

Initial design of a communication device with non-invasive brain-computer interface (BCI), adaptive language modeling and Rapid Serial Visual Presentation (RSVP)



Abstract

- We are designing a portable communication device that relies on a non-invasive brain-computer interface (BCI) with optimized language modeling for literate individuals who are functionally locked-in.
- We use single trial P3 detection for binary selection of single characters in a rapid serial visual presentation (RSVP).
- The innovative BCI has three essential, unique features:
 - 1) Linguistic components ranging from letters to words to phrases that are presented on a computer screen one at a time in rapid succession;
 - 2) A detection mechanism that employs multichannel electroencephalography (EEG) and/or other suitable response mechanisms that can reliably indicate the binary intent of the user and adapt based on individualized neurophysiologic data of the user; and
 - 3) An open-vocabulary natural language model with a capability for accurate predictions of upcoming text.
- The collaborative nature of the proposed translational research is expected to yield new knowledge for both BCI development and clinical augmentative communication use.

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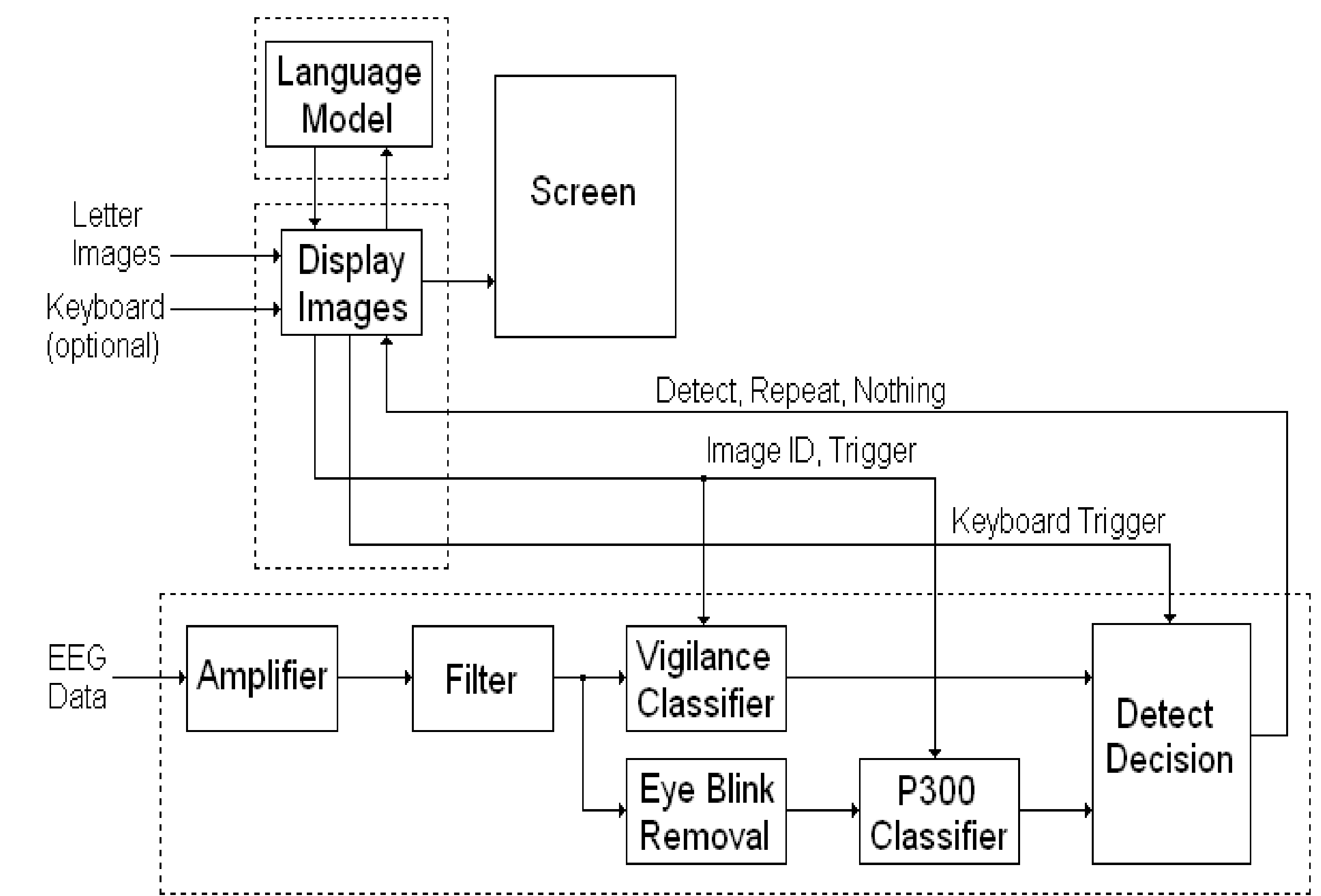
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Typical System for Portable RSVP Device

- Quad-core, 2.53 GHz laptop
- Code written in Labview, Matlab (Psychophysics Toolbox), C
- 24-bit, 16-channel amplifier from Guger Technologies (gTec Austria)
- 30 symbols
 - 26 uppercase letters, comma, period, space, backspace
- Symbols shown using RSVP
- Support vector machine (Gaussian kernel) used to detect P3

Anticipated System



Language Model Comparison

Row/column scanning

(uses optimized grid frequency layout)

we run the risk of failure					
we run t					
←	e	a	i	c	f
←	o	n	d	g	,
	t	r	h	m	.
	s	l	p	b	-
	u	w	k	j	q
	y	v	x	z	:

Huffman scanning

(uses an 8-gram language model and a Hoffman code)

we run the risk of failure					
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←	e	a	i	c	f
←	o	n	d	g	,
	t	r	h	m	.
	s	l	p	b	-
	u	w	k	j	q
	y	v	x	z	:

RSVP (Rapid Serial Visual Presentation)

(uses an 8-gram language model and Displays in rank order)

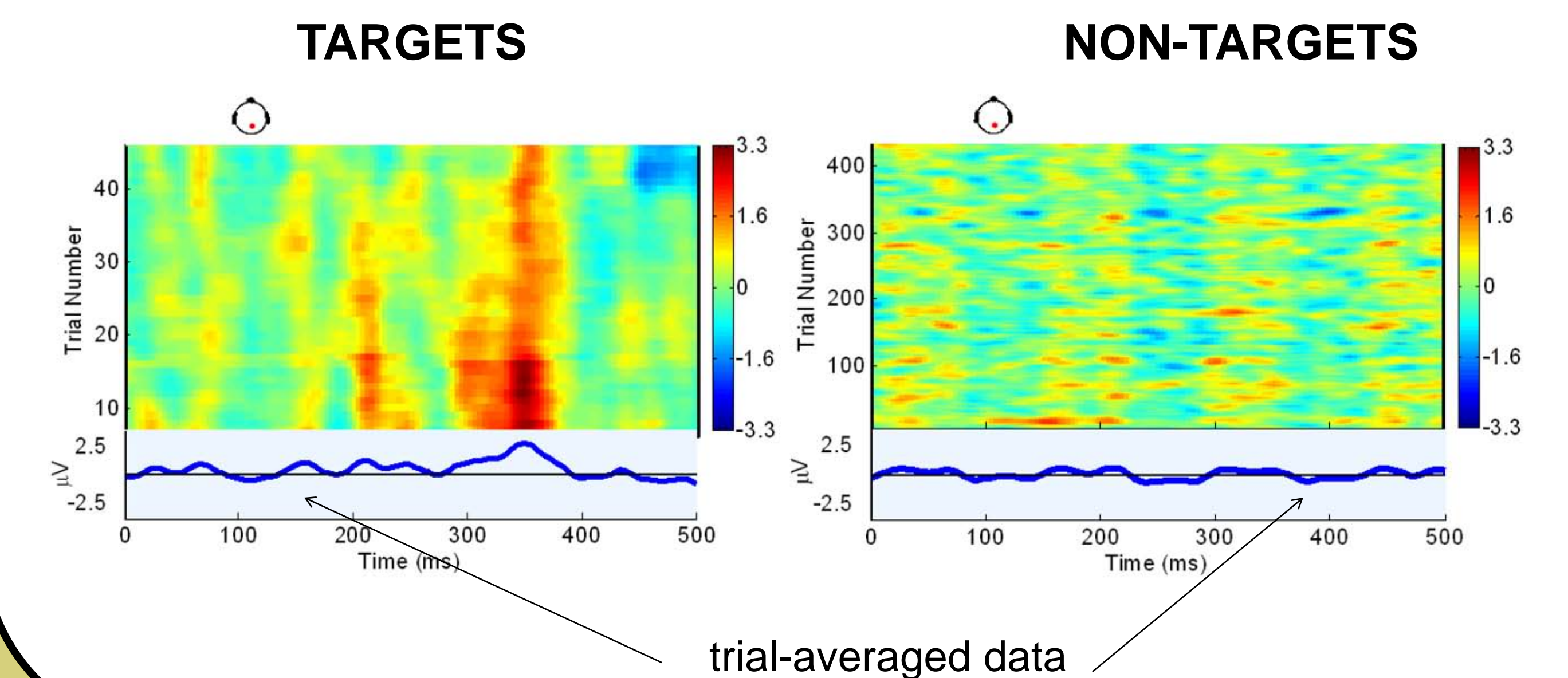
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(Models trained using NYT data)

A locked-in subject/collaborator and his personal assistant



Single trial RSVP Selections



Acknowledgments

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