Improving user comfort in auditory-steady-state-response brain-computer interface by using a co-adaptive stimulus

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\textbf{Motivation}

- Auditory steady-state responses (ASSR) modulated through auditory selective attention (ASA) \cite{1}.
- ASSR generated without training; convenient for brain-computer interface use.
- Current paradigms: binary classification, but result in subject tiredness.
- Improvements of the bearability of the stimulus attempted \cite{2}, but level of attention required remains an issue if two beats are displayed continuously at the same level.
- Keeping focus on salient stimuli easier and requires less effort \cite{3}: co-adaptive paradigm. We hereby prove the feasibility of such a paradigm.

\textbf{Adaptive Auditory Stimulus}

- Two amplitude-modulated tones (one per ear).
- Three intensity levels: high (no adaptation), intermediate (decrease of non-target sound to achieve enhanced comfort), low (lowest level to hold focus on a tone).
- Levels tuned to each subject by decreasing the intensity of the non-target tone to match the described perceptual conditions:
  - 1 high: 100\%
  - 2 intermediate: 81\%
  - 3 low: 64\%

\textbf{Experiment Design}

- With 3 sound levels and the decision rules designed, we distinguish 5 combinations of accessible sound levels:
  - L1R1
  - L1R2
  - L2R1
  - L1R3
  - L3R1
- Subject listens to the two tones for 5 seconds while focusing on the instructed tone.
- Each of the 5 conditions is presented 50 times.
- Brain Product’s actiCHamp.

\textbf{Statistical simulation of online decoding}

- Compare online performance to the non-adaptive paradigm on two probability tables and two decision rules.
- Choice of the decision rule for the best accuracy

\textbf{Results}

- Classification: power in the bands $f_{\pm \Delta2Hz}$ for LDA classifier
- Average decoding accuracy: 67%
- Accuracy increase when the target stimulus is the stimulus at highest volume

\textbf{Conclusion}

- Equally performant decoding of intent with unbalanced (adaptive) and balanced stimuli.
- Simulated co-adaptive online performance comparable to non-adaptive one, easier focus.

\textbf{References:}


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