INTRODUCTION

Static posturography is a technique providing measurements of center of pressure (COP) to assess postural sway during quite standing. Analyzing the COP in temporal, spatial and frequency domains offers insights to the control mechanisms involved in maintaining posture.

It has been extensively reported that lower frequency components of sway are influenced by visual and vestibular inputs, whereas middle and higher frequencies are influenced by somatosensory inputs (Giacomini et al., 2004; Nagy et al., 2004). There is, however, a lack of definitive recommendations in terms of the size and range of these frequency bands. Hence, this study sought to determine the influence of vision and somatosensory inputs on different frequency bands.

METHODS

Sixteen healthy young participants (8 males and 8 females) were selected from the local community. Each participant completed an informed consent procedure approved by the local Institutional Review Board before conducting the experimental procedures.

Independent variables were vision (eyes open and closed), surface (compliant and hard), and gender. Participants performed initial practice sway trials to help familiarize them with standing on a force plate (AMTI OR6-7-1000, Watertown, Massachusetts, USA). During the trials, participants were required to stand upright on the force plate (FP) with feet together, arms by their sides, and head straight. For the eyes open condition, a cross-mark placed 75 cm away and for the compliant surface condition, a foam board, 23mm in height, was placed on the force plate.

Each participant performed three trials in each of the four combinations of vision and surface compliance. One minute of rest was provided in between, and the presentation order of conditions was fully randomized. Each trial lasted 75 s and was sampled for 60 s (initial 10 s and final 5 s removed). Triaxial ground reaction forces and moments were sampled at 100 Hz and transformed to obtain COP values. After zero-padding and removal of means, Fast Fourier Transform (FFT) was used to calculate the power spectra for frequencies of the COP signal in both antero-posterior (AP) and medio-lateral (ML) directions.

Dependent measures were obtained from the AP and ML power spectra, after normalizing to total power in the signal and then dividing the spectra into 30 bands of 0.05 Hz each (i.e. ranging from <0.05 to 1.5 Hz). For the purposes of analysis, bands 1 – 6 (<=0.3 Hz) were considered low, bands 7-17 (0.35-0.85) middle and bands 18 – 30 were high frequency. Analysis of variance (ANOVA) was used to determine the effects of the sway conditions and gender on normalized power in each of the spectral bands, with significance at p<0.01.
RESULTS AND DISCUSSION
Absence of vision significantly increased the normalized power in almost all AP frequency bands from 0 – 1.5 Hz, except the 2nd band (0.05 - 0.1 Hz). However, in the ML direction, absence of vision significantly increased power in the only the low frequency bands (<=0.45 Hz). These results are in contradiction with previous studies which reported that visual control influences only the lower frequencies in both the AP and ML directions (Giacomini et al., 2004; Nagy et al., 2004).

Introduction of surface compliance significantly increased normalized power in the middle frequencies (0.3 – 0.65 Hz) for both AP and ML. This is in agreement with previous reports (Giacomini et al., 2004; Nagy et al., 2004). Additionally, significant gender differences were observed in AP spectra in 2 low frequency bands (<0.1 Hz), 3 mid frequency bands (0.6-0.8 Hz), and 2 high frequency bands (>0.9 Hz).

Calculated effect sizes (ω²) suggested that vision had a stronger effect on AP sway than surface compliance. This could be due to the fact that all study participants had at least moderate levels of regular physical activity, and hence relied more on visual cues.

Effects of vision and surface on power for band 8 (0.35 – 0.4 Hz) are illustrated as an example (Figure 1). Increased power was observed in both AP and ML directions, for eyes closed vs. open, and for the compliant vs. hard surface condition.

SUMMARY/CONCLUSIONS
Overall, vision had a stronger and more distributed effect on the spectral composition of sway as compared to surface compliance. Understanding the influence of sensory inputs on the spectral components of sway will facilitate a better mapping of the sensory systems and their roles in postural performance, and aid in developing more effective intervention strategies.

REFERENCES

![Figure 1: Mean AP (left) and ML (right) normalized power in the 8th frequency band (0.35 – 0.4 Hz) under different visual and surface conditions (* p < 0.01)](image-url)