Covert and Overt ERP-based BCI

Summary

This dataset represents a complete record of P300 evoked potentials recorded with BCI2000[1] using two different paradigms: a paradigm based on the P300 Speller originally described by Farwell and Donchin [2]in overt attention condition and a paradigm based on the GeoSpell interface [3] used in covert attention condition. In these sessions, 10 healthy subjects focused on one out of 36 different characters. The objective was to predict the correct character in each of the provided character selection epochs.

The paradigms

P300 Speller - Overt attention

(A01S – A02S – A03S – A04S – A05S – A06S – A07S – A08S – A09S – A10S)

In the first interface, cues are organized in a 6×6 matrix and each character is always visible on the screen and spatially separated from the others. By design, no fixation cue is provided, as the subject is expected to gaze at the target character. Stimulation consists in the intensification of whole lines (rows or columns) of six characters.

GeoSpell - Covert attention

(A01G – A02G – A03G – A04G – A05G – A06G – A07G – A08G – A09G – A10G)

In the second interface [3], only six characters at a time are presented at the vertices of a hexagon, at the same angular distance (0.9°) from a central foveation point, marked by a fixation cross. Thus, in its intended operation, stimuli must be attended by the subject using covert attention only. New sets of 6 characters are presented in a sequence, until all 36 have been delivered twice after 12 intensifications; sequences are designed so that a given character is only presented at a specific vertex, which the subject had previously learned by practicing.
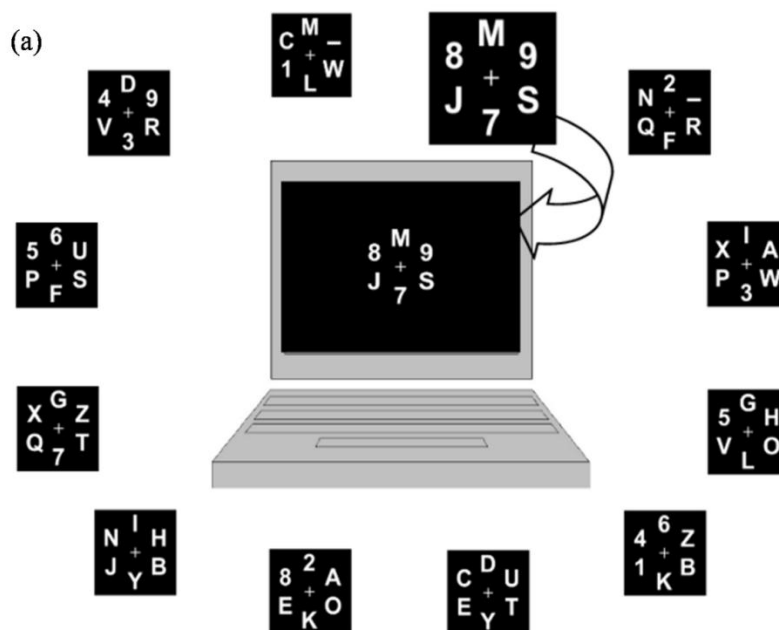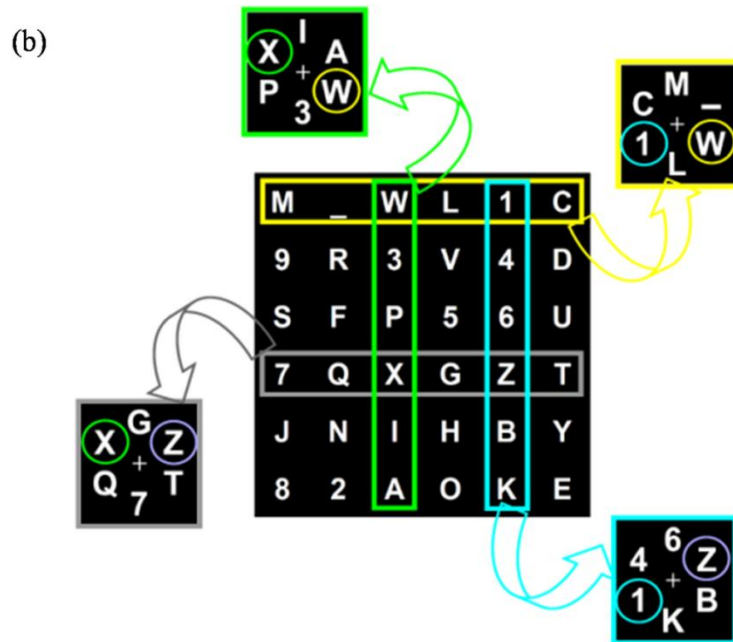
Figure 1: (a) The GeoSpell (Geometric Speller) BCI. Each group contains six alphanumeric items that are presented in a random sequence in the centre of a screen. (b) Group organization. Each group contains the characters of one row or one column of a matrix; thus, the new interface maintains a similar approach as the row-by-column P300 Speller for the stimulation, but it can be used under covert attention conditions

Experimental Protocol

Ten healthy subjects (10 female, mean age = 26.8 ± 5.6, table I) with previous experience with P300-based BCIs attended 3 recording sessions. Scalp EEG potentials were measured using 16 Ag/AgCl electrodes that covered the left, right and central scalp (Fz, FCz, Cz, CPz, Pz, Oz, F3, F4, C3, C4, CP3, CP4, P3, P4, PO7, PO8) per the 10-10 standard, arranged on an elastic cap (Electro-Cap International, Inc.). Each electrode was referenced to the linked earlobes and grounded to the right mastoid. The EEG was acquired using a g.USBamp amplifier (g.Tec, Austria), digitized at 256 Hz, high pass- and low pass-filtered with cutoff frequencies of 0.1 Hz and 20 Hz, respectively. The electrode impedance did not exceed 10 kΩ. Visual stimulation, acquisition and online classification were performed with BCI2000 [1] using a stimulus presentation application that was modified for this study. Each subject attended 4 recording sessions. During each session, the subject performed three runs with each of the stimulation interfaces. At the beginning of each trial, before the stimulation began, the system prompted the subject with the character that he had to attend. The target prompt appeared during a 2 s pre-trial interval. The target appeared in the same position as in the following stimulation to allow the subject to focus his spatial attention before the trial started. A trial consisted of eight stimulation sequences, and thus, 16 intensifications of the target character. Each stimulus was intensified for 125 ms, with an inter stimulus interval (ISI) of 125 ms, yielding a 250 ms lag between the appearance of two stimuli (SOA). To avoid the attentional blink phenomenon, which occurs when the target-to-target interval (TTI) is shorter than 500 ms [4], pseudorandom stimulation sequences were assembled, so that each target intensification would not occur within 500 ms after the previous one. The same parameters were set for both the GeoSpell and P3Speller [5].

Table I : participants		
Code	Sex	Age
A01	F	22
A02	F	23
A03	F	27
A04	F	23
A05	F	23
A06	F	26
A07	F	40
A08	F	23
A09	F	26
A10	F	35

References

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[3] F. Aloise, P. Aricò, F. Schettini, A. Riccio, S. Salinari, D. Mattia, F. Babiloni, e F. Cincotti, «A covert attention P300-based brain-computer interface: Geospell», *Ergonomics*, vol. 55, n. 5, pagg. 538–551, mag. 2012.

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