Science Advances
AAAS
advances.sciencemag.org/cgi/content/full/1/10/e1500677/DC1

Supplementary Materials for

Does the mismatch negativity operate on a consciously accessible memory trace?

Andrew R. Dykstra and Alexander Gutschalk

Published 13 November 2015, *Sci. Adv.* **1**, e1500677 (2015)
DOI: 10.1126/sciadv.1500677

This PDF file includes:

Other Supplementary Material for this manuscript includes the following:
(available at advances.sciencemag.org/cgi/content/full/1/10/e1500677/DC1)

Audio S1 (.wav format). Example of an auditory oddball sequence (an isochronous 902-Hz standard stream with a 947-Hz deviant and a 500-ms stimulus onset asynchrony) embedded in a random multitone masker cloud.
Audio S2 (.wav format). Example of an auditory oddball sequence in isolation.

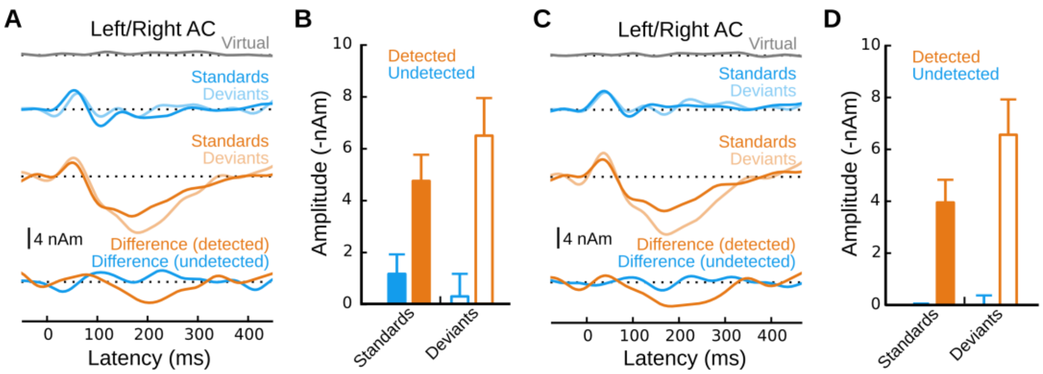

Fig. S1. Neural activity under masked conditions after equalization of the number of epochs in each frequency bin across detected and undetected standards and deviants. (**A**) Grand-averaged MxNE solutions for virtual targets (black), deviants and standards for undetected standard streams (blue), deviants and standards for detected standard streams (orange), and respective difference waveforms (deviants minus standards – detected: orange, undetected: blue). (**B**) Quantified amplitudes for MMN responses generated in the context of detected (orange) and undetected (blue) standard streams. A two-way ANOVA performed on these quantified amplitudes revealed a significant main effect of percept [detected vs. undetected: $F_{1,19} = 38.1$, $P < 0.0005$] and a significant two-way interaction between percept and condition [$F_{1,19} = 6.6$, $P < 0.05$]. Subsequent paired t-tests confirmed an effect of condition for amplitudes in the context of detected standard streams [$T_{19} = 2.2$, $P < 0.05$]; no such effect was found in the context of undetected standard streams [$T_{19} = -1.1$, *n.s.*]. (**C**) Same is in (A), but using all data (i.e. that from Fig. 2), for comparison. (**D**) Same as in (B), but using all data. Main effect of percept: $F_{1,19} = 29.5$, $P < 0.0005$. Two-way interaction between percept and condition: $F_{1,19} = 5.7$, $P < 0.05$. Undetected deviants vs undetected standards: $T_{19} = -0.1$, n.s.. Detected deviants vs detected standards: $T_{19} = 3.7$, $P < 0.005$.

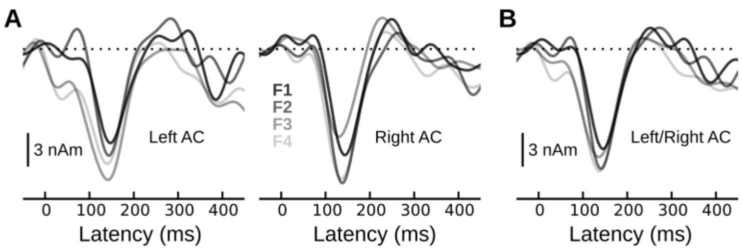

Fig. S2. Neural activity under control condition, binned by frequency. (**A**) Grand-averaged MxNE solutions for deviant-minus-standard difference waveforms for each hemisphere. (**B**) Same as in (A), combined across hemispheres. The MMN is clearly visible as a negative-going peak between 100 and 200 ms, and its amplitude was highly similar across frequencies.

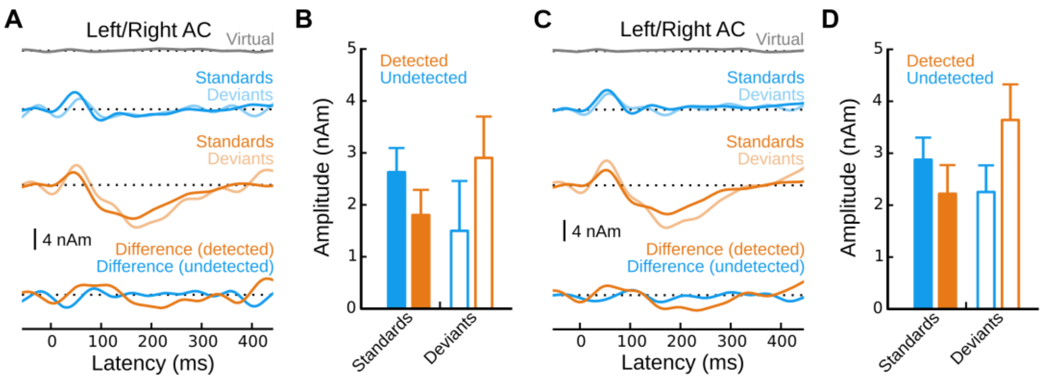

Fig. S3. Neural activity under masked conditions after epoch equalization, with emphasis on the P1 latency range. (**A**) Grand-averaged MxNE solutions for virtual targets (black), deviants and standards for undetected standard streams (blue), deviants and standards for detected standard streams (orange), and respective difference waveforms (deviants minus standards – detected: orange, undetected: blue). (**B**) Quantified P1 amplitudes. Although this pattern of results is highly similar to that from our main analysis, unlike the main analysis, a two-way ANOVA performed on these quantified P1 amplitudes did not reveal a statistically significant two-way interaction between condition and percept [$F_{1,19}$ = 2.3, P = 0.15]. However, a paired comparison between detected deviants and standards was significant [T_{19} = -2.2, P < 0.05]; no such effect was found between undetected deviants and standards [T_{19} = -1.1, *n.s.*]. (**C**) Same as in (A), but using all data (i.e. that from Fig. 5), for comparison. (**D**) Same as in (B), but using all data. Here, as in the main analysis including hemisphere as a factor, there was a significant condition-by-percept interaction [$F_{1,19}$ = 10.3, P < 0.005], and no main effects. Subsequent paired tests indicated that deviants occurring during detected standard streams elicited larger responses than detected standards [T_{19} = -2.6, P < 0.05]. Deviants occurring during undetected standard streams elicited slightly smaller P1 amplitudes than undetected standards, but this effect did not reach statistical significance [T_{19} = -1.3, *n.s.*]. In addition, deviants occurring during detected standard streams elicited larger responses than deviants occurring during undetected standard streams [T_{19} = -2.4, P < 0.05], and the responses to detected standards were marginally smaller than undetected standards [T_{19} = 1.9, P = 0.08], consistent with a percept-dependent SSA-based interpretation of the P1.

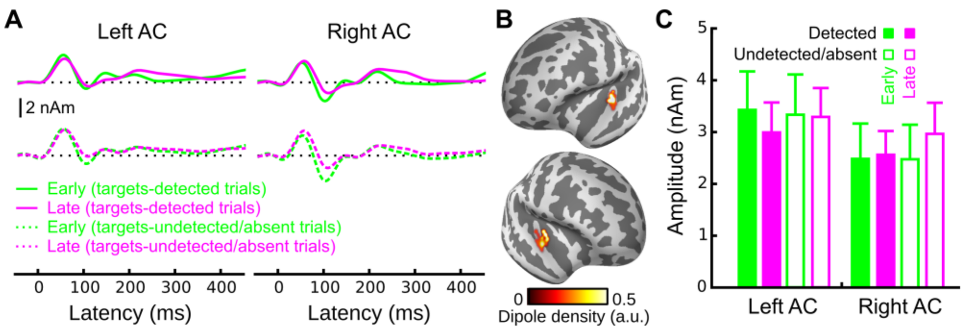

Fig. S4. Masker-elicited P1 responses using the same source space as was used for MMN (c.f. Fig. S6). (**A**) Grand-averaged MxNE solutions. (**B**) Corresponding dipole locations. (**C**) Quantified P1 amplitudes. A three-way ANOVA with hemisphere, target detection, and time interval as factors revealed only a significant two-way interaction between interval and target detection [$F_{1,19} = 4.8$, $P < 0.05$]. However, this reflects the fact that in right AC for targets-undetected/absent trials, the effect went in the opposite direction from what would be expected based on adaptation (i.e. larger responses during the late interval) [$T_{19} = 2.2$, $P < 0.05$]. No other significant differences were found using paired comparisons [$T_{19} \leq 1.5$, $P \geq 0.14$]. In particular, differences between masker-elicited P1 responses on targets-detected trials in the early and late (i.e. before and after detection) detection intervals were not significant.

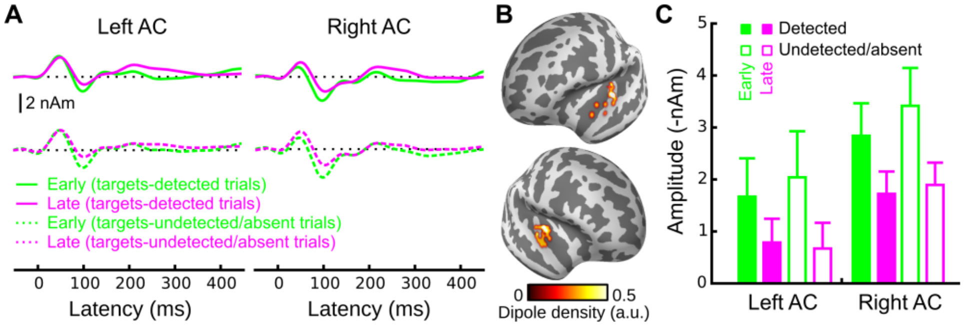

Fig. S5. Masker-elicited N1 responses using the same source space as was used for MMN (c.f. Fig. S6). (**A**) Grand-averaged MxNE solutions. (**B**) Corresponding dipole locations. (**C**) Quantified N1 amplitudes. A three-way ANOVA with hemisphere, target detection, and time interval as factors revealed a significant main effect of interval [$F_{1,19} = 12.8$, $P < 0.005$] as well as a significant two-way interaction between interval and target detection [$F_{1,19} = 5.0$, $P < 0.05$]. As in the main analysis, however (c.f. Fig. 5), this interaction went in the *opposite* direction that would be expected based on an attentional account of the data (i.e., the early-late difference was *larger* for targets-undetected/absent trials). A main effect of hemisphere was also observed [$F_{1,19} = 4.8$, $P < 0.05$], reflecting the overall larger amplitudes in right AC.

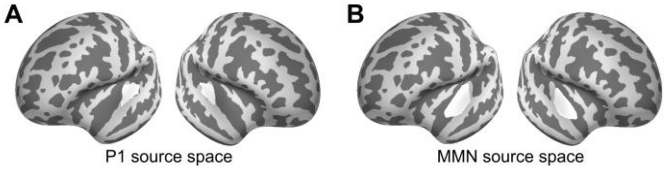

Fig. S6. Source-space vertices for P1 and MMN source analyses. (**A**) Posterior source-space vertices (in white) for source analysis of the P1 component. (**B**) Anterior source-space vertices for source analysis of the MMN. The source space in (A) was used to analyze target-elicited P1 responses (Fig. 3) as well as masker-elicited P1/N1 responses (Figs. 4 and 5). The source space in (B) was used to analyze target-elicited MMN responses (Fig. 2) as well as masker-elicited P1/N1 responses (Figs. S4 and S5).

	Left AC	**Right AC**
Undetected standards	$T_{19} = 6.3$ $P < 0.0005$	$T_{19} = 3.7$ $P < 0.005$
Undetected deviants	$T_{19} = 4.1$ $P < 0.001$	$T_{19} = 1.6$ *n.s.*
Detected standards	$T_{19} = 4.6$ $P < 0.001$	$T_{19} = 2.1$ $P < 0.05$
Detected deviants	$T_{19} = 4.9$ $P < 0.0005$	$T_{19} = 3.5$ $P < 0.005$

Table S1. Target-tone P1 statistics. Each entry displays T and P values indicating whether the across participant distribution of P1 amplitudes in that condition was significantly different from zero.

		Left AC	**Right AC**
P1	Targets-detected trials	$T_{19} = -2.2$ $P = 0.05$	$T_{19} = 1.0$ *n.s.*
	Targets-undetected trials	$T_{19} = -0.74$ *n.s.*	$T_{19} = 2.5$ $P < 0.05$
	Subtraction	$T_{19} = -0.94$ *n.s.*	$T_{19} = -1.5$ *n.s.*
N1	Targets-detected trials	$T_{19} = -1.7$ *n.s.*	$T_{19} = -2.7$ $P < 0.05$
	Targets-undetected trials	$T_{19} = -2.5$ $P < 0.05$	$T_{19} = -3.4$ $P < 0.005$
	Subtraction	$T_{19} = 1.8$ $P = 0.09$	$T_{19} = 2.0$ $P = 0.06$

Table S2. Masker-tone P1/N1 statistics from the analysis using the posterior source space (c.f. Fig. S6A). Each entry displays T and P values indicating whether the across participant distribution of P1/N1 amplitudes in that condition were significantly different before and after standard-stream detection (or virtual detection, in the case of targets-undetected trials). Note that while there was a trend for masker-elicited N1 responses between early and late time intervals in targets-detected minus targets-undetected trials, the difference went in the opposite direction than what would be expected based on an attentional account of the data.

Audio S1. Example of an auditory oddball sequence (isochronous 902 Hz standard stream with a 947 Hz deviant and 500 ms stimulus onset asynchrony) embedded within random multi-tone masker cloud. The oddball sequence can initially be quite difficult to identify; headphones are recommended. The oddball sequence is often much more readily identified after listening to it in isolation (Audio S2).

Audio S2. Example of an auditory oddball sequence in isolation (i.e., in the absence of the random multi-tone masker stimulus. This particular example consists of an isochronous (500 ms stimulus onset asynchrony) 902 Hz standard stream with a 947 Hz deviant. The oddball sequence embedded in the multi-tone masker (Audio S1) is often much more readily identified after listening to it in isolation.