

The Relationship between Tourette syndrome and Attention deficit hyperactivity disorder

Abstract

Tourette syndrome is a chronic disorder that has both motor and vocal tics. Tics are involuntary and repetitive movements that may occur many times a day. Tourette syndrome tends to progress and become more severe during puberty and stabilizes in adulthood. Attention deficit hyperactivity disorder is a condition of the brain that makes it difficult for children to control their behavior in school and social life. ADHD is one of the most common chronic conditions of childhood and affects between 4-12% of all school-age children. This paper focuses mainly on the relationship between Tourette syndrome and ADHD. Researchers have found that TS patients present with an increase in the neurotransmitter, dopamine. Dopamine is one of the most important neurotransmitter in the brain that is responsible for movement and emotions. It is located within the pre-synaptic neuron and will move across the synaptic space to reach the dopamine receptors on the postsynaptic neuron. However, the levels of dopamine play an important role in the ADHD mechanism as well. Decreased levels of dopamine in some regions of the brain will lead to dysfunction of the motor and the cognitive functions of the brain, which cause ADHD as well as other neurological disorders.

Tourette syndrome:

History:

In 1825, Jean Marc Gaspard Itard who described a first case of Tourette syndrome with the Marquise de Dampierre, a French noblewoman with body tics, barking sounds and uncontrollable utterance of obscenities. Also, Itard described 7 men and 3 women with a variety of sudden, bizarre behaviors that we would now call tics. In 1885, Dr. Georges Gilles de la Tourette, a French neurologist, first described an 86 year old woman with this condition. After that, the syndrome was known by his name. Originally, Tourette syndrome was considered as a psychiatric disease. However, in 1960 the observation that certain drugs called neuroleptics were effective in treating TS, refocused attention from a psychological to a central nervous system cause.

Definition:

Tourette syndrome is a chronic disorder that has both motor and vocal tics. Tics are involuntary and repetitive movements occur many times a day, almost every day. Tics typically change in anatomic location, frequency, type, complexity, and severity over time. It can be simple or complex. Tourette syndrome tends to progress and become more severe during puberty and stabilizes in adulthood. It is inherited and starts between 6 years old and 10 years old. TS occurs in people from all different racial groups and males are affected three times more than females. Specifically, In the USA, researchers estimated that 200,000 Americans have the more severe or of TS than any population (Matsuda et al., 2012).

Symptoms:

Tics are classified as either simple or complex. Simple motor tics are sudden, brief, and repetitive movements which involve limited numbers of muscle groups. The more common simple tics include eye blinking and other eye movements, facial grimacing, shoulder shrugging, and head or shoulder jerking. In addition, Simple vocalizations include repetitive throat clearing, sniffing, and grunting sounds. The complex tics are distinct, coordinated patterns, of movements involving several muscle groups. Also, complex motor tics might include facial grimacing combined with a head twist and a shoulder shrug. Other complex motor tics may actually appear purposeful, including sniffing, touching objects, hopping, jumping, bending, and twisting as shown in figure 2 (Gravino, 2013).

Diagnosis:

There are no exact tests that can tell us whether a person has TS or not. However, there are some examinations such as; magnetic resonance imaging (MRI), computed tomography (CT), and blood tests that help rule out other diseases which may have symptoms similar to TS. If these tests are negative for other diseases and the person has had multiple motor or vocal tics for over a year the person may have TS (Rivera, Cubo, Almazán, 2009).

Treatment:

The majority of people with TS do not need medication because the symptoms do not impair the individuals. Also, there is no medication that completely eliminates symptoms. However, the medication is used to reduce intensity of tic symptoms. Some of the drugs include

the Neuroleptic drugs like Haloperidol and Pimozide which are used in a small doses (Hartmann & Worbe, 2013).

Attention Deficit Hyperactivity Disorder:

The definition of "Attention Deficit Hyperactivity Disorder" goes back to the mid-20th century, when physicians developed a diagnosis for a set of conditions variously referred to as "minimal brain damage", "minimal brain dysfunction", "learning/behavioral disabilities" and "hyperactivity". ADHD is a condition of the brain that makes it difficult for children to control their behavior in school and social life. ADHD is one of the most common chronic conditions of childhood and affects between 4 and 12 percent of all school-age children. Boys are affected more than girls. In fact, attention deficit disorder is a chronic neurological condition characterized by developmentally inappropriate attention skills, impulsivity, and in some cases hyperactivity. Hyperactivity is a behavioral that is described as a constant, driving motor activity in which a child races from one endeavor or interest to another as shown in figure 2 (Wagner, 2000).

In 493 BC , the scientist Hippocrates described a condition that appears to be compatible with what we now know as ADHD. He described patients who had "quickened responses to sensory experience, but also less tenaciousness because the soul moves on quickly to the next impression." Hippocrates attributed this condition to an "overbalance of fire over water." His therapy for this "overbalance" was "barley rather than wheat bread, fish rather than meat, water drinks, and many natural and diverse physical activities." Shakespeare made reference to a "malady of attention" in King Henry VIII, which at least "proves" that people don't pay attention when other things are on their mind (Baumeister, Henderson, Pow, & Advokat, 2012).

Symptoms:

It is classified by three groups which are inattentiveness, hyperactivity, and impulsivity. Some people have inattentive symptoms while others have both hyperactive and impulsive symptoms. The inattentive symptoms include failure to give close attention to details in school or work. Also, it includes difficulty keeping attention during tasks, problems organizing tasks and activities, or avoiding or disliking tasks that require constant mental effort. Hyperactivity symptoms include fidgeting with hands or feet in seat, leaving the seat when remaining seated is expected, or talking excessively (Biederman & Mick, 2000).

Diagnosis:

There is no exact test for ADHD, but making a diagnosis will include a medical exam which helps rule out other possible causes of symptoms. Interviews are conducted for family members and the child's teachers. To be diagnosed with ADHD, the child must have six or more signs and symptoms from one or both of the two categories which are inattention and hyperactivity and impulsivity (Baron, 2007).

Treatment:

There is no specific treatment for ADHD, but there is a medication that reduces symptoms and improves functioning. Treatments include different types of psychotherapy, education, and training (Baron, 2007).

Physiological Connection between Tourette syndrome and Attention Deficit Hyperactivity Disorder:

The dopamine hypothesis is the most likely studied theory for ADHD mechanism. This hypothesis is based on malfunction or decreased function of the dopamine system in specific regions

of the brain. In general, dopamine is important to the motor and cognitive functions of the brain, and a dysfunction of a single part of this system causes a several neurological disorders (Coccaro et al. 2007). The dopamine hypothesis of ADHD is particularly related to the malfunctioning of D4 and D2, in addition to abnormally low or high levels of dopamine in the brain (Shaw, 2007). Coccaro et al. (2007) conducted a study investigating the relationship between dopamine activity and ADHD symptoms by testing chemical levels of plasma homovanillic acid in both healthy and ADHD patients. They found that there is a converse relationship between the level of dopamine activity and the symptoms of ADHD as shown in figure 1. In addition, Volkow et al., (2009) studied the dopamine pathway's involvement in ADHD. Non-medicated patients, both with and without ADHD were given a dopaminergic stimulant while being examined by neuroimaging equipment. The study suggested that the patients with ADHD had significantly decreased dopamine pathways consistent with the dopamine hypothesis of ADHD (Volkow et al. 2009).

However, Tourette syndrome results from the increase in neurotransmitter, Neurotransmitters are the chemicals which allow the transmission of signals from presynaptic neuron to postsynaptic neuron via the synaptic cleft. Dopamine is one of the most important neurotransmitter in the brain that is responsible for movement and emotions. Dopamine is located within the pre-synaptic neuron and will move across the synaptic space to reach the dopamine receptors on the postsynaptic neuron(Singer et al., 2002). Since dopamine is responsible for movement , it is apparent in patients with TS that an imbalance in dopamine level is the cause of TS. It is obvious that dopamine levels are involved in TS because most pharmaceutical drugs that target the symptoms of TS effect dopamine levels in the brain. These

pharmacological drugs block the D2 receptors which have been shown to decrease the symptoms of TS (Buse et al., 2012).

On the other hand, ADHD patients have low levels of dopamine. The DRD4 gene is associated with a dopamine receptor in the brain. A study on the genetics of ADHD suggested that ADHD patients are more likely to have a specific variation of the DRD4 gene than healthy people. Another study believed that ADHD patients had a sluggish dopamine system. These studies helped explain why ADHD medications such as Ritalin are beneficial. Stimulant ADHD medicines increase dopamine level by strengthening the weak dopamine system in the brain (González et al., 2012). Furthermore, drugs of abuse such as nicotine or cocaine that temporarily increase dopamine level decrease ADHD symptoms. Therefore, the decreased dopamine level linked with ADHD may help explain why ADHD patients may have a greater risk of drug abuse (Zhu & Reith, 2008).

Dopamine affects the striatum and the caudate nucleus in TS patients more than unaffected controls as shown in figure1. The effects of increased dopamine on TS patients could be the result of two mechanisms. First, the TS patient may produce more dopamine in the brain, thus causing their receptors to over stimulate, leading to excessive neuronal firing, and therefore resulting in involuntary movements. Second, TS patients' have normal levels of dopamine as unaffected controls, but the dopamine receptors are supersensitive. Research revolving around dopamine binding in implicated structures of the brain stated, "that binding to D2 dopamine receptors in the caudate nucleus was higher in the sibling with the more severe symptoms. 'Unusually, the degree to which the twins differed in this caudate D2 binding predicted almost absolutely their difference in tic severity.'" Therefore, the study supports the role of dopamine

and explicates why Tourette's are subject to increased dopamine effects (Gerfen & Engber, 1990).

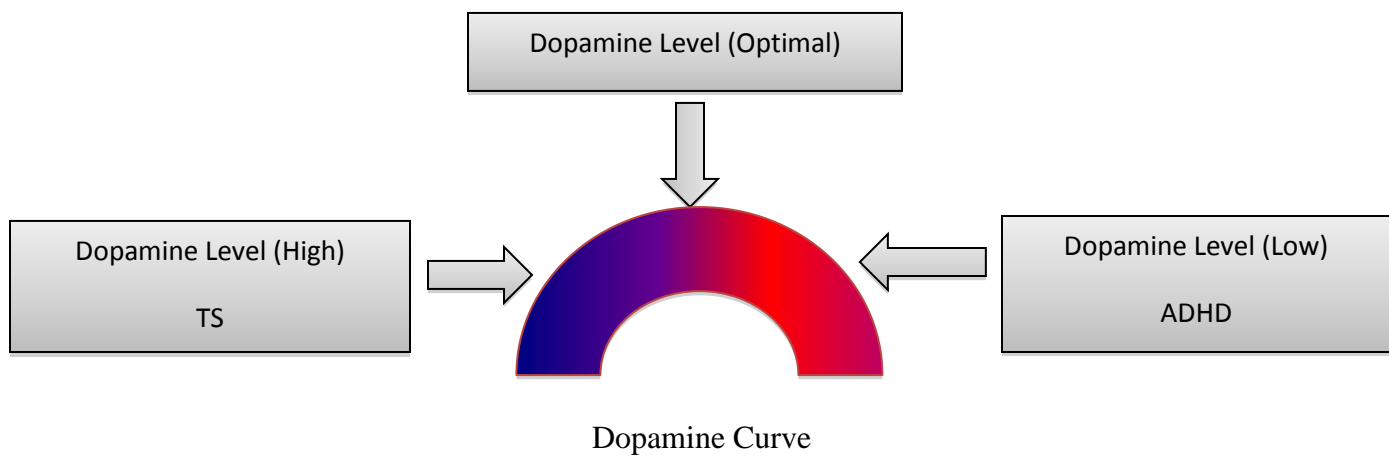


Figure 1: Curve showing levels of dopamine for healthy people, patients with ADHD, and patients with TS. ADHD; Attention Deficit Hyperactivity Disorder. TS; Tourette syndrome.

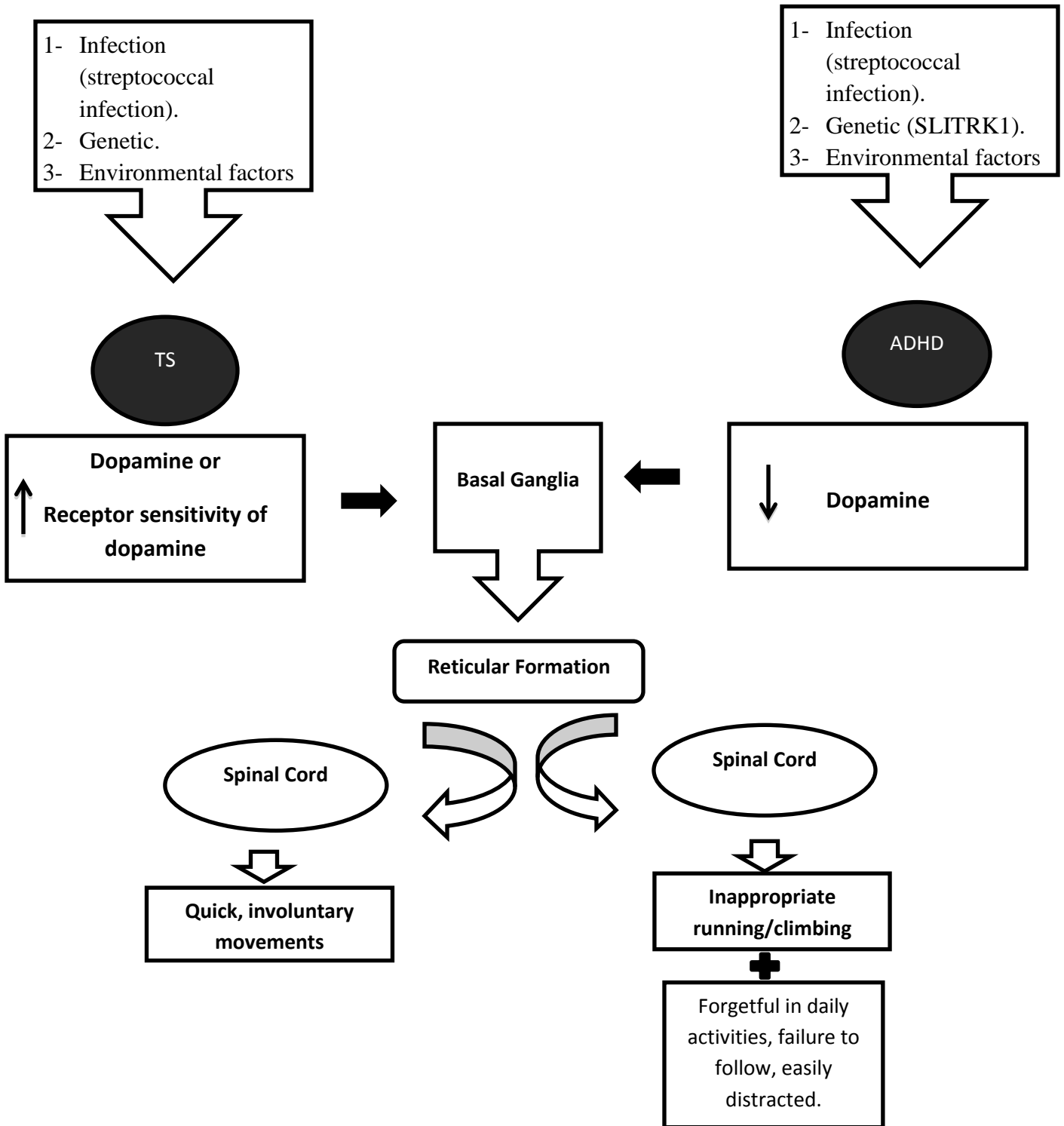


Figure 2: Schematic drawing of the of Tourette syndrome and Attention Deficit Hyperactivity Disorder, and how the two diseases start from risk factors and cause dysfunction of the spinal cord in the end. Basal ganglia is the target place for both diseases.

In conclusion, the levels of dopamine play an important role in the ADHD mechanism. Decreased levels of dopamine in some regions of the brain will lead to dysfunction of the motor and the cognitive functions of the brain, which cause several neurological disorders. One of the most important study found that there is a converse relationship between the level of dopamine activity and the symptoms of ADHD. On the other hand, increased levels of dopamine or increased sensitivity of dopamine receptors cause TS. In addition, dopamine affects the striatum and the caudate nucleus in TS patients more than unaffected controls. Many studies have confirmed that TS patients have high levels of dopamine

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