

REVIEW

Mozart's movements and behaviour: a case of Tourette's syndrome?

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In this review, we intend to explore the often asked question: "Did Mozart have Tourette's syndrome?" Although there are numerous reports attributing Mozart's peculiar personality and behaviour to a spectrum of neurobehavioural disorders such as Tourette's syndrome, autistic disorder, Asperger's syndrome, attention deficit hyperactivity disorder, obsessive-compulsive disorder and paediatric autoimmune neuropsychiatric disorders associated with streptococcal infection, the evidence for any of these disorders is lacking. Whether Mozart's behaviour was nothing more than a reflection of his unique personality or a more complex neurological disorder, aggravated later in life by enormous demands by his father and society, his behaviour has been the subject of many biographies. It will also remain unknown to what extent his accomplishments and failures were shaped by his childhood experiences, pressured lifestyle, and his innate genius and extraordinary talent. Lessons from his life may have important implications for other gifted individuals and savants whose special attributes may lead them to succeed or, on the other hand, suppress their emotional growth and make them more vulnerable to stress and failure.

syndrome.^{7–8} Various structural and functional imaging studies of brains of musicians have found that in contrast with non-musicians, the musicians' brains tend to have increased gray matter in Broca's area and in certain portions of the auditory cortex, such as the Heschl's gyrus and planum temporale.^{9–10} Studies of developmental and acquired disorders of musical listening and interpretation have shown that brain plasticity is involved in musical perceptions and integration with cognitive and emotional responses,¹¹ and that music could have both evocative and suppressive effects on some patients with movement disorders such as TS and parkinsonism.¹²

Although many individuals with unique talents have been carefully studied, no unified theory has emerged to explain the neurological basis of such exceptional creative or interpretive abilities, as demonstrated by some people with autism or some savant artists. It is beyond the scope of this review to discuss the neurobiology of savant and the reader is referred to other sources,^{13–14} but the brain mechanisms giving rise to savant-like features may be relevant to the understanding of the neurobiology of a genius mind, such as that of Mozart. Whether savant is more frequently observed in patients with TS or whether some savant cases manifest features of TS, such as tics and OCD, has not been systematically studied.

Insanity and exceptional musical talent have often been thought to be linked, but the mechanism of this relationship is unknown.¹⁵ As an example, David Helfgott, a prodigious pianist featured in the movie "Shine," has been thought to suffer from a mild form of schizophrenia with positive symptoms. He grunts, mutters, sings, talks to himself very loudly and exhibits other tic-like mannerisms as he plays.¹⁶ Creativity has often been associated with bipolar disorder and some composers, artists, authors and other creative geniuses of the past have observed loss of their creative talents with pharmacological treatment of their bipolar disorder. Vincent van Gogh, who committed suicide at the age of 37 years, in the last few years of his life suffered from episodes of mania and depression. Despite the mood swings and mental torment, he completed more than 300 of his best paintings, suggesting that his manic state may have facilitated his creativity.¹⁷ There is a lengthy list of other famous figures such as Ludwig von Beethoven, Robert Schumann, Peter Ilyich Tchaikovsky, Sergei Rachmaninoff, Ernest Hemingway, Leo Tolstoy, Jonathan Swift, Oliver

The 250th anniversary of the birth of one of the greatest musical geniuses of all times, Wolfgang Amadeus Mozart (1756–1791), provides an opportunity not only to reflect on his immeasurable contributions to the world of classical music, but also to examine him as a man of exceptional creative power. Mozart's biographical accounts often comment on his peculiar behaviour which has been interpreted by some as a manifestation of an underlying neurobehavioural disorder, such as Tourette syndrome (TS). Once considered a rare psychiatric curiosity, TS is now recognised as a relatively complex neurobehavioural disorder, affecting approximately 2% of the general population.^{1–2} Some studies have suggested that TS affects up to 3.8% of children, and two-thirds of them have coexistent attention deficit hyperactivity disorder (ADHD), obsessive-compulsive disorder (OCD) or other behavioural comorbidities.³ Although learning disabilities have been suggested to be present in some patients with TS,^{4–5} most reach their full potential without any residual psychiatric or neurological handicap. Many notable figures, such as Dr Samuel Johnson, have made extraordinary contributions to the arts and sciences despite, or perhaps because of, their TS.⁶ Several reports have drawn attention to the observation that some TS patients possess unique talents and skills, similar to individuals with autism and savant

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Abbreviations: ADHD, attention deficit hyperactivity disorder; OCD, obsessive-compulsive disorder; TS, Tourette syndrome

Cromwell, Abraham Lincoln, Theodore Roosevelt, John Nash, Nikolai Gogol, Edgar Allan Poe and many more who have suffered from a variety of mental or personality disorders.^{15 18 19} Besides Samuel Johnson and Mozart, many celebrities such as Howard Hughes, Marc Summers, David Beckham, Tim Howard, Jim Eisenreich, Chris Jackson (Mahmoud Abdul-Raul), David Aldridge, Michael Wolff, Dan Ackroyd, Howie Abdul-Rauf Mandel and Mel Gibson are among those thought to manifest some features of TS and its comorbidities, particularly OCD.^{16 20 21}

MOZART'S BACKGROUND

Wolfgang Amadeus Mozart was born on 27 January 1756 in Salzburg, Austria, and grew up in a very influential and intellectual family. Mozart very much admired and loved his mother, Anna Maria Mozart (1720–1778). His father, Leopold Mozart (1719–1787), was an excellent musician, a violin composer and a Vice-Kapellmeister in the archiepiscopal court at Salzburg. Before his death, Leopold carefully collected family letters, intended to be used to write his son's biography. They were later handed to his daughter, Maria Anna Mozart (1751–1829), known as Nannerl (Marianne von Berchtold), who referred to them in her *Reminiscences*. Nannerl was 5 years older than Wolfgang and less prodigal in music than he. Later, Friedrich Schlichtegroll used Nannerl's reminiscences for writing the first official biography about Mozart.^{22 23}

A child prodigy with an unerring musical ear, flawless musical memory and infallible sight reading ability since the age of 3 years, Mozart's hearing acuity was so delicate that loud sounds would make him physically ill. By the age of 4 years, Mozart could tell whether an instrument was out of tune and could learn a piece in half an hour. He became an excellent clavichordist at the age of 5 years. Unlike other children who started going to school at the age of 6 years, Wolfgang started touring and concerting with his father, Leopold, and his sister Maria Anna. He wrote his first symphony at age 8 years, and then grew into a prolific composer of over 600 pieces of music, including more than 50 symphonies, 27 concert arias, 26 string quartets, 25 piano concertos, 21 stage and opera works, 17 piano sonatas, 15 masses and 12 violin concertos. Among his most famous works are *Eine kleine Nachtmusik* (A Little Night Music, 1787) and the operas *Don Giovanni* (1787) and *Die Zauberflöte* (The Magic Flute, 1791).^{24 25}

Mozart married Constanze Weber (1762–1842) in 1782 and they had two children, including the second surviving son Carl Thomas Mozart (1784–1858). Mozart's cause of death, at age 35 years and 10 months just before one o'clock in the morning on 5 December 1791, is controversial. His odd behaviour, portrayed by actor Tom Hulse in the hit 1984 movie "Amadeus", has been a topic of numerous essays.^{26 27} This review attempts to provide an objective and non-judgmental evaluation of the evidence for and against the diagnosis of TS as a possible explanation of Mozart's manners, gesticulations, conduct and personality.

MOZART'S LANGUAGE

Fog and Regeur,²⁸ and later Davies²⁹ and Keynes,³⁰ were among the first investigators who talked about Mozart's TS and cyclothymic disorder. Simkin, an endocrinologist, pianist, musicologist and historian, elaborated on Mozart's art and life from a medical point of view and has discussed Mozart's TS extensively.^{31 32} Based on Simkin's meticulous investigation, evidence of scatology exists in 39 of 371 letters (10.5%) written by Mozart. When all letters referring to anal matters are added up, the total number of vulgar letters rises to 12.9%. Nine of these letters were written to his cousin, Marianne. In his letters, Mozart made excessive use of obscene words, primarily focusing on defecation and anal vulgarities, suggesting the presence of coprographia.³¹ As an example, in one letter, written to Marianne on 28 February 1778, Mozart overly repeats the word "muck" (sh-): "Muck! – Muck! – Ah, muck! Sweet word!

Muck! Chuck! That too is fine. Muck, chuck! – muck! – suck – o *charmante!* Muck, suck! That's what I like! Muck, chuck and suck! Chuck muck and suck muck!"³³ Another example of a propensity towards foul language (coprolalia) is Mozart's cannons titled "*Leck mich am Arsch*" ("Lick my ass"), composed when he was 26 years old.³⁴ Joseph Lange, who was an actor with the Burgtheater company and Mozart's brother-in-law (husband of Aloisia Weber, Mozart's earliest girlfriend and sister of his wife Constanze) and who had very close relations with Mozart, wrote about Mozart's vulgar platitudes. However, he believed that Mozart's inane and immature behaviour was a byproduct of the creative intensity surrounding his process of composition: "Never was Mozart less recognisably a great man in his conversation and actions, than when he was busied with an important work. At such time he not only spoke confusedly and disconnectedly, but occasionally made jests of a nature which one did not expect of him, indeed he even deliberately forgot himself in his behaviour....Either he intentionally concealed his inner tension behind superficial frivolity, for reasons which could not be fathomed, or he took delight in throwing into sharp contrast the divine ideas of his music and these sudden outbursts of vulgar platitudes, and in giving himself pleasure by seeming of make fun of himself".^{35 36}

Although coprolalia is a characteristic feature of TS, and recent studies indicate its association with activation of various areas in the brain such as the left middle frontal and right precentral gyri,³⁷ this language abnormality is not universally present or specific for TS.³⁸ Some investigators, in fact, believe that the scatological features exhibited by Mozart may simply represent a style of speech and silliness that was acceptable behaviour in the population of the South German middle class or was influenced by his family.^{36 39} Mozart's scatological language may have been just a reflection of his satirical, hypomanic humour and intentional rather than involuntary or could have been an influence from his mother's "Salzburgisch" humorous characteristic.⁴⁰ For example, in one of her letters to her husband from Munich in 1777, Anna Maria (Mozart's mother) wrote the following: "Keep well, my love. Into your mouth your ass you'll shove. I wish you good-night, my dear, but first sh- your bed and make it burst".⁴¹ Nannerl, Mozart's sister, showed signs of vulgar language too as she wrote the following about her pet fox-terrier in her letter to her mother and brother: "All the same she is quite well, eats, drinks, sleeps, sh-s, and pisses".⁴² Contrary to these assumptions, Simkin eloquently studied the occurrence of scatology among Mozart's family members and documented that Anna Maria (Mozart's mother), Maria Anna (Mozart's sister) and Leopold Mozart (Mozart's father) showed 2.5%, 6.7% and 0.3% scatological usage in their correspondences, respectively, compared with 10.5% scatological incidence present in Mozart's letters.³¹ Whether such linguistic features suggest coprographia and support the diagnosis of TS or are indicative of excessive humour, arrogant behaviour of a savant or impulsive outbursts of stressful life remain controversial.

MOZART'S MOTOR BEHAVIOUR

In addition to uttered vulgar platitudes,³⁴ Mozart's frequent facial grimaces, inadvertent repetitive movements of hands and feet, and jumping,^{43 44} have been regarded by some as phonic and motor tics and used to support the diagnosis of TS.^{31 32} Several descriptions of Mozart detail his hyperactive behaviour. For example, while composing he was simultaneously involved in other activities such as walking, riding or playing billiard.⁴⁵ Sophie Haible, Mozart's sister-in-law, wrote in one of her letters that he often used to touch his napkin to his lips, make grimaces, tap his hands or feet on objects, or play with hats, pockets, tables and chairs seemingly playing clavichord.³⁴ Karoline Pichler (1769–1843), daughter of the senior civil servant Franz Sales von Greiner and a member of the intelligentsia in Vienna who had musical affiliation with Mozart, described Mozart and

Haydn as "persons who displayed in their contacts with others absolutely no other extraordinary intellectual capacity and almost no kind of intellectual training, of scientific or higher education.... Silly jokes, and in case of Mozart an irresponsible way of life, were all that they displayed to their fellow men". She and others also recalled Mozart's abrupt changes of mood, at one moment gripped with divine musical inspiration, while a minute later acting in a facetious and ridiculous fashion. For example, she described Mozart's "catty" behaviour during an improvisation on *Non più andrai* (from Act I of Figaro). Mozart apparently became "...suddenly tired of it, jumped up, and, in the mad mood which so often came over him, he began to leap over tables and chairs, miaow like a cat, and turn somersaults like an unruly boy". Later in her memoirs, Pichler also referred to Mozart's "irresponsible way of life".^{36 46} Eleven out of 25 people who had association with Mozart in their memories mentioned his perpetual movements and mannerisms, which were regarded as facial and bodily tics.⁴⁷

Regardless of these reports, some investigators still argue that the observed unusual motor behaviours and vocalisations seen in Mozart are simply indicative of eccentric personality, sometimes associated with the unusual gift (or a curse) of a genius.^{6 36 39} Some scholarly thinkers or creative individuals who are deeply involved in their profession may ignore time, place and people around them and outpour their anxiety or stress in a form of peculiar body movements, mannerisms or gesticulations, talking to themselves, yelling or even grunting without necessarily satisfying diagnostic criteria for TS.⁴⁸

COMORBID BEHAVIOURAL SYMPTOMS

One of the behavioural disorders most commonly coexisting with other symptoms of TS is OCD.^{1 2} Mozart did exhibit features that strongly suggest that he harboured obsessions with objects, thoughts, repetition of certain things and the use of scatological language. For example, one of his biggest obsessions was his unnatural fear of his wife leaving the house: "Never go out walking alone. It terrifies me" and "Please do not go to the casino today even if Mme Schwingenschuhs should go out to Baden". Mozart was obsessively meticulous even about his wife's mode of hygiene: "I entreat you to take the bath only every other day, and only for an hour. But if you want me to feel quite easy on my mind, do not take them at all, until I am with you again".⁴⁹

Mozart often had sudden mood swings from depression to elevated or expansive moods without an obvious cause, but which appeared to emanate from within,^{50 51} suggestive of bipolar disorder, another comorbidity often encountered in creative geniuses.⁵² Mozart's socially unusual behaviour probably contributed to his financial struggles and prevented him from reaching material success.^{32 36} Mozart used to practice inappropriate joking and punning and indulged in frivolous behaviour without appreciation of consequences.²⁶ This could be interpreted as analogous to impulse control or conduct disorder, frequently encountered in patients with TS,⁵³ and occasionally leading to problems with the law.⁵⁴

Nannerl, Mozart's sister, wrote the following about her brother: "This same being who, considered as an artist, had reached the highest stage of development even from his very earliest years, remained to the end of his life completely childish in every other aspect of existence. Never, until he died, did he learn to exercise the most elementary forms of self-control".⁵⁵

Several elements of Mozart's behaviour may indicate the presence of ADHD during his childhood and extending to his adult years. Although Mozart has been described to easily switch from serious and impulsive to jolly and rowdy mood, some have suggested that the various accounts of his eccentric behaviour have been exaggerated and his impulsiveness was merely a personality trait rather than a psychiatric disorder.^{6 39 56} In addition to ADHD, conduct disorders, drug and

alcohol abuse, possibly reflect abnormalities in dopamine D2 (*DRD2*) and serotonin transporter (*5-HTT*) genes.^{57 58}

Some of Mozart's compositions and phrasings in his works may reflect his impatient personality, possibly related to difficulties with attention. Karl Ditters von Dittersdorf, an eminent violinist and composer, wrote "He leaves his hearer out of breath, for hardly has he grasped on beautiful thought than another of greater fascination dispels the first, and this goes on throughout, so that in the end it is impossible to retain any one of these beautiful melodies".²⁶ Even the statement by the Emperor Joseph II, made famous in Milos Forman's movie *Amadeus*, "too beautiful for our ears, and far too many notes, my dear Mozart", has been used by some to suggest that some of his musical phrases reflect Mozart's excesses and frequent reversal and repetitions of words, rhyming and play of words.²⁷ Hyperkinetic (incontinence of emotions), comic aspects, simultaneously performing of several different compositions in the form of quodlibet, and the peculiarity of Quartet K298 are attributed to sublimation of Mozart's TS into musical tics.³²

Paradoxical to many reports about Mozart's mental health status, his music, such as the Piano Sonata in D Major (K.448), has been described to have a "Mozart Effect", which includes enhancement in IQ and spatial-temporal performance of cortical and cerebellar parts of the brain within a few minutes of listening.^{59 60} His music has also been reported to have a therapeutic effect on epileptic patients,⁶¹ possibly by increasing blood flow to temporal, dorsolateral prefrontal and occipital areas and the cerebellum, in comparison with Beethoven's *Fur Elise* and 1930s piano music⁶² associated with activation of task relevant brain areas.⁶³

Pervasive developmental and other autistic disorders, particularly Asperger's syndrome, have also been linked to unique abilities, seen in savants, and TS-like features.⁶⁴⁻⁶⁶ Autistic savants have been shown to have attention impairment, particularly in auditory and multiple stimuli,⁶⁷ which is in contrast with Mozart's exquisitely sensitive ears and pitch that enabled him to hear several musical pieces simultaneously, and combining them in a quodlibet.³² Although some aspects of autism, such as repetitive body movements and certain preoccupations could be identified in Mozart,^{34 50 51} other features such as avoiding change or transition and preferring sameness do not make him a good candidate for autistic disorders. Some aspects of Asperger's syndrome such as repetitive body movements, motor or phonic tics and preoccupation with some parts of objects⁶⁴ have been described in Mozart.^{44 50 51}

Davies chronologically documented the series of Mozart's illnesses between 1763 and 1766, including tonsillitis and upper respiratory tract infections, with symptoms and signs of rheumatic fever.²⁹ The link between rheumatic fever and St Vitus Dance was made by Thomas Sydenham, who was the first to recognise St Vitus Dance as a rheumatic manifestation in 1686. "Sydenham's chorea" occurred in one of five cases of rheumatic fever. Chorea associated with previous streptococcal infections also produces a variable degree of behavioural disturbances which overlap with ADHD and OCD, and other features resemble some of the behavioural comorbidities seen in patients with TS.^{68 69} This raises the question of whether Mozart suffered from Sydenham's chorea or paediatric autoimmune neuropsychiatric disorders associated with streptococcal infections known as PANDAS.^{70 71}

Maynard Solomon eloquently analysed the duality between Mozart's behavioural non-conformism and his divine power as a musical genius from different perspectives and sources: violinist Karl Holz in 1825 depicted Mozart as "Outside of his genius as a musical artist, Mozart was a nullity". Wolfgang Hildesheimer, a twentieth century historian, commented that Mozart "was as great a stranger to the world of reason as the sphere of human relations. He was guided solely by the aim of the moment".

Probably such comments could explain Mozart's liberal sexual attitudes, critique of authorities, bohemianism and Freemasonry.²³

Despite the tantalising notion that Mozart may have exhibited features of TS and perhaps some of its comorbidities, such as OCD and ADHD, it is possible that his peculiar behaviour simply reflected the complex interaction between his innate genius and the social milieu of his childhood and professional life. This is suggested by the following statement from a biography by Davies⁴⁸: "Mozart never attended a school and received his entire initial, general and musical education from his father. Such an insulated upbringing would further have prejudiced his emotional development while his preoccupation with music probably retarded the general growth of some of his other talents, such as those in mathematics and drawing. During his social development and his education there came about an imbalance between different facts of his development: its major outcome was a retardation of his emotional maturation which could not keep pace with the creativity of his intellect". That may explain his periodic anxiety, loneliness and sadness,²⁹ as he mentioned in his last and dire memo that: "I have come to the end before having enjoyed my talent...".²⁷ Another assumption of his odd behaviour such as excessive use of joke, humorous acts and distinctive clothing with vivid colours such as red and use of accessories might be explained to gain more grandiosity over nobles around him to overcome his physical features such as short height, strange shape of the head with pockmarked face, large nose, receding chin and deformed left ear, and pale skin.⁶

In conclusion, this review of Mozart's distinctive character and behaviour raises the possibility that his extraordinary creativity was not only the product of his exceptional abilities but was also influenced by his distinctive cognitive and neurological function. While remembering Mozart's creative contributions, it is important to appreciate the capacity of the brain to markedly augment certain uniquely human qualities and to encourage research of finding possible ways of accessing and harvesting these powers. If Mozart did have TS, he was clearly able to compensate well, in contrast with a small minority of TS patients whose tics or comorbidities may become disabling or even life-threatening.⁷²

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REFERENCES

- Robertson MM. Tourette's syndrome, associated conditions and the complexities of treatment. *Brain* 2000;**123**:425-62.
- Jankovic J. Tourette's syndrome. *N Engl J Med* 2001;**345**:1184-92.
- Kurlan R, McDermott MP, Deeley C, et al. Prevalence of tics in schoolchildren and association with placement in special education. *Neurology* 2001;**57**:1383-8.
- Eapen V, Robertson MM, Zeitlin H, et al. Gilles de la Tourette's syndrome in special education schools: a United Kingdom study. *J Neurol* 1997;**244**:378-82.
- Verte S, Geurts HM, Roeyers H, et al. Executive functioning in children with autism and Tourette syndrome. *Dev Psychopathol* 2005;**17**:415-45.
- Keynes M. The convulsory Samuel Johnson and the Miaowing of Mozart. In: Rose FC, eds. *Neurology of the arts: Painting, music, literature*. London: Imperial College Press, 2004:317-27.
- Moriarty J, Ring HA, Robertson MM. An idiot savant calendrical calculator with Gilles de la Tourette's syndrome: Implications for an understanding of the savant syndrome. *Psychol Med* 1993;**23**:1019-21.
- Mottron L, Dawson M, Soulières I, et al. Enhanced perceptual functioning in autism: An update, and eight principles of autistic perception. *J Autism Dev Disord* 2006;**36**:27-43.
- Schneider P, Sluming V, Roberts N, et al. Structural, functional, and perceptual differences in Heschl's gyrus and musical instrument preference. *Ann N Y Acad Sci* 2005;**1060**:387-94.
- Aydin K, Ciftci K, Terzibasoglu E, et al. Quantitative proton MR spectroscopic findings of cortical reorganization in the auditory cortex of musicians. *AJNR Am J Neuroradiol* 2005;**26**:128-36.
- Stewart L, von Kriegstein K, Warren JD, et al. Music and the brain: Disorders of musical listening. *Brain* 2006;**129**:2533-53.
- Sacks O. The power of music. *Brain* 2006;**129**:2528-32.
- Pring L. Savant talent. *Dev Med Child Neurol* 2005;**47**:500-3.
- Treffert DA, Christensen DD. Inside the mind of a savant. *Sci Am* 2005;**293**:108-13.
- Witzum E, Lerner V, Kalian M. Creativity and insanity: The enigmatic medical biography of Nikolai Gogol. *J Med Biogr* 2000;**8**:110-16.
- Rosen A, Walter G. Way out of tune: lessons from Shine and its expose. *Aust N Z J Psychiatry* 2000;**34**:237-44.
- Rose FC. Neurology of the art: An overview. In: Rose FC, eds. *Neurology of the arts: painting, music, literature*. London: Imperial College Press, 2004:43-76.
- Chessick RD. What grounds creativity? *J Am Acad Psychoanal Dyn Psychiatry* 2005;**33**:3-27.
- Andreasen N. *The creating brain: the neuroscience of genius*. New York: DanaPress, 2005.
- Murray TJ. Dr Samuel Johnson's movement disorder. *Br Med J* 1979;**1**:1610-14.
- Summers M. *Everything in its place: My trials and triumphs with obsessive compulsive disorder*. New York: Penguin Putnam Inc, 1999.
- Simkin B. *Medical and musical byways of mozartiana*. Santa Barbara, CA: Fithian Press, 2001.
- Solomon M. *Mozart*. London: Pimlico, 1995.
- Gutman, RW. *Mozart: A cultural biography*. Florida: Harcourt Inc, 1999.
- Burk, JN. *Mozart and his music*. New York: Random House, 1959.
- Shonberg CH. *The lives of the great composers*. New York: WW Norton, 1997.
- Parouty M. *Mozart the real Amadeus*. New York: Gallimard, 1988.
- Fog R, Regeur L. Did Mozart suffer from Tourette syndrome? Proceedings of the World Congress of Psychiatry, Vienna, 1985:214.
- Davies JP. *Mozart in person: his character and health*. New York: Greenwood Press Inc, 1989.
- Keynes M. The personality and illnesses of Wolfgang Amadeus Mozart. *J Med Biogr* 1994;**2**:217-32.
- Simkin B. Mozart's scatological disorder. *BMJ* 1992;**305**:1563-7.
- Simkin B. *Medical and musical byways of mozartiana*. Santa Barbara, CA: Fithian Press, 2001.
- Anderson E. *Mozart's letters*. London: Barnie & Jenkins Ltd, 1990.
- Lange J. Reminiscences (1808). In: Deutsch OE, eds. *Mozart, a documentary biography*. Stanford: Stanford University Press, 1965:503.
- Deutsch OE. *Mozart, a documentary biography*. Stanford: Stanford University Press, 1965.
- Landon HCR, ed. *The Mozart compendium*. Ann Arbor: Borders Press, 1990:102-10.
- Gates L, Clarke JR, Stokes A, et al. Neuroanatomy of coprolalia in Tourette syndrome using functional magnetic resonance imaging. *Prog Neuropsychopharmacol Biol Psychiatry* 2004;**28**:397-400.
- Lawden M. Gilles de la Tourette syndrome: a review. *J R Soc Med* 1986;**79**:282-8.
- Karhausen LR. Weeding Mozart's medical history. *J R Soc Med* 1998;**91**:546-50.
- Davies JP. *Mozart in person: his character and health*. New York: Greenwood Press Inc, 1989.
- Anderson E. *The letters of Mozart and his family*, 3rd Edn. London: Macmillan, 1985.
- Anderson E. *The letters of Mozart and his family*, 3rd Edn. London: Macmillan, 1985.
- Deutsch OE. *Mozart: A documentary biography*. Blom E, Lanscombe P, Noble J, translators. London: Adam & Charles Black, 1966.
- Haibel S. Memories. In: Deutsch OE, eds. Nissen (1828). *Mozart, a documentary biography*. Stanford: Stanford University Press, 1965.
- Jahn O. *Life of Mozart*, Townsend PD, translator. London: Novello, Ewer, and Company, 1891.
- Pichler K. Memories (1843-44). In: Deutsch OE, eds. *Mozart biography*. Stanford: Stanford University Press, 1965:556-7.
- Simkin B. The case for Mozart's affliction with Tourette syndrome. *J Conductor Guide* 1991;**12**:50-64.
- American Psychiatric Association. *Diagnostic and Statistic Manual of Mental Disorders (DSM-IV)*. Washington: APA Press, 2005.
- Anderson E. *The letters of Mozart and his family*, 3rd Edn. London: Macmillan, 1985.
- Davies JP. Mozart's Manic-depressive tendencies, part I. *Musical Times* 1987;**128**:123-6.
- Davies JP. Mozart's manic-depressive tendencies, part II. *Musical Times* 1987;**128**:191-6.
- Berthier ML, Kulisevsky J, Campos VM. Bipolar disorder in adult patients with Tourette's syndrome: a clinical study. *Biol Psychiatry* 1998;**43**:364-70.
- Goudriaan AE, Oosterlaan J, de Beurs E, et al. Neurocognitive functions in pathological gambling: a comparison with alcohol dependence, Tourette syndrome and normal controls. *Addiction* 2006;**101**:534-47.
- Jankovic J, Kwak C, Frankoff R. Tourette's syndrome and the law. *J Neuropsychiatry Clin Neurosci* 2006;**18**:86-95.
- Stendhal HB. *The Lives of Haydn, Mozart & Metastasio*, Coe R, translator. London: Calder & Boyars, 1972.
- Karhausen LR. Mozart in person. *Times Lit Suppl* December 21-27, 1990.
- Comings DE. Genetic factors in substance abuse based on studies of Tourette syndrome and ADHD probands and relatives. *Drug Alcohol Depend* 1994;**35**:1-16.
- Thompson MD, Gonzalez N, Nguyen T, et al. Serotonin transporter gene polymorphisms in alcohol dependence. *Alcohol* 2000;**22**:61-7.
- Hughes JR, Fino JJ. The Mozart effect. In: Rose FC. *Neurology of the arts: Painting, music, literature*. London: Imperial College Press, 2004:237-49.
- Gillette KS, Vrbancic MI, Elias LJ, et al. A Mozart effect for women on a mental rotations task. *Percept Mot Skills* 2003;**96**:1086-92.
- Hughes JR, Daaboul Y, Fino JJ, et al. The "Mozart effect" on epileptiform activity. *Clin Electroencephalogr* 1998;**3**:109-19.
- Bodner M, Mufuler LT, Nalcioglu O, et al. fMRI study relevant to the Mozart effect: brain areas involved in spatial-temporal reasoning. *Neurology* 2001;**23**:683-90.
- Jausovec N, Jausovec K, Gerlic I. The influence of Mozart's music on brain activity in the process of learning. *Clin Neurophysiol* 2006;**117**:2703-14.
- Ringman JM, Jankovic J. The occurrence of tics in Asperger syndrome and autistic disorder. *J Child Neurol* 2000;**15**:394-400.

- 65 **Berthier ML**, Kulisevsky J, Asenjo B, *et al.* Comorbid Asperger and Tourette syndromes with localized mesencephalic, infra-thalamic, thalamic, and striatal damage. *Dev Med Child Neurol* 2003;**45**:207–12.
- 66 **Baron-Cohen S**, Scahill VL, Izaguirre J, *et al.* The prevalence of Gilles de la Tourette's syndrome in children and adolescents with autism: a large scale study. *Psychol Med* 1999;**29**:1151–9.
- 67 **Casey BJ**, Gordon CT, Mannheim GB, *et al.* Dysfunctional attention in autistic savants. *J Clin Exp Neuropsychol* 1993;**15**:933–46.
- 68 **Dewhurst K**, Oliver J, Trick KL, *et al.* Neuro-psychiatric aspects of Huntington's disease. *Confin Neurol* 1969;**31**:258–68.
- 69 **Mell LK**, Davis RL, Owens D. Association between streptococcal infection and obsessive-compulsive disorder, Tourette's syndrome, and tic disorder. *Pediatrics* 2005;**116**:56–60.
- 70 **Church AJ**, Dale RC, Lees AJ, *et al.* Tourette's syndrome: a cross sectional study to examine the PANDAS hypothesis. *J Neural Neurosurg Psychiatry* 2003;**74**:602–7.
- 71 **Swedo SE**, Leonard HL, Garvey M, *et al.* Pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections: clinical description of the first 50 cases. *Am J Psychiatry* 1998;**155**:264–71.
- 72 **Cheung MY**, Shahed J, Jankovic J. Malignant Tourette syndrome. *Mov Disord* 2007 (in press).

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Bilateral caudate nucleus infarction associated with variant in circle of Willis

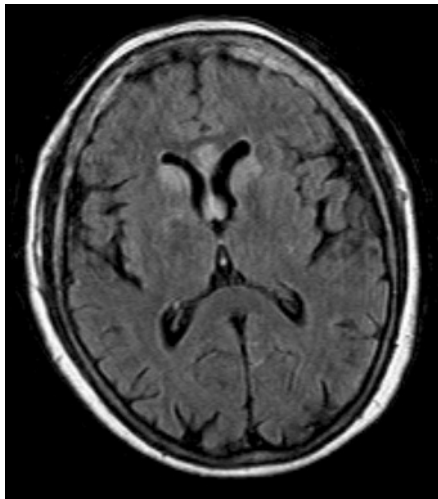


Figure 1 Axial FLAIR MR image shows bilateral high signal intensity of the head of the caudate nuclei, the genu of the corpus callosum and the fornices, consistent with acute infarction.

A 76-year-old woman presented with syncope. The next day she had disorientation, confabulations, slight dyspraxia of the left hand and bilateral Babinski signs. A fluid attenuated inversion recovery MR scan showed high signal intensity of the head of the caudate nuclei, the anterior part of the corpus callosum and the fornices, consistent with bilateral infarction (fig 1). The vascular territory comprised bilaterally the recurrent artery of Heubner and the medial lenticulostriate artery, both branches of the anterior cerebral artery. The fornices and part of the genu of the corpus callosum are vascularised by proximal perforating branches of the anterior cerebral artery or the anterior communicating artery.¹ Magnetic resonance angiography of the circle of Willis performed within 1 week showed absence of the A1 segment of the anterior cerebral artery on the left side (fig 2). Echo Doppler of the carotid arteries showed moderate stenosis. Her Mini-Mental State Examination score 3 weeks later was 23/30. Verbal working memory and delayed recall were low, with normal recognition and no aphasia, apraxia or fluency problems.

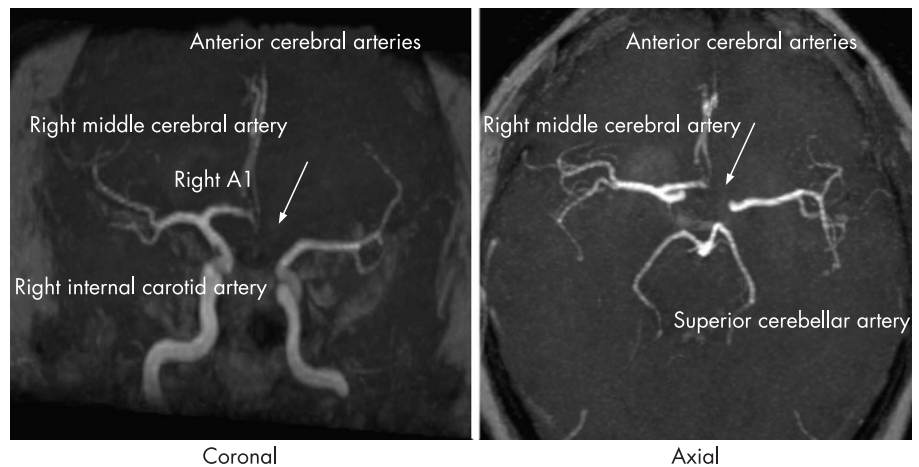


Figure 2 Magnetic resonance angiography of the circle of Willis shows an absent A1 segment of the left anterior cerebral artery (arrow).

Bilateral caudate nucleus infarctions are rare.² Neurobehavioral consequences of caudate nucleus infarctions include abulia,^{2,3} dysarthria,² aphasia,² confabulations⁴ and global dementia.⁴ Left caudate nucleus infarction can lead to verbal memory dysfunction with intact recognition, in line with our findings.⁵ Involvement of the fornices may contribute to amnesia.¹

Our finding is the first description of bilateral cerebral infarctions associated with the absence of the left A1 segment. In this case, the right A1 segment provided bilaterally the recurrent artery of Heubner and the anterior circulation.

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REFERENCES

- 1 **Moudgil SS**, Azzouz M, Al-Azzaz A, *et al.* Amnesia due to fornix infarction. *Stroke* 2000;**31**:1418–19.
- 2 **Kumral E**, Eyyapan D, Balkir K. Acute caudate vascular lesions. *Stroke* 1999;**30**:100–8.
- 3 **Narumoto J**, Matsushima N, Oka S, *et al.* Neurobehavioral changes associated with bilateral caudate nucleus infarctions. *Psychiatry Clin Neurosci* 2005;**59**:109–10.
- 4 **Mendez MF**, Adams NL, Lewandowski KS. Neurobehavioral changes associated with caudate lesions. *Neurology* 1989;**39**:349–54.
- 5 **Mizuta H**, Motomura N. Memory dysfunction in caudate infarction caused by Heubner's recurring artery occlusion. *Brain Cogn* 2006;**61**:133–8.