Introduction

‘Express’ saccades (ES) are reflexive, visually-guided saccades, with a latency of approximately 100ms. They may form a separate early peak in saccade latency distributions (Fischer & Weber, 1993). In normal, naive subjects, the proportion of ES is increased in reflexive saccade tasks when the fixation point is extinguished prior to saccade target appearance (the ‘gap’ paradigm) and decreased, often to near zero, when the fixation target remains illuminated when the saccade is made (‘overlap’ paradigm). There are some healthy subjects, ‘express saccade makers’ (ESMs), who exhibit a high proportion of express saccades (>30%), even in overlap tasks. Previously they were reported to be relatively rare, comprising an estimated 1%-5% of the normal population (Biscaldi et al., 1996). However, we recently reported that ESMs are encountered much more frequently among Chinese subjects, occurring in 10%-25% subjects tested (Amatya et al., 2011). We present here further evidence for a higher proportion of ESMs in the Chinese population and confirm that ESMs behave differently to non-ESMs in a different task context.

Methods

With local ethical approval, 76 healthy adult Chinese subjects (median age: 23.5y; range: 20-45y) were recruited from staff and students of West China Hospital and Sichuan University; experiments were conducted in West China Hospital, Chengdu, China. No subject had used any medication used to control eye movements. Data were recorded using a Saccadometer (Advanced Clinical Instrumentation, Cambridge, UK), which projected a fixation and saccade targets (Figure 1), recorded the resulting saccades using infrared reflectance (sampling rate 1kHz) and stored the data for offline analysis. Subjects completed 4 runs of 200 trials. Two runs were composed of separate trials (fixation target remained illuminated throughout the trial and two were interstimulus trials (fixation target was turned off when the saccade target appeared) in which subjects were instructed to saccade to the target mirror image position (i.e. in the opposite direction to, and the same distance from fixation as, the target). Overlap and antisaccade runs were blocked, block order was randomised. For overlap data mean and median saccade latencies were calculated for each subject, the distribution of latency plotted, and the proportion of ES (latency 80ms to 130ms) of all saccades in the latency range 50ms to 1000ms calculated. In order to identify ESMs (>30% ES). Antisaccade directional error rate and latency of error pro- and correct antisaccades were calculated and distribution of latency for error pro- and correct antisaccades plotted. Finally we conducted a combined analysis of overlap data from this and our previous experiment.

Results

17 of 76 (22%) Chinese subjects were ESMs (Figure 2). Antisaccade data were available for 16/17 and initially compared with data from 22 non-ESM subjects (Figure 3). Antisaccade directional error rate was (non-statistically) significantly higher in ESMs. The latency of error prosaccades was lower compared to the Normal subjects, while correct antisaccade latency was similar. In a repeated measures ANOVA, Group (between subjects) and Saccade Type (within subjects) were statistically significant (F<sub>2,60</sub>=4.2; p=0.05; F<sub>1,30</sub>=171; p=0.001) with the interaction falling short of significance (F=3.0; p=0.094).

A clearer difference emerged between the groups when we compared latency distributions for correct antisaccades and error prosaccades. Figure 4 shows typical individual distributions, and Figure 5 average distributions for 16 normal vs 16 ESM subjects. In the ESM group, a high proportion of prosaccade errors were ES. For the normal group there were few ES among the prosaccade errors. For correct antisaccades, the distributions of the two groups were statistically identical. This meant that there was a statistically significant difference between the groups for the difference between mean prosaccade and antisaccade latency in each subject (Figure 6). There was also a strong overall relationship between the percentage of ES in overlap tasks and the percentage of prosaccade error ES in antisaccade tasks (Figure 7). Combining overlap data from this experiment with that from Amatya et al. (2011) provided data for 27 ESMs which was compared with that of 65 normal subjects. The average latency distributions for these groups were significantly different (Kolomogorov-Smirnov; p=0.001) with the ESM data exhibiting a clear peak in the express saccade range.

Discussion

Within the Chinese population there is a far higher proportion of subjects who generate high numbers of ES even in overlap conditions evidenced by a prominent early peaks in latency distributions. Across two experiments we identified 27/110 subjects (25%) with >30% express saccades. For most of the ESMs described in previous studies, an ‘overlap’ paradigm was used. Our findings suggest that the overlap paradigm does not always lead to high numbers of express saccades. We found a high proportion of ESMs (>30%) in a normal, naive population of adult Chinese subjects, occurring in 93%-100% of those tested. This finding is consistent with previous studies in Chinese subjects (Biscaldi et al., 1996; Amatya et al., 2011). Our results suggest that the overlap paradigm may not be the most effective way to identify ESMs. Further studies are needed to determine the optimal conditions for identifying ESMs in different populations.

References


Acknowledgements

This study was supported by the National Natural Science Foundation of China (Grant No. 30605240) and a UK Royal Society International Joint Project Grant (No. 2871130298).

CHINESE “EXPRESS SACCADE MAKERS”: ANALYSIS OF ANTISACCade PERFORMANCE

Paul C. Knox¹, Nabin Amatya², Qiyong Gong²

¹. Eye and Vision Sciences, University of Liverpool, Liverpool, UK. ². Huaxi MR Research Centre, Department of Radiology, Centre for Medical Imaging, West China Hospital, Sichuan University, Chengdu, China

Figure 1. Experimental tasks.

Fixation Time: Randomised 1-2s
Direction: Randomised

Antisaccade task: Posonl target of when saccade target appears. Subjects instructed to saccade to the mirror image position.
Antisaccade/overlap order balanced between subjects

Figure 2. Frequency distribution histograms for normal and express saccade makers. Normal control subjects: Normal express saccade makers.

Figure 3. Comparison of antisaccade performance between 27 normal Chinese subjects: NORMs and 27 ESMs. Points are individual subject means; central line is interquartile mean (IQR); α. Directional error rates; difference between groups NS. b. Error pro-saccade latency. c. Correct antisaccade latency.

Figure 4. Individual latency distributions for an ESM (b) and a normal subject (c) showing anacade (ac) and error prosaccade (EP) latencies. Directional error rate (DER), the percentage of express saccades (ES), and the mean latency are shown.

Figure 5. Comparing latency distributions for 27 normal Chinese subjects: NORMs and 27 ESMs. Points are individual subject means; central line is interquartile mean (IQR) α. Directional error rates; difference between groups NS. b. Error pro-saccade latency. c. Correct antisaccade latency.

Figure 6. Comparative CDF for antisaccades and overlap trials. For normal and ESMs, the overlap trials were plotted against the null distribution. The ESM had a significantly higher proportion of ES in the overlap paradigm as compared to the normal subjects. This suggests a statistically significant overlap across all subjects.

Figure 7. Mean 50%-95% latency distributions for 27 ESMs and 45 Normal: non-ESM Chinese subjects. Mean latency of the overlap distribution is 214msec. The overlap distribution is significantly different from the normal distribution (p<0.001) suggesting that there is a significant difference between the overlap and normal latencies.

Figure 8. Mean 50%-95% latency distributions for 27 ESMs and 45 Normal: non-ESM Chinese subjects. Mean latency of the overlap distribution is 214msec. The overlap distribution is significantly different from the normal distribution (p<0.001) suggesting that there is a significant difference between the overlap and normal latencies.