Specific negative component elicited by the perception of biological motion—An ERP study—

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Recent studies have revealed that the superior temporal sulcus (STS) plays an important role in 'social perception'. In this study, we measured event-related potentials (ERPs) during the perception of biological motion that can be perceived from locomotion which is monitored by only points of light. Twelve subjects participated and they were shown representations of biological motion and scrambled motion. In the scrambled motion, each light point had the same velocity vector as in the biological motion, but the initial starting positions of the lights were randomized. The perception of both the biological and scrambled motion elicited negative peaks at around 200 (N200) and 240 (N240) ms. Notably, the N240 component was significantly larger over the bilateral occipitotemporal region for the biological motion than for the scrambled motion condition. These findings do not contradict previous neuroimaging results, but imply that the N240 component seems to be specific to biological motion perception. Furthermore, this component might be similar to the detection of intention component that was found in gaze direction.

Key words: biological motion, event-related potentials, superior temporal sulcus, motion perception

Our brain can reconstruct rich visual images from sparse input. Biological motion is such a well known phenomenon that we can get a vivid impression of human form and activity from just 11 light points of the motion. Previous human neuroimaging studies have revealed that the superior temporal sulcus (STS) plays an important role in perception of biological motion. However, the dynamics of brain activation during the perception of biological motion have not been studied. In the present study, we observed the dynamics of brain activity during the perception of biological motion by measuring event related potentials (ERPs).

Methods

Twelve naive subjects, 9 males and 3 females, aged between 23 and 29 years (mean±SD; 26±2.3 years) participated in the experiment. The subjects viewed two different kinds of animation (Fig. 1A). The animations (5.7×5.7°, 2.0 gait/s) were displayed on a 17-inch CRT monitor. All of the points of light (9.8 arcmin) were displayed as black against a white background. The experiment consisted of 5 blocks with inter-block intervals of one minute. Each block had 50 biological motion stimuli and 50 scrambled motion stimuli in a pseudo-random order. In each trial, the stimulus was presented (biological motion or scrambled motion) for 1,000 ms and followed by a fixation point (a cross bar, 0.41×0.41°) for 3,000 ms. The electroencephalogram (EEG) activity was recorded by using a geodesic sensor net (Electrical Geodesics) consisting of 64 silver-silver chloride electrodes evenly distributed across the scalp of a participant. The electrical potential was amplified and filtered with a 0.1 to 50-Hz bandpass, and then digitized with a sampling rate of 250 Hz. The trials in which the signal variation exceeded 50 μV in either the EEG or EOG were excluded from the averaging. The analysis window was extended for 1,000 ms following the onset of each stimulus, and a pre-stimulus period (100 ms) was used as the baseline. The vertex served as a reference, and the ERPs were referenced to the average potential over a subject's scalp. Figure 1(B) shows the total averaged ERPs across the 12 subjects under each condition.
Results and Discussion

During perception of the stimuli of both the biological and scrambled motion two negative components could be distinguished: one was approximately 200 ms and the other approximately 240 ms. We named the components N200 and N240, respectively. The amplitude and latency of N200 and N240 were subjected to a two-way analysis of variance (ANOVA) with the repeated measurement factors of hemisphere (left, T5; and right, T6) and condition (biological motion and scrambled motion). For the amplitude of N200, the interaction of electrode position and condition was significant \( F[1,11]=7.6, p<.05 \). The simple main effect of hemisphere was significant for the biological motion condition \( F[1,22]=8.5, p<.01 \) and it reflected the fact that the amplitude for the biological motion condition was larger in the right hemisphere. The simple main effect of condition was also significant for the right hemisphere \( F[1,22]=7.2, p<.05 \), indicating that the amplitude of the biological motion condition was larger than that of the scrambled motion condition in the right hemisphere. We also observed that the simple main effect of condition was significant for the amplitude of the N240 \( F[1,11]=20.3, p<.01 \). This result indicated that the amplitude for the biological motion was larger than the scrambled motion for both hemispheres. In contrast, we did not find any significant factors in the latency of both components. Previous neuroimaging studies have shown that the V5/MT area is responsible for motion perception. In both of the stimuli, the number of points and the velocity vector were the same, and this indicates that the V5/MT area might be activated equally. However, we found amplitude differences in both conditions, which implied that there is a specific mechanism that responds to biological motion in addition to that in the V5/MT area. Recent human neuroimaging studies have reported that the right STS was activated during the perception of biological motion. We hypothesized that the observed two negative components can be explained as follows: the N200 component reflected motion perception involving the V5/MT region, and the N240 component was associated with higher processing of the motion stimuli involving the STS region. A recent study has revealed that the STS is activated not only by biological motion perception, but also by other stimuli of biomechanical motion (e.g., gaze direction and sign language). This type of perception has been called 'social perception'. We intend to clarify the relationship between the N240 component and social interaction in future investigations.

References

