Online Journal Club-Article Review

Background/Overview	
Article Citation	Lee BC, Kim J, Chen S, Sienko KH. Cell phone based balance trainer. J Neuroeng Rehabil. 2012 Feb 8;9(1):10. doi: 10.1186/1743-0003-9-10.
Study Objective/Purpose (hypothesis)	Describe design, efficacy, and applicability of hardware ("tactor buds") and software (to estimate body tilt) for an iPhone (chosen because it already has a built-in tri-axial linear accelerometer) that provides a vibrotactile feedback system for balance rehabilitation training to be used in the home to assist a patient with therapist-assigned balance exercises or in an environment where access to balance therapy is limited
Methods	
Study Design	n= 4 individuals with vestibular deficits & 5 young, healthy control subjects Subjects wear an iPhone at waist level and "tactor buds" that plugs into the headphone jack of the iPhone to provide vibrotactile cues of body tilt. Vibrotactile feedback was provided when the subject exceeded either an anterior-posterior (A/P) or a medial-lateral (M/L) body tilt threshold. Subjects were instructed to move away from the vibration until the vibration stopped. Subjects with vestibular deficits used the system with both eyes-open and eyes-closed conditions during semi-tandem Romberg stance. Healthy subjects used the system with eyes closed during Romberg, semi-tandem Romberg, and tandem Romberg stances. For the Romberg stance condition, tactors were placed on the trunk midline (navel and spine) at approximately the L4/L5 vertebrae level. For the semi-tandem Romberg and tandem Romberg stance conditions, tactors were placed on the medial and lateral sides of the trunk at approximately the L4/L5 vertebrae level. All participants participated in practice trials, then data was collected for 8 total trials (2 trials without vibrotactile feedback, followed by 4 trials with vibrotactile feedback, followed by 2 trials without vibrotactile feedback.)

Target Population	Individuals with bilateral or unilateral vestibular deficits (Exclusion criteria: severe visual impairment, history of fainting, idiopathic vestibulopathies, or neurological disease affecting balance (e.g., Parkinson's).)
Interventions (if applicable):	NA
Outcome Measures	Root mean square (RMS) of body tilt (smaller RMS= increased balance performance) Elliptical area (EA) of body sway trajectory (smaller EA= increased balance performance) Percent time spent in the dead zone (in which tactors are not activated) (PZ) (larger PZ= increased balance performance) Mean power frequency (MPF) of body tilt (larger MPF= increased balance performance) Subjective 6 Question survey
Results	
Summary of Primary and Secondary Outcomes: note results that were statistically significant	When feedback was available, both healthy subjects and those with vestibular deficits had 1. significantly smaller A/P or M/L RMS sway (depending on the direction of feedback): the main effects of vibrotactile feedback were observed only in the direction in which vibrotactile feedback was provided. (e.g. A/P RMS showed no significant changes in the presence or absence of vibrotactile feedback in either eyes-open or eyes-closed conditions when feedback was provided solely in the M/L direction.) 2. significantly smaller EA fits to their sway trajectory 3. spent a significantly greater PZ within the no feedback zone and 4. showed a significantly greater A/P or M/L MPF: the main effects of vibrotactile feedback were observed only in the direction in which vibrotactile feedback was provided (e.g. A/P MPF showed no significant changes in the presence or absence of vibrotactile feedback in either eyes-open or eyes-closed conditions when feedback was provided solely in the M/L direction.)
Authors' Conclusions	
Authors' Conclusion	Their main finding is that body tilt can be captured by a cell phone and used to assist balance. Therefore, this system offers the advantages of cost, size, weight, functionality, flexibility, and accessibility versus more complex laboratory-based and commercial systems. The data from the trials suggest that subjects make more frequent corrections of tilt in the presence of vibrotactile feedback in order to maintain balance. In addition, the survey results indicate that the majority of subjects feel that the proposed cell phone balance training system could be used at home without difficulty; and the subjects with vestibular deficits consistently rated the utility of the feedback higher than the healthy subjects.
Reviewer's Discussion and Conclusion	

Study Strengths	Statistical analysis Utilizes a healthy, control group
Study Limitations and Potential for Bias	Small n The subjects and healthy controls undergo differing practice trials and trial conditions (semi-tandem v tandem) Observes balance *performance* but does not address long term/lasting effects Addresses static but not dynamic balance conditions Does not compare appropriately to gold standard Authors are investigating their own technology, with potential for financial gain
Applicability:	Types of patients (dx) that results apply to: mild to moderate vestibulopathy Types of settings that the results apply to: outpatient, home health, community-based programs, and potentially inpatient rehab Can interventions be reproduced? Not at this time, without the technology Can results be applied to other patient populations? Potentially, per response of healthy controls. This appears to be applicable to individuals with intact vibration and touch sensory systems, regardless of underlying diagnosis.
How will study results impact PT management of this patient population?	Promising technology that is portable, cost-effective, and more easily accessible to address balance performance in patients. Therapists might consider their own handling/PNF/tactile cues when working on balance activities with patients: hand placement at sites where tactor buds were placed; direction of feedback (AP v ML) Food for thought: Is this technology comparable to a portable TENS unit or home traction unit? When might it be more appropriate to provide hands on/ therapist-supervised interventions? Might this be useful for individuals with complete vestibular loss, to wear for safety.