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EVENT-RELATED POTENTIAL CORRELATES OF MINDFULNESS MEDITATION COMPETENCE

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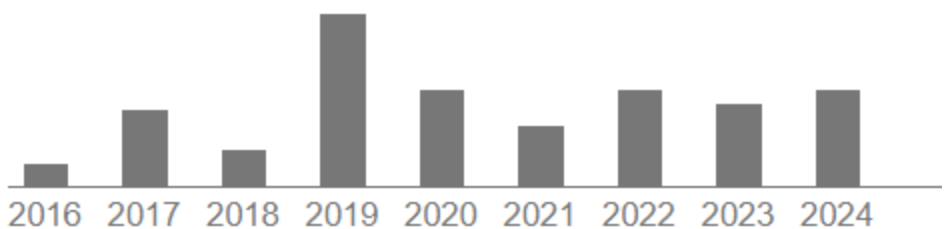
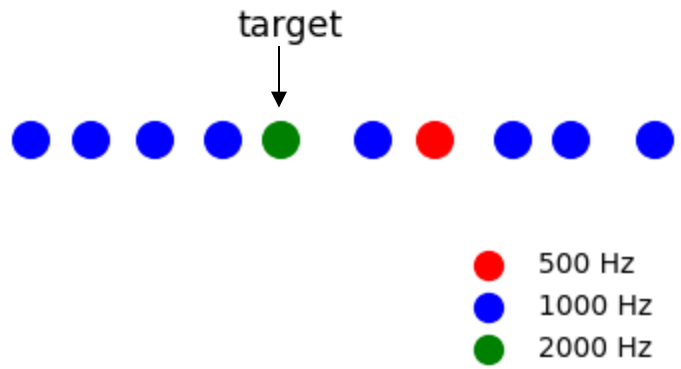


Goal: To identify an electrophysiological bio-marker for mindfulness meditation competence.

Design:

- 3 groups of people – **naïve**, **novice** and **experienced** meditators (n=42)
- 2 tasks
  a) **Tone Detection (oddball)** – 15 minutes
  b) **Breath Counting (meditation)** – 15 minutes
- *Data*:
  a) Questionnaires – Sleep and Meditation Depth
  b) EEG (32-channel)
  c) Respiration (piezoelectric belt)
- *Measures*:
  - Behavioural scores (button press + questionnaires)
  - Primed ERP (N2 and P3; exploratory N1 and P2)
  - Drowsiness analysis (Frontal-midline theta 4-8 Hz; posterior alpha 8-13 Hz)



Hypothesis:

N2 and P3 amplitudes

Task	Naïve	Novice	Experienced
Tones	Lower than Novice	Higher than Naïve Lower than Experienced	Highest of all
Breath Count	Higher than Novice	Lower than Naïve Higher than Experienced	Lowest of all

- 2x3 mixed ANOVA
- Univariate ANOVA
- t-tests follow-up

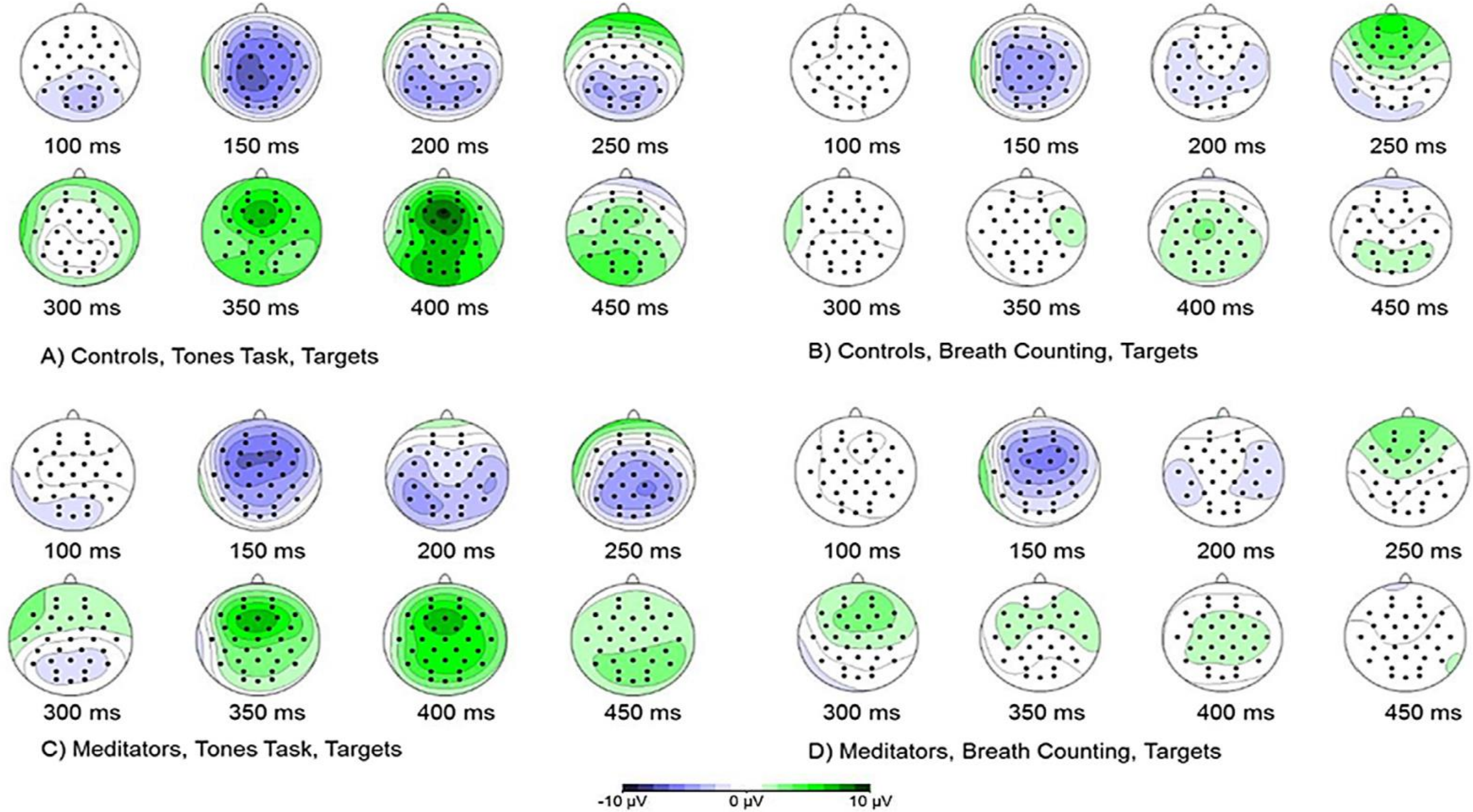


Fig. 3. Topographic maps of brain activity in response to target tones across conditions.

Results:

b) N2 ERP

- same effect as P3 was observed

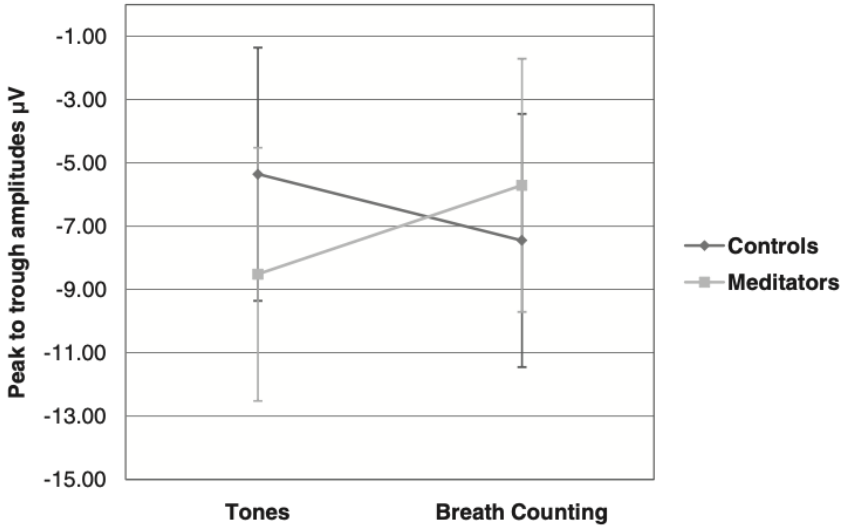


Fig. 5. N2 responses to targets, Cz. *This interaction was significant at the Cz site, $p = .017$, with a more pronounced effect than at the Pz site and meditators exhibiting a greater difference in N2 peak-to-trough amplitudes from the Tones Task to Breath Counting.

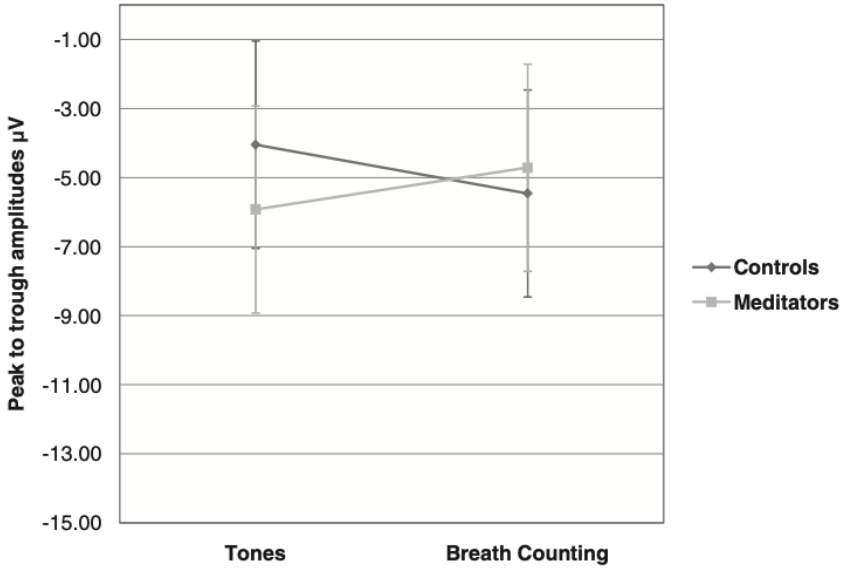


Fig. 6. N2 responses to targets, Pz. *This interaction was significant at the Pz site, $p = .044$, with meditators on average showing greater peak-to-trough N2 amplitudes during the Tones task and attenuated N2 amplitudes during the Breath Counting task in comparison to controls.

Results:

c) Exploratory ERPs

- **P3 for standard and low infrequent (non-target) tones -** No group effects
- **N2 at Pz**
  - Meditators showed higher amplitude than Controls in both tasks for low infrequent tones
  - No significant results for standard tones
- **N1 at all sites**
  - Reduction in amplitude from Tones to Breath Counting task for all tone types (except for Pz – no effect in low infrequent tones)
  - At Cz, meditators showed higher amplitude than controls for low infrequent tones
- **P2 results are scattered**

d) Respiration (breath rate)

- 2 (tasks, within subjects) x 3 (groups, between subjects) ANOVA revealed a main effect of task
- Respiration count during ”meditation” << during Tones task
- This effect stays valid even if the 15 min data is split into 3 segments.

Results:

e) Drowsiness

- No differences in drowsiness measures across groups
- When theta and alpha measured separately, there is a significant task x group interaction for theta.
- naive had greater theta than meditators – suggesting a less vigilant state.

f) MEDI scores

- Significant difference between naïve and experienced meditators (*p = .024)*
- Marginal significance between naïve and novice (*p = .054)*

g) Behavioral Measures

- Target hit rate: 98% for meditators; 97% for controls
- No analysis on reaction time

Discussion:

1) Objective measures of mindfulness meditation competence – ERP markers of auditory attention
2) Meditators – greater attentional control compared to non-meditators
3) Drowsiness is not a cause of the effects observed
4) Does counting breath really count as meditation?
    - A possible reason why there are no differences between novices and experienced.

Table 1. Participant characteristics

	All participants (SD)	Non-meditators (SD)	Novice meditators (SD)	Experienced meditators (SD)
N	42	13	15	14
Age (*M*)	49 (13)	48 (11)	50 (13)	49 (15)
Female	62%	69%	73%	43%
Minority	24%	23%	27%	21%
Practice in years (*M*)	–	–	2.4 years (2.5)	22.6 years (13.2)

There were no significant demographic differences among groups.

Table 2. Tone and Breath Counting tasks

Tones tasks	Breath Counting task
Length: 15 min	Length: 15 min
Stimuli: ~45 target tones	Stimuli: Same as tones task
10% High-frequency target tone	
10% Low-frequency distracter tone	
80% Standard tone	
Instructions: Sit still with eyes closed and press a button for the high-frequency target tones only	Instructions: Sit still with eyes closed, ignore all tones, and count breaths. If count is lost, press a button and resume counting
Hypothesis: Participants' neurophysiological responses (N2 and P3 amplitudes) to the target tones would correlate with amount of attention training—the more training, the higher the amplitude	Hypothesis: N2 and P3 amplitudes elicited by high-frequency tones (previous target) would be most attenuated in experienced meditators, less attenuated in novice meditators, and least attenuated in naive subjects

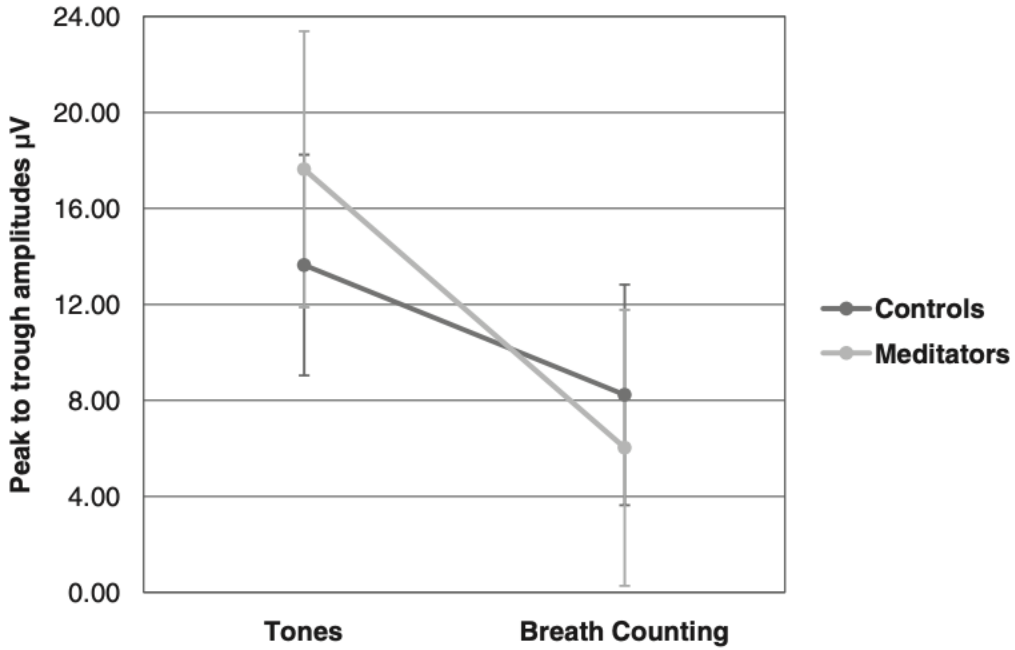


Fig. 1. P3 responses to targets, Cz. *For target tones this interaction was significant, $p = .039$, with meditators showing a greater change in peak-to-trough P3 amplitudes from the Tones to the Breath Counting task.

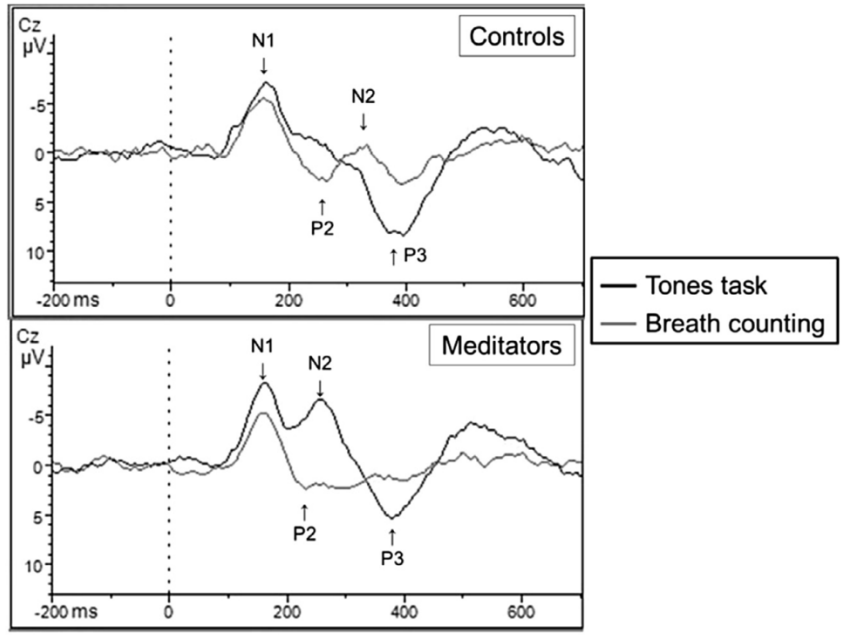
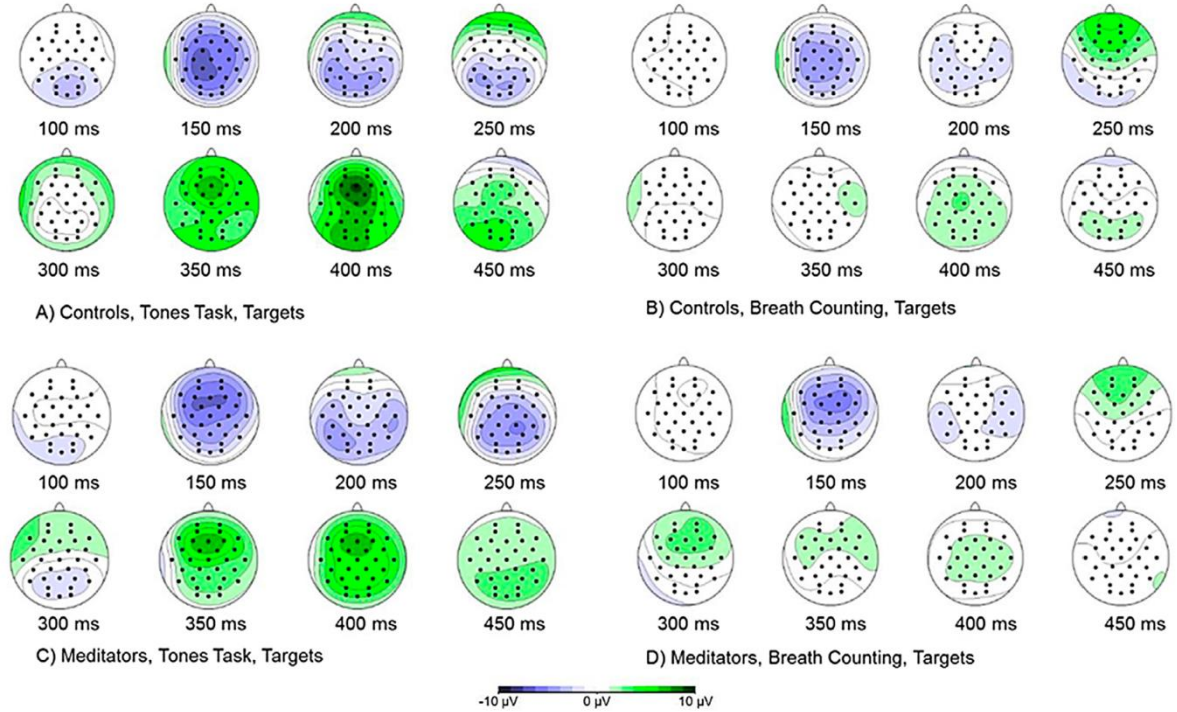


Fig. 2. Target tone event-related potential responses. *With novice and experienced groups combined, meditators showed a greater peak-to-trough change in P3 and N2 across tasks in comparison to non-meditators when responding to infrequent target tones. Data here are reported from the Cz electrode site. Please note that the ERP component labels are approximate denotations of general areas that may not apply to both overlapping conditions.



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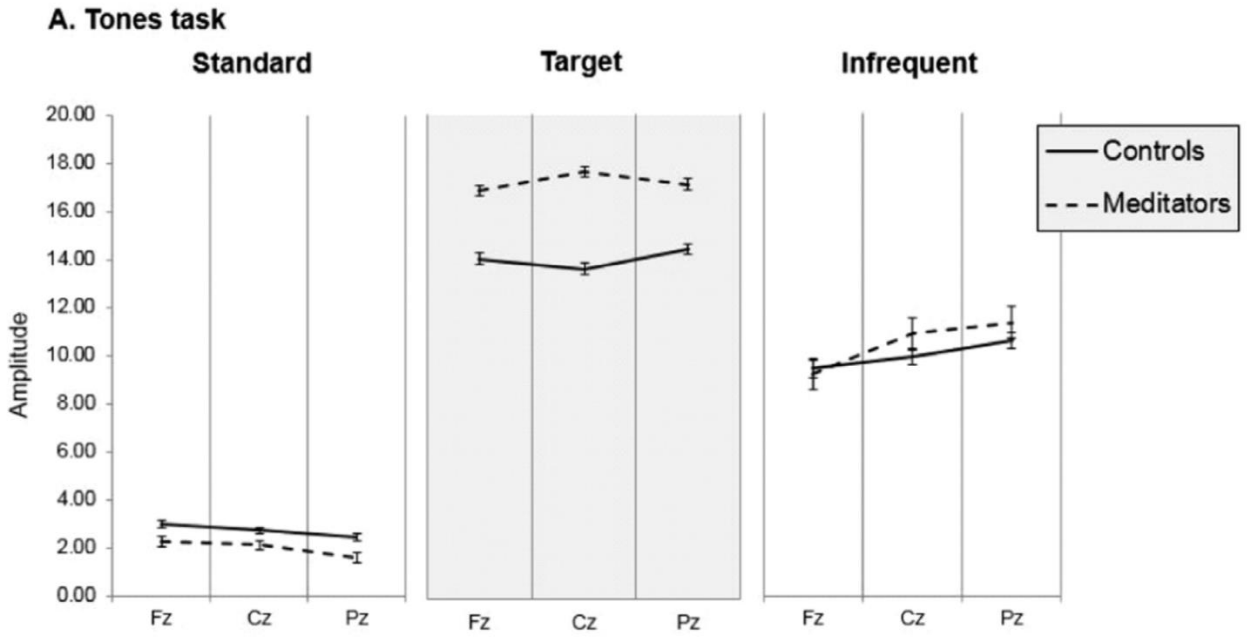


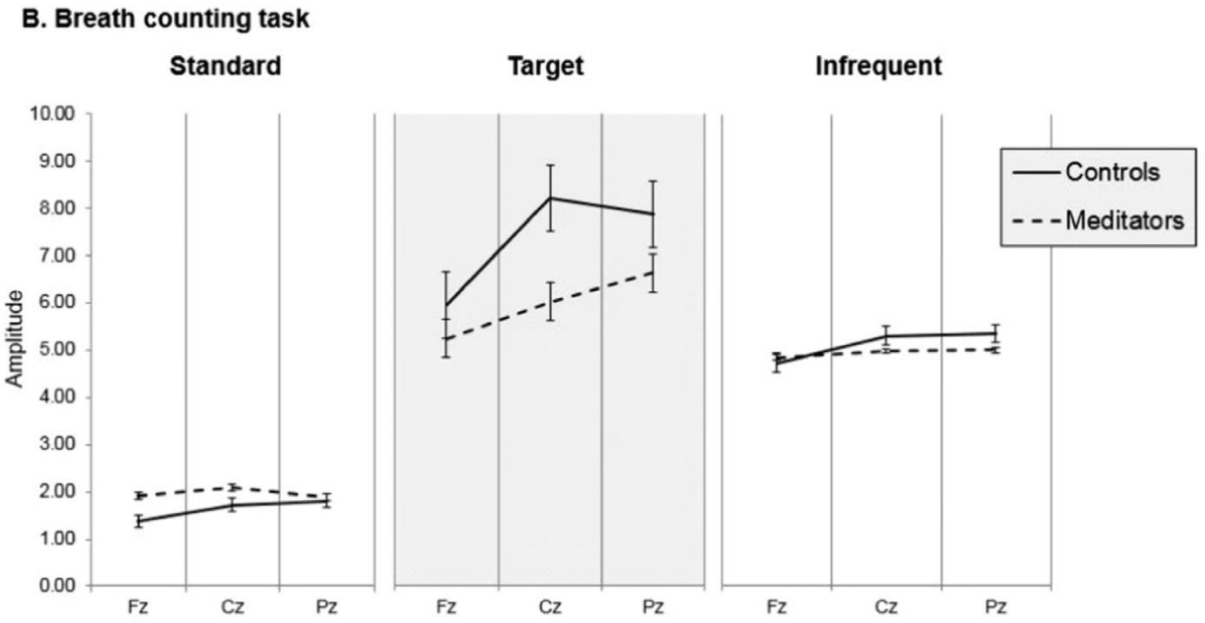
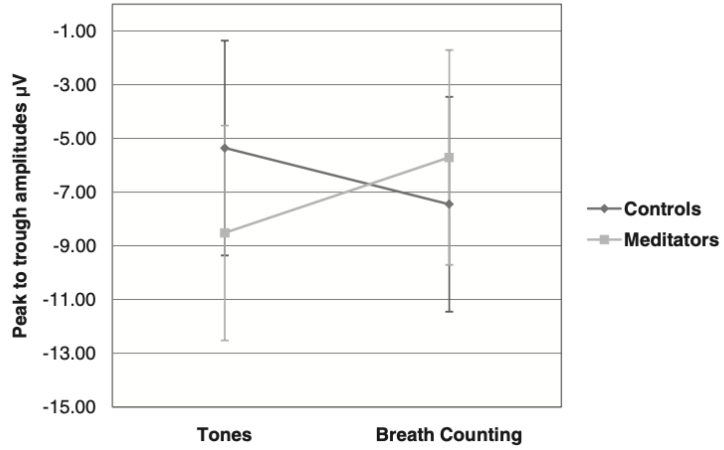


Fig. 4. P3 amplitudes across all conditions (group, task, tone, type).



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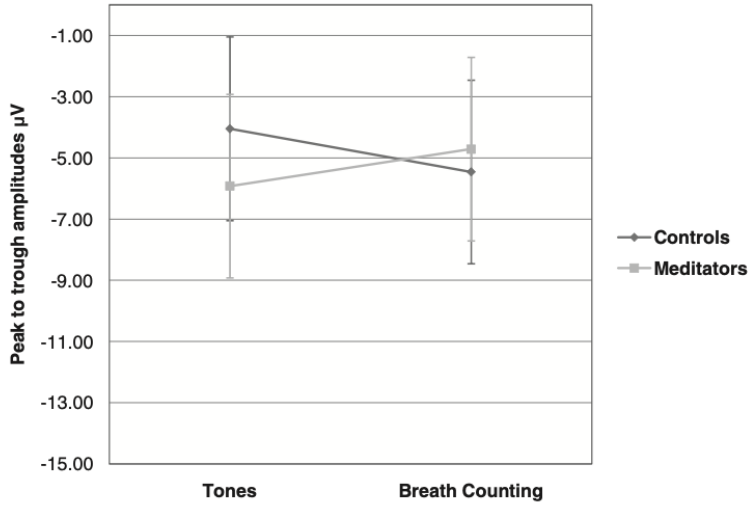

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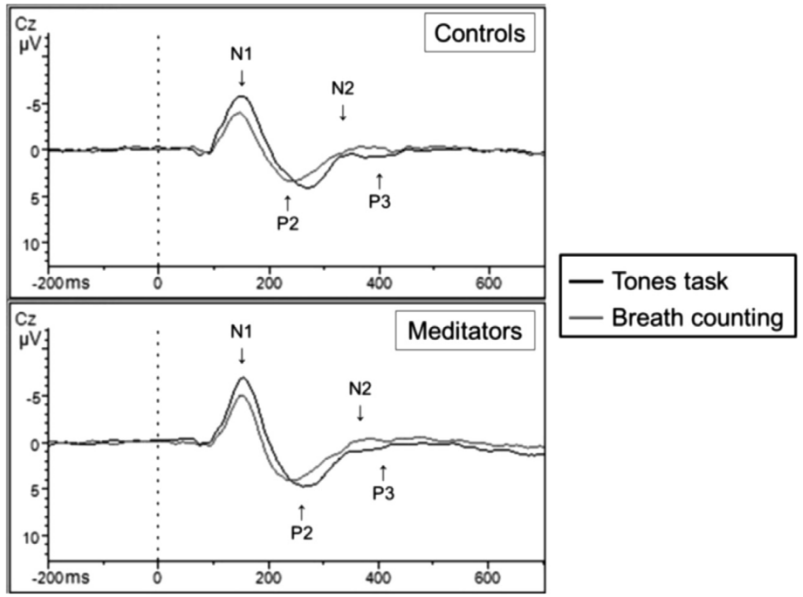

Fig. 7. Frequent standard tone event-related potential responses. *For frequent standard tones there were significant changes in N1 and P2 peak-to-trough values from the Tones task to the Breath Counting task, but there were no group effects, as expected.

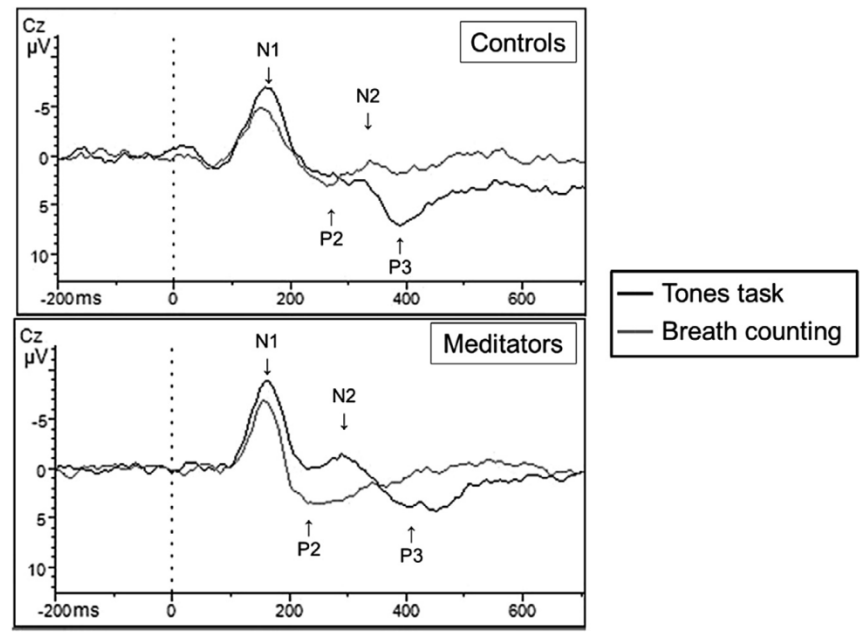

Fig. 8. Infrequent non-target tone event-related potential responses. *At the Cz site, there were significant changes in amplitude in N1 and P3 responses to infrequent non-targets as well as a group effect for N1 responses, with meditators showing higher amplitudes during the Tones task, $p = .02$. There was an additional group effect for P2 with meditators showing higher amplitudes during the Breath Counting task, $p = .04$.