SIT-UP: Smart-Integrated Technology for Upright Posture

Developing a posture correction system with minimal disruptions

Motivation

Posture is how you hold your body.

We were not evolved to sit for hours in an unnatural position.

Essentially, **your desk work causes bad posture**.*

Maintaining good posture requires a constant engagement of core and back muscles.

→

As people tire mentally, they pay less attention to their posture.

→

As you work for long hours, you slouch unconsciously, reinforcing poor postural habits.

Related Work

1. **Wearable technologies:** Smart necklace system to detect poor posture and sends reminders to the user's smartphone, belts to provide real-time feedback through vibration and visual cues.

2. **Computer vision approaches:** Some studies have utilized video-based methods to measure neck angles and assess posture, can provide accurate posture detection but may raise privacy concerns.

3. **Furniture-based solutions:** Developed "smart chairs" with pressure sensors to monitor seated posture. These provide valuable data on sitting habits, but has not led to long-term behavioral change.

4. **Mobile device sensors:** Leveraged built-in sensors in smartphones and other mobile devices to track posture, such as using accelerometers to address device tilt.

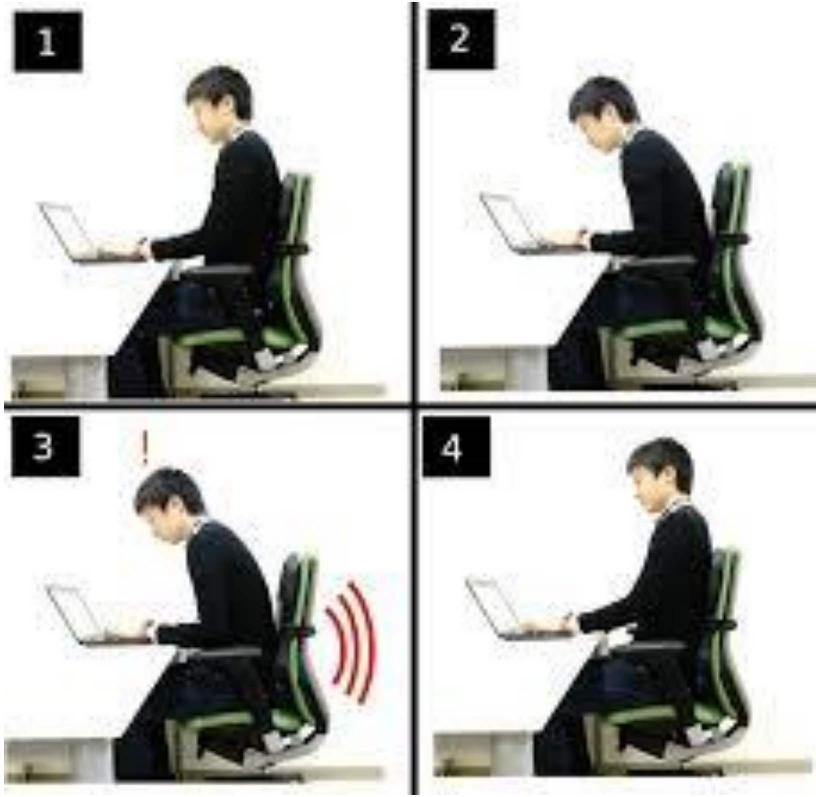
SIT-UP, our posture solution

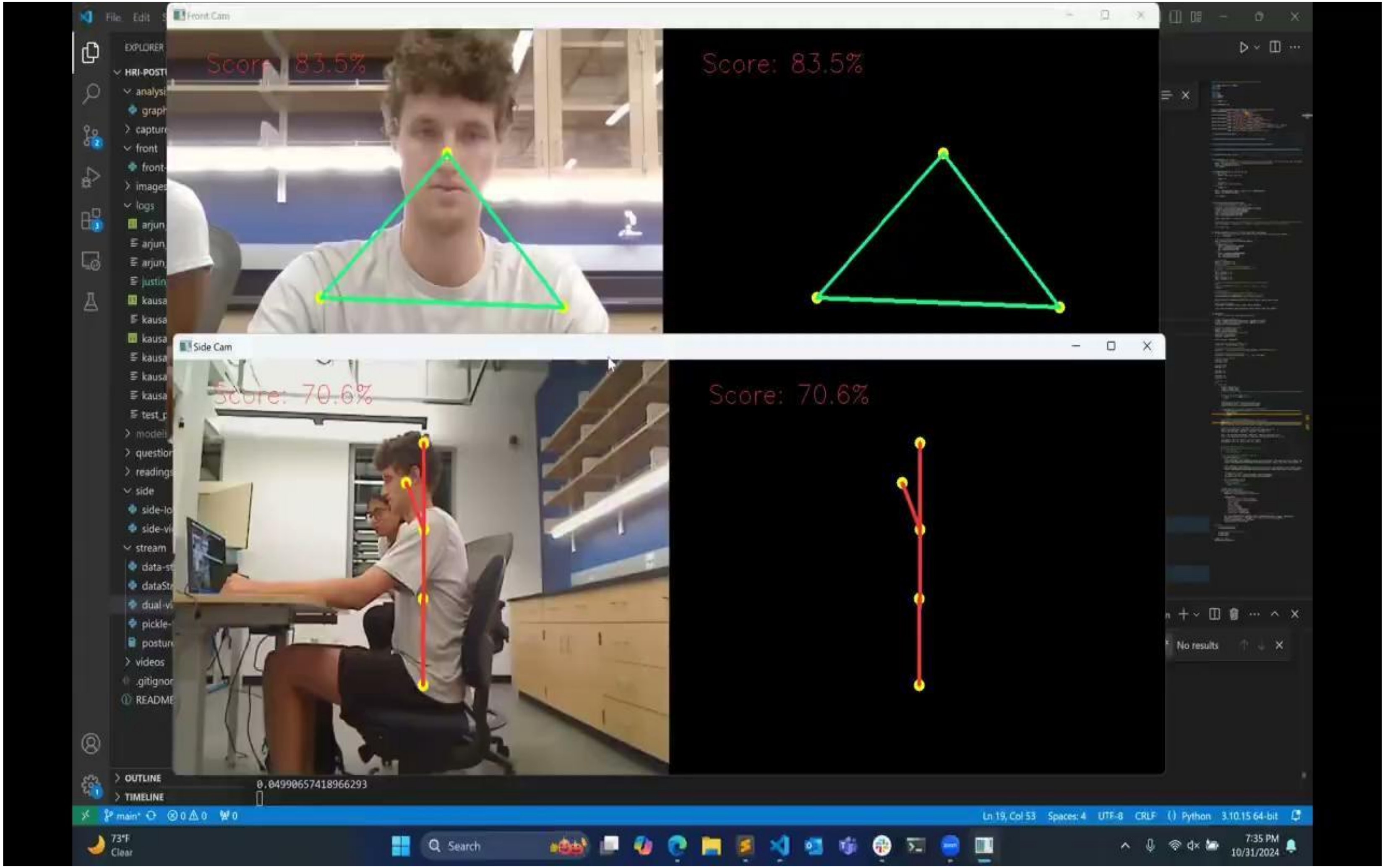
01 A solution that integrates computer-vision with haptic and sound feedback to aid posture correction.

02 We use a standing desk that autonomously adjusts height when poor posture is detected.

03 A comprehensive user study was conducted where the effectiveness of different stimuli for posture correction was evaluated.

04 Extensive posture logging was carried out to provide a quantitative basis to verify if posture was successfully corrected.




Front Cam
Score: 83.5%
Score: 83.5%
Side Cam
Score: 70.6%
Score: 70.6%
EXPLORER
OUTLINE
TIMELINE
0.04990657418966293
No results
main*
Ln 19, Col 53
Spaces: 4
UTF-8
CRLF
Python
3.10.15 64-bit
73°F
Clear
Search
7:35 PM
10/31/2024

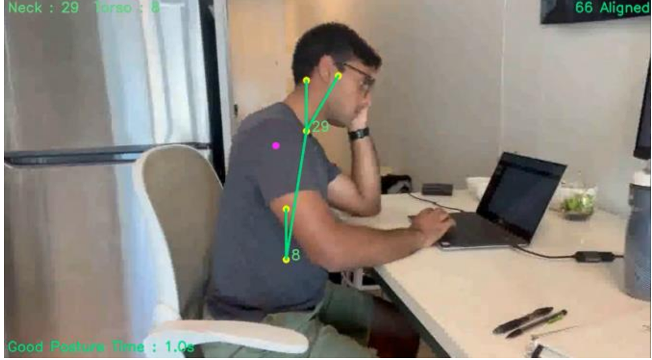
What’s measured?

Torso inclination: angle between hip (x,y,z) and shoulder (x, y, z)
Neck angle: relative angle between ear, shoulder and hip (3D coordinates)
Spine length: distance between hip and shoulder (3D frame)
Level: difference in y-coordinates of left and right shoulder
Lean: difference in mean-z values between ear and shoulder
Neck_: normalized neck angle based on thresholded neck_min, neck_max
Torso_: normalized torso inclination based on torso_min, torso_max
Level_: normalized level based on level_min, level_max
Lean_: normalized lean based on lean_min, lean_max
Front score: 40 x (1 - level_) + 60 x (1 - lean_)
Side score: 70 x neck_ + 30 x torso_

Composite: 55 x neck_ + 40 x torso_ + 3 x (1 - lean_) + 2 x (1 - level_)

Thresholds:

Notification cooldown: 30 seconds
Bad posture time: 10 seconds
Composite threshold: 77
Study time, calibration, vibration, sound: 35, 5, 15, 15 minutes

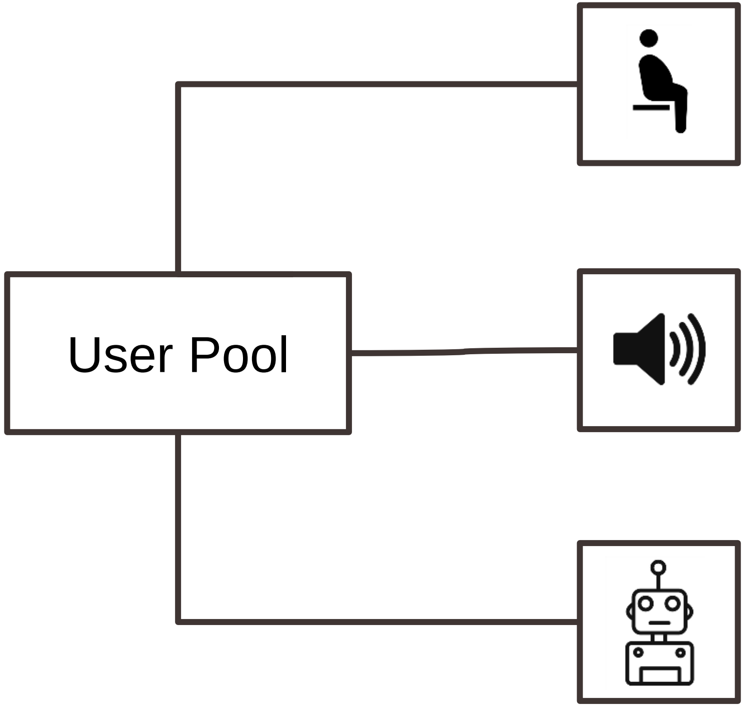


(a) Side (true score)

(a) Front (eval score)

User Study Design

The study goes on for 40 minutes - 5 minutes of calibration, 30 minutes of study, and 5 minutes of post-study questions. A total of 15 participants were needed.



Control (n=5)

Users work on their laptops while their posture measurements are logged.

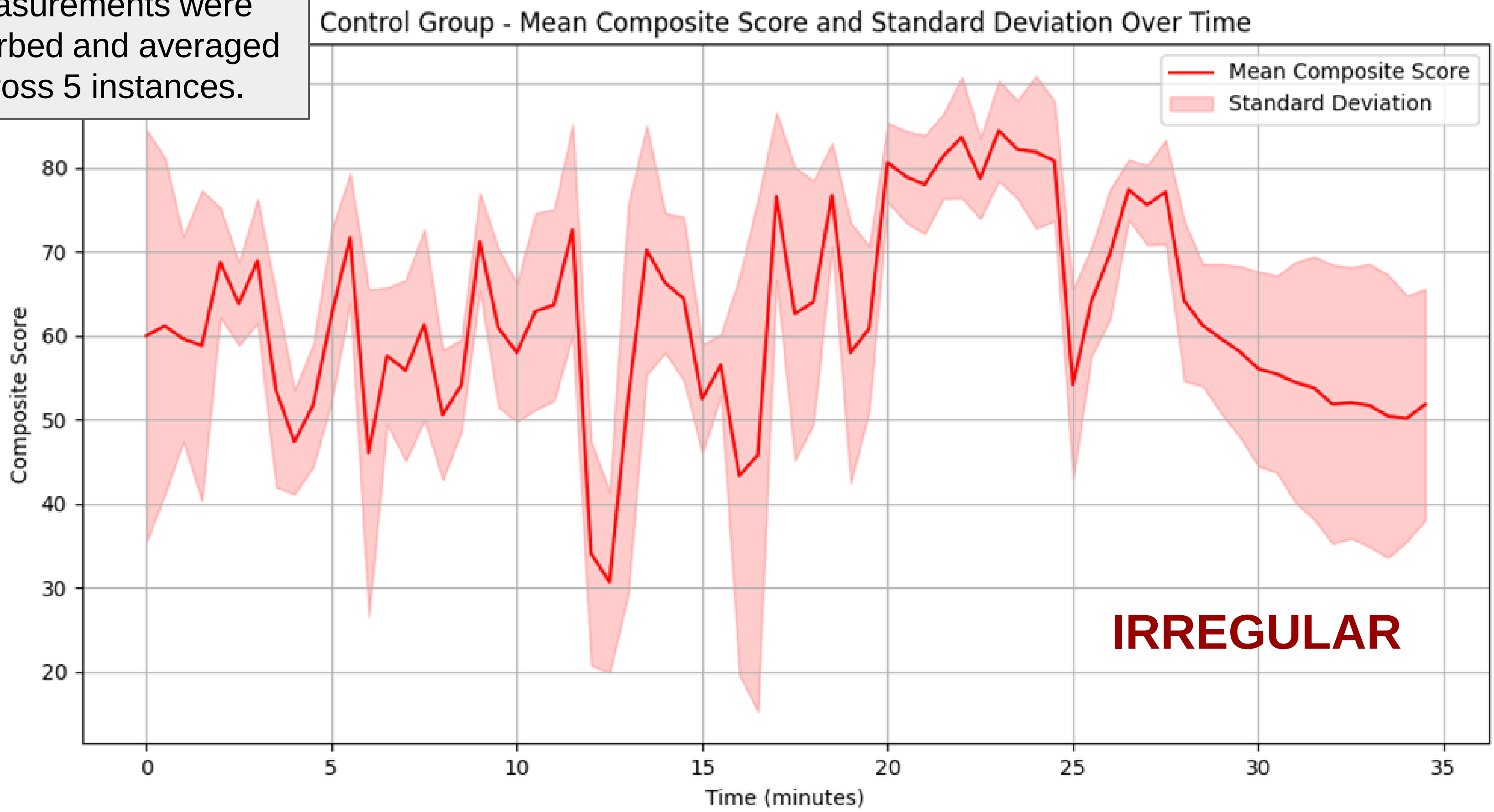
Passive (n=5)

15 mins of vibration feedback and 15 mins of sound feedback.

Active (n=5)

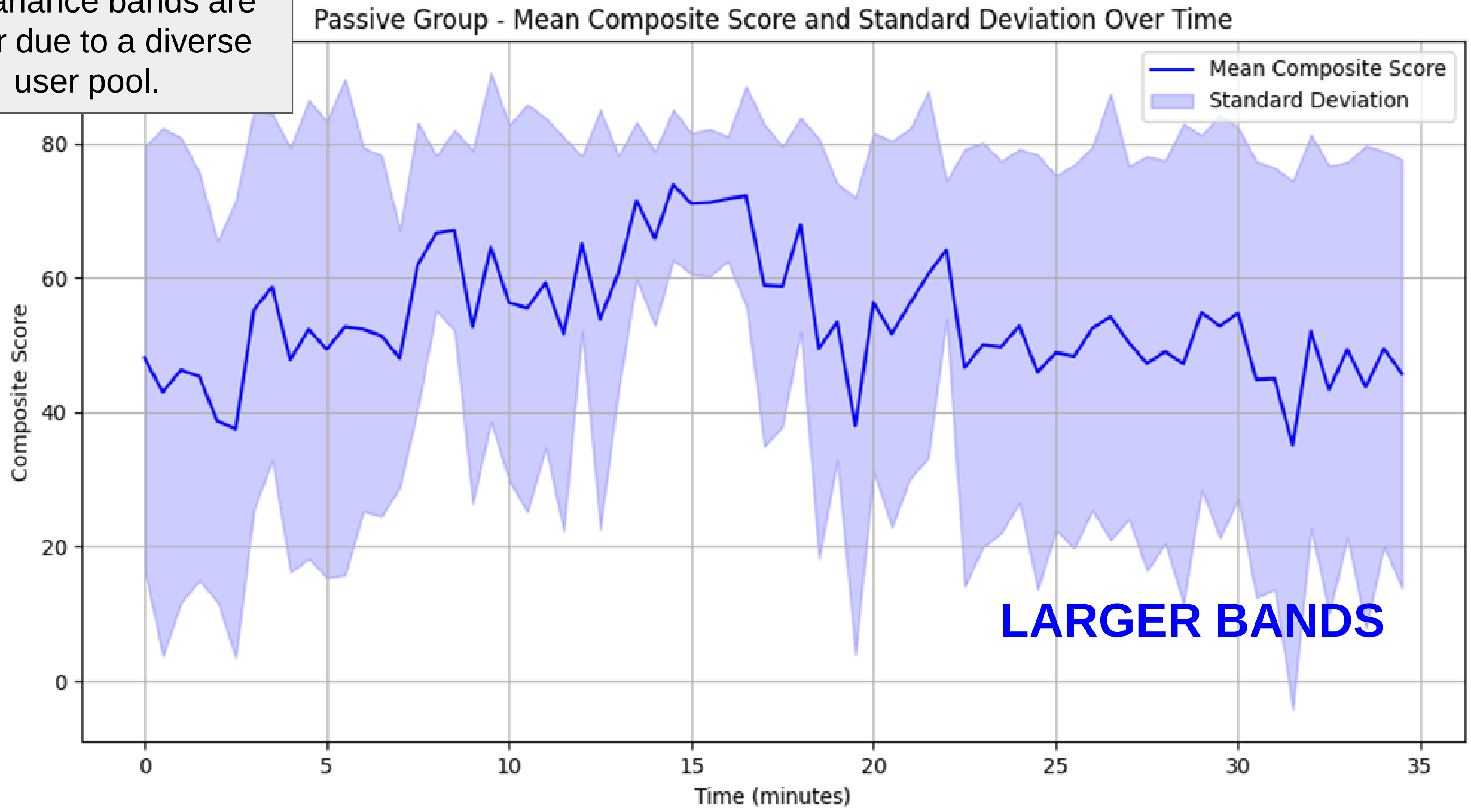
Automatic table height adjustments to be made if the user is found to lean too close.

A single user was treated as baseline, measurements were perturbed and averaged across 5 instances.

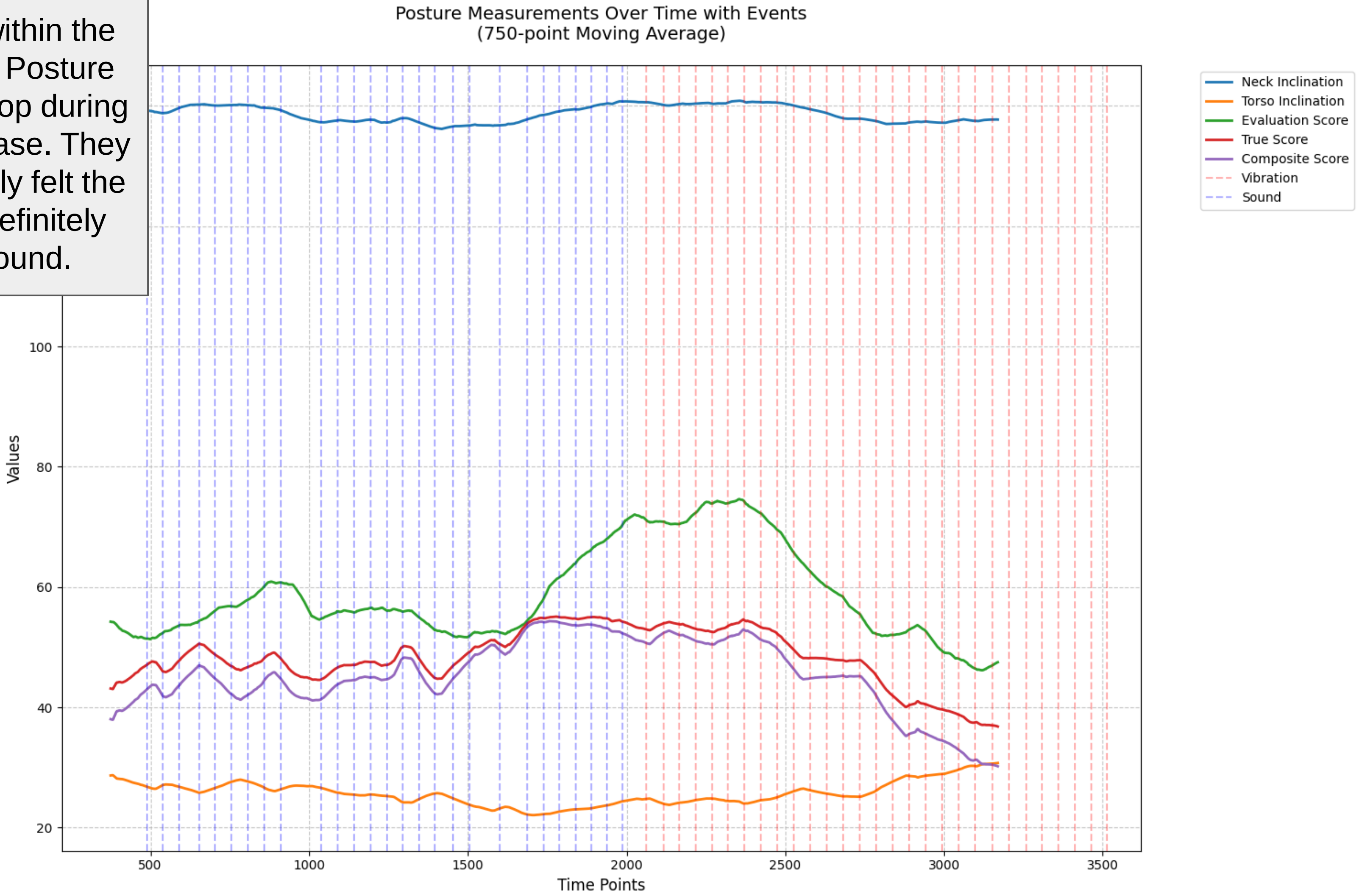


μ = 61.96, σ = 16.89, 18101 data points

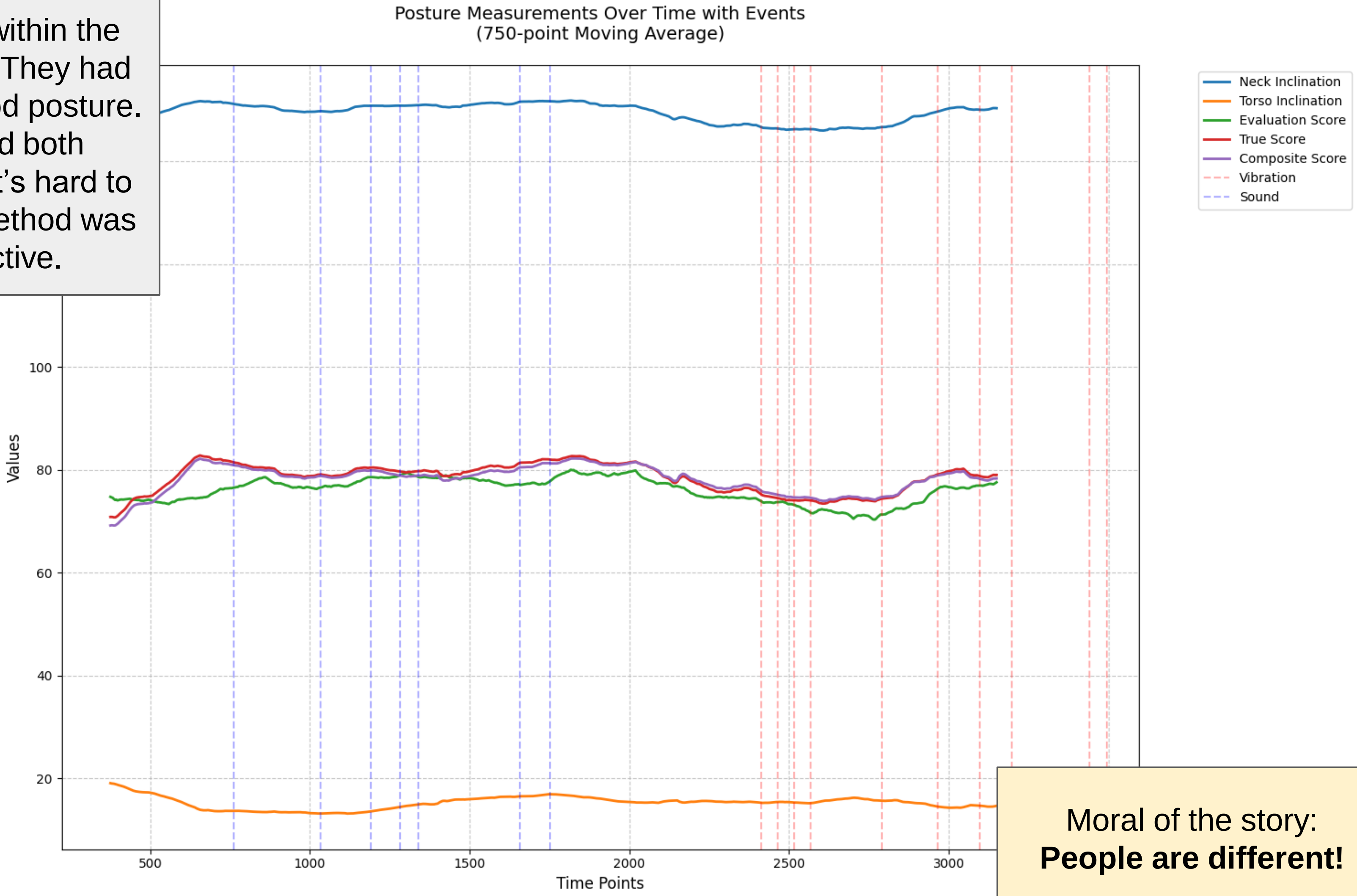
With the passive group, the mean is lower and the variance bands are larger due to a diverse user pool.



A single user within the passive group. Posture data tends to drop during the vibration phase. They noted they hardly felt the vibration but definitely heard the sound.



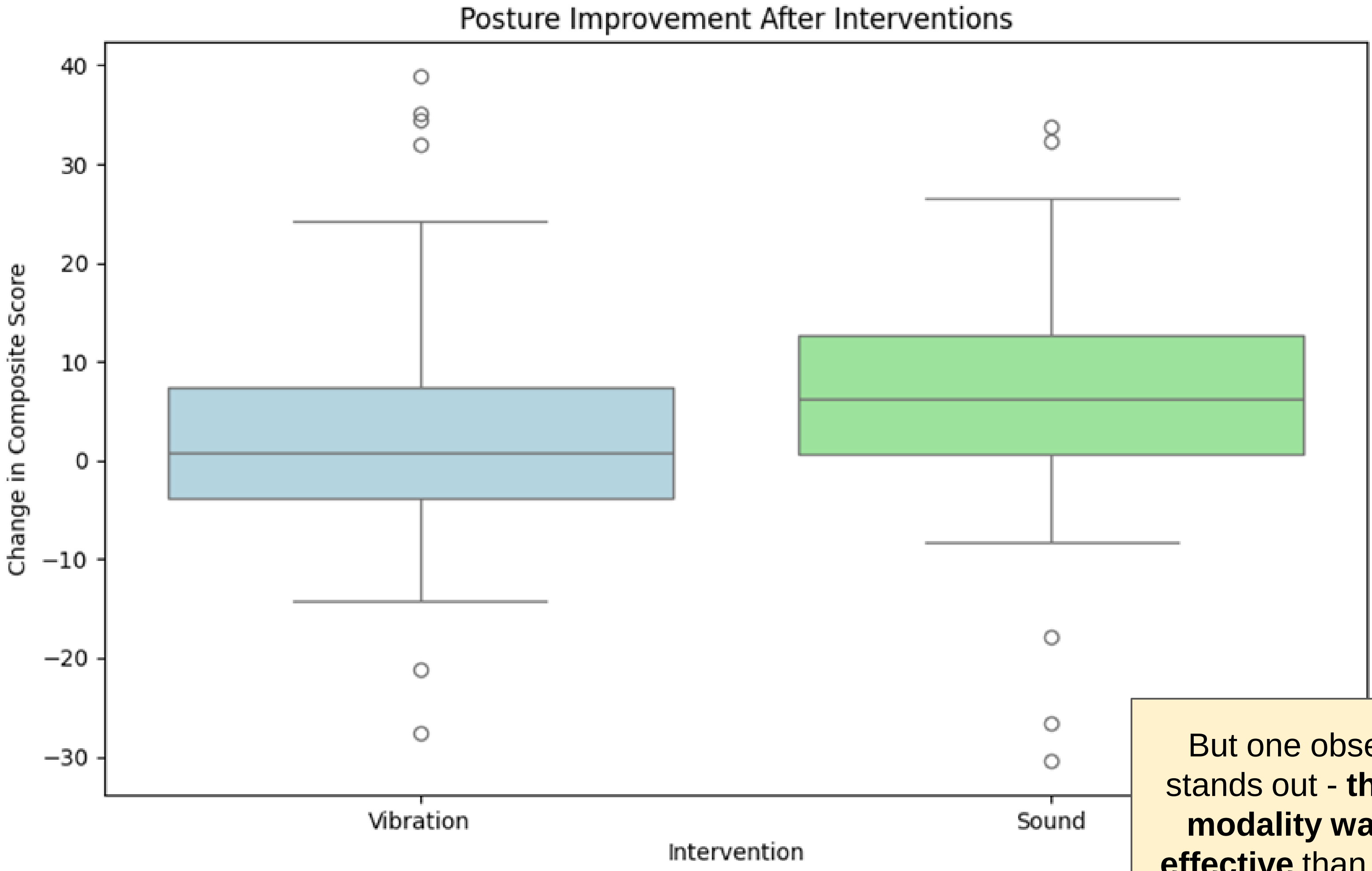
Another user within the passive group. They had consistently good posture. They noticed both modalities, so it's hard to gauge which method was more effective.



Moral of the story:
People are different!

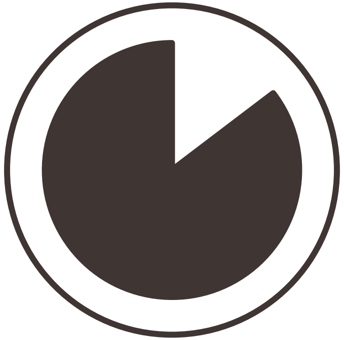
Statistical Tests

#	Hypothesis	Result
1	The mean composite score will be higher than calibration during periods where passive intervention was used.	**Kruskal**: p = 0.914. No significant difference between the mean composite score during the calibration phase, the noise intervention, and the vibration intervention.
2	The mean composite score will improve after a passive intervention.	**Sound**: p = 0.69. No significant difference between mean composite score before and after sound intervention. **Vibration**: p = 1. There is no significant difference between mean composite score before and after vibration intervention.



But one observation stands out - **the sound modality was more effective** than vibration.

User Survey



86%

8+ hours

Daily Computer Use

Age

18-30

Gender

57%

No significant differences were observed between genders. The user demographics show a nearly even distribution.

User Survey

	Control	Passive	Δ(P-C)
Effectiveness	1x5	4+3+4+4+4	19-5=14
Productivity	3x5	3+3+4+3+4	17-15=2
Intelligence	1x5	4+3+4+4+3	18-5=13
Comfort	5x5	3+3+3+5+3	17-25=-8
Fatigue	1x5	4+2+5+2+3	16-5=11
Intrusiveness	1x5	4+3+4+4+2	17-5=12

User Feedback

“A good reminder to maintain posture”

“Study was designed well”

“Kausar was great to speak with”

“The sound was distracting me”

“I barely felt the vibration”

“What was wrong with my posture?”

The desk-moving user study could address these issues by being less distracting than sound, more assertive than vibrations, and allowing users to infer the reason for the shift.

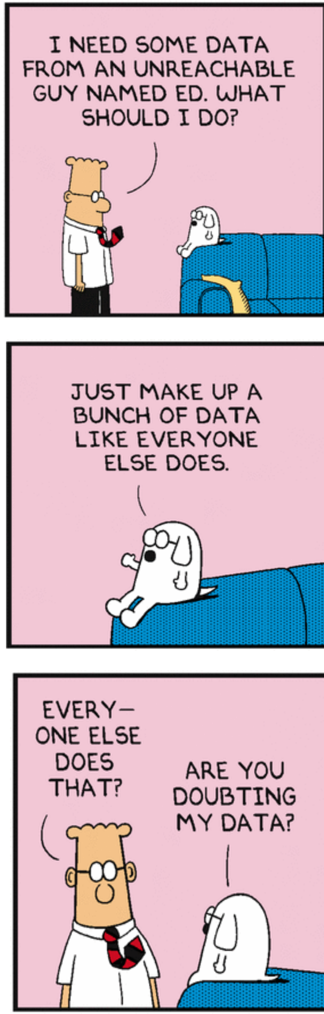
Limitations

1 **Defining "Good Posture"**
It's hard to mathematically codify due to individual body differences.
Requires for extensive calibration for personalized evaluation.

2 **Study Design Constraints**
Lack of within-participants testing limits direct comparison of responses.
Participants may "try too hard" due to awareness of being studied.

3 **Technical and Setup Challenges**
Script interruptions due to power issues, mitigated with study resumptions.
Vibration feedback not integrated into the chair, reducing effectiveness.

4 **Small Sample Size**
Single-person control group with perturbed data limits baseline accuracy.
User shortages required compromises in experimental design.



Next Steps

Active Intervention

Launch user studies with the active adjustment desk to explore its impact and refine its capabilities.

Data Deep-Dive

Perform advanced analyses to uncover trends, which stimuli influence neck vs torso inclination.

Improved Studies

Explore studies with fewer, longer-interval stimuli. Rerun studies affected by technical difficulties.

This pilot study highlighted key areas for improving posture detection and will inform future research directions and the potential for broader implementation.