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Published in:
Psychiatry Research

DOI:
[10.1016/j.psychres.2010.05.008](https://doi.org/10.1016/j.psychres.2010.05.008)

2011

[Link to publication](#)

Citation for published version (APA):

Hofvander, B., Ståhlberg, O., Nydén, A., Wentz, E., Degl'innocenti, A., Billstedt, E., Forsman, A., Gillberg, C., Nilsson, T., Råstam, M., & Anckarsäter, H. (2011). Life History of Aggression scores are predicted by childhood hyperactivity, conduct disorder, adult substance abuse, and low cooperativeness in adult psychiatric patients. *Psychiatry Research*, 185(1-2), 280-285. <https://doi.org/10.1016/j.psychres.2010.05.008>

Total number of authors:
11

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This is an author produced version of a paper published in *Psychiatry Research*. This paper has been peer-reviewed but does not include the final publisher proof-corrections or journal pagination.

Citation for the published paper:
Björn Hofvander, Ola Ståhlberg, Agneta Nydén,
Elisabet Wentz, Alessio Degl'innocenti, Eva Billstedt,
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Psychiatry Research 2010 Aug 2

<http://dx.doi.org/10.1016/j.psychres.2010.05.008>

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Life History of Aggression scores are predicted by childhood hyperactivity, conduct disorder, adult substance abuse, and low cooperativeness in adult psychiatric patients

Running head: Aggression in adults with autism spectrum disorders or AD/HD

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ABSTRACT

The prevention of aggressive behaviours is a core priority for psychiatric clinical work, but the association between the diagnostic concepts used in psychiatry and aggression remains largely unknown. Outpatients referred for psychiatric evaluations of childhood-onset neuropsychiatric disorders (n=178) and perpetrators of violent crimes referred to pre-trial forensic psychiatric investigations (n=92) had comprehensive, instrument-based, psychiatric assessments, including the Life History of Aggression (LHA) scales. Total and subscale LHA scores were compared to the categorical and dimensional diagnoses of childhood and adult DSM-IV axis I and II mental disorders, general intelligence (IQ), Global Assessment of Functioning (GAF), and personality traits according to the Temperament and Character Inventory (TCI). Overall, the two groups had similar LHA scores, but the offender group scored higher on the Antisocial subscale. Higher total LHA scores were independently associated with the hyperactivity facet of attention-deficit/hyperactivity disorder (AD/HD), childhood conduct disorder, substance-related disorders, and low scores on the Cooperativeness character dimension according to the TCI. IQ and GAF-scores were negatively correlated with the LHA subscale Self-directed aggression. Autistic traits were inversely correlated with aggression among outpatients, while the opposite pattern was noted in the forensic group. The findings call for assessments of aggression-related behaviours in all psychiatric settings.

Keywords: Aggression; Psychiatry; AD/HD; Conduct Disorder; Personality; Adult

1. Introduction

The prevention of aggressive behaviours is often referred to as an important target for psychiatric treatment, but there is little systematic knowledge about which psychiatric problems that may herald violence. The major mental disorders, such as schizophrenia and bipolar disorder, have been shown to carry an increased risk for violent offending (Hodgins, et al., 1996; Fazel et al., 2009), but this association is mainly caused by a subgroup of disordered persons who have had an early onset of norm-breaking, aggressive behaviours (conduct disorder) (Tengström et al., 2001). Similarly, substance abuse is associated with aggression but mainly through the early-onset type-II alcoholism, which has a strong patrilinear inheritance and often includes poly-substance abuse and criminality (Cloninger et al., 1981). There is also a large body of longitudinal research on the progression of childhood-onset disruptive disorders, such as hyperactivity and conduct disorder (CD), towards antisocial personality disorder (ASPD) in adulthood (for a review, see Hofvander et al., 2009). The psychiatrist charged with assessing the risk of aggressive behaviours in his/her patients, thus has every reason to consider not only the current mental status but also the childhood-onset behaviour patterns and disorders in each case. The knowledge about which aspects of childhood-onset problems that predict aggression is, however, preliminary as yet.

Hyperactivity has been inculcated based on several prospective, longitudinal studies, clinical as well as population-based (Satterfield et al., 1982; Hechtman and Weiss, 1986; Biederman et al., 1996; Babinski et al., 1999; Mannuzza et al., 2008). The link between hyperactivity and violent criminality is, however, not straightforward, as it seems to require the combined presence of hyperactivity and childhood CD (referred to as hyperkinetic conduct disorder in

the ICD), which in its turn, constitutes a major risk factor for sustained aggressiveness over the life-course (Moffitt et al., 2002; Lahey et al., 2005).

A broader range of childhood-onset cognitive and social disorders, such as the autism spectrum disorders (ASDs) and learning disorders (LDs), have also been implicated in the background to aggressive behaviours across all ages in case reports (Mawson et al., 1985; Wolff and Cull, 1986; Baron-Cohen, 1988; Kohn et al., 1998; Kristiansson and Sörman, 2008), in clinical surveys of correctional/forensic groups (Dalteg and Levander, 1989; Scragg and Shah, 1994; Rasmussen et al., 2001; Siponmaa et al., 2001; Kroll et al., 2002; Soderstrom et al., 2004), and in epidemiological research (Farrington, 1987; Hodgins, 1992; Rasmussen and Gillberg, 2000; Moffitt and Caspi, 2001).

Childhood-onset neurodevelopmental disorders such as AD/HD, ASDs, and LDs are more frequent than previously assumed (Landgren et al., 1996; Kadesjo and Gillberg, 1998; Kadesjo et al., 1999; Baird et al., 2006), with severe variants affecting at least 5 % of all children. They are also linked to milder phenotypical expressions in relatives (Epstein et al., 2000; Briskman et al., 2001; Happe et al., 2001; Dawson et al., 2002; Baron-Cohen, 2003;), and in many cases they persist into adulthood in similar or modified forms (Rasmussen and Gillberg, 2000; Moffitt and Caspi, 2001; Beadle-Brown et al., 2002; Willoughby, 2003). These disorders coincide both with each other at a very considerable rate (Rutter et al., 2006) and with major mental disorders across the life course (Weiss et al., 1985; Biederman et al., 1993; Rasmussen and Gillberg, 2000; Fisher et al., 2002). In addition, they have been shown to play a key-note role in the development of personality and its disorders (Anckarsäter et al., 2006, Nigg, 2006).

Several important questions concerning the relation between childhood neuropsychiatric disorders and aggression remain to be disentangled by systematic studies. It is an open question whether childhood attention deficits and hyperactivity in the absence of CD also carry an increased risk for violent acts in adulthood (Lilienfeld and Waldman, 1990), and if the ASDs in the absence of hyperactivity could lead to an increased risk of aggressive behaviours. Using the Temperament and Character Inventory (TCI, Cloninger et al., 1993), Anckarsäter and co-workers (2006) showed a specific temperament configuration in ASDs, with low Novelty Seeking, low Reward Dependence, and high Harm Avoidance, while subjects with AD/HD reported high Novelty Seeking and high Harm Avoidance. Character scores, defined as conceptual tools for handling oneself and others (Self-Directedness and Cooperativeness), were extremely low in both groups, and personality disorders (PDs) according to the DSM-IV were found in the majority of adults diagnosed with ASDs and/or AD/HD. These results have recently been replicated for subjects with AD/HD (Faraone et al., 2009). Low scores in Self-Directedness and Cooperativeness have also been related to feelings of distrust or anger and to direct aggressive expressions, both in clinical groups (Fassino et al., 2001) and in community-based samples (Yoo et al., 2006), and specific associations have been noted between low character scores and self-injurious behaviours (Evren and Evren, 2006; Favaro et al., 2008). Antisocial aggressive behaviours may even be thought of as a prototypical expression of hampered self-regulation and cooperativeness.

We have now used subscales from the Life History of Aggression (LHA) measuring different forms of aggressive behaviours in relation to lifetime psychiatric diagnoses in two groups of adult psychiatric patients (outpatients seeking evaluations of childhood-onset neuropsychiatric disorders and violent offenders referred to forensic psychiatric investigations) to test the following hypotheses:

1. That outpatients with AD/HD and/or ASDs would have high LHA scores, on par with those found among violent offenders.
2. That high LHA scores would be specifically associated with symptoms of hyperactivity, CD, and substance abuse in both groups.
3. That high LHA scores would be associated with disordered personality profiles with explosive temperaments and low character scores in both groups.

2. Methods

2.1. Procedures

The analyses presented in this paper were made possible by access to two independent study groups, both of which were assessed for childhood-onset neuropsychiatric disorders and aggression by basically the same research protocol. The Gothenburg Child Neuropsychiatric Clinic (CNC) had, at the time, the nation-wide responsibility for assessments of autism and related disorders in Sweden and was the only diagnostic centre specifically focused on neuropsychiatric assessments of childhood-onset disorders in the city of Gothenburg. An adult project carried out at the CNC included specialized evaluations of possible childhood-onset neuropsychiatric disorders (AD/HD, ASDs, tic disorders, and various kinds of LDs) in outpatients referred by general practitioners, by other specialists in adult psychiatry, or by self-referral, forming a consecutive, large, well-characterized, clinical case cohort for the Gothenburg Neuropsychiatric Genetic Study (NPG). The Gothenburg Forensic Neuropsychiatry Project (the FNP project) includes all consenting subjects referred for inpatient forensic psychiatric investigations in Gothenburg during a defined period who were charged with a severe violent crime (homicide, attempted homicide, aggravated assault, arson, rape, or sexual violation of minors) and had received their basic education in Sweden. In this

group, childhood-onset neuropsychiatric disorders were previously analysed in relation to adult psychopathic personality traits, overall aggression scores, and recidivistic crimes (Soderstrom et al., 2005). The results were used to formulate the hypotheses for the present paper, which includes subscale analyses of aggression and the comparisons to the much larger group of outpatients with childhood-onset neuropsychiatric disorders.

In both groups, DSM-IV diagnoses were assigned by two senior psychiatrists in consensus (in the NPG project by MR and HA, in the FNP project by AF and HA), based on longitudinal, all-data considerations of available information, including clinical status, the Structured Clinical Interview for Diagnosis according to the DSM (SCID-I, First, 1997a, and SCID-II, First, 1997b), the Asperger Syndrome and high-functioning autism Screening Questionnaire (ASSQ, Ehlers et al., 1999), the Asperger Syndrome Diagnostic Interview (ASDI, Gillberg et al., 2001), and the DSM-IV criteria check-lists for other disorders not included in any of the cited instruments, currently and retrospectively. Reliability and validity for all these scales are good to excellent. When possible, a semi-structured collateral interview was performed (n=123, 69 % in the NPG-project and n=29, 32 % in the FNP-project) with a relative who had known the index subject as a child. Clinical records were collected from paediatric and child psychiatric services and from school health services.

For all disorders, criteria limiting the possibility of assigning other comorbid psychiatric diagnoses were disregarded to allow comprehensive recording of the pattern of comorbidity. The numbers of fulfilled DSM-IV AD/HD and Gillberg & Gillberg criteria for Asperger syndrome/high-functioning autism in childhood were used as dimensional assessments of AD/HD and autism spectrum traits. Full-scale IQ and the subscores for verbal and

performance IQ were calculated on the Wechsler Adult Intelligence Scale-Revised (WAIS-R, Wechsler, 1981).

Different aspects of aggression, and the frequency of its occurrence, were measured dimensionally using the LHA. The LHA has been shown to have excellent test-retest stability, inter-rater reliability, and internal consistency reliability (Coccaro et al., 1997). It has been used in many studies of violent behaviour (e.g. Coccaro et al., 1998; Hoptman et al., 2002). The 11-item scale was developed to assess trait aggressive behaviour, with each item reflecting a different form of aggressive behaviour. Coccaro and co-workers (1997) used the items to create three a priori subscales. The Aggression subscale includes temper tantrums, physical fights, verbal aggression, physical assaults on people (or animals), and assaults on property (items 1-5). The Self-directed aggression subscale quantifies self-injurious and suicide attempts (items 6a and 6b). The Consequences/Antisocial behaviour subscale denotes school disciplinary problems, problems with supervisors at work, antisocial behaviour not involving the police, and antisocial behaviour involving the police (items 7-10). Each item is rated on a five-point scale based on the number of occurrences of the behaviour since adolescence, from 0 ("no event") to 5 ("so many events that they cannot be counted"), with possible total scores ranging from 0 to 55. In these studies, the LHA was used as an initial self-rating instrument, where subjects who had problems filling-out self-rate questionnaires received help from contact persons or clinicians. Subsequently, patients' self-reports were supplemented by extensive clinical interviews and review of all available records and file reports.

2.2. Subjects

Totally 273 consecutive subjects in the NPG group (149 men, 124 women, median age 31.0, range 18-61) gave informed consent, and the 178 subjects (98 men, 80 women, median age 31.5, range 19-59) who completed the LHA constitute the outpatient study group. There were no statistically significant differences between those who were rated with the LHA and those who were not in terms of age, sex, intelligence, tics, depression, bipolar disorder, psychotic disorder, and ASDs. A diagnosis of AD/HD was, however, significantly less common (48 % vs. 65 %, $p<0.01$) among those not assessed by the LHA. Among the included subjects, 161 (90 %) had a childhood-onset neurodevelopmental disorder (AD/HD and/or ASD), 81 subjects (46 men, 35 women, median age 28, range 19-57) had ASD (5 autism, 32 Asperger syndrome, and 44 atypical autism), and 116 (61 men, 55 women, median age 33, range 19-55) had AD/HD (35 predominately AD, 12 predominately HD, 58 combined form, and 11 AD/HD in remission). Thirty-six of these subjects had both AD/HD and ASD, and thus 31 % of subjects with AD/HD also met criteria for ASD, and 44 % of those with ASD also met criteria for AD/HD. Among the 178 subjects, 117 had a mood disorder (i.e. a life-time diagnosis of major depressive or bipolar disorder), 12 met criteria for a psychotic disorder, 41 had an alcohol abuse disorder, 37 had a substance abuse disorder, and 91 subjects met criteria for a personality disorder (PD).

For the FNP project, a total of 121 subjects met the inclusion criteria, and 100 consented to participate (92 men, 8 women, median age 30.0, range 17-76) in some or all parts of the study. In 92 subjects (85 men, 7 women, median age 30.0, range 17-76), the LHA was completed. This group is referred to as the forensic study group. In this forensic group, 46 subjects (50 %) had a childhood-onset neurodevelopmental disorder (AD/HD and/or ASD), 17 subjects met criteria for an ASD (4 autism, 3 Asperger syndrome, and 10 atypical autism), 38 subjects had AD/HD (6 predominately AD, 6 predominately HD, and 26 in combined

form), 42 subjects had a mood disorder, 16 met criteria for a psychotic disorder, 49 had an alcohol abuse disorder, 29 had a substance abuse disorder, and 38 subjects had a PD. For more specific information on diagnostic procedures and prevalence figures, readers are referred to Soderstrom and co-workers (2005).

2.3. Statistical methods

Since distributions were skewed, statistical analyses were all non-parametric, including χ^2 -tests of distributions, Mann-Whitney U Test for group comparisons of continuous variables, and Spearman's rank correlation coefficients, with a level of statistical significance set at 1% ($p \leq 0.01$) in order to reduce the risk for Type I errors considering the large number of analyses performed. As most tests assessed previously established hypotheses, further corrections for multiple comparisons were not deemed necessary. In contrast, even if we have used two established consecutive clinical study groups, no pre-hoc power analyses were performed, which implies that negative results have to be interpreted with caution in view of the possibility of Type II errors. Multiple linear regression analysis models were used to test the association between the clinical and demographical variables on the total score of the LHA. Initially using the full multivariable model including all independent variables that had $p < 0.30$ in bivariate analyses, we excluded one insignificant independent variable at a time, starting with the variable with the highest p-value, until all predictors remaining had $p < 0.10$. However, we did not exclude variables that changed the estimated effect of symptoms of CD with more than 10 %. The adjusted amount of explained variance (R^2) and standardized regression coefficients (β) are presented. Analysis of variance assessed the significance of the explained amount of variance (R^2). A t statistic assessed the significance of β . All statistics were calculated, using anonymized data, with the SPSS 17.0 software, using two-tailed p-values.

2.4. Ethics

The NPG and Gothenburg FNP projects were approved by the Research Ethics Committee of the University of Gothenburg. All participants gave informed consent.

3. Results

The outpatient and the forensic group did not differ in terms of age or full scale IQ, but there were significantly more men in the forensic group (55 % vs. 92 %, $\chi^2=38.7$, $df=1$, $p<0.001$). Group comparisons using the Mann-Whitney U Test indicated no significant difference between the outpatient and the forensic group on LHA Total score, or the Aggression and Self-directed aggression subscores, but the forensic group scored significantly higher on Antisocial behaviour ($p\leq 0.001$). Again, the only difference between men and women was a significantly higher score for men on Antisocial behaviour ($p<0.01$), which relates to the difference on this subscale between the two study groups. As seen in Table 2, age was negatively correlated with all LHA scores except the Self-directed aggression score in the forensic group, but not to any of the LHA scores in the outpatient group.

Table 1 about here

Correlations were subsequently sought between the LHA total and subscale scores and assessments of childhood-onset neuropsychiatric disorders, IQ, and alcohol or drug abuse/dependence. This showed significant correlations between LHA scores and attention deficits (except the Self-directed aggression subscale), hyperactivity, and CD before the age of 15 (Table 2). The number of SCID-II PD diagnoses, used as a dimensional variable, was also positively correlated with all LHA subscales (except the Antisocial behaviour subscale in

the outpatient group). Among the TCI measures of temperament, high Novelty Seeking was the only correlate to the LHA, with the exception of the Self-directed aggression subscore. Harm Avoidance showed a weak, but significant, positive association with Self-directed aggression in the total group, but not in either separately analyzed group. Low Persistence correlated with Antisocial behaviour in the total group but not in any of the subgroups. With minor exceptions, all three character variables (low Self-Directedness, low Cooperativeness, and high Self-Transcendence) were significantly related to LHA. Lower global and subfactor IQ scores (both for the verbal and non-verbal factors) and lower GAF-scores were specifically correlated with the Self-directed aggression subscale among outpatients. In contrast to all other studied parameters, ASD symptoms showed a non-linear relation to LHA across the two groups. A lower rate of autistic symptoms was correlated with increased LHA scores in the outpatient group (except for Self-directed aggression in the outpatient group), while the opposite was true for the forensic group. Alcohol and/or drug abuse, as well as CD, was significantly more frequent ($p < 0.05$ and $p < 0.01$) in the forensic than in the outpatient ASD subjects, which could explain this finding. As mentioned above, age was negatively correlated with the total LHA score, the Aggression and the Antisocial behaviour subscales in the forensic group but not to any of the LHA scales in the outpatient group. Sex was not associated with any of the scales in the two subgroups, though a weak correlation with Antisocial behaviour was seen in the total group. None of the clinical disorder variables, depression, bipolar disorder, or psychotic disorder showed any significant relation to any of the LHA scores.

Table 2 about here

Eventually, we tried to identify the most important clinical covariates of aggressive behaviour scores in a linear regression model (Table 3), using the variables previously identified as significant covariates in the bivariate correlations described above. In the total study group, conduct problems before the age of 15 emerged as the single most important predictor of high adult LHA scores, followed by three other significant, independent predictors: childhood hyperactivity, drug abuse/dependence, and low Cooperativeness. In this model, the thirteen independent variables together predicted 49 % of variance in the dependent variable ($P < 0.001$). Applying this model to the data of the two subgroups separately, it turned out to be highly significant in both groups ($p < 0.001$) and to explain very similar amounts of variance (50% in the outpatient group and 49% in the forensic group) in the dependent variable.

Table 3 about here

4. Discussion

The aim of this study was to identify clinical psychiatric symptoms associated with increased aggression in adults. The two study groups (outpatients diagnosed with neuropsychiatric disorders and violent offenders, all with extensive clinical psychiatric assessments) were heterogeneous but represented a wide spectrum of psychiatric problems that may be assessed in relation to aggression. Childhood-onset hyperactivity and CD together with substance abuse and low Cooperativeness outperformed all other adult psychiatric measures as predictors of aggressive behaviours directed at others. The prediction model found in this study showed a consistent effect across the two study groups and is consistent with the previously cited longitudinal studies on childhood-onset hyperactivity and CD. Low Cooperativeness does not have the same empirical basis as a predictor of aggression, but at

least in an antisocial context, aggression may by definition be taken as an expression of poor character development. Other definitions of PDs did not add to the prediction of adult life aggression in the presence of the behavioural predictors reported here. It is important to note that psychosis and mood disorders, which are often associated with acts of violence, were not related to aggressive behaviours in the presence of childhood-onset behaviour disorders and substance abuse.

Self-directed aggression seems to have a slightly different background than aggression directed at others in that low IQ and GAF were significant co-variables among these patient groups.

ASDs and LDs have been much less studied than disruptive disorders in relation to aggression. Severe violent acting-out is a problem in patient groups with ASD (Kristiansson and Sörman, 2008, Anckarsäter et al., 2008). The lack of association between LHA and autistic traits, the relationship being explained by symptoms of CD and substance abuse, in the present study may be due to the fact that LHA rates the number rather than the severity of aggressive events over the lifetime. A tentative conclusion based on the current literature might be that AD/HD is specifically associated with frequent aggressive behaviours, while autism may entail a risk of, especially stress-related, violent acting out.

In our study groups, low IQ was significantly related to self-injurious behaviours, but contrary to several other studies (Harris, 1993; Emerson et al., 2001), IQ was not related to other forms of aggressive behaviour or antisociality.

The association between low Cooperativeness and aggression replicates previous studies using the TCI (Kim et al., 2006). The character facets reflected in Cooperativeness describe tendencies to make inaccurate interpretations of intentional cues and a bias towards hostile attributions in ambiguous situations. There are robust correlations between these modes of social information processing and aggression (Orobio de Castro et al., 2002). The lack of relationship between any of the temperament scales (e.g. Novelty Seeking) and aggression could be due to the high prevalence of subjects with AD/HD or be understood as a confirmation of Cloninger's model, in which the actual psychosocial functioning is expressing character maturity rather than the patterns of direct reactions to stimuli captured by the temperament scales. The expressed aggressive behaviours included in the LHA are expressions of deficient control mechanisms, such as the conceptual deliberations of consequences, mental processes in others and in oneself, and ethics contained in the descriptions of character.

The findings presented here call for assessments of aggression-related behaviours in psychiatric investigations and treatment planning, not only in forensic psychiatric settings but also in community-based adult psychiatric services, and clearly demonstrate the importance of childhood and adolescence behavioural aberrations as the strongest predictor of such behaviours in adulthood. Our analyses also point out hyperactivity, not attention deficits, as the marker for the increased risk for aggression associated with AD/HD, suggesting that hyperactivity, even independently from CD, actually carries an increased risk for aggression. Longitudinal epidemiological research has not been able to identify hyperactivity as a predictor of ASPD or criminality in the absence of early CD (Lilienfelt & Waldman 1990), even if claims to the contrary have been made (Mannuzza et al., 2008, see Hofvander et al, 2009 for a full discussion of the method problems involved). The strong relationship between

violent criminality and substance abuse has been demonstrated in a variety of settings, in prison surveys (Fazel et al., 2006) as well as in medical facilities (Steadman et al., 1998). Our study supports these findings in an outpatient as well as in a forensic psychiatric context.

This study has several important limitations. Statistical shortcomings include pre-hoc assessment of power for the correlational and predictive models applied, and the impossibility of strict Bonferroni or other correction of p-values to the number of analyses performed. Retrospective data on developmental trajectories and childhood-onset disorders from cross-sectional studies must be cautiously interpreted despite access to a wealth of data from medical/psychiatric records and relatives. The sex ratios differed between the two samples. This is inevitable when collecting consecutive data on violent offenders, but sex effects could be included in all the analyses, and very similar associations of aggression scores to psychiatric covariates were found in both men and women. The LHA builds on self-assessments though aggressive behaviours were also addressed in the clinical psychiatric evaluations and reviews of files and medical records in both study groups reported here. Studies on associations within study groups are sensitive to the composition of the groups, and our two groups have a number of particular features that may have influenced results, not least in the context of autism. Here again, the consistency of findings across both groups strengthen the results, while a need naturally remains for larger and more representative clinical studies and, optimally, population-based prospective studies on the relation between psychiatric diagnostic concepts and aggressive acting-out.

The results support that childhood hyperactivity and CD, adult substance abuse, and low Cooperativeness, carry specific associations with increased levels of aggression in adult outpatients from a non-correctional setting just as among violent offenders. This finding

could, of course, be due to the selection in the present study groups, and calls for replication in other general psychiatry groups, but as it is in line with the literature on ASPD in which the role of childhood CD and substance abuse has always been highlighted, we think that childhood hyperkinetic CD can safely be accepted as a key predictor of adult aggression together with adult substance abuse.

Acknowledgments

The study was supported by grants from the *Region Skåne*, the *Swedish Research Council (VR)*, the *National Board of Forensic Medicine*, *Stiftelsen Lindhaga*, and *Stiftelsen Professor Bror Gadelius Minnesfond*.

The authors thank Jonas Björk for excellent statistical advice, Agneta Brimse, Åse Holl, Anita Larsson, Anders Yngvesson Rastenberger and Monika Montell for technical assistance. We thank our patients and their families for their participation.

None of the authors has interests pertaining to the results of this study.

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Table 1. Comparison between the study groups on demographic variables and LHA subscales

	Outpatient group (n=178)	Forensic group (n=92)	Group comparison	
			χ^2 (df=1)	p
Males (n, %)	98 (55%)	85 (92%)	38.7	<0.001
Females (n, %)	80 (45%)	7 (8%)		
	Mean and standard deviation	Mean and standard deviation	Mann-Whitney	p
Age	32.5±9.1	34.3±13.9	8111.000	0.899
FSIQ	87.7±19.2	91.6±21.5	5837.500	0.221
LHA Total score	21.8±12.9	22.7±13.5	7940.000	0.683
LHA Aggression	14.2±7.0	12.6±7.2	7096.000	0.072
LHA Self-directed aggression	2.5±2.9	2.9±3.4	7866.500	0.582
LHA Antisocial behaviour	5.1±5.1	7.2±5.4	6107.000	0.001

Table 2. Correlations (Spearman's rho, two-tailed) between LHA scores, demographic and clinical data

		LHA Total score	LHA Aggression	LHA Self-directed aggression	LHA Antisocial behaviour
		Spearman's rho	Spearman's rho	Spearman's rho	Spearman's rho
Attention deficits	total group	0.39**	0.38**	0.13	0.34**
Hyperactivity	total group	0.48**	0.48**	0.19*	0.40**
Autistic symptoms	total group	-0.07	-0.06	0.04	-0.13
Conduct problems	total group	0.65**	0.55**	0.38**	0.67**
Full scale IQ	total group	-0.07	-0.03	-0.24**	0.01
Verbal IQ	total group	-0.08	-0.04	-0.24**	-0.01
Performance IQ	total group	-0.02	-0.00	-0.21**	0.04
GAF	total group	-0.15	-0.09	-0.31**	-0.09
Novelty Seeking	total group	0.36**	0.38**	0.10	0.34**
Harm Avoidance	total group	-0.00	-0.05	0.17*	-0.05
Persistence	total group	0.16	-0.15	0.00	-0.20*
Self-Directedness	total group	-0.34**	-0.29**	-0.29**	-0.27**
Cooperativeness	total group	-0.34**	-0.34**	-0.17*	-0.31**
Self- Transcendence	total group	0.30**	0.25**	0.21**	0.28**
Number of PDs	total group	0.34**	0.26**	0.28**	0.33**
Alcohol abuse	total group	0.39**	0.32**	0.20**	0.42**
Drug abuse	total group	0.49**	0.39**	0.29**	0.53**
Age	total group	-0.09	-0.09	-0.13	-0.01
Sex	total group	-0.06	-0.04	0.09	-0.19*

^aSpearman rank correlation

*P<0.01 **P≤0.001.

Table 3. Multiple regression analyses with LHA total score as dependent variable and clinical and demographic variables as predictors

Predictor	β	95 % CI	t
Clinical variables			
Attention symptoms	-0.17	-1.45-0.10	-1.71
Hyperactivity symptoms	0.22	0.16-1.64	2.39*
Alcohol abuse	0.10	-0.96-6.72	1.48
Drug abuse	0.16	0.40-9.04	2.16*
Conduct symptoms	0.31	0.65-1.93	3.97***
FSIQ	-0.08	-0.15-0.03	-1.33
Total number of PDs	0.08	-0.41-1.39	1.08
Temperament and Character Inventory dimensions			
Novelty Seeking	0.10	-0.03-0.25	1.55
Self-Directedness	-0.04	-0.17-0.09	-0.58
Cooperativeness	-0.10	-0.25- -0.04	-2.81**
Self-Transcendence	0.10	-0.03-0.20	1.54
Age	-0.10	-0.26-0.04	-1.44
Sex	-0.01	-3.56-3.05	-0.15
	Adj R ²	F	
Full model	0.49	12.9***	

*Standardised regression coefficient (β) are presented, which indicate the relative magnitude of prediction for each independent variable.

*P<0.05 **P<0.01 ***P≤0.001.