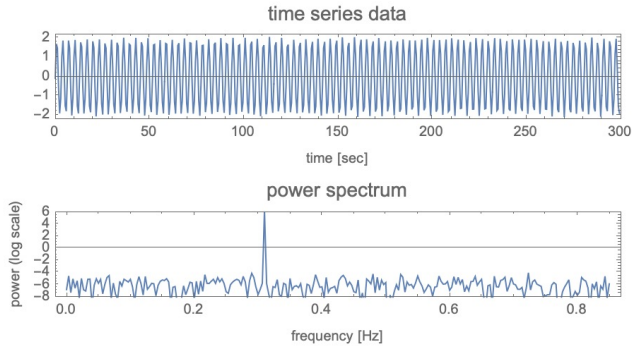
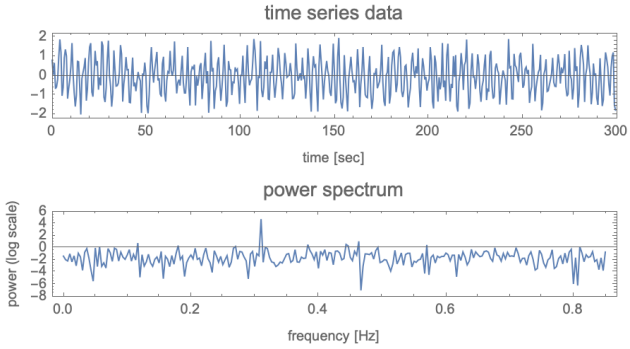
**a**




**b**




**c**

| | | a | | b |
|---|---|---|---|---|
| time-domain analysis | SDNN | 1.416 | > | 0.919 |
| | SDSD | 1.530 | > | 1.118 |
| | RMSSD | 1.530 | > | 1.118 |
| chaos/complexity analysis | CD | 1.286 | < | 2.067 |
| | ICD | 1.016 | < | 1.773 |
| | ApEn | 0.140 | < | 1.356 |
| | SampEn | 0.155 | < | 2.068 |

**Figure S1.** Independence of chaos/complexity analysis and conventional time-domain analysis. **(a)** A highly periodic wave generated by adding random numbers uniformly distributed in the interval $[-0.1, 0.1]$ to a sine wave with a frequency of 0.31 [Hz] and an amplitude of 2. **(b)** A highly irregular wave generated by adding random numbers uniformly distributed in the interval $[-1, 1]$ to a sine wave with a frequency of 0.31 [Hz] and an amplitude of 1. **(c)** SDNN, SDSD, RMSSD, CD, ICD, ApEn, SampEn of two time series data shown in (a) (b). Since time series data (a) is larger in amplitude and more periodic (less complex) than (b), SDNN, SDSD, and RMSSD take large values, while CD, ICD, ApEn, and SampEn are small. Conversely, time series data (b) has smaller amplitude and lower periodicity (higher complexity) than (a), so SDNN, SDSD, and RMSSD take small values, while CD, ICD, ApEn, and SampEn take large values. In other words, the chaos/complexity analysis indices (CD, ICD, ApEn, and SampEn) are independent of the time-domain analysis indices (SDNN, SDSD, and RMSSD) of the conventional analysis.

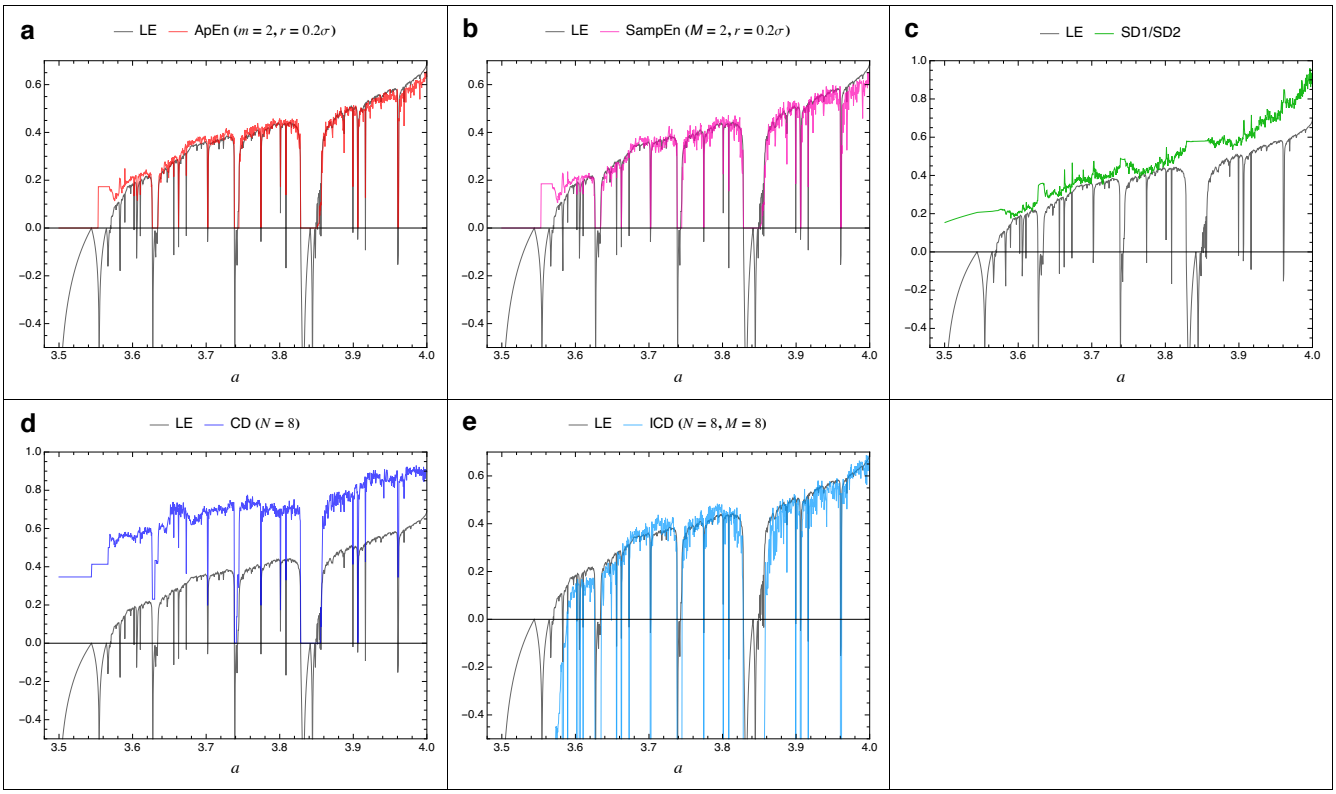



**Figure S2.** Comparison of Lyapunov exponent (LE) and chaos indices (ApEn, SampEn, SD1/SD2, CD, and ICD) of Logistic map. **(a)** ApEn and LE. **(b)** SampEn and LE. **(c)** SD1/SD2 and LE. **(d)** CD and LE. **(e)** ICD and LE. In each figure from (a) to (e), the black solid line shows LE of the logistic map, $x_{n+1} = ax_n(1 - x_n)$, at its control parameter $a$. Intervals where LE is positive are chaos region, and the larger LE is, the stronger chaos. In contrast, intervals where LE is negative are nonchaos region (i.e., the periodic region). ApEn and SampEn give good approximations of LE, but the computational complexity is $O(n^2)$ for data size $n$. CD has a numerical difference from LE, but it behaves almost the same as LE. ICD has a value closer to LE. The computational complexity of CD and ICD is $O(n)$ for data size $n$. Therefore, it is much more advantageous to use CD or ICD.

| | Experiment 1 | | | | | | Experiment 2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rest 1 | | Standing | | Cognitive Task 1 | | Rest 2 | | Cognitive Task 2 | |
| | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ | $\mu$ | $\sigma$ |
| **time-domain analysis** | | | | | | | | | | |
| SDNN | 55.96 | 21.58 | 51.59 | 20.82 | 45.23 | 14.92 | 57.32 | 23.71 | 52.67 | 26.34 |
| SDSD | 32.47 | 17.34 | 24.50 | 15.70 | 31.94 | 17.29 | 32.50 | 19.26 | 37.37 | 35.67 |
| RMSSD | 32.47 | 17.34 | 24.50 | 15.70 | 31.94 | 17.29 | 32.50 | 19.26 | 37.37 | 35.67 |
| pNN50 | 0.14 | 0.16 | 0.06 | 0.09 | 0.13 | 0.14 | 0.13 | 0.15 | 0.14 | 0.15 |
| **frequency-domain analysis** | | | | | | | | | | |
| LF | 490.43 | 431.95 | 520.07 | 596.89 | 313.69 | 273.44 | 494.51 | 403.34 | 776.33 | 3773.93 |
| HF | 197.22 | 196.92 | 121.45 | 185.78 | 143.79 | 195.73 | 184.47 | 219.93 | 221.78 | 557.75 |
| LF/HF | 3.93 | 3.35 | 7.02 | 5.91 | 3.30 | 2.51 | 4.48 | 4.23 | 3.62 | 2.63 |
| LFnorm | 71.56 | 15.30 | 81.08 | 11.69 | 70.20 | 13.28 | 72.47 | 17.12 | 71.86 | 13.87 |
| HFnorm | 28.44 | 15.30 | 18.92 | 11.69 | 29.80 | 13.28 | 27.53 | 17.12 | 28.14 | 13.87 |
| **chaos/complexity analysis** | | | | | | | | | | |
| ApEn | 1.13 | 0.15 | 1.00 | 0.21 | 1.22 | 0.14 | 1.11 | 0.14 | 1.19 | 0.14 |
| SampEn | 1.31 | 0.31 | 1.06 | 0.31 | 1.49 | 0.29 | 1.26 | 0.29 | 1.40 | 0.27 |
| Fractal Dimension | 1.76 | 0.09 | 1.67 | 0.10 | 1.82 | 0.09 | 1.74 | 0.11 | 1.79 | 0.08 |
| SD1/SD2 | 0.31 | 0.13 | 0.24 | 0.11 | 0.38 | 0.14 | 0.30 | 0.13 | 0.36 | 0.15 |
| CD | 1.94 | 0.23 | 1.74 | 0.26 | 2.08 | 0.22 | 1.92 | 0.22 | 2.03 | 0.20 |
| ICD | 1.34 | 0.21 | 1.16 | 0.23 | 1.48 | 0.20 | 1.33 | 0.20 | 1.43 | 0.19 |

**Table S1.** Index values as experimental results : Mean $\mu$ and standard deviation $\sigma$ of index values in each state in Experiment 1 and 2. Upper 4 indices: The indices included in the time-domain analysis. Middle 5 indices: The indices included in the frequency-domain analysis. Lower 6 indices: The indices included in the chaotic/complexity analysis. The number of data points (sample size) was 135 (= 27[participants] × 5[times])

| Index | (1) Rest 1 and Rest 2 | (2) Cognitive Task 1 and Cognitive Task 2 |
|---|---|---|
| **time-domain analysis** | | |
| SDNN | 0.87 | 0.0134 |
| SDSD | 0.976 | 0.247 |
| RMSSD | 0.975 | 0.247 |
| pNN50 | 0.827 | 0.251 |
| **frequency-domain analysis** | | |
| LF | 0.693 | 0.000174 |
| HF | 0.779 | 0.0148 |
| LF/HF | 0.337 | 0.205 |
| LFnorm | 0.337 | 0.205 |
| HFnorm | 0.338 | 0.205 |
| **chaos/complexity analysis** | | |
| ApEn | 0.169 | 0.0259 |
| SampEn | 0.139 | 0.00134 |
| Fractal Dimension | 0.244 | 0.00555 |
| SD1/SD2 | 0.612 | 0.159 |
| CD | 0.301 | 0.00635 |
| ICD | 0.333 | 0.00899 |

**Table S2.** P-values as the result of the statistical significance test between Rest 1 and Rest 2 conditions and between Cognitive Task 1 and Cognitive Task 2 conditions. (1) Comparison between Rest 1 and Rest 2. (2) Comparison between Cognitive Task 1 (mental arithmetic) and Cognitive Task 2 (Sudoku). Upper 4 indices: The indices included in the time-domain analysis. Middle 5 indices: The indices included in the frequency-domain analysis. Lower 6 indices: The indices included in the chaotic/complexity analysis. We investigated whether there was a significant difference between the Rest of Experiment 1 and Experiment 2 and whether there was a significant difference between the Cognitive Task of Experiment 1 and Experiment 2. Considering the p-values listed in the table comprehensively, no difference was considered to be between Rest 1 and Rest 2 or between Cognitive Task 1 and Cognitive Task 2. Since there was no correspondence between the data in Experiment 1 and Experiment 2, the Mann-Whitney U test was used for the statistical significance test.