Neural generators of children's event-related potentials to standard, target, and novel visual events

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Introduction

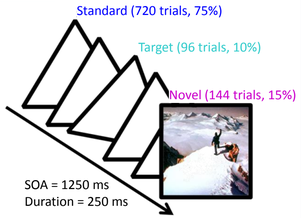
- Visual ERPs to standard stimuli are known to be generated within occipital (P1, N1), inferior temporal (N1), and parietal-occipital (P2) cortices[1].
- Children's novelty N2s were postulated to be generated within frontal-parietal attention network[2].
- However, this supposition was mostly based on frontal N2 topography and similarity to adult N2 generators[3].
- Neural generators of adult novelty N2s are located within frontal, occipital, and inferior temporal cortices[4] and might involve anterior cingulate cortex similar to control-related N2 (Go/NoGo task) generators[5,6].

Objective: To identify the neural generators of children's ERPs to standard, target, and novel stimuli

Methods

Participants: 62 children, 8-9 years old

Stimuli & Task:
Visual novelty oddball paradigm
- Press button to tilted triangles (Target) while ignoring upright triangles (Standard) and photos (Novel).



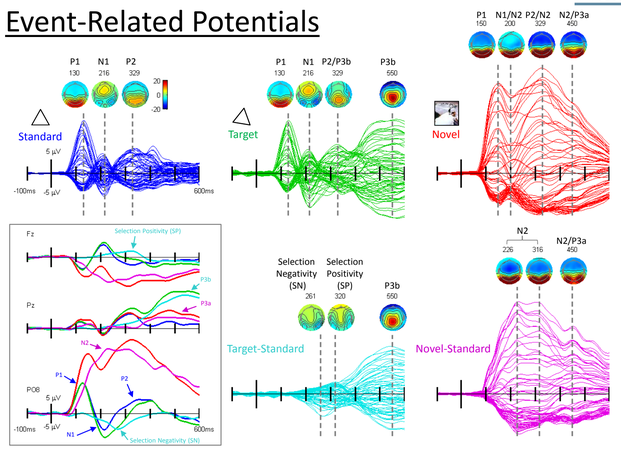
Recordings
- 64-channel ActiView2 BIOSEMI system, re-referenced to linked mastoid

Discrete Dipole Source Modeling
- Spatiotemporal dipole modeling using BESA software
- Fitted dipoles to P1, N1, P2, selection negativity (SN), selection positivity (SP), P3b, N2, and P3a.

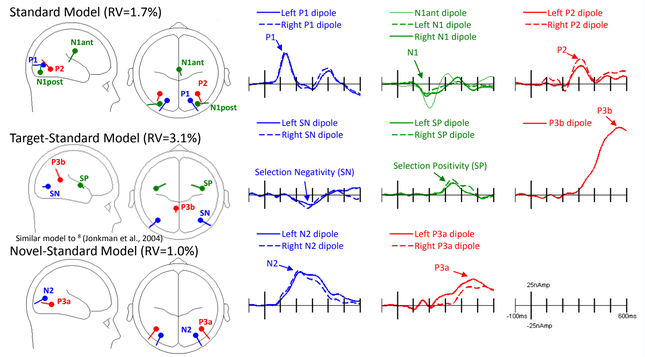
Distributed Dipole Source Modeling
- Linearly-constrained minimum-variance (LCMV) beamformer provided in the Brainstorm3 software package[7]
- EEG channel covariance estimated using single-trial data between -200 to 600 ms
- Beamformer weights estimated from participant's single-trial EEG data
- Source reconstruction using cortically-constrained dipoles (n=1502)
  ERP data x beamformer weights = source activity
- Averaged source activity across 30-50 ms intervals to yield beamformer maps for each component: P1, N1, P2, SN, SP, P3b, N2, and P3a.

Results

Event-Related Potentials

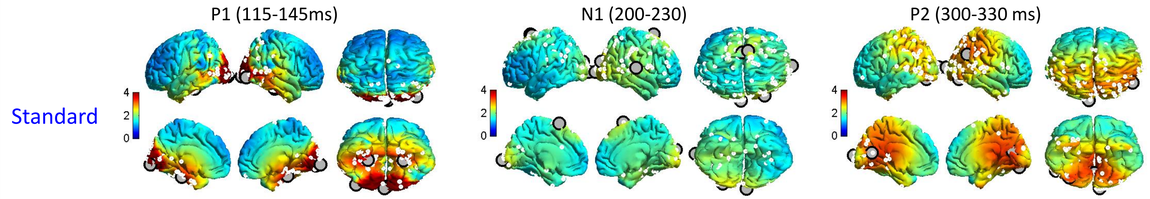


Discrete Dipole Source Modeling (BESA)

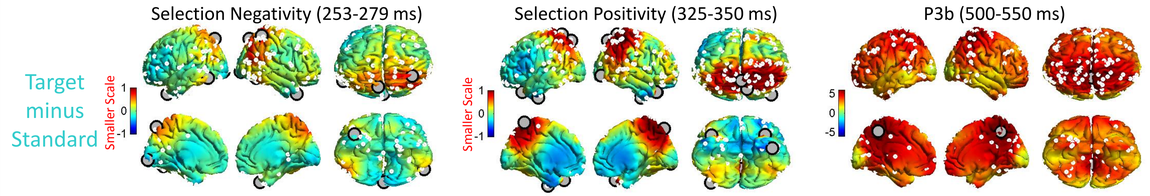


Distributed Dipole Source Modeling (LCMV Beamformer)

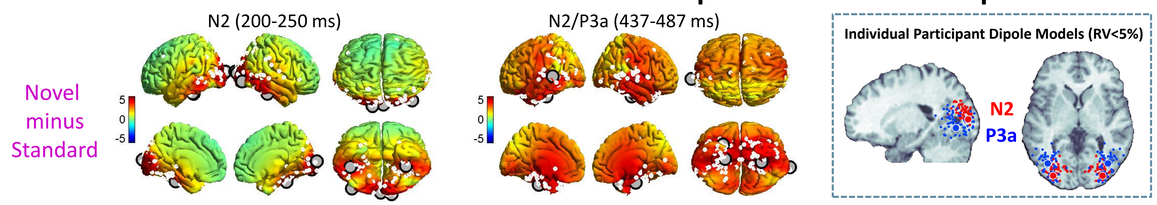
Expected P1-N1-P2 sources (grey circles), except for a frontal N1 source



Beamformer revealed distributed P3b activity in individual children (white dots)



Children's N2 sources are located within occipital and inferior-temporal cortices



Summary

- Children's N1 had frontal and occipital sources which could reflect activation of frontal-occipital network
- Individual children's P3b responses had wide-spread distributions of sources across frontal, parietal, and occipital cortices.
- Good correspondence for N2 source locations between discrete and distributed dipole models
- Children's N2 sources were located within occipital and inferior temporal cortices for all children.
- No evidence of frontal sources (i.e., anterior cingulate) were found for children's novelty N2 responses using either discrete or distributed source modeling.

Conclusions

- **Children's novelty N2 responses are primarily generated within occipital-temporal regions**
- Thus, children's novelty N2 responses likely reflect template mismatching rather than frontally-mediated response-conflict monitoring
- Children's P3b responses have a distributed network of neural generators

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