Processing Stages of Visual Stimuli and Event-Related Potentials

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Abstract

Event-related potentials (ERP) in electroencephalograms reflect various visual processing stages according to their latencies and locations. Thus, in this short review article, we present some ERP components which appears 100, 170, 200 and 300 ms after the onset of a visual stimulus. They correspond respectively to a selective attention, the processing of color, shape and rotation, human faces and a degree of attention.

Event Related Potential (ERP)

ERPs are electrical changes in electroencephalographic (EEG) recordings that are time-locked with sensory or cognitive events.

- ERPs are more visible when responses are averaged.
- ERPs are useful to track the temporal brain dynamics.
- Peaks names are designated by their negative (N) or positive (P) polarity and their approximate latency in ms.

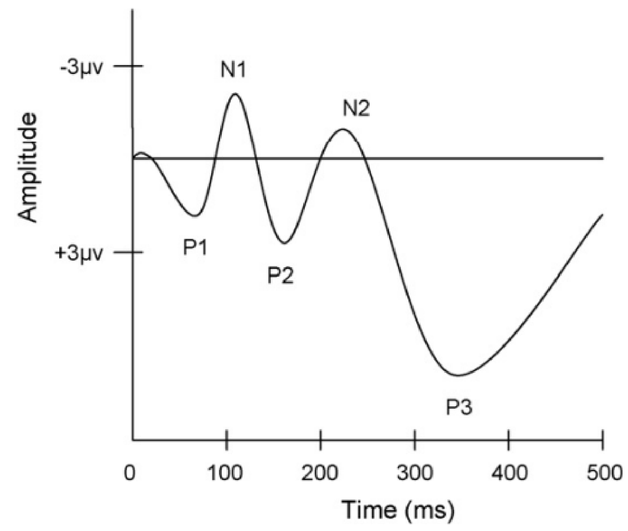

Figure: Event-related potentials main components. ERPs are plotted with negative voltages upward.

ERPs evoked by Visual Stimuli

- **C1**

  location Primary visual area (striate cortex; area 17)

  onset/peak 50 ms / 90 ms [1, 2]

  polarity The standard nomenclature (N or P) is not applied. C1 has a negative polarity when the stimulus is in the upper visual field and a positive one when presented in the lower visual field [2].

  neural processing This component is usually used to study attention and learning processes [2] and is sensitive to contrast [1].

- **P1**

  location Lateral occipital cortex [1, 3]

  onset/peak 60-80 ms/100-130 ms

  polarity Positive

  neural processing Mandatory response elicited by a visual stimuli because they are influenced by external stimulus, such as luminance [1]. P1's amplitude is larger for unpleasant target stimuli than pleasant stimuli, showing a relation between the P1 component and the affective processing. A correlation between P1 and face expression has also been found [3].

- **N1**

  location Parietal cortex / lateral occipital cortex

  first peak/second peak 100-150 ms/150-200 ms

  polarity Negative

  neural processing The first peak is influenced by spatial attention (attended vs. unattended locations). The second one is sensitive to a discrimination process [1]. N1 is also sensitive to lexical processing, having an increased amplitude in response to pleasant words during silent reading.

- **N170**

  location The N170 source is still controversial but in the lateral occipito-temporal cortex [3].

  onset/peak 120 ms / 170 ms

  polarity Negative

  neural processing Sensitive to face perception (distinguishes faces from non-faces).

- **N200**

  location Temporal occipital

  peaks N200 can be decomposed into two VEP subcomponents: the N2b and N2c.

  polarity Negative

  neural processing N2b is evoked during conscious stimulus attention (visual discrimination tasks) and the N2c which arises during classification tasks [4]. Furthermore, some stimuli may evoke a N2pc ("pc" stands for "posterior–contralateral" cortex), produced when the attention is focus on one object while ignoring others [5].

- **P300**

  location Frontal lobe / temporal parietal

  onset/peaks The P300 can be separate in two subcomponents, called P3a (220-280 ms) and P3b (310-380 ms).

  polarity Positive

  neural processing Polish [6] proposed a P3a and P3b integrative theory suggesting that P3a is produced by the frontal lobe as the result of early attention process and P3b is the result of the signal transmitted to the temporal/parietal lobes.

Conclusion

ERPs have been studied for 40 years. Even if their neural origins are still unclear, in recent studies, scientists have been able to better identify their locations and latencies making easier to relate them to visual processing. According to the increase of the latency, the locations of the ERP components become larger starting in the primary visual area, passing through the lateral occipital cortex and ending to the parietal cortex and the lateral occipito-temporal cortex. Thus, the first ERP components when elicited by visual stimuli are correlated to selective attention, processing of color, shape, rotation and degree of attention. As well, the last components are related to discrimination tasks revealing more complex cognitive processes.

References

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