MOTOR DISORDERS

Developmental Coordination Disorder
Stereotypic Movement Disorder
Tic Disorders

OVERVIEW

Motor disorders begin early in the developmental years and involve problems with movement. Children with motor disorders may be substantially delayed in reaching motor milestones (such as navigating stairs or tying shoes); they may make repetitive and driven movements (such as rocking); or they may have physical or verbal tics. As with other disorders, these behaviors cause impairment and result in negative physical and/or social consequences.

The three main categories of motor disorders are developmental coordination disorder, stereotypic movement disorder, and tic disorders (see Table 1). Because each category has different treatments, each will be discussed in its own section of this chapter.

Table 1
Motor Disorders Affecting Children & Adolescents

Disorder	Description
Developmental coordination disorder	Coordinated motor skills, both developing and executing, are substantially below expectations based on age and education. Symptoms include clumsiness and slow and inaccurate motor skills. Onset is early in development.
Stereotypic movement disorder	Includes repetitive, driven, and purposeless motor behavior like shaking, rocking and hitting oneself. Onset is early in development.
Tic disorders	Tics are involuntary movements, sounds, or words that are sudden, rapid, recurrent, and nonrhythmic. The 3 main kinds of tic disorders are outlined in Table 2.

Table 2
Types of Tic Disorders

Tic Disorder	Description
Tourette syndrome	Both vocal and motor tics are present for a period of more than one year, but not necessarily concurrently. The tics may wax and wane in frequency. Onset is prior to age 18.
Persistent (chronic) vocal or motor tic disorder	Single or multiple motor or verbal tics occurring multiple times daily or almost daily for more than one year. Onset before age 18. Both motor and verbal tics cannot be present for this diagnosis.
Provisional tic disorder	Single or multiple vocal and/or motor tics present for less than one year. Onset before age 18.

CAUSES AND RISK FACTORS

Underlying causes for the development of motor disorders are not well understood. However, as with many psychological disorders, the evidence suggests that numerous factors, such as genetic vulnerability, learning, and environment, may contribute to the development of these disorders.

Studies of families suggest the presence of genetic underpinnings in the development of tic disorders. For example, relatives of individuals with Tourette syndrome are 10 to 15 percent more likely to develop the syndrome and 15 to 20 percent more likely to have another tic disorder.[1] These risk levels are significantly higher than in the general population. Studies have also shown that 25 percent of youth with stereotypic motor disorder have an affected relative.[2] There is also likely to be a family history of obsessive tendencies often in the form of counting rituals.

There is reason to believe that learning factors are significant in the development and maintenance of motor disorders. In stressful situations, for example, youth can develop the urge to trigger their tics or to self-injure. After the tic or self-injury becomes habitual, all similar situations may elicit the same response. These situations may, in turn, elicit an urge to perform the habit. Youth with motor disorders report an uncomfortable urge that is satisfied by the tic or self-injury. The satisfaction or reduction of the urge may reinforce the habit and thus increase the likelihood that the youth will repeat the behavior.

Environmental factors have also been implicated in the development of motor disorders. Developmental coordination disorder may be caused by prenatal exposure to alcohol, and it is often associated with preterm births and children with a low birth weight. Stereotypic movement disorder is frequently seen in socially isolated children who tend to self-stimulate, which may progress to stereotypic movements and even repetitive self-injury. There have also been cases in which individuals who suffered from a traumatic head injury (e.g.

[1] Woods, D., Flessner, C., & Conelea, C. (2008). Habit disorders. In M. Hersen (Series Ed.), & D. Reitman (Vol. Ed.) *Handbook of psychological assessment, case conceptualization, and treatment: Vol 7. Children and adolescents* (pp. 542-570). New York: Wiley.
[2] Mills, S., & Hedderly, T. (2014). A guide to childhood motor stereotypies, tic disorders and the Tourette spectrum for the primary care practitioner. *The Ulster Medical Journal, 83*(1), 22-30.

concussion) had symptoms that mimic those seen in of stereotypic motor disorder. Movement disorders may also be a side effect of certain medication.

DEVELOPMENTAL COORDINATION DISORDER

Developmental coordination disorder presents early in development. A child with developmental coordination disorder develops and executes coordinated motor skills substantially below expectations based on the child's age and education. A child may be clumsy, or his or her motor skills may be slow, inaccurate, or both. Although onset is early in a child's life, most diagnoses normally do not occur prior to age five, when a child enters school. Problems remain in about 50 to 70 percent of children diagnosed, even after coordination improves.

KEY POINTS

- **Characterized by delays in reaching motor milestones.**
- **About half of children with this disorder also have ADHD.**
- **There are no evidence-based treatments at this time.**
- **Activity-oriented and body function-oriented treatments have the best results.**

For developmental coordination disorder, it is important to recognize that symptoms may be confused with those of other conditions. There are four criteria that must be met:

1. The child shows delays in reaching motor milestones.
2. The condition significantly interferes with activities of daily living and/or academic performance.
3. The symptoms begin early in the child's life.
4. Difficulties with motor skills are not better explained by intellectual disability, visual impairment, or brain disorders.

Young children with developmental coordination disorder may be delayed in reaching motor milestones such as climbing stairs and buttoning shirts. They may reach these milestones, but do so with awkward, slow, or imprecise movements when compared with their peers. Alternatively, older children may display slow or inaccurate movements with skills like handwriting, puzzles, model building, ball games, or self-care. Only when these slow, awkward movements interfere with performing or participating in daily activities can a developmental coordination disorder diagnosis be given. Also, the child must be assessed for any visual impairments and neurological disorders before they are diagnosed with developmental coordination disorder.

Attention-deficit/hyperactivity disorder (ADHD) is the most frequent coexisting condition in youth with developmental coordination disorder, with about 50 percent co-occurrence. Other common co-occurring disorders include autism spectrum disorder (ASD), disruptive and emotional behavior problems, speech and language disorder, and specific learning disorder, especially with reading and writing.

TREATMENTS FOR DEVELOPMENTAL COORDINATION DISORDER

There are no evidence-based practices identified for motor disorders at this time. This is, in part, because this disorder can manifest in a variety of ways, and because issues such as co-occurring conditions and associated

emotional difficulties vary from child to child. However, results have overwhelmingly shown that activity-oriented and body function-oriented interventions (such as physical and occupational therapy) have the best results. Table 3 describes treatments for developmental coordination disorder.

In general, therapies that aim to improve motor function can use a task-oriented or process-oriented approach.

- In a task-oriented approach, an observed motor challenge is identified (for instance, catching a ball), and the task is broken down into step-by-step interventions that focus on teaching and practicing the skill.
- In a process-oriented approach, the therapist focuses not on tasks (at least initially), but on how children manage their bodies and process sensory information. The assumption is that once the underlying mechanism causing the motor challenge is improved, related motor skills will also improve.

Table 3
Summary of Treatments for Developmental Coordination Disorder

What Works	
There are no evidence-based practices at this time.	
What Seems to Work	
Cognitive motor intervention	Therapists design a set of exercises into steps for children to practice at home. Emotional, motivational, and cognitive aspects are emphasized, as children are taught how to plan a movement, how to execute it, and how to evaluate their success. Building self-confidence through positive reinforcement is a critical goal, as success depends upon the patient's motivation to practice outside of therapy.
Physical and occupational therapy	Tailored to a child's specific needs.

STEREOTYPIC MOVEMENT DISORDER

Stereotypic movement disorder presents early in a child's development. Symptoms include repetitive and driven motor behaviors (stereotypies), like shaking, rocking, and hitting oneself. Stereotypies frequently involve arms, hands, or the entire body. Simple stereotypic movements are often present in typically developing children under the age of three. As these children get older, they can stop repetitive motions when asked or when they choose. However, children with stereotypic movement disorder cannot stop the motions by force of will; instead, they will restrict their movements through other means such

KEY POINTS

- **Characterized by repetitive and driven motor behaviors, like rocking or hitting oneself, that the child cannot stop through force of will.**
- **Can be a symptom of another disorder.**
- **Often co-occurs with ID or ASD.**
- **Habit reversal therapy is the most effective treatment.**

as sitting on their hands or wrapping their arms in their clothing. Table 4 describes the difference between stereotypies and tics.

Table 4
Stereotypies vs. Tics

	Stereotypies	Tics
How do they manifest?	Rhythmic, prolonged, repetitive movements, such as rocking; movements are fixed, identical, and predictable.	Brief, rapid, sudden movements and/or vocalizations, such as grimacing or shouting a word; a tic is random and unpredictable.
What part of the body is involved?	Frequently involve arms, hands, or the entire body.	Frequently involve eyes, face, head, and shoulders.
In what circumstances do they occur?	Commonly occur: • When the child is engrossed in an activity. • During periods of anxiety, excitement, or fatigue.	Commonly occur during periods of anxiety, excitement, or fatigue.
Are they preceded by an urge or physical sensation?	No	Yes
How does the child feel?	Movements often appear enjoyable.	Tics are often associated with distress or discomfort.
Can they be reduced by distracting the child?	Yes (more immediately than tics)	Yes
Can they be suppressed?	Rarely; typically the child must stop the movement by other means (e.g., by sitting on hands).	Yes, temporarily; suppression usually causes distress.

There are two types of classifications for stereotypic movement disorder: “with self-injurious behavior” and “without self-injurious behavior.” Children with the classification “with self-injurious behavior” engage in movements that could be harmful to their bodies (e.g. lip biting, head banging, or eye poking). Conversely, children with the classification “without self-injurious behavior” engage in movements that are not physically harmful to themselves (e.g. body rocking, arm flapping, or head nodding).

Stereotypies are frequently a presenting symptom of intellectual disability and ASD, or may be a secondary diagnosis. Disorders such as ADHD, obsessive-compulsive disorder, tic disorders, and anxiety disorders can also co-occur with stereotypic disorder. In addition, stereotypies can be a manifestation of another disorder, such as Lesch-Nyhan syndrome, Rett syndrome, Fragile X syndrome, Cornelia de Lange syndrome, and Smith-Magenis syndrome. For these reasons, a comprehensive assessment is critical.

EVIDENCE BASED TREATMENTS FOR STEREOTYPIC MOVEMENT DISORDER

Table 5 describes treatments for stereotypic movement disorders.

Table 5
Summary of Treatments for Stereotypic Movement Disorder

What Works	
Habit reversal therapy (HRT)	Increases awareness to the feelings and context associated with the stereotypies and implements competing and inconspicuous habits in their place. HRT can be modified to include rewards, relaxation, education, self-awareness, and situational changes. It is sometimes combined with other therapies.
What Seems to Work	
Medication	Medications may be considered for moderate to severe stereotypies causing severe impairment in quality of life or when co-occurring conditions that would also benefit from the medication are present.

Habit Reversal Therapy (HRT)

HRT is the most well-studied and effective treatment for youth with motor disorders. HRT involves first teaching youth to become aware of instances of the habit, then teaching awareness of the associated environment and internal sensations (e.g., recognizing stressful situations that trigger stereotypies). Once the youth can identify feelings and situations likely to elicit the habit, he or she is taught a competing response. A competing response is a behavior that is physically incompatible with the habit and is socially inconspicuous. Supportive individuals are recruited to provide gentle reminders when the youth is engaging in the habit and praise when the competing response is implemented correctly. HRT can be modified to include other components, including rewards and relaxation training.

TIC DISORDERS

Tics are involuntary movements, sounds, or words that are sudden, rapid, recurrent, and nonrhythmic. Tics are often worse when a child is stressed, anxious, or tired. There are several kinds of tics:

- **Vocal tics** – examples include repeated throat clearing or spoken words
- **Motor tics** – examples include repeated blinking or arm movements
- **Simple tics** – a short, brief noise or movement

KEY POINTS

- **Characterized by rapid and nonrhythmic movements or vocal sounds.**
- **Can be a symptom of another disorder.**
- **Often co-occurs with obsessive-compulsive disorder or ADHD.**
- **Habit reversal therapies that target tics are the most effective treatments.**

- **Complex tics** – a vocalization, noise, or movement that appears to take effort, like a spoken word, a complex sound, or raising one's arm up over one's head

Tics vary from other childhood movement disorders in a few ways: They have varied severity, their movement characteristics change over time, the movements are temporarily suppressible, and they are associated with sensory phenomena. Table 4 describes the difference between tics and stereotypies.

The three primary tic disorders are outlined below:

- **Tourette syndrome** is the most well-known tic disorder, largely because of its depictions in movies and television shows, but it is relatively uncommon. Symptoms of Tourette syndrome must be present before age 18, and both vocal and motor tics must be present. The tics may vary over time and must persist for over one year since the onset of the original symptoms. Age of onset can be anywhere between the ages of two and 18, with the most severe tics occurring between the ages of 10 and 12. Less than one half of people who have Tourette's syndrome as children have moderate to severe tics as adults.

- **Persistent (chronic) motor or vocal tic disorder** involves one or more motor or vocal tics but cannot include both. If both motor and vocal tics occur, the child should be screened for Tourette disorder. The tics may vary in frequency and must persist for more than one year after onset. Tics must begin before age 18 and cannot be attributable to another disorder or substance.

- **Provisional tic disorder** is diagnosed when tics are present for less than one year. There can be one or more tics, which can include motor and/or vocal tics. Tics cannot be attributable to another disorder or substance. Additionally, the child cannot have been diagnosed with Tourette disorder or persistent (chronic) motor or vocal tic disorder in the past.

Assessment of tic disorders should include a medical examination to rule out conditions that can mimic tic disorders, such as behaviors related to allergies, eye problems that mimic tics, and stereotypic movement disorder. Other medical conditions that may cause tics, such as Huntington's disease or post-viral encephalitis, must also be considered prior to diagnosing a motor disorder.

Youth with tic disorders frequently experience co-occurring obsessive-compulsive disorder and ADHD. Individuals with tic disorders can also have other movement disorders, as well as depressive, bipolar, or substance-use disorders. Pre-pubertal children with tic disorders are more likely to experience ADHD, obsessive-compulsive disorder, and separation anxiety disorder than are teenagers and adults, who are more likely to experience the new onset of major depressive disorder, substance use disorder, or bipolar disorder.

Given the frequent comorbidity of tic disorders with other psychiatric conditions, any assessment of a child or adolescent that reveals the presence of tics should prompt assessment for co-occurring mental health disorders.

EVIDENCE-BASED TREATMENTS FOR TIC DISORDERS

Table 6 describes treatments for tic disorders.

Habit Reversal Therapy (HRT)

Habit reversal therapy (HRT) is the most well-studied and effective treatment for youth with motor disorders. HRT involves first teaching youth to become aware of instances of the habit, then teaching awareness of the associated environment and internal sensations, such as muscle tension and urges. Once the youth can identify feelings and situations likely to elicit the habit, he or she is taught a competing response. A competing response is a behavior that is physically incompatible with the habit and is socially inconspicuous. Supportive individuals are recruited to provide gentle reminders when the youth is engaging in the habit and praise when the competing response is implemented correctly.

Comprehensive Behavioral Intervention for Tics (C-BIT)

Comprehensive behavioral intervention for tics (C-BIT) combines habit reversal and awareness of tics through techniques like self-monitoring, along with education about tics and relaxation techniques. A therapist works with the child and his or her family to understand the types of tics and situations in which the tics occur. Where HRT combines tic awareness and competing-response training, C-BIT includes relaxation training and functional intervention. C-BIT helps the patient identify situations in which tics occur and develop strategies to overcome the tic.

Table 6
Summary of Treatments for Tic Disorders

What Works	
Habit reversal therapy (HRT) for tic disorder	A type of cognitive behavioral therapy, HRT increases awareness to the feelings and context associated with the urge to tic, then replaces it with competing, inconspicuous habits.
Comprehensive behavioral intervention for tics (C-BIT)	Combines HRT and other approaches like education, awareness via self-monitoring, relaxation techniques, and sometimes situational changes.
What Seems to Work	
Exposure with response prevention (ERP)	Consists of repeated, prolonged exposures to stimuli that elicit discomfort and instructions to refrain from any behavior that serves to reduce discomfort.
Medication	Medications may be considered for moderate to severe tics causing severe impairment in quality of life or when co-occurring conditions that would also benefit from the medication are present.

What Seems to Work (Continued)	
Massed negative practice (MNP)	Treatment involves developing reactive inhibition through the child's over-rehearsal of target tic in high-risk situations.
Not Adequately Tested	
Web-based exposure with response prevention (ERP)	ERP virtual treatment is considered generally effective, but there are limited studies on how it compares with in-person treatment.
What Does Not Work	
Deep brain stimulation (DBS)	A neurostimulator is surgically implanted into the brain; not proven to be effective and not recommended.
Repetitive transcranial magnetic stimulation (rTMS)	Uses magnetic fields and electrical pulses to affect neurons in the brain; safety in youth has not been established; not recommended.
Plasma exchange; Intravenous immunoglobulin (IVIG) treatment	Blood transfusions alter levels of plasma or immunoglobulin; while several of these treatments have been shown to be promising, they are not empirically supported and not recommended.
Dietary supplements (magnesium and vitamin B6); Special diets	Supplements may have the potential to negatively interact with other medications; not recommended until safety in children is established.

RESOURCES AND ORGANIZATIONS

American Academy of Child & Adolescent Psychiatry (AACAP)
http://www.aacap.org/

American Academy of Family Physicians
Understanding Tics and Tourette's Syndrome
https://www.aafp.org/pubs/afp/issues/1999/0415/p2274.html

American Psychiatric Association (APA)
https://www.psychiatry.org/

Gillette Children's Specialty Healthcare
Complex Movement Disorders
https://www.gillettechildrens.org/conditions-care/complex-movement-disorders

Neuropediatric Journal
https://pubmed.ncbi.nlm.nih.gov/36423651/

Society of Clinical Child and Adolescent Psychology
https://sccap53.org/

The Collection of Evidence-based Practices for Children and Adolescents with Mental Health Treatment Needs, 9th Edition

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