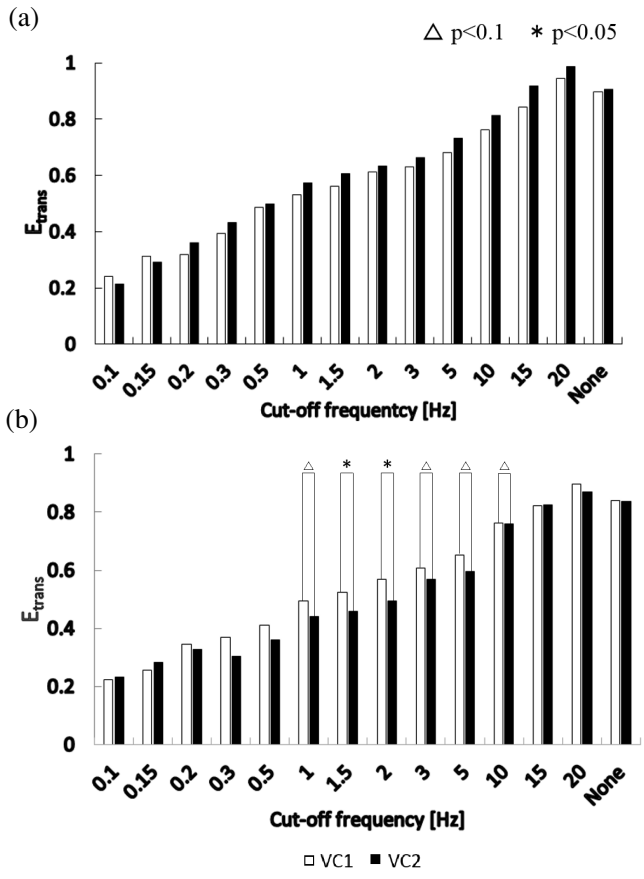

Fig. 8. Lateral translation errors for each stabilogram component while viewing VCs: (a) translation error estimated from time series body sway data and (b) translation error estimated from sequences of their temporal differences.

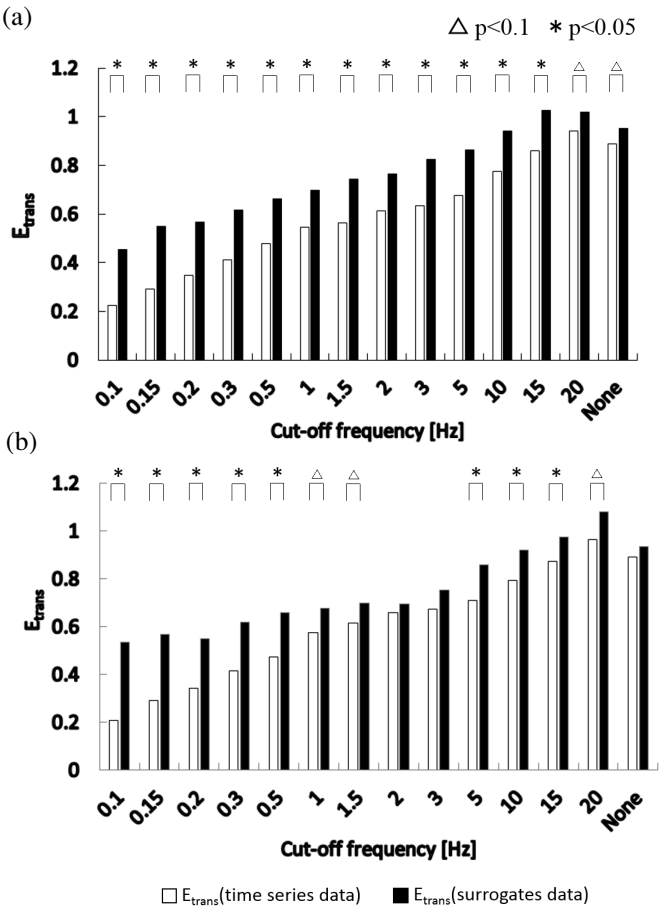

Fig. 9. Lateral translation errors estimated from each stabilogram component and their surrogate data (a) while viewing VC1 and (b) while viewing VC2.

translation errors estimated from the sequences of temporal differences with those obtained from their surrogate time series (Fig. 7b).

4.2 Experiment 2

The translation errors were estimated from the time series body sway data for the X component (lateral direction) and Y component (anterior/posterior direction) while viewing VC1 and VC2, respectively. Significance was not observed in the translation error values estimated from the time series data. For the lateral direction, by setting the cut-off frequency of the low-pass filtering to 1.5 and 2 Hz, significant differences were observed in the values of the translation error E_{trans}' estimated from the differences between the time series data recorded while viewing VC1 and those recorded while viewing VC2 (Fig. 8).

When the cut-off frequency of the low-pass filtering was set to 1–10 Hz, the values of the translation error E_{trans}' that were recorded while viewing VC1 tended to be different from those recorded while viewing VC2. However, statistical significance was not found in the the anterior/posterior direction.

The translation error values estimated from the surrogate data were compared with those obtained from each stabilogram component while viewing the VCs (Fig. 9).

By setting the cut-off frequency of the low-pass filtering to 0.1–0.5, 5, and 10 Hz, significant differences were observed between the values of the translation error while viewing VC2. Additionally, by setting the cut-off frequency of the low-pass filtering to 1, 1.5, 10, and 15 Hz, significant differences tended to exist between the translation error values (Fig. 9b). Hence, the nonlinearity of the mathematical body sway model could only be determined if the cut-off frequency was set to the abovementioned condition. Moreover, the nonlinearity of the mathematical model of the body sway while viewing the VC1 (Fig. 9a) could not be found in the results of statistical comparisons while viewing the VC2 (Fig. 9b).

5. Discussion

This study conducted nonlinear analysis for the cerebral hemodynamics and body sway. Additionally, we successfully determined the cut-off frequency of the low-pass filtering, from which the nonlinear stochastic differential equations were obtained as the mathematical models of the abovementioned bio-signals. Generally, the cut-off frequency in common was considered to be suitable for nonlinear analysis.

The BFT is also known as a countermeasure for patients with intractable epilepsy and as a method of reducing mental stress [28, 29]. Although an objective evaluation method has not yet been established, subjective evaluation has been