Habitual swimming exercise induced partial resistance to rat Alzheimer's disease

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Objective In MSSE, we have divided male 2.5-month-old Sprague-Dawley rats into the following 4 groups: control (C), habitual swimming (SW), Alzheimer's disease (AD) induction without swimming (AD), and habitual swimming and then AD induction (SA), and found the perfect resistance of habitual swimming to AD induction by using the P value statistics of the 5 behavior parameters of rats and the 23 physiological and biochemical parameters of their hippocampus. The topological difference of four groups were further calculated in this paper by using quantitative difference (QD) and self-similar approach.

Methods 1. The logarithm to base golden section τ (lt) is called golden logarithm. It was found that $\sigma = lt\sigma \approx 0.710439287156503$. 2. For a process from x_1 to x_2, $l_x(1,2) = lt(x_2/x_1)$ and its absolute vale are called the process logarithm and its QD, $QD_x(1,2)$. There are QD threshold values $(\alpha_x, \beta_x, \gamma_x)$ of function x which can be calculated in terms of σ. The function x is kept to be constant if $QD_x(1,2) < \alpha_x$. A function in/far from its function-specific homeostasis is called a normal/dysfunctional function. A normal function can resist a disturbance under its threshold so that $QD_x(1,2) < \beta_x$. A dysfunctional function is defined as the QD is significant if $\beta_x \leqq QD_x(1,2) < \gamma_x$ and extraordinarily significant if $QD_x(1,2) \geqq \gamma_x$. 3. Self-similarity was studied in the fractal literature: a pattern is self-similar if it does not vary with spatial or temporal scale. First-order self-similarity condition leads to the power law between two data sets A = $\{x_i\}$ and B = $\{y_i\}$; $y_i = a_i x_i$ if the QD_i of a_i and the average of $\{a_i\}$ is smaller than $\beta_{min} = min\{\beta_i\}$ and the average QD of $\{QD_i\}$ is smaller than $\alpha_{min} = min\{\alpha_i\}$. 4. The σ algorithm for integrative biology was established based on high-order self-similarity. Those parameters that contribute to the topological difference were the biomarkers.

Results The 28 dimension data set consisted of all the 28 parameters. The first-order self-similarity held true for the 28 dimension data sets between groups C and SW. The topological algorithm of other groups suggested three AD biomarkers, protein carbonyl, granules density of presynaptic synaptophysin in the hippocampal CA1 and malondialdehyde intensity. The first two biomarkers were completely reversed by exercise pretreatment, but the third biomarker was partially reversed.

Conclusions Exercise pretraining exerts partial benefits on AD that support its use as a promising new therapeutic option for prevention of neurodegeneration in the elderly and/or AD population.