

Deviant-standard comparisons

Visual inspection of the ERP waveforms comparing standards to deviants in the two experimental conditions shows no apparent mismatch in the N1-P2 complex, although there is a large mismatch effect in the time window coinciding with the N2 (around 300 ms) and a later mismatch effect (around 400-600 ms). There is also a clear mismatch effect in the Random Standards Control condition when comparing the 55-95 ms VOT stimuli to the 50 ms VOT stimulus. The Control condition waveform has a structure very similar to the High and Low conditions, with the clearest negativity around 300 ms. This was unexpected, due to the random and equiprobable presentation of the stimuli in this condition.

Mean voltage was extracted for statistical analysis from the individual electrode Fz over the time windows of 252-352 ms (N2) and 452-552 ms (the late effect). Data from Fz were entered into a 2×2 repeated measures ANOVA with the within-subject factors MMN (Standard vs Deviant) and Distance (High vs Low), and the between-subject factor Thresholds (>50 ms vs <50 ms). This between-subject factor was computed from the behavioral categorization data. Threshold scores from the categorization pre-test and post-test were averaged for each participant, and participants were then sorted into two groups: threshold scores below 50 ms (11 participants), and threshold scores greater than or equal to 50 ms (10 participants). This was to measure the effect of categorization on prediction during the EEG session.

For the 252-352 ms time window, the repeated measures ANOVA found a highly significant main effect of MMN at Fz ($F(1,19) = 24.025$; $p < 0.001$; $\eta^2_p = 0.558$). There was a significant MMN×Thresholds interaction ($F = 5.444$; $p = 0.031$; $\eta^2_p = 0.223$), but no significant MMN×Distance interaction ($F = 0.187$; $p > 0.05$; $\eta^2_p = 0.01$) and no significant MMN×Distance×Threshold interaction ($F = 0.706$; $p > 0.05$; $\eta^2_p = 0.036$). See Figure 8 for a plot

of the MMN×Thresholds interaction. Planned t-tests found a significant difference between standard and deviant in the Control condition ($t(20) = -3.212$; $p = 0.002$; $1-\beta = 0.927$, $BF_{01} = 20.2$), the High condition ($t(20) = -3.186$; $p = 0.002$; $1-\beta = 0.924$, $BF_{01} = 19.2$), and the Low condition ($t(20) = -4.233$; $p < 0.001$; $1-\beta = 0.993$, $BF_{01} = 158.7$). In addition, we ran paired samples t-tests for each threshold group. For the >50 ms threshold group, paired samples t-tests found a significant difference between standard and deviant in the High condition ($t(8) = -1.87$; $p = .049$; $1-\beta = 0.434$; $BF_{10} = 2.07$), Low condition ($t(8) = -2.21$; $p = .029$; $1-\beta = 0.73$; $BF_{10} = 3.13$), and Control condition ($t(8) = -3.3$; $p = .005$; $1-\beta = 0.64$; $BF_{10} = 11.74$). For the <50 ms threshold group, paired samples t-tests found a significant difference between standard and deviant in the Low condition ($t(11) = -3.34$; $p = .003$; $1-\beta = 0.874$; $BF_{10} = 16.47$). The difference between standard and deviant was marginal in the High condition ($t(11) = -1.66$; $p = .063$; $1-\beta = 0.563$; $BF_{10} = 1.55$), and Control condition ($t(11) = -1.55$; $p = .074$; $1-\beta = 0.874$; $BF_{10} = 1.36$).

For the 452-552 ms time window, there was again a highly significant main effect of MMN ($F(1,19) = 26.635$; $p < 0.001$; $\eta^2_p = 0.584$) and a significant MMN×Thresholds interaction ($F(1,19) = 7.574$; $p = 0.013$; $\eta^2_p = 0.285$), but no significant two-way interaction of Distance×Thresholds ($F = 0.597$; $p = 0.449$; $\eta^2_p = 0.030$) or three-way interaction of MMN×Distance×Thresholds ($F = 1.097$; $p = 0.30$; $\eta^2_p = 0.055$). See Figure 9 for a plot of the MMN×Thresholds interaction. Paired samples t-tests found a significant difference between standard and deviant in the Control condition ($t(20) = -2.15$; $p = 0.022$; $1-\beta = 0.667$; $BF_{10} = 2.934$), High condition ($t(20) = -3.544$; $p = 0.001$; $1-\beta = 0.962$; $BF_{10} = 38.982$), and Low condition ($t(20) = -3.923$; $p < 0.001$; $1-\beta = 0.984$; $BF_{10} = 84.078$). For the >50 ms threshold group, paired samples t-tests found a significant difference between standard and deviant in the

High condition ($t(8) = 2.47$; $p = 0.019$; $1-\beta = 0.892$; $BF_{10} = 4.331$), Low condition ($t(8) = 2.73$; $p = 0.013$; $1-\beta = 0.944$; $BF_{10} = 5.902$), but not in the Control condition ($t(8) = 0.316$; $p < 0.38$; $1-\beta = 0.087$; $BF_{10} = 0.410$). For the <50 ms threshold group, paired samples t-tests found a significant difference between standard and deviant in the High condition ($t(11) = 2.58$; $p = 0.013$; $1-\beta = 0.506$; $BF_{10} = 5.45$), Low condition ($t(11) = 2.78$; $p = 0.009$; $1-\beta = 0.596$; $BF_{10} = 7.27$), and in the Control condition ($t(11) = 2.53$; $p < 0.014$; $1-\beta = 0.706$; $BF_{10} = 5.07$).

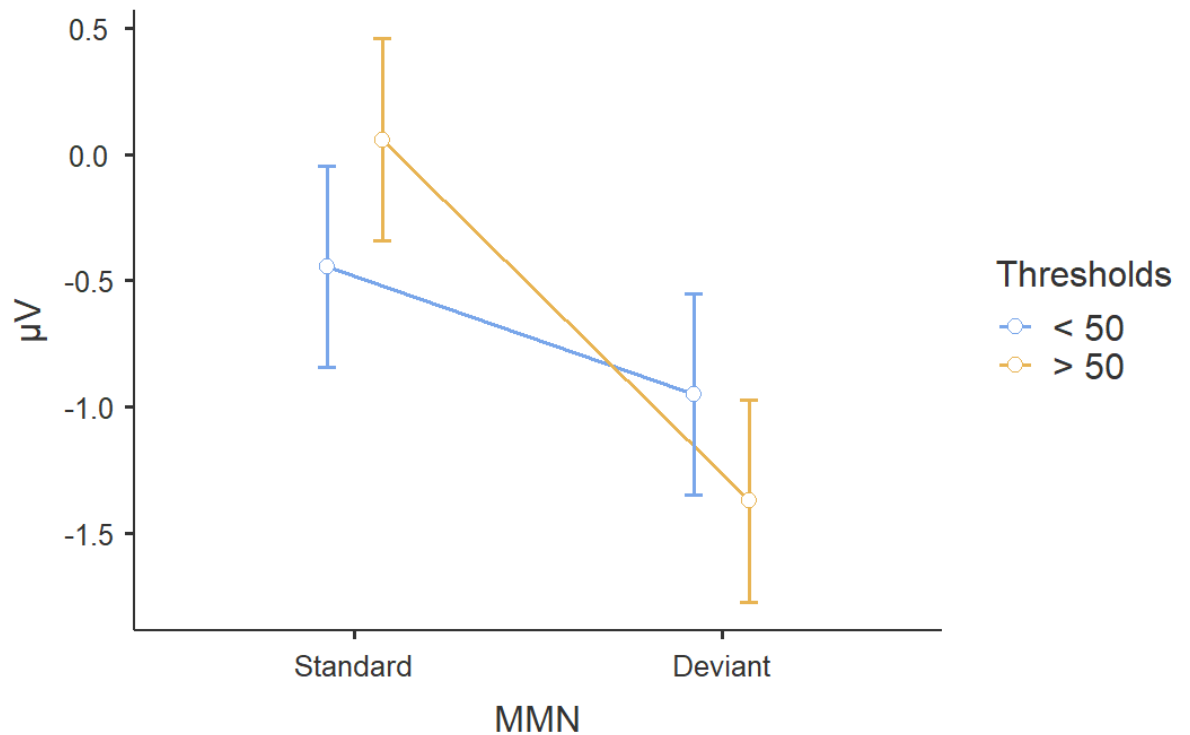


Figure 8. Plot of the MMN \times Thresholds interaction in the 252-352 ms time window.

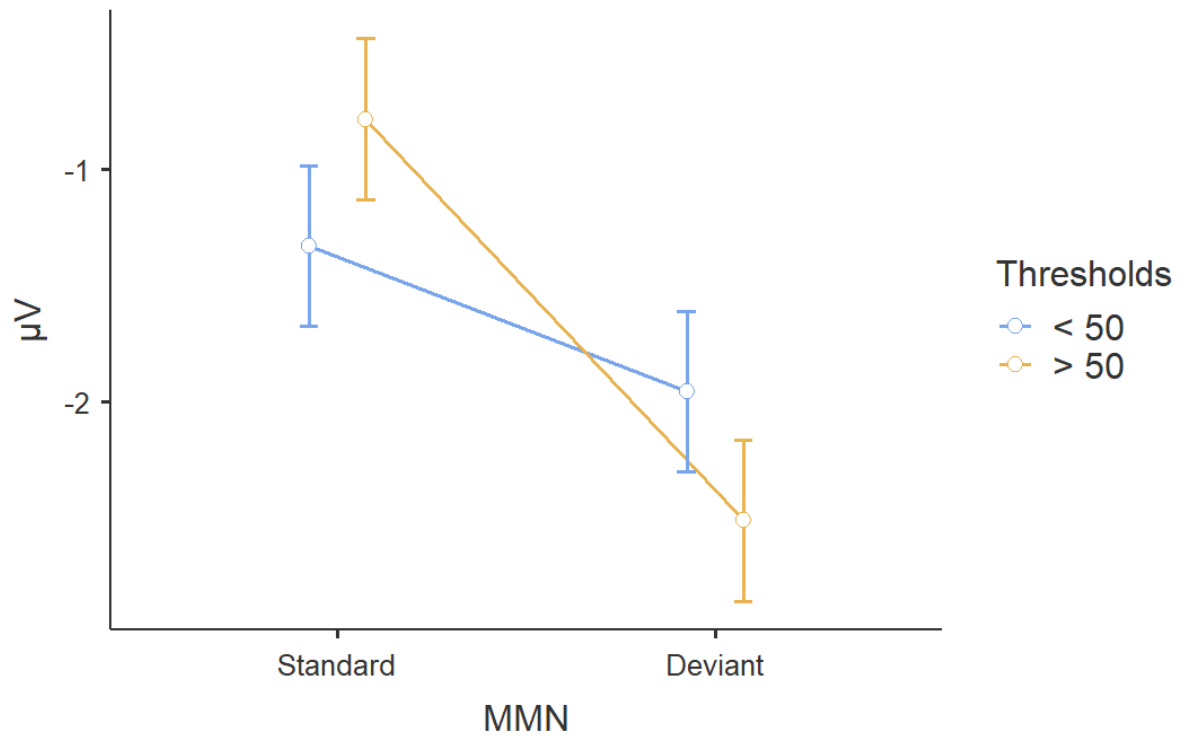


Figure 9. Plot of the MMN×Thresholds interaction in the 452-552 ms time window.

To account for the mismatch effect in the random standards control condition, we conducted an additional analysis of the control condition. The raw EEG data from the control condition of this experiment were re-segmented so that each stimulus was grouped into a cell according to its VOT value. This gave 10 cells: 50 ms, 55 ms, 60 ms, 65 ms, 70 ms, 75 ms, 80 ms, 85 ms, 90 ms, and 95 ms. When visually inspecting the waveforms, there is a clear pattern of increasing voltage with increasing VOT, particularly apparent between 252-352 ms in the N2¹ (see Figure 10). Averaged single subject data were extracted from Fz across a 252-352 ms time window. Mean voltage was regressed over VOT, finding a significant correlation ($R^2 = 0.0310$; $t = 2.52$; $p = 0.013$). See Figure 11 for a plot of the linear regression at Fz. This pattern mirrors the

¹ While there appear to be differences in the N1 (75-150 ms) related to VOT, we find no significant effects in this time window.

results of Toscano et al. (2010) and accounts for the apparent MMN in the control condition as a function of gradient perceptual encoding.

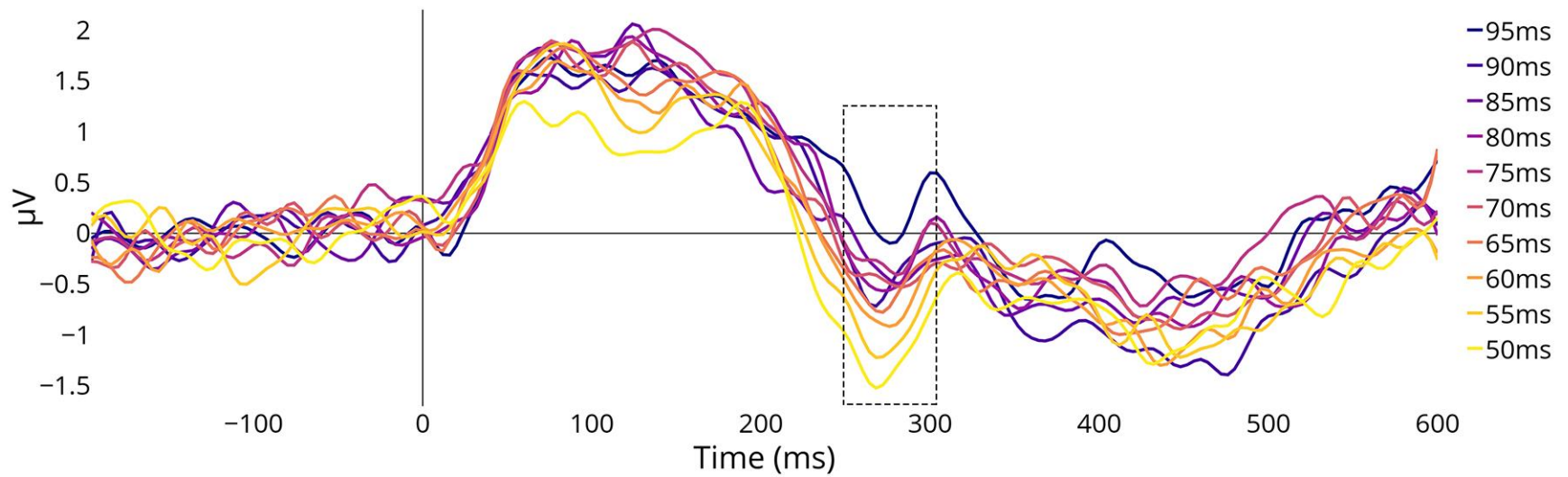


Figure 10. Waveforms in the Random Standards Control Condition at Fz. Stimuli ranged from 50-95 ms VOT in 5 ms increments. The brain response to these stimuli show a roughly linear pattern of increasing voltage at the N2 as VOT increases. The time window for analysis is marked with a dashed-line box.

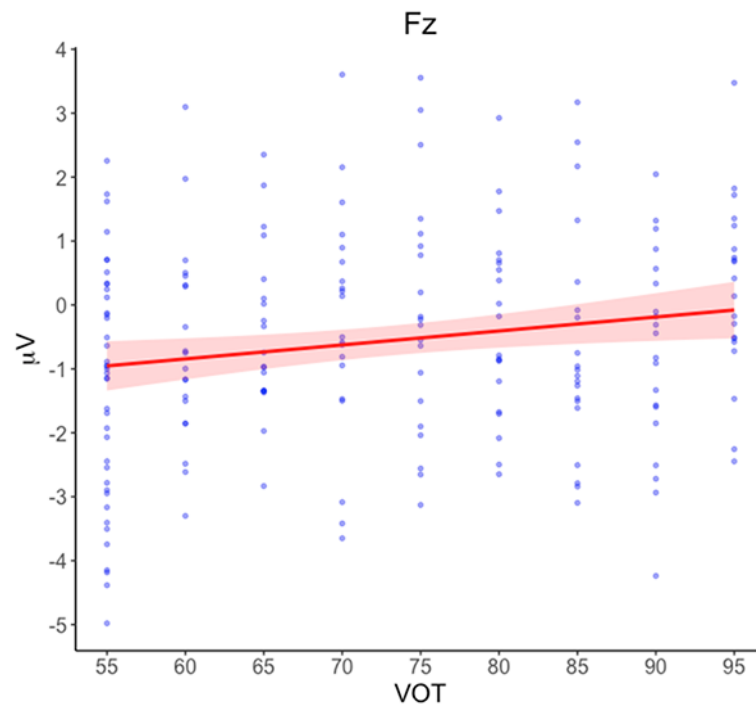


Figure 11. Regression plots showing a linear trend of VOT on brain voltage at Fz.