

# Utilizing Teslasuit to Analyze Changes in Joint Angles and Galvanic Skin Responses During Slips (A Stress-Inducing Task)

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## Abstract

- Goals:**
  - Analyze the Galvanic Skin Response (GSR) and joint angle measurements when the participant undergoes an unexpected slip
  - Test the accuracy of the Teslasuit in capturing motion data.
- Hypothesis:** The joint angles and stress levels will decrease during repeated slips because the participant will begin adapting (learning effect) to the test with each additional slip.

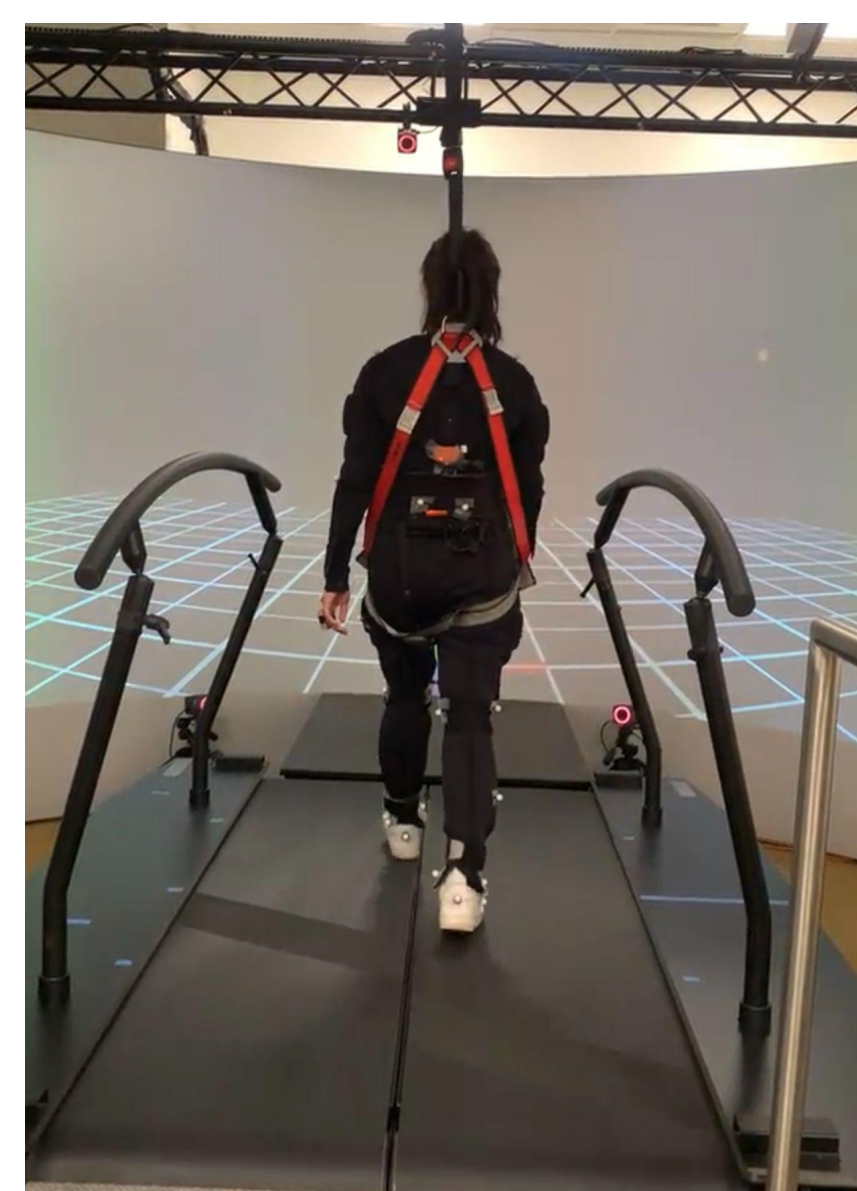


Figure 1: Subject walking on treadmill during slip trials.

## Introduction

- Humans have two different responses when facing a dangerous situation: fight or flight
- During the fight-or-flight response, the sympathetic nervous system takes control causing the body to work overtime to increase the chances of survival.
- Slips often occur in everyday activities, which can trigger the fight or flight response leading to increases in heart rate.
- Motion capture suits and biometric sensors can help analyze the physiological responses from the human body in stressful situations like during a slip.

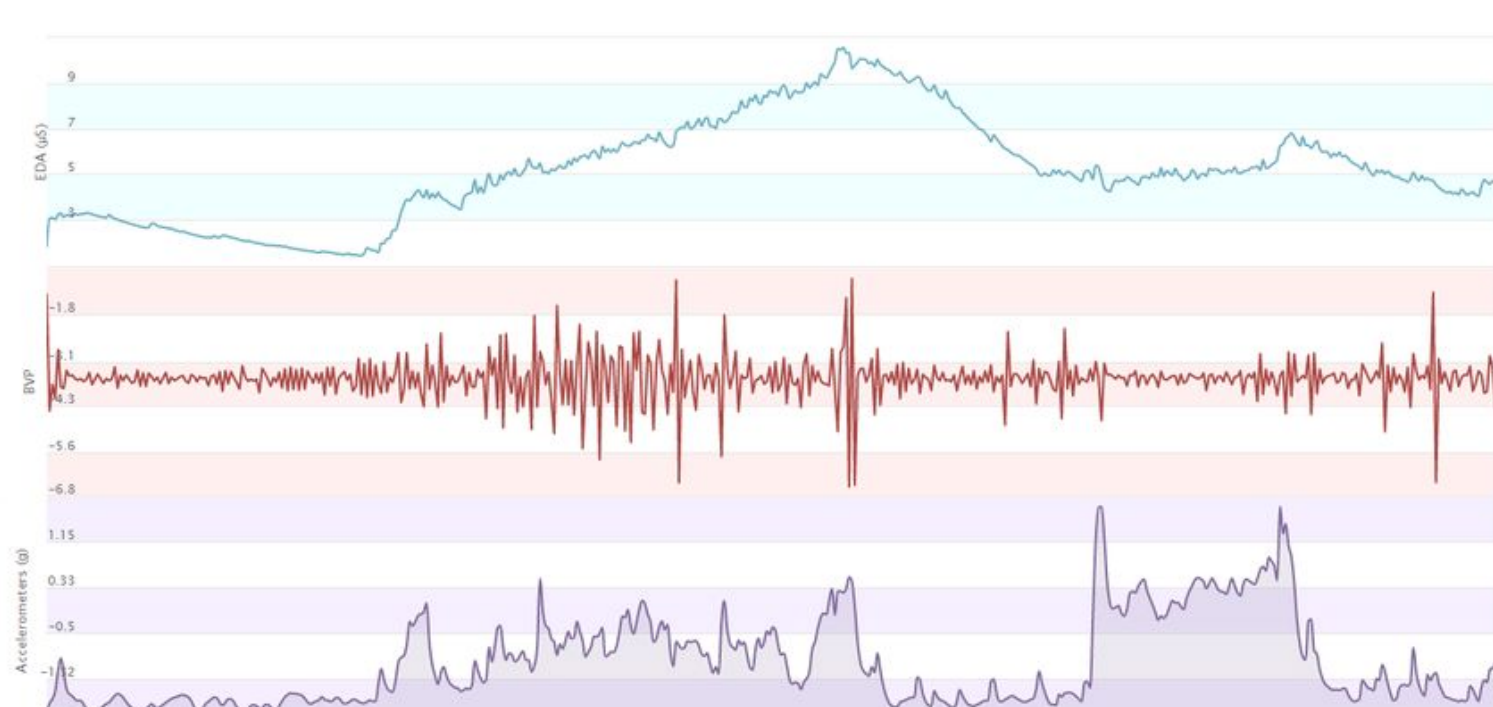


Figure 2: Example data collected from biometric sensors of the Empatica E4 watch.

## Materials and Methods:

- Gait Rehabilitation and Research Lab (GRAIL)
- Teslasuit containing 14 Inertial Measurement Unit (IMU) sensors.
- 4 Xsens IMU sensors and 34 reflective markers placed on the bony processes.
- Empatica E4 watch to record stress levels and heart rate.
- Subjects were asked to complete a 5-minute walking trial followed by a 10-minute blind slip trial, where they were expecting to slip in both trials. The slip occurred unexpectedly (at randomized time frames) during the ten-minute trial.
- When the right heel strike was detected, the treadmill reversed to pull the foot that just made contact towards the front, which induced the slip.
- Data was collected from 7 females and 5 males.



Figure 5: Teslasuit worn by participants.

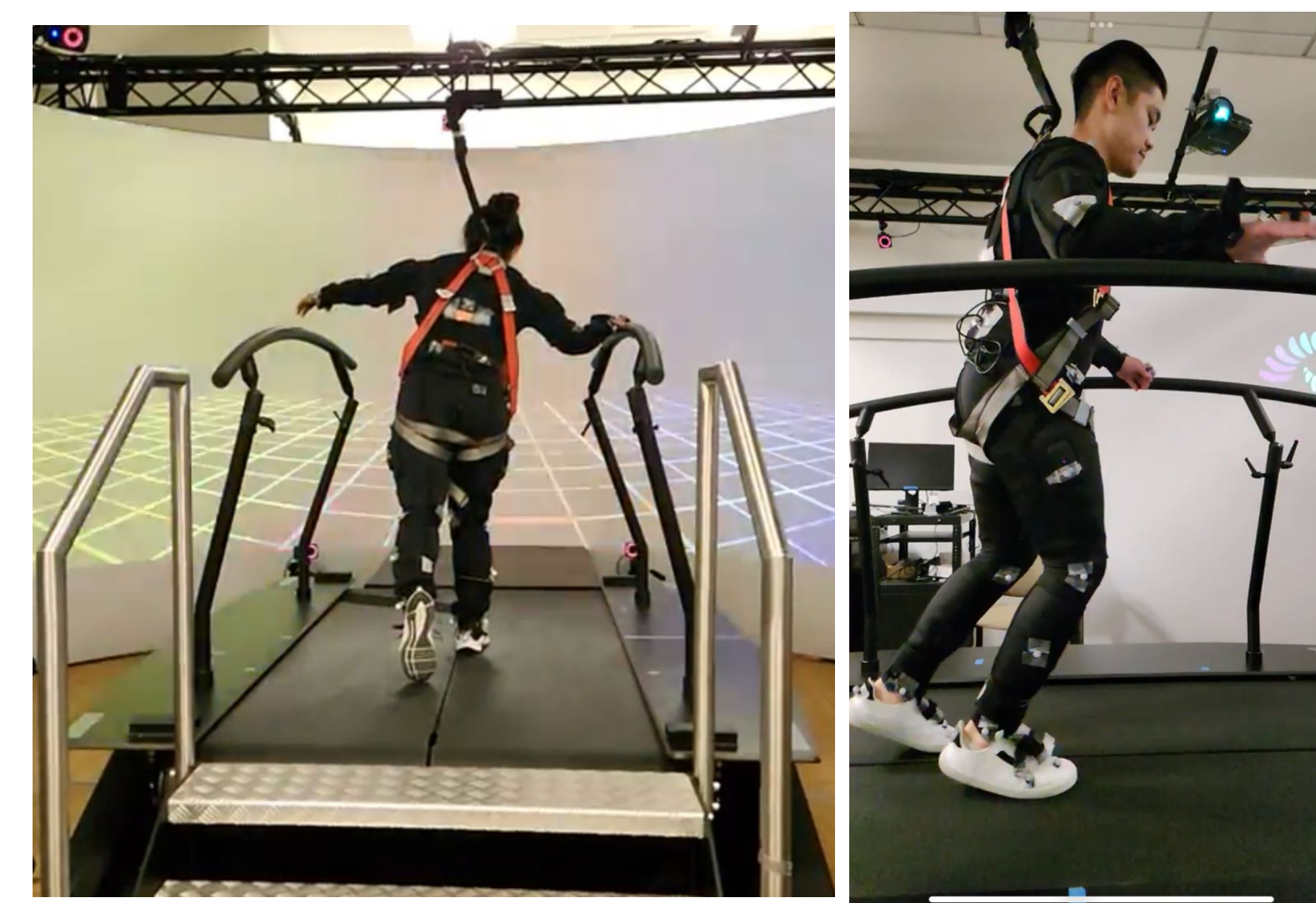


Figure 6: Two participants undergoing an induced slip on treadmill in GRAIL.



Figure 3: Xsens IMU sensors and reflective markers placed on the subject.



Figure 4: Empatica E4 Watch

## Results:

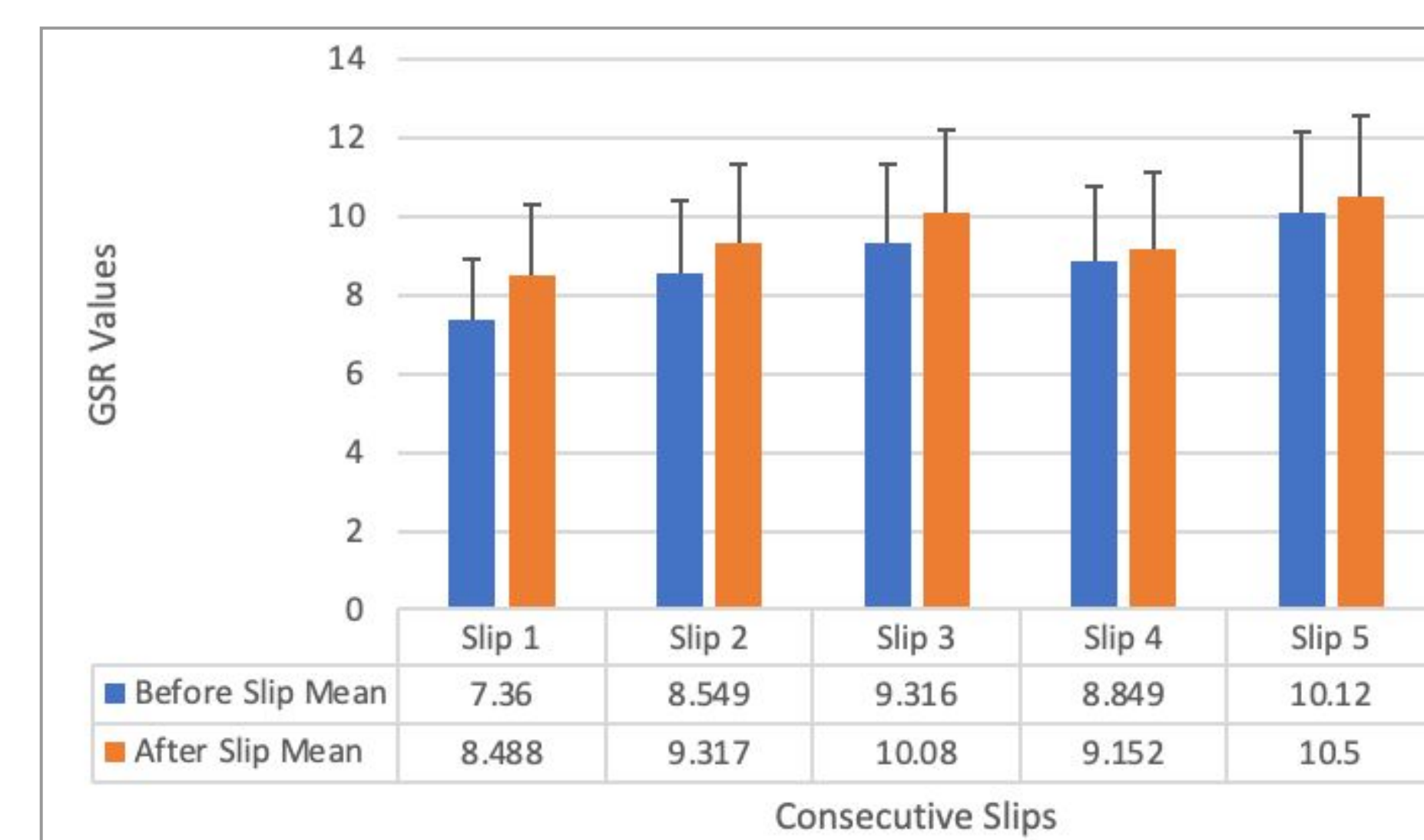


Figure 7: Average GSR values measured before and after each slip.

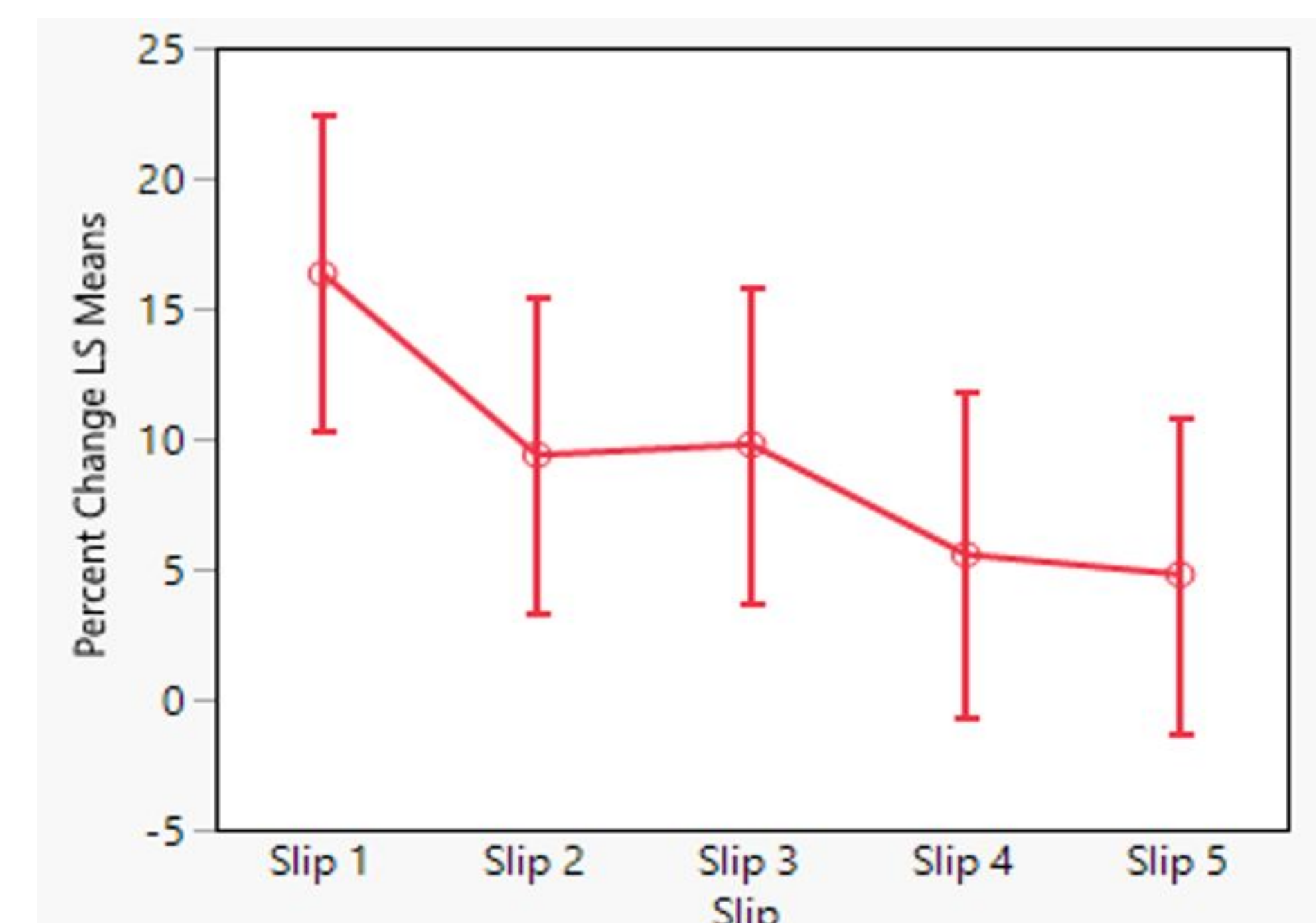


Figure 8: Percent change in least squares (LS) means for each slip.

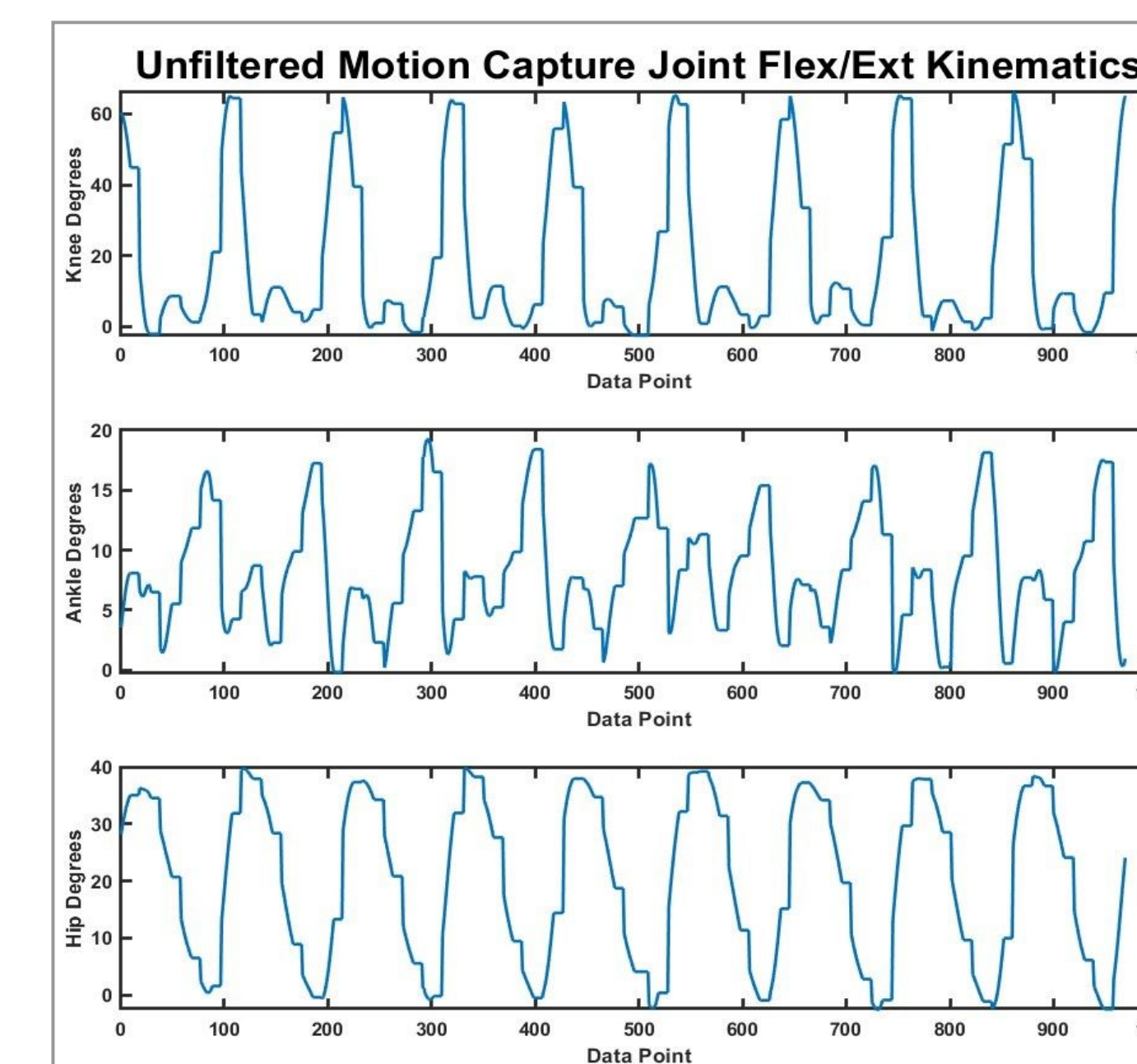


Figure 9: Joint angle data collected from Motion Capture.

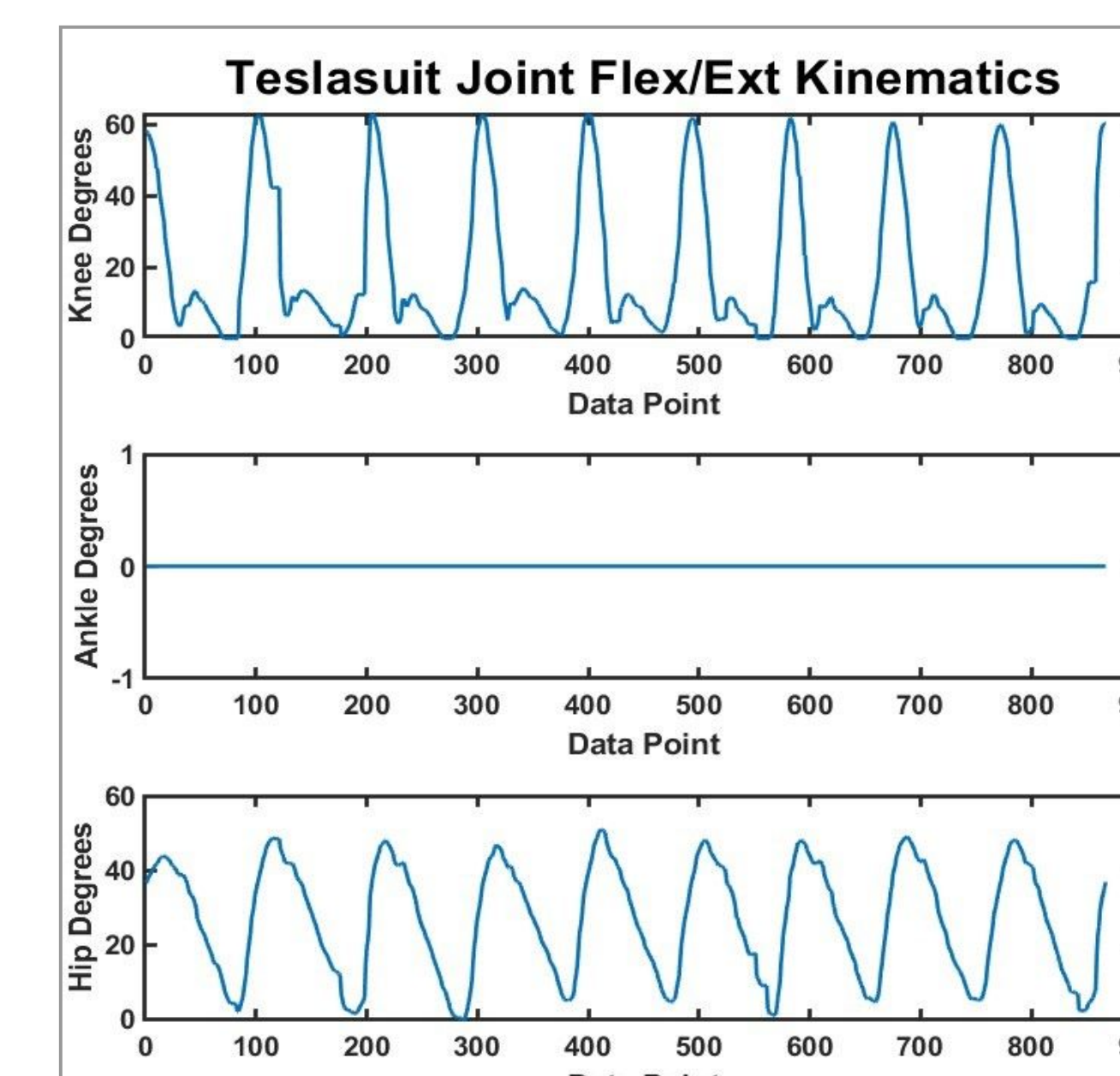


Figure 10: Joint angle data collected from Teslasuit.

## Discussion

- The difference in stress levels measured before and after the slip was smaller after each slip. This means that with each consecutive slip, stress levels decreased. After experiencing the first slip, which caused the highest stress levels, the subjects knew what to expect of the next consecutive slips. This adaptation to each following slip likely caused stress levels to decrease.
- For the normal walking trials, the knee and hip joint angle data outputted from the Teslasuit is similar to the Motion Capture data when comparing the graphs. Thus, the Teslasuit is relatively accurate when collecting joint angle data. The only limitation is Teslasuit does not collect ankle joint angle data.

## Conclusion

- Stress levels consistently decreased with each consecutive slip as the participants learned to adapt to each slip.
- The Teslasuit has the capability to collect relatively accurate joint angle data.
- Further analysis will be done to compare the joint angle data of the participants during each slip with the normal walking data.

## References

- Navea, R. F., Buenvenida, P. J., Cruz, C. D. (2001). Stress Detection using Galvanic Skin Response: An Android Application. *Journal of Physics*, 1372(2019).
- Jansen, Arthur et. al. (1995). Central command neurons of the sympathetic nervous system: basis of the fight-or-flight response. *Science*, 270(5236): 644.