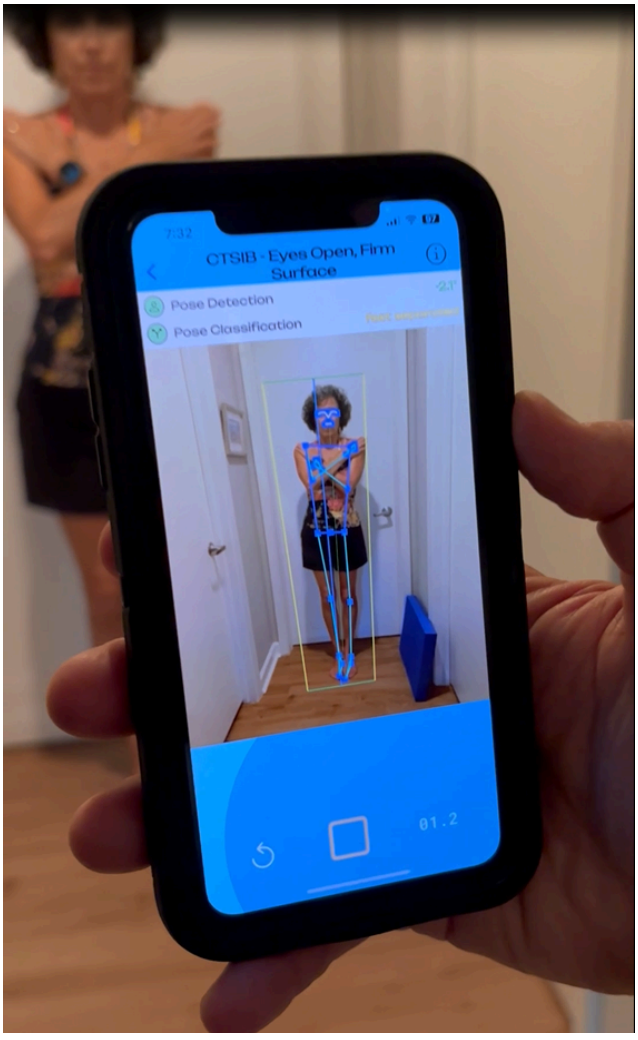
Data Collection with the VisualPT.ai Computer Vision tool

Procedure Workbook



Welcome!

Thank you for agreeing to participate in the VisualPT.ai **Data Collection Experience in AI** - I'm sure you have a few questions!

My name is Tim Richardson. I'm a physical therapist and I'll be introducing you to **The Experience!**

This **Workbook** will show you the proper way to test individual subject OR patients using the **Clinical Test of Sensory Integration and Balance (CTSIB).**

To keep the Tester Experience fun and productive, please reach out if you ever have questions or concerns. My contact info is:

Email: Tim.Richardson@VisualPT.ai
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Let's get started so you can start collecting data.

Tim

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Summary & Background

Falls are the most common cause of injury (nonfatal and fatal) among U.S. adults aged 65 or older. Annually, over 14 million older adults, equivalent to one in four, report a fall, according to the Centers for Disease Control & Prevention (CDC) - and not all falls are reported.

Meanwhile, an estimated 3 million older adults receive treatment in an emergency room due to a fall each year, per the CDC, and approximately 37% of individuals who reported a fall experienced an injury or needed to limit their activity for at least one day.

The Problem

Falls risk is underreported and falls are undertreated. Time and money are the two biggest obstacles to better falls risk screening:

- **Time:** The current pen-and-paper CTSIB requires 3 trials of 30-seconds for each of the 6 conditions. That's over 15 minutes for a CTSIB; neither the busy PT clinician nor the symptomatic patient want to do more testing. Treatment is what the patient demands and what the busy PT prefers to provide.
- **Money:** Current hardware alternatives (Bertec, BodiTrak, NeuroCom) to the pen-and-paper CTSIB cost between $5,000 and $87,000 and they take up a large clinical footprint.

Current hardware alternatives still take 20 minutes so they don't solve the time problem, either.

Test Description

The **Clinical Test of Sensory Integration and Balance** (CTSIB) is a screening test used in physical therapy clinics, hospitals and skilled nursing facilities to screen for falls risk in adults.

Test Psychometrics (Rehab Measures Database):

- **Standard Error of Measurement (SEM):** Wrisley et al 2007 (n = 13 healthy young adults (mean age 24±4 years, 6 men) tested 2 days apart). Composite Score: SEM (calculated) = 2.81.
- Minimal Detectable Change (MDC): Wrisley et al 2007: a composite change of greater than 8 points would indicate a change due to rehabilitation (n = repeated testing of 13 healthy young adults).
- **Cut-Off Scores:** Whitney et al 2006 : SOT composite score of less than 38 increases the likelihood ratio (4.13) for identifying repeated fallers in the past 6 months (n =100 vestibulopathic individuals) (sensitivity 53%, specificity 87%).
- **Normative Data:** The SOT composite score and condition 2-6 significantly decreases with increased age in healthy individuals: ANOVA on SOT equilibrium score showed a main effect of age F(3.90) = 23.24 and test condition (F(5.90) = 355.91.
- **Test/Retest Reliability:** Ford-Smith et al 1995 : Healthy non-institutionalized older adults (n = 40): Tested at a one week interval: Composite score: Good test-retest reliability (ICC 0.66, SOT average of three trials ranged from poor (Condition 3: ICC = 0.68) to fair test-retest reliability (condition 5: ICC = 0.68, condition 6: ICC = 0.64). Wrisley et al 2007. Adequate composite score reliability ICC = 0.67. Individual equilibrium scores ranged from poor to adequate ICC = 0.35 -0.79.
- **Criterion Validity (Predictive/Concurrent):** Cohen et al 2008: SOT vestibular condition (condition 5/1) had moderately high sensitivity (85%) and specificity (77%) in identifying vestibulopathies (n = 40 adults, 40 adults with vestibular impairements),
    - The review article by Di Fabio (1995) reports that many studies on sensitivity and specificity of using the SOT to identify people with vestibulopathy, most studies found low to moderate sensitivity and specificity. The responsiveness increases when the SOT is combined with rotary chair or caloric test results.

    - Basta et al 2005 investigated the influence of pure otolith disorders on SOT scores in 33 adults with minor head injury with utrical or sacculo-utricular disorders, finding SOT were abnormal in 76.9% of the people with combined sacular-utricular involvement, while the scores were only abnormal in 45% of utricular disorder group.
- **Construct Validity:** Gill-Body et al 2000: SOT, Timed up and Go(TUG), Dizziness Handicap Inventory (DHI) scores of people with unilateral (n = 41) and bilateral (n = 44) vestibular hypofunction: bilateral vestibular hypofunction: Adequate correlation (-0.31) between DHI emotional score and mean SOT sway in condition 3, and in unilateral vestibular hypofunction clients an adequate correlation (-0.35) was found between mean sway in condition 3 and the physical DHI score.
    - TUG scores were not correlated to any SOT scores for both groups. Whitney et al 2006: The composite score and self-reported falls history within the past 6 months were significantly related (F3 5.81, $p < 0.01$) (n = 100 vestibulopathic individuals) (Whitney and Wrisley, 2004; n = 30; mean age = 63 (17); patients with balance and vestibular disorders, Balance and Vestibular Disorders).
    - Modified CTSIB and SOT (Sensory Organization Test) scores were slightly more correlated when participants completed the assessment with their feet together than when completed with feet apart.
- **Face Validity:** Basta et al 2007: Sensitivity and Specificity of the SOT to detect otolith disorders (as measured by VEMP and Subjective Visual Vertical tests (n = 22 patients and controls): Sensitivity = solely in condition 3,5 and 6 is it higher than 50%). Specificity decreases with increasing difficulty of the condition

Link to CTSIB psychometrics: Clinical Test of Sensory Interaction on Balance | RehabMeasures Database

The CTSIB is a timed test that systematically measures the influence of visual, vestibular, and somatosensory input on standing balance.

CTSIB Test Description

The Subject is asked to perform 3 trials of the test under 6 conditions, each lasting 30 seconds:

Condition 1: standing upright on a smooth, level surface, with eyes open.

Condition 2: standing upright on a smooth level surface, with eyes closed (vision eliminated).

Condition 3: standing upright on a smooth level surface with a visual conflict device (hat, dome, optokinetic video goggles).

Condition 4: standing upright on 18” x 18” blue foam AirEx mat with eyes open.

Condition 5: standing upright on 18” x 18” blue foam AirEx mat with eyes closed.

Condition 6: standing upright on 18” x 18” blue foam AirEx mat with a visual conflict device (hat, dome, optokinetic video goggles).

Equipment Needed for the CTSIB

- An 18” AirEx blue foam pad or a pillow or any other unstable surface of approximately the same dimensions is needed for this test.
- A baseball hat, sun hat or wide-brimmed sombrero will serve as a visual conflict device. Video googles with an optokinetic moving image are increasingly available but are not required.

Test Subject Instructions

The subject is instructed in the starting position for all 6 test conditions:

- *“Please don’t move, do not look around, do not move your head.”*
- *“Look straight at the camera and breathe normally.”*
- *“Stand still with your arms crossed for 30 seconds.”*

To make the test more difficult, the Tester may then instruct the Subject to tilt their head, close their eyes or place one foot in front of the other.

What is a ‘fall’?

The CTSIB test is designed to measure human balance under various conditions by creating trunk sway.

Trunk Sway: Sway occurs the instant the human body responds to a perceived challenge to its balance. Sway is anything that is outside of the ‘sway’ envelope (see below). Trunk Sway can be defined as follows:

- Increased trunk deviation from the center of mass or midline. The midline is defined as a line parallel to the gravitational vector. Sway can be measured relative to the midline (see image). Sway can be measured as an angle with the horizontal line describing a level surface or the ground.
- Wide base of support. Feet wider than the shoulders is typically a response or a reaction to the body’s perceived loss of balance.
- Legs asymmetric. One leg abducted from the center midline, with or without the knee flexed, can be seen as a response to loss of balance.

- Arm(s) extended or abducted. Any movement of the arms away from a relaxed, dependent position hanging straight down from the shoulders may be a response to loss of balance.
- Trunk leaning or trunk flexion. Movement or twisting of the trunk in response to a perceived loss of balance is characterized as sway.

Computer Vision

Computer vision is a field of computer science that focuses on enabling computers to identify and understand objects and people in images and videos. Like other types of AI, computer vision seeks to perform and automate tasks that replicate human capabilities.

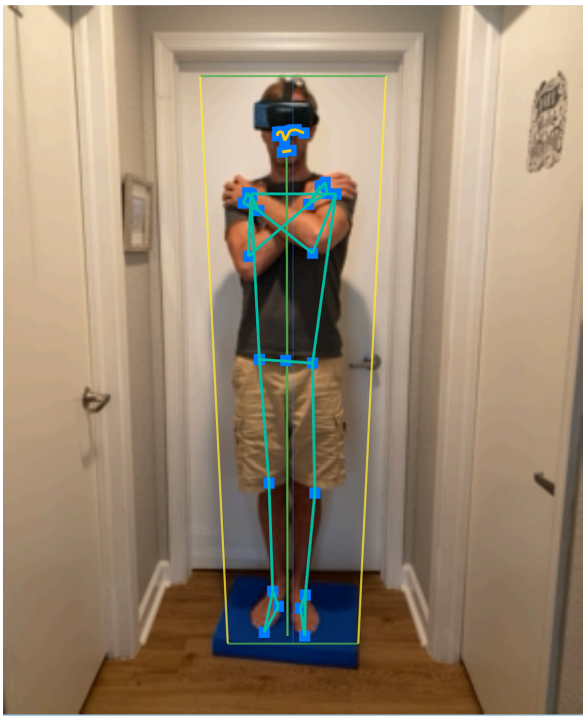


Figure 1: *A human figure in Condition 6 of the CTSIB (unstable surface with visual conflict) with vector lines to measure trunk sway directly.*

Measure Trunk Sway

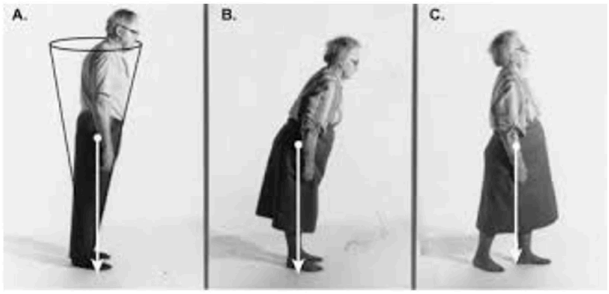
The VisualPT.ai Computer Vision Tool measures trunk sway 2 times per second for 30 seconds per Condition. There are 6 Conditions of the CTSIB test. Each image is compared to the expected Limits of Stability in 2 directions:

1. Lateral Right
2. Lateral Left

Note: Standard force plates use an algorithm to calculate trunk sway based on Center of Pressure measurements in 2 directions, anterior-to-posterior.

Limits of Stability (LOS)

- The boundary of sway trajectories radiating out in all directions from the centered position placing the COG at outer perimeters from the current BOS.
- Called a “Sway Envelope”



Anterior	**8.0 degrees**	**12.5 degrees**
Posterior	**4.5 degrees**	
Left Lateral	**8.0 degrees**	**16.0 degrees**
Right Lateral	**8.0 degrees**	

Figure 2: Limits of Stability

Remember, there are 6 conditions tested in the CTSIB test; each condition has 60 images. This means there are 360 images per CTSIB test.

1- page AI Data Collection Opportunity for PT Students

Where do I collect the data?

New account set-up: We will help all DPT/PTA students to download the Apple iPhone app to an Apple device (iPad or iPhone):

- *The mobile app is ONLY available on the Apple App Store.* The mobile app ONLY works on the Apple iPhone or iPad. Currently, Android or Google Crome devices will not support the **VisualPT.ai Computer Vision tool.**
- Use a personal email you can access. Use a phone or tablet for which you have download permissions.
- Download the mobile app to your iPhone or iPad at <<< TestFlight link >>>.

All data is collected within the mobile app and is protected under the VisualPT.ai **HIPAA Compliance Program Policy.**

How do I collect data?

Instructions to Subjects during the CTSIB

Condition #1 - (Eyes open, firm surface).

Starting position: Standing position, feet shoulder width apart, arms crossed in front of you, head and face looking straight forward.

Optional challenges (to induce trunk sway):

- Turn head right and left
- Look up and down
- Stand with one foot in front of the other

Condition #2 - (Eyes closed, firm surface)

Starting position: Standing position, feet shoulder width apart, arms crossed in front of you, head and face looking straight forward.

Optional challenges (to induce trunk sway):

- Turn head right and left
- Look up and down
- Stand with one foot in front of the other

Condition #3 - (Visual conflict, firm surface)

Starting position: Standing position, feet shoulder width apart, arms crossed in front of you, head and face looking straight forward.

Optional challenges (to induce trunk sway):

- Turn head right and left
- Look up and down
- Stand with one foot in front of the other

Condition #4 - (Eyes open, unstable surface)

Starting position: Standing position, feet shoulder width apart, arms crossed in front of you, head and face looking straight forward.

Optional challenges (to induce trunk sway):

- Turn head right and left

- Look up and down
- Stand with one foot in front of the other

Condition #5 - (Eyes closed, unstable surface)

Starting position: Standing position, feet shoulder width apart, arms crossed in front of you, head and face looking straight forward.

Optional challenges (to induce trunk sway):

- Turn head right and left
- Look up and down
- Stand with one foot in front of the other

Condition #6 - (Visual conflict, unstable surface)

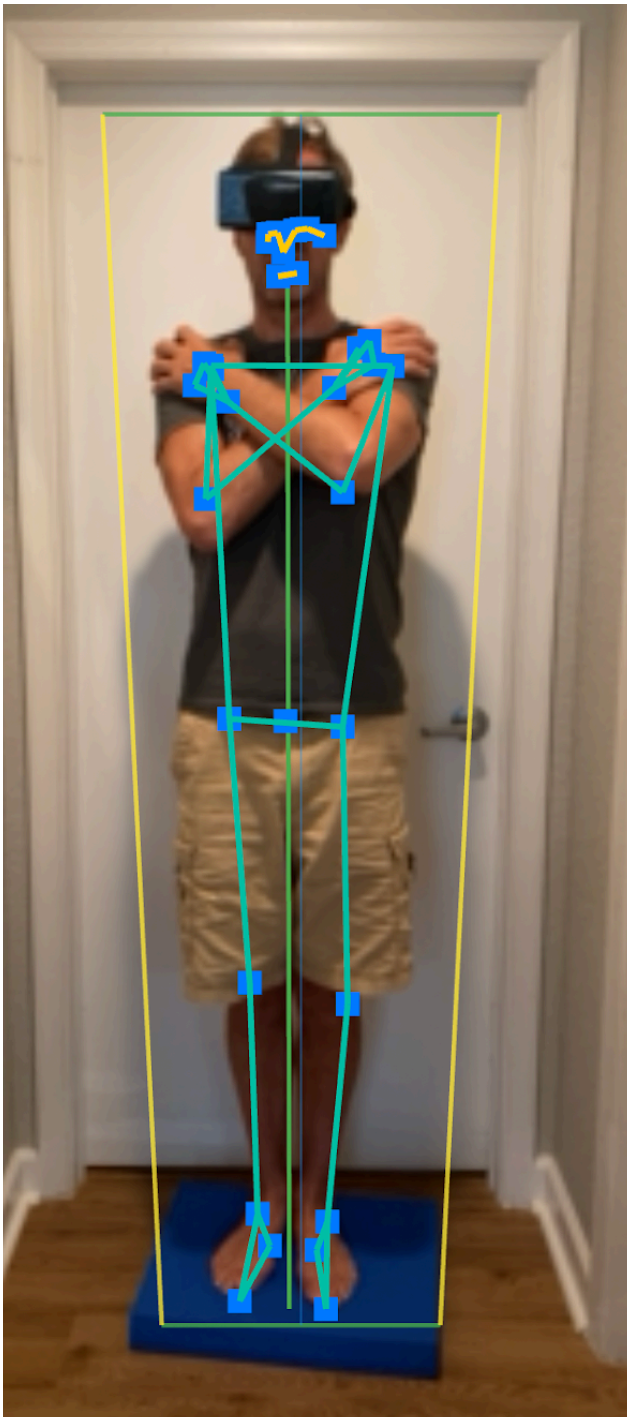
Starting position: Standing position, feet shoulder width apart, arms crossed in front of you, head and face looking straight forward.

Optional challenges (to induce trunk sway):

- Turn head right and left
- Look up and down
- Stand with one foot in front of the other

Bounding Box

The subject should completely fill the bounding box from top to bottom; note the space above the head - **fill the space!**



Tester Agreement Letter

I _____ agree to help and assist VisualPT.ai collect ten (10) test subject's data for validation of an artificial intelligence algorithm.

I agree not to expose or record actual medical patients, who may be subject to HIPAA, to the VisualPT.ai Computer Vision device.

I agree that I will not collect or store any Personal Health Information (PHI) in the VisualPT.ai mobile app.

All data collected in the course of this project is the property of VisualPT.ai. I surrender all claims to any images, data, renders or interpretations now and in the future.

Signed,

Student Name _____

Date _____