Comparison of vestibular input statistics during natural activities and while piloting an aircraft

Running title: Vestibular inputs in natural activities and while piloting

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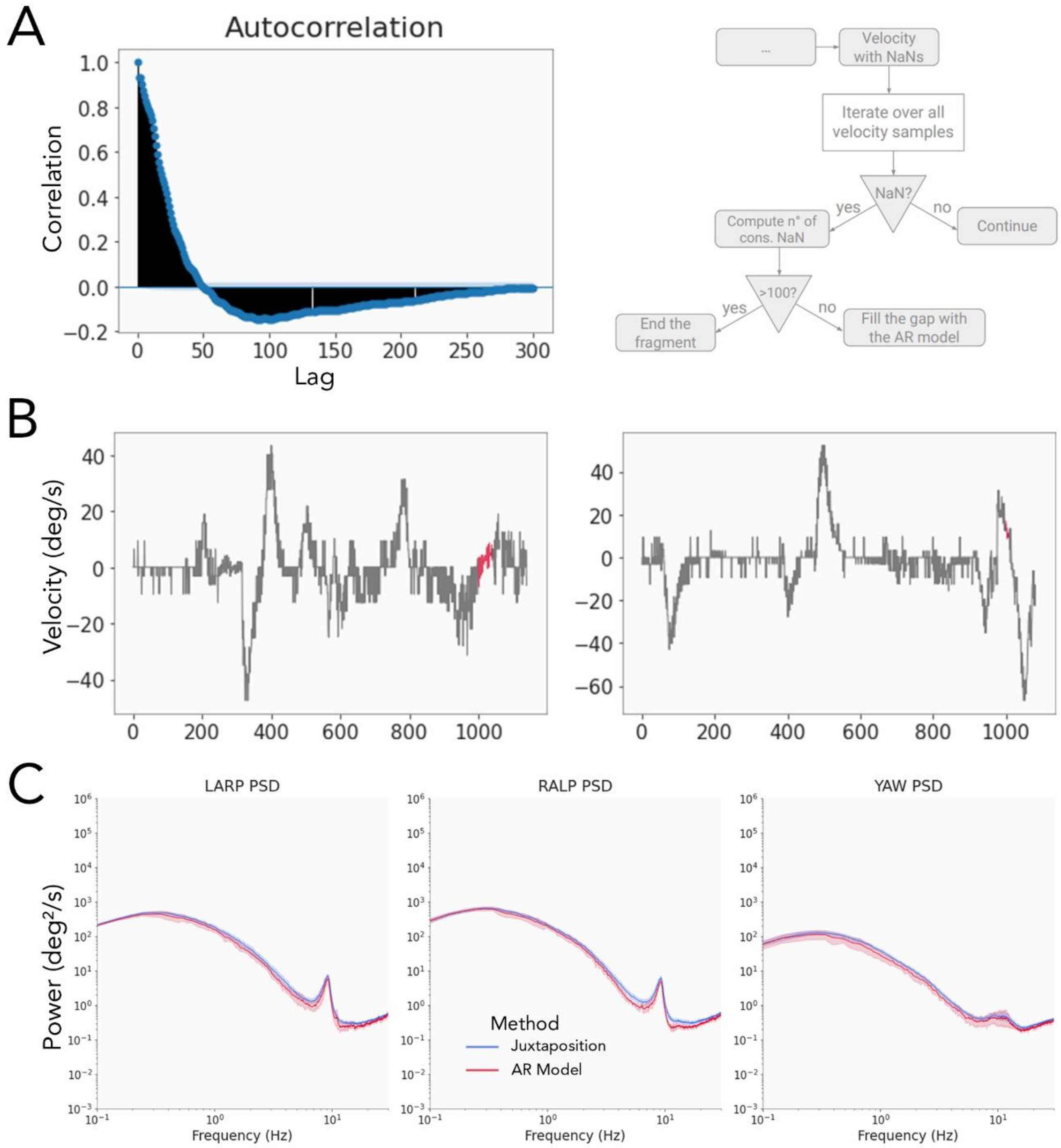
Data analysis: Missing values

An autoregressive (AR) model predicts the future values of a time series from its past values. We employed an AR model (AutoReg function from the statsmodel python package, which estimates an AR-X model using Conditional Maximum Likelihood) to interpolate the missing values in the data that were created after the filtering step. Such a model was appropriate since the angular velocity of the head is auto correlated: future values depend closely on recent previous values (see Panel A, left). To avoid generating erroneous samples, we introduced a duration threshold on the maximum duration of consecutive missing values allowed. In the following paragraph, we will denote by *gap* a succession of missing values.

Starting from the beginning of the signal, the duration of each gap was computed. If the gap duration was greater than the duration threshold, the current *data fragment* (a subsequence of the complete time series) was ended and a new fragment was created at the end of the gap. Otherwise, we used the AR model to fill the gap. The model was trained on ten seconds of data preceding each gap. We chose a number of lags in the model as a linear function of the size of the gap: from 30 lags if the gap's size is of length 1 (only one sample discarded) up to 300 lags if the gap's size is of length 100 (100 successive samples discarded). Panel A, right, schematically represents the general idea of the algorithm. Panel B presents two examples of interpolation with the AR model on a pilot's head angular velocity signal. Each gap appears to be completed with appropriate data samples.

After processing with the AR model, we obtain a collection of relatively clean, evenly sampled measurements of angular velocity signals. We further chose to only consider for analysis fragments exceeding 3 minutes in length to focus on the more robust parts of the recordings. Welch's method was then used on the collection to obtain the power spectra of the signal. Panel C compares the power spectra obtained with the aforementioned method *vs.* the spectra obtained after simply removing all missing values. Clearly, both methods produce comparable results.



Supplementary Figure 3:

Panel A: Left: autocorrelation function of the head angular velocity signal in the LARP plane. Correlation decreases steadily until a lag of 50 time steps where it changes sign. From there it rises again in absolute value until a lag of 100 time steps before decreasing again to zero for a lag of 300 time steps. Right: schematic representation of the processing of raw head data.

Panel B: Head angular velocity in the LARP plane after applying the AR model. Both curves present the first 10 seconds of training data (in grey) followed by the completion of the gap by the AR model (red) and the next 1 s of real data (grey).

Panel C: Population-averaged power spectra of the head-velocity in the LARP, RALP and YAW planes with corresponding 95% confidence interval (shaded areas). Blue: power spectra obtained with the simple juxtaposition method (i.e., missing values were discarded), red: power spectra obtained after application of the AR Model.