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Tic Disorders and Learning Disability: Clinical Characteristics, Cognitive Performance and Comorbidity

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Tics are involuntary movements or sounds. Tourette syndrome is one of a family of tic disorders that affect around 1% of the population but which remains underrecognised in the community. In paediatric special education learning disability classes, the prevalence of individuals with tic disorders is around 20–45% — higher still in special education emotional/behavioural classes. Given the high rates of individuals with tic disorders in special education settings, as well as the unique challenges of working in an educational setting with a person with a tic disorder, it is incumbent upon professionals working in these settings to be cognisant of the possibility of tic disorders in this population. This review seeks to provide an overview of tic disorders and their association with learning and mental health difficulties. The review focuses on an exploration of factors underpinning the association between tic disorders and learning disabilities, including neurocognitive corollaries of tic disorders and the influence of common comorbidities, such as ADHD, as well as upon strategies to support individuals with tic disorders in the classroom.

Keywords: Tourette syndrome, tics, special education, learning disabilities

Introduction

Once thought to be a rare disorder, the prevalence of Tourette syndrome (TS) is now understood to be around 1% in the general population (Robertson, Eapen, & Cavanna, 2009). The prevalence of all enduring tic disorders, including TS and chronic motor and vocal tic disorders is estimated to be 1.5–3% during childhood (Scahill, Sukhodolsky, Williams, & Leckman, 2005), with transient tics thought to occur in around 6–20% of children (Swain, Scahill, Lombroso, King, & Leckman, 2007). Individuals with tics and tic disorders are significantly overrepresented in certain contexts, especially special education and paediatric mental health settings (Eapen, Robertson, Zeitlin, & Kurlan, 1997). Nonetheless, milder presentations of tic disorders remain underrecognised in the community at present (Eapen & Sachdev, 2008). Tics are often not recognised as they may be masked by comorbid behaviours and mental health difficulties, and are thus not always noted among the presenting complaints in clinic or educational

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settings (Eapen & Črnčec, 2009). The poor awareness of tics and tic disorders by mental health professionals compounds this problem of underdiagnosis (Marcks, Woods, Teng, & Twhig, 2004).

TS is an inherited neurodevelopmental disorder with childhood onset and a fluctuating course with periods of remission and exacerbation. Tics are recurrent and stereotyped and frequently change location over time. For example, a child may initially have an eye-blinking tic that wanes over time and is 'replaced' with nose-twitching and mouth-opening tics. People with tic disorders are evident in all cultures, racial groups and social classes; however, males are overrepresented by around 3–4:1 (Eapen & Sachdev, 2008). The severity of tics is age dependent, with peak severity between 8 and 12 years of age. For many individuals with TS, tic symptoms reduce during the second decade of life (Swain, et al., 2007).

One study that examined the prevalence of tics in children attending a unit for emotional and behavioural disturbance found a prevalence of tics of 65%, compared with 24% in children attending a special education unit for learning disability, and 6% in children attending mainstream classes who were identified by the teacher as being 'problematic' within the classroom (Eapen et al., 1997). It was also noted that children in the emotionally and behaviourally disturbed unit who had tics were more likely to exhibit coprophenomena (tics involving swearing or using obscene gestures), echophenomena (tics involving copying/repeating) and self-injurious behaviour. The authors concluded that, in light of this finding, '... tics may have a specific association with emotional/behavioral disturbance rather than being a sign of global neurological impairment' (Eapen et al., 1997, p. 381).

Background to Tic Disorders

Tics are involuntary movements of the body (motor tics) or the phonic system (resulting in vocal tics) that are sudden, rapid, recurrent, non-rhythmic, and stereotyped (Jankovic, 1997). Tics can occur for a brief period in a child's life but then completely remit (sometimes called 'developmental tics', but referred to as provisional tic disorder in the *Diagnostic and Statistical Manual of Mental Disorders 5th ed.* [DSM-5], due to be released in May 2013; American Psychiatric Association [APA], 2012) — or may persist. When motor *or* vocal tics, but not both, continue for over one year, this is referred to as a chronic tic disorder; when motor *and* vocal tics co-occur for over one year, this indicates Tourette's disorder (more commonly known as Tourette syndrome).

The proposed diagnostic criteria for Tourette syndrome in the DSM-5 (APA, 2012), which contains some minor modifications from the criteria utilised in the DSM-IV-TR (APA, 2000; cf. Walkup, Ferrão, Leckman, Stein, & Singer, 2010), are as follows:

- A Both multiple motor and one or more vocal tics are present at some time during the illness, although not necessarily concurrently.
- B The tics may wax and wane in frequency but have persisted for more than 1 year since first tic onset.
- C The onset is before 18 years of age.
- D The disturbance is not due to the direct physiological effects of a substance or a general medical condition.

Common simple motor tics involve the eyes (e.g., eye blinking, eye rolling), face (e.g., nose twitching, grimacing), neck (jerking) and shoulders (shrugging). These can be

TABLE 1
Tics and Related Behaviours Commonly Encountered in Tourette Syndrome

Simple (involuntary, meaningless movements)	Blinking, raising the eyebrow, eye rolling, nasal twitch or flare, upper or lower lip movements, mouth to the side, facial grimace, shoulder shrug, arm flex/extend, tongue protrusion, head nod, neck stretch, chin on chest or shoulder, torso/thorax twist, abdominal contractions, leg or feet movements, tapping	Grunt, throat clear, cough, bark, growl, snort, squeak, shriek, scream, low- or high-pitched sounds, noisy or unusual breathing, sniffing, humming, whistling, hoot, hiss, pant, wail, gasp, click, yelp, burp, raspberries, yell, moan, ugh/ah/eh/ooh sounds
Complex (involuntary, seemingly purposeful movements)	Forced touching of self, others or objects, puffing or blowing, lick, smell, spit, stamp, hop, jump, skip, turn, bend, kick, hit, unusual gait (walking), feet shuffling, flapping arms, twirling around, tensing muscle groups, thrusting movements, twirling hair, adjusting clothing	Making animal-like sounds, barely audible muttering, changing the pitch or volume of voice, assuming different characters or intonations
Related behaviours	Self-injurious behaviours: Punching or poking self, biting, picking skin or scabs Copropraxia: Involuntary obscene gesturing, touching private parts of self or others Coprographia: Writing obscenities Echopraxia: Copying or repeating other people's actions or movements Palipraxia: Repetition of last act or movement Non-obscene socially inappropriate behaviours (NOSI): Making socially inappropriate statements or comments; kissing self or others	Echolalia: Repeating what others say Palilalia: Repeating only the last word Coprolalia: Involuntary swearing, uttering obscenities Internal tics: Bladder or bowel tics Stimulus-induced tics: Tics precipitated by events in the environment including seeing or talking about tics

embarrassing or even painful for the individual (e.g., jaw snapping), and are easily distinguished from muscular twitches (fasciculations), for example, of the eyelid or lip. Complex motor tics may involve either a cluster of simple motor tics or a more coordinated sequence of movements, but these are still rapid or abrupt. Complex motor tics include licking, hitting, jumping, smelling, spitting, squatting, abnormalities of gait, forced touching, kissing self or others, and socially inappropriate comments. Complex tics can appear purposeful and may greatly impair functioning in the classroom.

Vocal tics can also be grouped into 'simple' and 'complex' categories. Simple vocal tics include throat clearing, sniffing, grunting, coughing, barking, snorting, humming, clicking and low- or high-pitched noises. Conversely, complex vocal tics typically comprise linguistically meaningful utterances such as words and phrases, interruptions in the flow of speech, and sudden alterations in pitch and volume (Eapen & Sachdev, 2008). The uttering of obscenities (coprolalia) or making of obscene gestures (copropraxia) remain among the most well-known TS symptoms. Contrary to popular belief, these tics occur in only 5–30% of individuals with TS; however, when present they can be disabling, as well as confronting and disruptive to others. Thus, the range of symptoms and presentations in individuals with tic disorders can be substantial. See Table 1 for additional examples of motor and vocal tics and related behaviours in tic disorders.

It is worth noting that involuntary movements are present in several neurological conditions (e.g., Sydenham's chorea; Huntington's disease). However, the characteristics

of a tic that separate it from other involuntary movements include the waxing and waning course; one type of tic being replaced by another; voluntary suppression (even if this is for only brief periods); and the fact that the tic is preceded by an 'inner urge' and in some cases a premonitory somatic sensation, such as an itch, stretch, or tightness at the site, and the movement or noise is reported to occur in response to this urge. Ironically, the ability of people with tic disorders to voluntarily suppress or postpone responding to this urge with a tic, although at the expense of mounting inner tension, can lead to misinterpretation by others that tics are under voluntary control (Eapen & Sachdev, 2008). Voluntary suppression of tics for a period of time may be associated with a later 'rebound' effect of increase in the occurrence of tics. This, in turn, can sometimes lead to conflict, as the person is viewed as deliberately doing it or not trying enough to stop the tic (Eapen & Črnčec, 2009).

Tic Disorders and Associated Psychiatric Comorbidity

It has been frequently observed that for children and adults with tic disorders, psychiatric comorbidity is the rule rather than the exception, with around 80% of people with tic disorders affected by comorbid conditions across the life span (Freeman et al., 2000).

Foremost among these comorbidities is attention-deficit/hyperactivity disorder (ADHD). Epidemiological studies indicate that ADHD co-occurs with TS (TS+ADHD) in around 50–60% of individuals with TS, higher still if subclinical symptoms of ADHD are considered. In terms of clinical course, ADHD predates the emergence of tics in the majority of cases. The general consensus from various studies comparing control participants to people with TS-only, ADHD-only, and TS+ADHD is that the observed difficulties in relation to behavioural problems, poor social functioning and functional impairment may be attributed to comorbid ADHD rather than tics or tic severity per se (Carter et al., 2000; Hoekstra et al., 2004; Stephens & Sandor, 1999; Sukhodolsky et al., 2003). A diagnosis of ADHD has been shown to be associated with poorer cognitive functioning, and maladaptive and disruptive behaviour. Moreover, children with TS+ADHD have greater difficulties with aggression than those with ADHD-only (Rizzo et al., 2007).

Thus, it seems that the frequently co-occurring ADHD contributes substantially to psychological and learning problems in children with tic disorders. The impact of ADHD upon learning is well documented and includes resultant difficulties in (a) applying learning; (b) executive functioning difficulties (including problems with managing time, forming goals, organising materials and activities, starting/completing tasks, breaking down long assignments and projects, and storing memories); and (c) attention and impulsivity mediated difficulties with problem-solving and sequencing (Dornbush & Pruitt, 1995).

Obsessive–compulsive behaviour (OCB) and obsessive–compulsive disorder (OCD) occur in approximately 30–50% of people with TS, with obsessive–compulsive symptoms typically presenting after the tic symptoms (Bloch & Leckman, 2009). Like ADHD, the presence of OCD in addition to TS places a young person at considerable risk for a range of psychological and psychosocial morbidities in childhood and adulthood that can be particularly disruptive to learning. Anxious children may find learning difficult, and those with OCD in particular can feel too cognitively 'stuck' to learn (Packer & Pruitt, 2010). The doubting and checking behaviours that may be present can slow down completion of activities and can be a significant challenge in timed tasks and examinations. Similarly, OCD symptoms can disrupt memory processes, application of strategies, sequencing abilities, and problem-solving. Although these skills do not appear to be deficient per se

in children with OCD, they can be disrupted by the cognitive and attentional resources devoted to OCD cognitions and behaviours (Dornbush & Pruitt, 1995).

Behavioural/emotional problems such as aggression and anger control problems, sleep disturbances, and self-injurious behaviour have been noted to occur at higher than expected levels in people with tic disorders, usually when ADHD or OCD are already present (Freeman et al., 2000). Other behavioural/emotional disabilities such as non-OCD anxiety, separation anxiety in particular, and depression/depressive symptoms have also been noted to occur at high levels in individuals with tic disorders (Coffey et al., 2000). One study observed that 13% of individuals with TS in a sample of 3500 had depression, while 76% of the sample experienced depressive symptoms (Robertson, 2006). It is conceivable that the emergence of depression and anxiety in individuals with existing comorbidities reflects the cumulative psychosocial burden faced by this population (Swain et al., 2007).

Also increasingly observed in recent years are the similarities that exist between TS and autism spectrum disorders (ASD). ASD and TS are both neurobiological conditions that predominantly develop during childhood and affect mostly boys, and which consist of stereotypic or repetitive behaviours, ordering or arranging behaviours, as well as echolalia and echopraxia. As is the case in ASD, difficulties with empathy can also occur regularly in people with tic disorders (Kadesjö & Gillberg, 2000). Specifically, in that study around two-thirds of 58 children and adolescents with TS, who did not have a comorbid ASD, scored above the clinical cut-off on the Autism Spectrum Screening Questionnaire, and were also rated by their teachers as having major social interaction difficulties. Around one third were also rated as having empathy difficulties (i.e., they were reported to lack the ability to adjust to expectations or demands made by peers and/or they did not notice implicit negative reactions on the part of peers). Abnormal motor movements are present in both ASD and TS; however, the types of movements vary, with tics being experienced in tic disorders and stereotypic movements in ASD. Tics and stereotypic movements can be difficult to differentiate; however, they do have some distinguishing features. Tics tend to be quick movements that last for only brief periods; in contrast, stereotypies are more coordinated and unhurried. Also, tics vary in severity and site over time, whereas stereotypies often tend to remain unchanged. Tics have been shown to occur frequently in people with ASD. Although there is significant variability in the extant research, the literature suggests that around 20–40% of individuals with ASD experience tics (Baron-Cohen, Scahill, Izaguirre, Hornsey, & Robertson, 1999; Canitano & Vivanti, 2007; Ehlers & Gillberg, 1993). Perhaps the largest and best controlled study to date reported that the occurrence of TS in ASD was 6.5% (Baron-Cohen et al., 1999).

Tics have also been observed in individuals with intellectual disability, with the prevalence of tics appearing to increase with the severity of the disability (Bodfish, Symons, Parker, & Lewis, 2000). When individuals with intellectual disability only are studied, the prevalence of tics is reported to be around 5–10% (Bodfish et al., 2000; Bradley, Summers, Wood, & Bryson, 2004). However, consistent with the literature on ASD and tics reviewed previously, when individuals with intellectual disability and ASD are considered over 50% may present with tics.

Why do Tic Disorders and Associated Comorbidities Affect Learning?

The relationship between tic disorders and learning disabilities (taken to mean difficulties with learning rather than intellectual disability) has been studied by examining the prevalence of learning disabilities in cohorts of children with tic disorders, and also the

prevalence of tics and tic disorders in cohorts of children attending special education classes.

In terms of cohorts of individuals with tic disorders, learning problems have been identified in around 30–40% of cases (Abwender et al., 1996; Burd, Kauffman, & Kerbeshian, 1992; Erenberg, Cruse, & Rothner, 1986). A more recent study suggested that in uncomplicated TS (i.e., TS without any comorbidities) only 11% of children had academic difficulties, whereas when TS was comorbid with ADHD, this figure rose to 31%. The full range of specific learning disabilities was observed in children with tic disorders, although difficulties with reading and handwriting tended to predominate (Packer, 2005).

In special education/learning disability classes, several studies have indicated a prevalence of around 20–45% for tic disorders (Comings & Comings, 1987; Eapen et al., 1997; Khalifa & von Knorring, 2003; Kurlan et al., 2002; Kurlan et al., 2001; Kurlan, Whitmore, Irvine, McDermott, & Como, 1994) and around 7–20% for TS (Eapen et al., 1997; Kurlan et al., 2001). Given that the prevalence of TS is thought to be around 1% in the community, the observed rate in these settings is thus approximately 10 times higher.

Burd, Freeman, Klug, and Kerbeshian (2005) reported that around 23% of people with tic disorders have learning disabilities. These authors identified phenotype differences between the tic disorder–LD group and the tic disorder+LD group, with the tic disorder+LD group more likely to be male and have (a) an age of tic onset before 8 years and presentation for evaluation before 18 years, (b) fewer family members affected by tics, (c) a history of perinatal problems, and (d) more comorbidities. These features tend to suggest the role of additional nongenetic factors, or ‘second hits,’ such as perinatal events, trauma, injury, hypoxia, neural and psychosocial stressors that affect neuronal development with consequent impairment in cognitive processes and learning (Eapen, 2011).

Although comorbid ADHD can lead to educational difficulties and underachievement in its own right, the presence of learning disability should always be a consideration when working with children who have tic disorders, even where ADHD is not present (Eapen & Črnčec, 2009). This is because learning and cognitive performance can be affected in tic disorders in a number of ways. These include (a) deficits that are integral to tic disorders; (b) deficits arising from efforts at tic suppression; (c) deficits resulting from compensatory mechanisms (neural and otherwise); (d) factors that affect neuropsychological test performance, such as fluctuations in cognitive performance due to waxing and waning course; (e) effect of medication, such as sedation and cognitive slowing; and (f) the impact of comorbidities. All of the above factors may independently and collectively contribute to neuropsychological and executive function impairments noted in tic disorders and may explain the variation in performance across studies.

Studies in individuals with tic disorders have reported increased intrusions during recall on a word list suggesting an inhibitory dysfunction during learning tasks (Mahone, Koth, Cutting, Singer, & Denckla, 2001). This inhibitory dysfunction may be at the core of the attentional impairment found in uncomplicated TS. In this regard, Johannes et al. (2001), using event-related brain potentials, observed that although children and adults with TS showed normal behavioural performance on a dual-performance task, they demonstrated evidence of increased attention to irrelevant stimuli. Thus, the person with a tic disorder may have difficulty in keeping at bay the interference from irrelevant stimuli. This is in keeping with the observation that people with tic disorders constantly experience somatosensory urges and premonitory sensations that represent a loss in the normal ‘automatic’ ability to suppress or ‘gate’ irrelevant information in sensory, motor, and cognitive domains. These experiences, described as the ‘relentless drumbeat’ (Leckman,

TABLE 2
School-Based Strategies to Assist Young People With Tic Disorders

-
- a. Specifically educating staff and peers about tic disorders.
 - b. Adopting predictable routines that are tailored to the student's 'best' times of day in terms of their learning and 'ticcing'.
 - c. Designating a safe place for the student to go when tics are severe. A time-out pass or signal can often be useful in this regard; however, it is important to avoid allowing tics to become a reason for missing substantial amounts of class time or particular lessons.
 - d. Affording the student time for breaks, especially with opportunities for movement.
 - e. Using preferential seating (e.g., close to the front of the class and/or close to the door).
 - f. Using a buddy system for both learning needs and for social support to enhance friendships and prevent bullying.
 - g. Allowing the use of computers or a scribe to overcome slowness or specific writing-related problems.
 - h. Considering special provisions for formal examinations, including being seated in a separate room and allowing extra time.
 - i. Identifying and fostering strengths — art, music, sport, etc. — to build self-esteem.
-

Bloch, Scahill, & King, 2006), intrude into conscious awareness resulting in the generation of tics and related symptoms.

Strategies to Assist Students With Tics in Special Education

Although there is certainly no requirement upon educators to become 'experts' in tic disorders, a degree of familiarity with tic disorders would seem to be critical given the high rates of students affected in special education contexts. The seemingly purposeful nature of tics can lead to a management approach based on behavioural contingencies. For example, the young person may be punished for the 'misbehaviour' of ticcing or otherwise advised to 'stop it', or rewarded for not engaging in tics. Unfortunately, the mismatch between the young person's lived experience of tics as involuntary and a punishment/rewards management approach often leads to stress and tic exacerbation. Similarly, the waxing and waning course of tics can often lead to a sense that an individual may be 'doing it on purpose' during a waxing phase. A school-wide culture of familiarity with the involuntary nature of tics and tolerance of tics within the school can also lead to reductions in, and more appropriate management of, any bullying by peers. Suitable accommodations for children with tic disorders require something of a balancing act between including the student in all school activities and organising their experience so that they can participate on their own terms. In general terms, the aim is to create an environment that is emotionally 'safe' and where tics are proactively managed.

Management strategies need to be tailored to the individual child. For example, for some children, stress and unpredictable events will exacerbate tics, whereas for others boredom may serve to exacerbate their tics. In addition to management strategies suited to children with learning and disruptive behavioural difficulties, some general management strategies are detailed in Table 2.

With children, active collaboration and feedback between family and school is essential to facilitate appropriate classroom management and optimal curriculum planning; for example, in identifying times of day when tics may be worse, fostering the young person's strengths and interests, and revising strategies in use in response to any issues that have arisen. For adolescents and adults, appropriate adaptations may be needed at home or in the workplace.

We will not review here strategies for management of comorbidities such as ADHD and OCD within the classroom, as these have been published elsewhere (e.g., Packer & Pruitt, 2010). Nonetheless, management of comorbidities is often equally, if not more, critical than management of tics themselves. Further, familiarity with some of the features of and complexities surrounding tic disorders will assist in the task of differentiating between oppositional and disruptive behaviours, and tics.

Overview of Medical Management

Pharmacological treatment for tic disorders may include clonidine, especially when ADHD presents comorbidly, or antipsychotic agents such as risperidone when there are comorbid behavioural problems such as irritability, aggression and insomnia or ASD (Eapen & Gururaj, 2005; Eapen & Sachdev, 2008). Comorbid conditions such as OCD and ADHD would need attention and may necessitate treatment with specific serotonin reuptake inhibitors, and stimulants (with caution, monitoring for tic exacerbation) or atomoxetine, respectively. The risk of drug interactions and side effects may be increased in those with brain damage or epilepsy, and gradual increase in dosage with close monitoring is recommended (Eapen & Črnčec, 2009; Eapen & Sachdev, 2008). Psychotherapeutic techniques such as cognitive-behaviour therapy for OCD or comprehensive behavioural intervention for tics (CBIT) have established efficacy (Piacentini et al., 2010; Watson & Rees, 2008); however, outcomes may be constrained in individuals where poor cognitive and learning abilities, and hyperactivity, are a factor. Other strategies for minimising tics include input around engendering calm and consistent family dynamics and routines, the use of physical activity to 'channel' energies, as well as encouraging the individual with tics to engage in talents and hobbies, as hyperfocused activity often reduces tic expression.

Conclusion

Individuals with tic disorders are overrepresented in special education settings and in learning disability populations. The reasons for this co-occurrence of tics and learning problems are varied and include common aetiological factors such as shared neurodevelopmental and neurotransmitter genes that disrupt cognition and behaviour, as well as comorbid conditions. In this regard, ADHD is a regularly occurring comorbidity and in combination with tic disorders is associated with a significant impact on learning and behaviour. There is continuing debate about the types and nature of learning disabilities in the context of TS and whether these are comorbid disorders or part of a broader TS phenotype. Further research is needed to elucidate whether people with TS have different types of learning disability and patterns of comorbidity. Regardless of the underlying pathogenic mechanisms, early recognition and appropriate management is key to preventing secondary impairments.

Given the high co-occurrence, clinicians working with learning disability and special education groups should be alert to the possibility of co-occurring tic disorders. There is a strong case for graduate and professional development programs for people working within these contexts to include components on tic disorders. Awareness of tic disorders will allow for tics to be sensitively managed and possible comorbidities anticipated and differentiated from tics, which in turn can lead to the minimum possible disruption to the young person's education. For example, tics may be mistaken for fidgetiness that can occur with ADHD, and coprolalia may attract negative consequences such as disciplinary action in children and stigma and social embarrassment in adults. The support of advocacy groups, such as the Tourette Syndrome Association of Australia, can also assist in enhancing

awareness about tic disorders and their management for families, educators and peers. Appropriate management, understanding and tolerance can have a positive influence on the overall course of illness and improve quality of life in the individual with a tic disorder (Eapen & Črnčec, 2009; Leckman, King, & Cohen, 1999).

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