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The risk factors for criminal behaviour in high-functioning autism spectrum disorders (HFASDs): A comparison of childhood adversities between individuals with HFASDs who exhibit criminal behaviour and those with HFASD and no criminal histories

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ABSTRACT

Most reports of the criminal behaviour of individuals with high-functioning autism spectrum disorder (HFASD) have been case studies, and few have empirically examined the risk factors of criminal behaviour among these individuals. This study examined 175 individuals with HFASD, including 36 individuals who had a prior history of criminal behaviours (the criminal group) and 139 individuals without a criminal history (the control group), with regard to 15 types of childhood adversities (CAs). The age of initial HFASD diagnosis and history of neglect and physical abuse were significantly correlated with an increased risk of criminal behaviour. These findings agreed with previous studies on general populations. The unique characteristics of individuals with HFASD and a history of criminal behaviour are discussed.

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1. Introduction

Over the past two decades, an increasing amount of attention has been given to high-functioning autism spectrum disorders (HFASDs). This diagnosis includes high-functioning autism (HFA) and Asperger's syndrome (AS). High-functioning pervasive developmental disorder (HFPDD) is generally defined as a pervasive developmental disorder (PDD) in individuals with normal or above-average intelligence (i.e., either IQ ≤ 70; Howlin, 2003, or IQ ≤ 85; Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999). In England, the estimated prevalence of PDD in preschool children is 0.626%, and 74.2% of this group do not have intellectual disabilities (IDs; Chakrabarti & Fombonne, 2001). The estimated prevalence of HFASD in the general preschool population is 0.464%. Similarly, Kadesjö, Gillberg, and Hagberg (1999) reported that the estimated prevalence for ASD is 1.2%, and approximately 70% of those with this condition do not have IDs. The prevalence of HFASD is approximately 0.84%.

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Although individuals with HFASD often have average or above-average intellectual abilities, they exhibit impairment in social, communication and imagination areas. These impairments often result in difficulties with interpersonal relationships (Frith, 1991; Wing, 1996). Moreover, individuals with HFASD often have comorbid psychiatric disorders, such as anxiety disorder and depression, or display problematic behaviours, such as violence and/or other antisocial behaviours (Tantam, 1991). Although research on the violent, antisocial or criminal behaviours committed by individuals with HFASD was scarce until the 1980s, it has increased since 1990 (Bjørkly, 2009; Newman & Ghaziuddin, 2008). Bjørkly (2009) conducted a systematic review on violence in people with AS that included 11 published case studies of 22 patients and 29 violent incidents. Many of these patients made threats or committed physical assaults, and others attacked or made threats with weapons such as screwdrivers (Mawson, Grounds, & Tantam, 1985) or knives (Murrie, Warren, Kristiansson, & Dietz, 2002; Raja & Azzoni, 2001). Other incidents included homicide (Schwartz-Watts, 2005; Scragg & Shah, 1994), attempted rape (Kohn, Fahum, Ratzoni, & Apter, 1998), and arson (Murrie et al., 2002). Additional studies of individuals with HFASD reported theft (Chen et al., 2003; Sugiyama, 2003), vandalism (Simblett & Wilson, 1993; Tantam, 1988), sexual offence (Silva, Ferrari, & Leong, 2002; Sugiyama, 2003), and arson (Everall & Lecouteur, 1990; Tantam, 1991).

Based on the definition used in the studies listed above, we define criminal behaviour as an illegal act for which an individual can be punished by law. This definition includes juvenile delinquencies such as running away from home as well as underage drinking or smoking.

Many of the studies on the criminal behaviour of individuals with HFASD are case studies, and empirical studies are scarce. Ghaziuddin, Tsai, and Ghaziuddin (1991) made the first attempt to examine the relationship between HFASD and criminal behaviour. These authors reviewed 21 peer-reviewed articles regarding people with AS that included 132 individuals. Of this group, only three (2.3%) had a history of violence.

Scragg and Shah (1994) found that the rate of AS among patients hospitalised in a high-security hospital was 1.5–2.3%. Note that the majority of admissions to this hospital were the result of criminal behaviour. However, some non-criminal patients were transferred because of their unmanageable behaviour at less secure psychiatric facilities. Siponmaa, Kristiansson, Jonson, Nydèn, and Gillberg (2001) also found that 15% of 126 young (15–22-year-old) offenders in Stockholm, Sweden met the diagnostic criteria of PDD, including 12% with PDDNOS and 3% with AS. Therefore, their estimated prevalence of HFASD in the young forensic population was greater than 3%. These findings indicate that, although these studies regarding the rates of criminal behaviour among individuals with HFASD do not necessarily show a strong correlation between HFASD and criminal behaviour, it is apparently higher in individuals with HFASD compared with the general population (i.e., less than 1%; Chakrabarti & Fombonne, 2001; Kadesjö et al., 1999).

Although the estimated prevalence of criminal behaviours among individuals with HFASD is higher than that of the general population, little is known about the risk factors for individuals with ASD, especially those with HFASD. In one of the few empirical studies on the subject, Mouridsen, Bente, Torben, and Niels (2008) investigated the prevalence rate and patterns of criminal behaviour in 313 former child psychiatric inpatients with PDD and compared them with 933 matched controls from the general population. These patients were divided into three groups: those with childhood autism ($n = 113$), those with AS ($n = 114$), and those with atypical autism ($n = 86$). They found that 9% of 113 individuals with childhood autism exhibited criminal behaviours; furthermore, 8.1% of 86 patients with atypical autism and 18.4% of 114 patients with AS were convicted of crimes. These results indicate that HFASD might be a risk factor for criminal behaviour. Långström, Grann, Ruchkin, Sjostedt, and Fazel (2009) also compared 31 individuals with ASD (including those with autism and AS) who committed violent, non-sexual crimes as well as two sexual offences with those with ASD and no history of violence. These authors reported that the violent offences among those with ASD were predicted by gender (i.e., males), sub-diagnosis (i.e., AS rather than autism), and comorbid psychiatric disorders (i.e., psychotic and substance use disorders). These results matched a previous study reporting the risk factors of criminal behaviour among individuals without ASD (Långström et al., 2009).

An awareness of criminal behaviour in individuals with HFASD is increasing, but how criminal behaviour risk factors interact with one another still remains unclear. Although several criminal behaviour risk factors and psychiatric disorders have been identified in the general population, most studies have examined only one or two factors (Green et al., 2010). However, risk factors are highly clustered with one another and should be examined using a multivariate model.

Based on this notion, a large-scale epidemiological study known as the National Comorbidity Survey Replication (NCS-R) was conducted in the US (Green et al., 2010). The NCS-R reported 12 risk factors, named "childhood adversities" (CAs), which were selected through a review of risk factor studies that influenced the development of psychiatric disorders. These CAs included maladaptive family functioning (i.e., parental mental illness, substance use, criminality, family violence, physical and sexual abuse, and neglect) and were significantly related to the initial age of onset of disruptive behaviours (Green et al., 2010). CAs may be risk factors for criminal behaviour in individuals with HFASD. In fact, some individuals with HFASD who exhibit violent behaviour were physically abused as children (Mandell, Walrath, Manteuffel, Sgro, & Pinto-Martin, 2005).

Other CAs that are related to criminal behaviour include a history of being bullied (Saito, Kobayashi, Tanaka, & Shimizu, 2003; Sugiyama, 2003; Tantam, 2000) and childhood hyperactivity (Biederman, Mick, Faraone, & Burback, 2001). Bullying and hyperactivity are risk factors for criminal behaviour according to community (Connor, 2002) and clinical samples (Barkley, 1998; Sugiyama, 2000). Similar to the general population, individuals with ASD often exhibit hyperactivity and become the target of bullying (Heinrichs, 2003; Wing, 1996).

In addition, three offenders who were victims of bullying received diagnoses of PDD later in life (Schwartz-Watts, 2005). These cases suggest that an early ASD diagnosis and proper intervention is important to decrease the risk of developing

Table 1
Demographic characteristics of participants.

	Criminal	Control	Total	$\chi^2(df)$
Sex				
Male	30	117	147	0.02 n.s.
Female	6	22	28	(1)
Total	36	139	175	
Diagnosis				
Autism	9	36	45	
Asperger	11	47	58	0.22 n.s.
NOS	16	56	72	(2)
Total	36	139	175	

criminal behaviours (Schwartz-Watts, 2005; Sugiyama, 2003). In fact, the age at which ASD was first diagnosed often affects early interventions and could thereby influence prognosis (Lord, 1995). Based on these reports, the timing of the initial ASD diagnosis and appropriate intervention might influence the later development of criminal behaviour in those with HFASD. A delay in the initial ASD diagnosis might be another risk factor of criminal behaviour in individuals with HFASD.

Thus, the purpose of this study was to examine the risk factors of criminal behaviour, including CAs and the age of initial diagnosis, in individuals with HFASD.

2. Methods

2.1. Participants

The participants included 175 individuals (147 males, 28 females) who were diagnosed with HFASD by child psychiatrists based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 1994). We divided participants into two groups: those who exhibited criminal behaviour (the criminal group) and those without a history of criminal behaviour (the control group). There were 36 participants (30 males, 6 females) in the criminal group, and their mean age was 16.83 years (age range = 7–30 years, *SD* = 5.59). There were 139 participants (117 males, 22 females) in the control group, and their mean age was 14.89 years (age range = 6–28 years, *SD* = 4.24; Table 1). There were no significant between-group differences with regard to gender, age or sub-diagnosis (Table 2).

2.2. Measures

2.2.1. Data collection procedure

We collected data by reviewing existing clinical records as well as interviewing participants and their parents. Child psychiatrists obtained any information that was missing from the clinical records by interviewing participants and their parents. Clinical psychologists and child psychiatrists with more than 15 years of experience with developmental disorders collected all the data.

2.2.2. Childhood adversity

We used dichotomous items for CAs (Green et al., 2010), which included two types of CAs: maladaptive family functioning (MFF) CAs and other CAs. MFF CAs included seven items: parental mental illness, parental substance abuse, parental criminality, family violence, physical abuse, sexual abuse, and neglect. Other CAs included five items: parental death, parental divorce, other types of parental loss, life-threatening childhood physical illness, and extreme childhood economic adversity.

In addition to the above-mentioned CAs, the age of the individual at initial diagnosis with HFASD, bullying or being bullied, and propensity for hyperactivity were also included because these items are risk factors for criminal behaviour in individuals with HFASD (e.g., Connor, 2002; Lord, 1995; Wing, 1996).

All items concerning family and parents focused on only biological factors (Green et al., 2010). The MMF parental illness item was assessed by recording family histories of major depression, generalised anxiety disorder and panic disorder. If participants lived in foster homes, they were rated as experiencing other parental loss. We assessed family economic adversity based on whether the family received welfare, other forms of governmental assistance, or both.

2.2.3. Criminal behaviour data

Using clinical records, we collected additional information about the criminal group, such as the types and frequencies of criminal behaviour, the onset of criminal behaviour and the age at which their last criminal behaviour was observed. Regarding the types of criminal behaviour, kleptomania entails the stealing of both material goods and money. Sexual misconduct includes voyeurism, peeping, juvenile prostitution and lingerie theft. The participants checked all the behaviours that applied to them. We also assessed the frequency of criminal behaviours using a 3-point Likert scale: "only

Table 2
Mean (*SD*) age and IQ of each group.

	Criminal ($N = 36$)		Control ($N = 139$)		t
	M	(*SD*)	*M*	(*SD*)	
Age	16.83	(5.59)	14.89	(4.24)	−1.94 n.s.
IQ	96.86	(18.25)	92.20	(13.46)	−1.43 n.s.

once (no recurrence at the time of the assessment)", "multiple recurrent incidents without a current episode" and "multiple recurrent incidents with a current episode".

2.3. Data analyses

First, the types and frequency of criminal behaviours in the criminal group were calculated. Second, the CA prevalence rates for each group were calculated, and the χ^2 test and unadjusted odds ratio (OR) were used to analyse the associations between CAs and the groups. Third, based on Green et al.'s (2010) suggestion, a logistic regression analysis estimated the influence of each CA. Several multivariate models were estimated; each included a CA dummy variable.

The first logistic regression model was additive; it included a separate predictor variable for each of the CAs without interaction terms. Fourteen CAs except for the "age of initial HFASD diagnosis" was included. This model also included the "number of the CAs" experienced by participants as an additional predictor for each of the 14 CAs (Green et al., 2010). Following Green et al.'s (2010) suggestion, a cut-off point for the number of the CAs was explored to compare the two groups. We observed significant differences between the two groups in the number of CAs when the number of CAs was divided into groups of "4 or less" and "5 or more," which indicates that 5 was an appropriate cut-off point for this variable. Hereafter, the number of CAs refers to a dichotomous variable.

The second model included all 15 CAs. We added the variables using the forced entry method in the first and second models. The third model used the stepwise method to explore the best combination of these variables. This method included 15 CAs for the type and number of CAs. Survival coefficients and their standard errors were exponentiated and reported as ORs and 95% confidence intervals (95% CI), respectively. We used the Akaike information criterion (AIC) to select the best multivariate model (Burnham & Anderson, 2002) and evaluated statistical significance using 2-tailed tests ($p < 0.05$).

3. Results

3.1. Criminal behaviour features

The most common problem in the criminal group was theft, followed by sexual misconduct, violence, and running away (Table 3). Trouble act was sending spoofed e-mail; one of male participants was bullied by his female friends, and he spoofed her as a retaliation. Table 3 shows that 47.2% of participants in the criminal group exhibited the problem "only once (no recurrence at assessment)"; the same proportion exhibited the problem "multiple recurrent incidents without a current episode)". The onset of criminal behaviour ranged from 5 to 21 years old, with a mean (*SD*) age of 11.42 (4.45) years. The age at which the last criminal behaviour occurred ranged from 6 to 24 years old, with a mean (*SD*) age of 14.31 (4.39) years (Table 4). The most common age for the onset of criminal behaviour was 6 years old (19.4%), followed by 8 (11.1%), 14 (11.1%) and 16 (11.1%). The last criminal behaviour was most commonly displayed between age 14 (11.1%) and 18 (11.1%).

Table 3
The type and frequency of criminal behaviour in the criminal group.

	N	(%)
Type[a]		
Theft, kleptomania (things, money)	20	(55.6)
Sexual misconduct (voyeurism, peeping, juvenile prostitution, lingerie theft)	9	(25.0)
Violence	9	(25.0)
Running away	7	(19.4)
Arson	4	(11.1)
Blackmail	2	(5.6)
Trouble act	1	(2.8)
Frequency		
Only once (no recurrence at the time of the assessment	2	(5.6)
Multiple (recurrent incidents without a current episode)	17	(47.2)
Multiple (recurrent incidents with a current episode)	17	(47.2)
Total	36	(100)

[a] Checked all that apply.

Table 4
The information about onset of criminal behaviour and age at which most recent criminal behaviour.

Age	Onset		Most recent	
	N	(%)	*N*	(%)
5	1	(2.8)	0	(0.0)
6	7	(19.4)	1	(2.8)
7	2	(5.6)	2	(5.6)
8	4	(11.1)	1	(2.8)
9	1	(2.8)	1	(2.8)
10	0	(0.0)	2	(5.6)
11	2	(5.6)	2	(5.6)
12	2	(5.6)	3	(8.3)
13	3	(8.3)	3	(8.3)
14	4	(11.1)	4	(11.1)
15	2	(5.6)	1	(2.8)
16	4	(11.1)	7	(19.4)
17	1	(2.8)	1	(2.8)
18	2	(5.6)	4	(11.1)
19	0	(0.0)	1	(2.8)
20	0	(0.0)	0	(0.0)
21	1	(2.8)	0	(0.0)
22	0	(0.0)	1	(2.8)
23	0	(0.0)	0	(0.0)
24	0	(0.0)	2	(5.6)
Total	36	(100)	36	(100)
M (*SD*)	11.42 (4.45)		14.31 (4.39)	

3.2. The prevalence of childhood adversity

The frequency of the presence of each CA is shown in Table 5. Significant differences in MFF CAs were observed between the criminal group and the control group with regard to family violence, physical abuse, sexual abuse and neglect. Specifically, more participants in the criminal group experienced these CAs than those in the control group. With regard to the other CAs, significant differences were observed in parental death, parental divorce and other parental loss: More participants in the criminal group experienced these CAs compared with controls. With regard to the additional CAs, no significant differences were observed in bullying or hyperactivity. The mean age at which HFASD was first diagnosed in the criminal and control groups were 10.25 (*SD* = 4.68, range = 2–22) and 5.94 (*SD* = 3.79, range = 1–17) years, respectively. The

Table 5
Prevalence of childhood adversities (CAs).

	N (%)			$\chi^2(1)$
	CD	Control	Total	
I. Maladaptive family functioning CAs				
Parental mental illness	6 (16.7)	15 (10.8)	21 (12.0)	0.9
Parental substance use	1 (2.8)	1 (0.7)	2 (1.1)	1.1
Parental criminality	0 (0.0)	0 (0.0)	0 (0.0)	-
Family violence	2 (11.1)	4 (1.4)	6 (3.4)	8.1**
Physical abuse	13 (36.1)	10 (7.2)	23 (13.1)	20.9***
Sexual abuse	2 (5.6)	0 (0.0)	2 (1.1)	7.8**
Neglect	9 (25.0)	3 (2.2)	12 (6.9)	23.4***
II. Other CAs				
Parental death	3 (8.3)	2 (1.4)	5 (2.9)	4.9*
Parental divorce	10 (27.8)	11 (7.9)	21 (12.0)	10.7**
Other parental loss	3 (8.3)	1 (0.7)	4 (2.3)	7.4**
Physical illness	7 (19.4)	24 (17.3)	31 (17.7)	0.1
Economic adversity	5 (13.9)	8 (5.8)	13 (7.4)	2.8
III. Additional CAs				
Bullying	23 (63.9)	104 (74.8)	127 (72.6)	1.7
Hyperactivity	21 (58.3)	80 (57.6)	101 (57.7)	0.0
The age of initial HFASD diagnosis	-	-		
No. of CAs				
≥5	9 (25.0)	2 (1.4)	11 (6.3)	26.9**

* Significant at the 0.05 level, two tailed.
** Significant at the 0.01 level, two tailed.
*** Significant at the 0.001 level, two tailed.

Table 6
Bivariate and multivariate associations (odds ratios) between childhood adversities (CAs) and criminal behaviour.

	OR (95% CI)		
	Bivariate	Multivariate (additive)	Multivariate (interactive)
I. Maladaptive family functioning CAs			
Parental mental illness	1.7 (0.6–4.6)	0.9 (0.2–3.7)	0.7 (0.1–3.3)
Parental substance use	3.9 (0.2–64.6)	0.2 (0.0–73.3)	0.1 (0.0–32.2)
Parental criminality	–	–	–
Family violence	8.6* (1.5–48.8)	3.9 (0.3–57.6)	2.7 (0.1–49.2)
Physical abuse	7.3* (2.9–18.6)	4.1* (1.2–13.8)	3.3 (0.9–12.1)
Sexual abuse	0.2* (0.1–0.3)	–	
Neglect	15.1* (3.8–59.5)	5.3* (1.0–29.4)	2.9 (0.4–19.4)
$\chi^2(df)$ (p value)	–	$\chi^2(5) = 32.6$ ($p < 0.001$)	–
II. Other CAs			
Parental death	6.2 (1.0–38.8)	0.4 (0.0–6.1)	0.2 (0.0–4.6)
Parental divorce	4.5* (1.7–11.6)	3.7 (0.8–17.5)	3.3 (0.6–18.0)
Other parental loss	12.5* (1.3–124.5)	3.8 (0.1–102.7)	3.6 (0.1–145.7)
Physical illness	1.2 (0.5–2.9)	0.5 (0.1–2.0)	0.4 (0.1–1.7)
Economic adversity	2.6 (0.8–8.6)	0.7 (0.1–5.3)	0.4 (0.0–4.7)
$\chi^2(df)$ (p value)	–	$\chi^2(5) = 16.3$ ($p < 0.01$)	
$\chi^2(df)$ (p value)	–	$\chi^2(10) = 36.9$ ($p < 0.001$)	
III. Additional CAs			
Bullying	0.6 (0.3–1.3)	0.5 (0.2–1.3)	0.5 (0.2–1.3)
Hyperactivity	1.0 (0.5–2.2)	1.4 (0.5–3.7)	1.6 (0.6–4.3)
The age of initial HFASD diagnosis	–	1.2* (1.1–1.3)	1.2* (1.1–1.4)
$\chi^2(df)$ (p value)	–	$\chi^2(3) = 30.3$ ($p < 0.01$)	–
$\chi^2(df)$ (p value)	–	$\chi^2(13) = 53.2$ ($p < 0.001$)	–
No. of CAs			
≥5	22.8* (4.7–111.6)	–	17.7 (0.6–553.2)
$\chi^2(df)$ (p value)	–	–	$\chi^2(14) = 56.7$ ($p < 0.001$)

* Significant at the 0.05 level, two tailed.

initial HFASD diagnosis occurred at a significantly older age for participants in the criminal group than for those in the control group ($t = -5.78$, $df = 173$, $p < 0.001$).

Regarding the number of CAs, significantly more participants in the criminal group belonged to the "5 or more group" than those in the control group.

3.3. CAs and the likelihood that individuals with HFASD will display criminal behaviours

First, each CA variable was examined using a bivariate model that did not control for the influence of each variable. The MFF categories family violence, physical abuse, sexual abuse and neglect had significant ORs (Table 6). Neglect had the largest OR (OR = 15.1). With regard to the other CAs, the significant ORs for parental divorce (OR = 4.5) and other parental loss (OR = 12.5) indicate that the risk for criminal behaviour increases for those who experience these CAs. Concerning the additional CAs, the ORs for bullying and hyperactivity were not significant. Lastly, the OR for the number of CAs was significant, which means that the risk for criminal behaviour increased as individuals experienced more CAs.

Second, we conducted a multivariate logistic regression analysis to control for the influence of each variable (Table 6). The results of this analysis revealed that the ORs for physical abuse and neglect were significant. Sexual abuse was not included in the analysis because none of the participants in the control group reported sexual abuse. The other CAs did not affect the likelihood of criminal behaviour (i.e., the ORs were not significant after controlling for the other variables). With regard to the additional CAs, the OR for the age of initial HFASD diagnosis was significant. In the multivariate model, the authors examined χ^2 statistics and the AIC in the following models: one in which only the MFF CAs were entered ($\chi^2(5) = 32.6$ ($p < 0.001$), AIC = 153.61); one in which only the other CAs were entered ($\chi^2(5) = 16.2$ ($p < 0.001$), AIC = 171.6); one in which only the additional CAs were entered ($\chi^2(3) = 30.3$ ($p < 0.001$), AIC = 153.6); one in which the MFF CAs and the other CAs were entered ($\chi^2(10) = 36.9$ ($p < 0.001$), AIC = 161.0); and one in which all CAs were entered ($\chi^2(13) = 53.2$ ($p < 0.001$), AIC = 150.7). The latter model provided the best fit for the data.

Finally, the multivariate model that included all the types and numbers of the CAs was examined to control the influences of each variable (Table 6). The model was interactive in that the type and number of CAs were both included in the model (Green et al., 2010). Only the OR for the age of initial HFASD diagnosis was significant in this model ($\chi^2 = 56.7$, $df = 14$, $p < 0.001$, AIC = 149.2).

3.4. Determining the best combination of variables to predict the most common criminal behaviours in individuals with HFASD

A logistic regression analysis using the backward selection method determined the variable that most contributed to the risk for criminal behaviour in individuals with HFASD (Table 7). Among all of the variables, the Wald statistic confirmed that

Table 7
The results of a logistic regression analysis with backward selection.

	B	SE*	Wald (*df* = 1)	OR	95% CI
The age of initial HFASD diagnosis	0.18	0.05	13.34***	1.20*	(1.1–1.3)
Neglect	1.85	0.77	5.70**	6.34*	(1.4–28.8)
Physical abuse	1.32	0.57	5.30**	3.73*	(1.2–11.4)
Bullying	-0.84	0.49	2.96**	0.43	(0.2–1.1)
Parental divorce	1.01	0.59	2.96**	2.74	(0.9–8.6)
$\chi^2(5)$	49.5***				
AIC	138.4				
Correct classification (%)	85.7				

* Significant at the 0.05 level, two tailed.
** Significant at the 0.01 level, two tailed.
*** Significant at the 0.001 level, two tailed.

the age of initial HFASD diagnosis, neglect, physical abuse, bullying and parental divorce were significant. The model that included these five variables initially provided the best fit in this study ($\chi^2 = 49.5$, $df = 5$, $p < 0.001$, AIC = 138.4). Of these five variables, only the ORs for the age of initial HFASD diagnosis, neglect and physical abuse were significant. Individuals who experienced childhood neglect or physical abuse were most likely to have criminal behaviours later in life. Criminal behaviour was 6.3 times more likely to occur in those who experienced neglect and 3.1 more likely in those who experienced physical abuse compared with the control group. There was a 1.2-fold increase in criminal behaviours for each year that the psychiatric diagnosis was delayed.

4. Discussion

4.1. Characteristics of individuals with HFASD who exhibit criminal behaviours

In this study, the most common criminal behaviour was theft (55.6%), followed by sexual misconduct (25.0%), violence (25.0%), and running away (19.4%). Theft is also the most common criminal behaviour in the general Japanese population (Ministry of Justice, Japan, 2008) and in many European countries (e.g., Junger-Tas et al., 2010). The rates of sexual misconduct, violence, and running away in the general Japanese population are not high (Japanese Ministry of Justice, 2008); thus, the relatively high rate of sexual misconduct in this study may by a characteristic of individuals with HFASD. Hellemans, Colson, Verbraeken, Vermeiren, and Deboutte (2007) interviewed 24 adolescents and adults with HFASD regarding their sexuality and reported that approximately one-third required sexual development or behavioural interventions. Indeed, previous case studies have reported that individuals with HFASD and excessive sexual interest engaged in sexual misconduct (e.g., Kohn et al., 1998; Murrie et al., 2002). Accordingly, a feature of ASD was derived: Restricted and repetitive patterns of behaviour, interests, and activities may take on a sexual aspect, and their unique or intense sexual interests may lead to criminal behaviour (Murrie et al., 2002).

In the present study, 94.4% of participants in the criminal group exhibited "multiple recurrent incidents with a current episode of criminal behaviour" or "multiple recurrent incidents without a current episode;" 5.6% of participants reported only once and no recurrences illicit behaviours at the time of the assessment." This result corresponds with many previous case studies reporting that individuals with HFASD repeat criminal behaviours (e.g., Baron-Cohen, 1988; Chen et al., 2003; Mawson et al., 1985). As mentioned earlier, restricted and repetitive patterns of behaviour, interests, and activities might contribute to recurrent criminal behaviour. Moreover, a lack of empathy for others (Wing, 1981), which relates to severe and sustained impairments in social interactions, might also be related to recurrent criminal behaviour (Woodbury-Smith et al., 2005).

More importantly, these individuals often repeat criminal behaviours even though they were seeing child psychiatrists and receiving traditional interventions. These findings reflect the difficulty of intervening in cases of criminal behaviour. Preventive approaches should focus on ASD traits.

4.2. Criminal behaviour risk factors in individuals with HFASD

The results indicated that the age at which HFASD was first diagnosed, physical abuse and neglect significantly predicted criminal behaviour in individuals with HFASD. This finding corresponds with previous case reports suggesting that a delayed initial diagnosis and appropriate treatment lead to violent behaviours (Mukaddes & Topcu, 2006). Our findings demonstrating that neglect and physical abuse have significant effects are also in agreement with previous results from the general population. For example, childhood neglect and physical abuse significantly predict aggression that results in violent crime arrests in adulthood (Maxfield & Widom, 1996). Thus, neglect and physical abuse are significant risk factors of criminal behaviour in the HFASD population. Neglect and physical abuse exert a large influence on children's physical and psychological development. For instance, when children experience neglect or physical abuse, their physical growth is stunted, and their mental status is unstable; these children are more likely to have mental disorders such as depression or aggression towards others (Child Welfare Information Gateway, 2008). Such problems exert negative influences on their

emotional regulation, friendships and adjustment to school (Sroufe, Egeland, Carlson, & Collins, 2005), which may result in criminal behaviour.

This study is one of the few to assess the relationship between the age of initial HFASD diagnosis and the likelihood of criminal behaviour. The results show that a later diagnosis is correlated with an increased prevalence of criminal behaviour. In general, the presence of HFASD is easily overlooked in young children (De Giacomo & Fombonne, 1998) because speech delays, a common characteristic of ASD, are unlikely to be observed. Later diagnoses lead to a lack of early medical and educational interventions and perhaps the inability to acquire social skills and adapt to society (e.g., Lord, 1995). It is critical that children with ASD increase their repertoire of appropriate behaviours at an early age (Howlin, 1997; Richman, 2001); thus, late diagnoses might be a significant risk factor of social adaptation failures in individuals with ASD.

Parents of children with ASD typically report higher levels of parenting stress and affective symptoms compared with parents of normally developing children and those of children with other disabilities (e.g., Bristol & Schopler, 1984; Dumas, Wolf, Fisman, & Culligan, 1991). Moreover, Hastings and Johnson (2001) found that parental stress correlated with levels of autism symptoms. From these findings, one might associate a delayed ASD diagnosis with criminal behaviour. A delayed diagnosis leads to a poor prognosis (Lord, 1995) and elevates parental stress; the parents may also become depressed or apathetic, which leads to harsher disciplines that could develop into child abuse (Sullivan & Knutson (2000). Child abuse exacerbates the child's socio-emotional development, which might lead to criminal activity.

The additional CA categories, hyperactivity and being bullied, were not significantly correlated with criminal behaviour; however, researchers have observed that there are significant correlations among these variables in the general population. For example, children who lack control at age three exhibit aggression later in life (Caspi, Henry, McGee, Moffitt, & Silva, 1995). Moreover, alienation from friends was positively correlated with aggression (Schwartz, McFadyen-Ketchum, Dodge, Pettit, & Bates, 1998). One possible explanation for the present study's non-significant results is the high percentages of hyperactivity and bullying in both the criminal and control groups. The lack of a significant between-group difference with regard to hyperactivity and bullying may have masked the relationship between these factors and risk of criminal behaviours. Hyperactivity is often observed in children with ASD (e.g., Wing, 1996), and these children are often ridiculed and become targets of bullying because they fail to comprehend the intentions of others (Heinrichs, 2003; Yoshida & Uchiyama, 2004). Therefore, although hyperactivity and bullying were not significantly correlated with criminal behaviour in individuals with HFASD in the present study, practitioners must still consider these factors when working with this population.

4.3. Limitations

This study selected several CAs to predict criminal behaviour in individuals with HFPDD. However, many of these CAs are environmental factors; the only individual factors were physical illness and hyperactivity. As a result, other individual factors (e.g., hereditary) were not taken into account. In addition, the interaction between individual factors and environmental factors was not examined. Therefore, future studies are needed to examine the influence of biological and environmental factors on criminal behaviour in individuals with HFASD.

Except for the age of initial HFASD diagnoses, all the CAs were rated as either present or absent, even though the severity of these factors may differ among individuals. Sampson and Laub (1994) assessed quantitative variables similar to CAs and explained that family poverty interrupted informal social control processes in the family. The lack of informal social control in families increased the risk for delinquency. Thus, insufficient family functioning (e.g., economic adversity, parental criminality and family violence) might postpone the timing and age at which HFASD is first diagnosed. Therefore, studies that rate the presence and level of child abuse or neglect using multilevel rather than dichotomous scales may reveal additional details regarding the relationships among criminal behaviours and these variables. Moreover, prospective studies might provide additional information on this topic.

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Evaluation of the Japanese version of the Developmental Coordination Disorder Questionnaire as a screening tool for clumsiness of Japanese children

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ABSTRACT

Developmental Coordination Disorder (DCD) is characterized by clumsiness and coordination difficulties. DCD interferes with academic performance and participation in physical activities and psychosocial functions, such as self-esteem, cognition, or emotion, from childhood through adolescence to adulthood. DCD is a common pediatric condition and its prevalence is estimated to be 6% worldwide. Although English questionnaires are available, there is no questionnaire to identify DCD in Japan, and therefore, no information on its prevalence is available. Recently, we developed the Japanese version of the Developmental Coordination Disorder Questionnaire (DCDQ-J). The purpose of this study was to describe the applicability of the DCDQ-J for use with a community-based population of children in Japan and to investigate the relationships between coordination and attention-deficit hyperactivity disorder (ADHD) tendencies or intelligence. The DCDQ-J was completed by 6330 parents or guardians of children and adolescents. We employed the ADHD-rating scale and determined the intelligence quotient (IQ) of the children. Two-way analysis of variance showed that the scores linearly increased as the children's grades advanced in 2 subscales, namely, control during movement and fine motor. In contrast, non-linear changes were found in the scores of the general coordination subscale. The total scores of the DCDQ-J and ADHD-RS were significantly correlated, but no relationship between DCDQ-J scores and IQ was found. The DCDQ-J is expected to be a useful screening tool to identify and assess motor coordination difficulties of children in Japan and enable cross-cultural comparisons.

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1. Introduction

Daily living and school activities of children require various motor skills. Such motor skills depend on coordination of a wide range of movements of body parts, such as appropriate speed and strength, precise timing of movements, and control of posture and balance. The sum of the above-mentioned functions is called "coordination" and is one of the important brain functions that develops along with children's growth (Zwicker, Missiuna, & Boyd, 2009).

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Insufficient coordination function is likely to induce delayed motor development, clumsiness, limited manual dexterity, and difficulty in posture. In addition, children with insufficient coordination tend to show retarded development of activities of daily living, including eating, toileting, dressing, and tool using, as well as school activities, including writing, drawing, playing musical instruments, gymnastics, and outdoor play. In fact, many clinical reports show that difficulty in coordination correlates with slow learning of basic daily living, studying, and various other activities (Missiuna, Moll, Law, King, & King, 2006; Polatajko & Cantin, 2005; Tseng, Howe, Chuang, & Hsieh, 2007).

However, the cause of such coordination problems is likely to be mistakenly considered as the lack of discipline by parents or poor motivation of children. If inappropriate measures against such problems are continuously taken, a feeling of self-denial and/or emotional difficulties may occur in children, which may result in self-distrust, exacerbate a repugnance to exercise and school activities, and may worsen the problems (Missiuna et al., 2006; Piek, Baynam, & Barrett, 2006; Polatajko & Cantin, 2005; Skinner & Piek, 2001; Tseng et al., 2007). Parents/guardians (Missiuna, Moll, King, King, & Law, 2007; Stephenson & Chesson, 2008) and teachers (Rivard, Missiuna, Hanna, & Wishart, 2007; Sugden & Chambers, 2003) may often lose patience with their developmental delay or feel disgusted with themselves, which may result in a bad relationship with the child (Cairney, Veldhuizen, & Szatmari, 2010). In addition, some studies have pointed out that coordination is deeply related to children's development of cognition and socialization because coordination increases children's ability to explore and manipulate their environment and encourages them to participate in social activities (Cairney et al., 2010; Missiuna et al., 2006; Piek et al., 2006).

The 4th edition of the diagnostic and statistical manual of mental disorders (DSM-IV) (American Psychiatric Association; Diagnostic and statistical manual of mental disorders: DSM-IV-TR, 2000) defines developmental coordination disorder (DCD) as "a marked impairment in the development of motor coordination, which interferes with daily living and studying." The incidence rate of DCD is 6%, and it is a relatively common pediatric condition (American Psychiatric Association; Diagnostic and statistical manual of mental disorders: DSM-IV-TR, 2000); however, there is no scale to facilitate the screening of DCD in Japan, which makes it difficult to evaluate the children's actual motor performance. The Developmental Coordination Disorder Questionnaire (DCDQ) is a parent rating scale for screening pediatric DCD (Wilson, Kaplan, Crawford, Campbell, & Dewey, 2000; Wilson et al., 2009). Recently, we developed a Japanese version of the DCDQ (DCDQ-J) (Nakai et al., 2009) for the Japanese children and conducted a preliminary investigation on both the reliability of our questionnaire and the psychometric properties.

This relatively large-scale school-based study aimed to study the applicability of the DCDQ-J as a screening tool for DCD in Japanese children. Furthermore, in order to evaluate the validity of the DCDQ-J, we investigated the relationships between coordination and ADHD tendencies or intelligence. DCD interferes with coordination in children whose intellectual level is within the normal range (American Psychiatric Association; Diagnostic and statistical manual of mental disorders: DSM-IV-TR, 2000); thus, the scores of the DCDQ-J should not be significantly related to intelligence. On the other hand, the scores of the DCDQ-J may be positively associated with ADHD tendencies, since DCD is frequently associated with ADHD (Fox & Lent, 1996; Kopp, Beckung, & Gillberg, 2010; Lingam et al., 2010).

2. Methods

2.1. Participants

Parents/guardians of all students in public nursery schools, elementary schools, and junior high schools in the participating city were invited to take part in this study. Nursery school students (middle class: 4- to 5-year-old students; senior class: 5- to 6-year-old students) and all elementary and junior high school students were included in this study. The questionnaire was sent to the parents/guardians via the teachers. The responses from the 6330 respondents were analyzed. Table 1 shows the details of the children, as reported by the respondents. The majority (94%) of the respondents were mothers. Approximately 5% of the respondents were fathers, and the rest were grandparents. Data from parents and guardians of children in special classrooms was excluded from the study. The number of data inputs varied at analysis because missing data was excluded.

2.2. Development of the DCDQ-J

DCDQ 2007 is a parent questionnaire consisting of 15 items and was designed to screen for coordination disorders in children aged 5–15 years (Wilson et al., 2000, 2009). There are 3 subscales, namely, "control during movement (6 subitems)", "fine motor (4 subitems)", and "general coordination (5 subitems)". The descriptions of each item are scored as follows by a 5-point scale based on the comparison between the child and other (children): "Not at all like your child (1 point)", "A bit like your child (2 points)", "Moderately like your child (3 points)", "Quite a bit like your child (4 points)", and "Extremely like your child (5 points)", with higher scores indicating better coordination. Recently, the DCDQ-J was developed and adapted to the Japanese culture (Nakai et al., 2009) in accordance with the International Guidelines (Beaton, Bombardier, Guillemin, & Feraz, 2000).

We employed the Japanese version of the ADHD-rating scale (Japanese version ADHD-RS) developed by DuPaul, Power, Anastopoulos, & Reid (1998), DuPaul, Power, Anastopoulos, & Reid (2008). Based on the ADHD criteria of DSM-IV (American Psychiatric Association; Diagnostic and statistical manual of mental disorders: DSM-IV-TR, 2000), this scale consists of 2

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Table 1
Details of grade and sex of participants of this survey.

	Male	Female	Total
Nursery school			
Middle (4–5)	174	167	341
Senior (5–6)	154	176	330
Elementary school			
1 (6–7)	422	350	772
2 (7–8)	343	374	717
3 (8–9)	378	363	741
4 (9–10)	314	319	633
5 (10–11)	328	352	680
6 (11–12)	310	292	602
Lower-secondary school			
7 (12–13)	292	268	560
8 (13–14)	229	255	484
9 (14–15)	219	251	470
Total	3163	3167	6330

subscales to measure the 2 major characteristics of ADHD, namely, Inattentive (9 items) and Hyperactive-Impulsive (9 items). Both the school and home forms of the ADHD-RS have been confirmed to have sufficient reliability and validity (DuPaul, Power, Anastopoulos, & Reid, 1998; DuPaul, Power, McGoey, Ikeda, & Anastopoulos, 1998; DuPaul et al., 2008). As in prior surveys, parents or rearers rated each item on a 4-point Likert scale ranging from "Not at all or rarely (0)" to "Sometimes (1)," "Often (2)," or "Very often (3)." Therefore, the higher a child's score, the more the ADHD tendency.

Our survey employed the DCDQ-J and ADHD-RS and asked the parents or guardians to respond to all of the items for their children.

We measured the intelligence of elementary school children and lower-secondary schoolchildren by using the New Kyoken Support to Intelligence Tests for Each School Grade (Tatsuno, Ishida, & Hattori, 2002). This is a collective intelligence test conducted at the beginning of a school year to assess each child's intelligence quotient (IQ).

2.3. Procedure

This study was approved by the ethics committee of the Hamamatsu University School of Medicine. To request the cooperation of the target city, we provided the education committee of that city with an explanation of the purpose and method of our study, as well as an outline of our plan to protect the privacy of participants. We obtained consent from all the preschools and elementary and junior high schools in the participating city and performed the survey using the described questionnaires. We informed the parents and guardians before starting the study that participation was optional and that they would be notified of the results after the compilation of statistics.

2.4. Statistical analysis

SPSS version 16 (IBM Corporation, NY, USA) was used for statistical analysis.

3. Results

3.1. Scaling method of the DCDQ-J, confirmatory factor analysis, and reliability of DCDQ-J

A confirmatory-factor analysis of the DCDQ-J was performed by assuming the 3 factors reported by Wilson et al. (Schoemaker et al., 2006; Wilson et al., 2000, 2009). All factor loading values were ≥ 0.5, while indicators of good fit were slightly low, such as comparative fit index (CFI) = 0.86 and mean square error of approximation (RMSEA) = 0.13. Therefore, 4 error covariances were added according to the modification indices. As a result, the CFI increased to 0.94 and RMSEA decreased to 0.09, which were acceptable results. The α factors were calculated by subscale yielded values for control during movement, fine motor, and general coordination as 0.91, 0.91, and 0.81, respectively, which indicated that the subscales had high levels of internal consistencies. Accordingly, the study employed 3-factor analysis, and total scores per item were defined as subscale scores. The correlation coefficient between the subscales ranged from 0.59 to 0.73. The total scores of all items were defined as all scores of the DCDQ ($\alpha = 0.93$).

3.2. Gender difference and school grade difference in the DCDQ-J

Two-way analysis of variance (ANOVA) with factors of age and school grade was performed to evaluate the subscale scores of the DCDQ-J (Table 2). The main effects of gender ($F(1, 6218) = 78.88$, $p < 0.001$) and school grade ($F(10, 6218) = 36.70$, $p < 0.001$) were significant, while the interaction effect ($F(10, 6218) = 0.54$) was not significant in the control

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Table 2
Descriptive statistics of the Japanese version of Developmental Coordination Disorder Questionnaire.

Grade (age)	Control during movement				Fine motor				General coordination				DCDQ total			
	Male		Female		Male		Female		Male		Female		Male		Female	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Middle (4–5)	19.46	5.40	19.04	5.35	12.44	4.17	14.78	4.02	16.09	4.76	17.19	4.79	47.99	12.84	50.97	12.69
Senior (5–6)	21.31	5.46	19.99	5.26	13.63	4.20	15.59	3.76	17.23	4.27	17.73	4.59	52.51	12.11	53.38	12.50
1 (6–7)	21.22	5.48	20.38	5.32	14.53	3.72	16.12	3.63	16.75	4.57	17.99	4.59	52.55	12.24	54.56	12.03
2 (7–8)	21.51	5.22	20.45	5.12	13.82	3.63	15.70	3.39	16.27	4.39	17.66	4.34	51.73	11.58	53.81	11.31
3 (8–9)	22.29	5.38	20.76	5.01	14.17	3.56	15.60	3.50	16.98	4.26	17.53	4.16	53.44	11.71	53.94	11.00
4 (9–10)	22.94	5.43	21.27	5.38	14.91	3.51	16.02	3.44	17.76	4.33	17.77	4.20	55.79	11.67	55.18	11.51
5 (10–11)	23.29	5.21	21.86	5.64	14.98	3.74	16.58	3.47	17.83	4.46	18.41	4.44	56.10	11.96	56.99	12.00
6 (11–12)	23.39	5.77	22.09	5.21	14.88	4.00	16.71	3.35	17.72	4.75	18.30	4.15	55.99	13.29	57.12	11.34
7 (12–13)	23.64	5.26	22.39	5.41	14.88	3.93	16.45	3.53	17.78	4.50	18.35	4.40	56.39	12.33	57.16	12.01
8 (13–14)	24.62	5.10	23.03	5.52	15.97	3.77	17.05	3.26	19.07	4.46	18.62	4.55	59.72	12.19	58.59	12.08
9 (14–15)	25.11	4.92	23.73	5.55	16.00	3.70	17.39	3.44	19.04	4.61	18.96	4.64	60.36	12.00	60.04	12.22
Sex		78.88***				284.13***				21.44***				6.86**		
Grade		36.70***				25.35***				13.33***				29.67***		
Sex × grade		0.54				1.20				2.26*				1.30		

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

during movement subclass. In addition, the main effect of gender was higher in boys than in girls, and the main effect of school grade tended to increase as the grade level increased. The main effects of gender ($F(1, 6251) = 284.13$, $p < 0.001$) and school grade ($F(10, 6251) = 25.35$, $p < 0.001$) were significant in the fine motor subclass, while the interaction effect ($F(10, 6251) = 1.20$) was not significant. The main effect of gender was higher in girls than in boys, and the main effect of school grade tended to increase as the grade level increased. The main effects of gender ($F(1, 6231) = 21.44$, $p < 0.001$) and school grade ($F(10, 6231) = 13.33$, $p < 0.001$) and the interaction effect ($F(10, 6231) = 2.26$, $p < 0.001$) were significant in the general coordination subclass. The simple main effect by school grade was significant in the middle class students of the nursery school ($F(1, 6231) = 5.07$, $p < 0.001$), the elementary Year 1 schoolchildren ($F(1, 6231) = 14.60$, $p < 0.001$), and the Year 2 children ($F(1, 6231) = 17.14$, $p < 0.001$), and was higher in girls than in boys. The simple main effect of school grade was significant in both genders, boys ($F(10, 6231) = 11.86$, $p < 0.001$) and girls ($F(10, 6231) = 3.50$, $p < 0.001$), but the difference in school grade tended to be greater in boys than in girls. When the total scores of the DCDQ-J were analyzed using two-way ANOVA, the main effect of gender ($F(1, 6150) = 6.86$, $p < 0.01$) and that of school grade ($F(10, 6150) = 29.67$, $p < 0.001$) were significant, while the interaction effect ($F(10, 6150) = 1.30$) was not significant. The main effect of gender was greater in girls than in boys, and the main effect of school grade tended to increase as the grade level increased.

A main effect of school grade was observed at the subscale level and the total scores of the DCDQ-J; thus, the tendency of their developmental changes was evaluated using multiple regression analysis. The 1st to the 10th items were prepared by assigning a value of 1–11 to the middle class students of the nursery school through to Year 9 students. The influence of gender against each subscale and the total score were controlled at Step 1, and the items regarding their school grade from the 1st to the 10th were input by using a forward selection method at Step 2. The first item was significant in the control during movement subclass ($\beta = 0.23$, $p < 0.001$), and it tended to increase as the grade level increased. In the fine motor subclass, the first item was significant ($\beta = 0.17$, $p < 0.001$), and it tended to increase as the grade level increased. In the overall coordination subclass, an interaction of gender and school grade was observed, so that multiple regression analysis by gender was performed. The 2nd item was significant in boys ($\beta = 0.17$, $p < 0.001$), and in girls ($\beta = 0.09$, $p < 0.001$), and it increased as the grade level increased. In the total scores of DCDQ-J, the first item was significant ($\beta = 0.21$, $p < 0.001$), and it tended to increase as the grade level increased. Fig. 1 shows the plot of scores by school grade and the approximation curve.

3.3. Subgroups of coordination

Using the standard scores of the 3 subscales of the DCDQ-J, *k*-means clustering was performed to study the subgroups of coordination by changing the number of clusters from 2 to 4. In consideration of the interpretive potentiality, a 4-cluster analysis was used. Fig. 2 shows the subscale scores of the DCDQ-J by cluster. All of the subscale scores of Cluster 1 ($n = 1414$, 22.87%) were lower than the mean value; especially, the subscale score of the fine motor subclass was low. Therefore, Cluster 1 was defined as a "poor fine motor group." Cluster 2 ($n = 2307$, 37.31%) was characterized as having high subscale scores, and it was defined as an "excellent coordination group." The subscale score of fine motor alone in Cluster 3 ($n = 1377$, 22.27%) was greater than the mean value, and other 2 subscale scores were lower than the mean value, and it was defined as an "excellent fine motor group." All of the subscale scores of Cluster 4 ($n = 1086$, 17.56%) were far lower than the mean values, and it was defined as a "poor coordination group."

The frequency of cluster occurrence was studied when school grade and gender were different. The bias between the cluster and school grade was significant ($\chi^2(30) = 294.66$, $p < 0.001$). As the grade level increased, the number of participants

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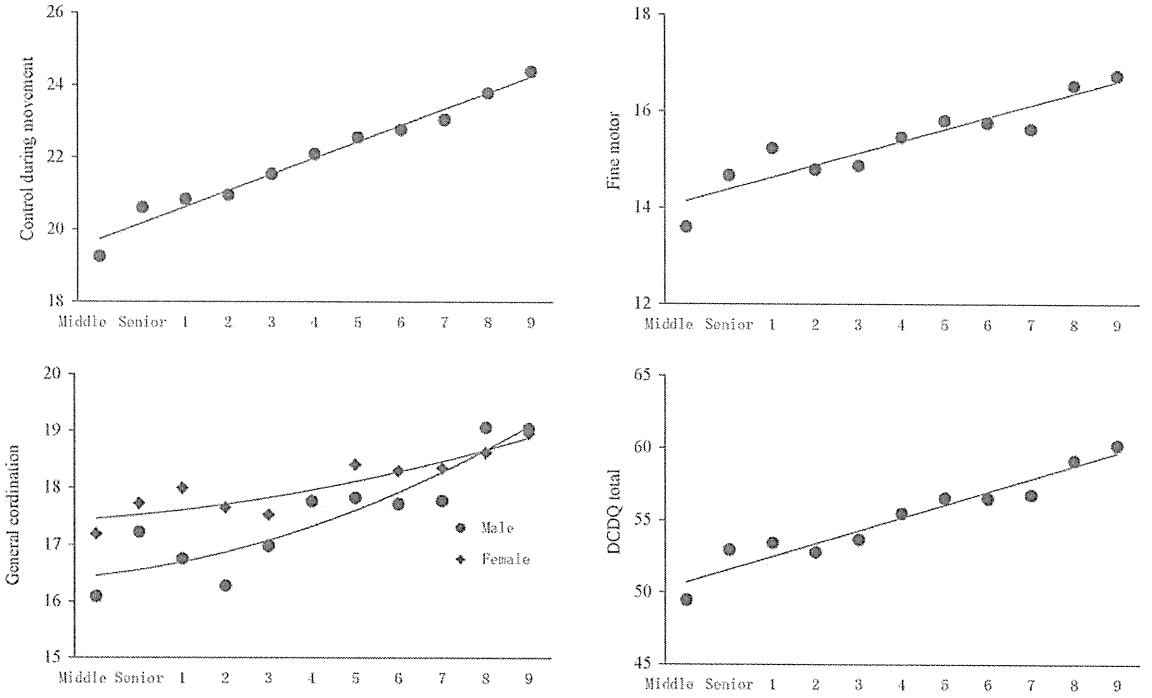

Fig. 1. The score of Japanese version of Developmental Coordination Disorder Questionnaire by grade.

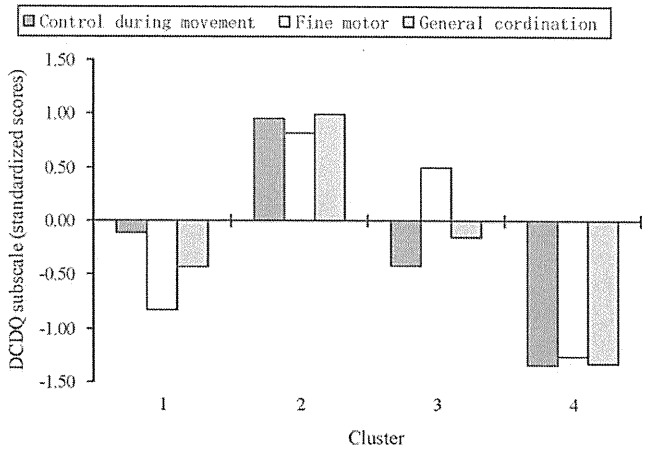

Fig. 2. The score of Japanese version of the Developmental Coordination Disorder Questionnaire subscales by cluster (standardized scores).

in the excellent coordination group increased, while those in the poor coordination group decreased (Fig. 3). The frequency of cluster occurrence of the other 2 groups was approximately 20% regardless of their school grade. In addition, there was a significant bias between the cluster and gender ($\chi^2(3) = 275.13$, $p < 0.001$), which indicated that the poor fine motor group had more boys than girls, while the excellent fine motor group had more girls (Fig. 4).

3.4. Relationship of the DCDQ-J with intelligence and ADHD-RS

In the Japanese version ADHD-RS, each subscale was averaged, and the resulting data was defined as inattentive ($\alpha = 0.90$) and hyperactive/impulsive ($\alpha = 0.86$); further, the total score of all items indicated ADHD tendencies ($\alpha = 0.93$). The correlation between the subscales was 0.75. The correlation coefficient between the DCDQ-J, the IQ, and the Japanese version ADHD-RS was calculated (Table 3). The 3 subscale scores and the total scores of the DCDQ-J were slightly positively associated with intelligence. Furthermore, a negative correlation of −0.2 to −0.5 was observed between the 3 subscale scores and the total scores of the DCDQ-J and the Japanese version ADHD-RS.

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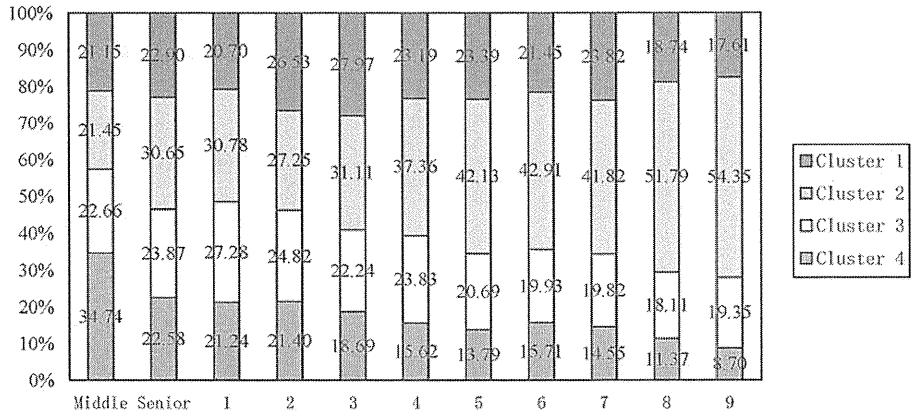

Fig. 3. The frequency ratio of each cluster by grade.

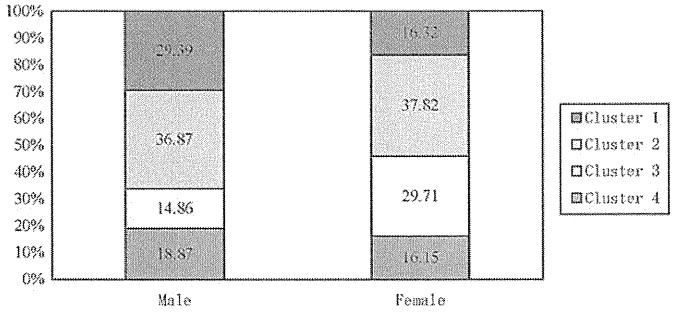

Fig. 4. The frequency ratio of each cluster by sex.

4. Discussion

This study was undertaken in a large sample of Japanese children by using DCDQ-J, ADHD-RS, and the New Kyoken Support to Intelligence Tests to establish relationships among coordination, ADHD tendencies, and intelligence. In this study, differences in development were evaluated, taking into consideration that motor skills increase with age and that the scores of control during movement and fine motor subclasses tend to increase linearly as the grade level increases. The general coordination changed non-linearly regardless of gender, and the scores tended to increase sharply as the grade level increased. The mean value and the development-related changes obtained in this study may be useful to study normal development of coordination and for screening of DCD in Japanese children.

When the subgroups of coordination were studied using the DCDQ-J, they were classified into 4 groups, including the poor fine motor group, the excellent coordination group, the excellent fine motor group, and the poor coordination group. Among these groups, the number of the participants in the excellent coordination group increased as the grade level increased, while those in the poor coordination group decreased. Furthermore, the poor fine motor group had more boys, while the excellent fine motor group had more girls. There were various patterns, for example, children with poor coordination were the weakest at fine motor or poor at all physical exercises, and the frequency of these patterns varied depending on their school grade and/or gender. Accordingly, special attention should be paid to children with clumsiness to determine the kind of movement that is their weak point, in consideration of their school grade and gender.

Table 3
Relationship between Developmental Coordination Disorder Questionnaire and intelligence quotient or attention-deficit hyperactivity disorder-rating scale.

	DCDQ			
	Control during movement	Fine motor	General coordination	DCDQ total
IQ	.12***	.14***	.11***	.14***
ADHD-RS				
Inattention	−.26***	−.46***	−.48***	−.43***
Hyperactive-Impulsive	−.19***	−.36***	−.35***	−.33***
ADHD total	−.24***	−.45***	−.45***	−.41***

*** $p < 0.001$.

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The DCDQ-J was related to the ADHD tendencies in children. Previous studies have mention that DCD is associated with ADHD, and that children with ADHD present clumsiness (Fox & Lent, 1996; Kopp et al., 2010; Lingam et al., 2010). In this study as well, all subscales and total scores of the DCDQ-J were significantly associated with the Japanese version ADHD-RS, which suggested that children with poor coordination more frequently showed inattention and hyperactivity in some situations. On the other hand, there was almost no relationship between scores of the DCDQ-J and the IQ. The correlation between the subscales and the total score of the DCDQ-J and their IQ ranged from 0.1 and 0.2, and children with poorer coordination tended to have lower IQs, but the relationship was very weak. Considering that the IQ should be within the normal limit in the diagnosis criteria of DCD by DSM-IV (2000), this study indicates that the DCDQ-J has some degree of validity and may be a useful screening tool for DCD in Japan.

5. Limitation and perspectives

Only the questionnaire survey was done in this study, which was not intended to provide a medical diagnosis of DCD. In countries other than Japan, the cutoff value of the DCDQ is set in terms of the medical diagnosis as well as other batteries of tests (Schoemaker et al., 2006; Tseng, Fu, Wilson, & Hu, 2010; Wilson et al., 2000, 2009). Therefore, the predictive validity of the DCDQ-J should be studied in Japan in the future.

Conflict of interests

The authors have no conflict of interests to declare.

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Validation of an interview-based rating scale developed in Japan for pervasive developmental disorders

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ABSTRACT

The pervasive developmental disorders (PDDs) Autism Society Japan Rating Scale (PARS), an interview-based instrument for evaluating PDDs, has been developed in Japan with the aim of providing a method that (1) can be used to evaluate PDD symptoms and related support needs and (2) is simpler and easier than the currently used "gold standard" instruments such as the Autism Diagnostic Interview-Revised (ADI-R). We examined the reliability and validity of PARS on the basis of data from 572 participants (277 PDD patients and 295 nonclinical controls). Inter-rater reliability was sufficient at both the item and scale level. Factor analysis extracted four subscales, for which internal consistency was found to be high. The sub and total scores of PARS showed correlations with the domain and total scores of ADI-R, in line with theoretical prediction, indicating the convergent validity of PARS. A receiver operating characteristic analysis showed that PARS has good discriminative validity in differentiating between PDD patients and nonclinical controls, regardless of intellectual capacity. Considering that PARS can be easily implemented by professionals with appropriate knowledge regarding PDDs, PARS may be superior to the existing instruments in terms of cost performance.

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1. Introduction

Over the course of many years, several instruments have been developed for the diagnosis, evaluation, and screening of pervasive development disorders (PDD). In recent years, the Autism Diagnostic Interview-Revised (ADI-R; Le Couteur et al., 1989; Lord, Rutter, & Le Couteur, 1994) has been broadly accepted as a standardized interview-based diagnostic instrument for

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PDD. The Autism Diagnostic Observational Schedule (ADOS; Lord et al., 2000, 1989) is also widely used as an observation-based diagnostic instrument. These instruments have a high level of discriminative validity with respect to the differentiation of PDD from non-PDD and are useful in reaching a definitive diagnosis; however, their implementation requires special training and significant time, leading to the development of numerous simpler evaluation scales in recent years.

The Modified Checklist for Autism in Toddlers (M-CHAT; Robins, Fein, Barton, & Green, 2001), which has been broadly accepted as a screening instrument, is a unique tool that comprises a combination of questionnaires, telephone interviews, and structured follow-up interviews. Although it is a highly useful tool, its use is limited to toddlers because it was developed with the aim of early identification of PDD. In countries such as Japan and other Asian countries lacking the medical and governmental services for PDD that exist in the United States and Europe, it is believed that many people with undiagnosed PDD exist in a broad age group. In fact, Kawamura, Takahashi, and Ishii (2008) reported that in Toyota City, Japan, where a new systematic PDD screening system has been implemented, there were 11 times more detections of PDD compared with that observed in a survey done 20 years ago. However, few regions in the world have an adequate PDD detection system of this kind. Considering this, the development of a simple and practical evaluation scale that can be applied to a wide age group is an important and pressing issue.

The Autism Spectrum Screening Questionnaire (ASSQ; Ehlers, Gillberg, & Wing, 1999), Autism Screening Questionnaire (ASQ; Berument, Rutter, Lord, Pickles, & Bailey, 1999), and Social Responsiveness Scale (Constantino et al., 2003) have been developed as PDD evaluation scales that can be applied to a relatively broad age group. As all of these evaluation tools are in the format of a questionnaire that can be evaluated by parents or teachers, they have the advantage of being fairly easy to implement. However, in most cases, parents lack the specialized knowledge needed to understand PDD, so the standards for rating individual items can vary greatly depending on the individual conducting the evaluation, possibly leading to a deterioration of the reliability of evaluation results. Furthermore, though teachers generally have more PDD-related knowledge than do parents, they have less specific knowledge of each individual child; hence, their evaluations tend to be less reliable than those of parents. In practice, the sensitivity (true positive rate) and specificity (one minus false positive rate) of the ASSQ in distinguishing PDD and non-PDD was .91 and .77, respectively, for the parent evaluation and .90 and .58, respectively, for the teacher evaluation (Ehlers et al., 1999). Considering that the sensitivity and specificity of the ADI-R were 1.00 and .90, respectively (Lord et al., 1997), the level of accuracy of the ASSQ in distinguishing PDD from non-PDD was insufficient in the hands of both parents and teachers. Furthermore, in a simultaneous comparison conducted by Charman et al. (2007), sensitivity and specificity in identifying autistic spectrum disorders was .86 and .78, respectively, for the ASQ and .78 and .67, respectively, for the SRS, thereby indicating its insufficient precision in practical use.

To resolve this dilemma between accuracy and simplicity, the PDDs Autism Society Japan Rating Scale (PARS) has been developed in Japan as an instrument for evaluating PDDs (Adachi et al., 2006; Kamio et al., 2006; Tsujii et al., 2006). This scale was developed with the aim of providing an instrument that is simpler to use than the ADI-R and ADOS; is applicable to any age group, unlike the M-CHAT; and has better reliability and validity than questionnaire scales such as the ASSQ and ASQ. While PARS uses an interview format similar to ADI-R, the procedures, which are briefly summarized in the manual, can be implemented after simple training. Furthermore, because the criteria for rating each item is clearly defined in PARS, a more reliable and valid evaluation is possible than with questionnaire scales. In order to ease the rating process and shorten the evaluation time, the evaluator assigns values at three levels—none (0 points), somewhat apparent (1 point), and apparent (2 points)—for the 34 items listed as typical behavioral symptoms of PDD. This innovation ensures that the time required to implement PARS is kept to 30–90 min, depending on the interviewer's proficiency and the target's age and symptoms.

There is no international literature on the psychometric properties of PARS, although PARS is now widely used in Japan. This study examined the reliability and validity of PARS and involved a study population of 628 test subjects that included 302 people with PDD and 326 people without PDD. Specifically, we evaluated the inter-rater reliability, factor structure, internal consistency, correlation with the ADI-R, and the ability to distinguish subjects with PDD from a nonclinical sample.

2. Methods

2.1. PARS

The PARS instrument has been developed (Adachi et al., 2006; Kamio et al., 2006; Tsujii et al., 2006) and published (PARS Committee, 2008) in Japan. It involves the evaluation of PDD symptoms through a semi-structured interview conducted with a parent or family member of the subject as the target. This tool can be used to assess not only the risk of PDD but also the need for support pertaining to administrative and medical services. PARS comprises both an evaluation of symptoms when they were most pronounced during infancy (named the peak symptoms scale) and an evaluation of current symptoms (named the current symptoms scale). The former is used mainly to an assessment of PDD risk, and the latter is mainly used in assessment of actual support needs. The peak symptoms scale, which comprises 34 items, is the same for subjects of all age groups, whereas the current symptoms scale, which comprises 57 items, has 3 versions targeting different age groups: preschoolers, primary schoolers, and adolescents/adults. This study reports on data obtained from the peak symptoms scale.

The PARS peak symptoms scale comprises 34 items that describe the characteristic behavioral symptoms of PDDs during the preschooler phase. The items were selected by a panel of eight child psychiatrists and a developmental clinical psychotherapist who were specialized in autism research and clinical practice with more than 10 years of expertise. They compiled behavioral characteristics shown by children with PDD and classified them into eight categories—Interpersonal

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Relationship, Communication, Restricted Interests, Stereotyped Behavior, Resistance, Hypersensitivity, Clumsiness, and other complications. From these, 34 items relating to symptoms that are specific to PDD, as well as items relating to nonspecific symptoms with high need for either clinical or administrative support, were selected. Twenty-two out of the 34 items corresponded to diagnostic features for PDD in the *Diagnostic and Statistical Manual 4th Edition, Text Revision* (DSM-IV-TR; American Psychiatric Association, 2000), and 8 corresponded to associated features. Symptoms described in the remaining four items (items 15, 27, 28, and 32) were not listed in the DSM-IV-TR, but since they are often present in PDD children seen in everyday clinical experience, they were included in the scales.

The evaluation of each item in PARS is based on a 30-page manual (PARS Committee, 2008). This manual includes detailed explanations of the questioning and rating standards for each item. For example, for item 1 of the peak symptoms scale (not making eye contact), a sample question "has the child ever had difficulty making eye contact?" is presented, and the rating standards are listed in detail: "0: made eye contact always," "1: had some difficulty making eye contact (made eye contact when requesting or showing interest in something but not otherwise; sometimes made eye contact and sometimes did not; made eye contact only with the parents but not with others)," and "2: rarely made eye contact (did not make eye contact with parents; avoided eye contact)." In this way, evaluation based on subjective criteria of the interviewer is avoided, and a more objective evaluation is possible.

2.2. Sample

The 572 subjects of the main sample comprised two broad groups: a PDD group made up of 277 subjects and a nonclinical control group made up of 295 subjects (Table 1).

Participants in the PDD group were diagnosed as having PDD or subordinate disorders based on the DSM-IV by experienced psychiatrists of medical and educational facilities in 28 areas throughout Japan. The diagnoses were made by integrating data from parental interviews; developmental and medical information; records provided by parents, other caregivers, and teachers; and direct observations of and interactions with the children. Subjects were referred to the facilities due to developmental concerns and randomly recruited for the study by examiners belonging to the facilities. Among these, 175 subjects underwent full-scale IQ tests using intelligence scales such as the Wechsler (Japanese WISC-III Publication Committee, 1998; Shinagawa, Kobayashi, Fujita, & Maekawa, 1990), Binet (Tanaka Institute for Educational Research, 2003), and K-ABC scales (Kaufman, Nadeen, & Kaufman, 1993). Of the 175 subjects, 51 were considered mentally retarded (IQ < 70), while 118 were not (IQ ≥ 70). To evaluate the correlation between PARS and the ADI-R, an ADI-R interview was additionally administered to 74 subjects (mean age = 14.0 years; SD = 3.6; range = 7–24 years; mean IQ = 86.2; SD = 24.7; range = 40–135) from the PDD group.

Table 1
Characteristics of the main sample.

	Age			IQ			Gender		
	M[a]	SD[b]	Range	*M*	SD	Range	Male	Female	Total
All age groups									
PDD[c] group	12.5	5.8	3–39	81.6	29.2	19–142	233	44	277
Without MR[d] (IQ[e] ≥ 70)	12.7	5.5	4–39	97.2	16.8	70–142	105	13	118
With MR (IQ < 70)	12.3	4.9	5–31	43.6	15.7	18–69	44	13	57
IQ unknown	12.4	6.3	3–32	–	–	–	84	18	102
Nonclinical control group	1.08	7.6	3–38	–	–	–	153	142	295
Preschoolers (age, 3–6 years)									
PDD group	5.1	1.0	3–6	74.1	24.5	22–121	27	12	39
Without MR (IQ ≥ 70)	5.4	0.8	4–6	87.7	13.6	70–121	9	5	14
With MR (IQ < 70)	5.9	.4	5–6	47.0	17.8	22–68	3	3	6
IQ unknown	4.5	1.0	3–6	–	–	–	15	4	19
Nonclinical control group	4.8	1.0	3–6	–	–	–	69	63	132
Primary schoolers (age, 6–12 years)									
PDD group	9.9	1.8	6–12	80.9	31.9	18–140	94	15	109
Without MR (IQ ≥ 70)	10.2	1.7	7–12	99.6	16.2	71–140	46	5	51
With MR (IQ < 70)	9.2	2.0	6–12	40.5	13.5	18–65	16	5	21
IQ unknown	10.0	1.7	7–12	–	–	–	32	5	37
Nonclinical control group	9.2	1.8	6–12	–	–	–	34	33	67
Adolescents and adults (age, 12–39 years)									
PDD group	17.3	5.2	12–39	77.4	31.2	19–142	112	17	129
Without MR (IQ ≥ 70)	17.1	5.5	12–39	97.9	16.9	70–142	50	3	53
With MR (IQ < 70)	15.9	3.7	12–31	44.9	16.7	19–69	25	5	30
IQ unknown	17.8	5.0	12–32	–	–	–	37	9	46
Nonclinical control group	20.1	6.0	13–38	–	–	–	50	46	96

[a] Mean.
[b] Standard deviation.
[c] Pervasive development disorders.
[d] Mental retardation.
[e] Intelligence quotient.

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