Prediction of children psychophysiological age using patterns of auditory event-related potentials

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Background

Although there are many psychological scales for determining whether a child's age corresponds to the norm in population, patterns of brain activity could also reflect child development and serve as valuable markers of psychophysiological age.

This study aimed to determine the psychophysiological age of children using components of auditory event-related potentials (ERPs). The novelty of the study approach is that age was predicted at an individual level by regression models of machine learning.

Materials and methods

ERPs were recorded in response to auditory tones presented with different loudness in three groups of children (N=7, age range 4.14-6.42; N=16, age range 7.08-11.98; N=9, age range 12.04-17.98).

Averaged amplitudes and latencies of ERPs were compared by Kruskal-Wallis test and served as features for classification by LightGBM machine learning algorithm. The importances of features were determined by the numbers of times the feature is used in a model.

Results

We observed significant group differences in amplitudes (**Figure 1**) of P1 (median=.82, std=1.62; median=1.99, std=1.63; median=.87, std=.1.01), P2 (median=.66, std=3.08; median=1.74, std=3.03; median=1.28, std=2.95), N2 (median=-2.82, std =5.21; median=-5.70, std=3.31; median=-2.91, std=2.69) and latencies (**Figure 2**) of P1 (median=88, std=19.87; median=80, std=14.22; median=70, std=18.82) and P2 (median=128, std=18.88; median=133, std=21.58; median=156, std=17.63) components of ERPs ($p<.05$). The classification accuracy between the three age groups was .85, ROC/AUC - .88. The most informative features for correct age recognition were latency of P1 and amplitude of N2.

Conclusion

The study findings confirm that auditory ERPs reflect brain developmental changes. The application of the machine learning approach for the classification of ERP data allowed us to determine the psychophysiological age range at the individual level.

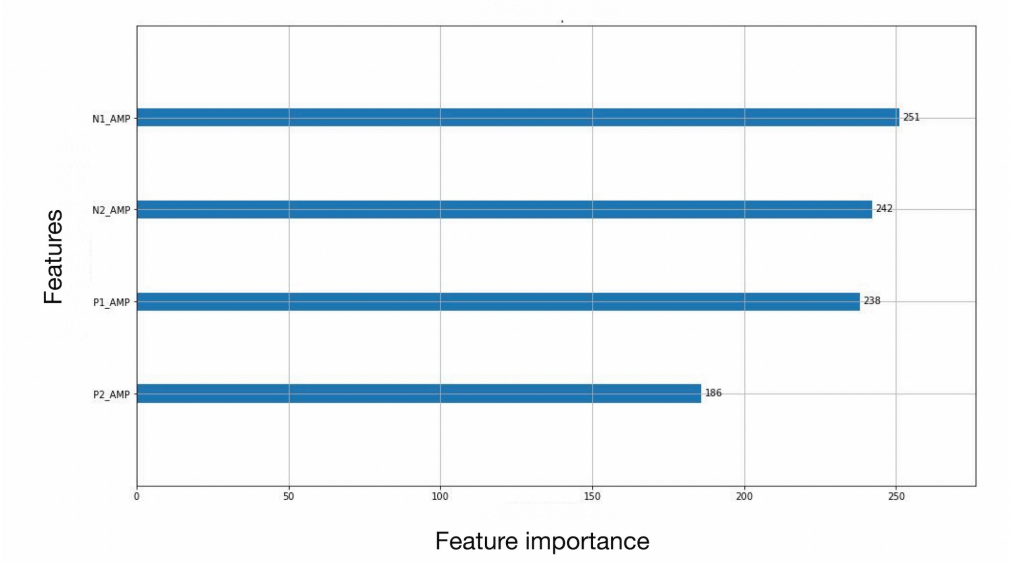

Figure 1: Feature importance for amplitudes of P1 and P2 components of ERP

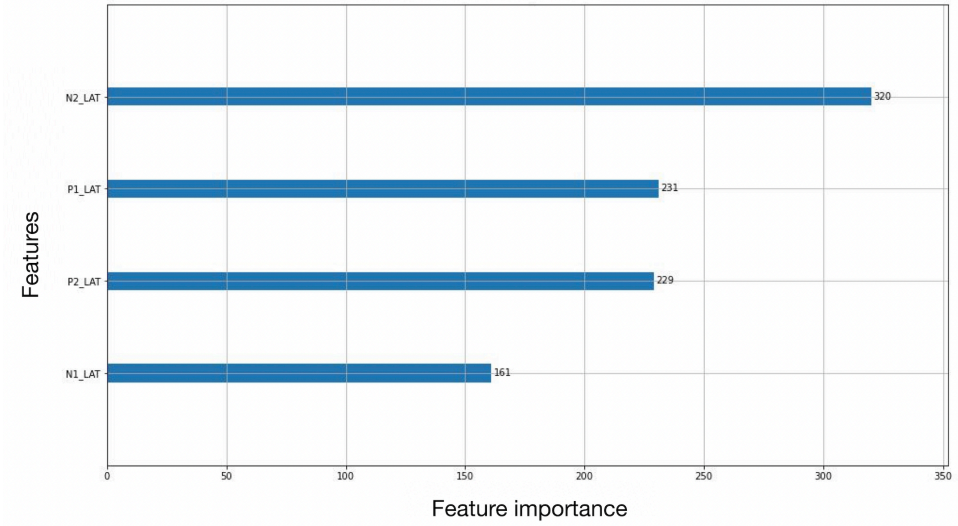

Figure 2: Feature importance for latencies of P1 and P2 components of ERP