OBJECTIVES

1. Discover context-dependent changes in EEG activities by blind decomposition of single-trial log spectral changes plus trial-identifying context vectors that answer a number of questions about past, current and/or future trial events (stimuli, behaviors, outcomes).

2. Identify complex relationships between data dynamics and subject experience, behavior, and information processing.

TASK

Two-back with feedback

Continuous performance task

Match

Response

Response outcome different from previous letter?

Non-match

Subjects were presented sequential single letters whose durations varied based on subject performance (ISO = ±1.5 s). Beginning with the third letter, subjects responded to each letter, specifying with a right or left thumb press whether the current letter was the same as the one presented two letters before. An auditory feedback signal at letter offset informed the subject of whether their answer was correct or wrong. After 800 ms the next letter was presented. Correct responses added 1 cent, and incorrect or delayed responses deducted 1 cent from the subject's performance reward. Following 20 percent of correct responses, a different feedback tone signaled a larger (3 cent) bonus. Similarly, following 20 percent of incorrect responses another tone signaled a larger (5 cent) penalty. In 8 percent of trials, a ‘neutral’ feedback signal gave no performance feedback.

Response 0 = Non-Match?

Penalty or ‘neutral’ feedback?

21 CONTEXT QUESTIONS

Letter 1 = Letter 0?

Feedback +2 = Feedback 0?

Feedback 0 = Penalty?

Feedback 1 = Bonus?

Feedback 0 = Neutral?

Feedback 1 = Neutral?

Response 0 = Match?

Response 0 = Non-Match?

Response 1 = Response 0?

Response 2 = Response 01?

Response 2 = Response 1?

Response 0 = Response 0?

Trial-to-trial variations in event-related log spectral power perturbations following auditory feedback tones in this task may depend on the task significance of the current stimulus or the immediately preceding letter or on the combination of past performance, sequential history and the letter sequence, among other known and unknown variables. Log spectral changes following the feedback signal might also predict subject performance in current and future letter trials. Clearly there are many possible such context dependencies.

Context ICA (xiCA) separates trial-to-trial spectral variability into a Big linear mixture of active context dependencies.

CONTEXT

Sample trial sequence:

Response 1

Match

Response followed by a bonus?

Some possible context dependencies:

Determine a characteristic log spectral change following the feedback tone that depends on whether the preceding letter was a two-back Match?

Context ICA (xiCA) decomposes the principal single-trial variabilities in the data into a trial mean (ignored here) plus a weighted mixture of trial-to-trial difference linked to various context factors that could include simple expected context dependencies (e.g., correct vs incorrect) or more complex or unexpected relationships.

xiCA can find linear dependencies between continuous (EEG log spectral) data and discrete binary (yes/no) variables because between any two points (e.g., yes, no) a straight line may be drawn. Further exploration of the stability and limits of the method is needed.

#### SUMMARY

Traditional methods of EEG analysis either ignore trial-to-trial variability or evaluate only a small number of planned comparisons (ex: correct vs incorrect). However, the functional relationships of EEG activity to subject behavior and experience cannot necessarily be predicted.

Context ICA (xiCA) decomposition separates the principal single-trial variabilities in the data into a trial mean (ignored here) plus a weighted mixture of trial-to-trial difference linked to various context factors that could include simple expected context dependencies (e.g., correct vs incorrect) or more complex or unexpected relationships.

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