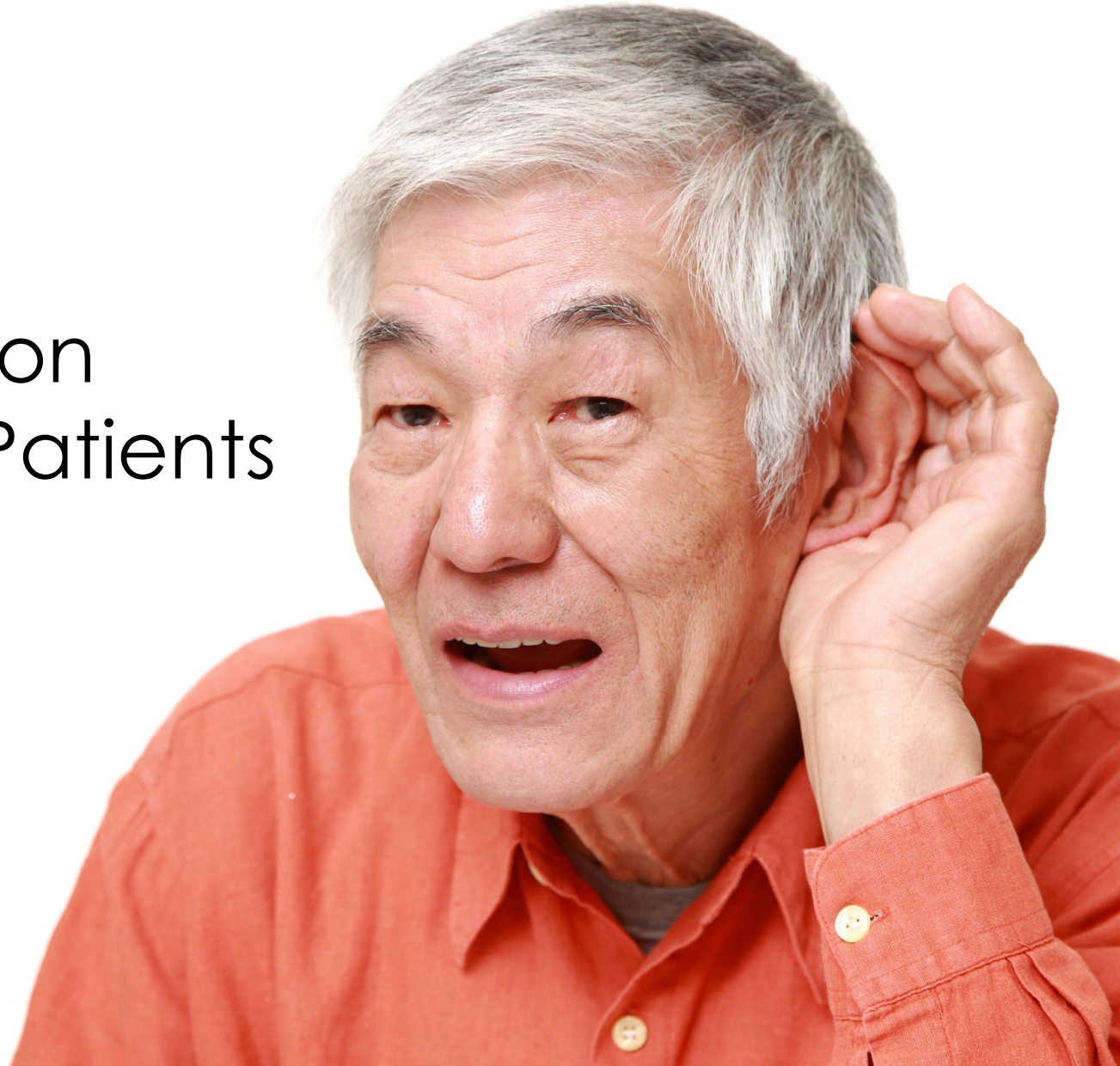
National University Hospital

NUS National University of Singapore

Division of Graduate Medical Studies
Yong Loo Lin School of Medicine

The Effect of Hearing Aids on Postural Control in Elderly Patients with Hearing Loss



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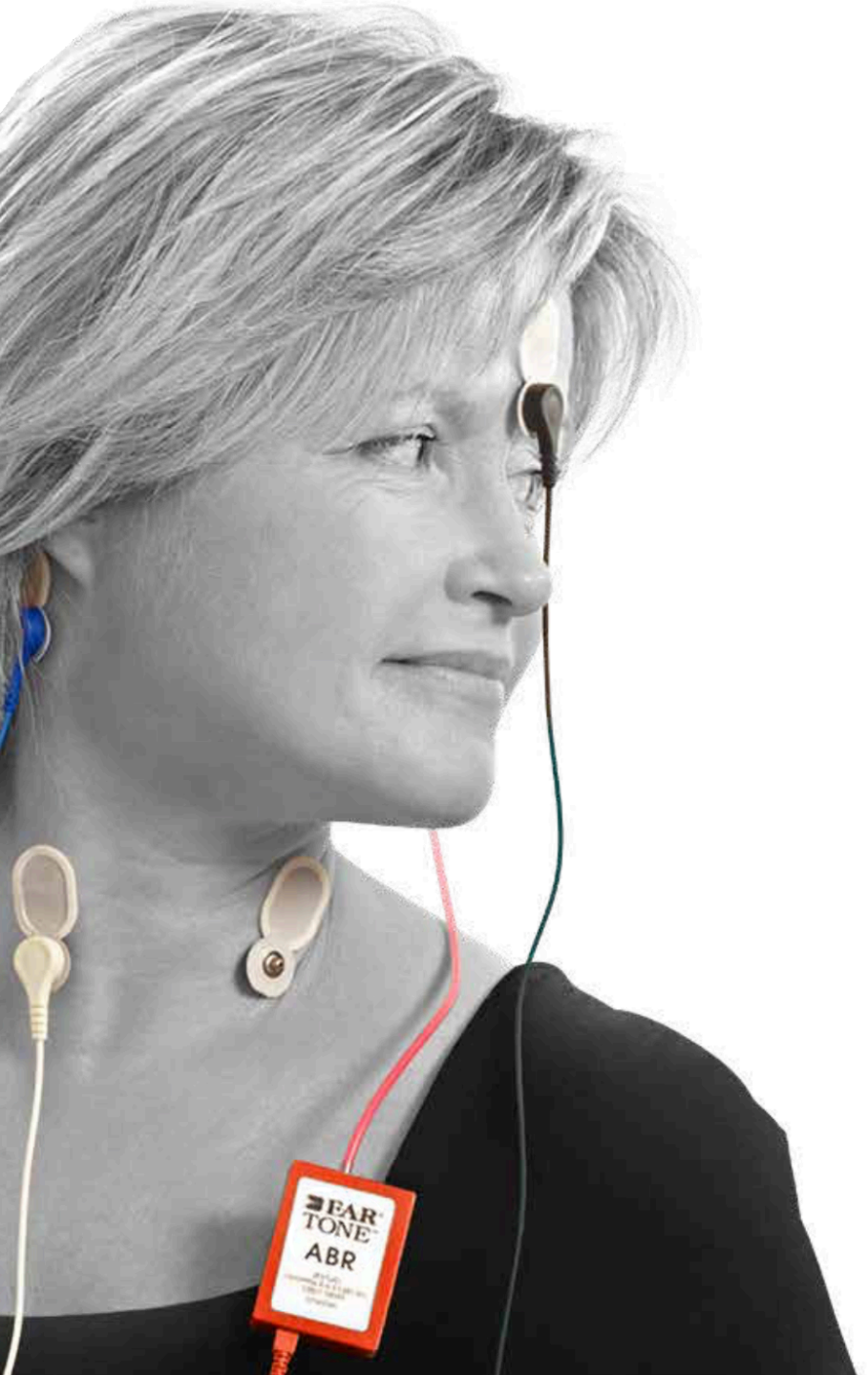


Contents

The Problem

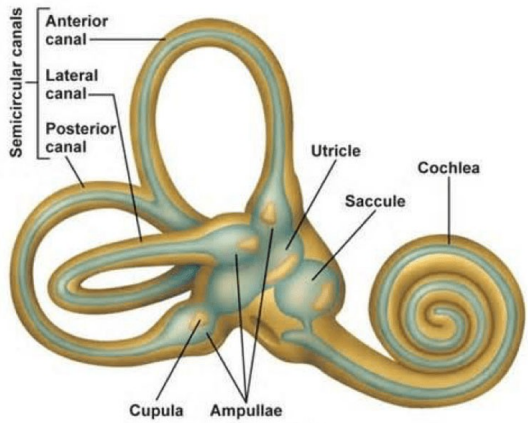
The deteriorating postural control and its consequences

Falls

- 1 in 3 adults aged 65 years and above falls once a year (Health Promotion Board, 2015)
- Leading cause of injury among Elderly in Singapore
- Can result in psychological (e.g. phobia, anxiety disorder) and social (e.g. self-imposed functional limitations) consequences as well
- Serious problem to Singapore's ageing population

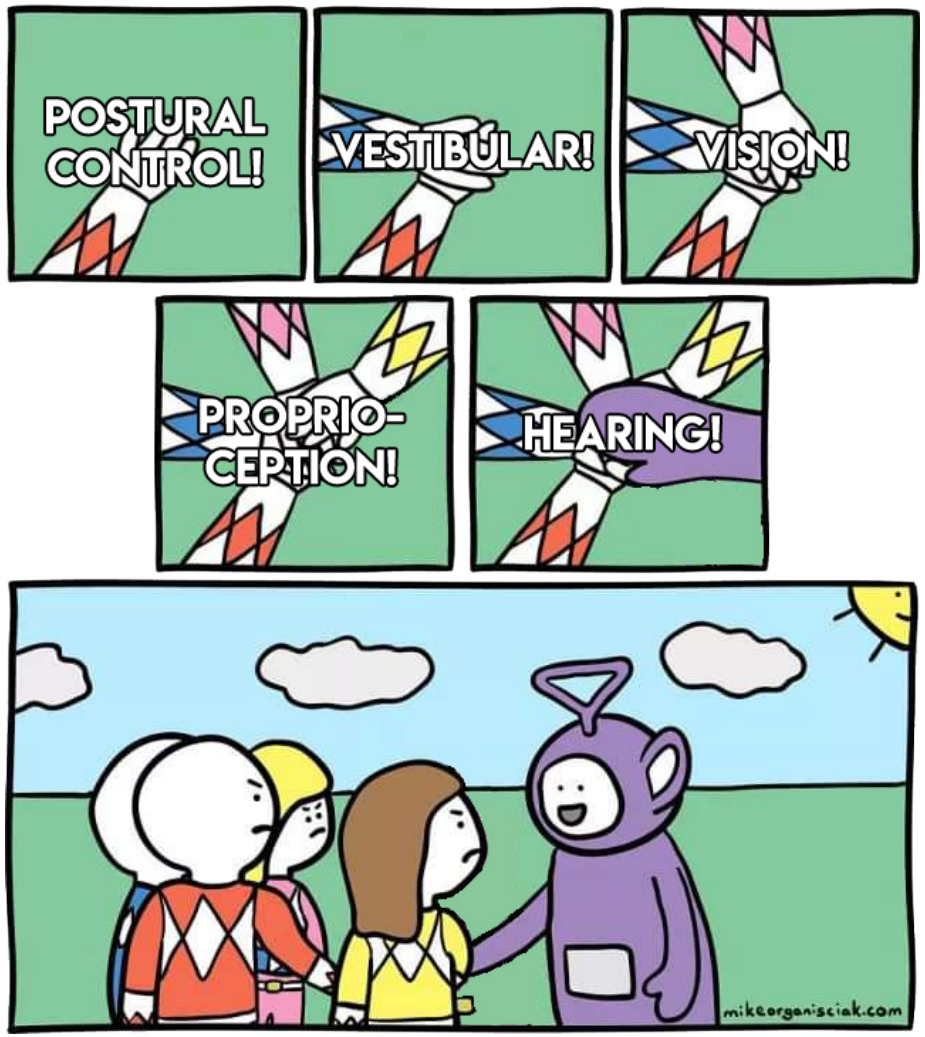
Postural Control

- Poor postural control can lead to falls
- Regulation of sensory information from other systems by Central Nervous System (CNS) to provide controlled, upright posture (Alghwiri & Whitney, 2012)
- Sensory information involved:
  - Vestibular system
  - Vision
  - Proprioception
- Sensory organization: selection of input to provide accurate orientation information and ignore misleading ones



Effects of Ageing

- Effects of ageing:
  - Vestibular: progressive loss of peripheral hair cells (Rosenhall, 1973) and vestibular nerve fibres (Bergstrom, 1973)
  - Vision: visual acuity, contrast sensitivity and depth perception diminish (Dayhew, 2001)
  - Proprioception: deterioration of muscle spindle function
- Results in sensory conflict: misleading or inaccurate information provided by one or more of the senses
- Postural control affected



Balance and Hearing Loss

So how does hearing come into the story?

Hearing Loss

- Hearing loss associated to self-reported falls (Lin & Ferrucci, 2012) which is related to poor postural control (Viljanen et al., 2009)
- 1.4 fold increase in odds of falling for every 10 dB of hearing loss (National Health and Nutrition Examination Survey, n.d.)
- Possible explanations:
  - Concomitant vestibular and cochlear dysfunction (cochlea-saccular degeneration)
  - Reduced awareness of auditory and spatial environment
  - Compensatory effect of hearing loss on cognitive loss and shared attention

Effects of Hearing Amplification

Cochlear Implants

- Contradictory results obtained
- Possible reasons for no significant improvement:
  - Most patients involved were fitted unilaterally; spatial benefits of binaural hearing eliminated
  - Underlying etiology of profound hearing loss unknown; could be associated with other deficits in the vestibular system (Vitkovic, Le, Lee & Clark, 2016)

Effects of Hearing Amplification

Hearing Aids

- Variations in study design:
  - Romberg on foam and tandem test (Rumalla et al., 2015)
  - Wii balance board (Vitkovic et al., 2016)
  - Force plate (Negahban et al., 2017)
  - TUG test (Weaver et al., 2017)
  - Sensory Organisation Test (SOT) (McDaniel et al., 2018)
- Different target age groups
- 3 out of 5 studies identified showed significant improvement in postural control

Aims and Hypothesis

Aims

- To investigate the relationship between auditory input and postural control
- To determine if the usage of hearing aids can help improve postural control in elderly with hearing loss

Hypothesis

The usage of hearing aids will help to improve postural control.

Methodology

Patient Selection and their Participation

Inclusion & Exclusion Criteria

Inclusion Criteria

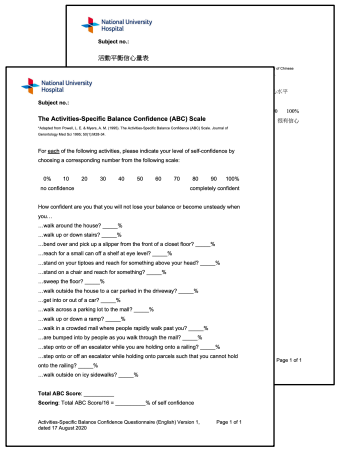
- 60 years old and above
- Sensorineural hearing loss with 4FA of at least 40 dB HL in the better ear
- Hearing aid users for at least 3 months
- Able to ambulate without assistive devices

*4FA: Average threshold value from 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz

Exclusion Criteria

- History of any neurological or musculoskeletal diagnosis that could account for possible imbalance and falls
- E.g. stroke, spinal stenosis, traumatic brain injury, Parkinson's disease, rheumatoid arthritis, cardiac problems, etc.
- Wheelchair-bound
- Had surgical operation on lower limb or spine in past 6 months

Assessments Performed


National University Hospital

Subject no.:

活動平衡信心量表

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Subject no.:

The Activities-Specific Balance Confidence (ABC) Scale

Adapted from Powell, L. E. & Myers, A. M. (1995). The Activities-Specific Balance Confidence (ABC) Scale. Journal of Gerontology: Med Sci 1995; 50(1):M28-34.

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following scale:

0% 10 20 30 40 50 60 70 80 90 100%
no confidence completely confident

How confident are you that you will not lose your balance or become unsteady when you...

...walk around the house? _____%
...walk up or down stairs? _____%
...bend over and pick up a slipper from the front of a closet floor? _____%
...reach for a small can off a shelf at eye level? _____%
...stand on your tiptoes and reach for something above your head? _____%
...stand on a chair and reach for something? _____%
...sweep the floor? _____%
...walk outside the house to a car parked in the driveway? _____%
...get into or out of a car? _____%
...walk across a parking lot to the mall? _____%
...walk up or down a ramp? _____%
...walk in a crowded mall where people rapidly walk past you? _____%
...are bumped into by people as you walk through the mall? _____%
...step onto or off an escalator while you are holding onto a railing? _____%
...step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? _____%
...walk outside on icy sidewalks? _____%

Total ABC Score: _____
Scoring: Total ABC Score/16 = _____% of self confidence

Activities-Specific Balance Confidence Questionnaire (English) Version 1, dated 17 August 2020

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Activities-specific Balance Confidence (ABC) Questionnaire

Otoscopy

Tympanometry

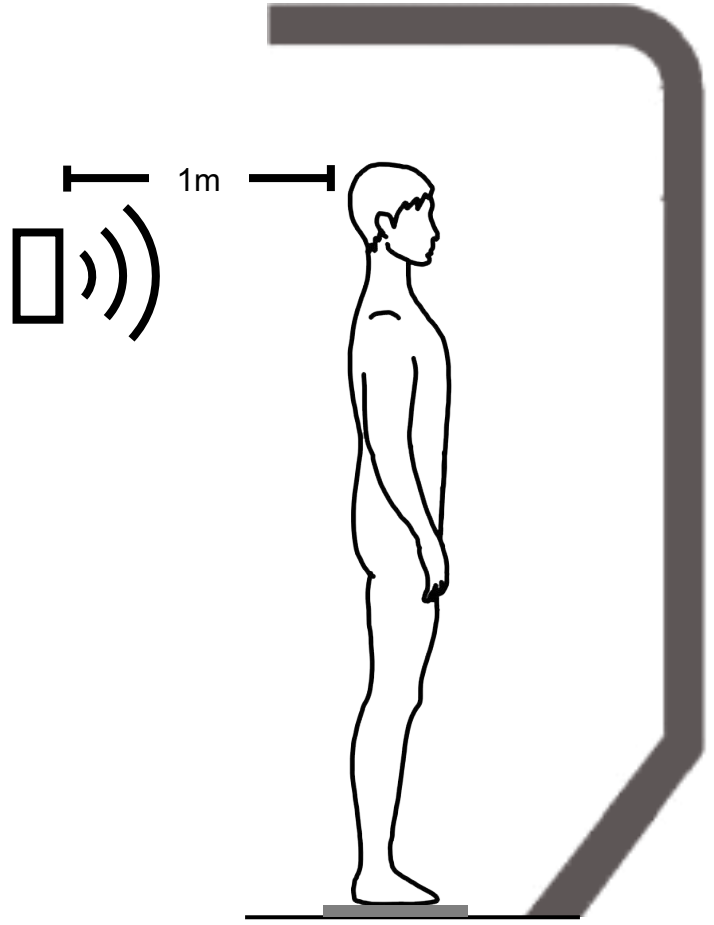
Cervical Vestibular-Evoked Myogenic Potentials (cVEMP)

Computerised Dynamic Posturography (Sensory Organisation Test)

Sensory Organisation Test (SOT)

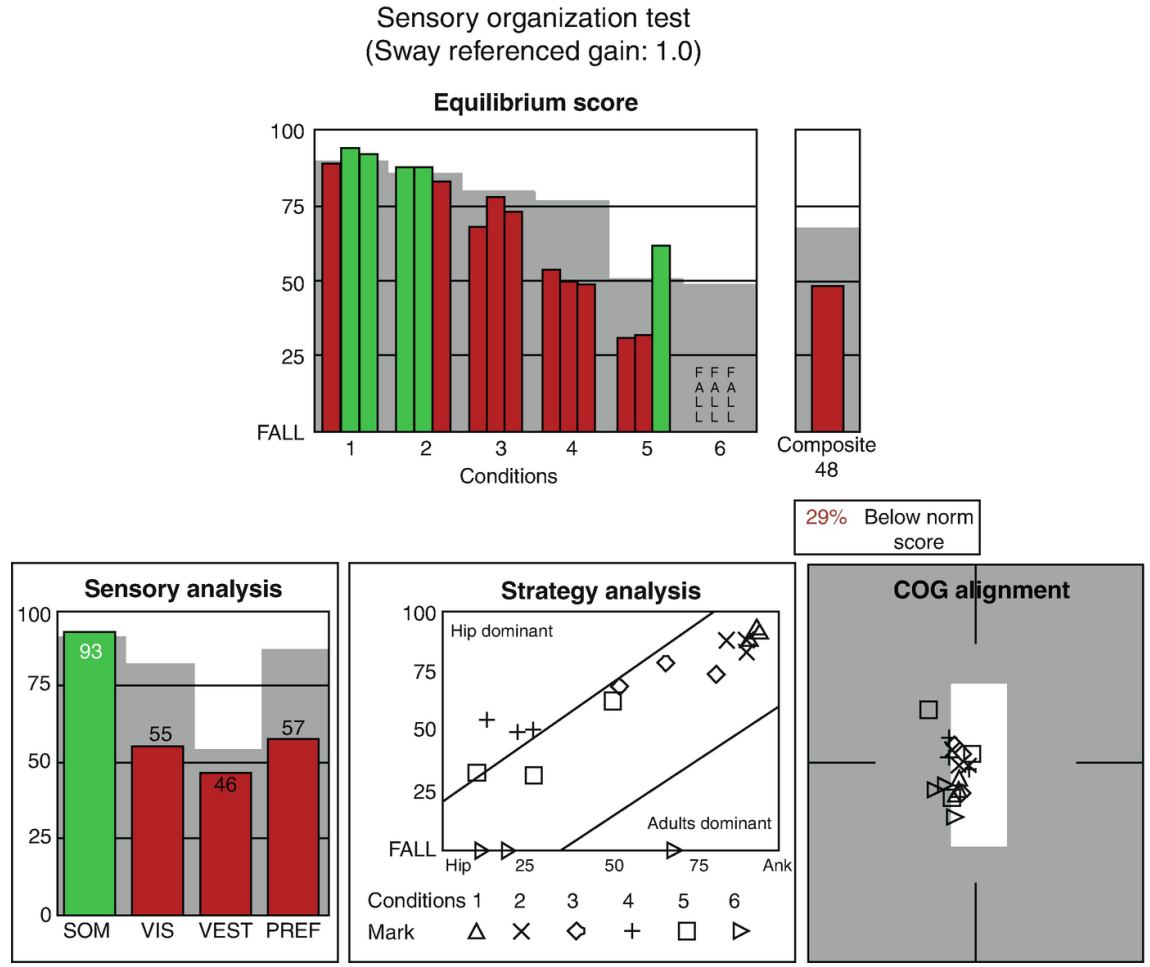
(Modifications for this Study)

- 2 sets of SOT to be done (order to be randomized across patients)
  - Hearing aids turned on
  - Hearing aids turned off
- At least 5 minutes of rest time in between sets
- 65 dB SPL recorded crowd noise played from speaker (Miniso DS-1338 Double-horn Stereo Wireless Speaker) 1m behind patient throughout SOT
- Sound level to be monitored by mobile app, iNVH (version 2.1.1) by BOSCH



Data Interpretation

- One-tailed paired *t*-test to determine if composite score is significantly higher when hearing aids switched on
- One-tailed paired *t*-test to determine if equilibrium scores in a particular condition showed significantly improvement with hearing aids usage
- Two-sample *t*-test to determine if differences in composite/equilibrium scores are significantly different between groups with and without pre-existing vestibular deficits
- Determination of correlation between ABC questionnaire scores and CDP SOT composite scores (with hearing aids)



Results and Discussion

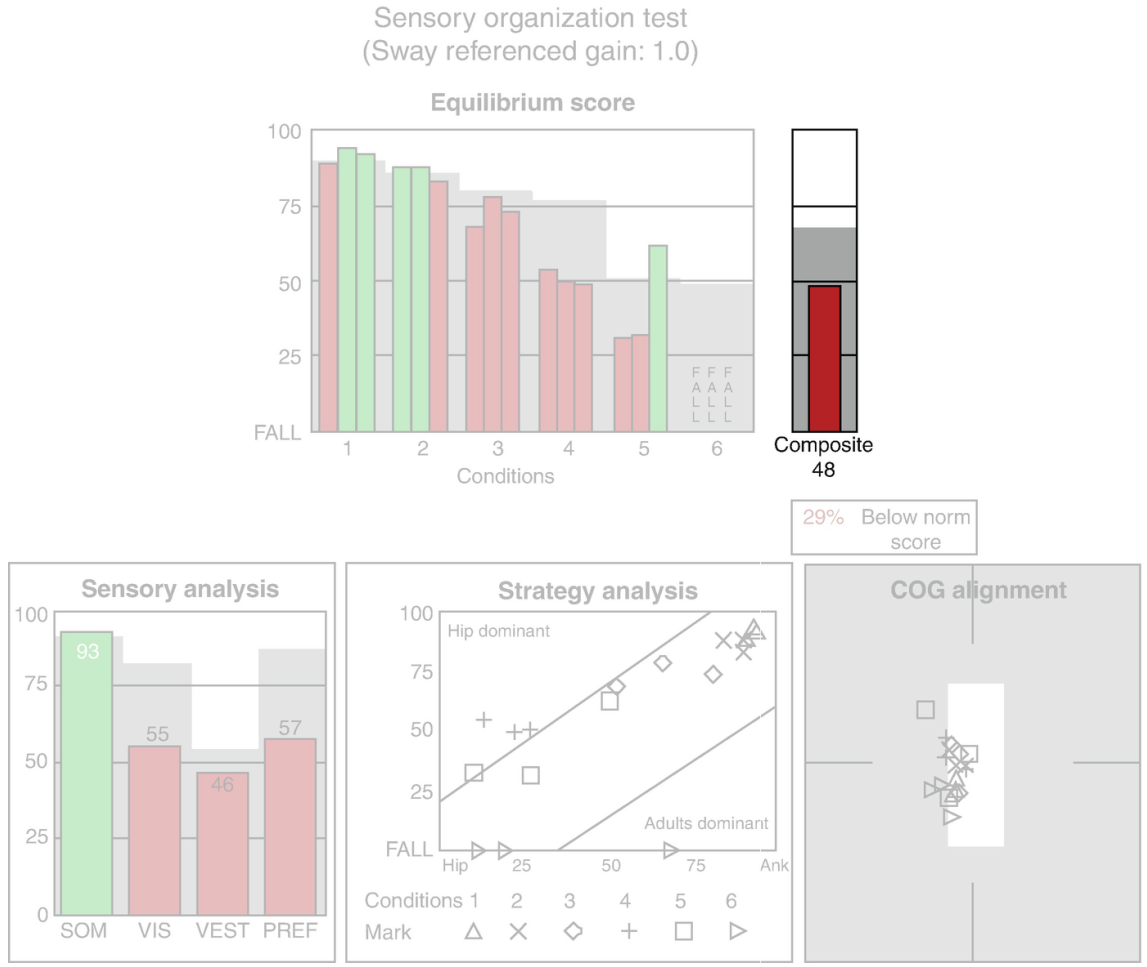
Findings of the Study

Participants Demographic

- 6 participants recruited (1 excluded from data analysis as 4FA<40 dB HL)
- 5 males, 0 females
- 65-84 years old (mean=73 years old)
- Hearing aid acquisition period from 7-96 months
- Pre-existing vestibular deficit (n=1)

Summary of Findings

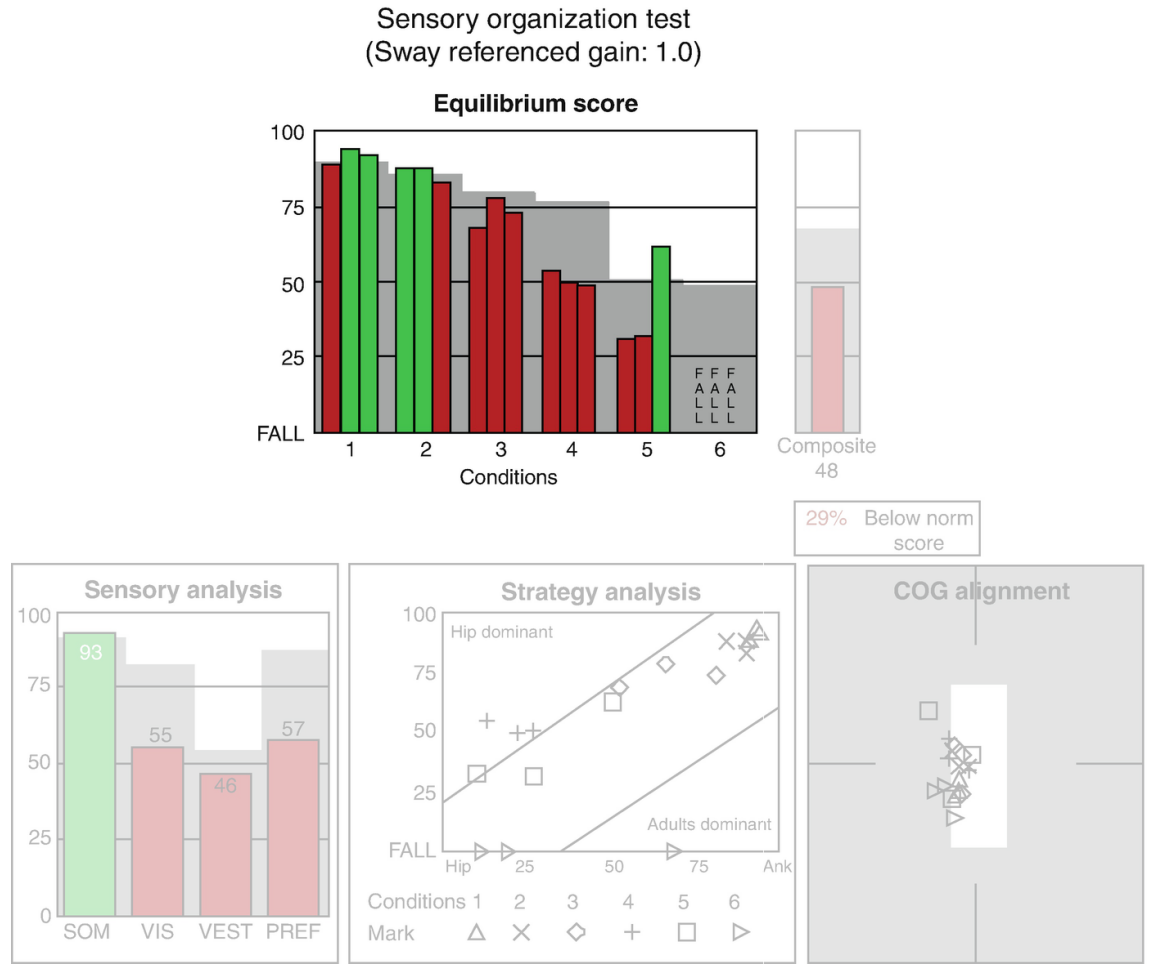
- No significant improvement was observed (*p*-value>0.05) in <u>composite scores</u> with the usage of hearing aids.



Summary of Findings

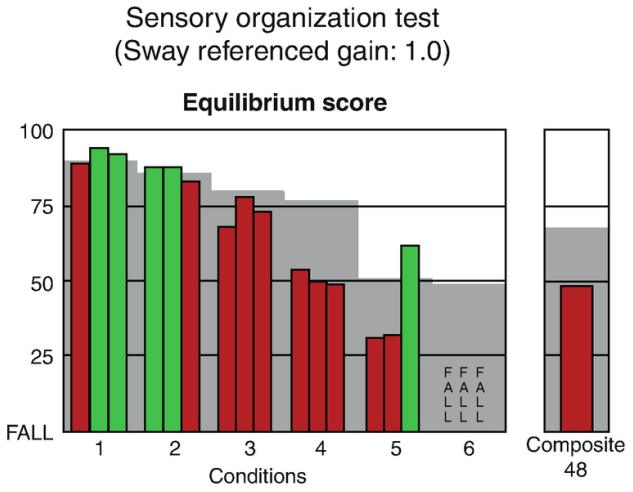
- No significant improvement was observed (*p*-value>0.05) in composite scores with the usage of hearing aids.

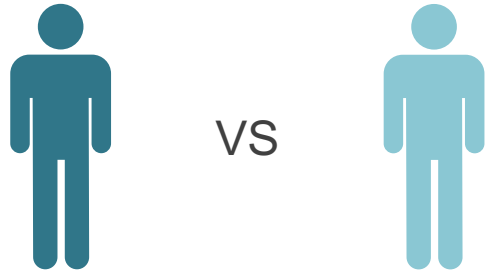
- No significant improvement was observed (*p*-value>0.05) in equilibrium scores with the usage of hearing aids for all 6 conditions



Summary of Findings

- No significant improvement was observed (*p*-value>0.05) in composite scores with the usage of hearing aids.
- No significant improvement was observed (*p*-value>0.05) in equilibrium scores with the usage of hearing aids for all 6 conditions
- No significant difference observed (*p*-value>0.05) between groups for composite score and equilibrium scores for all 6 conditions





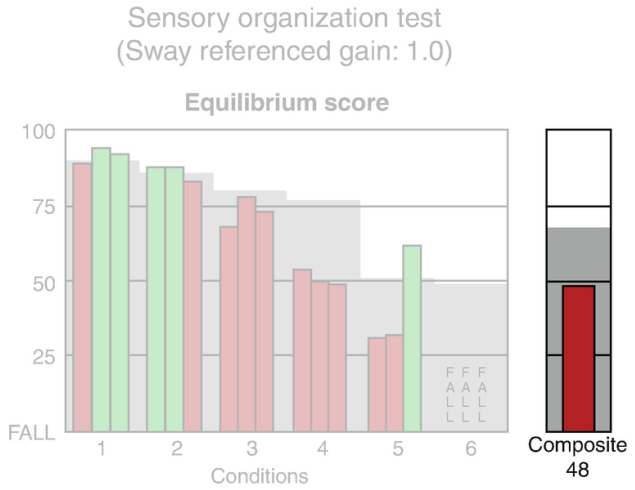
VS

With Pre-Existing Vestibular Deficit

Without Pre-Existing Vestibular Deficit

Summary of Findings

- No significant improvement was observed (*p*-value>0.05) in composite scores with the usage of hearing aids.
- No significant improvement was observed (*p*-value>0.05) in equilibrium scores with the usage of hearing aids for all 6 conditions
- No significant difference observed (*p*-value>0.05) between groups for composite score and equilibrium scores for all 6 conditions
- No significant correlation was observed between ABC questionnaire scores and CDP SOT composite scores (with hearing aids)



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For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following scale:

0%	10	20	30	40	50	60	70	80	90	100%
no confidence										completely confident

Aims and Hypothesis

Aims

- To investigate the relationship between auditory input and postural control
- To determine if the usage of hearing aids can help improve postural control in elderly with hearing loss

Hypothesis

The usage of hearing aids will help to improve postural control

INCONCLUSIVE

Discussions

Relationship between Auditory Input and Postural Control

- Possible reasons attributing to findings:
  - Algorithm for hearing aid amplification tends to reduce background noise → processed hearing aid output insufficient to provide spatial cues to help in balance
  - Directionality of hearing aid microphones → unable to pick up auditory stimulus which was presented from the back
  - Long hearing aid acquisition ≠ good hearing aid compliance
  - Sensory reweighting → less reliant on auditory input for balance

Discussions

Effects of Pre-Existing Vestibular Deficit on SOT Improvement

- Studies shown that people with vestibular deficit rely on auditory cues for postural control (Dozza, Chiari & Horak, 2005; Vitkovic et al., 2016)

- Possible reason attributing to findings:

    - Small sample size (n=1 for participants with pre-existing vestibular deficit)

Discussions

Usage of Subjective Questionnaires

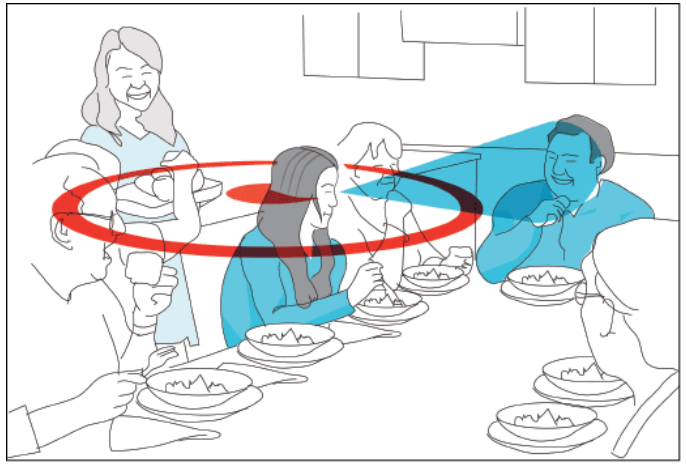
- Overestimation of balance ability
  - High ABC scores (mean=94.9, SD=4.93) not reflected in CDP SOT scores
  - Inflated self-appraisals in Asians (Yates, Lee & Shinotsuka, 1996)
- Results from subjective tests should be interpreted with caution
- Should be used in conjunction with objective tests

Limitations

- Small sample size
- Gender bias
  - Shorter reaction time and higher speed of movement in males (Faraldo-García, Santos-Pérez, Labella-Caballero & Soto-Varela, 2011)
  - Difference in balancing strategies between males and females (Faraldo-García, Santos-Pérez, Labella-Caballero & Soto-Varela, 2011)
- Screening for pre-existing vestibular deficit
  - Currently only limited to assessment of inferior vestibular nerve and saccular function

Future Direction

- Longer period of time for conduct of study
- Include other vestibular tests for to determine pre-existing vestibular deficit (e.g. oVEMP, vHIT, VNG)
- To check hearing aids data logging for hours of usage
- To standardise hearing aid settings, e.g. microphone directionality



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Participants of the study

THANK YOU

Any questions?

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