Daily Use of a Brain-Computer Interface by a Man with ALS

256.1

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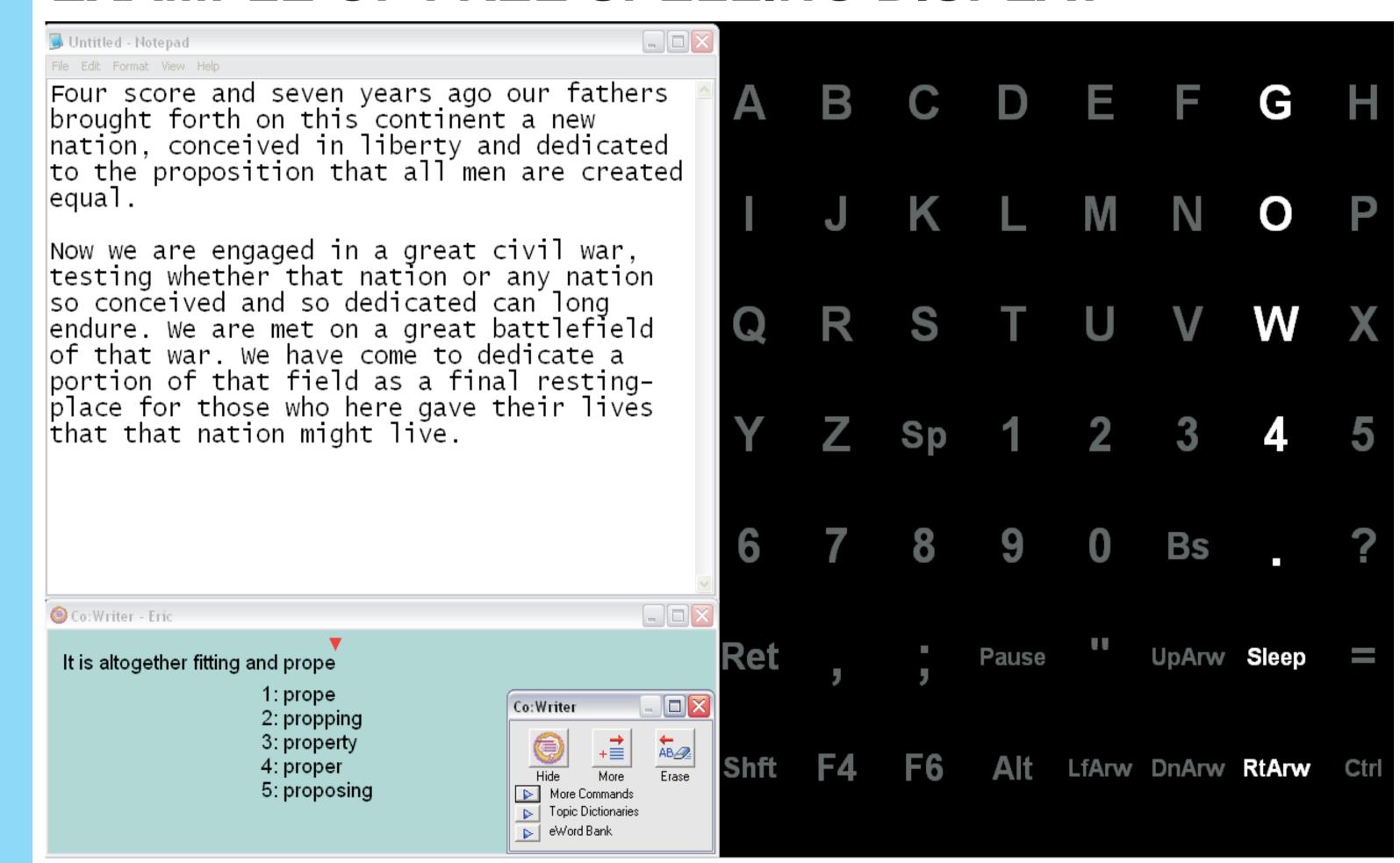[1]Wadsworth Center, NYS Dept Health, Albany NY; [2]Univ Penn, Philadelphia PA; [3]Univ Del, Newark DE; [4] Univ North FL, Jacksonville FL

Wadsworth Center
NYS Department of Health

INTRODUCTION

A non-invasive brain-computer interface (BCI) records brain activity from the scalp and uses the signals to convey intent.

Three users have been provided with portable P300 BCI systems that they use to perform a variety of tasks on a daily basis. Caregivers have been trained to apply electrode caps and start the systems. Each day data are transferred to the lab via an ftp protocol and analyzed. Classification coefficients are updated remotely on an as needed basis. Users are presented with a matrix of items, each emulates a keyboard command. The users operate the system by attending to a desired matrix item while all items flash rapidly. The attended item produces a P300 response and the unattended items do not. The system operates by detecting which item elicited the largest P300 on a given series of flashes. The system selects that matrix item, which emulates a keyboard command.

EXAMPLE OF FREE SPELLING DISPLAY

Free Spelling - Allows the user to produce messages of their own volition.
Copy Spelling - The user selects specific characters (i.e., Spells words) to provide calibration data.
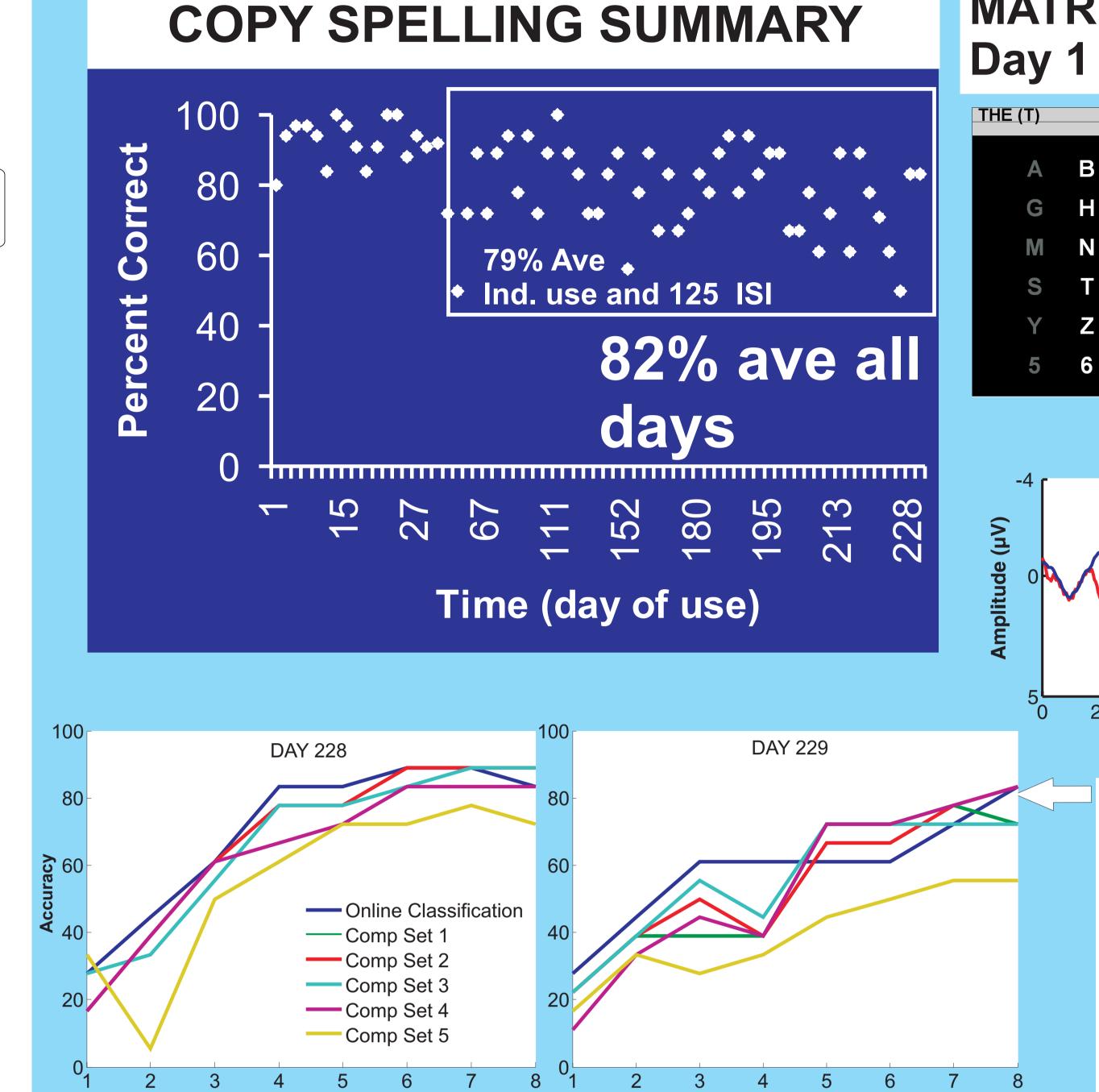
User A

Electrode Montage

- 48 y/o man
- Intubated
- Totally paralyzed except for eye movements
- System installed February 2006
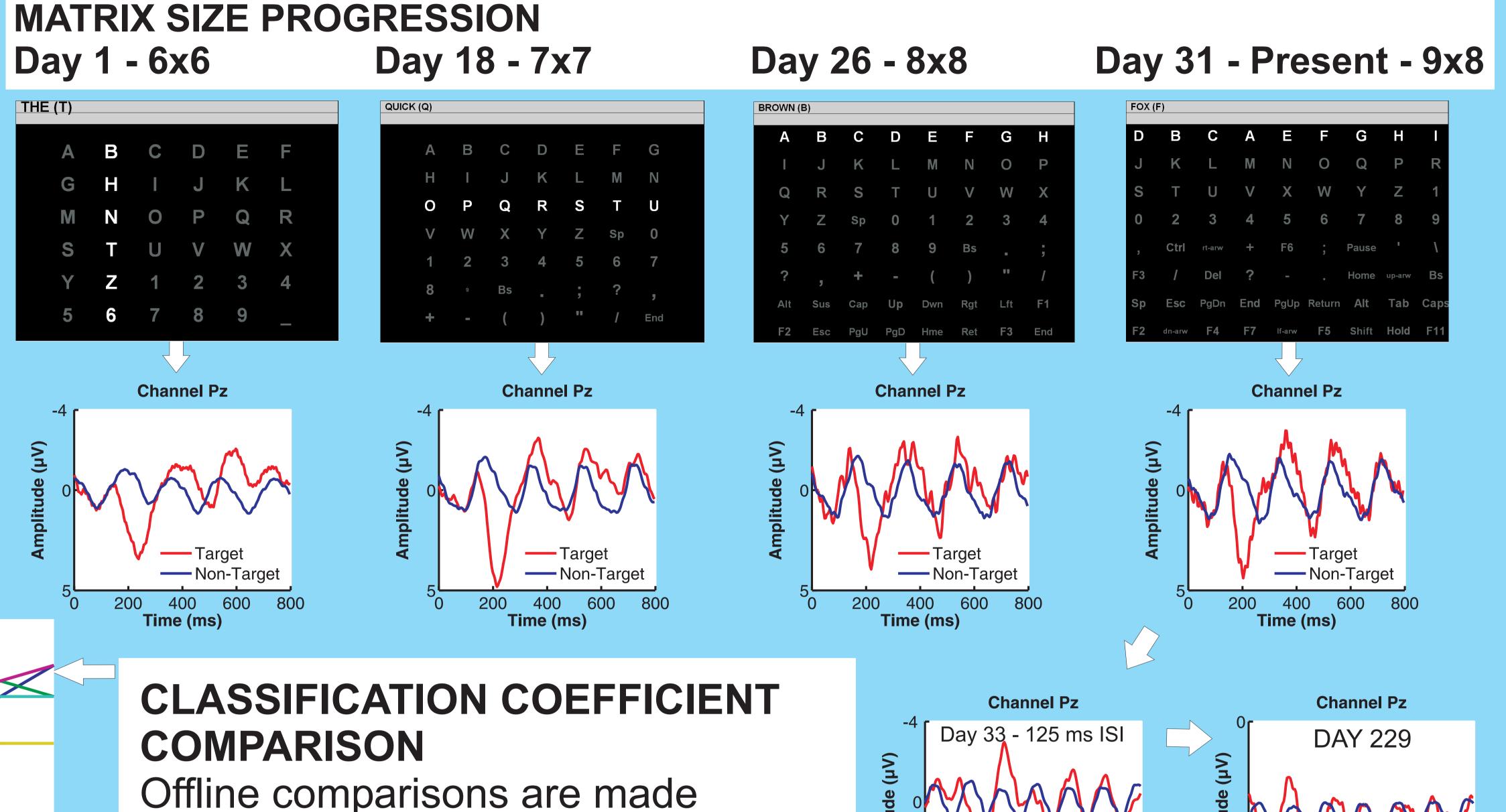- Immediately stopped using eye-gaze system

MATRIX SIZE and ISI PROGRESSION
- Systematic progression from 6x6 to 9x8 matrix
- Initial ISI was 188 ms and was reduced to 125 ms on day 33.
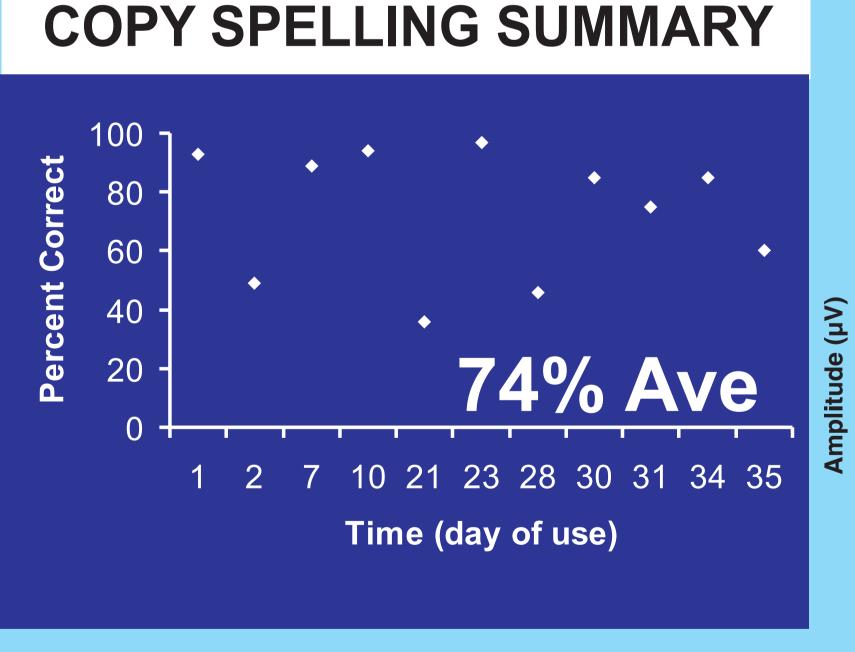
UNSUPERVISED WORK SUMMARY
- 2.7 hour daily average
- 189 selections/session average
- Primary tasks include email and word processing

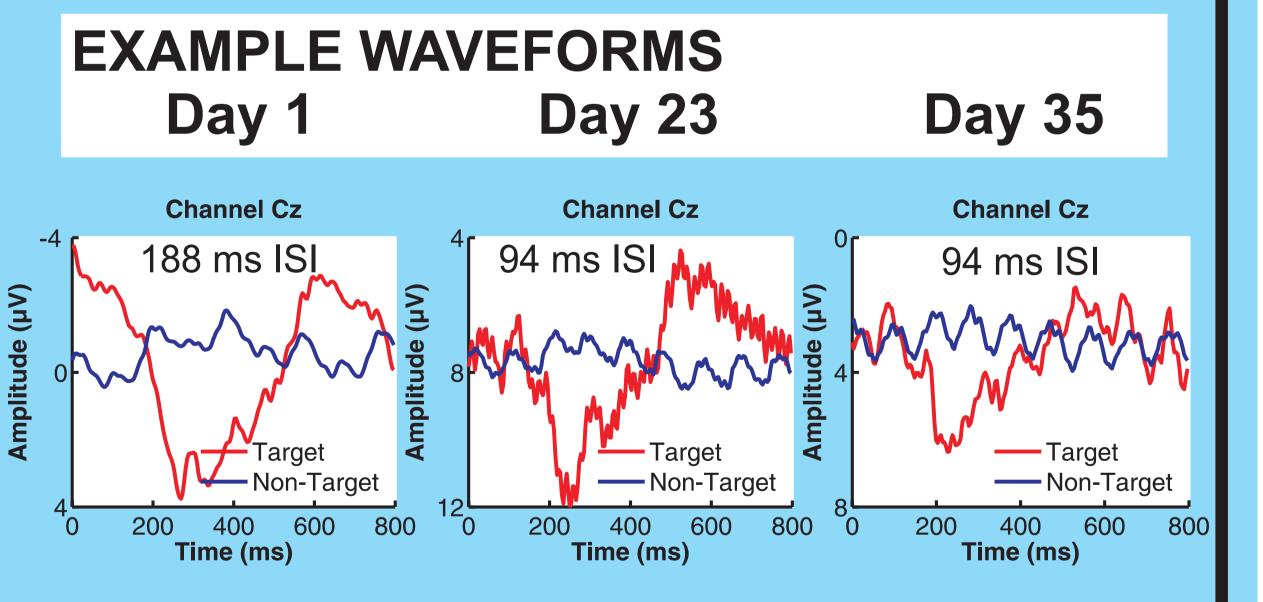### COPY SPELLING SUMMARY

79% Ave Ind. use and 125 ISI
82% ave all days

MATRIX SIZE PROGRESSION

Day 1 - 6x6   Day 18 - 7x7   Day 26 - 8x8   Day 31 - Present - 9x8

CLASSIFICATION COEFFICIENT COMPARISON
Offline comparisons are made between several sets of coefficients to optimize online performance and adjust the number of sequences (flashes).

DAY 228   DAY 229
Online Classification, Comp Set 1, Comp Set 2, Comp Set 3, Comp Set 4, Comp Set 5

Day 33 - 125 ms ISI   DAY 229

User B

- 61 y/o man
- Intubated
- Communicates via head/mouth/finger Movement (no speech)
- System installed September 2006

COPY SPELLING SUMMARY

74% Ave

EXAMPLE WAVEFORMS
Day 1   Day 23   Day 35

188 ms ISI   94 ms ISI   94 ms ISI

User C

- 59 y/o woman
- Intubated
- Totally paralyzed except for eye Movements
- System installed September 2006

COPY SPELLING SUMMARY

82% Ave

EXAMPLE WAVEFORMS
Day 1   Day 14   Day 28

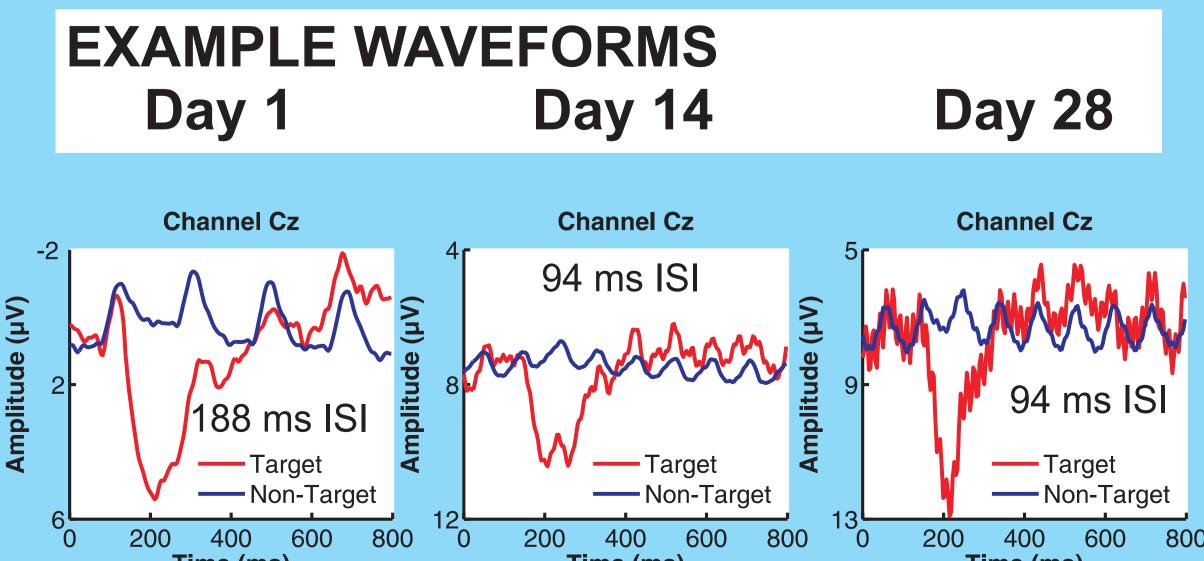188 ms ISI   94 ms ISI   94 ms ISI

INITIAL FINDINGS

1) Severely disabled people can and do use a BCI in their daily lives without close technical oversight.
2) The BCI improves communication ability.
3) In the first user, performance has been stable for 7 months.
4) The P300 response is relatively stable over time.
5) Quality of life is improved (self report).
6) Caregivers find the system easy to operate.

CONCLUSIONS

1) BCI technology is a feasible assistive technology for severely disabled people.
2) Subjects report improved quality of life and independence.
3) Future research will focus on additional modalities, automatic calibration, artifact rejection, improvement of the software interface, and documentation of the affects on quality of life.

ACKNOWLEDGEMENTS