

Neurodevelopmental movement disorders – an update on childhood motor stereotypies

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AIM The term 'stereotypies' encompasses a diverse range of movements, behaviours, and/or vocalizations that are repetitive, lack clear function, and sometimes appear to have a negative impact upon an individual's life. This review aims to describe motor stereotypies.

METHOD This study reviewed the current literature on the nature, aetiology, and treatment of motor stereotypies.

RESULTS Motor stereotypies occur commonly but not exclusively in autistic spectrum disorders. Similar movements are also found in otherwise healthy children and those suffering sensory impairment, social isolation, or severe intellectual disabilities; they may be persistent over time. Although often difficult, it is possible to define and differentiate stereotypies from other movement disorders such as tics through features of the history, such as earlier onset and examination, together with the presence or absence of associated neurological impairment or developmental difficulties. Co-occurrence with other disorders affecting frontostriatal brain systems, including attention-deficit-hyperactivity disorder, obsessive-compulsive disorder, and tic disorders, is common.

INTERPRETATION The underlying function of motor stereotypies remains unclear but may include the maintenance of arousal levels. A neurogenetic aetiology is proposed but requires further study. When treatment is sought, there are both pharmacological and behavioural options. Behavioural treatments for motor stereotypies may in time be shown to be most effective; however, they are difficult to implement in children younger than 7 years old.

The Diagnostic and Statistical Manual of Mental Disorders, 4th edition, Text Revision classifies stereotypies as 'repetitive, seemingly driven, and non-functional motor behaviours' that interfere with normal activities or result in injury and are present for a minimum of 4 weeks.¹ Consensus dictates that movements are considered to be stereotypic if they appear involuntary and rhythmic in nature, have a pattern, amplitude, and location that are predictable, and are of a nature that can often be suppressed with distraction.² Stereotypies are not better accounted for by a tic or compulsion, although some degree of overlap and co-occurrence with other disorders affecting frontostriatal brain systems, including attention-deficit-hyperactivity disorder, obsessive-compulsive disorder, and tic disorders, is common and also cannot be explained by the physiology of substance use or through a general medical condition. Stereotypic behaviours include hand flapping or twisting, body rocking, head banging, lip-smacking, chewing movements, and humming.³ Motor stereotypies are a subset of a broad range of stereotypic behaviours. This paper aimed to review current knowledge about the nature, aetiology, and treatment of motor stereotypies and highlight areas for future research.

Historical context

Stereotypies had been reported in the literature before emerging as an area of interest in their own right. Ridley and Baker.⁴ described stereotypies as a movement situated between those that are repetitive, such as tremor and myoclonic jerks, and those that are skilled, learned, voluntary repetitive movements. Referencing Woodward (1918), Ridley and Baker described stereotypies as movements that combine into rhythmic and complex sequences that have attained a degree of functional autonomy.⁴ Stereotypic movements exist within a spectrum of other neurological movement disorders. There has been debate in the literature concerning the nature of the movements, whether they can truly be considered to be without function, and how (if at all) they differ from other movements such as motor mannerisms and tics. Subtle differences in the nature of these types of movement according to current research and clinical observations are given in Table I. A definition of stereotypies was sought in Brussels in 1983 to allow those in the farming industry to recognize the behaviours of animals farmed intensively; however, Dantzer⁵ highlighted the conflict that can exist between subjective and objective inter-

Table I: Definitions

Term	Definition
Stereotypy	Repetitive, apparently non-functioning movement, vocalization, or behaviour which is present for over 4 weeks and interferes with life or results in self-injury. Lacks the premonitory urge associated with tics
Motor mannerism	Repetitive, distinctive behavioural trait displayed by an individual. No requirement for it to interfere with life or cause self-injury
Habit	Routine or behaviour repeated regularly. Can lack the distinctiveness of mannerisms. No requirement for it to interfere with life or cause self-injury. No requirement for it to be motor in origin
Tic	Sudden, rapid, recurrent, non-rhythmic motor movement or vocalization, often associated with a premonitory urge and feeling of relief once the tic has been performed. Usually suppressible and suggestible. Wax and wane. Type and site often change
Compulsion	An overwhelming irresistible urge to perform an act or ritual

pretation of behaviours. The consensus that stereotypies are non-functional is based on the observer's understanding of the nature of the action, rather than that of the person performing it.⁶ The definition currently applied is one based on a limited understanding of the nature of the movements; this may change with increased use of functional neuroimaging, advances in genetics, and neuropathology studies. It is the authors' opinion that they will become markers of specific genetically defined neurodevelopmental phenotypes.

Classification

Stereotypies may be divided into distinct groups. They are first categorized as primary or secondary, depending on whether or not they occur in the context of neurological or developmental disorders. Stereotypies most commonly involve the motor system; these form a distinct group of stereotypic behaviours. Primary motor stereotypies tend to occur in typically developing children, and these classically remain stable or regress with age. There are three subtypes of primary motor stereotypies: common, complex arm and hand, and head nodding.⁷ Head nodding is classified within a group of its own since it more commonly occurs in those who have a family history of this type of stereotypy. Stereotypies that belong in the 'common' class include rocking, head banging, and finger drumming. Complex hand and arm movements include hand and arm flapping, waving, and arm shaking. It has been reported that such stereotypies occur in up to 7% of healthy young children.⁸

Secondary stereotypies exist in the context of developmental delay or disorder and are less likely to regress over time. The nature of secondary stereotypies is diverse. Motor stereotypies are the most common class of stereotypic behaviour; however, other stereotypic behaviours, such as vocalizations or visual stereotypies, also occur. Rett syndrome is a well-known neurodevelopmental disorder linked to a mutation in the *MECP2*

What this paper adds

- We review how motor stereotypies are defined and classified as well as the proposed aetiological basis of motor stereotypies.
- Current data regarding the effectiveness of behavioural approaches for management are described.
- Examples to illustrate emerging evidence for a genetic aetiology in some children are provided.

gene. Hand stereotypies predominate this condition; however, it has been shown that phonic stereotypies may also be present.⁹ A study on frontotemporal lobe degeneration showed that 18.8% of individuals with this condition had a phonic stereotypy.¹⁰ These were divided into vocal speech, such as saying 'ouch' or 'OK', and non-verbal speech, such as throat clearing, humming, chuckling, and coughing.¹⁰ Atypical gazing at fingers or objects is also thought to represent possible stereotypy, especially with autism.¹¹ Stereotypies are also present in neurometabolic disorders alongside other movement disorders, such as dystonia, myoclonus, chorea, and tremor.¹² Table II outlines genetic, metabolic, and degenerative conditions associated with secondary stereotypies.

Differentiating from other conditions

Table I outlines the definitions of movements seemingly similar to stereotypies through features of history, observation, and examination. In typically developing children, tics, compulsions, and paroxysmal dyskinesias are significant differentials that have to be ruled out before diagnosing a primary stereotypy. A comprehensive list of differential diagnoses to be considered may include myoclonic jerks, dystonias, chorea, drug-induced movements, focal seizures, restless leg syndrome, hyperekplexia, and psychogenic movement disorders. Differentiation from seizures is important to avoid unnecessary antiepileptic pharmacotherapy.

Helpful features in differentiating stereotypies from tics are the presence of a premonitory urge suggestive of a tic, and onset after 3 years of age, as stereotypies typically first appear before 3 years of age.¹³ Migration of tics is also more common in Tourette syndrome than in stereotyped movement disorders, in which a single stereotypy remaining relatively stable through childhood is more commonly observed. In contrast to stereotypies, compulsions are often an attempt to reduce

Table II: Secondary causes of stereotypies

Genetic/ neurodevelopmental	Rett syndrome, Williams syndrome, Down syndrome, fragile X syndrome
Metabolic	Phenylketonuria, adenylosuccinate lyase deficiency
Degenerative	Frontotemporal lobe degeneration, pantothenate kinase-associated neurodegeneration
Vascular	Stroke
Sensory	Visual or auditory impairment
Infection	Post streptococcal pharyngitis
Inflammatory	Encephalitis lethargica syndrome
Immunological	Syndrome of paraneoplastic anti-N-methyl-D-aspartate receptor encephalitis
Acquired	Acquired brain injury

distress and their performance is in the context of inflexible rules and intrusive thoughts.¹⁴

It is vital not to overlook neurological signs on examination or in the history. It is necessary to differentiate a primary stereotypy from a secondary one, as appropriate treatment of the underlying neuropathology may improve the course and duration of the stereotypy. In following these criteria, the diagnosis of a stereotypy becomes a diagnosis of exclusion. Referral to an expert centre is recommended where doubt exists, or for support in classification.

Aetiological concepts

The functional and aetiological basis of stereotypies has been discussed in the literature. Troster et al.⁶ outlined four main viewpoints. The first view is that stereotypies are learnt behaviours that are maintained through continued reinforcement.⁶ The reinforcement can be associated with a positive or negative situation or sensation. The child initially learns that the stereotypy can lead to avoidance of a negative situation (negative reinforcement) or can induce a positive outcome (positive reinforcement), thus this behaviour is repeated in order to elicit the same desirable response. However, this theory does not explain why stereotypies persist in some people and not others, since if they are an adaptation to avoid distress or increase positive reinforcement, their existence would be favourable for survival.

A second theoretical basis of stereotypies is developmental, which suggests that the movements are an external reflection of internal neurological maturation occurring at differing appropriate stages of development. Children who have other developmental abnormalities would therefore display temporally inappropriate stereotypies, or they would persist for longer than anticipated.⁶ Gesell and Amatruda¹⁵ stated that 'an examination of infant behaviour is essentially an examination of the central nervous system', and in 1954 Gesell went on to suggest that rocking in a young child is a stage of prone progression related to neurological maturation.¹⁶ Thelen¹⁷ studied 20 infants biweekly during the first year of life and was able to describe 47 movement patterns that were repetitive in nature and occurred at specific times of development. He concluded that stereotypy was strongly correlated to motor development in the stereotypic area of motor action and suggested that 'incomplete cortical control of endogenous patterning in maturing neuromuscular pathways' was the aetiological basis.¹⁷ There are difficulties in applying this theory to children who display stereotypies at an incongruous time but have no other neurological impairment. However, detailed analysis of these cases, looking specifically at slight differences in neurobiology, neurotransmitters, and receptor density, might illustrate subtle differences that are not great enough to manifest in any way other than as a stereotypy.

A third proposal has been a functional view: stereotypies exist to moderate levels of arousal. This view proposes that stereotypies may be more common in children with a disability as they lack the creative means of increasing their interest in understimulated environments and also because they may receive less stimulation as a result of their disability.⁶ In this

way the role of stereotypies is to increase or decrease stimulation to the level at which other people function. Stereotypies occur more frequently in children with autism than in typically developing children. At times of high internal or external environment arousal, stereotypies may have a role in focusing attention into movement, thus decreasing the high input of stimuli. Similarly, in a child who is not receiving adequate stimulation from the environment, or who is unable to process this effectively, the stereotyped movement may increase (top up) the stimuli available to a more appropriate level for functioning. Thus, stereotypy acts as a form of self-stimulation that can compensate for a deficit in external arousal, or may be an attempt to reduce external distractions by directing actions into movement.¹⁸ Stereotypies are also common in children with sensory deficits, perhaps to moderate arousal in the absence of a sense that would typically increase or avert their attention. Fazzi et al.⁸ demonstrated stereotypic traits in 73% of blind individuals and found an increased incidence where the environment was restrictive, where there was reduced sensory stimulation, and where there was reduced mobility. Conversely, reductions in these behaviours could be achieved when appropriate adaptive behaviours were stimulated.⁸ Troster et al.⁶ analysed questionnaires relating to 85 children who were blind and found that all children displayed at least one stereotypic behaviour per week; in 25.9% of the population, at least one stereotypy could be observed almost hourly. The report also illustrated the environments in which the children displayed the most stereotypic behaviours – when bored, when delighted, when left alone, when excited, or when tired⁶ – thus supporting the idea of a functional role in modulating levels of arousal, as they appear at either end of the arousal continuum rather than at a level of medium stimulation.

A functional basis for stereotypies can also be applied to social deficits due to isolation. Bos et al.¹⁹ studied the incidence of stereotypies in children in foster care in Romania compared with children who remained in institutional care. There was no statistical difference in the presence of stereotypies in the children before the start of the study; however, there was a statistically significant difference at 30, 43, and 54 months.¹⁹ The functional viewpoint is also supported by early work by Thelen,²⁰ which suggested that humans are like other primates in their attempts to provide vestibular stimulation by their own movements when stimulation typically provided by their mother is greatly reduced. They found that the single variable accounting for most variance in the amount of stereotypy was the frequency of vestibular stimulation of the infant, from being rocked, bounced, or carried by a caregiver. Stereotypy was inversely related both to the amount of vestibular stimulation received and to the frequency of behaviours that involved close contact with the caregiver.²⁰

The final area for proposed aetiology (which the authors' own group believes has a strong role in stereotypy prevalence) is neurobiology and genetics. It is possible that stereotypies occur as a result of alteration in the biochemical pathways secondary to genetic alteration in the individual. A study by Harris et al.² of children without autism who displayed stereotypic movements found that 17% of participants had a first-

degree relative with motor stereotypies, and this figure rose to 25% when second-degree relatives were included.² A monozygotic twin pair with severe learning difficulties has also been used to suggest a genetic component, as they displayed a concordance rate for scored stereotypies of over 90%.²¹ Currently no data are available on the development of stereotypies in a twin pair raised in separate environments. Detailed genetic analysis has begun with regards to Rett syndrome as stereotypies are a constituent feature. In one study of 144 females with Rett syndrome, 96.4% of those with a pathogenic mutation experienced stereotypies, and 61.8% of participants who had a mutation in the *MECP2* gene displayed a midline hand-wringing stereotypy.²² Animal models of genetic disorders in which stereotypy is a significant feature have also been used to examine their genetic basis. An appropriate animal model was thought to be the Ts65Dn mouse model of Down syndrome, as one-third of humans with this condition display stereotypies. It was found that stereotypies occurred in a subset of Ts65Dn mice and there was an absence of repetitive jumping in control mice, suggesting that stereotypies were due to the genetic model of Down syndrome rather than the environmental restriction experienced by the animal.²³ A recent review by Muthugovindan and Singer²⁴ suggested a Mendelian inheritance of stereotypies based on the positive family history in 25% of cases.²⁴ We support this suggestion by reporting a family in which two siblings developed unusual movements before the age of 1 year that did not fulfil diagnostic criteria for tics, but which were purposeless involuntary movements, and could sometimes continue for several hours. Their father had severe obsessive-compulsive disorder and reported that as a child he had very similar movements. This family case adds evidence for a likely genetic basis for the movements.²⁵

The neuropathology of stereotypies is not fully understood. Anatomically, the basal ganglia have been implicated through case reports describing the emergence of stereotyped behaviour following lesions of the putamen, orbitofrontal cortex, and thalamus. Muthugovindan and Singer²⁴ have proposed the involvement of frontal subcortical circuits in the neuropathology of stereotypies; however, they conclude that more research is needed in this area. A study by Kates et al.¹⁸ compared the cerebral lobes and caudate nuclei of six males of average intelligence who displayed complex stereotypies with age-matched controls. Volumetric magnetic resonance imaging showed a 9% reduction in total cerebral white volume compared with controls; the frontal white matter reduction was significant when analysed as an absolute volume and relative to total cerebral white matter volume.¹⁸ It has been thought that dopaminergic pathways might mediate stereotypies. This association is due to the fact that dopamine is found to have a role in other movement disorders such as Parkinson disease and thus seems an appropriate candidate for stereotypy aetiology. Recently, it has been shown that cholinergic transmission may have a role in the arrest of motor stereotypy, through the observation that dopamine transmission remains increased during the decline and arrest of motor stereotypy, while cholinergic transmission normalizes.

Furthermore, lesioning the cholinergic interneurons of the prefrontal territory of the dorsal striatum on cocaine-induced motor stereotypy has been shown to lead to considerable prolonged duration of motor stereotypy.²⁶ The neuropathology of stereotypies is attracting research; however, we are not yet at the stage of reaching definitive conclusions.

At present, it is not possible to exclude any one of the four theoretical viewpoints outlined above. The involuntary nature of the movements lends support to a neurobiological basis; however, the existence of stereotypies in otherwise apparently neurodevelopmentally typical children suggests a subtle, rather than a gross, neuropathology. Furthermore, although cortical and subcortical structures are thought to be involved in stereotypies, no clear correlation between anatomical differences and clinical presentation has been demonstrated.³ The fact that some children appear to have a genetic predisposition to stereotypies suggests that it may be of benefit to apply a biopsychosocial model, whereby several factors can increase the likelihood of people displaying stereotypies, including levels of environmental stimulation. Whether or not these behaviours are due to reinforcement pathways, or whether they are indicative of underlying development of the central nervous system, continues to be an area of debate. Jankovic³ proposes that it may be beneficial to consider stereotypies as a phenomenological, rather than aetiological, category of hyperkinetic movement disorder. Studying these movements carefully will help us to understand other aspects of complex neurodevelopmental disorders.

Treatment

Stereotypies that present in isolation tend not to warrant pharmacological intervention, as the benefit-to-risk ratio is not great enough. When stereotypies occur with coexisting conditions, or are severely restricting or include self-injurious behaviours, then it may be appropriate to employ a pharmacological strategy. The coexisting conditions will require management in the first instance (Table III). Children with stereotypies may not present to clinicians and, where presentation does occur, it may be as a result of parental anxiety concerning a possible underlying neurological or developmental cause or a perceived difference between the child and its peer group or because the stereotypy is interfering with the child's life or family life. Freeman et al.²⁷ analysed questionnaire responses from parents of children diagnosed with a stereotypic

Table III: Coexisting conditions

Coexisting conditions with stereotypy

- Attention-deficit-hyperactivity disorder
- Autism spectrum disorder
- Behavioural/emotional difficulties
- Tourette syndrome
- Tic disorder
- Obsessive-compulsive behaviours/disorder
- Learning difficulties
- Language or motor developmental delay

Table IV: Two examples of using a behavioural approach to decrease stereotypies			
Author	Participants	Method	Result
Miller et al. ²⁸	12 non-autistic children (6–12y) with primary stereotypies	Habit reversal and differential reinforcement of other behaviour. Evaluated using scales of stereotypy severity and global assessment scales	Mean follow-up 12.1mo. Significant improvement in motor stereotypies (stereotypy linear analogue scale; $p=0.009$). Relationship between the number of treatment sessions attended and a reduction in movements
Miguel et al. ²⁹	4-year-old autistic male with communication delay and vocal stereotypies. Taking 10mg sertraline for 3mo before start	Implementation of RIRD. Every instance of vocal stereotypy was interrupted by removing an item the child was engaged with and the child was presented with a vocal demand (repeating an already mastered sound three times without the presence of stereotypy). Sertraline was then reduced over 2wks. Follow-up at 2wks	Before RIRD, the percentage of 1s intervals with a vocal stereotypy was 49%. Mean number of appropriate vocalizations per session was 6.3. When RIRD was implemented, mean percentage of 1s intervals containing a vocal stereotypy was 20%, with a mean number of appropriate vocalizations per session of 22.4. There was no change at 2wks following reduction of sertraline

RIRD, response interruption and redirection.

movement disorder and, where age and developmental were appropriate, from the children themselves. Results indicated that some children enjoyed the movements and triggers were typically positive, including excitement and daydreaming. Conversely, parents were less positive about their existence.²⁷

When treatment is sought, a behavioural approach is considered to be the appropriate option. Table IV outlines two cases of using behavioural approaches to decrease stereotypy. Miller et al.²⁸ demonstrated the effectiveness of a combination of modified habit reversal and differential reinforcement of other behaviours on non-autistic children with stereotypies. Miguel et al.²⁹ showed that response interruption and redirection decreased the rate of vocal stereotypy substantially more than that observed at baseline in a child with autism. There are several different behavioural approaches that can be used to treat stereotypies, therefore evaluation and comparison of these is necessary. A review of 41 studies, between 1995 and 2007, considered methods employed to reduce hand-related stereotypies in people with severe-to-profound intellectual disability and multiple difficulties. The methods used to treat the stereotypy were grouped into five categories: mechanical restraints alone or with other intervention variables; response blocking; non-contingent stimulation (environment enrichment); various contingency manipulations; and programmes based on microswitch clusters. Microswitch clusters refer to a technique whereby the child is taught an adaptive movement that activates a microswitch which turns on a preferred stimulus for a limited time. The preferred stimulus is available only if the adaptive movement is carried out in the absence of stereotyped movement, and the preferred stimulus is interrupted if a stereotypy occurs. It was found that various strategies were useful in reducing or eliminating hand stereotypies; however, there may be some preference from the individual and those carrying out the treatment about the most appropriate option. Mechanical restraints were effective; however, they can be severely distressing for the individual and may be emotionally challenging for the caregiver to employ. Comparatively, non-contingent stimulation was considered less aversive from the

perspective of the individual concerned and was more straightforward in application.³⁰

Pharmacological treatments are not necessarily more effective than behavioural approaches; however, difficulties in employing behavioural approaches day to day, and in environments such as school may warrant the addition of medication. Miguel et al.²⁹ investigated the effect of sertraline on stereotypy in conjunction with response interruption and redirection. They found that the removal of sertraline did not disrupt participants' low level of stereotypy, suggesting that sertraline was not of use in the treatment of stereotypies.²⁹ However, response interruption and redirection may have to be carried out up to 100 times a day at school in order to be effective; therefore there is a significant risk of non-compliance. Fluoxetine is a selective serotonin re-uptake inhibitor that has been shown to decrease stereotypic behaviours in vervet monkeys in captivity. The response to the drug was gradual and partial and was present in 60% of those receiving it.³¹ The difficulty in interpretation of these data is that the mechanism by which the stereotypy decreases is not known. The selective serotonin re-uptake inhibitor may ameliorate an imbalance in the serotonin system that drives the stereotypy; conversely the stereotypy may be a manifestation of anxiety due to captivity, which the selective serotonin re-uptake inhibitor acts on. This returns us to the core of the previous debate about whether stereotypies are the consequence of abnormalities in the brain or whether they are a manifestation of other factors that cannot be expressed or processed by other means. There has to be appreciation for the fact that stereotypies may be quantified in different ways by different researchers, and this can influence how data is interpreted and how comparable treatment options are to each other. Table V summarizes some of the ways in which stereotypies have been quantified in the literature.

CONCLUSION

Knowledge and understanding of stereotypies is important, particularly as correct and prompt diagnosis can avoid unnec-

Table V: Ways in which stereotypies are quantified in the literature

Author	Inclusion and exclusion criteria for study	Method for quantifying stereotypies
Miller et al. ²⁸	Participants had to satisfy the following criteria: (1) presence of movements with a fixed pattern that are repetitive, purposeless, and rhythmic; (2) presence of movements that are not habits, mannerisms, compulsions, or complex motor tics; (3) onset of these movements before age 2y; (4) no reported premonitory urge; (5) temporary suppression of movements by an external stimulus or distraction; (6) no evidence of autism, pervasive developmental disorder, or sensory deprivation	Stereotypy Severity Scale This consists of two components, one pertaining to the motor dimensions of the movement and the other pertaining to the global effects of the movement. The motor component rates the movement along four dimensions, including number (0–3 points), frequency (0–5 points), intensity (0–5 points), and interference (0–5 points) for a total of 18 points. An independent rating of global impairment caused by the movement (up to 50 points) is added to obtain the total score (maximum 68 points). Number increases with worsening severity Stereotypy Linear Analogue Scale Parents were asked to rank their child's stereotypy during the past few days from 0 (the best it has ever been) to 10 (the worst it has ever been) on a line 10cm long. Parents were told to consider number, frequency, intensity, and interference in making their ratings Child Global Assessment Scale Scoring Guide A numeric assessment of the child's overall function at home, at school, and with peers with respect to activities and interests, school performance, coping ability, mood, anxiety, and antisocial acts. The higher the score, the better the overall function Per cent improvement from baseline Parents were asked to give a per cent improvement in stereotypic movements from the child's baseline Motivation ranking Parents were asked to rank, from 1 to 4, their child's motivation to stop the movement at the onset of therapy (1=not motivated; 2=slightly motivated; 3=moderately motivated; 4=very motivated).
Freeman et al. ²⁷	Fulfilment of the DSM-IV criteria for SMD Exclusionary criteria were ASD, epilepsy, stroke, intellectual disability or marked developmental delay, and history of sensory impairment or major deprivation. Patients with tics or Tourette syndrome were not excluded. No children were receiving medication for tics or for ADHD at the time of diagnosis	Stereotypy Severity Scale Strengths and Difficulties Questionnaire 25 items rated by caregivers The Repetitive Behaviour Scale – Revised An empirically derived caregiver report of the spectrum of different reported behaviours (including compulsions) on 43 items in six subscales Short Sensory Profile A 38-item standard caregiver questionnaire, which assesses the sensory functioning
Goldman et al. ¹¹	Children had the diagnosis of ASD confirmed by using the Wing Autistic Disorder Interview Checklist, a 21-item precursor of DSM-III-R. No child who participated in this study was under heavy dosages of medication	Video tape analysis The children were videotaped for 30min, playing with the same large set of toys. The first 15min of standardized play session was coded. Each movement was described and assigned to one of eight discrete, mutually exclusive subtypes. No attempt to score duration and amplitude of movements because of imprecision regarding their start and end and lack of reliability. Neither vocalizations nor subtle face movements were recorded

DSM, Diagnostic and Statistical Manual of Mental Disorders; SMD, sensorimotor disorder; ASD, autism spectrum disorder; ADHD, attention-deficit–hyperactivity disorder.

essary investigations and distress to the family. The presence of motor stereotypies is more common than originally thought, and they represent an often chronic and persistent movement disorder. They can occur in otherwise healthy children, but more commonly occur in children with autism spectrum disorder and also in children with sensory impairment or severe intellectual disability or those raised in social deprivation. Motor stereotypies in individuals with and without autism are often indistinguishable. They can occur alongside other movements such as tics; however, they should be distin-

guished from them based on the age at onset and lack of premonitory urge. The factors contributing to their existence, and thus underlying aetiology, are still not fully understood. The theory that stereotypies exist to mediate arousal levels within sensory or socially deprived individuals is plausible; however, their appearance in otherwise healthy individuals presents a problem for this hypothesis. Our group suggests that a neurobiological or genetic component is a likely aetiological candidate for the expression of stereotyped behaviours. Motor stereotypies will continue to be viewed as a spectrum of

neurodevelopmental movement disorders that require further phenotypic and neurobiological exploration. When treatment is sought, behavioural approaches are thought to be most

effective in reducing stereotypic behaviours; however, they may be difficult to implement in those younger than 7 years old.

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