# Methods of Artifact Detection and Removal in Electrodermal Activity Gathered from Wearable Bio-sensors

CURCA Center for Undergraduate Research and Creative Activities
University at Buffalo The State University of New York


**Richard Burke, Randi Henricy, Eduardo Mercado, III**
University at Buffalo, The State University of New York


University at Buffalo
The State University of New York

## Background

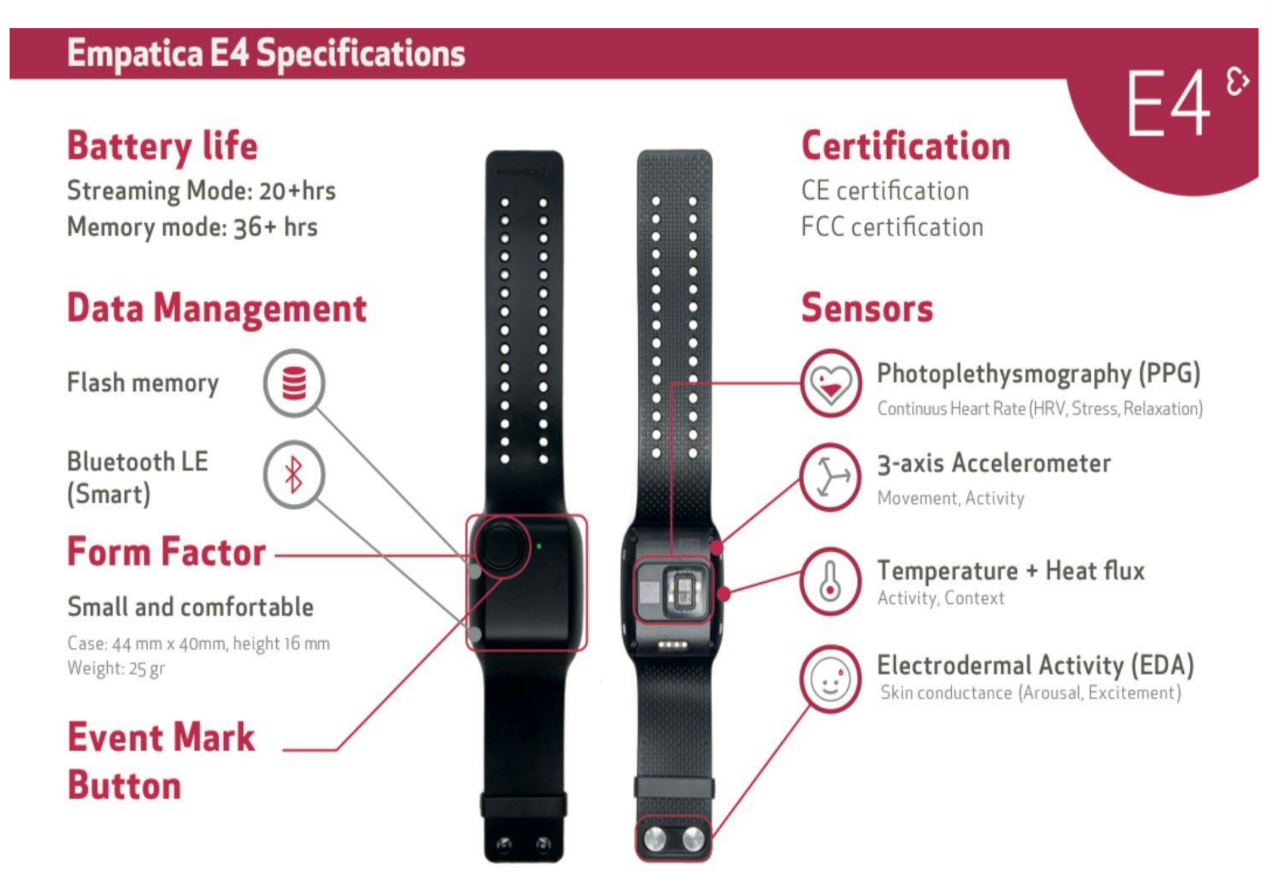
Historically, collecting physiological recordings requires movement to be restricted such as MRI and EEG. In both cases the recording of interest can be confounded by a single minute movement of the head or an eye blink. Similarly, the effectiveness of data collected from a wrist-worn bio-sensor is sensitive to small environmental factors (Boucsein, 2012).

In this experiment we identify a particular artifact that would likely occur as a result of normal movement, to further remove this uninformative segment from the data. This is a novel method since most approaches to filtering data control for and attend to the informative data rather than the uninformative data lacking a physiological covariate (Taylor, *et al.,* 2015).

## Experiment Design

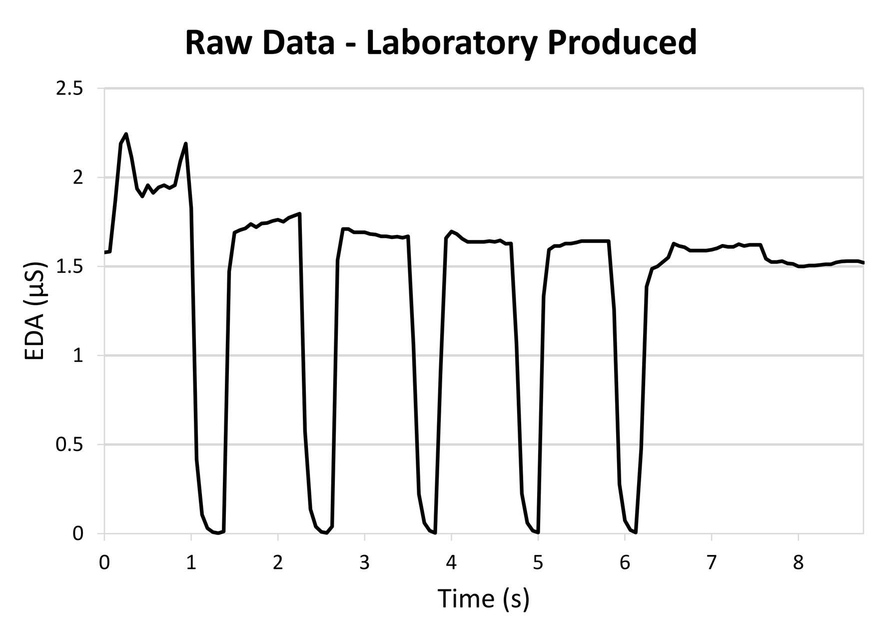
This experiment investigated two wrist worn bio-sensors: the Q-Sensor, made by Affectiva, and the E4, made by Empatica (Garbarino, *et al.,* 2014). A total of 38 participants were asked to wear either the Q sensor or the E4 sensor. A subgroup of 23 participants were asked to wear both the E4 and Q-Sensor.

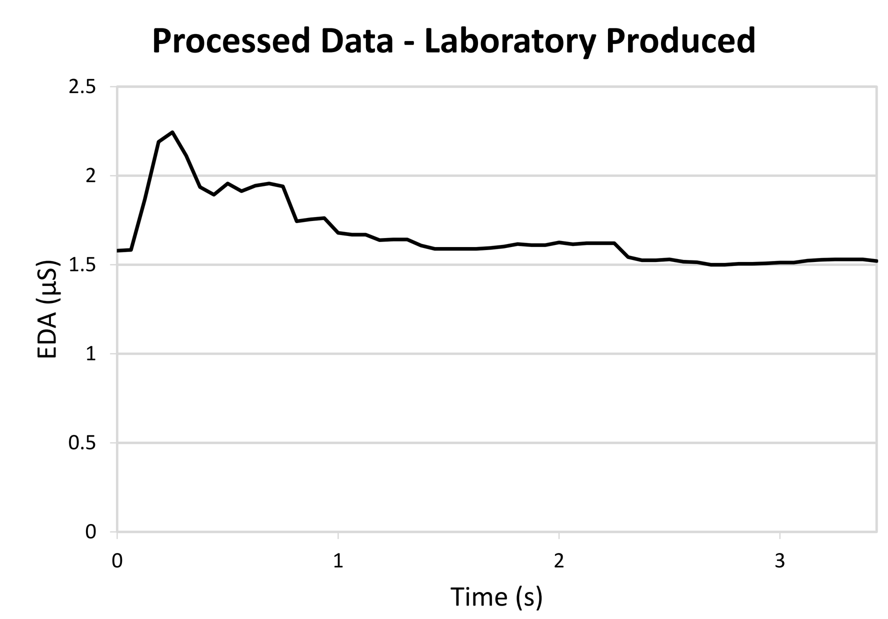
Participants were asked to complete a survey regarding caffeine and food intake, as well as sleep quality. At least three minutes were allowed for the sensors to reach close to baseline levels of EDA. An experimenter then lifted each sensor from the wrist five times, indicated by an event marker. Participants were asked to repeat this process , lifting the sensor from their own wrist.




## Laboratory Generated Artifacts

We then compared each artifact to the normalized artifact by a modified Kolmogorov-Smirnov two sample test at an α level of 0.05. Potential epochs were labelled as any two points having a slope < -2. After labelling, the lowest point within one second of the flag was queried, including each .5 or 2 second segment surrounding it. If resulting in a significant KS test, data was left untouched, otherwise removed. KS analysis flagged 100% of the controlled artifacts.



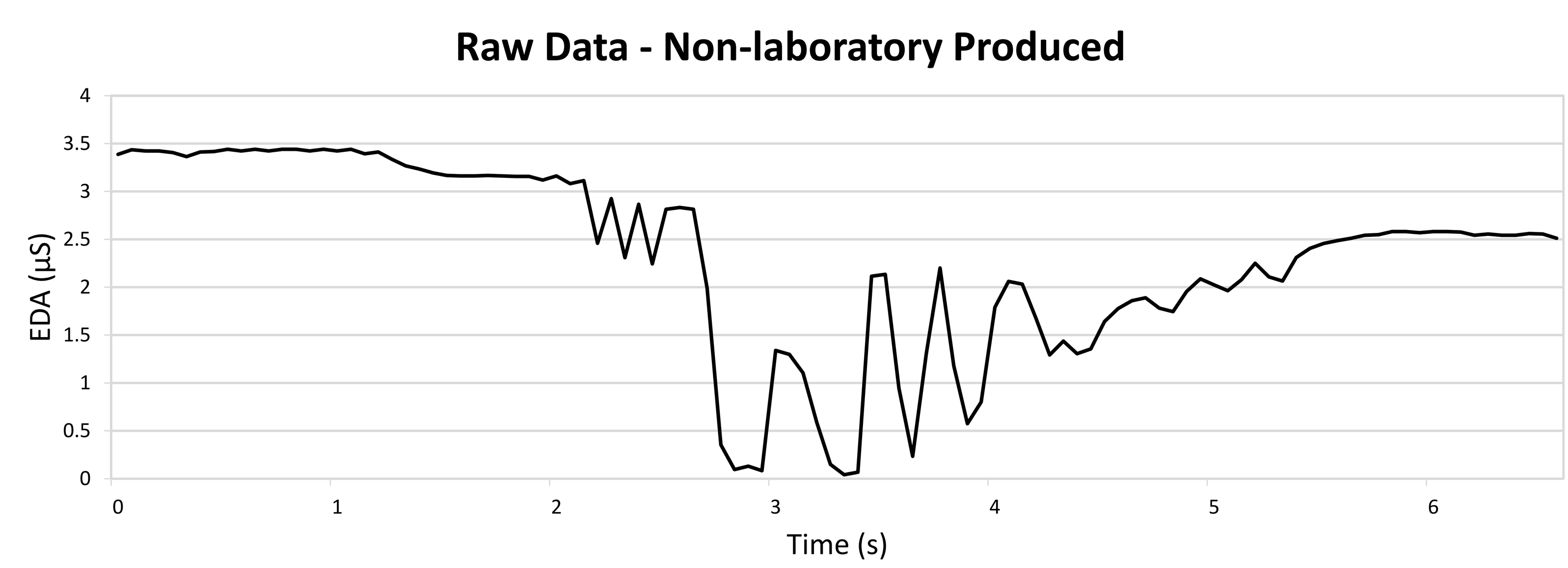

## Analysis

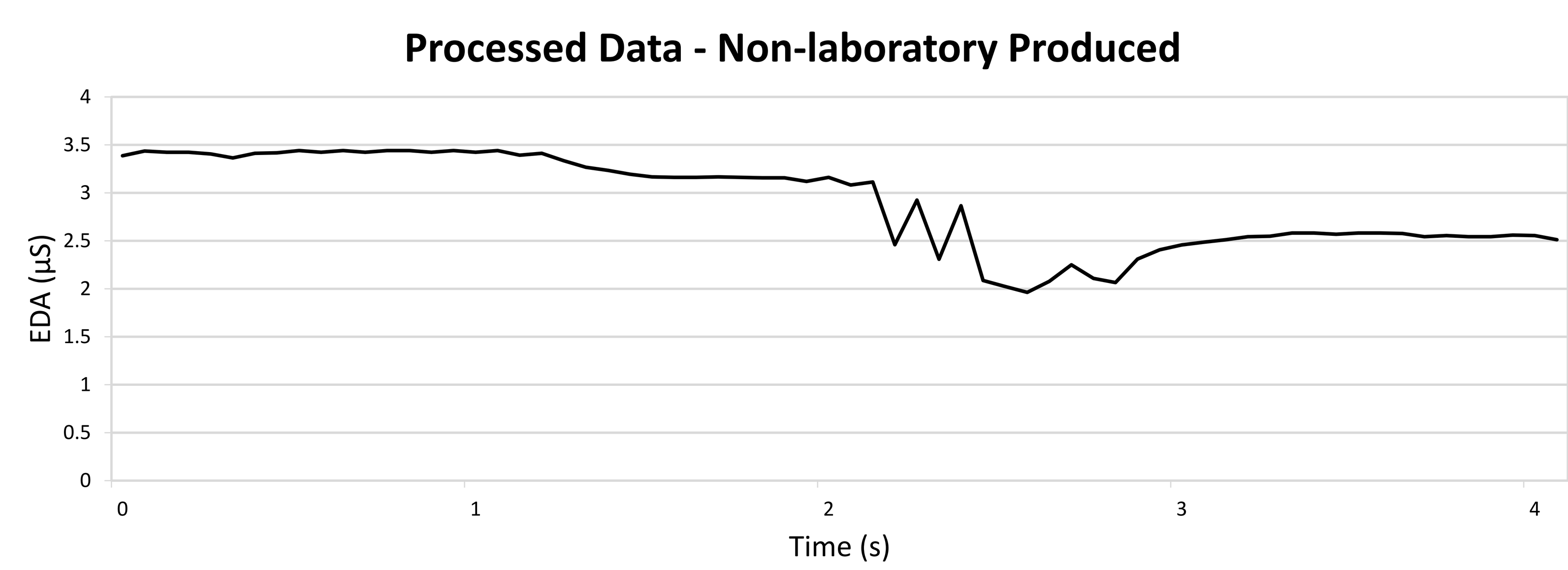
Each artifact was manually parsed from the data. Three participants with abnormally low EDA (<.1µS) were excluded from the study. The controlled artifacts were observed to be, and subsequently defined by 155 one-second and 80 four-second artifacts for the Q and E4 sensor, respectively. The lowest value in the given epoch was identified. This value was surrounded by .5 seconds (Q Sensor) or 2 seconds (E4 Sensor) of data. Each epoch was averaged among participants to generate a normalized artifact.

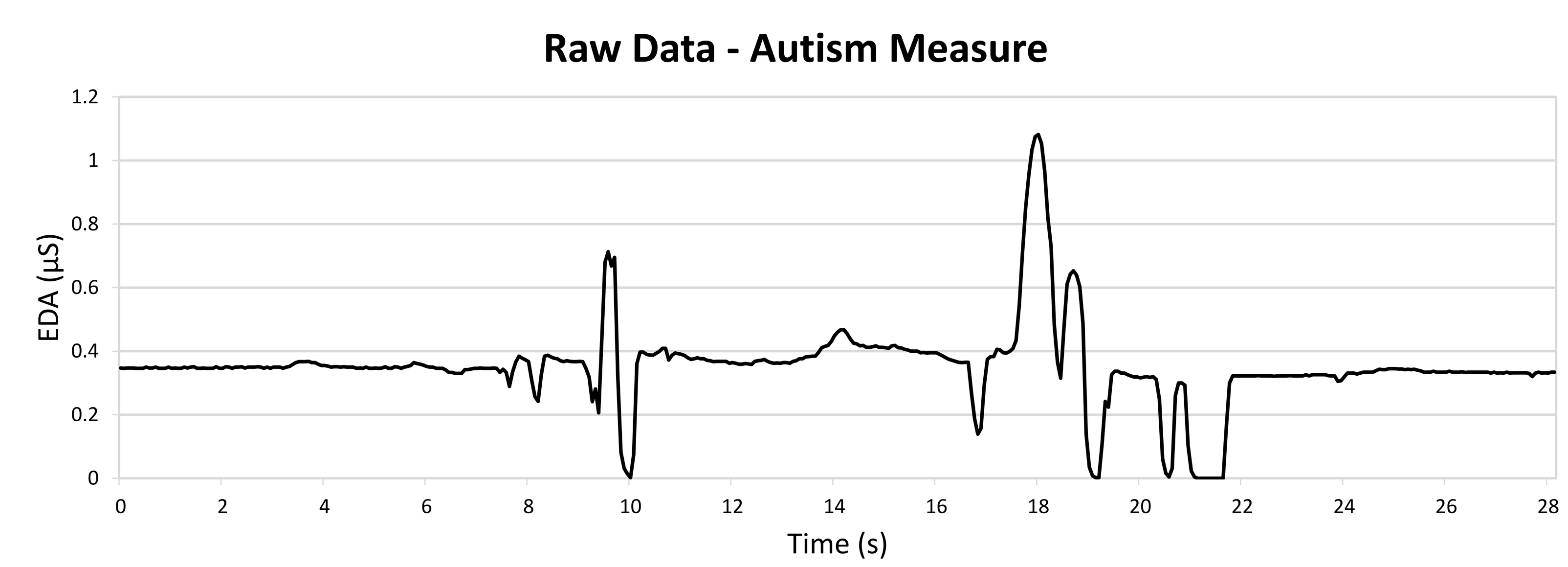
## Conclusion

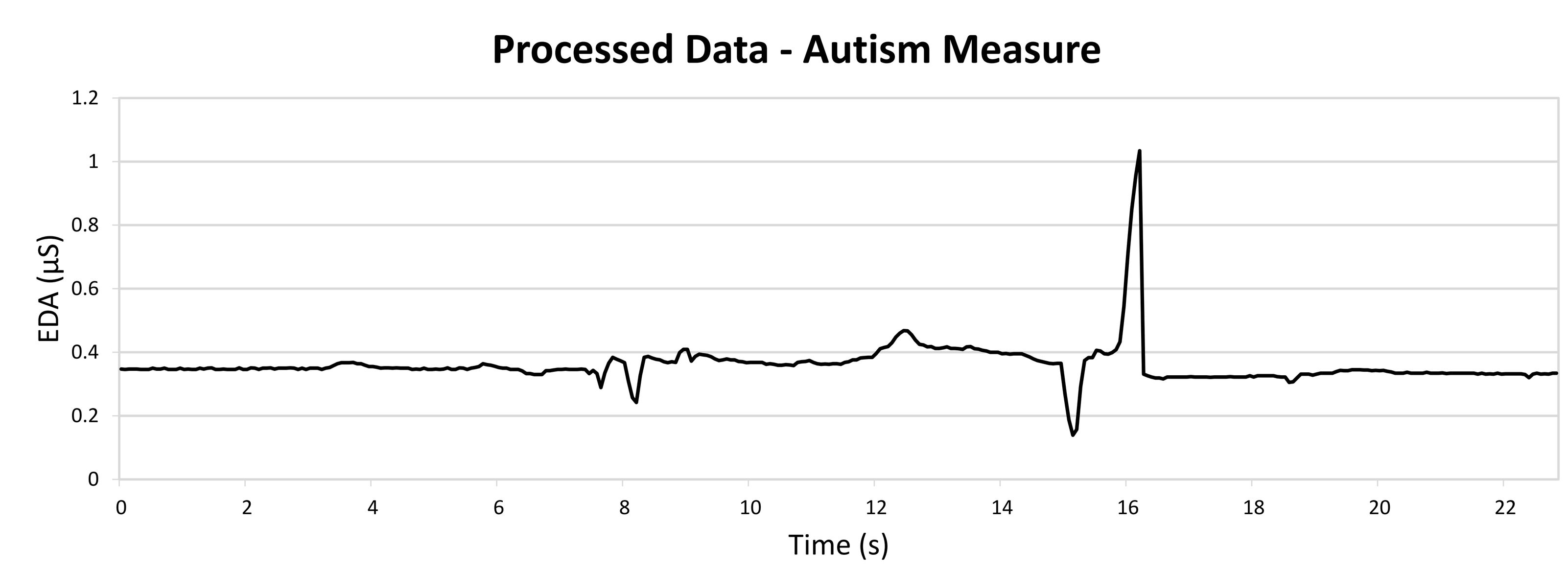
We have shown that comparisons of raw data to normalized artifacts can be valid measures to strongly reduce variability and can be done so automatically. This greatly reduces the impact of sensor disconnect on aspects of EDA such as baseline levels and arousal reactivity. Externally, this method could aid in analysis of both typically developing and autistic individuals. This helps reduce the effect of data artifacts in an already sensitive measure without unnecessarily discarding data.

## Externally Generated Artifacts




The same approach was applied to a noisy EDA sample collected in a non-laboratory setting. All artifacts specific to electrode disconnect were accurately identified, as determined by an expert labeler. Of the 6.5 second sample, 2.25 seconds were determined to fit the normalized artifact and removed.

Two-way t test yielded a significant increase in mean EDA of .577µS ($t(162) = 5.2$, $p < .001$). Test for equal variances yielded a $\Delta SD$ of -.49µS ($F(1,170) = 16.02$, $p < .001$). We performed the same process on a noisy EDA sample collected from an individual diagnosed with autism. Two-way t test yielded no significant change in mean EDA ($t(696) = -1.21$, $p = .227$), however Levene's test for equal variance did show a $\Delta SD$ of -.079µS ($F(1,815) = 21.94$, $p < .001$).

### References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