic individuals may access. Those with persistent aggressive behaviours over 10 years were more likely to have interacted with social workers, yet no other significant differences related to service access were identified. This is surprising, given the National Institute for Health and Care Excellence guidance for behaviours that challenge, which emphasises the importance of function-based assessment and intervention. There is no evidence to suggest that individuals who have shown persistent aggressive behaviour over 10 years are more likely to have received any evidence-based input from psychological services, despite being the very group arguably most in need of this specialist assessment and support. This highlights a potential discrepancy between clinical service need and receipt, consistent

with literature highlighting the paucity of service use for people with IDs when considering behaviours such as aggressive behaviours and self-injurious behaviour (Awan *et al.* 2018; Laverty *et al.* 2020). These findings suggest that more work is needed to improve appropriate and timely 'active support' with a view to empowering and supporting the unique needs of autistic individuals with an associated ID (Beadle-Brown *et al.* 2021). There is therefore considerable value in research considering risk markers for the persistence of clinically relevant behaviours to inform service planning and provision. Services should now seek to incorporate these risk markers into early identification pathways, whereby caregivers of individuals who present with elevated risk markers for poor behavioural outcomes receive targeted interventions. These may include psychoeducational interventions derived from the operant learning paradigm, highlighting the importance of facilitating children's communication to prevent behaviours that challenge. For cost efficiency, individuals deemed to be 'lower risk' could be offered digital or online lower cost prevention techniques and 'watchful waiting'. This would ensure that allocation of resources is efficient and risk based. Critically, a risk-informed service structure could ensure that service delivery for behaviours that challenge is proactive rather than reactive, thus improving outcomes for individuals and their families.

Limitations

Although the current study is the first to consider the longitudinal trajectory of aggressive behaviours in a community sample of autistic individuals over 10 years, the sample size is modest given the extended period of data collection. Additionally, the limitations of a questionnaire survey to investigate such behaviours should be acknowledged. The measure of aggression was a singular parent/caregiver response (yes/no in the past month); thus, it is not possible to draw any conclusions about changes to the topography and severity of individuals' aggressive behaviours over 10 years. The Wessex scales were chosen as they are evidenced to be reliable (Palmer & Jenkins 1982) and are a brief and an effective method of measuring adaptive ability in a large-scale survey context. Although it is acknowledged that a direct measure of intellectual functioning may have been more valid than a questionnaire measure, The Wessex has been considered an appropriate measure to be used in this way in many previous research studies and publications (Ross & Oliver 2002; Moss *et al.* 2009; Oliver *et al.* 2012). Given the large-scale nature of this longitudinal survey, direct measurements of all constructs would not be feasible and would undoubtedly lead to a smaller sample of participants. Therefore, future studies should expand upon the current findings by including direct assessments of aggressive behaviours, intellectual ability and the cognitive mechanisms underpinning behavioural correlates of ADHD in autistic individuals with an ID.

Statistical power precluded the exploration of demographic variables in combination with behavioural variables within the current study, and as such, they are analysed in isolation. Future research should explore these putative risk markers in combination with one another to further understand the potential explanatory power they hold individually and as clusters of putatively interactive risk markers in a well-powered sample.

Conclusions

Current findings suggest that aggressive behaviours do not persist for the majority of autistic individuals over 10 years, although total activity scores emerged as a longitudinal risk marker for those who do show persistent aggressive behaviour. Identifying measurable behavioural characteristics that predict the maintenance of aggressive behaviours over 10 years has considerable clinical implications for screening, assessment and intervention. Recent work to consider the emergence of a measurable behavioural profile that is predictive not only of persistent aggressive behaviours but also of other deleterious behaviours such as self-injury holds significant utility. Behavioural correlates of ADHD should therefore be considered when targeting proactive intervention to individuals at risk for these negative outcomes.

Author Contributions

C. L. collected and analysed the data. C. L., G. A. and L. S-B. drafted the manuscript. C. O. contributed to the design of the study and revised the

manuscript. J. M. and L. N. were involved in the data collection. C. R. contributed to the design of the study, and data collection and analysis and revised the manuscript. All authors read and approved the final manuscript.

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Conflict of interest

The authors declare that they have no competing interests.

Ethics approval statement

Ethical approval for this study was obtained from the ethical review committee at Coventry University.

Data availability statement

The datasets generated and/or analysed during the current study are not publicly available. Because of the sensitive nature of the research and ethical concerns surrounding the publication of sensitive personal data, no participants were asked for consent to their data being shared.

References

Alink L. R. A., Mesman J., Van Zeijl J., Stolk M. N., Juffer F., Koot H. M. *et al.* (2006) The early childhood aggression curve: development of physical aggression in 10- to 50-month-old children. *Child Development* **43**, 954–66.

Awan N., Oliver C., Wilde L., Eden K. & Waite J. (2018) Service receipt of adults with rare genetic syndromes who engage in challenging behaviour. *Journal of Intellectual and Developmental Disability* **43**, 308–16.

Beadle-Brown J., Beecham J., Leigh J., Whelton R. & Richardson L. (2021) Outcomes and costs of skilled support for people with severe or profound intellectual disability and complex needs. *Journal of Applied Research in Intellectual Disabilities* **34**, 42–54.

Berument S. K., Rutter M., Lord C., Pickles A. & Bailey A. (1999) Autism Screening Questionnaire: diagnostic validity. *British Journal of Psychiatry* **175**, 444–51.

Bresin K. (2019) Impulsivity and aggression: a meta-analysis using the UPPS model of impulsivity. *Aggression and Violent Behavior* **48**, 124–40.

Broidy L. M., Nagin D. S., Tremblay R. E., Bates J. E., Brame B., Dodge K. A. *et al.* (2003) Developmental trajectories of childhood disruptive behaviors and adolescent delinquency: a six-site, cross-national study. *Developmental Psychology* **39**, 222.

Burbidge C., Oliver C., Moss J., Arron K., Berg K., Furniss F. *et al.* (2010) The association between repetitive behaviours, impulsivity and hyperactivity in people with intellectual disability. *Journal of Intellectual Disability Research* **54**, 1078–92.

Charman T., Pickles A., Simonoff E., Chandler S., Loucas T. & Baird G. (2011) IQ in children with autism spectrum disorders: data from the Special Needs and Autism Project (SNAP). *Psychological Medicine* **41**, 619–27.

Crawford H., Karakatsani E., Singla G. & Oliver C. (2019) The persistence of self-injurious and aggressive behavior in males with fragile X syndrome over 8 years: a longitudinal study of prevalence and predictive risk markers. *Journal of Autism and Developmental Disorders* **49**, 2913–22.

Dalley J. W. & Robbins T. W. (2017) Fractionating impulsivity: neuropsychiatric implications. *Nature Reviews Neuroscience*, 158–71.

Davies L. & Oliver C. (2013) The age related prevalence of aggression and self-injury in persons with an intellectual disability: a review. *Research in Developmental Disabilities* **34**, 764–75.

Davies L. E. & Oliver C. (2016) Self-injury, aggression and destruction in children with severe intellectual disability: incidence, persistence and novel, predictive behavioural risk markers. *Research in Developmental Disabilities* **49–50**, 291–301.

Dominick K. C., Davis N. O., Lainhart J., Tager-Flusberg H. & Folstein S. (2007) Atypical behaviors in children with autism and children with a history of language impairment. *Research in Developmental Disabilities* **28**, 145–62.

Embregts P. J. C. M., Didden R., Schreuder N., Huitink C. & Van Nieuwenhuijzen M. (2009) Aggressive behavior in individuals with moderate to borderline intellectual disabilities who live in a residential facility: an evaluation of functional variables. *Research in Developmental Disabilities* **30**, 682–8.

Farmer C. A. & Aman M. G. (2011) Aggressive behavior in a sample of children with autism spectrum disorders. *Research in Autism Spectrum Disorders* **5**, 317–23.

Fitzpatrick S. E., Srivorakiat L., Wink L. K., Pedapati E. V. & Erickson C. A. (2016) Aggression in autism spectrum

disorder: presentation and treatment options. *Neuropsychiatric Disease and Treatment*, 1525–38.

Fritz C. O., Morris P. E. & Richler J. J. (2012) Effect size estimates: current use, calculations, and interpretation. *Journal of Experimental Psychology: General* **141**, 2–18.

Hartley S. L., Sikora D. M. & McCoy R. (2008) Prevalence and risk factors of maladaptive behaviour in young children with autistic disorder. *Journal of Intellectual Disability Research*, 819–29.

Hodgetts S., Nicholas D. & Zwaigenbaum L. (2013) Home sweet home? Families' experiences with aggression in children with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities* **28**, 166–74.

Hu L. T. & Bentler P. M. (1999) Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling* **6**, 1–55.

Hyman P., Oliver C. & Hall S. (2002) Self-injurious behavior, self-restraint, and compulsive behaviors in Cornelia de Lange syndrome. *American Journal on Mental Retardation* **107**, 146–54.

Kanne S. M. & Mazurek M. O. (2011) Aggression in children and adolescents with ASD: prevalence and risk factors. *Journal of Autism and Developmental Disorders* **41**, 926–37.

Kushlick A., Blunden R. & Cox G. (1973) A method of rating behaviour characteristics for use in large scale surveys of mental handicap. *Psychological Medicine* **3**, 466–78.

Lakin K. C. (1983) Forum: research-based knowledge and professional practices in special education for emotionally disturbed students. *Behavioral Disorders* **8**, 128–37.

Laverty C., Oliver C., Moss J., Nelson L. & Richards C. (2020) Persistence and predictors of self-injurious behaviour in autism: a ten-year prospective cohort study. *Molecular Autism* **11**, 1–17.

Lord C., Rutter M. & Le Couteur A. (1994) Autism Diagnostic Interview-Revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders* **24**, 659–85.

Maronna R. A., Martin R. D. & Yohai V. J. (2006) *Robust Statistics: Theory and Methods*, pp. 1–403.

Marsh H. W. & Hau K. T. (2007) Applications of latent-variable models in educational psychology: the need for methodological-substantive synergies. *Contemporary Educational Psychology* **32**, 151–70.

Martino A. S. & Schormans A. F. (2018) When good intentions backfire: university research ethics review and the intimate lives of people labeled with intellectual disabilities. *Social Research* **19**, 1–18.

Matson J. L., Dixon D. R. & Matson M. L. (2010) Assessing and treating aggression in children and adolescents with developmental disabilities: a 20-year overview. *An International Journal of Experimental Educational Psychology* **25**, 151–81.

Matson J. L. & Lovullo S. V. (2008) A review of behavioral treatments for self-injurious behaviors of persons with autism spectrum disorders. *Behavior Modification* **32**, 61–76.

Matson J. L. & Shoemaker M. (2009) Intellectual disability and its relationship to autism spectrum disorders. *Research in Developmental Disabilities* **30**, 1107–14.

McGrath R. E. & Meyer G. J. (2006) When effect sizes disagree: the case of *r* and *d*. *Psychological Methods* **11**, 386–401.

Moss J., Oliver C., Arron K., Burbidge C. & Berg K. (2009) The prevalence and phenomenology of repetitive behavior in genetic syndromes. *Journal of Autism and Developmental Disorders* **39**, 572–88.

Oliver C. (1995) Self-injurious behaviour in children with learning disabilities: recent advances in assessment and intervention. *Journal of Child Psychology and Psychiatry* **36**, 909–27.

Oliver C. & Richards C. (2015) Practitioner review: self-injurious behaviour in children with developmental delay. *Journal of Child Psychology and Psychiatry, and Allied Disciplines* **56**, 1042–54.

Oliver C., Royston R., Crawford H., Moss J., Waite J., Adams D. *et al.* (2021) Informant assessments of behaviour and affect for people with intellectual disability (V2). Available at: https://secure.viewer.zmags.com/publication/9964d37c#/9964d37c/1 (retrieved 17 May 2021).

Oliver C., Royston R., Crawford H., Moss J., Waite J., Arron K. *et al.* (2019) CCND manual 2019. Available at: https://secure.viewer.zmags.com/publication/9964d37c#/9964d37c/1 (retrieved 1 July 2020).

Oliver C., Petty J., Ruddick L. & Bacarese-Hamilton M. (2012) The association between repetitive, self-injurious and aggressive behavior in children with severe intellectual disability. *Journal of Autism and Developmental Disorders* **42**, 910–9.

Palmer J. & Jenkins J. (1982) The 'Wessex' behaviour rating system for mentally handicapped people: reliability study. *British Journal of Mental Subnormality* **28**, 88–96.

Richards C., Oliver C., Nelson L. & Moss J. (2012) Self-injurious behaviour in individuals with autism spectrum disorder and intellectual disability. *Journal of Intellectual Disability Research* **56**, 476–89.

Richards C., Moss J., Nelson L. & Oliver C. (2016) Persistence of self-injurious behaviour in autism spectrum disorder over 3 years: a prospective cohort study of risk markers. *Journal of Neurodevelopmental Disorders* **8**, 1–12.

Ross E. & Oliver C. (2002) The relationship between levels of mood, interest and pleasure and 'challenging behaviour' in adults with severe and profound intellectual disability. *Journal of Intellectual Disability Research* **46**, 191–7.

Ross E. & Oliver C. (2003) The assessment of mood in adults who have severe or profound mental retardation. *Clinical Psychology Review* **23**, 225–45.

Rosseel Y. (2012) lavaan: an R package for structural equation modeling. *Journal of Statistical Software* **48**, 1–36.

Russell G., Mandy W., Elliott D., White R., Pittwood T. & Ford T. (2019) Selection bias on intellectual ability in autism research: a cross-sectional review and meta-analysis. *Molecular Autism* **10**, 1–10.

Schmitt L. M., White S. P., Cook E. H., Sweeney J. A. & Mosconi M. W. (2018) Cognitive mechanisms of inhibitory control deficits in autism spectrum disorder. *Journal of Child Psychology and Psychiatry* **59**, 586–95.

Simmons B. & Watson D. (2015) From individualism to co-construction and back again: rethinking research methodology for children with profound and multiple learning disabilities. *Child Care in Practice* **21**, 50–66.

Simó-Pinatella D., Mumbardó-Adam C., Alomar-Kurz E., Sugai G. & Simonsen B. (2019) Prevalence of challenging behaviors exhibited by children with disabilities: mapping the literature. *Journal of Behavioral Education* **28**, 323–43.

Stith S. M., Liu T., Davies L. C., Boykin E. L., Alder M. C., Harris J. M. *et al.* (2009) Risk factors in child maltreatment: a meta-analytic review of the literature. *Aggression and Violent Behavior*, 13–29.

Stormshak E. A., Bierman K. L., Bruschi C., Dodge K. A., Coie J. D., Greenberg M. T. *et al.* (1999) The relation between behavior problems and peer preference in different classroom contexts. *Child Development* **70**, 169–82.

Tremblay R. E. (2000) The development of aggressive behaviour during childhood: what have we learned in the past century? *International Journal of Behavioral Development* **24**, 129–41.

Tremblay R. E., Nagin D. S., Séguin J. R., Zoccolillo M., Zelazo P. D., Boivin M. *et al.* (2004) Physical aggression during early childhood: trajectories and predictors. *Pediatrics* **114**, e43–50.

Turner M. (1999) Annotation: repetitive behaviour in autism: a review of psychological research. *Journal of Child Psychology and Psychiatry* **40**, 839–49.

Visser L., Vlaskamp C., Emde C., Ruiter S. A. J. & Timmerman M. E. (2017) Difference or delay? A comparison of Bayley-III Cognition item scores of young children with and without developmental disabilities. *Research in Developmental Disabilities* **71**, 109–19.

Wilde L., Wade K., Eden K., Moss J., de Vries P. J. & Oliver C. (2018) Persistence of self-injury, aggression and property destruction in children and adults with tuberous sclerosis complex. *Journal of Intellectual Disability Research* **62**, 1058–71.

Woodman A. C., Smith L. E., Greenberg J. S. & Mailick M. R. (2015) Change in autism symptoms and maladaptive behaviors in adolescence and adulthood: the role of positive family processes. *Journal of Autism and Developmental Disorders* **45**, 111–26.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article.

Table S1: Educational and financial characteristics of parents & caregivers of those who participated at T3 (54)
Table S2: Demographic and behavioural characteristics of those who participated at T2, and those who declined to take part T2
Table S3: Demographic and behavioural characteristics of those who participated at T3, and those who declined to take part T3
Table S4: T1 Demographic and behavioural characteristics for participants with and without aggression
Table S5: T2 Demographic and behavioural characteristics for participants with and without aggression
Table S6: T3 Demographic and behavioural characteristics for participants with and without aggression
Table S7: Model fit statistics for LGC