12-5-2022

How Does Perceived Human Instability Affect One's Own Stability?

Madi Braunersrither
Utah State University, madi.braunersrither@usu.edu

How Does Perceived **Human Instability** Affect One's Own Stability?

Madi Braunersrither | *Utah State University* Juergen Symanzik | *Utah State University* Breanna Studenka| *Utah State University*

UtahStateUniversity®

Introduction

Participants were prompted to evaluate the stability of pictured human postures while standing on a force plate. We measured irregularity through analyzing the presence of patterns in the sequential center of pressure values. To measure the presence of patterns, sample entropy, a time series statistic, was developed and we utilized it on the force plate data [2].

- Does one's own **stability change** when **viewing** a posture deemed **unstable**?
- Is **Sample Entropy (SampEn)** an effective tool to determine stability?

This relationship could have implications for modeling progression of motor skills, understanding human development, and the design of environments for rehabilitation.

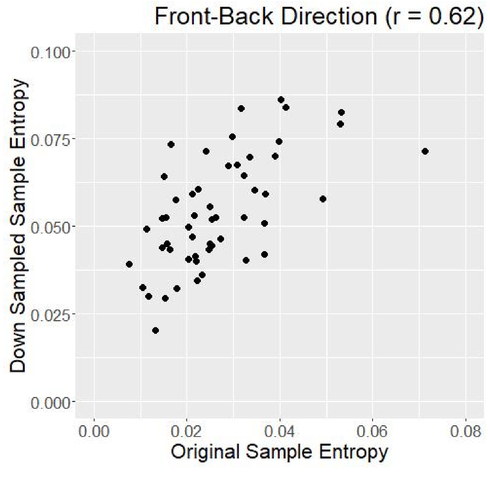

Figure 2: The SampEn of the 53 subjects during the one-minute standing still period calculated using the original data (1000 observations/s) plotted against the sample entropy calculated on aggregated down sampled data (100 observations/s).

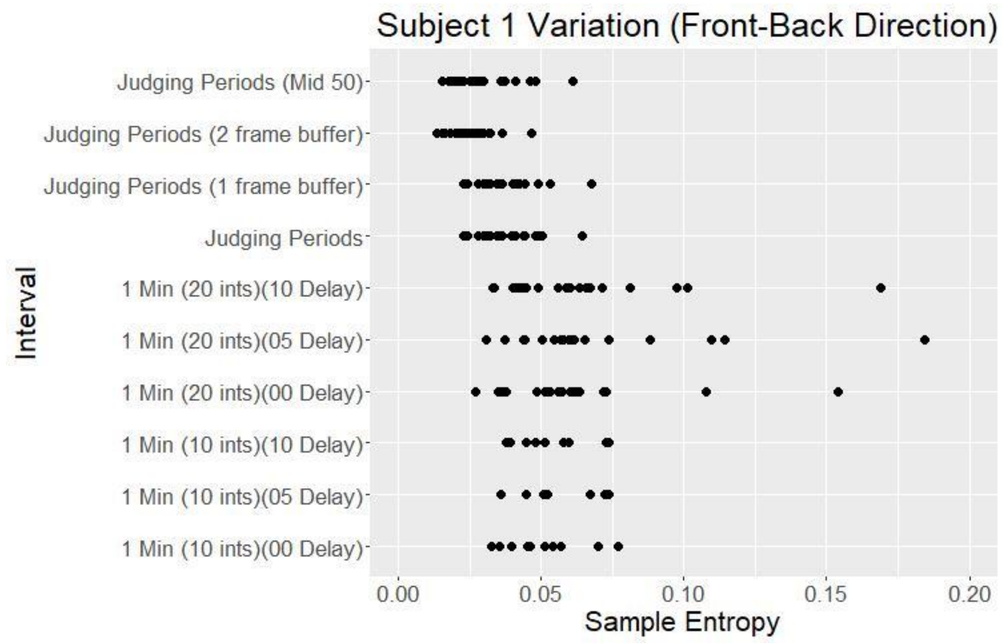

Figure 1: Comparison of variation in SampEn for Subject 1 between different partitions of the one-minute period and the judging periods with various buffers.

Data & Methods

The USU Posture Study [1] consists of many different data. This research focused on just one component of this larger study: the force plate data which was recorded two separate times per subject. First, a one-minute standing still period, and second, a longer recording of the process of judging 22 various pictured-postures. Each of these components had both video and force plate recordings. The videos were utilized to determine the judging periods of each posture. This timing had to be synced with observations in the force plate. At the end of each video, there were several hard taps on the force plate which were clear to see in the force plate data and were used to create a conversion to sync the data.

Once this was complete, the first consideration was to compare the variation in SampEn during the standing still to the variation in SampEn while judging each posture (Figure 1). The one-minute standing still period was divided into 10 and 20 intervals with no delay, 5 s delay, and 10 s delay. The SampEn of each interval was found to determine variation during this one-minute period. This was compared to SampEn of the center of pressure during the judging of each of the 22 postures. To consider the effect of transition periods, buffers of 1 frame, 2 frames, and the middle 50% of the data were considered.

Results

Using Figure 1, we can compare variation between the standing still and judging periods. The amount of variation during the one-minute base period is the same or even greater than the amount of variation during the judging periods. A shift in lower SampEn values is also observed in the judging periods. These results are for just one subject, but this phenomenon was observed for each of the 4 subjects considered.

An additional consideration here is further data processing prior to calculating SampEn. This was attempted via down sampling and the strong linear relationship between the entropy before and after down sampling suggests this would not improve the signal strength (Figure 2).

Conclusion

Measuring human stability is important for understanding behavior. Current literature [2] suggest sample entropy as the premier nonlinear measure for such studies.

- During an **uncontrolled task**, standing still, we observed more variability in SampEn and lower values when compared to the **controlled task** of judging postures.
- This is a success for the measure of **Sample Entropy** as it **successfully identified** the focused task that required more cognitive control.

References

[1] Coltrin, J., McKinney, E., Studenka, B., & Symanzik, J. (2020). Defining Areas of Interest for Eye-Tracking Data: Implementing a Systematic Approach. In: 2020 JSM Proceedings. American Statistical Association, Alexandria, VA, 1144–1153.

[2] Montesinos, L., Castaldo, R. & Pecchia, L. (2018). On the Use of Approximate Entropy and Sample Entropy with Centre of Pressure Time-Series. Journal of NeuroEngineering and Rehabilitation 15, 116. https://doi.org/10.1186/s12984-018-0465-9