

時序列的複雜度分析與其在生理監測的應用
**Multi-Scaled Entropy Analysis and its Application in
Medical Signal**

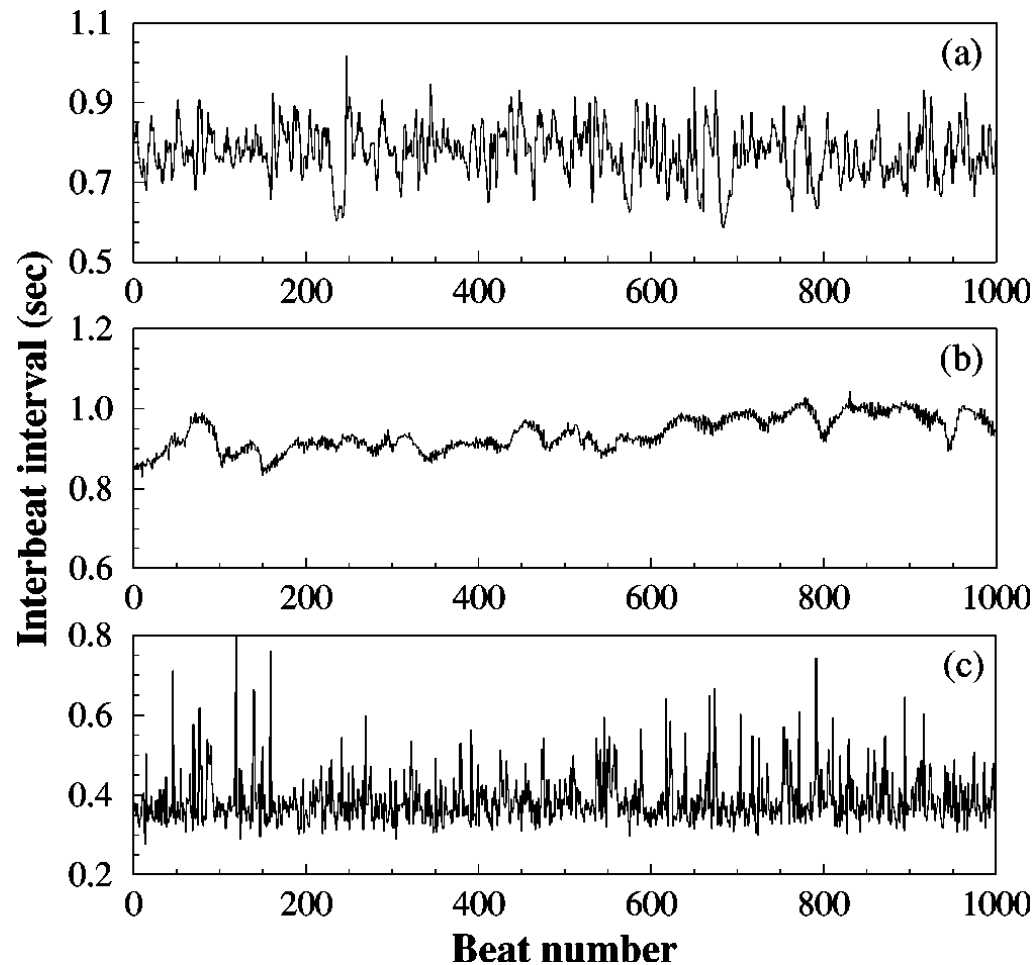
Yetmen Wang

2009/11/12

www.ancad.com.tw

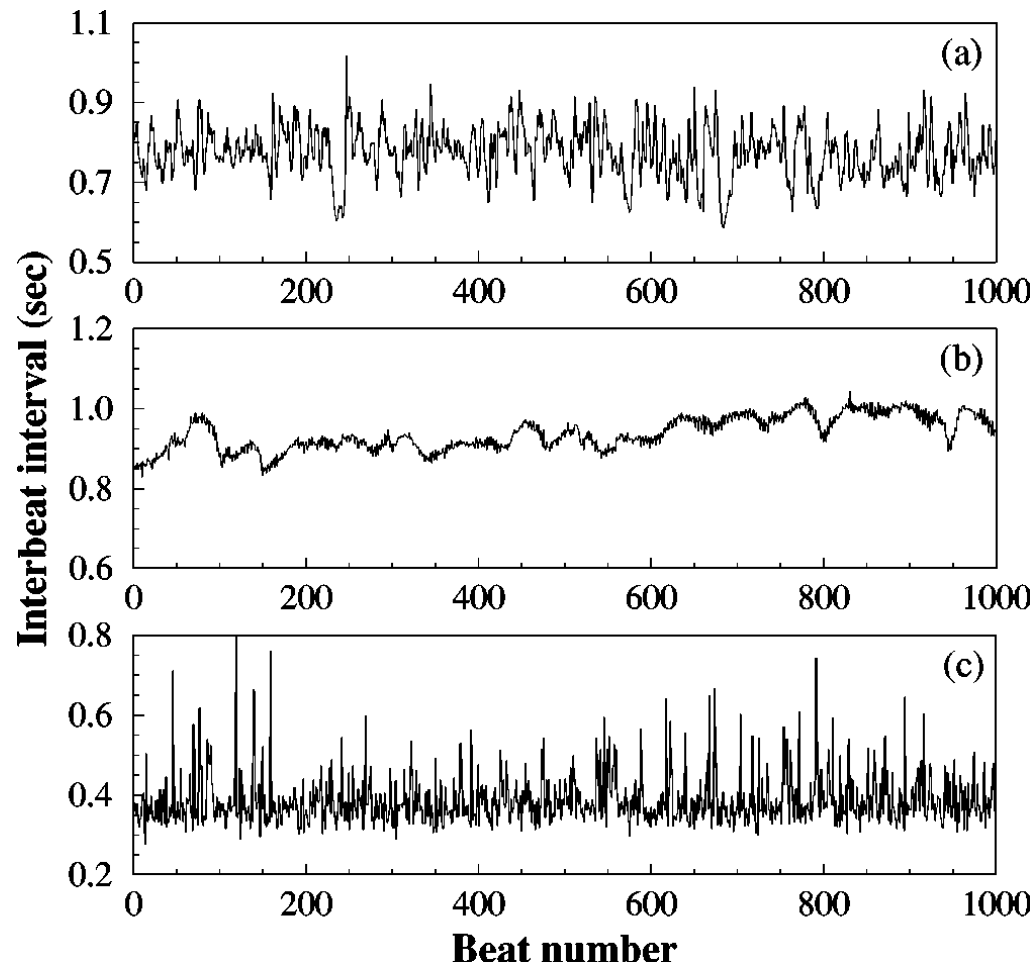
同中有異，異中存同

Which one is healthy?*



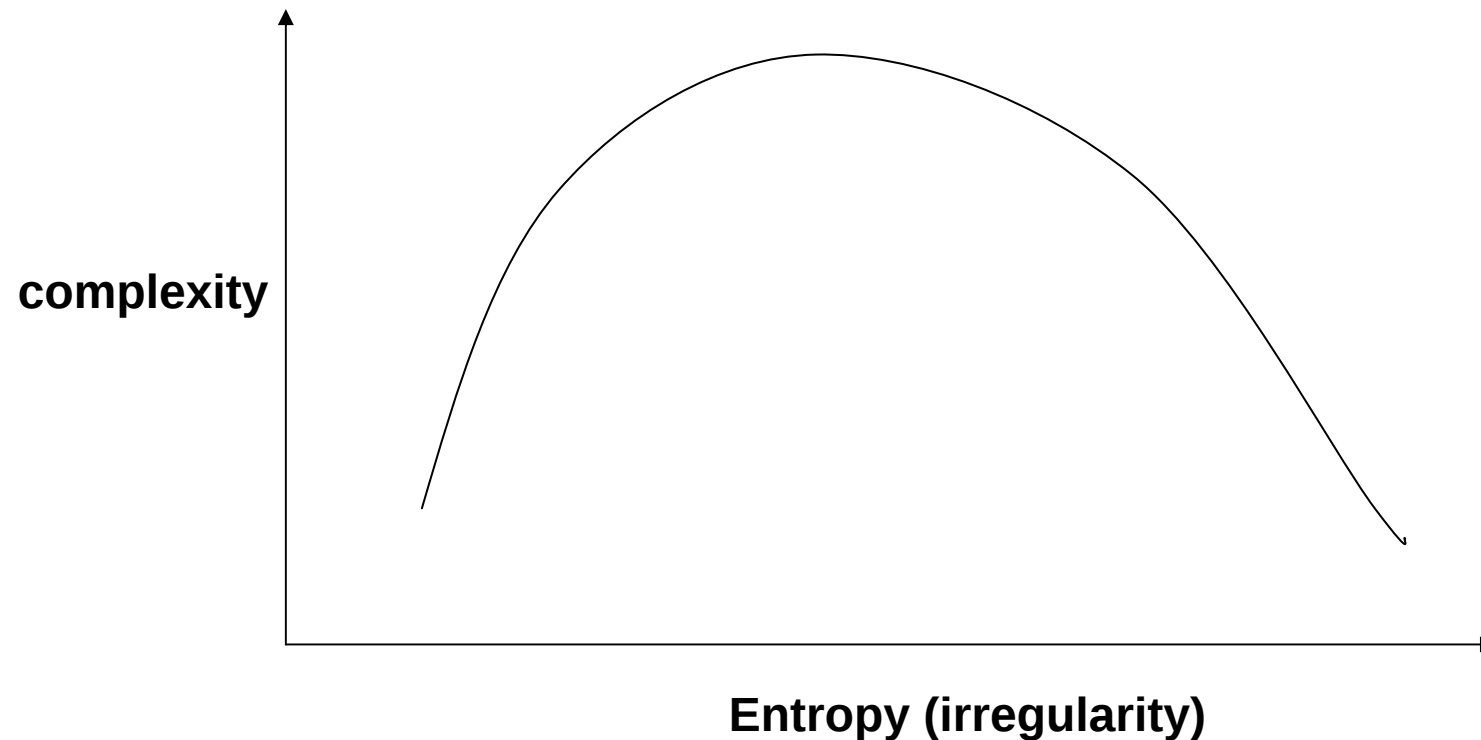
*Madalena Costa, Ary L. Goldberger and C.-K. Peng, 2005

Order vs. Disorder



*Madalena Costa, Ary L. Goldberger and C.-K. Peng, 2005

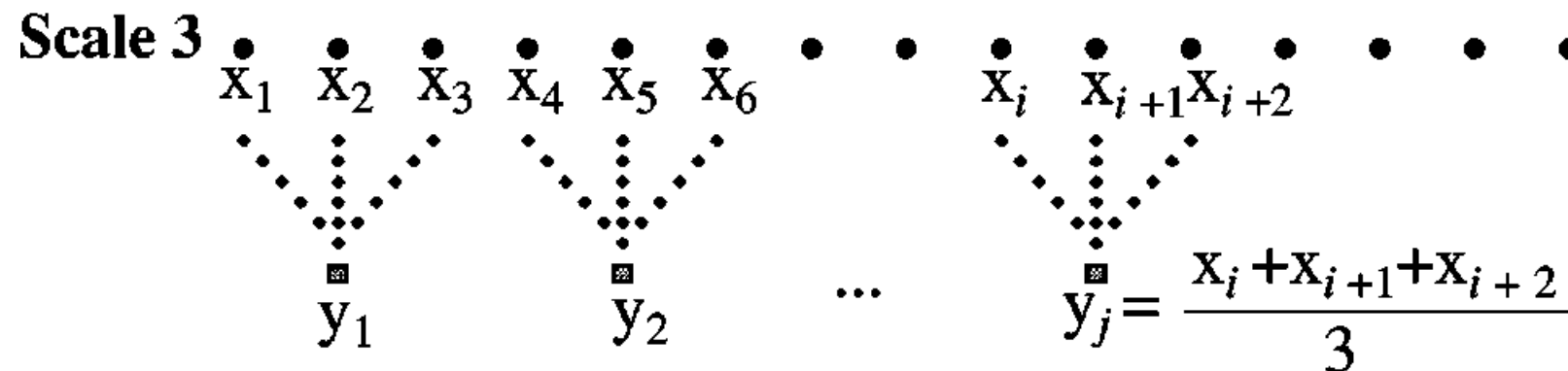
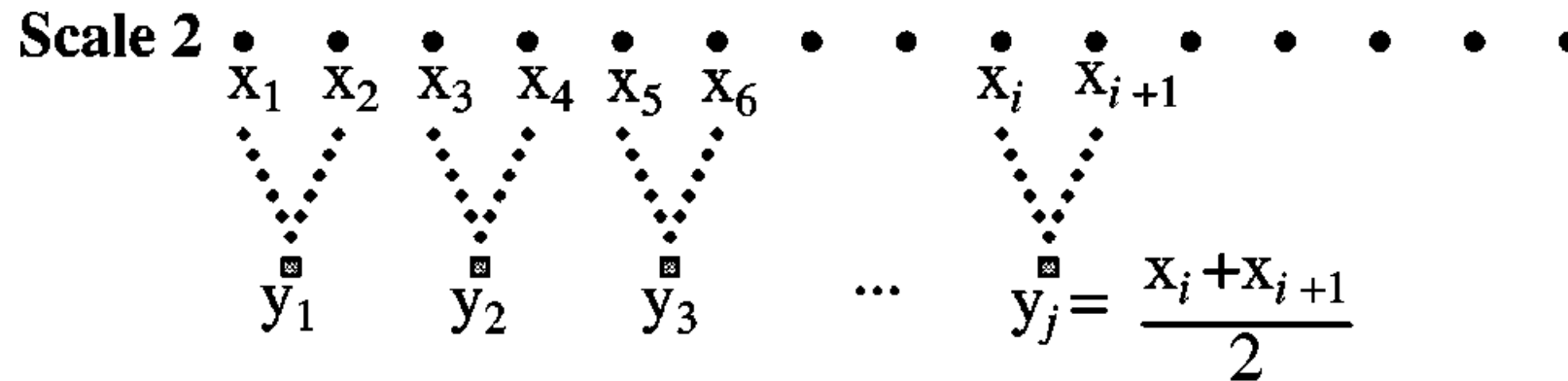
Complexity (health value) vs. Entropy



How to define complexity?

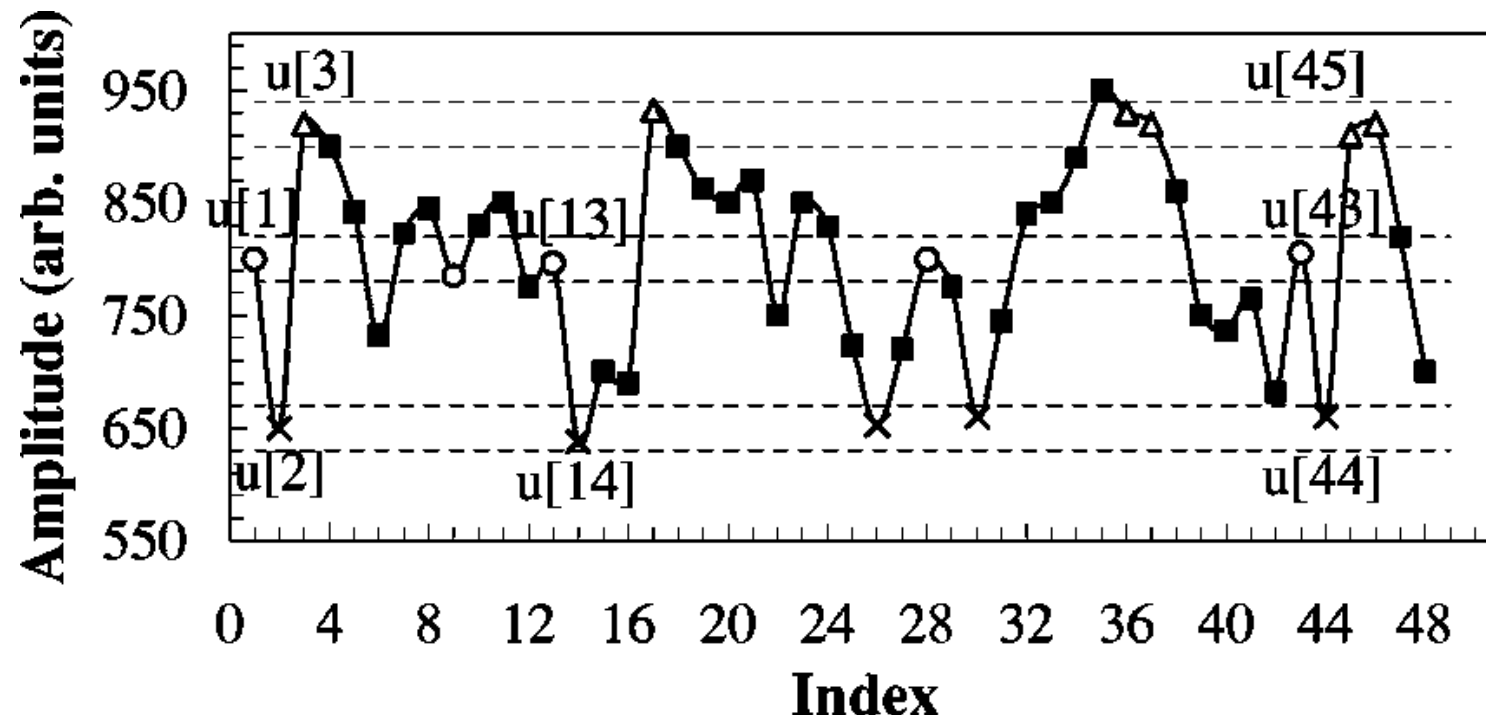
- Surface roughness of the Moon results in smooth look from the Earth. => Irregularity will be smoothed out through distant (scaled) perception.
- The irregular shape (fractal or self-similarity structure) of a tree remains the same in spite of distant or close look.
- Multi-Scale perception distinguishes the promethean system from irregularity.

Complexity: Multi-Scale Entropy*



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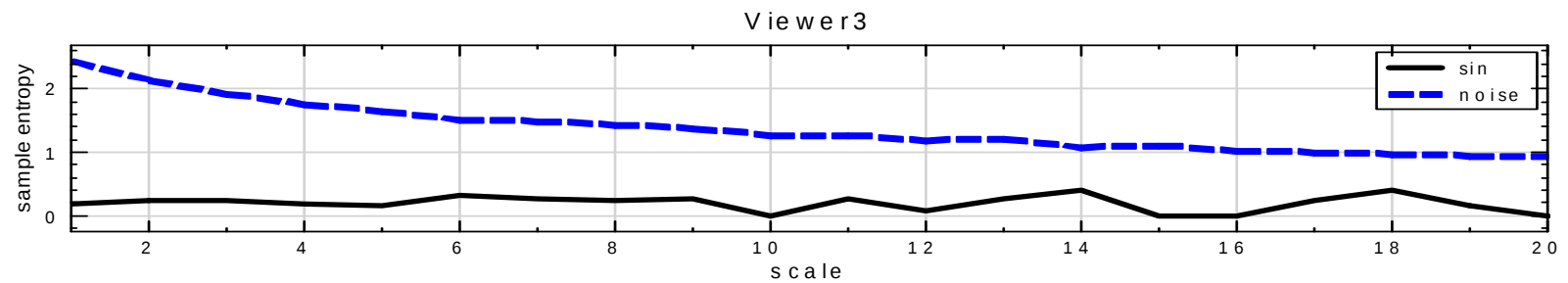
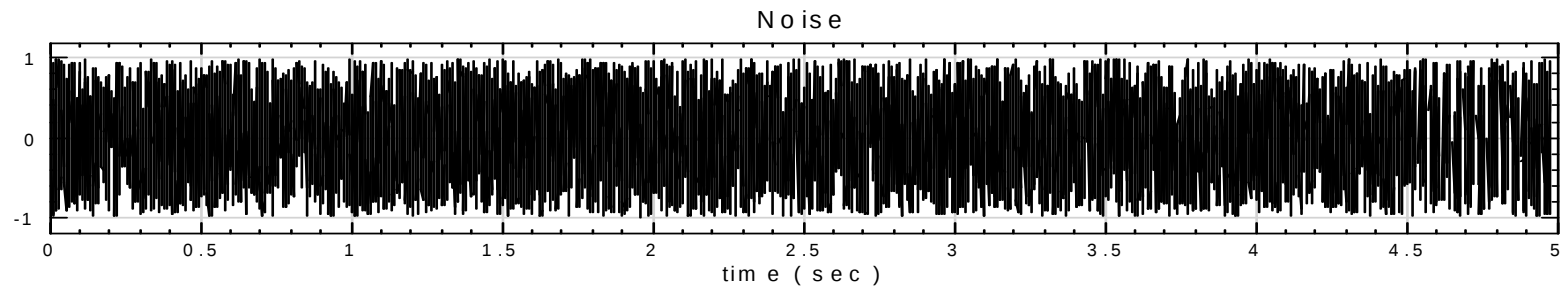
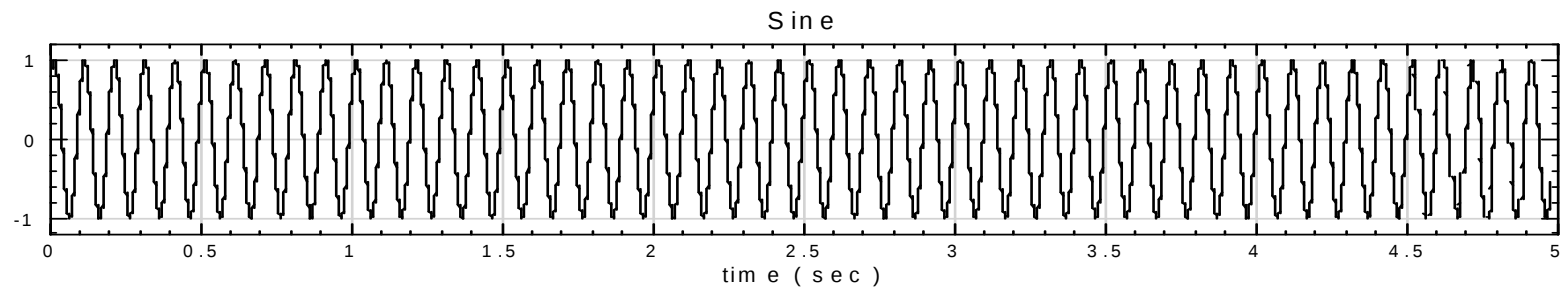
Sample Entropy: Measurement of self-similarity*



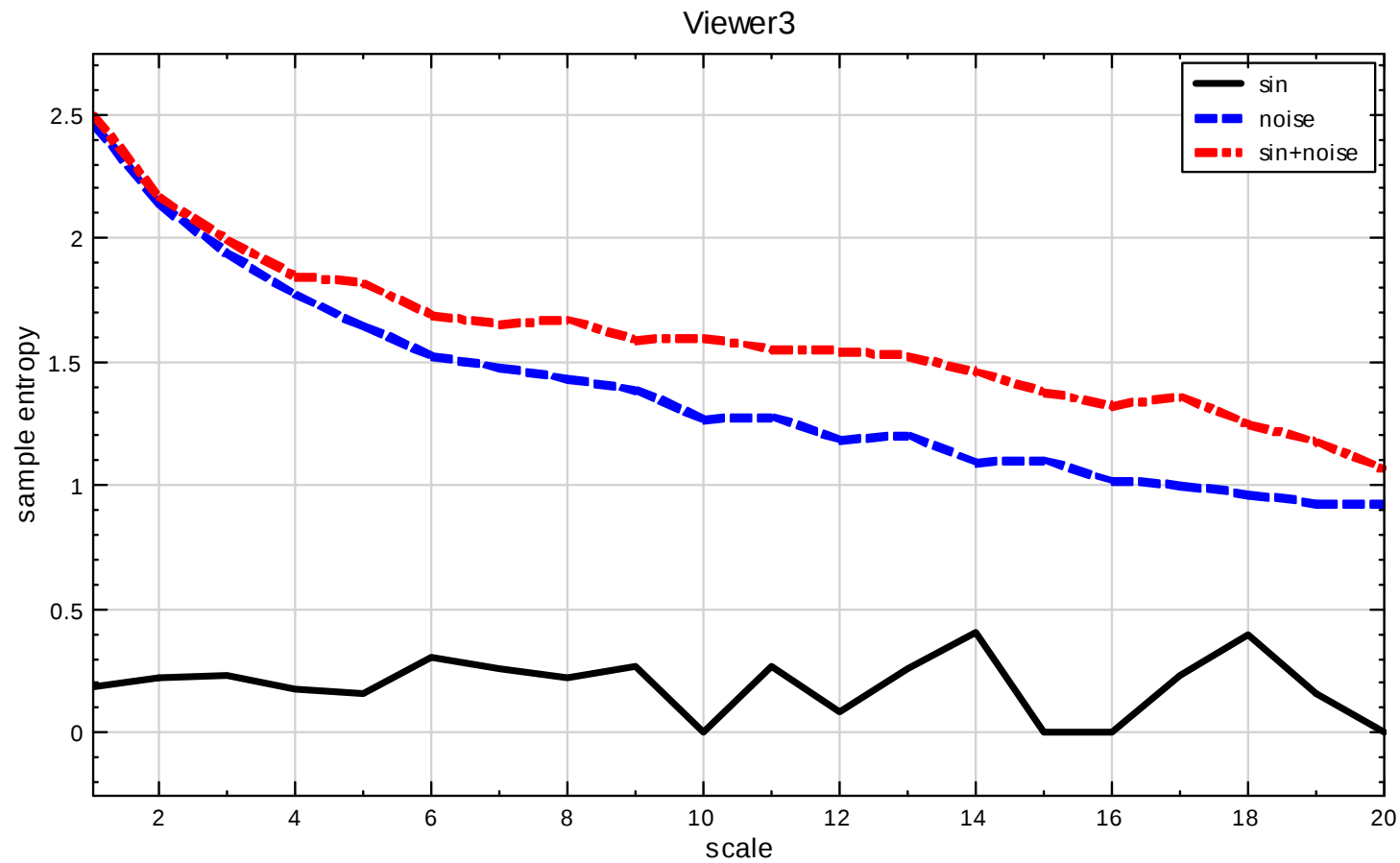
SE: the probability of which matching of two consecutive points suggests matching of three consecutive points.

*Madalena Costa, Ary L. Goldberger and C.-K. Peng, 2005

Order vs. disordered



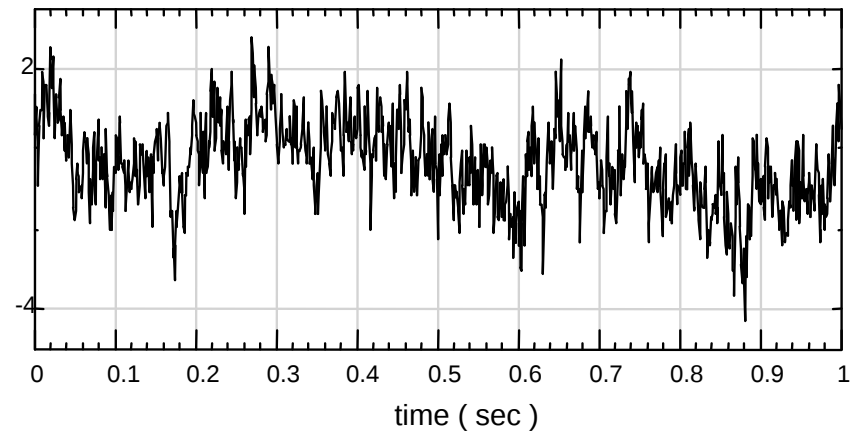
Mixed signal increases complexity



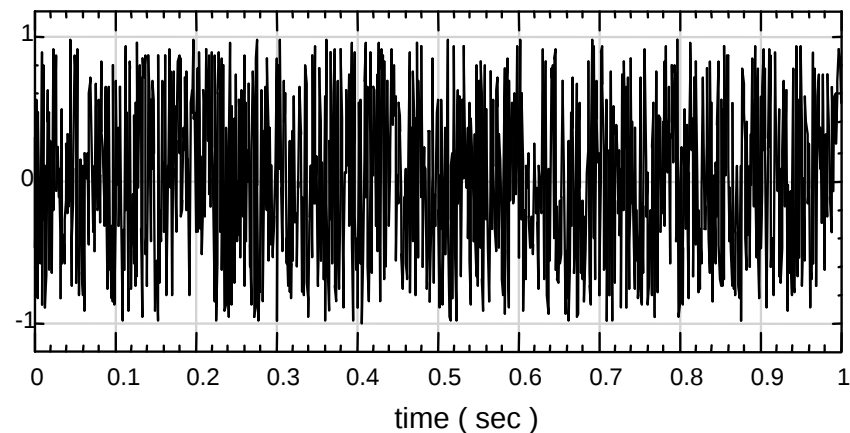
White Noise vs. Pink (1/f) Noise

- Pink noise
 - Correlated signal
 - Low frequency with high amplitude
- White noise
 - Uncorrelated
 - Amplitude the same whatever the frequency is

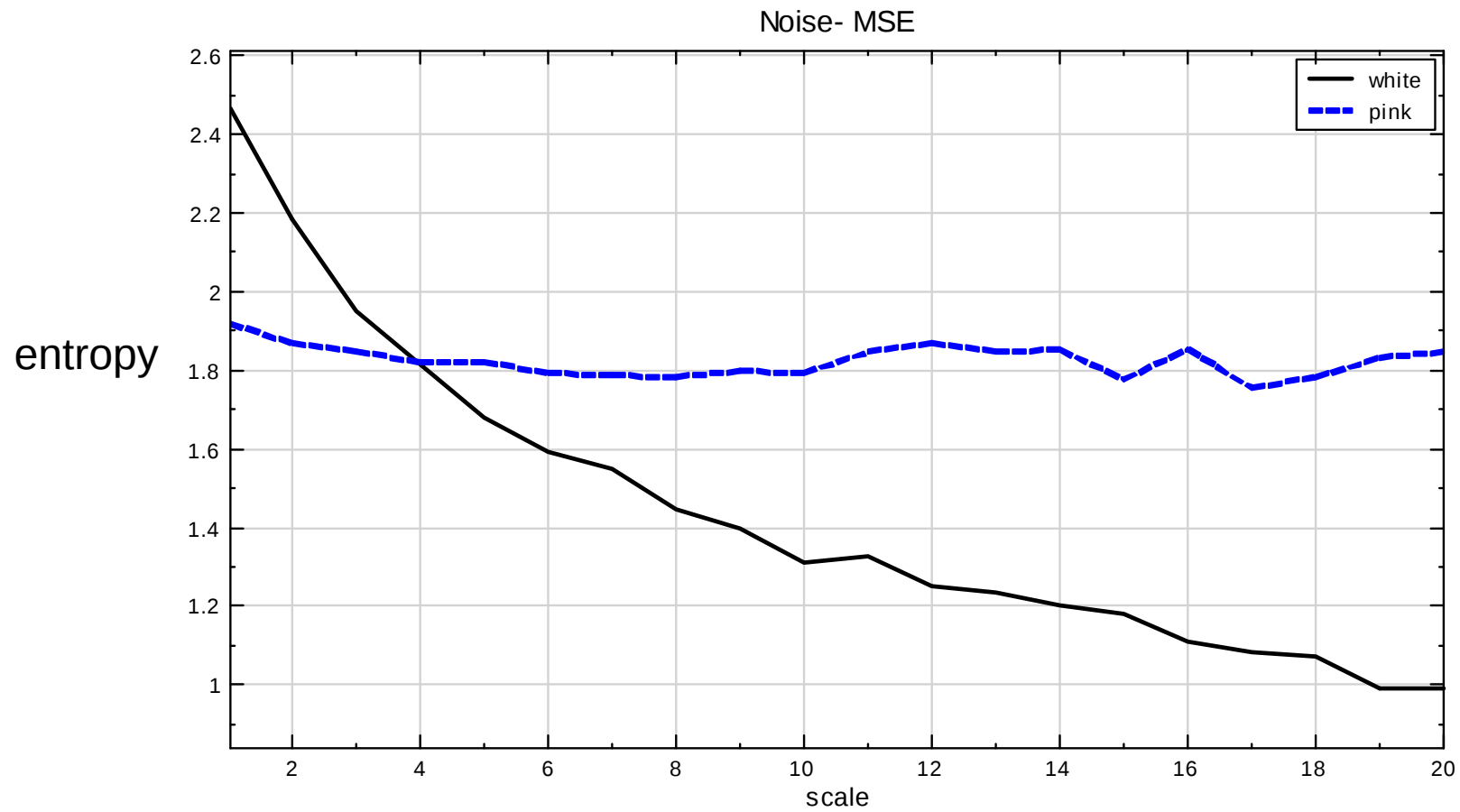
Pink Noise



White Noise

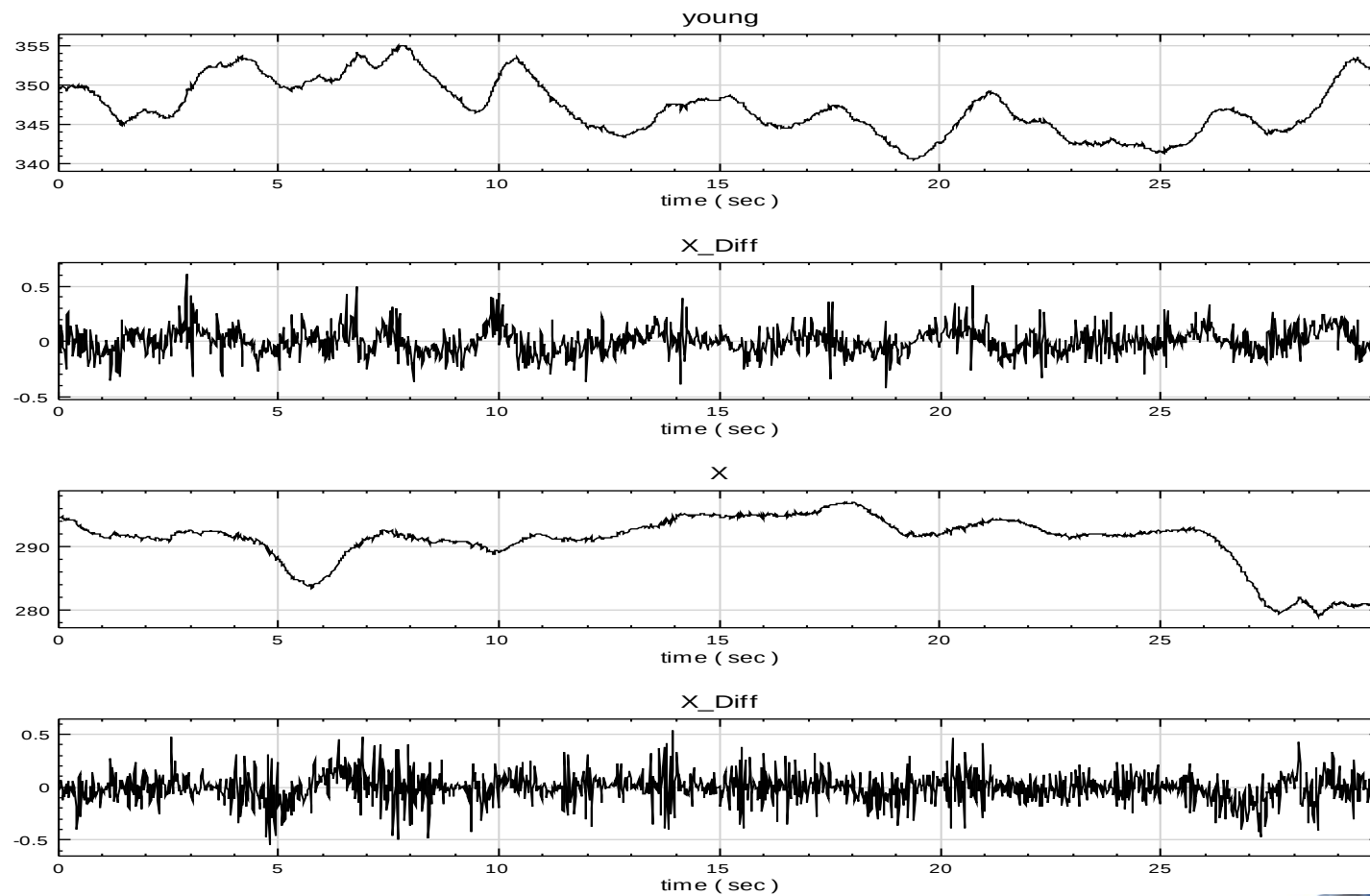


MSE: white vs. pink

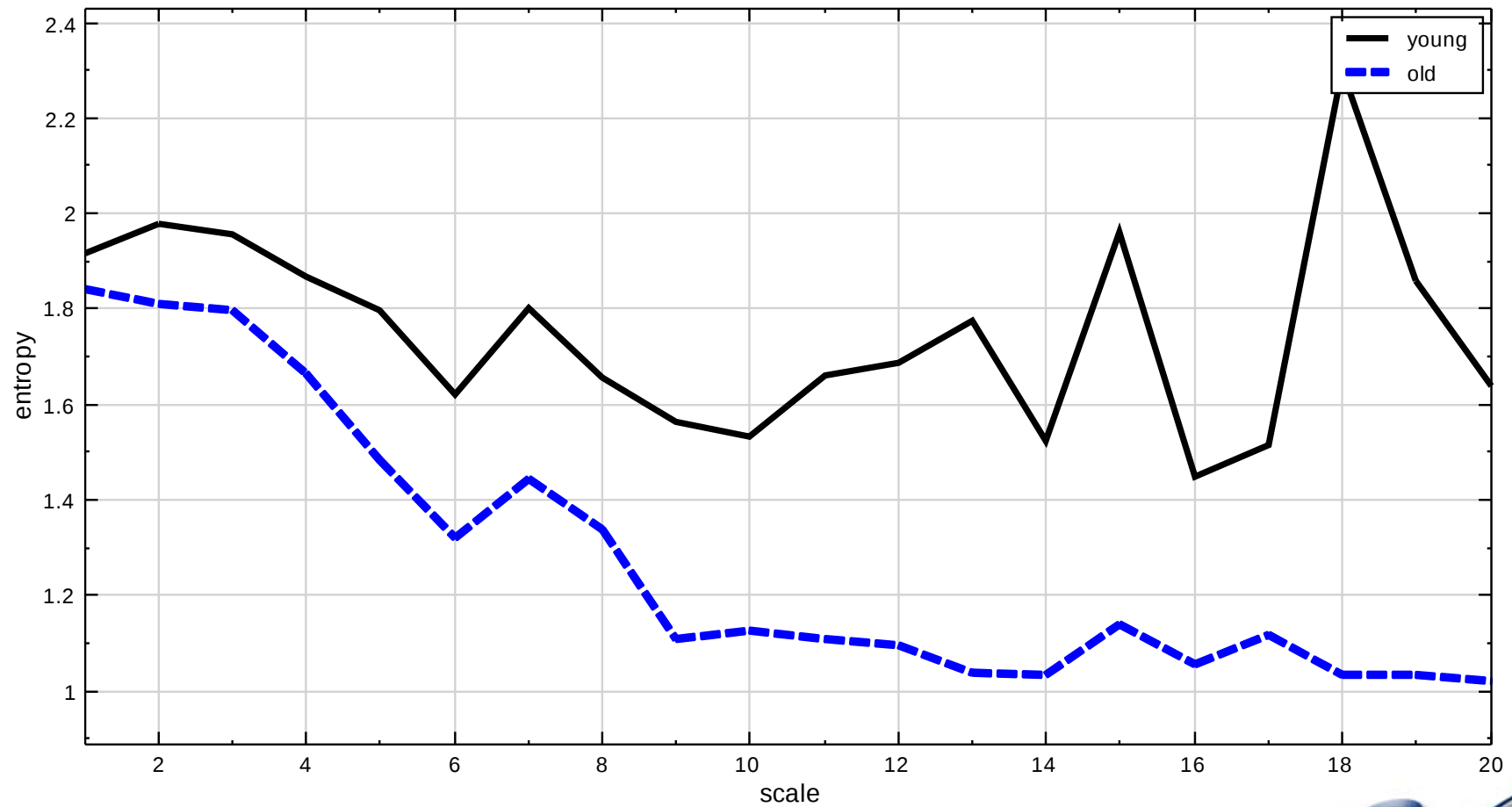


Center of Pressure Sway

COP Sway of the Young and the elderly

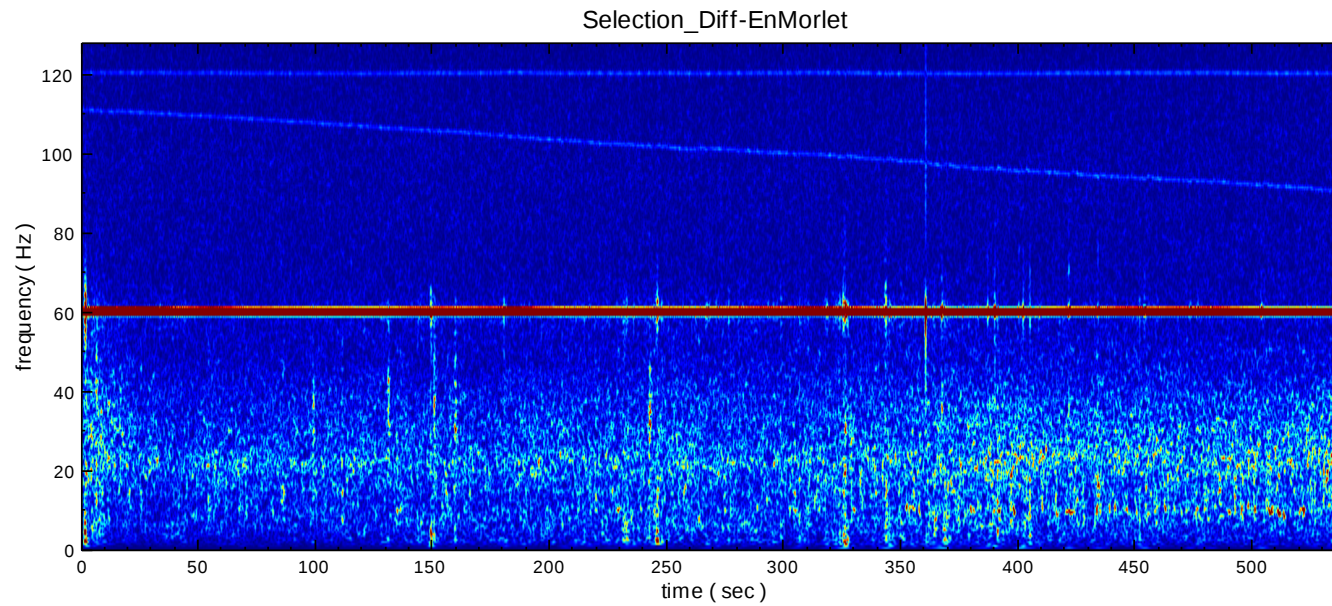
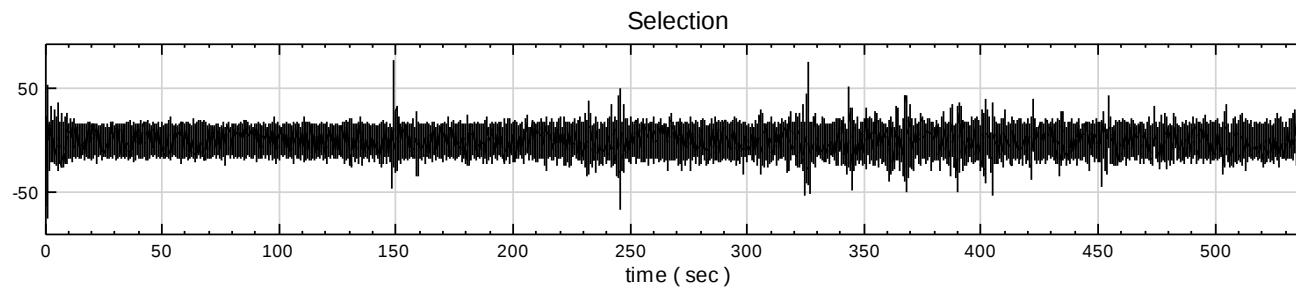


MSE Analysis of COP Sway



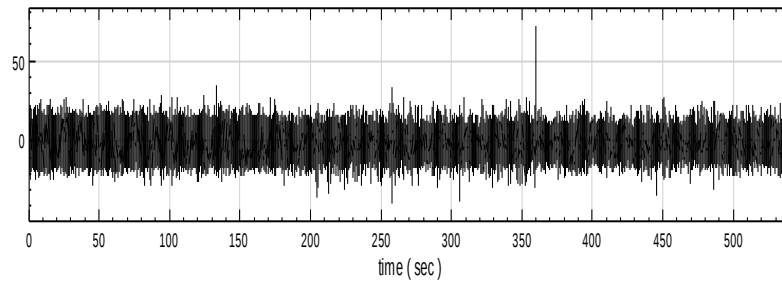
**Increase of complexity in brain wave
signal after days of meditation**

b1

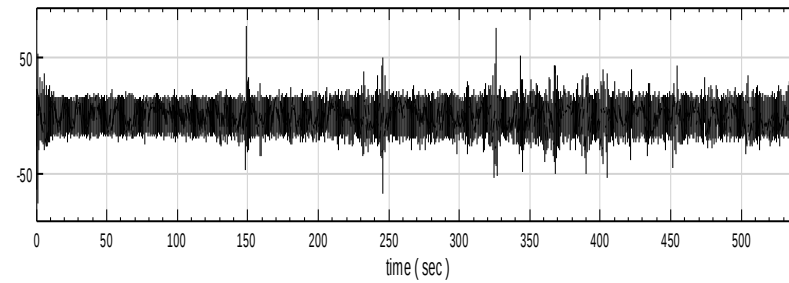


Bb1 vs b1

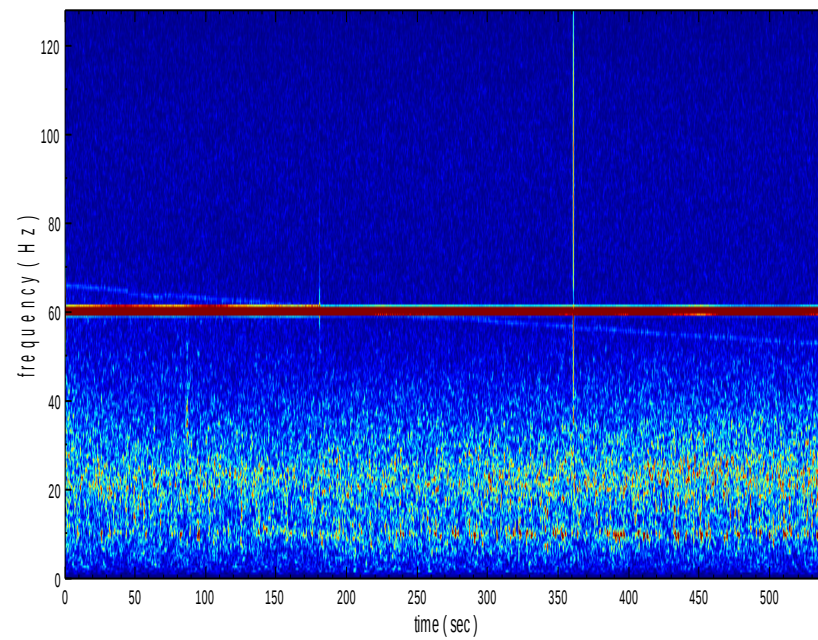
Selection



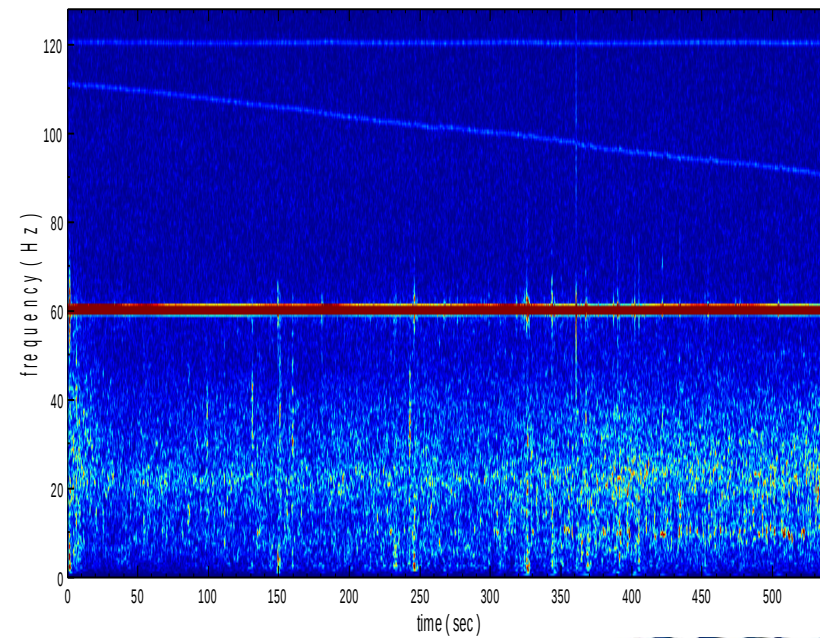
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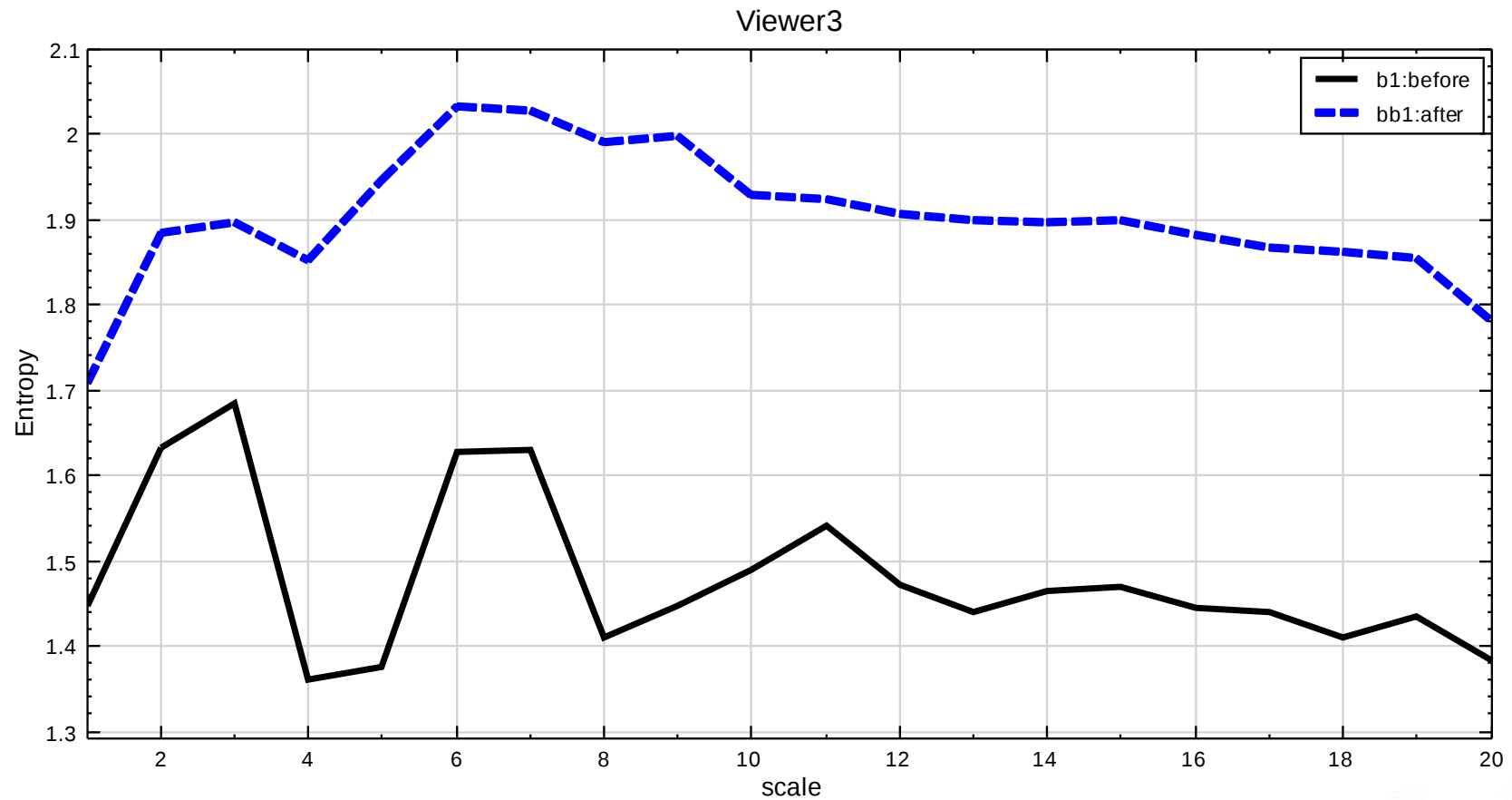
Selection_Diff-EnMorlet



Selection_Diff-EnMorlet

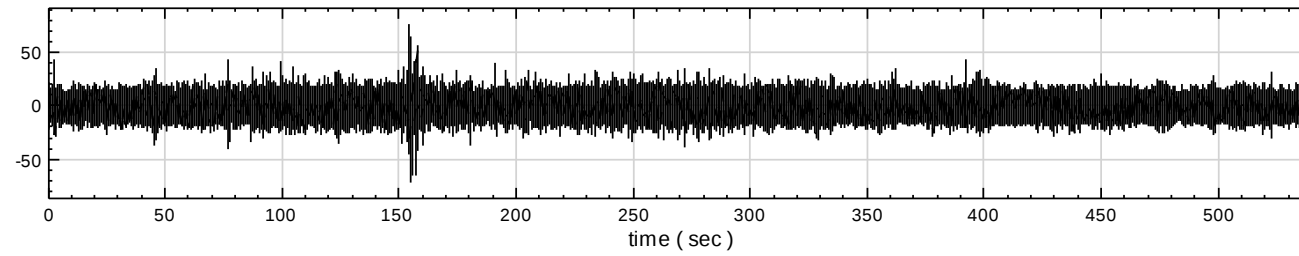


Complexity (MSE) Before and After Meditation

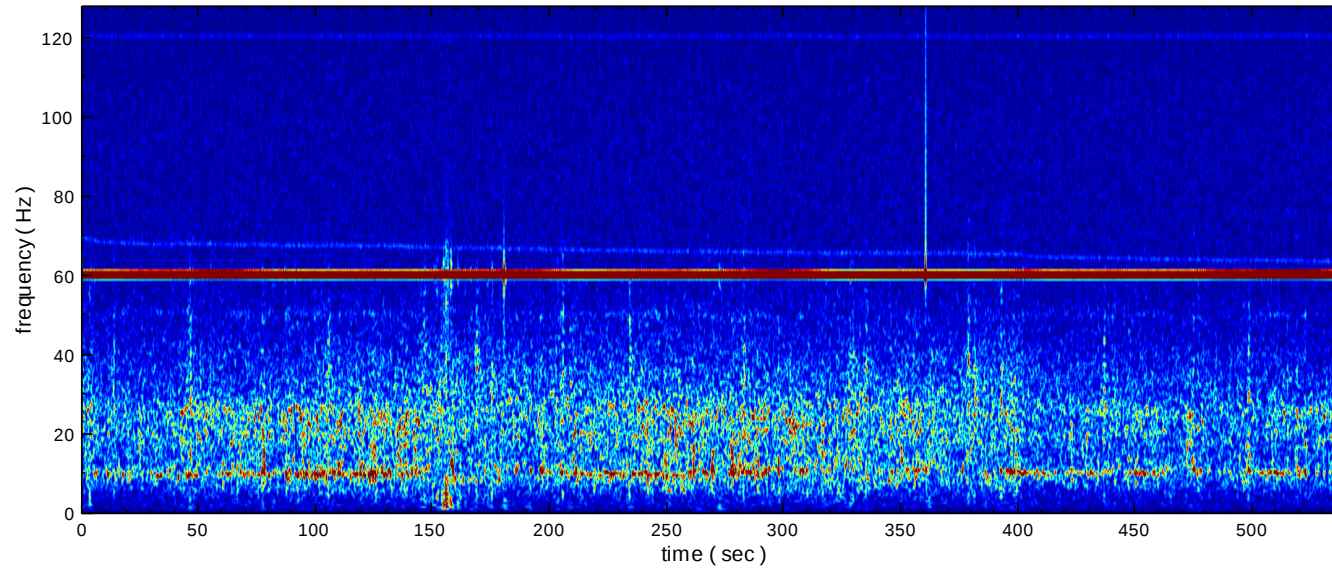


b17

Selection

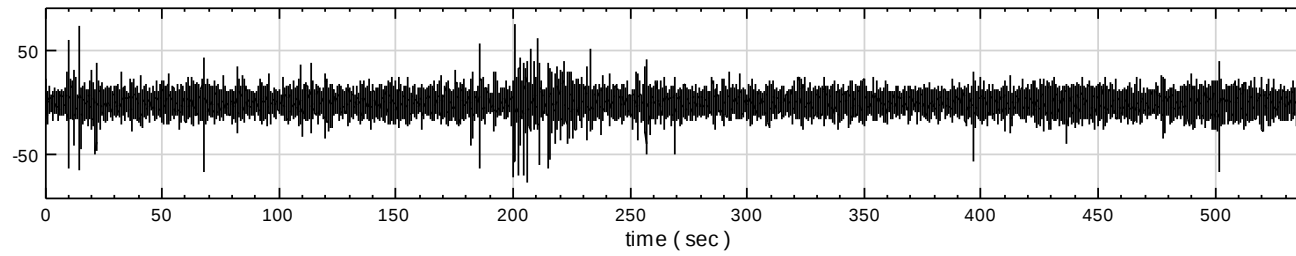


Selection_Diff-EnMorlet

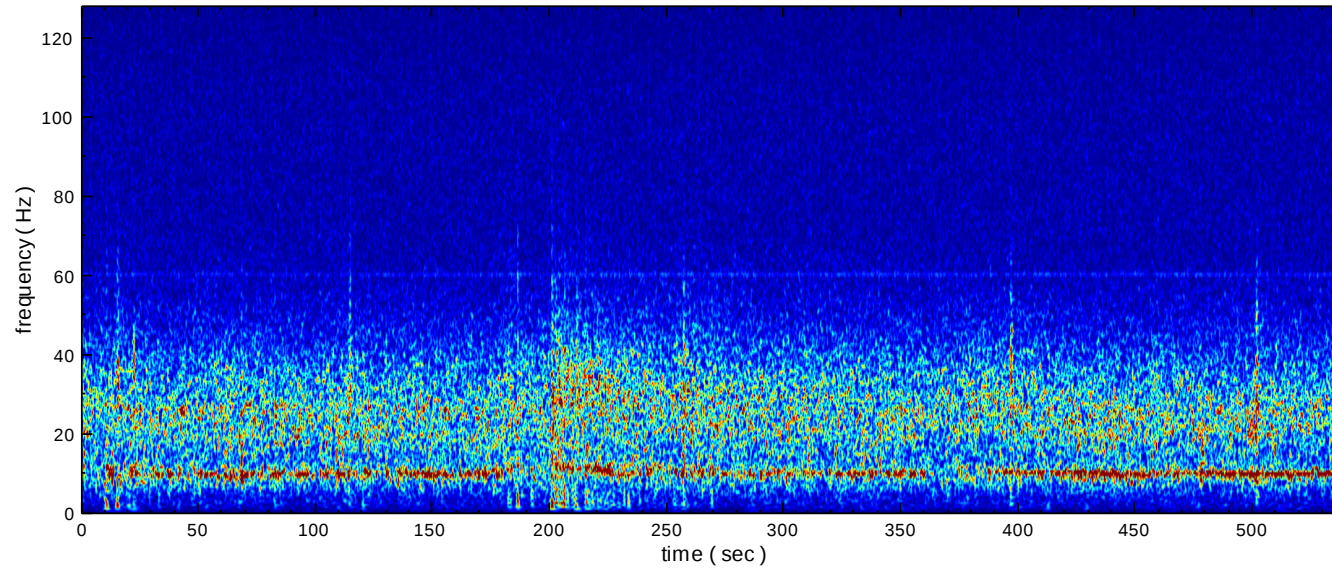


bb17

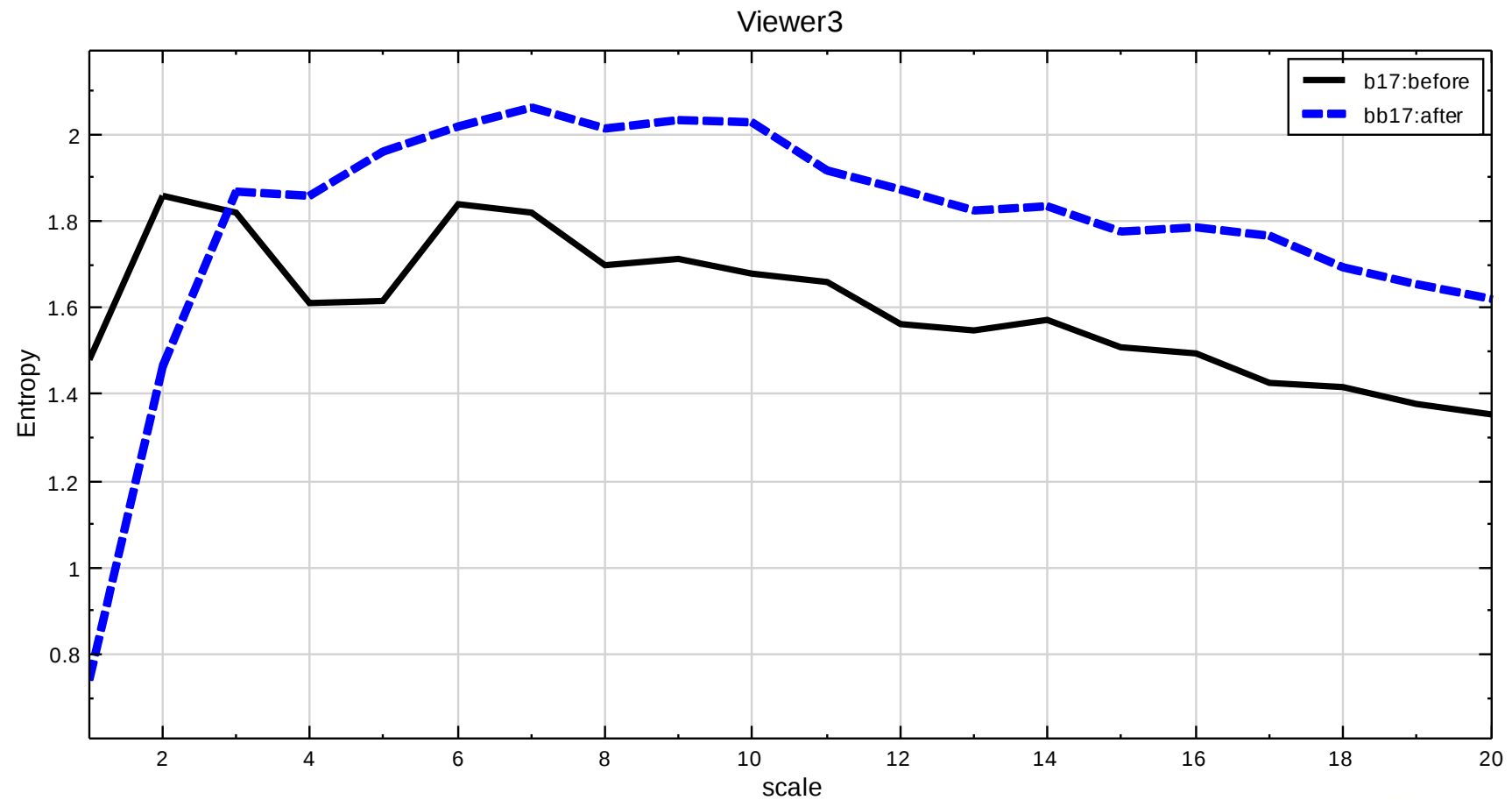
Selection



Selection_Diff-EnMorlet

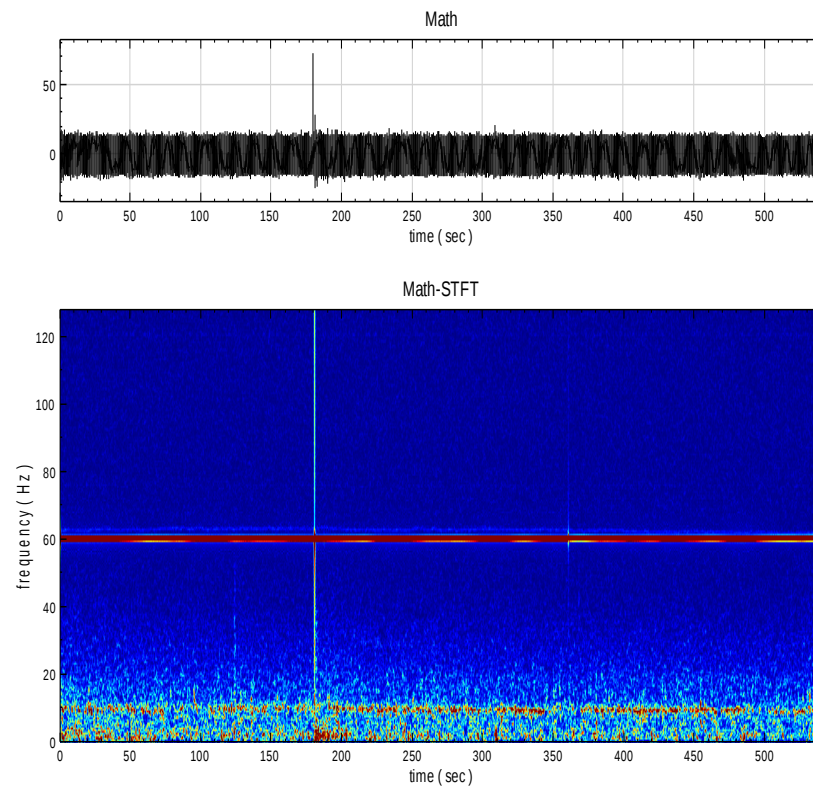


Complexity (MSE) Before and After Meditation

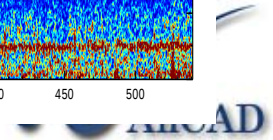
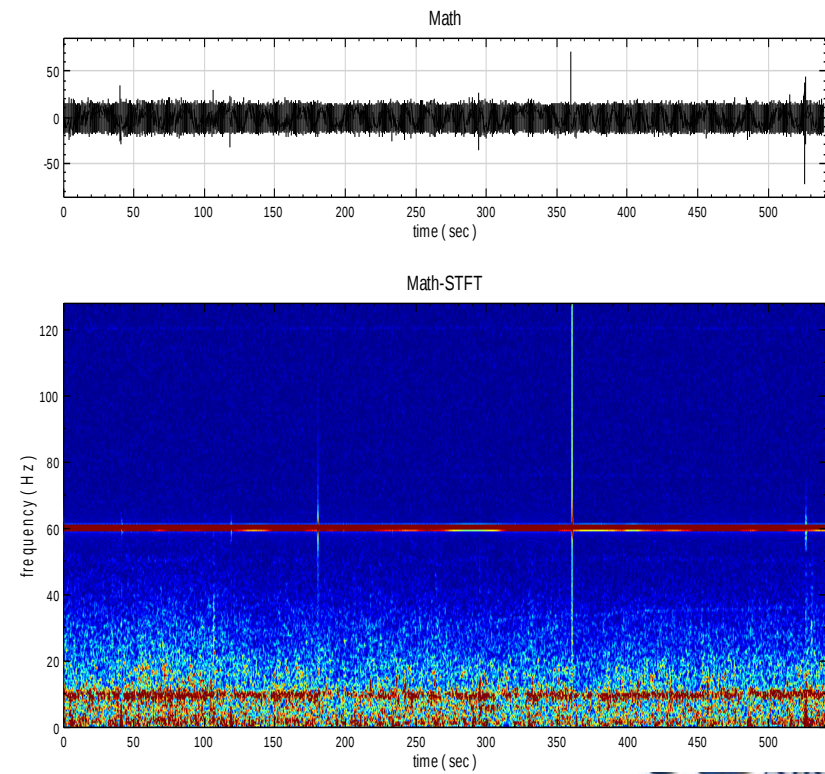




- d21

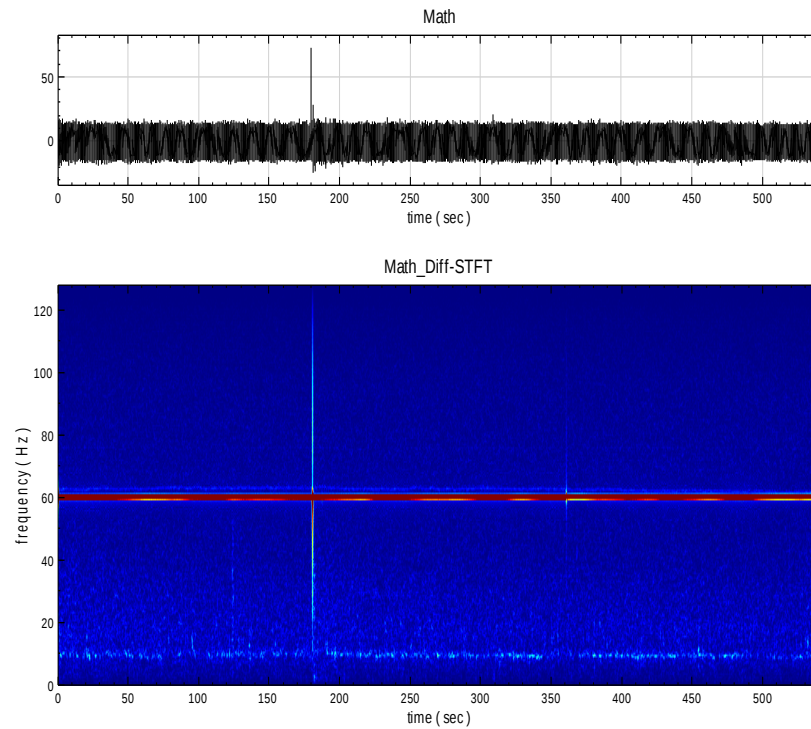


- dd21

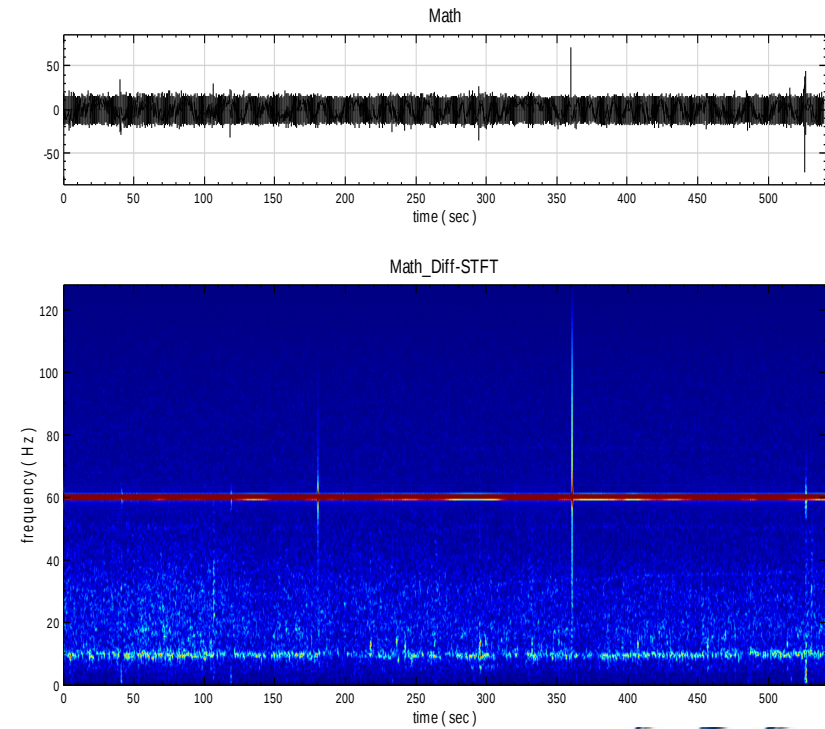


differential

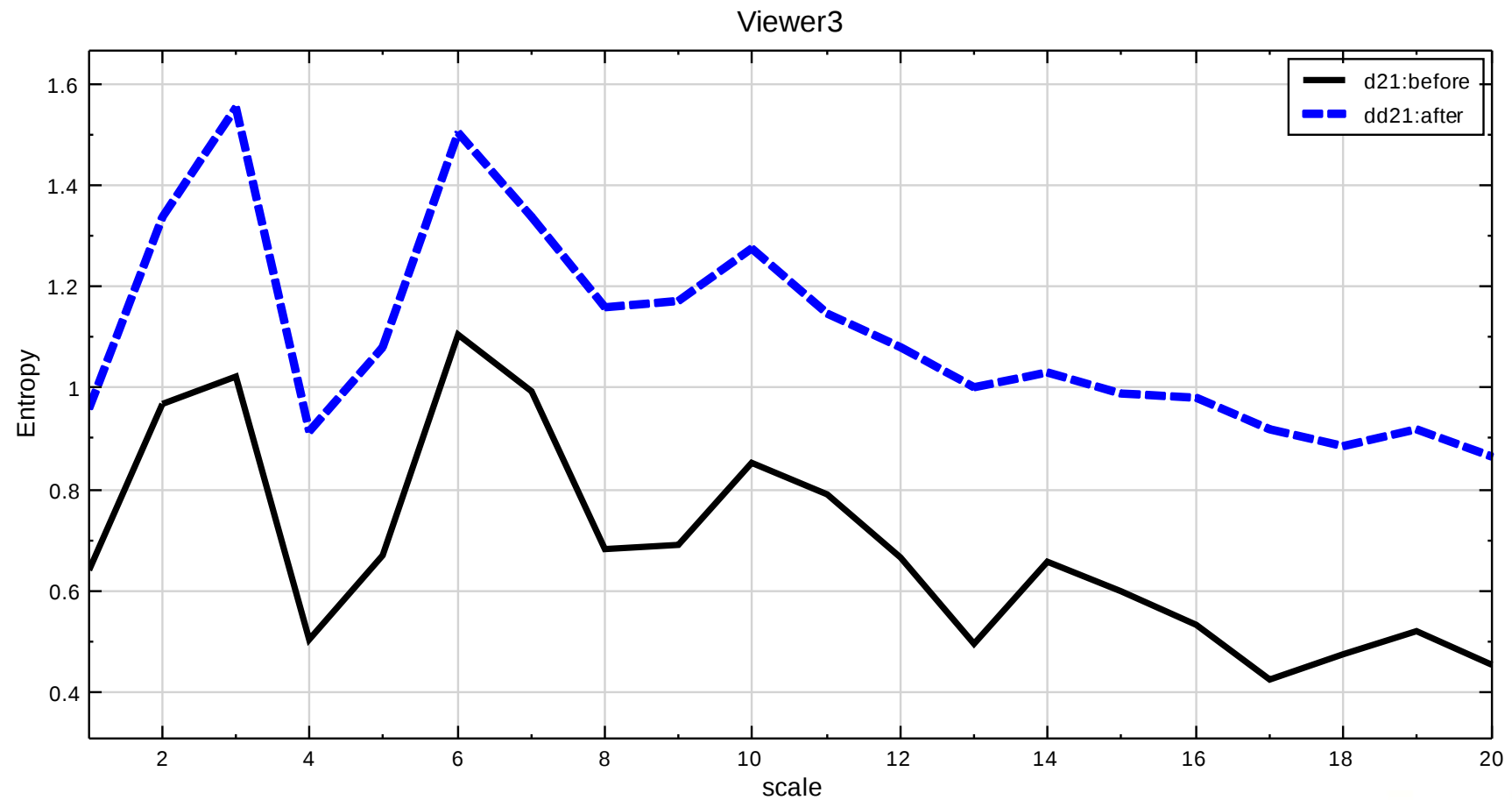
- d21



- dd21



Complexity (MSE) Before and After Meditation



Thank you!

