Talking off the top of your head: toward a mental prosthesis utilizing event-related brain potentials

L.A. Farwell, E. Donchin
Electroencephalography and Clinical Neurophysiology
Volume 70, Issue 6, December 1988

Tamara Denning
At a high level...

- EEG
- P300
- Can be used for communication?
Experimental Task...

MESSAGE

Choose one letter or command

A   G   M   S   Y   *
B   H   N   T   Z   *
C   I   O   U   *   TALK
D   J   P   V   FLN   SPAC
E   K   Q   W   *   BKSP
F   L   R   X   SPL   QUIT
Experimental Task...

MESSAGE

Choose one letter or command  100 ms

A  G  M  S  Y  *
B  H  N  T  Z  *
C  I  O  U  *  TALK
D  J  P  V  FLN  SPAC
E  K  Q  W  *  BKSP
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**Experimental Task...**

**MESSAGE**

Choose one letter or command  

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**ISI interval...**

125ms, 500ms
Experimental Task...

MESSAGE

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100 ms
Experimental Task...

MESSAGE

Choose one letter or command:

A G M S Y
B H N T Z
C I O U *
D J P V FLN
E K Q W *
F L R X SPL

* TALK* SPACBKSPQUIT
Experimental Task...

MESSAGE

Choose one letter or command

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Trial complete
Experimental Task...

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P300
Experimental Task...

MESSAGE

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B H N T Z *
C I O U * TALK
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F L R X SPL QUIT
Experimental Task...

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C I O U * TALK

D J P V FLN SPAC

E K Q W * BKSP

F L R X SPL QUIT
Experimental Task...

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Video...
Experiments

- 4 subjects (3 females, 1 male, 20-36 y.o.)
- EEG setup with amplification

**Session 1**
- ISI = 500ms
- ITI = 3120ms
- 6 blocks of 120 trials
  - Ended with real-time

**Session 2**
- ISI = 500ms, 125ms
- ITI = 1245ms, 3120ms
- 10 blocks of 30 trials
  - 5 blocks / ISI

Feasibility, real-time

Algorithms,
Accuracy/speed tradeoff
Algorithms

- SWDA (stepwise linear discriminant analysis)
- Peak-picking
- Area
- Covariance
Experiments and Timing

**Time Course of Events, 125 msec ISI**

- 1245 (ITI)
- ISI = 125
- Flash Duration
- Analysis Epoch ("subtrial") 1
- Subtrial 2
- Subtrial 3
- Subtrial 4
- Subtrial 5
- Subtrial 6

Each flash serves as the onset of a 600 msec analysis epoch ("subtrial").
Comparison of Scores of the 36 Stimuli

A) Subject 3
500 msec ISI
SWDA Scores

B) Subject 2
500 msec ISI
Covariance Scores
Accuracy
# Tradeoffs

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<th>Increase Speed</th>
<th>Decrease Accuracy</th>
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Overall

- 80% accuracy at 20.9 seconds
- 95% accuracy at 26.0 seconds
- SWDA most useful for 125ms
- Peak-picking most useful for 500ms
Discussion Points

- Algorithm findings given only 4 participants in 1 sitting
- Healthy versus locked-in participants
- Optimal grid-size for accuracy and speed
- Anticipation effect for non-randomized intensification
- …Fatigue effect?