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SOUND IMAGE SPACE AND DOMINANCE

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In a multichannel communication system,[4] coordination of two or more channels can improve perceptual accuracy,[9] e.g., "cocktail-party effect[2]" is producted by interaural and/or intermodal coordinations.[3] In order to analyze the mechanism of such an interaural system and its relationship to the system of speech perception, we have constructed a computer-assisted experimental system for binaural fusion.

System

As shown in Fig. 1, the stimuli of two pure tones (250 Hz) with different phases synthesized and stored in a laboratory computer are presented through a DA converter (16K sample points/s) and low-pass filters (1 kHz, -48 dB/oct) to both ears of subjects with by headphone (TEAC, TD-10). The subject sitting with eyes closed in a sound proof room is instructed to indicate the image position by pushing a button at the end of a short handle attached to the potentiometer. The data are then fed from the potentiometer to the laboratory computer, which stops presenting stimuli and stores the data. The subject is alternately presented one of twenty types of stimuli with different interaural phases and the reference stimulus. Prior to presentation of the stimuli, the subject reports the three positions in his interaural space, center, right, and left, by the potentiometer.

Procedure

Three or four sessions for each subject were conducted in one experiment. A few subjects were reexamined after a week.

Data Analysis

The angle of image position corresponding to each stimulus was calculated relative to the adjacent two reference stimuli.

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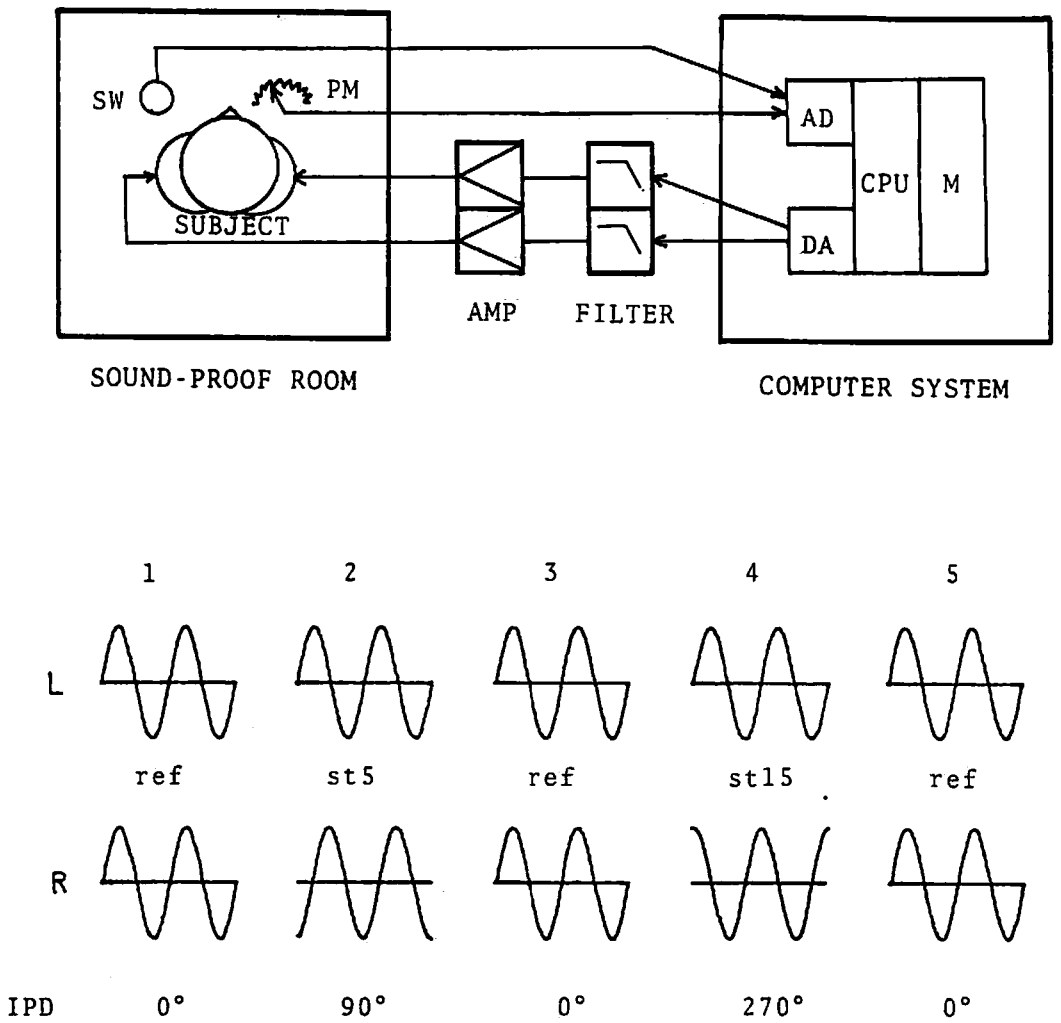

Fig. 1 Block diagram of experimental system

Each value of the angle and the average of all sessions were written down by X-Y plotter.

Results

Two examples of plotted data are indicated in Figs. 2 and 3. Subject SK in Fig. 2 shows left image space dominance but subject SM, right image space dominance. The angles of maximum right/left image positions for each subject are plotted in Fig. 4. Four, two

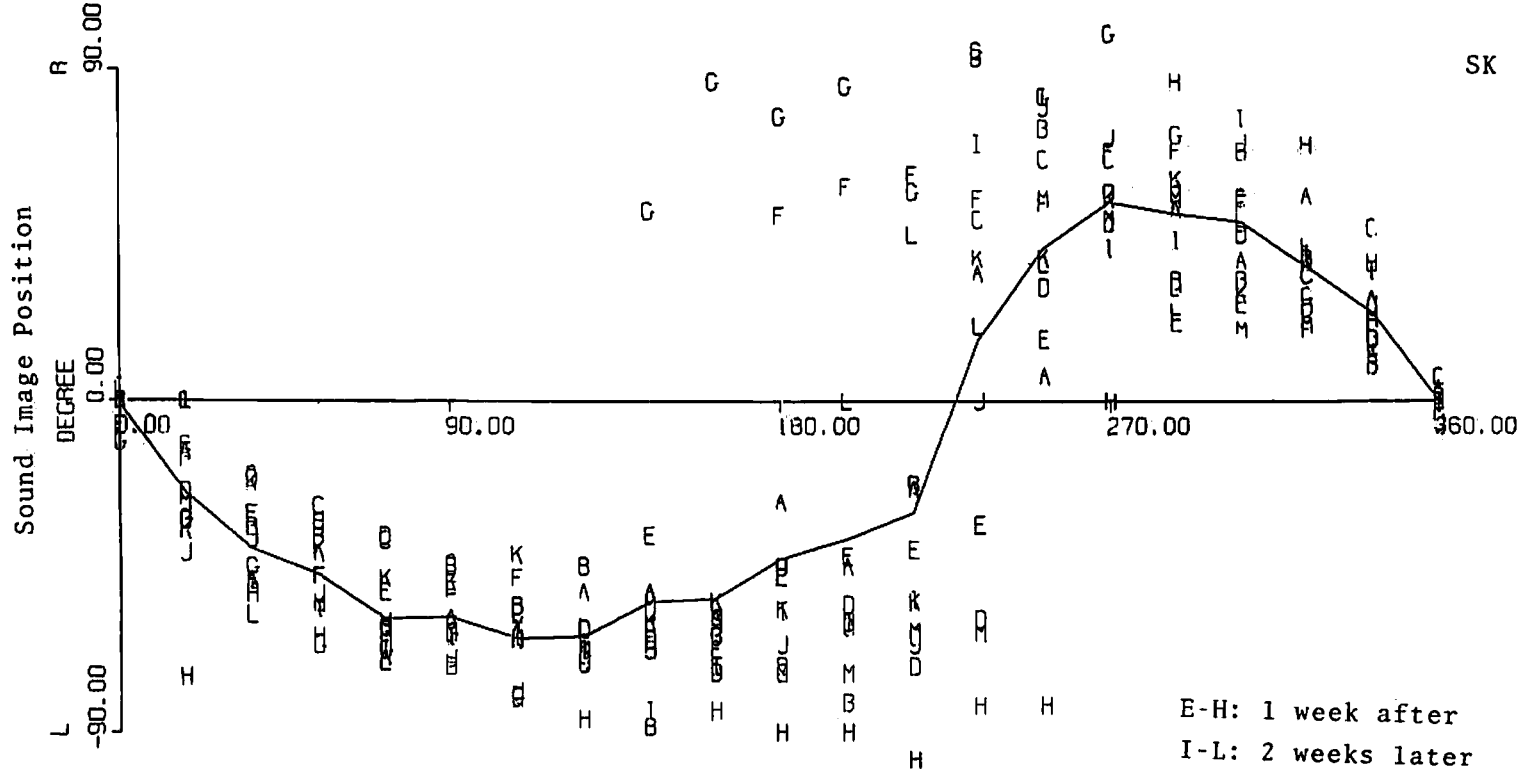

Fig. 2 An example of the result of one subject with left space dominance

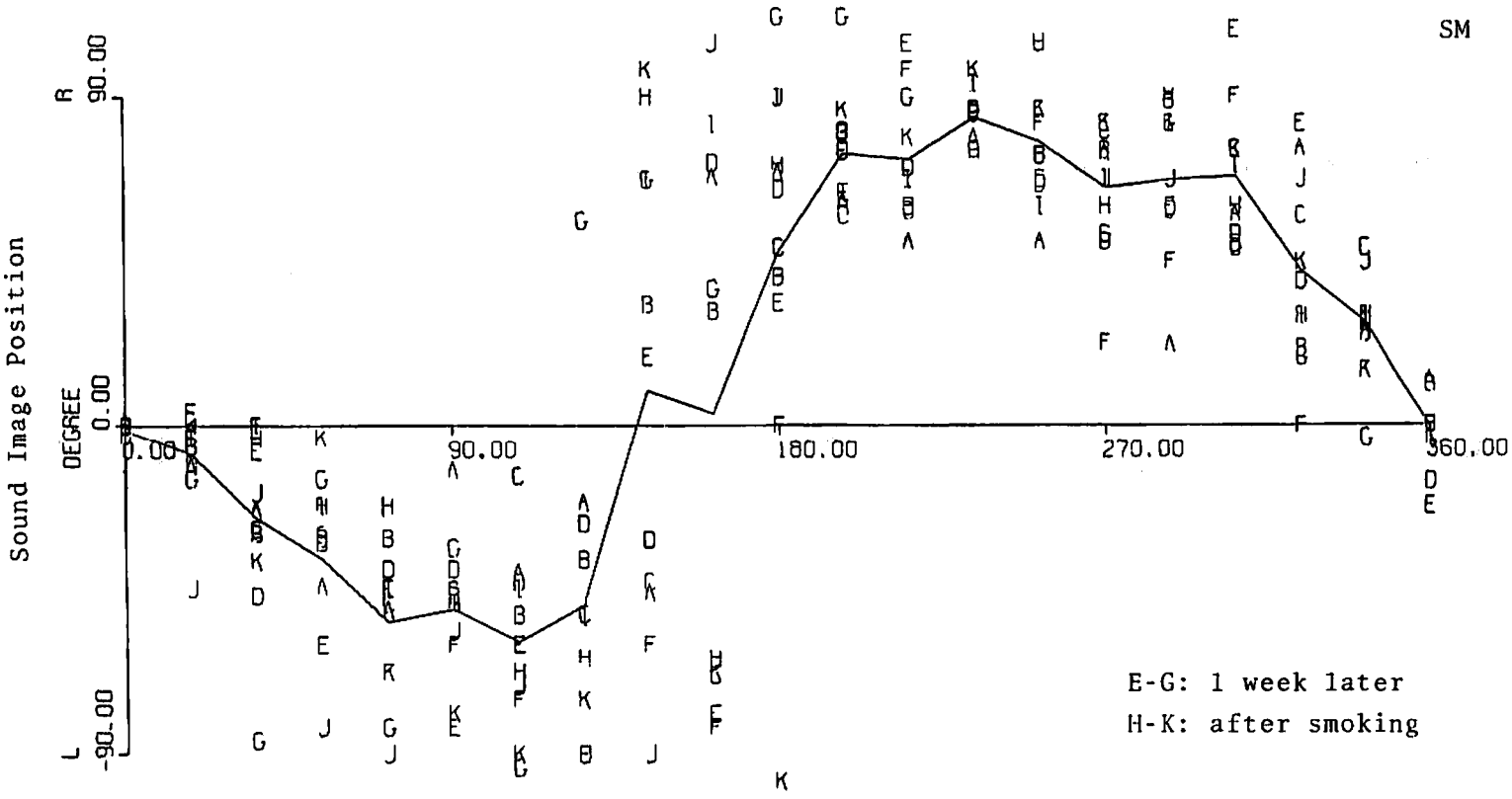

Fig. 3 An example of the results of one subject with right space dominance

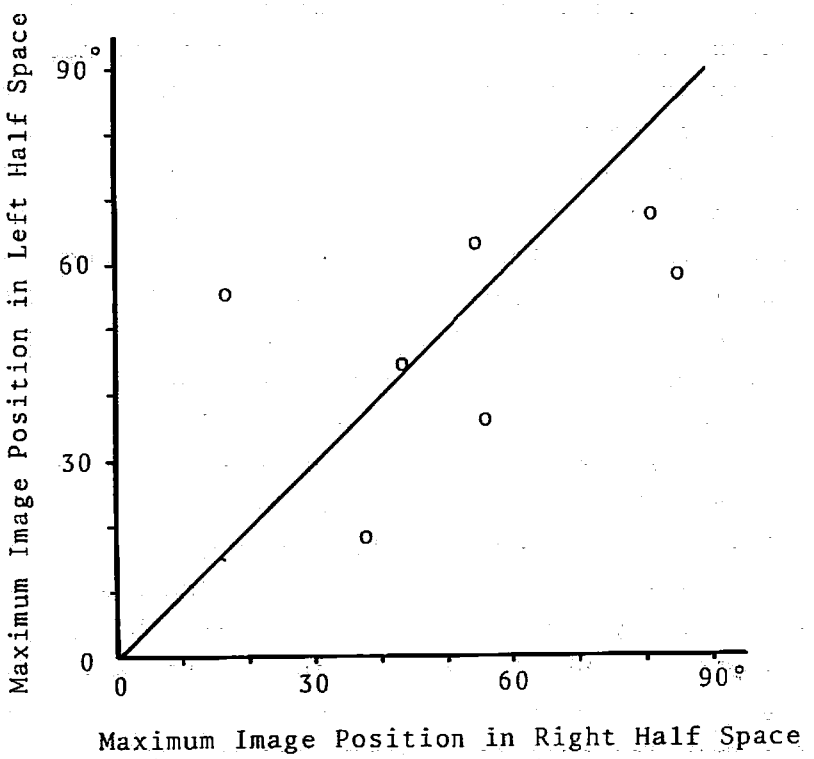

Fig. 4 Maximum values of image location in right (horizontal) and left (vertical) half spaces

and one of seven subjects showed right image field dominance, left dominance, and no dominance, respectively. Two, three, and two of seven subjects reported the range of almost full imagery space, half space, and quarter space, respectively.

Discussion

Five of seven subjects showed apparently asymmetrical image space. Sayers presented a result of image position with left space dominance in the animal auditory system.[13] Some phase-sensitive neurons have recently been found. Kuwada et al. investigated the responses of cat inferior colliculus neurons to binaural beat stimuli and reported that the activity of the collicular neurons corresponded to interaural phase difference.[11] Rose et al. found phase-sensitive neurons in cochlear nucleus with nonlinear output to monotically presented complex sound.[12] Cassedy and Neff[1] examined cat's performance of the discrimination of localization of

sound in space before and after the following operations: transection of the trapezoid body, unilateral or bilateral transection of the lateral lemniscus, unilateral or bilateral transections of the brachium of the inferior colliculus. From the results, they concluded that important encoding of the binaural cues for localization most likely occurs at the superior olivary complex, but the trapezoid body or other commissures of the brain stem auditory system are probably also involved in transmission of information necessary for localization to higher centers. In the superior olivary complex, Worden et al.[14] recorded the responses of bilateral cochlear nuclei and bilateral accessory nuclei to internaural time/intensity different stimuli. Both indicated bilateral responses to monotic right/left ear stimulus and no response to binaural stimulus. Their data demonstrate that the interaural phase detection necessary to localize the sound image are processed at the accessary olivary nucleus and the responses show polarity reversals and amplitude changes as functions of interaural intensity differences and interaural time differences. The olivocochlear bundle from the superior olivary complex is necessary to detect signals in noise.[10] The signal detection is maximum in performance when the signal/masker is in-phase/out-of-phase or out-of-phase/in-phase.[6]

The relationship between dominance of image space[5] and asymmetrical egocentric perceptual field[7] is interesting to analyze based on the interactions among auditory peripherals, superior olivary complex, and higher central nervous system.[8]

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