



# Abnormal line bisection judgements in children with Tourette's syndrome

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## Abstract

Tourette's syndrome (TS) has been associated with loss of normal basal ganglia asymmetry, as well as loss of normal functional asymmetry, including the leftward bias on traditional visuospatial tasks such as line bisection and turning bias tests. The aim of the present study was to examine the lateralisation of visuospatial attention in TS. We examined the effect of an irrelevant moving-dot background on line bisection judgements. Nine children with a DSM IV diagnosis of TS participated, in addition to 9 healthy controls, individually matched for age, sex and IQ. Horizontal lines of varying length were presented on a computer screen with either a blank background, or a moving, random-dot field. The dots moved either leftward or rightward across the screen at 40 or 80 mm/s, and participants were instructed to ignore these distracting stimuli when judging the lines. TS children were found to be abnormally *right-biased* in line bisection in a similar fashion to unmedicated ADHD children who, in a previous study, showed a similar small, yet significant, right-bias in line bisection. Matched controls showed a small, nonsignificant *left bias*, consistent with past research. Unlike previous findings with hemineglect patients, the irrelevant moving background had no effect on bisection performance for TS children or healthy controls. The present findings suggest a deficit in visuospatial attention consistent with the emerging picture of a lateralised dysfunction of frontostriatal circuitry in TS. © 2001 Elsevier Science Ltd. All rights reserved.

**Keywords:** Comorbidity; Laterality; Line bisection; Tourette's syndrome; Visuospatial attention

## 1. Introduction

Tourette's syndrome (TS), a neurodevelopmental disorder, results in the emergence of motor and vocal tics usually prior to about 10 years of age [26]. Other than the tics that typically change in severity and content as the disorder progresses, TS is often also accompanied by behavioural, emotional and cognitive problems [26]. The frontostriatal neuropathology of TS (i.e. reduced volumes and abnormal asymmetries of the basal ganglia (BG), and abnormal metabolic functioning of frontal and cingulate/limbic cortical regions) predict both motor and cognitive disturbances [8,12,13,20,27,37].

Although the continuous performance test (CPT) seems to readily discriminate ADHD from normal children, suggesting sustained attention problems [18], TS children appear to be relatively unimpaired on this task [35]. Other studies employing neuropsychological batteries have provided some evidence for attentional impairments in TS adults [11,36]. It has been suggested, however, that these neuropsychological deficits are attributable to the influence of comorbid obsessive-compulsive (OC) and ADHD behaviours [36,40]. Although an attention deficit could conceivably result from frontostriatal dysfunction (as is thought to be the case in TS), further research employing tasks *specifically* designed to investigate aspects of attention is required to support such a claim.

The present experiment involved the use of a horizontal line bisection task to examine the lateralisation of visuospatial attention in TS. Line bisection tasks

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may be particularly sensitive to lateral biases in visuospatial attention, such as those that arise in left neglect patients with right-hemisphere damage [9,22,33]. In a previous study of right-hemisphere patients with clinical left neglect using an identical line bisection paradigm, patients were shown to be significantly right-biased in their attempts to bisect the line [23]. An irrelevant, moving patterned background was also found to systematically bias patients' bisection judgements, such that their judgements were significantly shifted toward the neglected or *left* side by the *leftward* moving background [23], but not to the right by the rightward moving background. A further study using the same task demonstrated abnormal (reversed) functional asymmetry in ADHD children *off* stimulant medication [34]. This result perhaps reflects abnormal BG asymmetry in ADHD, as has been shown by neuroimaging studies [10,14,21].

TS has been associated with loss of the normal neuroanatomical BG asymmetries [27,37], as well as loss of the normal functional asymmetries (leftward biases for such traditional neuropsychological tasks as paper-and-pencil line bisection and turning bias tests) [39]. We therefore predicted that TS children would show abnormal visuospatial attention on line bisection in our computerised task. TS adults have been found to be unusually reliant on external visual cues during performance on a sequential button-pressing task [17]. Thus, we also predicted that line bisection performance in TS children might be abnormally affected by an irrelevant moving background. Despite the fact that the moving background array is not essential to perform the task unlike the visual cues in the button-pressing study [17], as noted above, the previous study with neglect patients showed that the leftward moving dots effectively shifted attention leftward and reduced the bisection error [23].

## 2. Method

### 2.1. Participants

Fourteen children were recruited through various paediatric outpatient units and the Tourette's Syndrome Association of Victoria. Of a total sample of 14 children with TS, only 9 (all male, 8 dextral and 1 sinistral) had TS without comorbid diagnoses. Of the 5 children with comorbid symptoms, 4 had comorbid ADHD and OCD, and 1 had comorbid ADHD only. Table 1 shows demographic information for the final sample of 9 'pure' TS children. Each child met the DSM-IV criteria for TS (according to a qualified consultant), and scored significantly on the Tourette's Syndrome Global Scale (TSGS, [19]). The mean score on the TSGS for the TS group ( $M = 23.7$ ) indicated a mild level of TS severity [19]. As the severity and complexity of tics in TS increase with age, it is only natural that the severity of TS symptoms was only 'mild' on average in our sample of TS children as these children were generally tested before the disorder had reached its most severe presentation. The severity of comorbid OC and ADHD symptoms was also measured using the Obsessive-Compulsive Disorder Inventory [15] and the ADHD Rating Scale (ADHD RS, [1]) respectively. Any TS child recruited who scored above the cut-off for the ADHD RS ([1] see Table 1 for scale criteria) or the OCD Inventory ([15] see Table 1 for scale criteria) was not included in the final sample. Of note here is one child with TS who scored 25 points thus meeting the first, but not the second requirement of the ADHD RS (see Table 1 for scale criteria). Of the sample of 9 children with TS, 3 were unmedicated and 6 were on typical neuroleptic medications (2 of whom were also taking a stimulant). Typical medications used for the treatment of TS (i.e. neuroleptics) have been shown to have no impact on neuropsychological test perfor-

Table 1  
Demographic details of the Tourette's Syndrome (TS) and matched control groups (S.D. in brackets, Ranges bottom line of each cell), and 1-way Group ANOVA statistics

	TS group ( $n = 9$ )	Controls ( $n = 9$ )	Significant group difference (1-way ANOVA)
Mean age (years:mths)	12:3 (3:0)	12:1 (2:6)	No ( $P = 0.92$ )
Age Range	7:0–15:8	7:7–14:10	
Mean IQ score <sup>d</sup>	104.4 (14.4)	110.4 (14.7)	No ( $P = 0.76$ )
IQ Range	74–125	92–142	
Mean ADHD RS score <sup>b</sup>	12.4 (10.0)	6.2 (4.2)	No ( $P = 0.10$ )
Range	0–25	0–14	
Mean TSGS <sup>a</sup> score <sup>c</sup>	23.7 (6.7)	–	–
Mean OCD Inv. <sup>c</sup> Score <sup>c</sup>	28.0 (5.5)	–	–

<sup>a</sup> TSGS—Tourette's syndrome Global Scale ('mild' = 0–24, 'moderate' = 25–39, 'severe' = 40–59, 'extreme' = 60–100).

<sup>b</sup> ADHD RS—ADHD Rating Scale (clinically significant score must always exceed 16, i.e. at least 2 or more for 8 of 14 items and must be over 1.5 S.D.s above norms which vary with age and gender).

<sup>c</sup> OCD Inv.—OCD Inventory (cut-off score for definitely elevated OCD symptoms = 70).

<sup>d</sup> KBIT IQ estimate.

<sup>e</sup> measure only taken for the TS Group.

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