Auditory and Postural Control

External sound stimulation has been shown to influence body sway particularly in the medial–lateral axis (Tanaka et al., 2001; Priplata et al., 2002; Deviterne et al., 2005; Alessandrini et al., 2006; Dozza et al., 2007).


The influence of moving auditory stimuli on standing balance in healthy young adults and the elderly.

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Source
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Abstract
The maintenance of postural balance depends on effective and efficient feedback from various sensory inputs. The importance of auditory inputs in this respect is not, as yet, fully understood. The purpose of this study was to analyse how the moving auditory stimuli could affect the standing balance in healthy adults of different ages. The participants of the study were 12 healthy volunteers, who were divided into two age categories: the young group (mean = 21.9 years) and the elderly group (mean = 68.9 years). The instrument used for evaluation of standing balance was a force plate for measuring body sway parameters. The toe pressure was measured using the F-scan Tactile Sensor System. The moving auditory stimulus produced a white-noise sound and binaural cue using the Beachtron Affordable 3D Audio system. The moving auditory stimulus conditions were employed by having the sound come from the right to left or vice versa at the height of the participant's ears. Participants were asked to stand on the force plate in the Romberg position for 20 s with either eyes opened or eyes closed for analysing the effect of visual input. Simultaneously, all participants tried to remain in the standing position with and without auditory stimulation that the participants heard from the headphone. In addition, the variables of body sway were measured under four conditions for analysing the effect of decreased tactile sensation of toes and feet soles: standing on the normal surface (NS) or soft surface (SS) with and without auditory stimulation. The participants were asked to stand in a total of eight conditions. The results showed that the lateral body sway of the elderly group was more influenced than that of the young group by the lateral moving auditory stimulation. The analysis of toe pressure indicated that all participants used their left feet more than their right feet to maintain balance. Moreover, the elderly had the tendency to
be stabilized mainly by use of their heels. The young group were mainly stabilized by the toes of their feet. The results suggest that the elderly may need a more appropriate stimulus of tactile and auditory sense as a feedback system than the young for maintaining and control of their standing postures.


**Auditory biofeedback substitutes for loss of sensory information in maintaining stance.**

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Source

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Abstract

The importance of sensory feedback for postural control in stance is evident from the balance improvements occurring when sensory information from the vestibular, somatosensory, and visual systems is available. However, the extent to which also audio-biofeedback (ABF) information can improve balance has not been determined. It is also unknown why additional artificial sensory feedback is more effective for some subjects than others and in some environmental contexts than others. The aim of this study was to determine the relative effectiveness of an ABF system to reduce postural sway in stance in healthy control subjects and in subjects with bilateral vestibular loss, under conditions of reduced vestibular, visual, and somatosensory inputs. This ABF system used a threshold region and non-linear scaling parameters customized for each individual, to provide subjects with pitch and volume coding of their body sway. ABF had the largest effect on reducing the body sway of the subjects with bilateral vestibular loss when the environment provided limited visual and somatosensory information; it had the smallest effect on reducing the sway of subjects with bilateral vestibular loss, when the environment provided full somatosensory information. The extent that all subjects substituted ABF information for their loss of sensory information was related to the extent that each subject was visually dependent or somatosensory-dependent for their postural control. Comparison of postural sway under a variety of sensory conditions suggests that patients with profound bilateral loss of vestibular function show larger than normal information redundancy among the remaining senses and ABF of trunk sway. The results support the hypothesis that the nervous system uses augmented sensory information differently depending both on the
environment and on individual proclivities to rely on vestibular, somatosensory or visual information to control sway.

PMID: 17021893 [PubMed - indexed for MEDLINE]


Auditory cues for orientation and postural control in sighted and congenitally blind people.

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Source
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Abstract
This study assessed whether stationary auditory information could affect body and head sway (as does visual and haptic information) in sighted and congenitally blind people. Two speakers, one placed adjacent to each ear, significantly stabilized center-of-foot-pressure sway in a tandem Romberg stance, while neither a single speaker in front of subjects nor a head-mounted sonar device reduced center-of-pressure sway. Center-of-pressure sway was reduced to the same level in the two-speaker condition for sighted and blind subjects. Both groups also evidenced reduced head sway in the two-speaker condition, although blind subjects' head sway was significantly larger than that of sighted subjects. The advantage of the two-speaker condition was probably attributable to the nature of distance compared with directional auditory information. The results rule out a deficit model of spatial hearing in blind people and are consistent with one version of a compensation model. Analysis of maximum cross-correlations between center-of-pressure and head sway, and associated time lags suggest that blind and sighted people may use different sensorimotor strategies to achieve stability.


Hearing as a predictor of falls and postural balance in older female twins.


Source
Abstract

BACKGROUND:
The purpose of the present study was to examine, first, whether hearing acuity predicts falls and whether the potential association is explained by postural balance and, second, to examine whether shared genetic or environmental effects underlie these associations.

METHODS:
Hearing was measured using a clinical audiometer as a part of the Finnish Twin Study on Aging in 103 monozygotic and 114 dizygotic female twin pairs aged 63-76 years. Postural balance was indicated as a center of pressure (COP) movement in semi-tandem stance, and participants filled in a fall-calendar daily for an average of 345 days after the baseline.

RESULTS:
Mean hearing acuity (better ear hearing threshold level at 0.5-4 kHz) was 21 dB (standard deviation [SD] 12). Means of the COP velocity moment for the best to the poorest hearing quartiles increased linearly from 40.7 mm(2)/s (SD 24.4) to 52.8 mm(2)/s (SD 32.0) (p value for the trend = .003). Altogether 199 participants reported 437 falls. Age-adjusted incidence rate ratios (IRRs) for falls, with the best hearing quartile as a reference, were 1.2 (95% confidence interval [CI] = 0.4-3.8) in the second, 4.1 (95% CI = 1.1-15.6) in the third, and 3.4 (95% CI = 1.0-11.4) in the poorest hearing quartiles. Adjustment for COP velocity moment decreased IRRs markedly. Twin analyses showed that the association between hearing acuity and postural balance was not explained by genetic factors in common for these traits.

CONCLUSION:
People with poor hearing acuity have a higher risk for falls, which is partially explained by their poorer postural control. Auditory information about environment may be important for safe mobility.