EATING DISTURBANCES IN AUTISM SPECTRUM DISORDERS WITH FOCUS ON ADOLESCENT AND ADULT YEARS

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Abstract

Object: 1. To present the documentation on eating disturbances in autism spectrum disorders (ASD) including autism and Asperger syndrome with focus on adolescent and adult years. 2. To present studies on autistic features in anorexia nervosa (AN), to be discussed in the context of a suggested link between ASD and AN.

Method: Because of the developmental aspects of behaviour in ASD, reports on childhood disturbances have been included in this review, which is based on bibliometric literature search in PubMed for the time period 1950 – 2007 with the addition of book chapters, and other articles not included in the PubMed search results.

Results: Few population-based studies on eating behaviours in ASD have been reported, none on adults. Of case series only a few include a control group. Concerning some ASD behaviours only case notes exist. Abnormal eating behaviours are overrepresented in ASD, including food refusal, pica, rumination, and selective eating. Those disturbances can have detrimental complications and are often resistant to treatment. There is a growing literature on AN as a neurodevelopmental disorder. ASD and the eating disorders, especially AN, have common features concerning genetics, cognitive style, and behaviours. With a few exceptions, ASD in AN have not been reported, or indeed researched. However, poor psychosocial functioning and a rigid lifestyle are commonly reported in AN outcome studies.

Conclusions: In spite of the impact on wellbeing and health, systematic research on eating behaviours in ASD is scant. In AN research the association with ASD deserves more attention.

Key words: Autism Spectrum – Asperger Syndrome – Developmental Disorder – Pica – Selective Eating – Eating Disorders – Anorexia Nervosa

Declaration of interest: None

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Introduction

Autism spectrum disorders (ASD) encompass developmental problems in three areas, social interaction, communication, and behavioural flexibility. Specific diagnostic labels in the autism spectrum (referred to as pervasive developmental disorders, PDDs in the DSM-IV, APA 1994) include autism (autistic disorder in the DSM-IV), Asperger syndrome (Asperger's disorder in the DSM-IV) and atypical autism or autistic-like condition (pervasive developmental disorder not otherwise specified, PDD NOS, in the DSM-IV). They will be referred to here as ASD.

Some of the associated features of ASD will be the main interests of this paper, namely eating disturbances and, to some extent, odd reactions to stimuli especially to taste and odours. Eating disturbances can be clearly distinguished from the clinically eating disorders e.g. anorexia nervosa (AN, APA 1994) (Cooper et al. 2002), but may lead to, or at least sometimes predate the eating disorder (Marchi and Cohen 1990, Rastam 1992, Eckern et al. 1999). The aims of this paper were to present the documentation on eating disturbances in ASD including autism and Asperger syndrome with focus on adolescent and adult years, and to present studies on autistic features in AN, to be discussed in the context of a suggested link between ASD and AN.

Methods

Because of the developmental aspects of behaviour in ASD, reports on childhood disturbances have been

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included in this review, which is based on bibliometric literature search in PubMed for the time period 1950 – 2007 with the addition of book chapters, conference reports and other articles not included in the PubMed search results, and Cochrane reviews (Millward et al. 2004). Relevant full text hard copies were read in whole and reference lists of those studies were searched for additional studies. The search terms autism, asperger, and schizoid were combined with each of the following separately: anorexia nervosa, diet, eating, feeding, food, low weight, neophobia, orthorexia, overeating, pica, polydipsia, rumination, selective eating, sensory, and water intoxication. The terms were first entered with no age limit, and then with the additional term adults.

Before 1966 ´autism´ was not listed among the MeSH-terms (The Medical Subject Headings) used by the National Library of Medicine to control vocabulary for indexing articles and books in PubMed (*www.pubmed.gov*). Instead the term "schizophrenia, childhood" was used.

Lastly, the term anorexia nervosa was combined with all of the terms above, and with the term males. With a few exceptions, ASD in AN have not been reported, or indeed researched. However, there is a growing literature on AN as a neurodevelopmental disorder, and concerning the terms anorexia nervosa and personality disorder a search for reviews, and scrutinising those, limited the amount of papers to read. The reference list of UK National Institute of Clinical Excellence (NICE) Guidelines for Eating Disorders (2004) was searched.

Results

The documentation on eating disturbances in adults with ASD has been scarce, and so has literature on eating problems in ASD in individuals with normal intelligence. Concerning eating behaviours in ASD, few population-based studies have been done, none on adults. In some studies children, adolescents and adults constitute one sample. Of the case series only a few include a control group. Concerning some ASD behaviours only case notes exist. Gravestock (2000) reviewed studies on eating disturbances in adults with mental retardation, and found that few studies included individuals with diagnosed autism. ASD associated with medical syndromes often includes aberrant eating behaviours, that would best be described in the context of the respective syndrome (see e.g. Smith 2001, Cass et al. 2003, Hovbye et al. 2007), and will not be dealt with in the present paper.

The behaviours in ASD entail problems with eating at all ages, and include food refusal, pica, rumination, vomiting, selective eating, and overeating. Diagnoses and classification of the broad spectrum of eating disturbances relevant in ASD have already been described in an excellent review (Gravestock 2003). Eating disturbances were included among the early diagnostic indicators of autism (Ritvo and Freeman 1978), and two of Hans Asperger's original three cases had a below average body weight (Asperger 1944). Forty primary caregivers, in most cases the mother, with a child or adolescent with ASD reported a higher incidence of food cravings, pica (the persistent eating of nonnutritive substances), and other eating problems, than parents of non-autistic children (Raiten and Massaro 1986). They also reported a higher caloric intake. Over 90 % of children with ASD seem to have problems at mealtime (DeMeyer 1979). Some of those problems exist in non-autistic children as well, but to a much lesser degree. In most children food aberrations are just a phase, while the difficulties tend to continue in adolescence and adulthood in individuals with developmental symptoms (Nicholls et al. 2001).

The relation between eating disturbances in childhood and the clinical eating disorders is insufficiently researched. Early feeding problems reported retrospectively was in a community based study correlated to development of teenage AN (Råstam 1992), and picky eating and digestive problems predicted AN in adolescence in one study (Marchi and Cohen 1990). Concerning the relation of pica to bulimic symptoms, studies have shown contradictory results (Marchi and Cohen 1990, Kotler et al. 2001). A search for eating disorders in eight volunteers with rumination, found that in three women childhood rumination predated the development of bulimia nervosa (BN) (Eckern et al. 1999).

Disturbed eating behaviours in ASD

Rumination

Rumination, the repetitive regurgitation of recently ingested food into the mouth with subsequent spitting or remastication and swallowing, is a problem in mental retardation and has been described in adolescents and adults with autism (Luiselli et al. 1994, Grewal and Fitzgerald 2002). Rumination should be considered at all ages, as well as at all levels of cognitive functioning (Parry-Jones 1994). In rumination gastric acids erode the teeth, and eating can be painful, which in turn can lead to food refusal. Medical problems also involve malnutrition and oesophageal abnormalities (Parry-Jones 1994).

Interventions in rumination

Treatment of rumination in ASD often includes medical, dietary and behavioural interventions (Luiselli et al. 1994). In individuals with normal intelligence interventions include reassurance, explanation and behavioural treatment e.g. habit reversal with practice of diaphragmatic breathing (Papadopoulos et al. 2007).

Pica

In pica, or eating inedible non-food substances, the individual has a preference for mouthing or chewing e.g. earth, paper, bottle caps, or parts of plants. In 70 mostly adult cases with mental retardation associated with autism, pica was a chronic problem in nine, and occurred occasionally in a further 33 patients, compared to 3 out of 70 hospitalised Down's syndrome patients (Kinnell 1985). Of note is that 25 in the autism sample were outpatients, thus, in both groups institutionalised

cases were included, and institutionalisation seems to be associated more with behaviour disturbances, including eating problems (Gravestock 2000). In a study of mentally handicapped adults living in community settings deviant eating behaviour was overrepresented in 15 subjects with autism compared to 33 adults with no autism diagnosis (O'Brian and Whitehouse 1990). Only two cases with autism (and none in the other group) had pica. Thus, pica may not be common in autism outside of the institutions, but when present it is potentially dangerous and not easy to treat. Pica may result in gastrointestinal problems or poisoning with heavy metals (Shannon and Graef 1996, Geier and Geier 2006). It has been recommended to test for lead in cases with a history of pica (Baird et al. 2003). Prescribed chelators have been used to try to remove tissue-bound heavy metals. However, one recent study of 17 individuals with autism, 12 of those with pica behaviour (Soden et al. 2007), failed to show excess chelatable body burden of arsenic, mercury, lead, or cadmium (although cadmium excretion rose marginally).

Interventions in pica

The individual with pica might be bored, anxious, or even depressed. Medication can reduce pica behaviours, but should be used together with stress alleviation, and positive reinforcement. Positive reinforcement is preferred to aversive treatment (Smith 1987) and includes snacks, increased activation, and praise and attention when the individual is engaged in desirable behaviours. Successful intervention replacing inedible items with e.g. chips has been described in a boy with autism and mental retardation. The schedule of reinforcement could be reduced without increases in pica (Kern et al. 2006). One young man ate cigarettes to get nicotine, a substance with a proven stimulating effect on attention, and lost interest when give nicotine-free herbal cigarettes (Piazza et al. 1996).

Overeating

Overeating is common in autism. In Boston, US, in a tertiary care clinic for developmental disorders, adolescents, mostly males, with ASD were more often overweight compared to those with ADHD and to an age-matched reference population (Curtin et al. 2005). Only a small number of those with ASD were on medication. In adult psychiatry where medication is often used for stress related behaviours with mood swings and aggressive outbursts, overweight is one of the most common adverse effects (Canitano 2005, Broadstock et al. 2007).

Eating disturbances in Asperger syndrome

In teenage boys with Asperger syndrome eating abnormalities with resulting underweight tend to be overlooked. The most common problem is selective eating, which risks getting out of hand in adolescence when parents surrender control to their teenager. Hebebrand and co-workers (1997) showed an over-representation of low body weight and abnormal eating behaviours in male adolescents with Asperger syndrome or schizoid personality disorder. That research group later found that of 36 male patients with ASD, mostly adolescents, three had anorectic-like eating behaviour. Thirteen had a BMI below the 10th percentile and five even below the third. As a group the patients with ASD had significantly lower BMI than that of a matched comparison group (Sobanski et al. 1999). Bolte et al. (2002) objected to the notion of anorectic problems in Asperger syndrome. However, while they found no case of AN, more than one male in four of their Asperger sample were underweight with BMI in the fifth percentile or below. Low weight was ascribed to hyperactivity. Men diagnosed with AN have been described as more often than women to be overactive, and at least as often as women to have obsessional traits and early problems with friendship (Crisp et al. 1986, Sharp et al. 1994). In adults with ASD and normal intelligence, health reasons are often the given explanation for vegetarianism and other special diets. Refusal of prescribed medicine except for vitamins, and preference of complimentary herbal medications seem to be common in clinical practice.

Polydipsia

For reasons unknown, psychogenic polydipsia, to the point of dangerous water intoxication, presents a special problem in autism with mental retardation, and might be twice as common as in mental retardation without autism (Terai et al. 1999). In Asperger syndrome many clinicians have come across ritualised, repetitive water intake. However, there is only one publication on water intoxication in Asperger syndrome, and that concerns a case of diabetes insipidus and an empty sella (Raja et al. 1998).

Food neophobia

In accordance with a general fear of anything new, avoidance of all new foods, a trait termed food neophobia, is common in autism and has been linked to selective eating (Cooke et al. 2006). High levels of general neophobia have been linked to low levels of sensation seeking (Galloway et al. 2003). Interestingly, food neophobia was a highly heritable trait in a large twin study in the United Kingdom (Cooke et al. 2007). Even if food neophobia and selective eating in ASD are linked together, one recent review stresses the importance to deal with them separately in research and in treatment (Dovey et al. 2007). The individual with a fear of everything new but who would eat most foods once he or she has tried them has a different problem from one who cannot stand the texture of certain foods.

Selective eating

Selective eating in children (e.g. eating only ten foods or fewer, sometimes food of a special colour, texture or brand, avoidance or refusal of new foods) seems to be more frequent in boys than in girls (Timimi

et al. 1997). The behaviour usually does not affect weight but the child's fussiness about food affects social activities (Christie et al. 1995). In most cases selective eating tends eventually to resolve. In other cases selective eating seems to be one expression of ritualistic behaviour in children with ASD, and some of those will persist in their eating patterns. Another cause of picky eating is that most people in the autism spectrum are sensitive to textures, smells, and looks of foods (Whiteley et al. 2000). In a study of observed feeding behaviour in 30 children with ASD, half the group had feeding patterns indicating problems with selective eating (Ahearn et al. 2001). In a controlled study, parents of 138 children with ASD significantly more often reported food refusal, requiring specific utensils or particular food presentations, acceptance of only pureed or low textured foods, and a narrow variety of foods (Schreck et al. 2004). Those findings did not extend to the other members of the families of children with ASD who ate as many foods as the families with normally developing children. However, in their next study of feeding in ASD, the authors demonstrated that families with restricted diets had children with autism with more restrictive eating (Schreck and Williams 2006). Selectivity, especially selectivity by type of food but also by texture, was overrepresented in children with autism when compared to peers with Down's syndrome and to those with cerebral palsy (Field et al. 2003). Another study reported almost exclusively selectivity by type (Ahearn et al. 2001) In rare cases the individual will go on eating only baby food from childhood. However, most adolescents and adults with Asperger syndrome are afraid of lumps in their food, but also have problems with mushy food. Foods mixed together, like stew or casseroles are inedible. Some want their food neatly separated on their plate. Some will eat meat first, after that the potatoes, while other vegetables are often avoided altogether. Colour can be an issue, e.g. only white food (rice, pasta, milk) is accepted.

Interventions in selective eating

Parents of non-autistic children are often told that selective eating is a phase. However, studies indicate that fruits and vegetables are the food items less liked, and a rather large-scale study showed that picky children by parent-led repeated exposure could learn to eat vegetables (Wardle et al. 2003). In ASD it is even more important to address the problem as soon as possible. Various food-presenting methods to facilitate acceptance of new food or previously rejected food could be used in any age group, also in adult years. Such strategies could be to make a rule of always to try at least a mouthful and at least once, or to fade in new foods, or non-preferred foods or drink (Hagopian et al. 1996), or to simultaneously present small amounts of non-preferred food to be eaten just before preferred food. Appreciated condiments such as ketchup, or sweeteners such as honey, could be used initially to make the new food palatable (Ahearn 2003). Positive attention and praise are given for eating non-preferred food (Najdowski et al. 2003). Combinations of fading in new foods, repeat taste sessions, and escape prevention requiring the person to really taste the food were effective in normalizing feeding in two children with ASD, one of which was fed with a gastrostomy tube before the interventions (Paul et al. 2007).

Underlying mechanisms in disturbed eating behaviours in ASD

Sensory abnormalities

Odd reactions to stimuli are commonly associated features of ASD (APA 1994). However, although often reported in ASD (e.g. Nieminen-von Wendt 2005, Rogers and Ozonoff 2005), sensory anomalies are not included in the ICD-10 research criteria for childhood autism or in the DSM-IV criteria for autistic disorder (Kern et al. 2007). Problems with food and mealtime behaviours in individuals with ASD have a multifactorial background, and sensory abnormalities with hyper- or hyposensitivity to auditory, visual, tactile stimuli and to smell/taste may play a large part. A recent study found 21 children and adolescents with autism and normal intelligence to be significantly less accurate in identifying basic tastes and odours than 27 typically developing age-matched participants (Bennetto et al. 2007). The use of extremes of ketchup or salt to make the food tasty might be attributed to taste hyposensitivity (Ahearn 2003). Problems with warm or cold food could be attributed to sensory aberrations. Odd reactions to auditory stimuli could make the noise of chewing an apple unbearable. Deficits in tactile sensitivity explain why the individual with ASD often does not feel when to wipe his/her mouth when eating.

Up till recently there has been no systematic instrument pertaining to autism that includes questions for the detailed study of sensory aberrations. Using the Diagnostic Interview for Social and Communication Disorders (DISCO) (Wing et al. 2002) to obtain information about responsiveness to a wide range of sensory stimuli, Lorna Wing's group found sensory abnormalities across age and ability in 185 of 200 children and adults with autism (Leekam et al. 2007). No age or IQ differences were found for touch, smell/taste, pain or auditory stimuli. Of adolescents and adults over 50 % of low functioning and 40 % of high functioning individuals with autism showed deviant reactions to smell and/or taste. Concerning visual stimuli, sensory symptoms seemed to be fewer with age, and they were less frequent in those with high functioning autism. Still, the authors show that individuals with high functioning autism differ more from non-autism peers than low functioning individuals, i.e. individuals with low IQ seem to have sensory aberrations to a large extent whether they have autism or not.

Of adolescents and adults, 26 % with low functioning and 12 % with high functioning autism tended to put everything in their mouth and/or refused food that was lumpy or needed chewing (Leekam et al. 2007). Non-food items might be mouthed for oral stimulation (Piazza et al. 1998). Unusual sensations in the mouth might lead to putting soothing stuff in the mouth. Increased sensitivity in the mouth, including the teeth, or in the pharynx could make the individual cautious about new foods.

Interests

Restricted and intense ideas and interests are part of ASD (APA 1994) and affect the eating repertoire in ASD. People with ASD may have their own ideas on nutrition. Some try to treat their body like a machine. They try to find out the appropriate food amount required, and do not feel, or do not attend to feelings of hunger and satiety, or to the pleasure of eating. They need knowledge of nutrition and metabolism. Some basic cooking training may help persons with Asperger syndrome to understand that feeding is not an exact science. Orthorexia nervosa (Donini et al. 2004) is a fixation on healthy food to a degree when the individual gives up his/her normal life style (Bagci Bosi et al. 2007) and where some foods are thought to be dangerous or artificial, as opposed to healthy or natural. Orthorexia nervosa has not been validated as a diagnosis and the proposed criteria suggest that some of the cases diagnosed with orthorexia nervosa might better be described as individuals with Asperger syndrome with an encompassing interest in food. The monomaniac pursuit of correct eating in combination with a deficit in common sense would make this fixation particularly dangerous in ASD.

Routines

Eating and food preparations are to some extent ritualized behaviours in most cultures. In ASD, eating routines are often rigorously ritualized. Eating the same food day after day is common and may be due to anhedonia, but as often it seems to be due to insistence on sameness. Quoting a patient who really enjoyed her food: 'If I liked it today, I will like it tomorrow.' Furthermore, their eating habits tend to be rather unconventional (Schreck et al. 2004), and such behaviours can have a negative impact on social life. It is important to learn to eat in a way acceptable to other people, and as someone with Asperger syndrome depend on good habits in socially challenging situations (Bledsoe et al. 2003) some routines may be beneficial. When eating in company, people with ASD have to know how to lay the table, how to serve food, which chair to use. They need to know the plan for the meal, how long it will take, what is to be served.

Social interaction and other skills involved in dining

Eating with other people is an ordeal for many in the autism spectrum. In most cultures eating together is a stimulating event to be looked forward to. To manage small talk, and at the same time chew and handle your fork and knife requires the ability to perform at least two things simultaneously and to automatise processes, which is insurmountable to most people with Asperger syndrome. If the parents have not been sensitive to their children's problem in picking up basic mealtime etiquette, it is difficult to acquire that knowledge in adulthood. Acceptable behaviour when eating with others is something that, to a certain extent, can be learned. For all ages social stories can be of use, provided that the individual is motivated (Crozier and Ticani 2007), and that the story can be elaborated together with the individual to meet his/her special needs. Case studies stress the importance of over-learning (Bledsoe et al. 2003). The difficulty in ASD to generalise from one situation to another makes it important to follow up on behavioural interventions. Good habits that have been learnt will not automatically be practised in a new situation. The poor time estimation makes it difficult to eat in pace with others and to know when the meal is over and it is appropriate to leave the table. One problem in ASD is to estimate quantity and size. Adults with ASD prefer exact recipes and 'standardized' food portions. An individual with Asperger syndrome would need to know exactly how many cookies to take when offered.

Motor functioning

Eating is a multitask performance requiring many skills that often are in deficit in ASD. Motor problems, or development coordination disorder (DCD) is common in ASD, and seem to persist in adults with Asperger syndrome (Tani et al. 2006). The use of knife and fork seems to be especially difficult. There is often a problem to imitate (Avikainen et al. 2003), which may explain observations of individuals using cutlery in an idiosyncratic way. To chew, and at the same time prepare for the next bite is difficult. Oral-motor dysfunction should be considered when there is avoidance of food items that are difficult to chew or swallow, or problem with drooling. Oral-motor training can be of help in some cases (Sjögreen et al. 2001).

Gastrointestinal problems

In children with ASD a high rate of gastrointestinal symptoms are reported, compared to peers, in most cases with no known medical causes (Levy et al. 2007). Frequency of gastrointestinal abnormalities, including abnormal stool consistency (e.g. bulky or loose), seems to be increased. Food allergies have been suspected to increase autistic behaviours in autism (Jyonouchi et al. 2005, Murch 2005), leading to the recommendations of diverse diets (Cormier and Elder 2007). A Cochrane review of casein and gluten free diets for ASD found insufficient ground for recommendation of such diets (Millward et al. 2004). It has even been proposed that autism might be a disorder with abdominal features, but according to a recent review, studies are far from conclusive (Erickson et al. 2005). However, in the individual with food, appetite or weight problems gastrointestinal and oral anomalies (Shapira et al. 1989) should be considered.

AN as a neurodevelopmental disorder

AN is a severe eating disorder characterized by underweight caused by intensive regimes or food refusal periods, and distorted ideas about weight and shape. Since the eighties it has been considered a multifactorial illness with biological, psychological, and social

determinants. Data from twin studies suggest that at least half of the variance in the development of the eating disorders may be accounted for by genes (Klump and Culbert 2007), and that factors suggested to be inherited might include obsessive-compulsive traits and a rigid cognitive style (Treasure 2007). That means environmental factors play a part, sociocultural factors for instance, but also biological factors; e.g. in a register study, perinatal factors, possibly reflecting brain damage, had independent associations with AN in girls (Cnattingius et al. 1999). Examination of personality traits and biological correlates in AN suggests that this eating disorder belongs to the spectrum of neurodevelopmental disorders, recently proposed by Connan and co-workers (2003), and by Gillberg who already in 1992 speculatively placed AN in the spectrum of neurodevelopmental disorders including ASD, ADHD, OCD/OCPD, and tic disorders. A newly published comprehensive review of social cognition in ASD and AN suggest the existence of a subgroup in AN with a cognitive style very similar to that in ASD (Zucker et al. 2007).

Familial factors - a suggested link between ASD and AN

Supportive of a connection between ASD and AN is the finding of AN in the extended families of children with autism. A few reports have been published on individuals with childhood autism and teenage onset of AN (Stiver and Dobbins 1980, Kinnell 1983, Rothery and Garden 1988, Fisman et al. 1996), and the occurrence of AN and autism in different members of extended families (Gillberg 1985, Comings and Comings 1991, Steffenburg 1991). In these reports are suggested that ASD and AN share some features, namely obsessiveness, insistence on sameness and social impairment. In a community-based study, there were significantly more first-degree relatives with two or more of the four DSM-IV social impairment symptoms of autism in the AN group than in a well-matched healthy comparison group (Wentz Nilsson et al. 1998).

Gender issues

AN and Asperger syndrome are both considered to be 'specific' to one gender. In AN 9 out of 10 are female (Råstam et al. 1989, Hsu 1996). In clinical studies only one or two in ten cases of Asperger syndrome is a girl, even though in the general population the gender ratio was shown to be three boys to one girl (Ehlers and Gillberg 1993). Instruments and criteria have been developed and validated mostly on males in the autism spectrum and on females in the clinical eating disorders. One study based on national registers in Sweden compared 61 male adults born in 1968 to 1977 who had been hospitalised because of AN at mean age 14.9 years to age matched peers in the general population (Lindblad et al. 2006). The AN sample seemed to have a rather favourable prognosis except for family aspects. In adult years, they significantly less often had a life involving a partner and children, which is in agreement with another controlled study of male AN (Woodside et al. 2001). In a report on males with eating disorders based on 135 medical records on both in and outpatients, 30 men had been diagnosed with AN (Carlat et al. 1997). Of that group six men were evenly divided across DSM clusters A, B, and C, which would suggest odd and eccentric personality to be more common in men than in women with AN according to a recent review (Cassin and von Ranson 2005), but the male sample was too small to draw conclusions. Concerning personality traits, there are only two interview studies describing reasonably large samples of males with AN (Crisp et al. 1986, Sharp et al. 1994), comparing them to female samples. Except for more exercising in men, both studies show women and men to be very similar concerning age of onset and symptoms of AN. In one study (Crisp et al. 1986) one in two out of 36 males had shown premorbid obsessionality, one in five had been very shy, one in two had few or no friends during childhood, and one in five reported poor appetite in childhood. In the study by Sharp and co-workers (1994) nearly one third of the men described obsessional traits throughout childhood, being "meticulous", "thorough", "ruled by the clock", "always taking hobbies to extremes".

Men with AN are more often than women described as atypical cases based on psychiatric traits and symptoms (Hilde Bruch 1973). Amenorrhea in females is a clear and often early symptom of AN, included in the DSM-criteria. The corresponding endocrinological aberration in men of lowered testosterone levels causing decreased sexual drive manifests itself more gradually (Andersen 1995). Low weight in males is often given other explanations than AN (Bolte et al. 2002). In order not to miss male individuals with AN or BN, instruments and criteria should be reconsidered with the male population in mind.

In the same way, if the criteria of ASD were to be broadened to include behaviours and attitudes more appropriate to females, maybe more girls would be considered for ASD. It would seem that at adult age gender differences are not so predominant (Stahlberg et al. 2004). One reason for this might be that girls with high functioning autism seem to have better early social development than boys, while after the age of ten, according to parent reports they have fewer friends than boys (McLennan et al. 1993), whether because the girls are more autistic at that age than before, or because of the increasing pressure with age on girls to be socially interactive, remains unknown.

Personality traits

Personality traits, suggested to be highly heritable, have always been given an important role in AN (Cassin and von Ranson 2005). Obsessionality is a major feature in AN and at least partly due to starvation. An experimental US study (Keys et al. 1950) demonstrated how obsessiveness could be induced by semi-starvation. Healthy young men agreed to practically starve for six months and then gradually increase their food intake for another six months. Their eating behaviour became increasingly disturbed, and some men showed

obsessions and fixations, some not even food-related. It has been argued that ASD, especially Asperger syndrome, and OCD (obsessive-compulsive disorder) and OCPD (obsessive-compulsive personality disorder) have many symptoms in common and overlap in subgroups (e.g. Gillberg and Råstam 1992, Gillberg and Billstedt 2000, Russell et al. 2005, Bejerot 2007). In a study of 238 adults with OCD, 27 % met criteria for comorbid OCPD. Those with OCD and OCPD combined were significantly more likely to have symmetry and hoarding obsessions, and cleaning, ordering, and repeating compulsions, and also avoidant personality disorder and impaired social functioning (Coles et al. 2007) i.e. symptoms reminiscent of ASD. In recovered AN subjects restraint in emotional expression and OCD/OCPD are overrepresented (Casper 1990, Halmi et al. 1991, Berkman et al. 2007), the most common OCD symptoms being symmetry, exactness, and ordering, arranging (Halmi et al. 2003, Råstam et al. 2003). Controlled studies have shown obsessionality premorbid to AN (Thornton and Russell 1997, Anderluh et al. 2003), and OCPD and autistic traits (Råstam 1992, Råstam and Gillberg 1992). In a risk factor study premorbid perfectionism was elevated in AN subjects compared to healthy controls (Fairburn et al. 1999). In a London clinic for treatment of eating disorders of long duration, a history of childhood autistic traits and attention problems was common in adult women (Wentz et al. 2005). A systematic review of outcome AN studies gave 'reasonable evidence' for associating perfectionistic and obsessive-compulsive personality traits with negative outcome (Crane et al. 2007).

In a controlled prospective community-based study from our group (Wentz et al. 2001), ten years after adolescent onset AN, only three out of 51 subjects had persisting AN. Still, global functioning scores were low, due to eating disorders or other psychiatric problems, the most common being OCD, OCPD and ASD, assigned by a rater blind to original diagnostic status of AN or healthy comparison group. At every follow-up of this sample, a (different) blind rater has diagnosed at least one in four as having autistic traits and 'empathy problems' (Gillberg et al. 1995, Råstam et al. 2003). Our group is currently studying outcome 18 years after onset of AN in the same sample with the aim to evaluate the prognostic impact of autistic traits. Within the original AN sample, there is a subgroup of one in seven with a childhood history of ASD or OCPD with marked autistic traits, and with a stable diagnosis of ASD at every evaluation. None of those had been diagnosed with ASD as children. According to their mothers interviewed retrospectively at the diagnostic study (Råstam 1992), in childhood those girls had few peer relations, tended to be dependent on only one friend and were extremely vulnerable to losing that friend. They were described as 'good' docile girls, who could be stubborn with inexplicable outbursts. They had been perfectionistic and overachieving. They would do bizarre things like replacing their doll with a dead squirrel, or go to school dressed as Pippi Longstockings for two whole years. According to their own report, they had tried to imitate role models and accommodate to rules made by other people, but had always felt like outsiders (Råstam et al. 2003).

Cognitive deficits

Problems with theory of mind, the ability to make inferences about other's mental states, a requirement for being able to empathize with other people (Happé et al. 1996) may be one explanation of the poor social skills observed in AN. A study by Tchanturia et al. (2004a) on story comprehension and cartoon tasks for Theory of Mind, could not demonstrate differences between 20 adult women with AN and 20 age- and sex-matched controls, but their report stresses that there was a subgroup within the anorexia group with a clear theory of mind impairment that the study did not have power to demonstrate statistically. Clinical studies using the Toronto Alexithymia Scale (TAS-20) have suggested an association between AN and alexithymia, defined as a restriction in the ability to identify and describe feeling states (Schmidt et al. 1993, Taylor et al. 1996), and also the difficulties in AN to identify feelings towards others (Sexton et al. 1998). Alexithymia has been described in Asperger syndrome as well (Fitzgerald and Bellgrove 2006), and could be seen as one aspect of Theory of Mind (Morigushi et al. 2006, Hill and Berthoz 2006, Lombardo et al. 2007). Råstam et al. (1997) found that a subgroup of weight-recovered anorexics had particularly high TAS-scores, and that most subjects in that group had 'empathy problems'.

Repeated neuropsychological assessments in weight-recovered AN point to normal intelligence compared to age-, and sex-matched controls and to norms (Gillberg et al. 2007). Studies indicate that weak coherence with a tendency to focus on details, and the inability to integrate pieces of information into coherent wholes, may be a cognitive style specific to both ASD and AN (Booth et al. 2003, Gillberg et al. 2007). Further, set-shifting difficulties persisting after recovery from the eating disorder, indicating a rigid cognitive style, have been reported (Tchanturia et al. 2005). That these might be endophenotypic traits has been proposed (Holliday et al. 2005) based on a study that showed that in 47 female twin pairs the subjects in the AN group did not differ in their slow set-shifting and perceptual rigidity from the non-anorectic sisters. Furthermore, the twin pairs had more set shifting problems than unrelated healthy women. In AN, dysdiadochokinesis has been reported (Råstam 1992, Tchanturia et al. 2004b) persisting long after recovery (Råstam et al. 2003). Dysdiadochokinesis, thought to involve the cerebellum, is a neurological soft sign often found in childhood neurodevelopmental disorders, and in Asperger syndrome seems to persist into adulthood (Tani et al. 2006).

Stress levels have been shown to predict the development of eating problems in AN (Rosen et al. 1993, Schmidt et al. 1997). The ability to cope with adverse events seems to be impaired in AN (Troop et al. 1998). In one study female adolescents with AN had neurophysiological anomalies in responses to stress compared to healthy controls (Zonnevylle-Bender et al. 2005). In both ASD and AN studies suggest a potential role for the neuropeptides in stress vulnerability and social affiliation (Fetissov et al. 2005, Bartz and Hollander 2006).

Brain Neurochemistry

Anomalies in the serotonergic system have been implicated in adults with Asperger syndrome (Bostic and King 2005, Murphy et al. 2006). Altered brain serotonin transmission after recovery from AN has been reported (Kaye et al. 2005), and findings suggesting that abnormal serotonin functioning may be a trait vulnerability for AN (Bailer et al. 2005). In a recent study, subjects with BN and their mothers and sisters had significantly lower density of platelet-paroxetine binding than did comparison subjects and *their* mothers and sisters (Steiger et al. 2006), suggesting a heritable trait involving the serotonin system. Alterations in the dopamine system have been linked to hyperactivity in neurodevelopmental disorders, and is altered in recovered AN (Frank et al. 2005). Mercer and Holder (1997), in an extensive review on both animal and human research, pointed to the relationship between endogenous opioid and food intake. Furthermore, altered central opioid activity could be linked to food cravings in autism and to the clinical eating disorders, AN and BN.

Conclusions

Concerning eating behaviours in ASD few population-based studies have been done, none on adults. Of the case series only a few include a control group. Concerning some ASD behaviours only case notes exist. There is a growing literature on AN as a neurodevelopmental disorder. With a few exceptions, ASD in AN have not been reported, or indeed researched.

Abnormal eating behaviours are overrepresented in ASD in all ages and at all cognitive levels, including food refusal, pica, rumination, and selective eating. Those disturbances can have detrimental complications and are often resistant to treatment. Selective eating and extreme diets are a special and common problem in adults with Asperger syndrome.

Early feeding problems appear to be a risk factor for later development of a clinical eating disorder. The findings of persistent dysdiadochokinesis, an uneven cognitive profile, and altered brain net working after recovering from AN may be the sequels of semi-starvation, further affected by the social isolation inherent in the illness. However, those findings also suggest the notion of AN as a developmental illness, especially considering the evidence from genetic studies and from reports of early developmental history in AN. Furthermore, in some cases the eating disorder may be regarded as one of the ritualistic phenomena expressed by an individual with a life-long mild ASD.

In the same way that Asperger syndrome is sometimes not recognised in female teenagers with an eating disorder, AN tends to be overlooked in obsessive young males with low weight and abnormal eating. Only if one takes an 'autism spectrum' view as regards the treatment of ASD is it likely that outcome will be positive. Treating eating disorders in ASD poses various kinds of challenges.

Some implications of this review of eating disturbances in ASD

1. Future research to address gender issues is required e.g. developing criteria and instruments less focused on the male prototype of Asperger syndrome and other ASD
2. There is a need for structured, standardised instruments detailing eating disturbances in ASD for all ages and for all levels of cognitive functioning
3. Epidemiologically based controlled long-term follow-up studies into adult years of eating behaviours in ASD are needed
4. The finding that ASD, OCD, OCPD and AN may share personality traits and cognitive style is worthy of future genetic study
5. The eating disturbances must be addressed in treatment research in ASD
6. In the field of eating disorders, criteria and instruments less focused on the typical clinical picture of a teenage girl with anorexia nervosa must be developed
7. Despite their supposedly small numbers, males should be more often included in clinical eating disorders research, also the atypical cases.

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