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

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At a high level…

- EEG
- P300
- Can be used for communication?

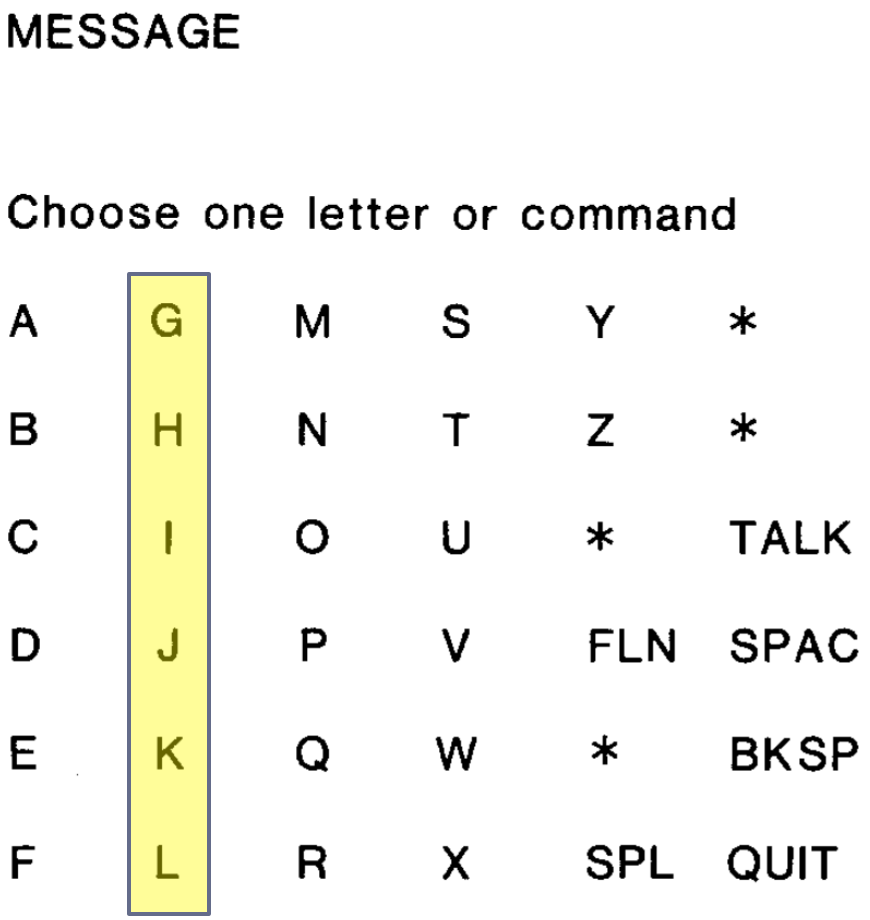
Experimental Task…

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…



100 ms

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ISI interval…

125ms, 500ms

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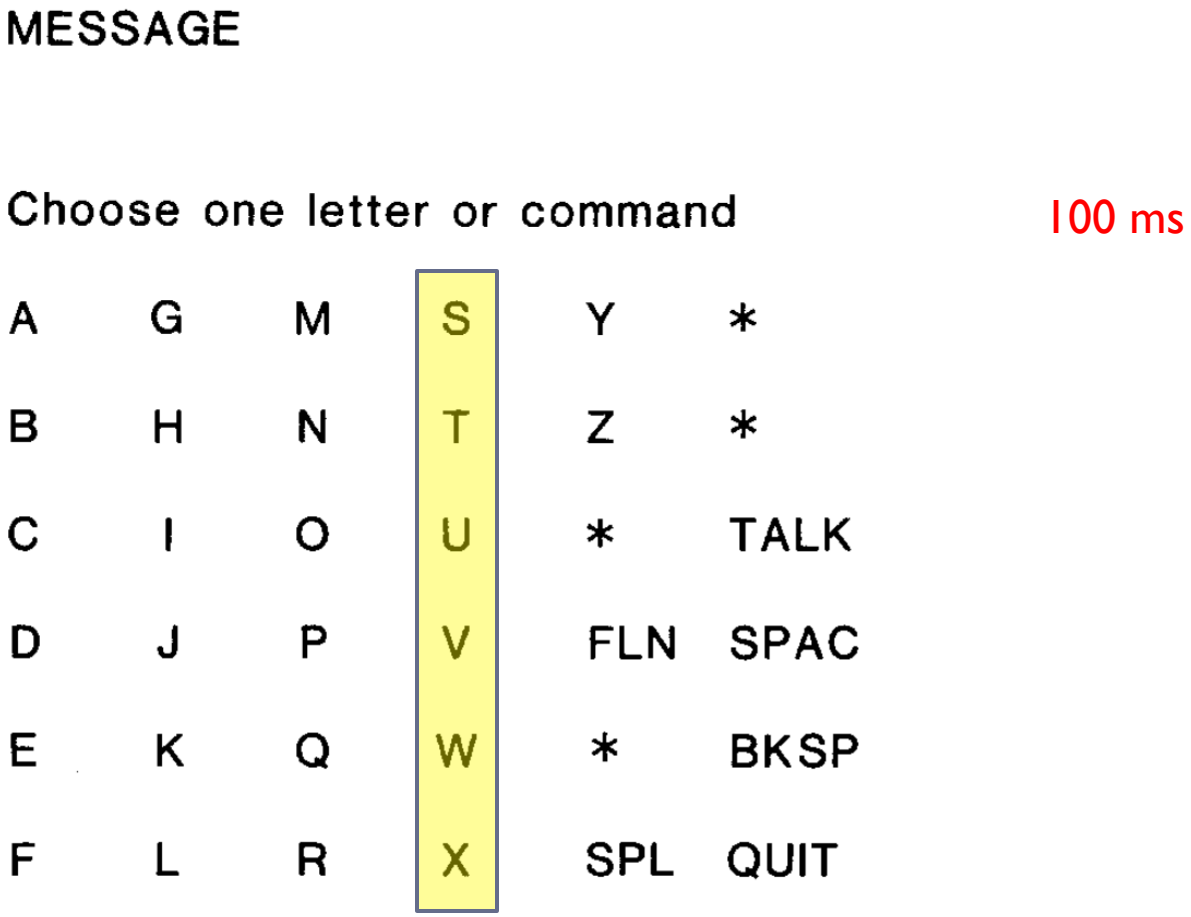

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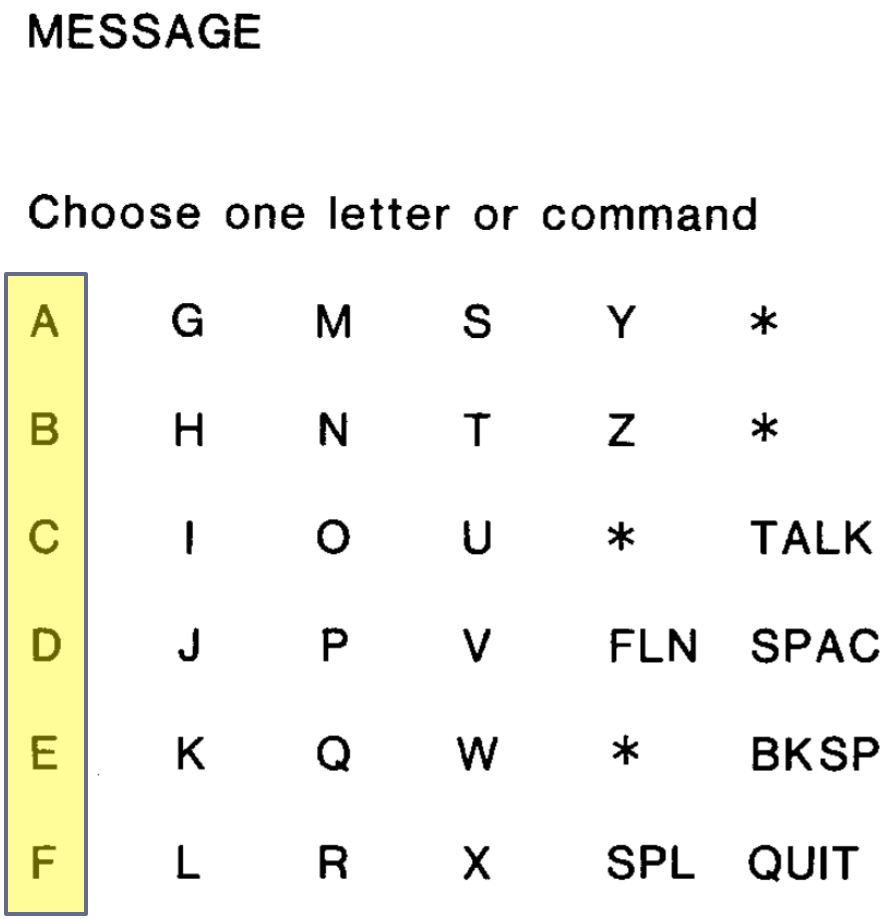

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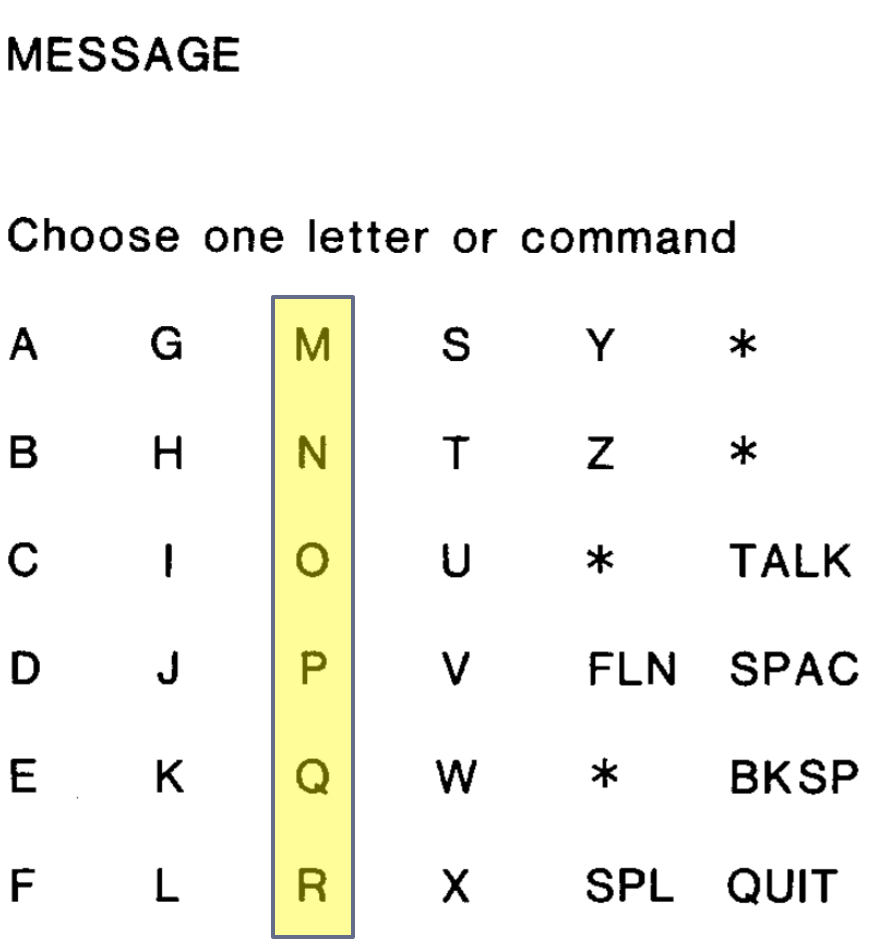

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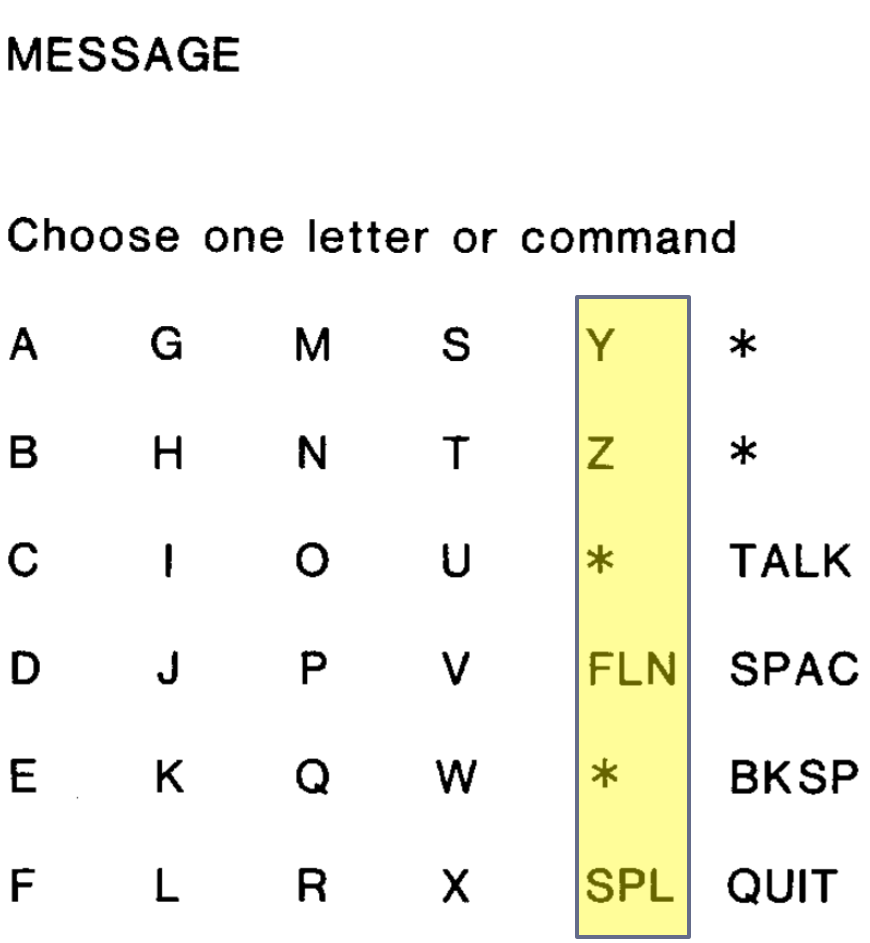

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Trial complete

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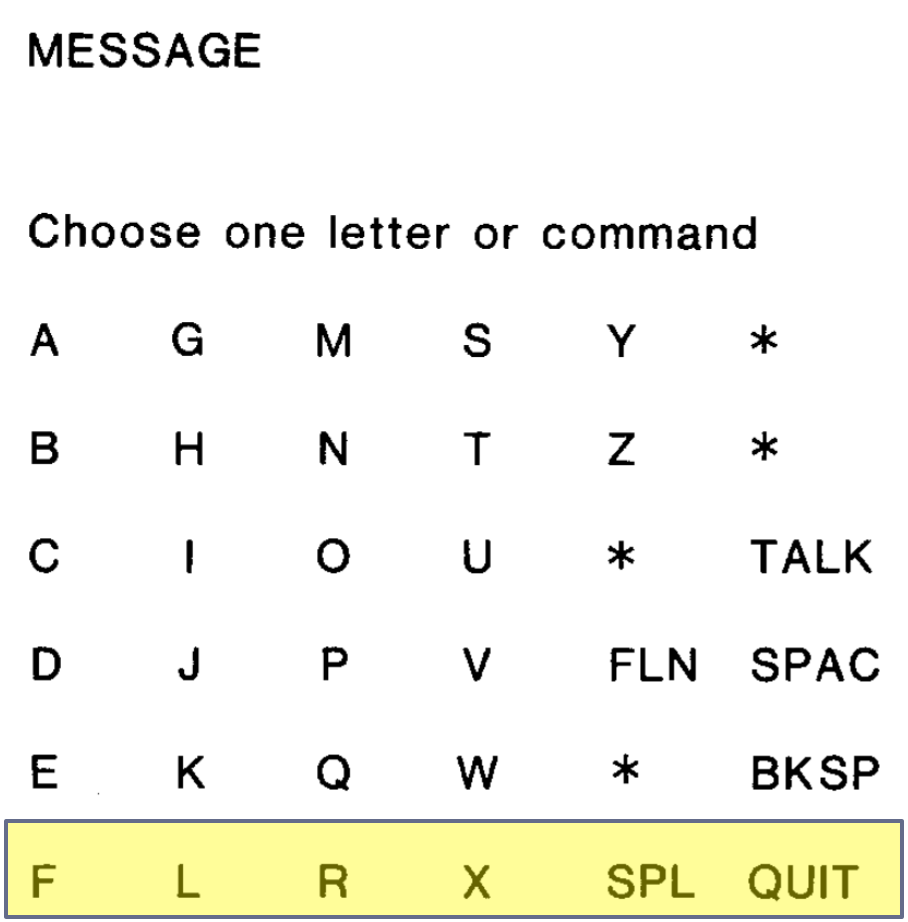

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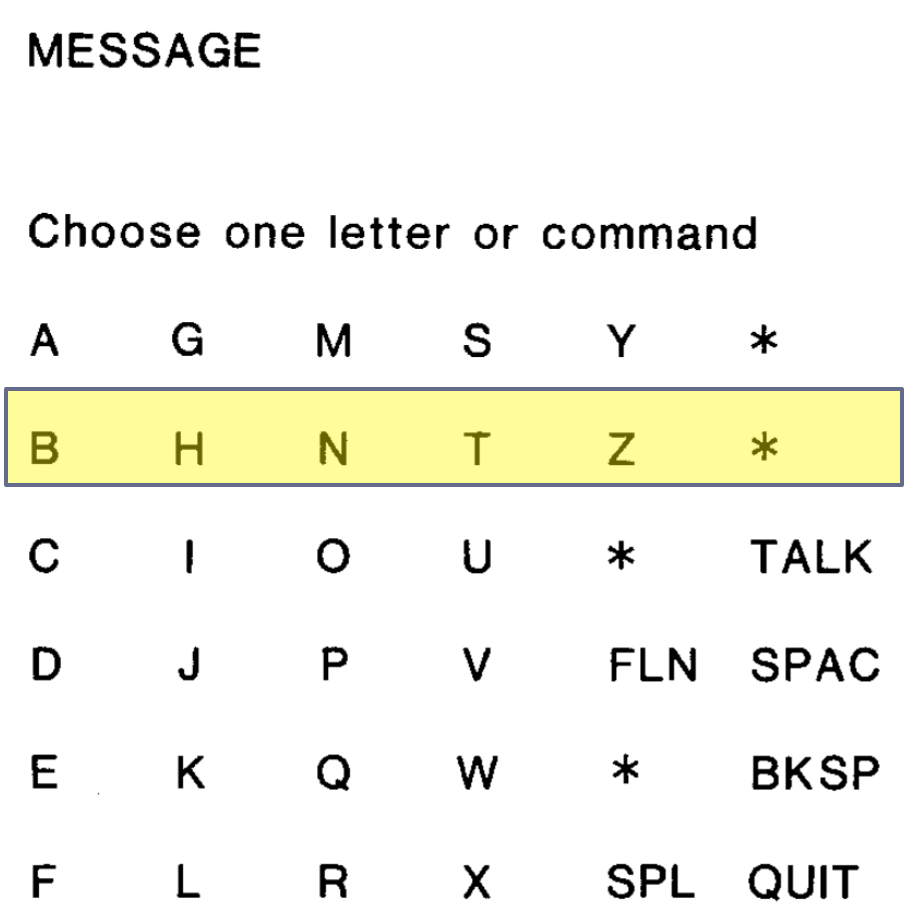

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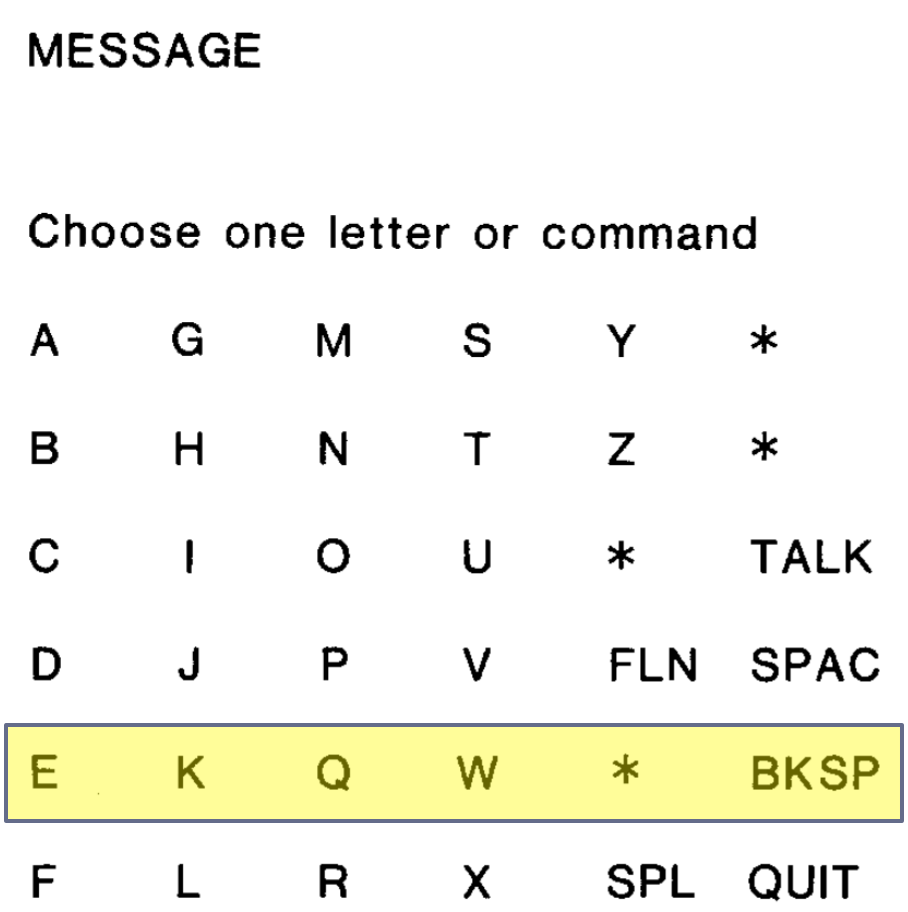

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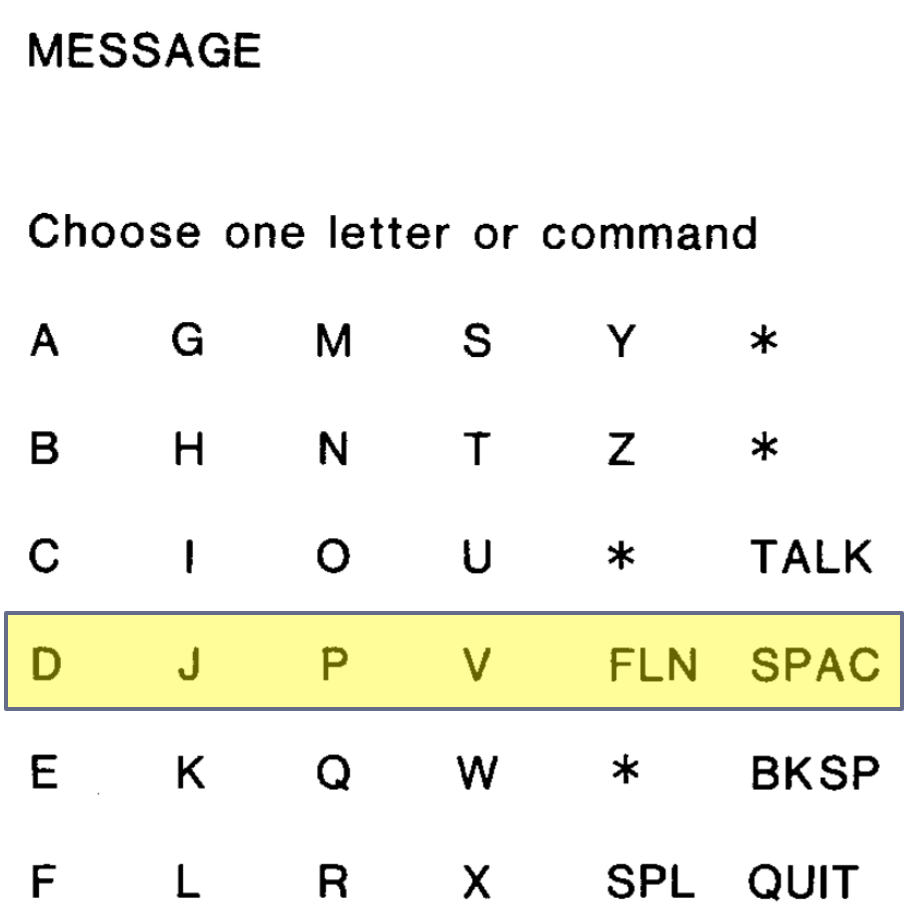

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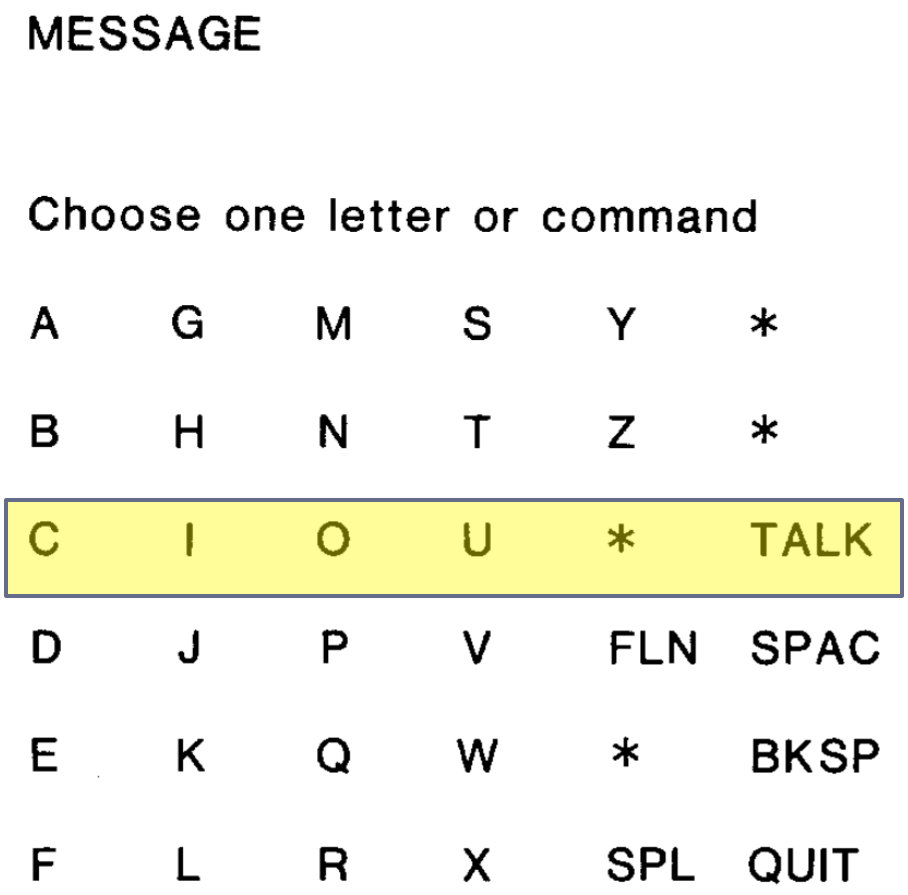

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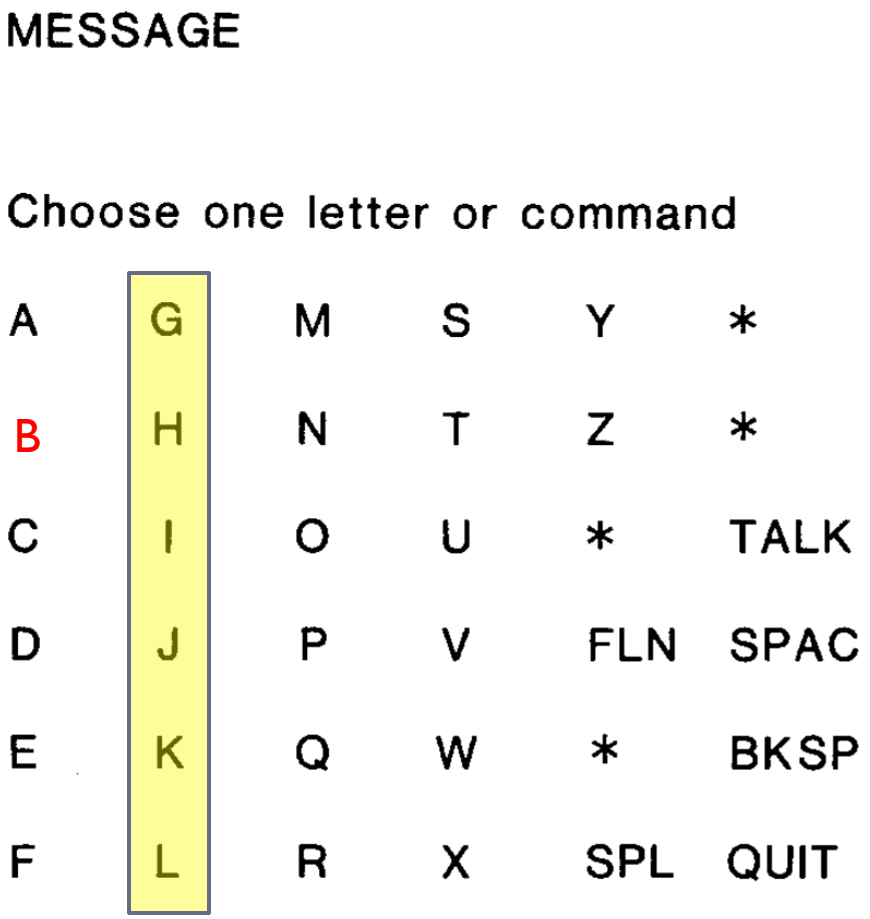

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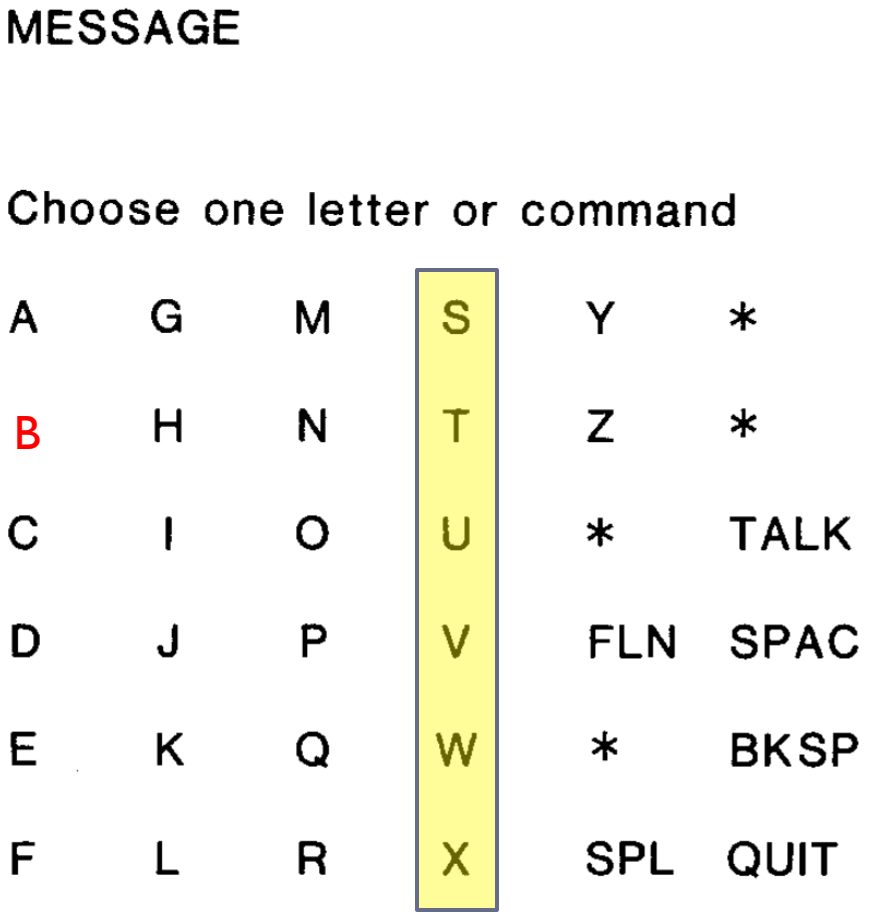

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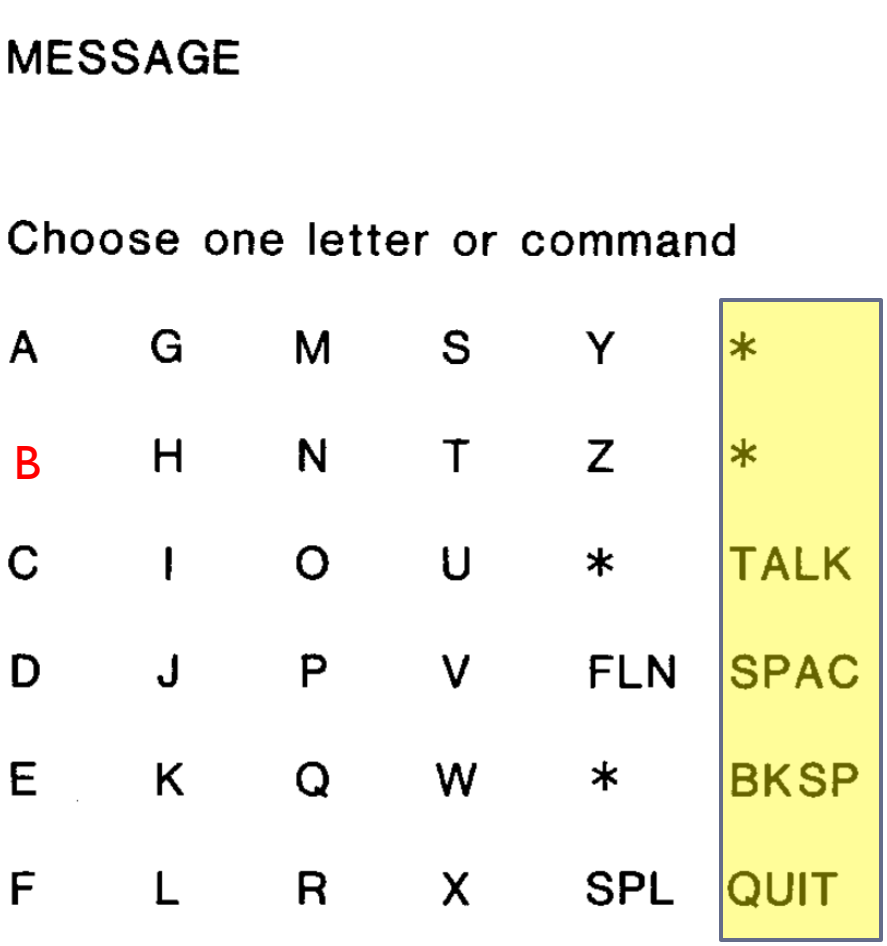

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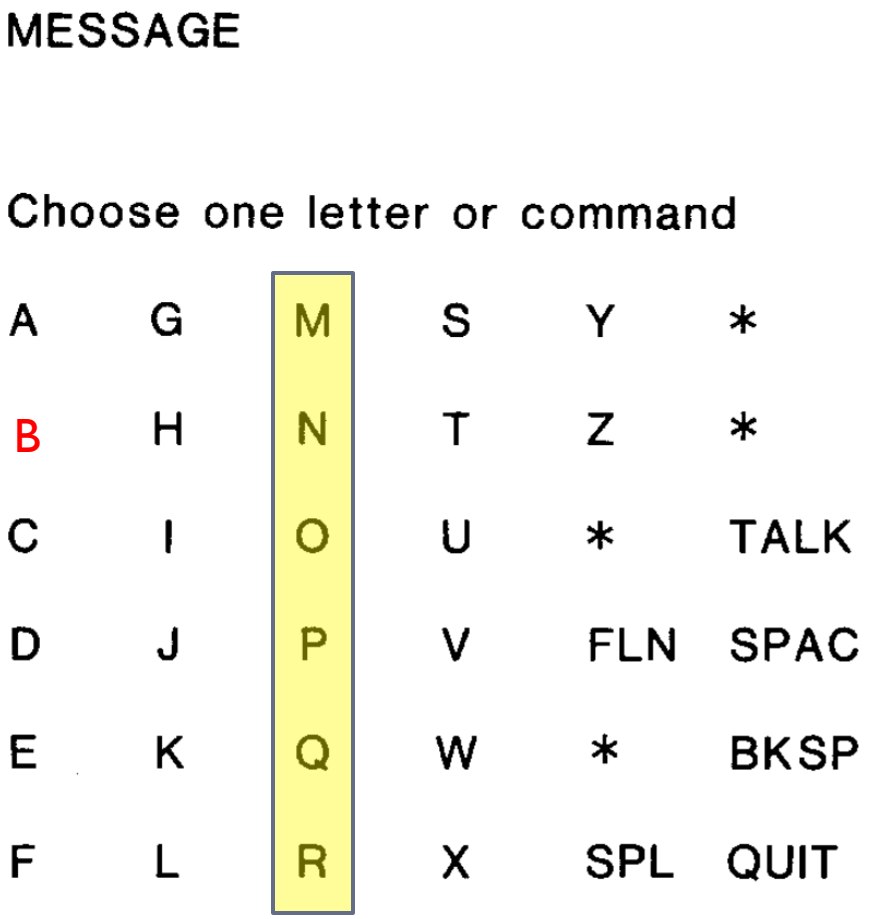

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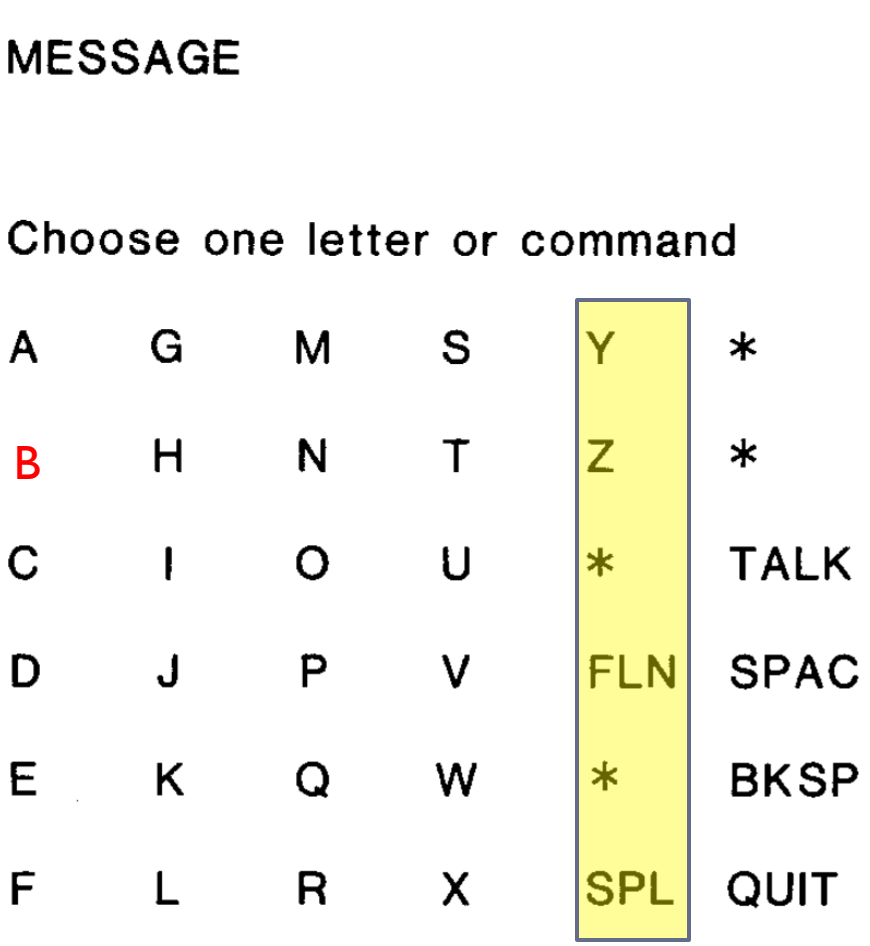

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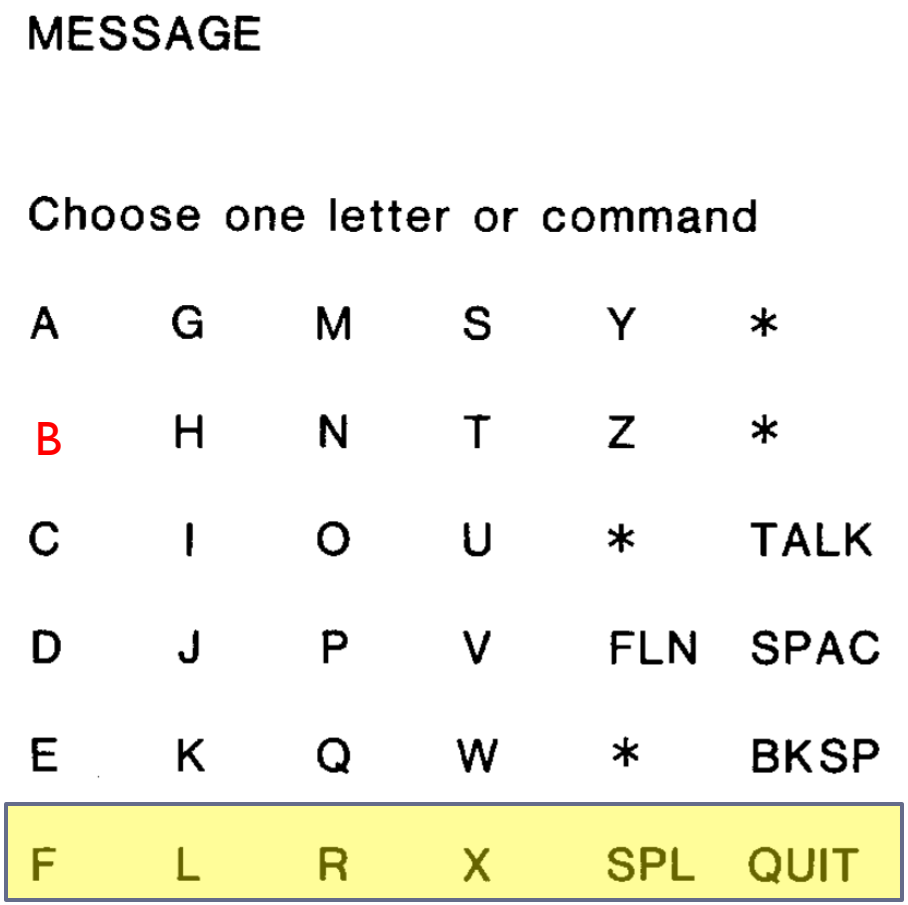

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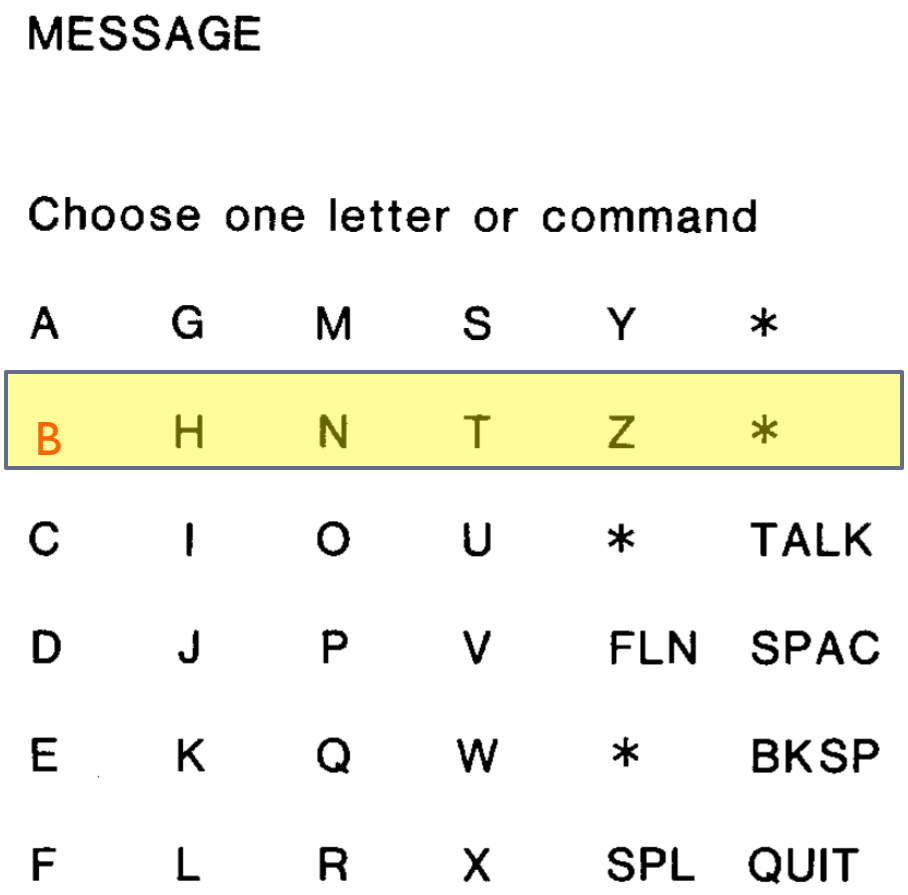

P300

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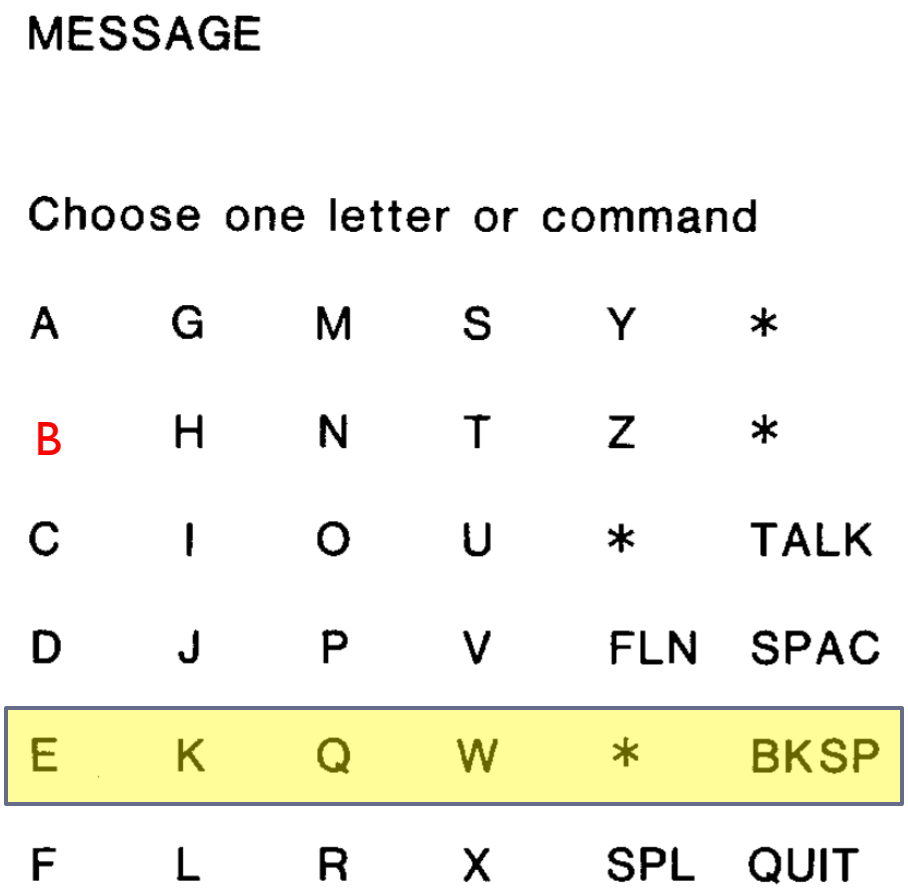

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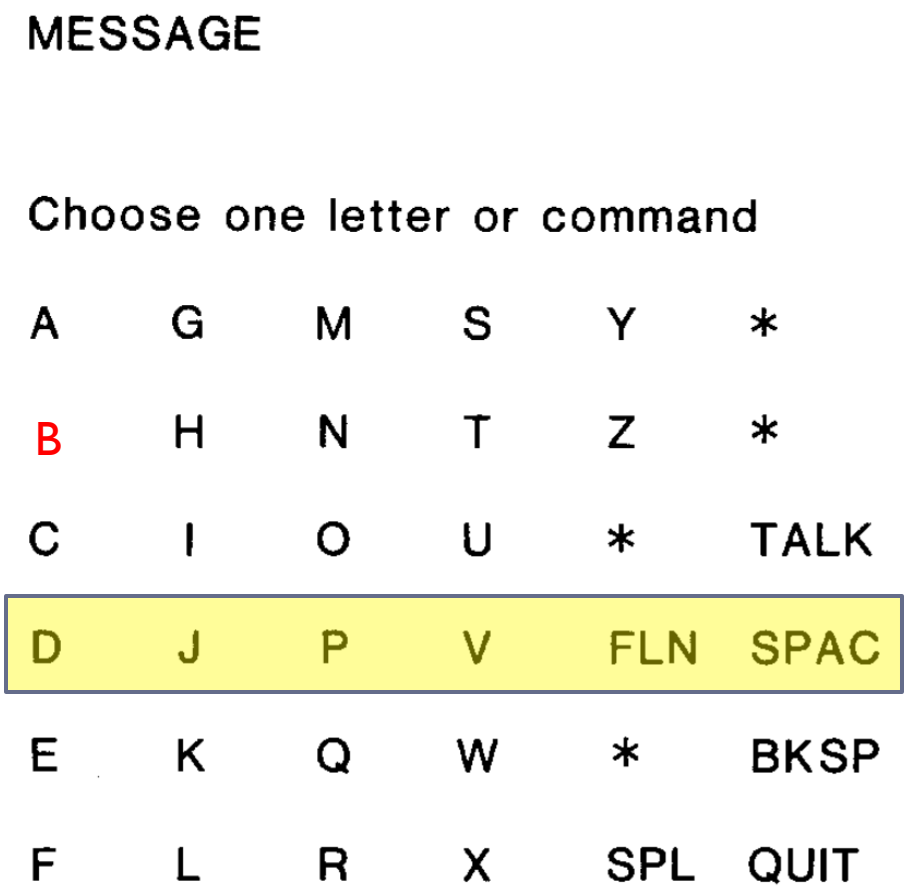

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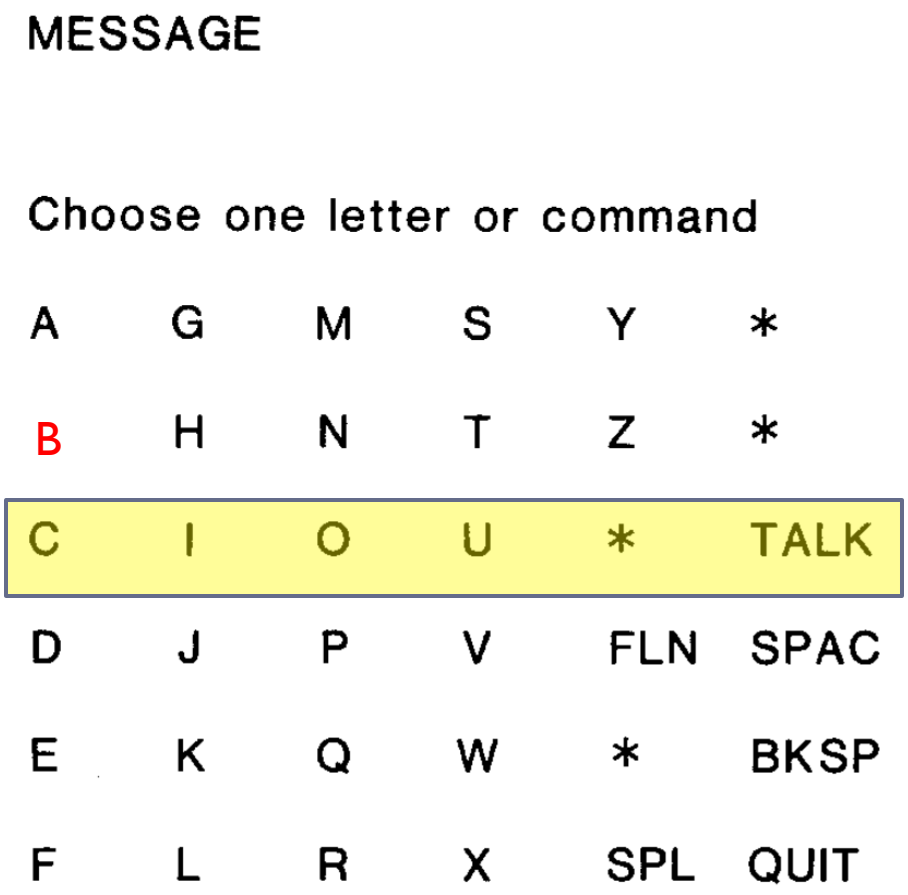

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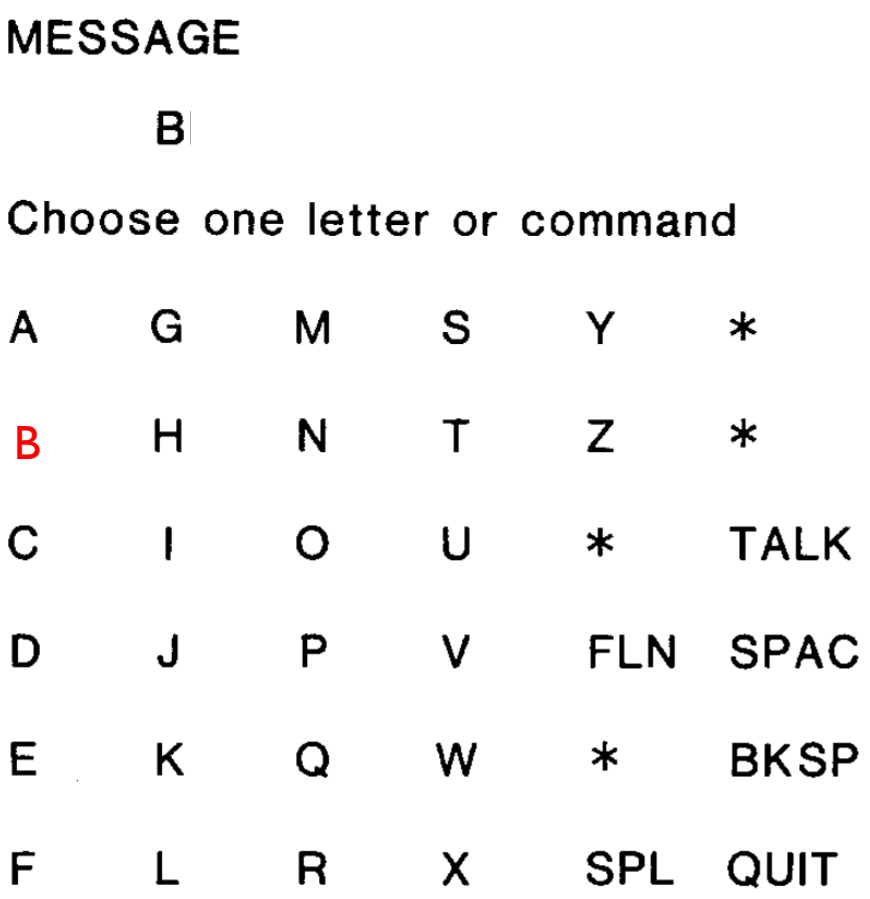


Video…

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

Feasibility, real-time

Session 2

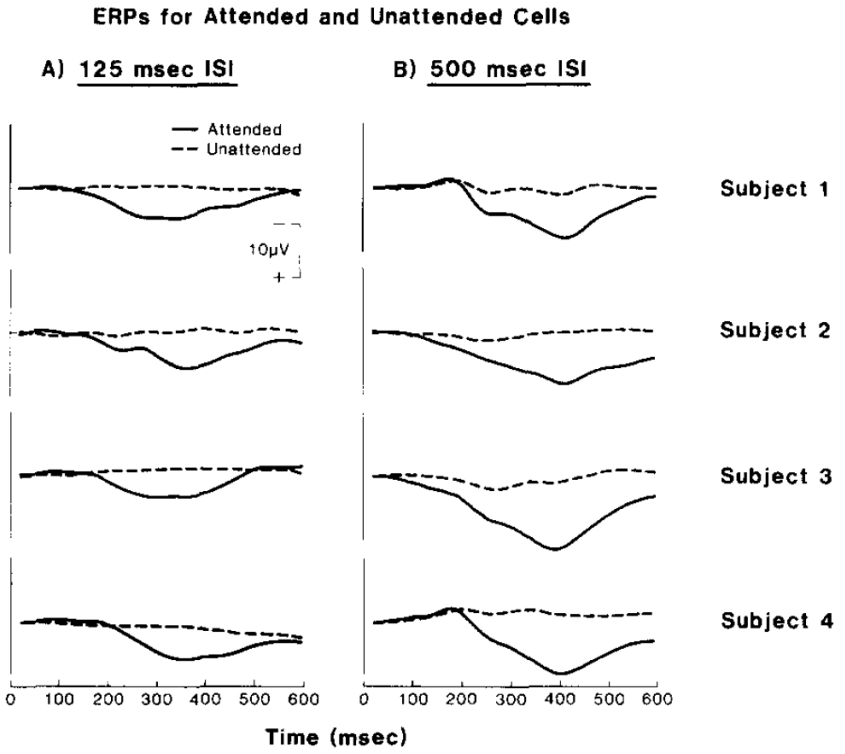
- ISI = 500ms, 125ms
- ITI = 1245ms, 3120ms
- 10 blocks of 30 trials
  - 5 blocks / ISI

Algorithms,

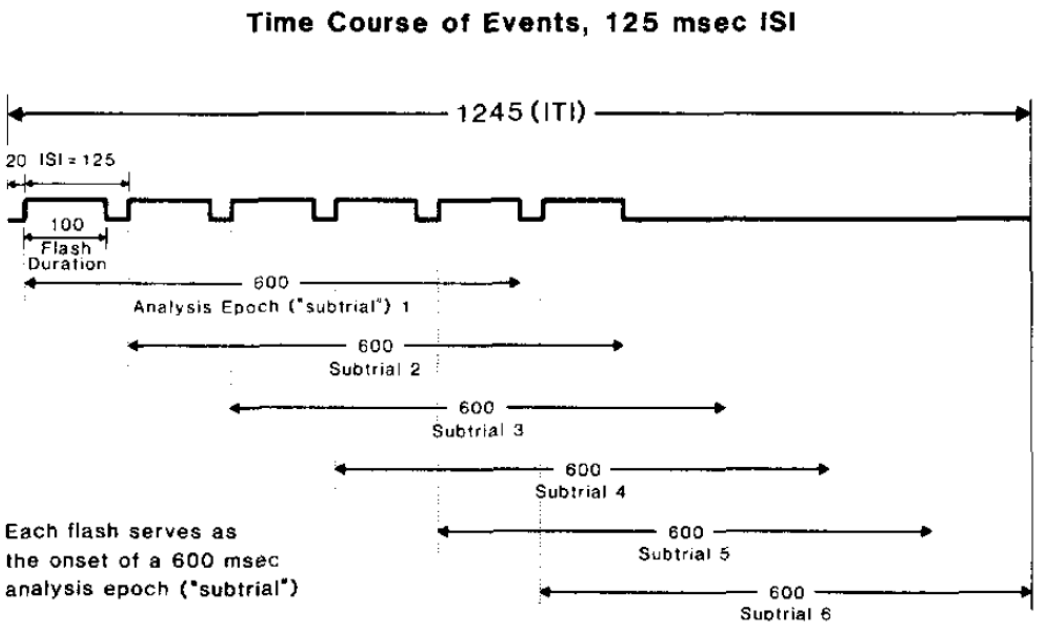
Accuracy/speed tradeoff

Algorithms

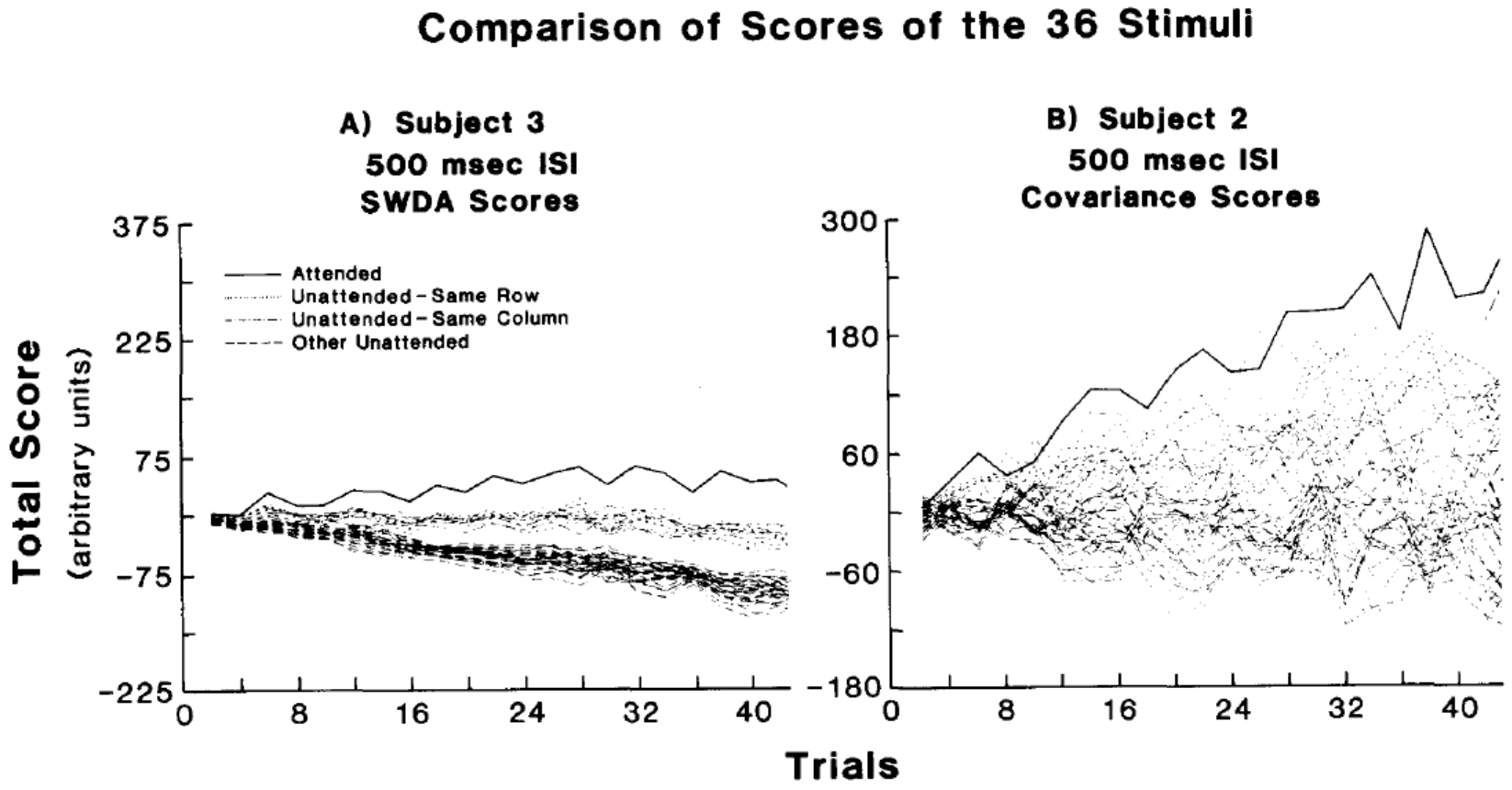
- SWDA (stepwise linear discriminant analysis)
- Peak-picking
- Area
- Covariance



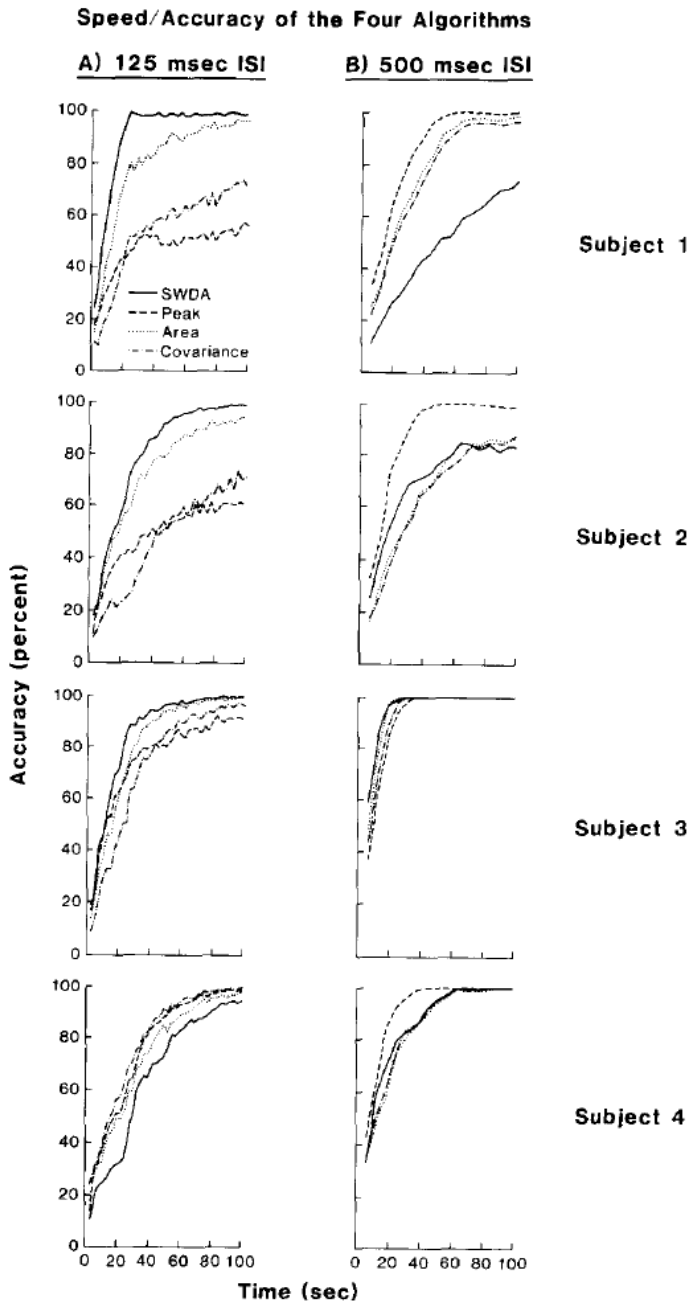
Experiments and Timing



Single Iteration…



Accuracy


Speed/Accuracy of the Four Algorithms
A) 125 msec ISI
B) 500 msec ISI
SWDA
Peak
Area
Covariance
Accuracy (percent)
Time (sec)
Subject 1
Subject 2
Subject 3
Subject 4

Tradeoffs

Increase Accuracy	Increase Speed	Decrease Accuracy	Decrease Speed
Longer ISI	Shorter ISI	Shorter ISI	Longer ISI
Increase Trial Count	Decrease Trial Count	Decrease Trial Count	Increase Trial Count

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?