BCI2000-Compatible Audio-Visual P3 Task

Jürgen Mellinger, Gerwin Schalk

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Abstract

The main purpose of this task is to present a series of (auditory or visual) stimuli sequentially to the user of the BCI system. The sequence and nature of the stimuli can be defined by the investigator. In addition to stimulus delivery, the task can optionally be used in conjunction with BCI2000's P300 Signal Processing module (P3SignalProcessing.exe) to provide feedback to a selected stimulus in either a copy or a free mode.

1 Functionality

1.1 Stimulus Definition

Stimuli are defined in a Windows^{TM} ini-file. This file defines the total number of stimuli, as well as the details of each stimulus. Each stimulus is defined by the following properties:

1. Caption

2. Icon file

3. Audio file

In addition to stimuli, the file contains definition for a stimulus that announces what to focus on, and a stimulus that announces the result. These stimuli are only used when the task is set to copy or free mode.

The following is an example of a stimulus definition file with two stimuli:

```
[global]
numstimuli      = 2

[focuson]
caption         = Please focus on
icon            = icons\focus on.bmp
audio           = wav\focus on.wav

[result]
caption         = The result was
icon            = icons\result.bmp
```

```
audio             = wav\result.wav

[stimulus1]
caption           = Donkey
icon              = icons\donkey.bmp
audio             = wav\snicker.wav

[stimulus2]
caption           =
icon              = icons\elefant.bmp
audio             = wav\trumpet.wav
```

Comments: The stimulus properties might contain white spaces. A caption/icon/audio file are not being presented, if they are not defined (e.g., see caption in stimulus2). The stimulus definition file does *not* contain a description on how the stimuli are presented. Stimulus numbers start at 1. For each run, the ini-file will be copied to the same location as the actual data file. For example, if the data file is "JJS007R03.dat," and the ini-file is "stimdefs.ini," then the ini-file will be copied and named "JJS007R03.ini."

1.2   Stimulus Sequence

Stimuli are presented in a certain sequence. This sequence can either be deterministic, i.e., defined by the investigator, or random.

1.2.1   Deterministic Sequence:

The investigator defines the order by entering a list of stimulus IDs to be presented. As an example:

```
1 5 3 4 2
```

defines a sequence in which stimulus 1 is first presented, followed by stimulus 5, etc.

1.2.2   Random Sequence:

The investigator defines the stimulus probabilities for each stimulus. Stimulus probabilities do not have to add up to 100%. (The sum of all probabilities will define 100%). As an example:

```
60 20 20
```

defines a probability of 60% for stimulus 1, and 20% each for stimuli 2 and 3.

A sequence can be played multiple times. The investigator can define how many times sequences are played.

1.3 Stimulus Delivery

For any stimulus, delivery occurs simultaneously for caption[1], icon, and audio. (A computer can only execute commands in sequence, but the time difference between start of presentation of caption, icon, and audio, is negligible). *Comment:* A knowledgeable investigator has to understand the implications of audio files that are of unequal length !

An investigator can specify:

- Size and position of the target window (using the same scheme/parameters as used by the RJB task, Oddball paradigm, or P3 speller).

- Width and height of caption and icon in percent of screen width/height

- Whether captions, icons, or audio files will be presented (i.e., a global switch – for each stimulus, captions/icons/wave files will not be presented individually, if not defined)

- The volume for audio playback

- Window background color in RGB

- Caption color in RGB

- The duration during which a stimulus is presented (in units of Sample-Blocks)

- The inter-stimulus interval that follows completed stimulus presentation [2]

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[1]A caption, if defined, always appears in front on an icon.
[2]During the inter-stimulus interval, the screen is blank and audio is turned off.

- A minimum and maximum time (in units of SampleBlocks) that will be added randomly to the inter-stimulus interval. If these variables are both set to 0, the actual inter-stimulus interval will always be exactly as defined above. If these variables are set to, for example, 0 and 3, inter-stimulus intervals will randomly be longer by between 0 and 3 units.

- A Comment. A user can enter comments to the specific run in a string parameter.

2   Processing of Classification Results

The task can be configured to interpret results communicated to it by the P3 Signal Processing module. These results represent a judgment on which of the stimuli was most likely selected. Handling of these results is identical to the P3 Spelling Task.

When it transmits a classification result, Signal Processing sets the state *StimulusCodeRes* to the stimulus code that was originally transmitted to it by the user application. For example, when it sets *StimulusCodeRes* to 3, it indicates that it transmits classification results for stimulus 3. In addition, it sets *StimulusTypeRes* to reflect the type of the stimulus (0=non-target, 1=target) when the system is in copy mode. Signal Processing transmits the classication result as one number (i.e., the first control signal).

2.1   Free Mode

The task can be configured to operate in free mode. In this case, the sequence of stimulus delivery is followed by a time period, in which the result of Signal Processing's classification is announced. The final classification result is the stimulus with the highest classification result.

In order to deliver this announcement, the system uses the stimulus defined in the [result] section of the stimulus ini-file. This announcement is followed by delivery of the determined stimulus. In other words, after a sequence of stimulus delivery, the system might play a .wav file that says: "the result is," followed by a .wav file that says "yes." (assuming "yes" represents the stimulus that produced the highest classification result).

Finally, the task sends this result to the operator module as an ASCII text message so that it appears in a log window.

Free mode does not terminate until the investigator suspends operation.

2.2   Copy Mode

Copy mode is similar to free mode. In copy mode, the investigator can define a list of stimuli to be copied (e.g., "3 5 4"). In this example, the user has to attend to stimulus 3 for the first sequence, 5 for the second sequence, etc.

In addition to an announcement of the result, in copy mode the delivery of stimuli is preceded by an announcement that describes which stimulus the user has to attend to. This announcement uses the stimulus that is defined in the `[focuson]` section of the ini-file. This announcement is followed by delivery of the desired target stimulus. As an example, the system might say "Please focus now on" ... "yes," before it starts with the sequence of stimulus delivery.

Copy mode terminates (i.e., the task suspends) when the user finished copying all stimuli specified by the investigator.

3   Parameters

Fill in the parameters incl. description, once completed.

4   States

The time line of stimulus delivery is encoded in state variables as defined in Table 1.

State Name	Bits	Description
SelectedStimulus	7	stimulus ID of finally selected stimulus
		only >0 when determining selected stimulus
PhaseInSequence	2	0 in inter-stimulus interval
		1 period prior to stimulus sequence (if any)
		2 stimulus sequence period
		3 period after stimulus sequence (if any)
StimulusTime	16	time in ms as calculated in P3 Speller
StimulusCode	7	stimulus ID of currently visible stimulus
		or 0 if no stimulus visible
StimulusType	1	0 in free mode; copy mode :
		1 when current stimulus equals target stimulus
		0 otherwise
Flashing	1	1 during stimulus presentation, 0 otherwise

Table 1: Encoding scheme for this task.