Reorientation of a visually evoked postural response does not require cognitive knowledge of display relative angular position

A E I Thurrell, P Bertholon, A M Bronstein

MRC Human Movement and Balance Unit, 8-11 Queen Square, London, WC1N 3BG

Introduction

Vision is used as an accompaniment to proprioception and vestibular signals in the control of posture. These control mechanisms have been investigated using visual stimuli experimentally moved to simulate the visual conditions that occur when a subject spontaneously sways. A previous experiment investigated the reorientation of a visually evoked postural sway response during fixation an off centre visual stimulus (Wolsley et al. 1996). It was discovered that subjects reorient their visually evoked postural sway response to match the direction of the visual stimulus for a variety of combinations of head-on-neck and eye-in-orbit rotations. However, this experiment was run in a well-lit, structured visual environment, where subjects were able to determine the orientation of the stimulus relative to themselves. As a consequence of the instructions received, subjects also had full cognitive knowledge of their orientation relative to the visual stimulus. The present experiment was run with a dark visual environment to remove external visual cues and a reduced instruction set. It is proposed that this approach can reveal the importance of cognitive knowledge and/or background visual texture for the reorientation of the visually evoked postural sway response.

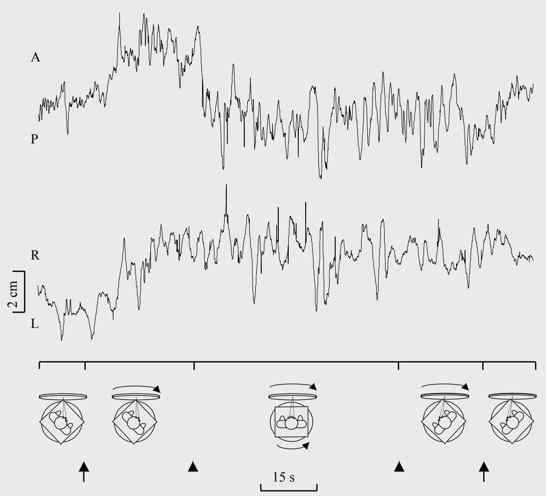

Fig.1 Raw posturography platform traces from subject JB, conditions as icons, the traces show the anterior-posterior and right-left movements of the centre of pressure of the feet. Visual stimulus rotation occurs between the arrows, subject rotation between the arrowheads.

Methods

Eight normal subjects were instructed to stand, fixating the centre of the visual stimulus - this consisted of a large luminous disk facing the subject and could be rotated (40º/sec) around the visual axis in either direction with the visual environment otherwise dark. Subjects stood on an externally controlled platform that could be rotated (2º/sec) to change the position of the subject relative to the visual stimulus. Sway was measured at the level of the centre of pressure (COP) and of the head. The sequence of events during each trial were: an initial period to measure base-line position; a period of visual stimulus rotation at one of five positions relative to the subject; a period of rotation of the subject to a different position relative to the visual stimulus; a further period of visual stimulus rotation; and a final period with no rotation (Fig.1, bottom panel).

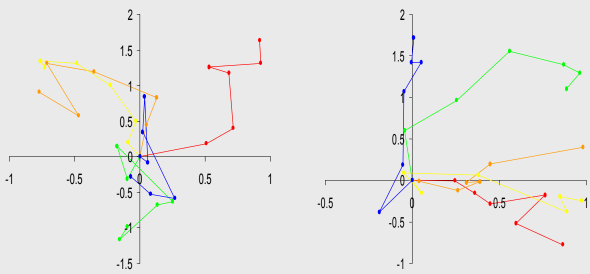

Fig. 2 Average COP movements from all subjects for each of the ten starting conditions relative to base-line, during the first 30 s of disk rotation. Each turning point represents a 5 s period, units are cm. Left figure shows conditions with anti-clockwise disk rotation and vice-versa. Colours denote position of disk relative to subject as follows: red: +90 º (right), orange: +45 º, yellow: 0 º(centre), green: -45 º, blue: -90º (left)

Results

Data from individual subjects (Fig. 1) were combined into groups of matching start or end positions and normalised to show the change in sway position induced by visual stimulus rotation onset or offset respectively (Fig. 2). The directions of the visually evoked postural sway response at the start and the relaxation back to centre are compared graphically with the orientation of the visual stimulus (Fig. 3). These direction vectors converted to degrees can then be compared statistically (Fig. 4) revealing an average gain of reorientation from straight ahead of 0.9.

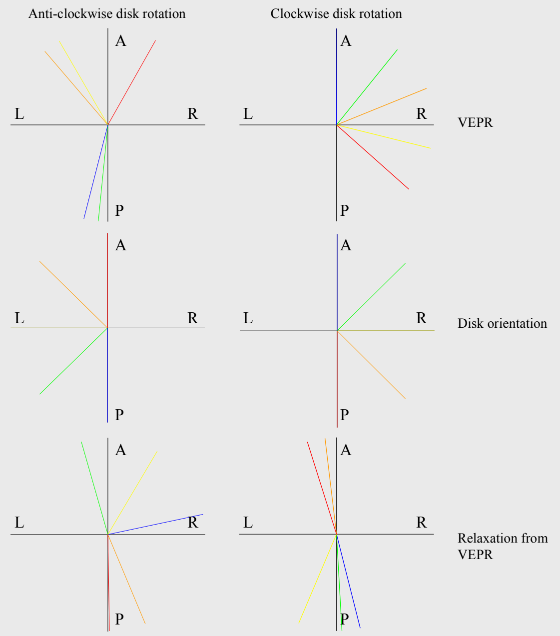

Fig.3 Direction of the visually evoked postural response (VEPR) and relaxation back to centre when the visual stimulus stopped for each condition compared with the orientation of motion of the visual stimulus. Left figure shows conditions with anti-clockwise disk rotation and vice-versa. Colours as Fig. 2

Discussion

The ability to use visual cues for posture is important physiologically, and this should be present in any direction of gaze. These experiments confirm that postural responses do reorient according to gaze angle. The mechanism for reorientation requires signal(s) of the misalignment between the visual and locomotor systems; these signals may originate from efference copy, proprioception, vision or cognitive knowledge of the environment. By reducing the cognitive and background visual signals compared with previous experiments their importance can be determined. The present experiment revealed a gain of reorientation of 0.9 which is not significantly different from that of Wolsley et al. (1996) where they found a gain of reorientation of 1.08 ± 0.2. Thus, we propose that cognition and background visual structure do not play a role in this reorientation.

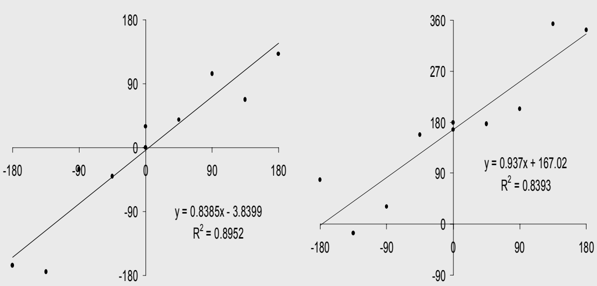

Fig. 4 Direction of sway in degrees from centre plotted against visual stimulus motion for onset (left) and offset (right) conditions.

References

Wolsley C J, Sakellari V, Bronstein A M (1996) *Reorientation of visually evoked postural responses by different eye-in-orbit and head-on-trunk angular positions* Exp. Brain Res.111: 283-288