The Medial Frontal Cortex and the Rapid Processing of Monetary Gains and Losses

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Supplementary Material

The electroencephalogram was recorded using tin electrodes embedded in a nylon mesh cap (Quik-cap, Neuromedical Supplies, Sterling, Virginia, USA), with a left mastoid reference and a forehead ground. An average mastoid reference was derived off-line. EEG data were corrected for ocular movement artifacts using the Gratton algorithm *(1)*. Data were recorded from 0.01 to 70 Hz (half-amplitude cutoffs) and digitized at 400 Hz, using a SynAmps data acquisition system (Neuroscan Labs, Sterling, Virginia, USA). Prior to analysis the data were filtered with a 9-point Chebyshev type II low-pass zero-phase shift digital filter (Matlab 5.3, Mathworks, Inc., Natick, Massachusetts, USA), with a half-amplitude cutoff at 12 Hz.

ERP activity was quantified as the mean amplitude in the 200-300 ms epoch following the onset of the stimulus, relative to a 100 ms pre-stimulus baseline. A 2 (gain/loss) × 38 (electrode location) repeated-measures analysis of variance (ANOVA) revealed a significant gain vs. loss effect, F (1, 11) = 9.71, P = 0.0098, *MSE* = 28.54, and a significant gain/loss × location interaction, F (37, 407) = 8.21, P = 0.00022, *MSE* = 0.56. When necessary, in this and all analyses, P-values were adjusted using the Greenhouse-Geisser correction for violations of the ANOVA assumption of sphericity. All figures show error bars consisting of 2 standard errors of the mean, derived from the corresponding mean squared error (MSE) from the ANOVA.

In the analysis dissociating gain/loss from correct/error effects on the amplitude of the MFN (Figure 3), the 2 (gain/loss) × 2 (correct/error) ANOVA showed a significant effect of gain/loss status, F (1, 11) = 21.19, P = 0.00076, *MSE* = 9.22. The error/correct effect was not significant F (1, 11) = 1.63, P = 0.23, *MSE* = 4.58.

To analyze the effect of position within the block on the proportion of risky responses, we used a repeated-measures ANOVA with a single four-level factor representing the quarter within a block. The effect of block quarter was significant, F (3, 33) = 4.24, P = .038, *MSE* = 0.0049, and a separate test contrasting the first quarter to the last quarter was also significant, F (1, 11) = 6.74, P = 0.024, *MSE* = 0.0089. The means for the quarters were (first to last): 0.58, 0.51, 0.53, 0.48.

The analysis of the effects of previous outcome on the proportion of risky choices and on the MFN effect (Figure 4) distinguished between two kinds of trials: trials where the alternatives were different ([5][25] or [25][5]) and trials where alternatives were equal ([5][5] and [25][25]). We refer to the former case as "choice" trials (where subjects had the opportunity to make a risky or cautious choice), and the latter case as "no-choice" trials. In the analysis of proportion of risky choices, a 2 (gain vs. loss) × 2 (25 vs. 5) × 2 (choice vs. no-choice) repeated measures ANOVA showed a significant effect of the gain/loss status of the previous trial, F (1, 11) = 23.54, P = 0.00051, MSE = 0.018. The significant gain/loss × 25/5 interaction F (1, 11) = 5.59, P = 0.038, MSE = 0.021, showed that the proportion of risky choices was affected by the gain/loss status of the previous trial more when the outcome was a gain or loss of 25 cents than when it was 5 cents. The MFN effect was also affected by the gain/loss status of the previous trial, F (1, 11) = 6.38, P = .028, MSE = 5.17, with a greater MFN effect following losses than following gains. The gain/loss × 25/5 interaction was not significant, F (1, 11) = 0.94, P = 0.35, MSE = 5.71. The linear trend apparent in Figure 4 was significant for both the probability of a risky choice and for the MFN effect (F (1, 11) = 17.05, P = 0.0017, MSE = 0.032 and F (1, 11) = 5.04, P = 0.046, MSE = 7.56, respectively). Standard error bars are derived from the gain/loss x 25/5 interaction MSE.

Using the Brain Electrical Source Analysis (BESA) software *(2)*, we derived a best-fit single-dipole model of the MFN, based on the amplitude of the gain-loss difference waveform computed at its peak, 265 ms following the stimulus. Then, with BESA's coordinates for the dipole solution, we located the dipole within a canonical magnetic resonance imaging template of the human head, derived from an average of scans from 152 individual heads (file avg152T1.img, available as part of the SPM99 software at http://www.fil.ion.ucl.ac.uk/spm, Wellcome Department of Cognitive Neurology, London). We aligned the spherical geometry of BESA with the MRI template by fitting a sphere to a convex hull circumscribing the average head defined in the MRI image, using a least-square best-fit criterion. The origin of the sphere within the voxel coordinates of the template was, x = 46.1, y = 55.8, z = 39.8, and the radius of the sphere was 47.5 voxels. The spherical coordinates of the dipole in BESA's coordinate system were theta = 67.0, phi = 83.4, eccentricity = 40.9%. Figure 2 depicts the dipole solution using a sphere with a radius of 5 voxels, centered at those coordinates. The residual (unaccounted-for) variance associated with the best-fit dipole model shown in Figure 2 was less than 5%.

References

1. G. Gratton, M. Coles, E. Donchin, *Electroenceph. Clin. Neuro.* **55**, 468 (1983).

2. M. Scherg in *Advances in Audiology: Vol 6. Auditory Evoked Magnetic Fields and Electrical Potentials*, F. Grandori, M. Hoke, G. L. Romani, Vol. Eds., M. Hoke, Series Ed. (Karger, Basel, Switzerland, 1990), pp. 40-69.

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