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ABSTRACT

This study investigated the possibility of a functional relation between the auditory and visual systems in the human newborn beyond reflexive organization. Visual activity was monitored in 16 newborns through the use of infrared corneal reflection video tape recording. Infants were observed in total darkness and while monocularly viewing a vertical bar presented either in the left or right part of the visual field. Sound was presented ipsilateral aud contralateral to the bar. Results indicate that sound produced looking first toward the source and then away from the source, thereby spatially biasing exploratory visual behavior. The data suggest that audition and vision are related at birth in a manner that is not purely reflexive. (Autbor/SB)

Spatial Effects of Sound on Visual Activity in Human Newborns

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Paper presented at the Meetings of the American Psychological Association, Washing, D. C., September, 1976.

Abstract

The study investigated whether there is a functional relation between the auditory and visual systems in the human newborn beyond reflexive organization. Through the use of infrared corneal reflection video tape recording visual activity was monitored in 16 newborns. Infants were observed in total darkness and while monocularly viewing a vertical bar presented either in the left or right part of the visual field. Sound was presented ipsilateral and contralateral to the bar. Sound produced looking first toward the source and then away from the source, thereby spatially biasing exploratory visual behavior.

Spatial Effects of Sound on Visual Activity in Human Newborns

Most psychologists hold the extreme empiristic view that auditory and visual space are totally dissociated in the newborn. However, work on sound localization suggests at least a reflexive relation between single eye movements and the direction of a source of sound (e.g., Turkewitz, Birch, Moreau, Levy, & Cornwell, 1966; Wertheimer, 1961). Stronger auditory-visual relations may exist in the newborn; but sound stimuli have been extremely brief in most previous studies. A certain period of time may be required for the newborn's visual system to conform to spatial requirements of auditory input. In addition, visual input generally has not been used in conjunction with the auditory event. Visual support may be necessary to enable a spatially meaningful response to sound at birth.

The study I shall report was designed to investigate the possibility that at birth there exists a functional, spatial organization between the auditory and visual systems beyond the reflexive organization reported in earlier studies. Stimulus conditions were chosen to enable the study of tonic rather than phasic spatial responding, and the method involved detailed measurement of visual activity by corneal reflection video tape recording.

Method

Subjects. Sixteen normal, full-term infants (mean age: 45.8 hr; mean birth weight: 7 lb 3 oz) served as subjects.

Procedure. Awake, wide-eyed newborns were selected for observation and were taken to the laboratory which was a small room in the newborn nursery of Swedish Hospital, Englewood, Colorado. A metal-framed wooden cabinet accommodated the infant and the equipment for recording eye movements (Figure 1). The infant was placed supine, 23 cm beneath a visual stimulus in a padded support so that one eye was in the field of the camera. The unrecorded eye was occluded with a sterile Telfa bandage. One experimenter presented a pacifier at the infant's midline which controlled both state and head position. Another experimenter operated the equipment and controlled presentation of the visual and auditory stimuli. Auditory stimuli were presented at specified times through speakers placed 20 cm lateral to the right and left ears.

Insert Figure 1 about here

Eye movement records were obtained with an infrared TV camera mounted vertically above the center of the stimulus screen. Infrared lights were also placed above the stimulus screen so that their beams passed through precalibrated positions of the stimulus plane and converged at the location of the infant's eye. The reflection of the infrared sources on the infant's cornea provided reference markers which were used later to determine fixation positions. A television monitor was available to observe the video output.

Stimuli. The visual stimuli were spray painted on aluminum window screens which were slid into position above the infant: Four stimuli (Figure 2) were prepared. Each consisted of a white, vertical bar 3.2 cm wide (approximately 7.5^{o}) on a black ground. The four stimuli differed only in the location of the bar--right and left bars for both right and left eyes (shifted in the field in the direction of the recorded eye). The auditory stimulus was 40 seconds of a repeating 16-second loop of a male reading an excerpt from a children's poem in a modulated voice.

Insert Figure 2 about here

All possible combinations of auditory and visual stimuli alone or in combination were presented. The experimental sequence of visual and auditory events varied for four experimental groups (n = 4). These groups contained an equal number of males and females—half of which were permitted to look with their right and half with their left eye.

The timing sequences for the experimental groups are shown in Figure 3. Groups 1 and 2 were presented a left bar; groups 3 and 4 were presented a right bar. The bar was presented twice for 60 seconds interspersed with dark control periods. The timing of visual events was 40 seconds dark—60 seconds light—60 seconds dark—60 seconds light—40 seconds dark. The auditory stimulus was presented four times for 40 seconds each, interspersed with 20-second silent control periods. Each subject heard the stimulus twice on the right and twice on the left. The sound order for groups 1 and 3 was Left-Right-Right-Left and for groups 2 and 4 Right-Left-Left-Right. Note that each infant heard the sound both ipsilateral and contralateral to the bar.

Insert Figure 3 about here

Design. The experimental design permitted examination of several factors. Those which concern us here were Visual Condition (Light and Dark), Bar Side (Left and Right), Auditory Condition (Sound and Silence), Auditory Side (Left and Right) and Eye Recorded (Left and Right). Visual Condition, Auditory Condition, and Auditory Side were within-subject variables; Bar

Side and Eye-Recorded were between-subject variables.

Results

The scoring method has been described in detail elsewhere (Haith, 1969). It provided a record of fixation position, sampled each half second for each infant. These data were further analyzed to obtain various parameters of scanning. However, I shall discuss mainly data pertaining to direction of gaze. The basic datum for analysis was mean fixation point on the X-axis for each period. A mean X-fixation of 0.0 corresponds to central looking, a negative mean X-fixation corresponds to looking in the left of the field, a positive value indicates looking in the right of the field.

Figure 4 shows mean X-fixation as a function of Auditory Side for 20-second periods at the beginning and end of sound presentation. The data show that subjects fixated ipsilateral to the sound at the beginning of a sound period but in a direction away from the sound at the end of a sound period, F (1,12) = 11.41, $p < .01$. This was true for both dark and light, although the effect was stronger in the light. Of course, this relation did not hold for comparable silent periods.

Insert Figure 4 about here

To further analyze location of fixations on the X-axis, the mean absolute value of the deviation from the center of the bar was computed for each condition. This permitted more direct comparisons between groups who viewed bars at different locations in the field.

First, it is worth noting that the directional effect of sound affected scanning of the bar. At the beginning of a sound period infants fixated closer to the bar for sound ipsilateral rather than contralateral to the bar. At the end of a sound period infants fixated closer to the bar for sound contralateral rather than ipsilateral to the bar. This effect was true for 12 of 15 newborns who showed a difference ($\chi^2 = 5.40$, $p < .025$). Scanning of the bar was different during Sound and Silent periods. Scanning was more constrained to the bar at the beginning and less constrained at the end of ipsilateral sound than in silent periods. The opposite was true for contralateral sound. These findings were not true in darkness. Thus sound did not merely increase bar scanning by shifting fixations but appeared to affect the way in which the bars were scanned as well.

Discussion

The major purpose of the study was to investigate the effects of lateralized sound on visual activity. Lateralized auditory stimulation produced fixations first in the directions of sound and then away from sound. Chun, Pawsat, and Forster (1960) reported that young infants responded to sound simply by visual roving in the horizontal plane. Detailed examination here has revealed that the effects of sound are not as general as they suspected. Lateralized sound does lead to visual roving, but the movement has a specific directional relation to the locus of sound.

The response to lateralized sound possibly serves the function of facilitating detection of visual events on the side ipsilateral to the sound. In this study a changing auditory event occurred with an unchanging visual event. This may have caused newborns to search for a visual event which changed correspondingly, a search that necessarily led them away from the sound source to the contralateral side. If so, the interesting hypothesis arises that the development of an appreciation of auditory-visual spatial relations may be fairly plastic. That is, the newborn may be prepared to learn about auditory-visual events whose components are not necessarily spatially consonant. The newborn may be sensitive to many types of correspondences between auditory and visual information which specify the same event. Common spatial location is likely a prepotent type of correspondence, but other types, such as common variations in rhythm, intensity, and movement may be equally important for the newborn. (These possibilities are currently being explored experimentally.)

Earlier studies (Mendelson & Haith, in press) showing an effect of sound on visual scanning are open to the interpretation that sound produces a non-specific state change. However, the spatial effect of sound on scanning cannot solely be a function of stimulus induced state changes. The effect of sound outlasted a brief post-auditory-onset interval which also suggests that it was not a function of phasix orienting, although it may be a tonic component of the orientation reaction.

The current study then has helped clarify ambiguities concerning effects of lateralized auditory input at birth. The effect of sound on scanning has a directional basis which precludes an exclusive state-change interpretation of the link between auditory and visual systems. In addition, the data suggest that audition and vision are related at birth in a manner that is not purely reflexive.

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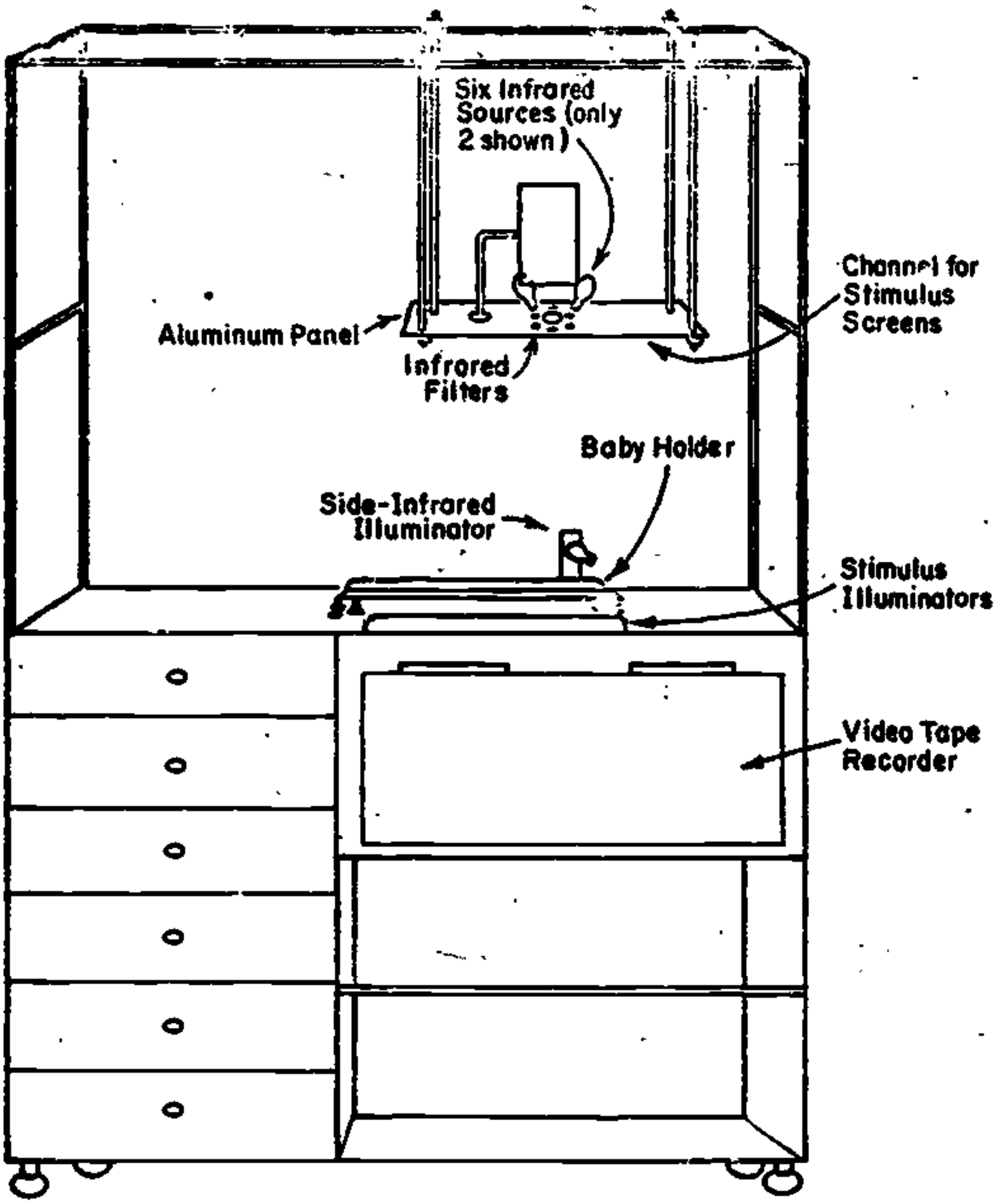

Figure 1. Schematic outline of recording apparatus.

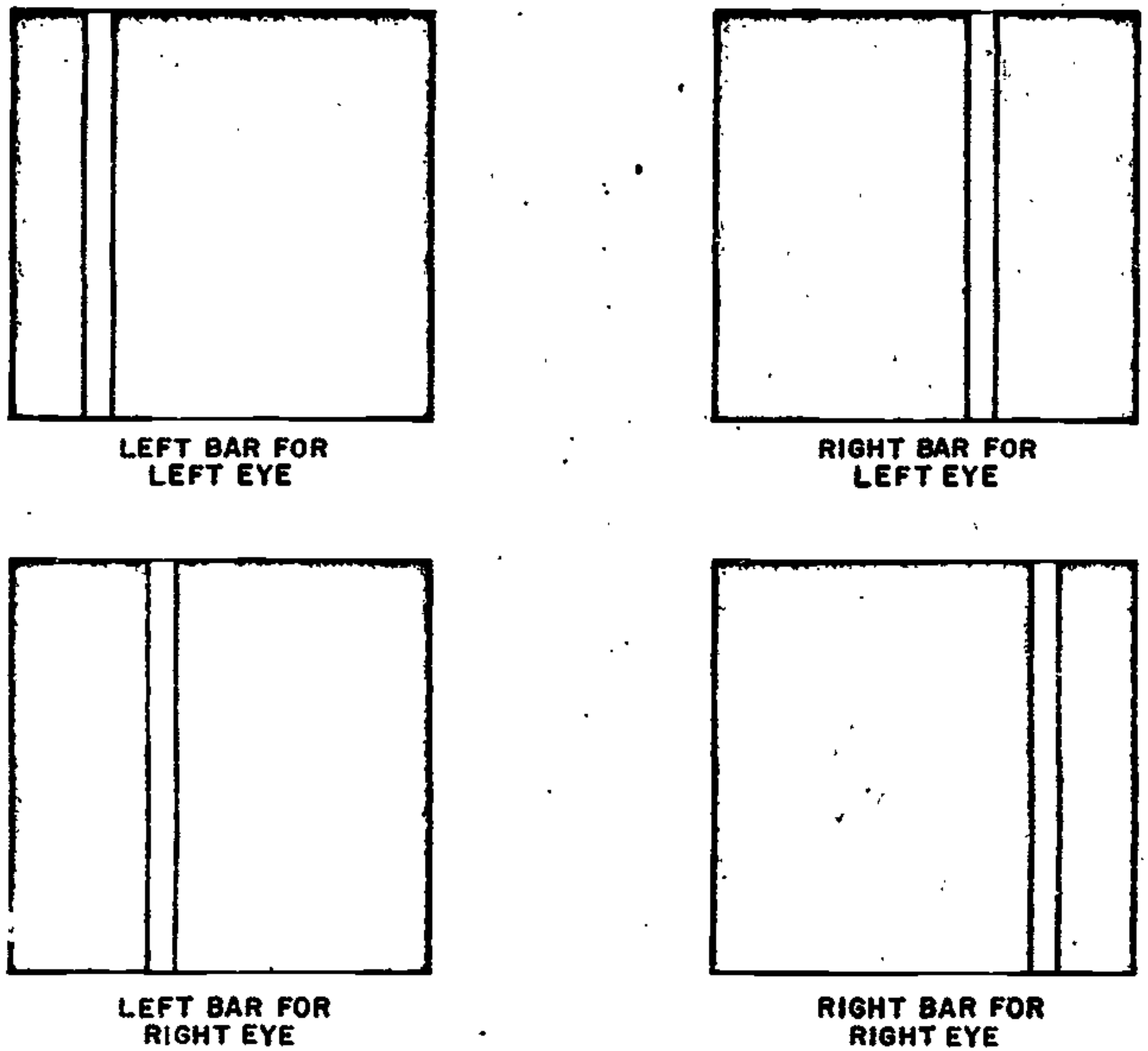

Figure 2. Visual stimuli used in study.

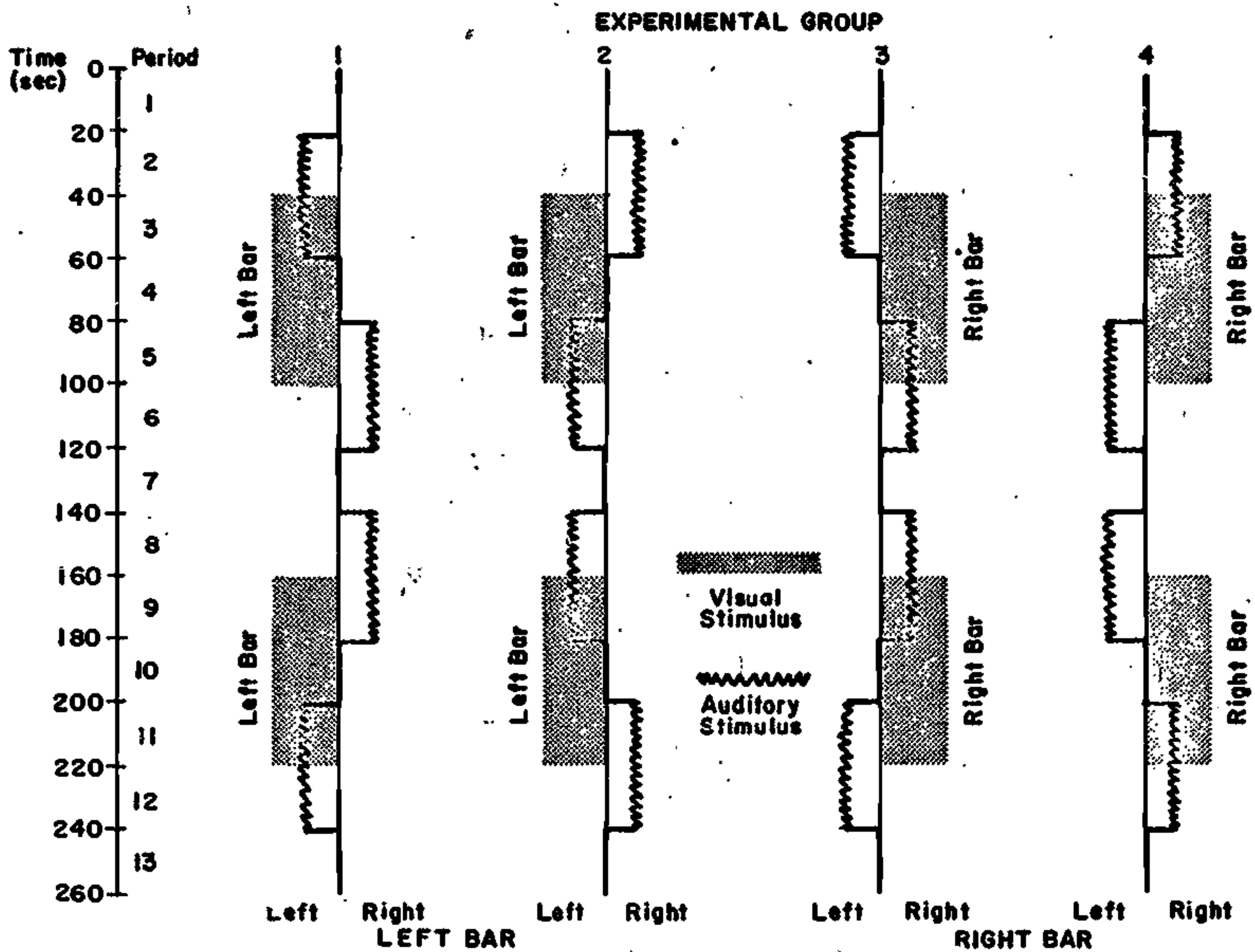

Figure 3. Timing sequence of visual and auditory stimuli for each Experimental Group.

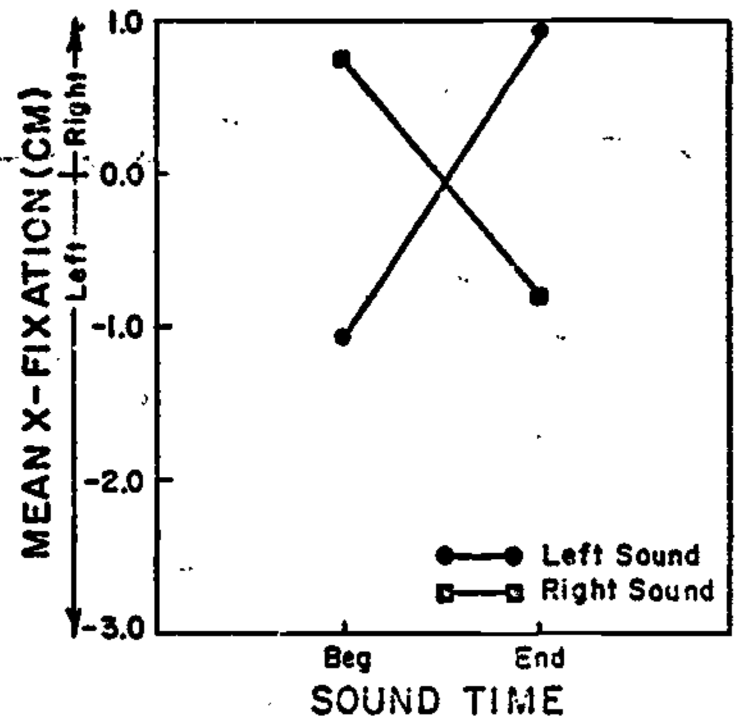

Figure 4. Mean X-fixation as a function of auditory side and sound time. (n = 16)