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Corrigendum: Riemannian geometry-based metrics to measure and reinforce user performance changes during brain-computer interface user training

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brain-computer interface (BCI), electroencephalography (EEG), user training, Riemannian geometry, user evaluation, simulation

A corrigendum on
Riemannian geometry-based metrics to measure and reinforce user performance changes during brain-computer interface user training

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In the published article, there was an error. An additional detail regarding the computation of the weighted average *classDistinct* and *classStability* metrics was missing.

A correction has been made to Section 2. Materials and methods, subsection "*2.1 Performance metric design*", paragraph 7. This sentence previously stated:

"The intra-class dispersion is computed using:

$$(1-\alpha_2)\,\Phi_{k-1,c}+\alpha_2\phi_{k,c} \tag{6}$$

where $\alpha_2 \in [0,1]$ is a constant, $\phi_{k-1,c}$ is the intra-class dispersion for the class c trials of the (k-1)th block, and $\phi_{k,c}$ is the intra-class dispersion of class c trials computed only during the current (kth) block."

The corrected sentences appear below:

"For the weighted average *classDistinct* and *classStability* metrics, we made the following modification to the calculation of the intra-class dispersion. We split the set of trials, T, into N_s subsets of N_t trials, T_j, such that

$$T_1 \cup T_2 \cup \cdots \cup T_{N_s} = T.$$

Subsets were formed by splitting trials according to the chronological order in which they were performed; for example, the first N_t trials performed during a block would be grouped into subset T_1. Using these subsets, we computed a modified intra-class dispersion as:

$$\Phi^* = \frac{1}{N_s}\frac{1}{N_t}\sum_{j=1}^{N_s}\sum_{i=1}^{N_t}\delta_R(\overline{\Gamma}_{T_j},\ \Gamma_{T_{j,i}})$$

where N_s is the number of trial subsets, N_t is the number of trials in each subset, $\overline{\Gamma}_{T_j}$ is the mean covariance matrix of trials within the j^{th} subset of trials, $\Gamma_{T_{j,i}}$ is the covariance matrix of the i^{th} trial within subset T_j, and δ_R denotes the Riemannian distance. The motivation behind this modification was to reduce the impact of signal non-stationarities that may artificially increase the intra-class dispersion when considering a large number of trials. For our analysis, we set $N_t = 5$. Trial subsets were disjoint save for when computing within-block post-trial intra-class dispersion values. If the number of trials completed within the block was not divisible by N_t, subset T_{N_s} was formed using the most recently completed N_t trials; consequently, this subset could share up to $N_t - 1$ trials with subset $T_{N_s - 1}$.

The post-trial intra-class dispersion was computed using this modified intra-class dispersion:

$$(1-\alpha_2)\ \Phi^*_{k-1,c} + \alpha_2\phi^*_{k,c} \quad (6)$$

where $\alpha_2 \in [0, 1]$ is a constant, $\Phi^*_{k-1,c}$ is the modified intra-class dispersion for the class c trials of the $(k-1)^{th}$ block, and $\phi^*_{k,c}$ is the modified intra-class dispersion of class c trials completed only during the current (kth) block."

The authors apologize for this error and state that this does not change the scientific conclusions of the article in any way. The original article has been updated.

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