Pitch-related mismatch negativity as an index of musical aptitude

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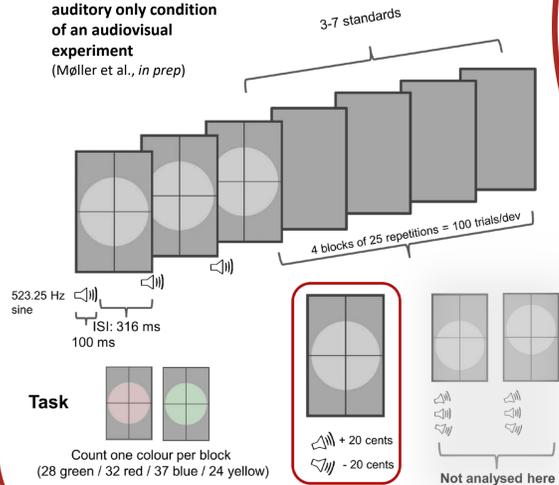
Background

- Musicians excel in pitch discrimination[1, 2]
- Behavioural performance is reflected in the MMN amplitude as evidenced by group level studies and by within-subject responses to different levels of deviance magnitude[3,4]
- Studies are needed also on individual levels in order to validate the MMN as a tool for the assessment of individual differences in auditory and musical skills

We asked:
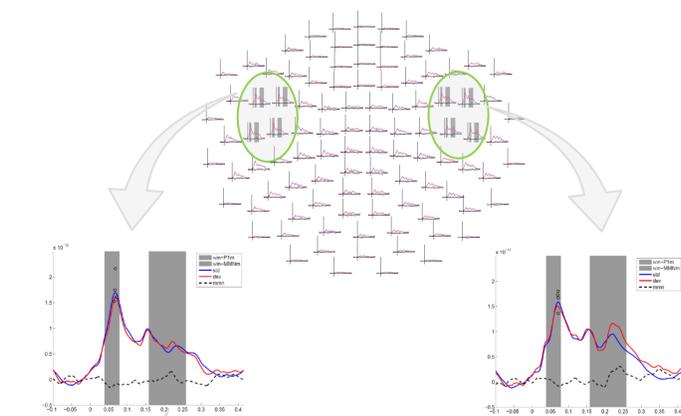
Can the pitch MMNm be used as a tool to assess inter-individual differences in auditory and musical skills?

Methods

MEG

A re-analysis focused on the auditory only condition of an audiovisual experiment
(Møller et al., in prep)

3-7 standards

4 blocks of 25 repetitions = 100 trials/dev

523.25 Hz sine
100 ms
ISI: 316 ms

Task
Count one colour per block
(28 green / 32 red / 37 blue / 24 yellow)

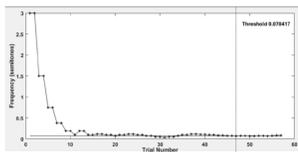+ 20 cents
− 20 cents

Not analysed here

Behaviour

The Musical Ear Test (MET): a short (52 trials), reliable, and easily accessible behavioural test of musical aptitude.[5] Here, we used the melodic part of the test
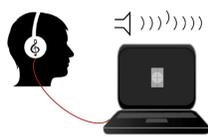
Same
Different
?

Pitch discrimination thresholds (PDT): estimated using a two-down, one-up adaptive staircase, AXB task, X = 523.25Hz, duration: 100 ms, SOA: 400 ms

Reaction time (RT) measures: derived from a behavioural equivalent of the MEG paradigm using 700 ms ISI to allow time to respond to the pitch changes[6]
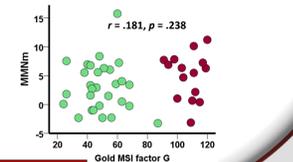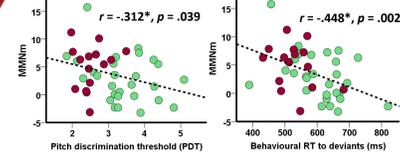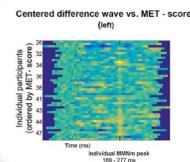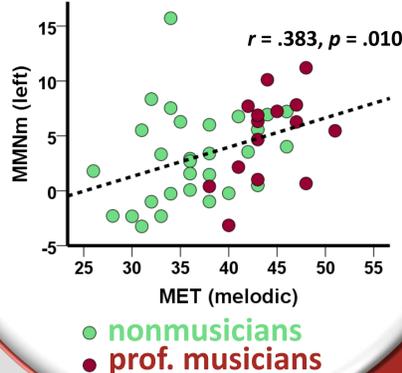
Goldsmiths Musical Sophistication Index (Gold-MSI): Factor G of the self-report questionaire assesses individual differences in general musical sophistication[7]

Analyses and results

Elekta Neuromag Triux™ whole-head 306-channel MEG system
Sensor-space ERF analyses (FieldTrip), root-mean-square combined gradiometers only.
MMNm = deviant – 3rd standard in a train
Individual MMNm amplitude = 20 ms windowed mean centered on individual peak, 100-200 ms post P1m.

Pitch MMNm as a function of musically relevant behavioural measures

$n = 44$ (15 musicians)

$r = .383, p = .010$

MMNm (left)
MET (melodic)

nonmusicians
prof. musicians

Centered difference wave vs. MET - scores (left)

$r = -.312*, p = .039$
$r = -.448*, p = .002$
$r = .181, p = .238$

Pitch discrimination threshold (PDT)
Behavioural RT to deviants (ms)
Gold-MSI factor G

Correlations between behavioral measures and MMNm amplitudes in both hemispheres				
	MET(melodic) r [lower, upper]	PDT r [lower, upper]	Behavioural RT r [lower, upper]	Gold-MSI, G r [lower, upper]
MMNm amplitude, left hemisphere	.383* [.098, .662]	-.312* [-.527, -.047]	-.448* [-.668, -.118]	.181 [-.097, .469]
MMNm amplitude, right hemisphere	.083 [-.173, .308]	-.135 [-.387, .134]	-.199 [-.444, .066]	.047 [-.263, .333]
MET(melodic)		-.546* [-.663, -.428]	-.424* [-.651, -.164]	.651* [.469, .804]

Pearson correlation coefficients (r) with bootstrapped bias-corrected and accelerated (BCa) 95% confidence intervals (CI) in brackets, $n = 44$. * = r is statistically significant at α .05, as indicated by 95% CIs not including 0

Conclusions

Using near-threshold pitch deviants in combination with an engaging task and an individualized analysis facilitated detection of MMN-behavior correlations. These results provide the first evidence of MET-MMNm correlations, and support the notion of the pitch-MMNm as an index of inter-individual differences in auditory and musical skills.

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