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Evidence from increased anticipation of predictive saccades for a dysfunction of fronto-striatal circuits in obsessive–compulsive disorder

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Abstract

In obsessive–compulsive disorder (OCD), a dysfunction of neuronal circuits involving prefrontal areas and the basal ganglia is discussed that implies specific oculomotor deficits. Performance during reflexive and predictive saccades, antisaccades and predictive smooth pursuit was compared between patients with OCD ($n=22$), patients with schizophrenia ($n=21$) and healthy subjects ($n=24$). Eye movements were recorded by infrared reflection oculography. In both patient groups, higher frequencies of anticipatory saccades with reduced amplitudes in the predictive saccade task were observed. Additionally, reduced smooth pursuit eye velocity and increased frequencies of saccadic intrusions during smooth pursuit as well as increased error rates in the antisaccade task were demonstrated for patients suffering from schizophrenia. Patients with OCD and schizophrenia revealed different patterns of oculomotor impairment: whereas increased anticipation of predictive saccades provides evidence for a dysfunction of the circuit between the frontal eye field and the basal ganglia in both groups, results from the antisaccade task imply additional deficits involving the dorsolateral prefrontal cortex in schizophrenic patients. Furthermore, the cortical network for smooth pursuit (especially the frontal eye field) is also assumed to be disturbed in schizophrenia.

Keywords: Obsessive–compulsive disorder; Schizophrenia; Reflexive saccades; Predictive saccades; Antisaccades; Eye movements; Smooth pursuit

1. Introduction

Obsessive–compulsive disorder (OCD) is characterized by repetitive obsessive thoughts or actions. In

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one explanation, a deficit in inhibitory control of reflexive responses is assumed. Normally, inhibitory control relies on frontal pathways including prefrontal areas, the dorsolateral prefrontal cortex (DLPFC) and the orbitofrontal cortex, as well as the basal ganglia (Baxter, 1992). Results from neuroimaging studies support the hypothesis that prefrontal areas and their connecting fibres to the basal ganglia are particularly greatly involved in the pathophysiology of OCD (Busatto et al., 2000). However, many questions remain to be resolved.

Since the neuronal circuits that control oculomotor responses also rely on frontal subcortical pathways, an investigation of oculomotor function may help to characterize the pathomechanisms underlying OCD, such as those that have been demonstrated in schizophrenia (Levy et al., 2000). The oculomotor network controls saccadic and smooth pursuit eye movements amongst other eye movements (Fig. 1):

1.1. Neuronal control of saccades

1.1.1. Reflexive saccades

Reflexive saccades are fast eye movements (peak velocity up to 400–500°/s) and serve to fixate objects with the fovea that enter the field of vision. The parietal eye field in the posterior parietal cortex (PPC) is regarded as the main cortical area for the generation of reflexive saccades; see Fig. 1. Lesions of the PPC lead to a marked reduction in the amplitude of reflexive saccades (Gaymard et al., 1998). In contrast, after lesions in the frontal eye field (FEF), visually guided saccades are only slightly affected, and the control of visually guided saccades quickly recovers (Gaymard et al., 1998; Broerse et al., 2001).

1.1.2. Predictive saccades

In predictive saccade tasks, the timing, amplitude and direction of the target step are all predictable. Healthy subjects are able to develop predictive behaviour within a few target presentations, as demonstrated by reductions in latency times. Primate studies and clinical lesion studies identified the FEF, supplementary eye field (SEF), and the basal ganglia as the most relevant cortical areas for predictive saccades (Gaymard et al., 1998; Broerse et al., 2001). Lesions in the FEF and the basal ganglia lead to saccadic hypometria and prolonged latencies (Ventre et al., 1992). The FEF plays an important role in the short-term memorization of saccades that provides the

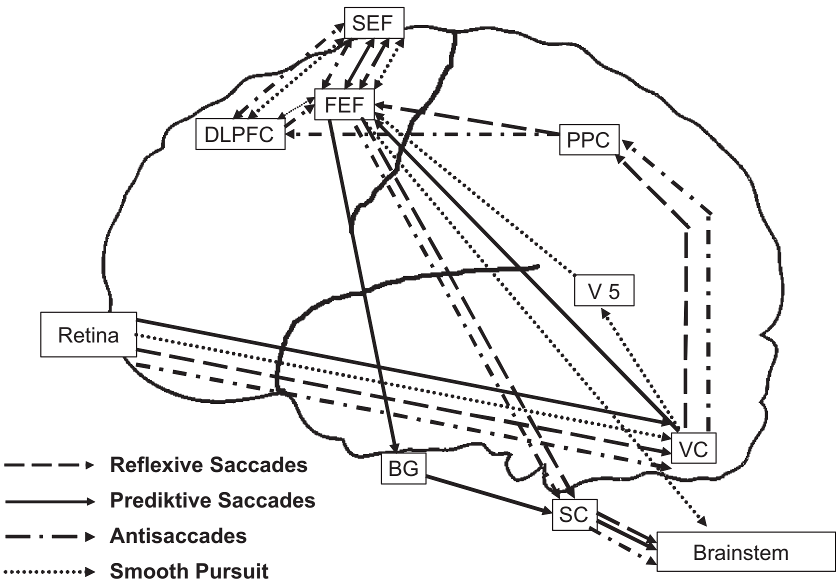

Fig. 1. Neural pathways for reflexive saccades, predictive saccades, antisaccades, and smooth pursuit; BG=basal ganglia, DLPFC=dorsolateral prefrontal cortex, FEF=frontal eye field, PPC=posterior parietal cortex, SEF=supplementary eye field, SC=superior colliculus, VC=primary visual cortex, V5=visual area 5 (MT/MST).