

# The CI MuMuFe

## - a new MMN paradigm for measuring music discrimination in electric hearing

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### Introduction

- Cochlear implants (CIs) allow good perception of speech while music listening is unsatisfactory [1].
- Extensive research has aimed to improve music perception with CIs [2].
- To measure music discrimination abilities of CI users, objective and feasible tests are in demand [3].
- The purpose of this study was to design and test a novel musical MMN-paradigm for use in future CI research.

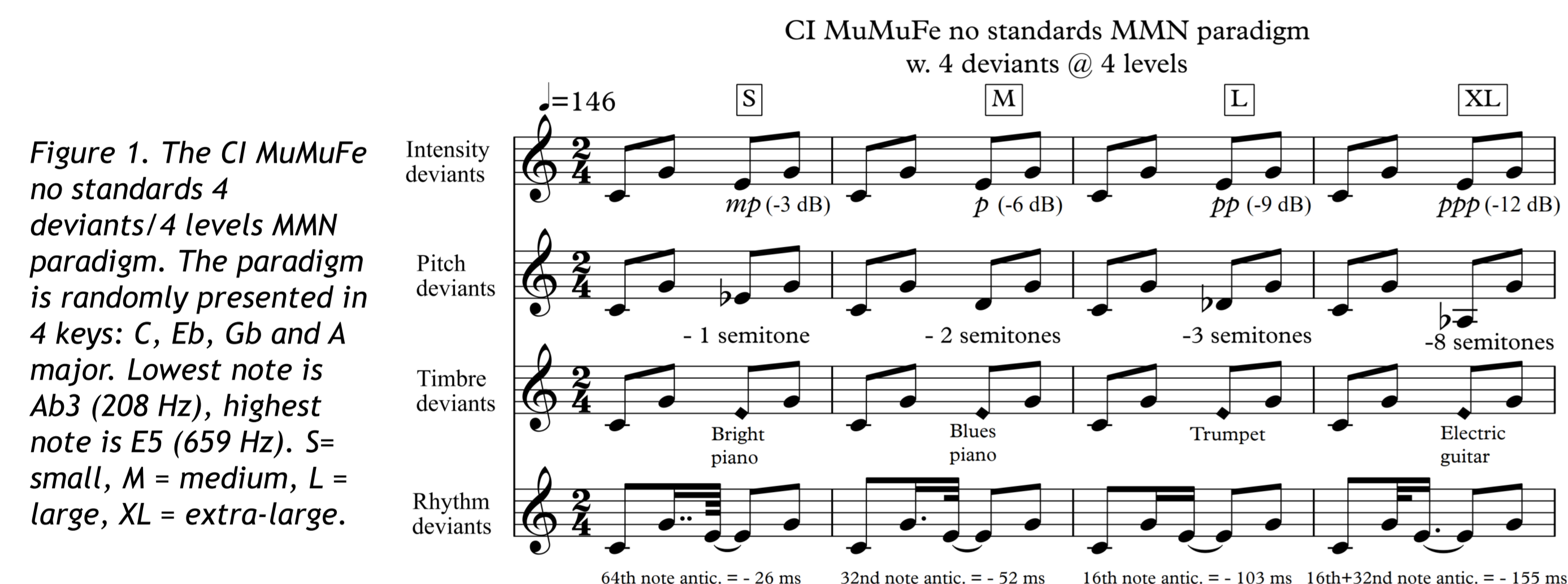
### Methods

#### Participants

Eleven adult CI users ( $M^{age}$ : 60.7 y) and 14 normal-hearing (NH;  $M^{age}$ : 63.4 y) controls took part in the study.

#### Tests

- Participants underwent EEG recording while listening to the *CI MuMuFe MMN-paradigm*. The paradigm randomly presents deviants in pitch, timbre, intensity and rhythm at four levels of magnitude (S, M, L, XL) in a 'no-standard' approach.
- In addition, participants completed a behavioral test, measuring discrimination of features and levels also presented in the MMN-paradigm.



### Results

- All deviant types and levels elicited statistically significant MMN responses in both the NH and the CI group.
- CI users' overall MMN amplitudes and latencies were not significantly different from those of the NH group (figure 2).
- We found an overall relationship between MMN strength and deviation magnitude across participants; the larger the deviation, the stronger the MMN response (figure 3).
- Behaviorally, CI-users scored significantly below the NH group in discrimination of intensity, pitch and timbre. For rhythm, the two groups had comparable results. Overall, hit rates corresponded well with levels of magnitude (figure 4).
- The NH group elicited significantly larger MMN amplitude for the XL level of the *pitch* deviant compared to L, M and S levels. CI-users showed no discrimination between any pitch levels in terms of MMN amplitude.

### Conclusion

- The CI MuMuFe paradigm can effectively estimate musical discrimination abilities and thresholds in CI users.
- The paradigm offers assessment of a wide range of perceptual profiles and may be a valuable tool in measurements of the effect of auditory training.
- The paradigm may have clinical relevance for evaluation of discrimination thresholds and limits in follow-up procedures, e.g., in young children.
- Future studies should investigate the possibility of applying the paradigm with the purpose of assessing discrimination skills at the individual level.

This study is reported in Petersen, B., Andersen, A. S. F., Haumann, N. T., Højlund, A., Dietz, M. J., Michel, F., Riis, S. K., Brattico, E. & Vuust, P. (2020). *The CI MuMuFe-A New MMN Paradigm for Measuring Music Discrimination in Electric Hearing*. *Frontiers in neuroscience*, 14, 2.

#### References

- [1] Cooper, W.B., Tobey, E. and Loizou, P.C. (2008). Music perception by cochlear implant and normal hearing listeners as measured by the Montreal battery for evaluation of Amusia. *EarHear*. 29.  
[2] Petersen, B., et al., Brain responses to musical feature changes in adolescent cochlear implant users. *Front Hum Neurosci*, 2015. 9: p. 7.  
[3] Näätänen R, Petersen B, Torppa R, Lonka E, Vuust P. The MMN as a viable and objective marker of auditory development in CI users. *Hearing Research*, 2017.

### Figures

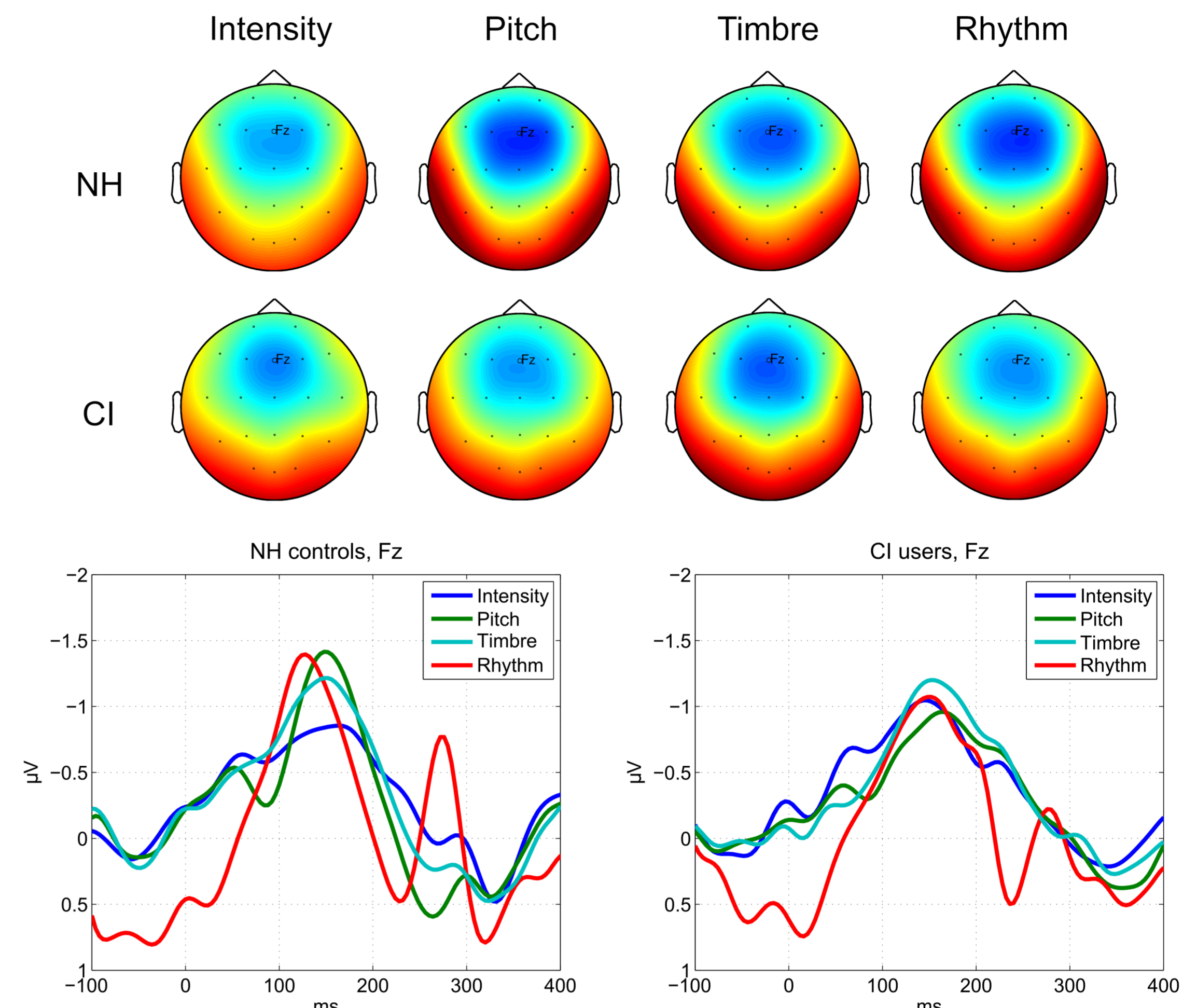


Figure 2. MMN responses to deviants in each auditory feature. (Top) Average MMN scalp topographies measured in a 30 ms time window centered on the peaks for each feature. The colors are scaled from -2 mV (blue) to +2 mV (red). NH, normal hearing controls; CI, adult cochlear implant users. (Bottom) Average MMN waveforms for each feature and group measured at the Fz electrode.

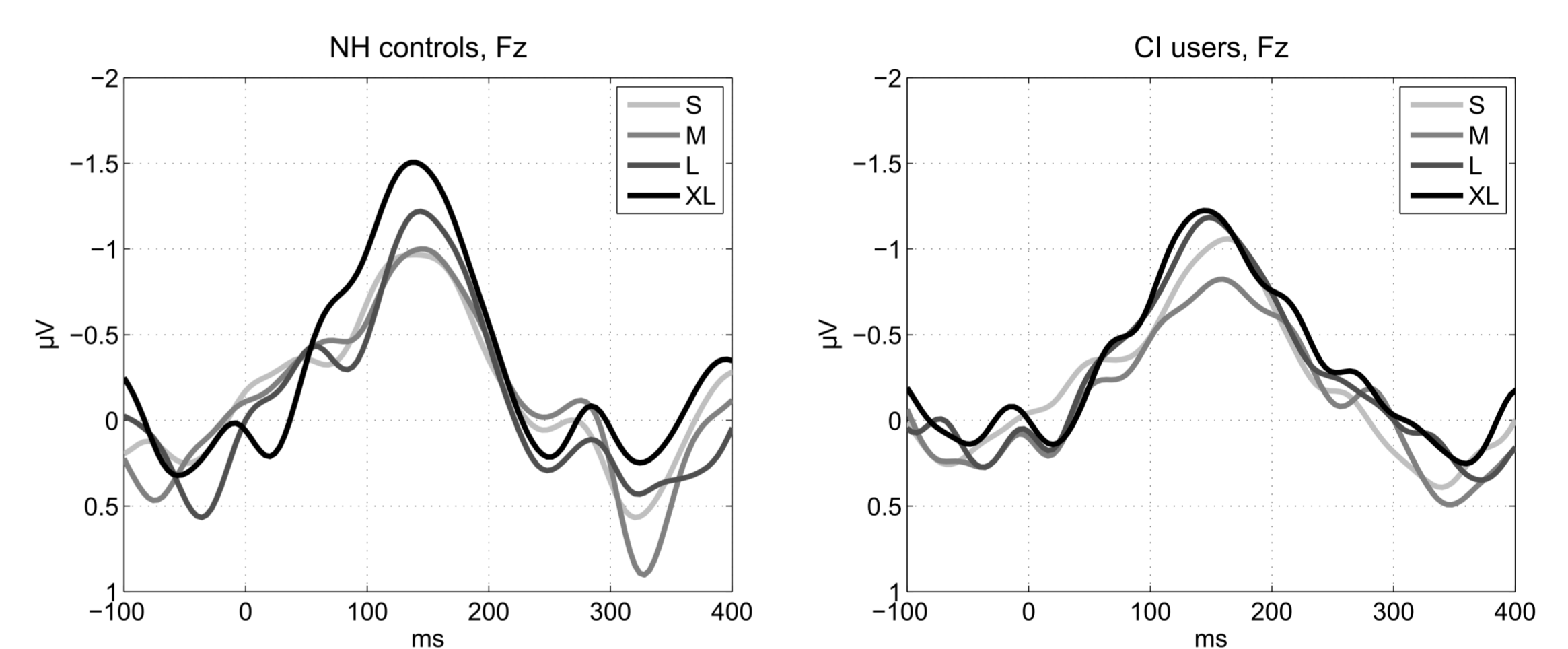


Figure 3. Average MMN waveforms for each deviant level and group measured at the Fz electrode.

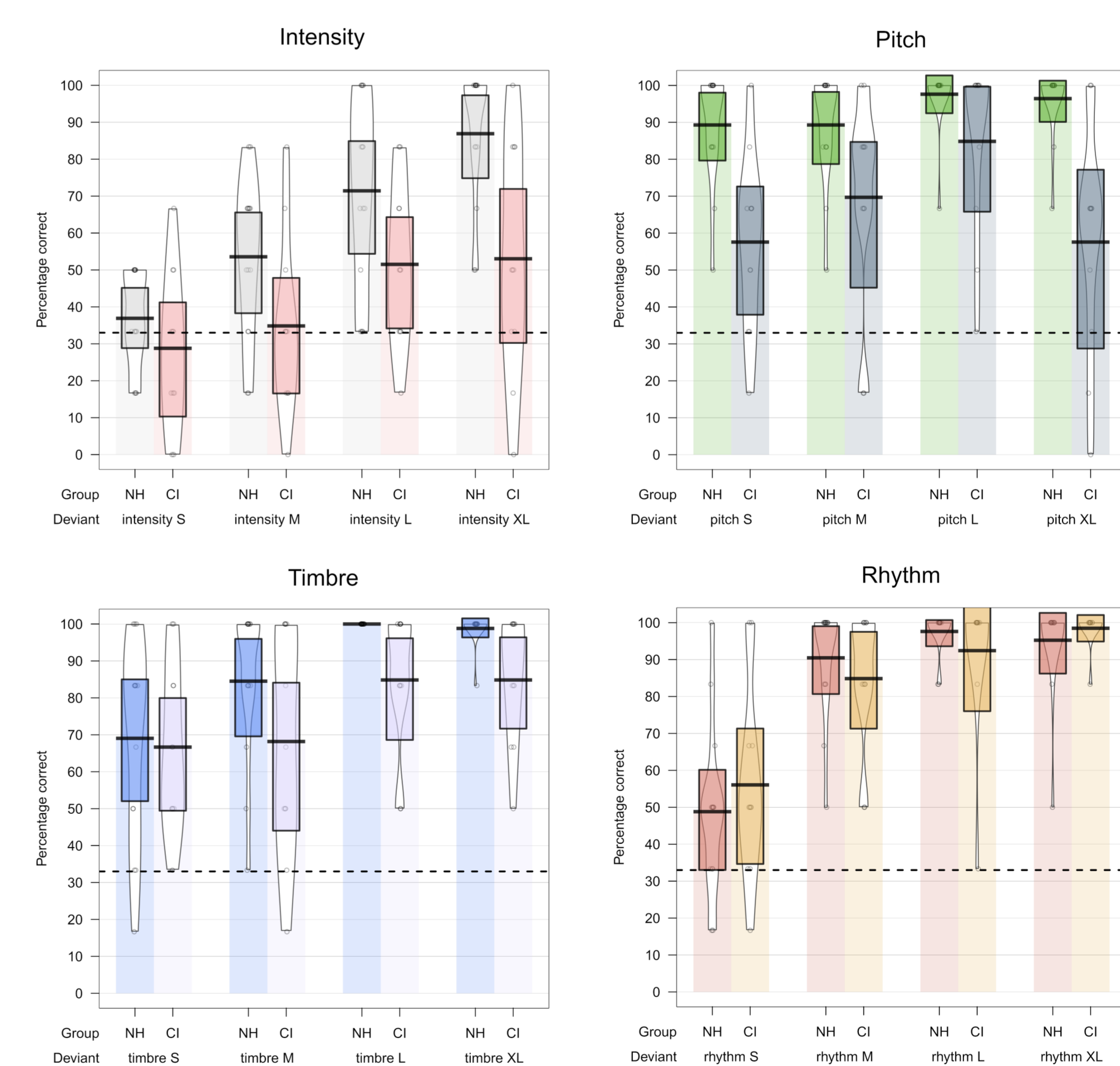


Figure 4. Violin plots showing behavioral hit rates for each feature, level, and group. Dotted line indicates chance level. Solid lines: mean % correct.

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