The interaction of the sound and color stimuli in the auditory and visual cortexes

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Summary

Being feelings have the contact with each other. In our study we make a comparison of the effects between multisensory interactions (auditory and visual stimulus). There is no doubt that the interaction between audio-visual stimuli is a very important function in human life. Here, the principle is analyzed and explained that auditory and visual stimuli are effectively integrated by human's primates under most naturalistic conditions. We use the ERP images to analysis the interaction between the visual and auditory stimulus.

Key words:

Visual stimulus, auditory stimulus, ERP, EEG

1. Introduction

Visual and auditory are the fundament aspect of human perception. They are considered that there are some relations between each other. Multisensory neurons are now known to be widespread in low-level regions of the cortex usually thought of as being responsible for modality-specific processing. Visual inputs into auditory cortex have been described in humans [1, 2, 3], non-human primates [4, 5, 6, 7, 8], ferrets [9, 10] and rats [11]. Previous studies of multisensory convergence in other species have focused primarily either on local field potential or multi-unit recordings [12, 13], which meant that the existence of multisensory convergence at the neuronal level, as opposed to a mixed population of modality-specific neurons, could be demonstrated by the presence of interactions between the different stimuli.

In this experiment, the responses in the human auditory cortex come from the visual stimulus are explained. In the other words, the colors stimulus could be have the auditory location responses but no only the visual areas. We investigated whether change mechanisms in the auditory cortex distinguish between different color-visual stimuli or whether acoustic stimuli are necessary for the detection of visual change in the auditory cortex. We will talk about the color stimuli for the auditory cortex. It is considered that, colors can cause different reactions in the brain because of the difference aberration. We provide analysis data which is after the stimulus happened long time (>30s), because of the multisensory interactions are not restricted in time [14]. And we give some conclusions for the discrepancies of the auditory location during the color stimulus happened.

For the other part of the experiment, the visual area responses, which are from the auditory stimuli, are also used. The data analysis focused on determining whether audio and visual stimuli elicited responses which are typically elicited by acoustic changes.

2. Experiment method

Experiment condition and toolbox

In the present work, the Active Two system produced by BioSemi Inc. with 64 channels is used for measure the signals come from the activity of the brain. The data, come from the system, is analyzed by the EEGLAB which is the toolbox under Matlab interface environment. The research has two parts experiments to explain our reflection.

Subject

Ten right-handed health volunteers (including five females, mean age 22 years, range 19-25 years, no elderly people, no bad habits such as smoking) with normal or corrected-to-normal vision, who have not participated in the similar experiences before, are employed to implement the experiment.

Auditory experiment

We used the 40Hz sine sound wave stimulus, the response of the stimulus is very close to normal adult thresholds for the audiometric frequencies, a fact that could have application in clinical hearing testing.

Visual experiment

The same volunteers are measured in this part of experiment. There are three colors to be stimulus, and changes the color in 2 min after the stimulus appeared 1second. The volunteers should have a rest between two stimuli.

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3. Result and discussion

Based on the correlation between the brain visual and auditory activities, we measured specially the auditory stimulus with a frequency of 40 Hz. Compared the EEG images in figure 1, we can found that the visual areas are not changed by the auditory stimuli in short duration (<100ms), and the ERP images show that the auditory cortex has earlier response time that the visual area as the auditory experiment. However, the response areas are not only at the auditory cortex but also appeared at the visual cortexes during long time color stimuli in figure 1.

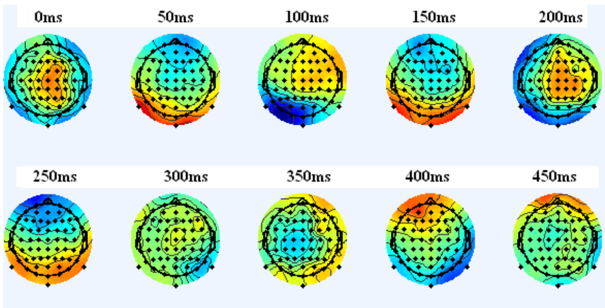
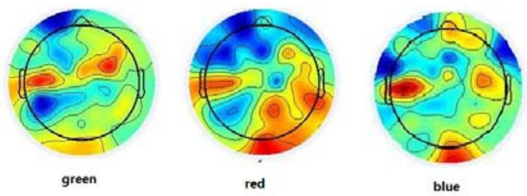


Fig 1. Responses of the sound stimulus of 40Hz between the starting and 450 ms.

On the other way, the results of the visual experiment give the different description. After long period visual stimulation, the auditory areas have some changes (figure 2). For different color stimuli, the powers of auditory locations have become higher. This is a clearly analyses as a visual change could activate supratemporal auditory cortices bilaterally [15]. The Auditory and visual areas are be produced by altering the naturally occurring relationships between two stimuli [16].



When the combinations of visual and sound stimuli are used to evoke cortical activity and have recorded the associated event-related potentials (ERPs), can most simply be explained if sound-activated thalamo-cortical input can rapidly produce extra activity in primed visual cortex [17]. In general speaking, over 16 cm^2 surface projection of V1, sound stimuli alone do not generate electrical response, but the response to visual stimuli can be modified by sounds [17, 18]. By the data of our experiments in figure 3, the response of the visual cortex has the interaction, and occurs even earlier (100ms) than the previous (170 ms). And the responses to the sound stimuli change the auditory cortexes under 50ms. In fact, this delay is often between 20-40 ms after the provoking auditory stimulus [58]. The pathway involved is therefore likely to be the fast auditory brain–stem response and excitation that passes through the thalamic radiation to the cortex. If there were to be feedback from auditory cortex (or from more anterior cortical areas) to visual cortex the additional activity could not occur so quickly. Direct input of visual information to the auditory cortex in the deaf [19, 20] and direct input of tactile information to visual cortex in the blind [21] has been described, so there is reason to suppose that potentially direct pathways between visual cortex and other afferent systems exist.

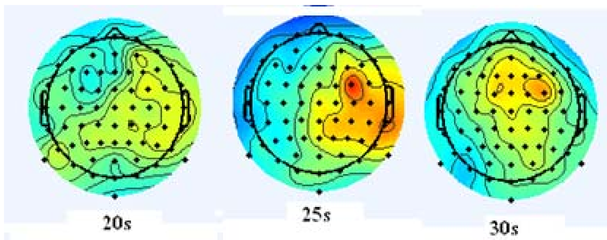


Fig 3. The state of a subject who received the sound stimuli for a long time

4. Conclusions

This paper provides electrophysiological evidence in humans that the effects of multisensory interactions. According to the ERP image of the visual and auditory stimulus, we provide a results visual and auditory relevant. Auditory and visual stimuli are effectively integrated by human's primates under most naturalistic conditions. Visual information reaches the brain, via midbrain and thalamic pathways that activate other visual areas in the cortex, and this information can be acted upon.

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