APPENDIX 1

The most common video and data sampling frequency in clinical integrated vestibular/oculomotor recording systems is 100 Hz, due to the limited bandwidth of the rotating interface that transmits the video data from the rotating chair. Only very recently, 250 Hz clinical systems are commercially available. Several studies[15, 30-32] have found that sampling frequencies less than 200-300 Hz generate an underestimate of the peak velocities of the saccades. Mack et al. [15] have shown, using simulated saccades, that for an acquisition frequency of 120 Hz, oversampling interpolation gives a pronounced improvement in the estimate of the peak velocity, particularly for small saccades. We therefore compared the main sequence parameters obtained applying the same-weight cubic spline on the position traces with no interpolation (1x) and with a 10x interpolation, simulating a 1 kHz acquisition frequency. Eye velocity traces were then computed from the 100 Hz and the 1000 Hz splined eye position traces with the same 2-point backward differentiation. As expected, the peak velocity values obtained using the interpolated eye velocity traces are equal or higher than the non-interpolated values due to the rounding between the 100 Hz samples, which is readily apparent in the left panel of Fig. 1. These changes are small but they have an effect on the model parameters. An example of this comparison is reported in the right panel of Fig. 1. The deviations in peak velocity measures – compare the 1x values in black and 10x values in red – are small, with very little change in overall R^2, 0.968 vs. 0.961. Due to the correlation between V_{max} and SAT and their non-linear crossed interaction, this small change in the main sequence profile causes a 20% change in the value of SAT. SAT decreases for the 10x estimates were observed in most of the data sets. The example in Fig. 1 also shows an 8% decrease in the V_{max} value for the 10x interpolated data, not an increase, as we would expect by all 10x peak velocity values being equal or higher than the 1x values, due to the change in curvature of the main sequence. Even small changes in the main sequence profiles can cause large changes in the model parameters, affecting the stability and reproducibility of the parametric results.

The quality of the fits for the interpolated data was comparable, with the average R^2 roughly 1% worse for all directions. The distributions of the V_{max} values were practically identical between the non-interpolated and interpolated data, as it can be seen from the largely overlapping normal functions in Fig. 2 and the “Mean” and “σ” values in the upper section of Table 1.

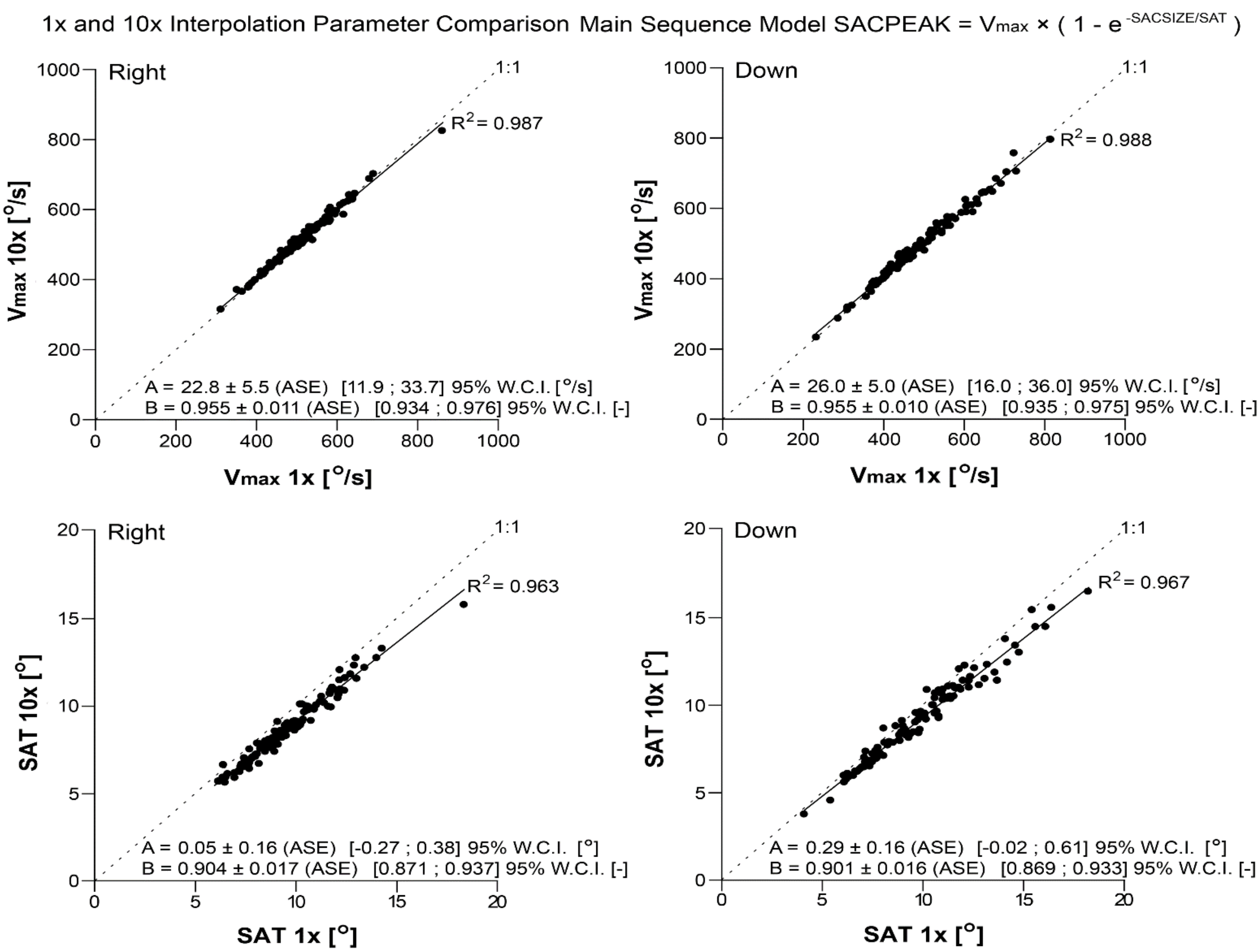

Figure A1. Set-by-set comparisons between the V_{max} values (upper plots) and SAT values (lower plots) obtained with the non-interpolated (1x) and interpolated (10x) data for the rightward and downward saccadic directions. The solid lines are linear regressions, while the dashed lines are the 1:1 lines, identifying identical 1x and 10x values. The offset and slope values of the linear regressions are reported near the x-axis of each panel, together with their asymptotic standard error (ASE) and Wald 95% C.I. limits.

The very small increase in the Mean V_{max} values for upward and downward interpolated data was significant (***P*** < .01; paired t-test). The 7.3% to 9.4% average decrease in SAT for the interpolated data was extremely significant (***P*** < 10^{-15}; paired t-test), resulting in a clear shift in the normal functions (Fig. 3). A set-by-set comparison of the non-interpolated and interpolated V_{max} and SAT values confirms the results seen in Figs. 2 and 3 and Tab. 1. The effects of the interpolation on V_{max} are negligible, while the effects on SAT, albeit small, are extremely robust. Figure A1 shows the set-by-set comparisons for the rightward and downward directions. Note the clear shift of the SAT 10x values with respect to the 1:1 line. In our sets, the use of interpolated data has little effect on the V_{max} estimates, but a roughly 8% average reduction in the SAT estimates. The shift in the SAT values between the 1x and 10x data is evident when comparing the black and red linear regression lines and the intercept values A in Fig. 5. With the exclusion of this shift and slightly worse R^2 values for the 10x interpolated data, all further observations apply equally to both non-interpolated and 10x interpolated data. Thus, for brevity, starting from Fig. 6 and Tab. 2, we used only the non-interpolated data.