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ABSTRACT

A total of 14 infants participated in this study of the recovery of visual orienting by crossmodal stimulation when no new visual information was present. The locus of the crossmodal stimulation (auditory stimulation) was discriminable to the subject. Infants in three age groups were tested on three occasions each separated by 30 days. No substantial differences were found between the age groups. All infants underwent visual trials utilizing slides and visual auditory trials that included slides and music presented on one of two visible speakers. It was shown that novel auditory stimulation reliably elicited orienting to both auditory and visual stimulation and both of these orienting responses appeared to habituate with repeated stimulation. (MS)

Infant Habituation to Visual and Auditory Stimulation

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A series of experiments in a recent monograph edited by Horowitz demonstrated that the addition of auditory stimulation can rerecruit visual attention to a previously fixation-habituated visual stimulus. The implication of this finding, as McCall pointed out in the monograph's commentary, is that visual orienting may be recovered by crossmodal stimulation when no new visual information is presented. A challenge to habituation of visual fixation as a measure which varies directly with visual information processing is posed by this finding.

However, since the auditory stimulation originated from a speaker located directly below the child, it is also possible that the infants in these studies were searching for the source of auditory stimulation. Sokolov has previously described modality-specific and generalized orienting responses with delivery of crossmodal stimulation, following habituation of adults' response to stimulation in one modality. Demonstration of modality-specific speaker fixations would alter the monograph's conclusion concerning infants' generalized visual attending. That is, the occurrence of speaker fixations while the original visual stimulus was available would modify the interpretation that the observed recovery of attending reflected only generalized reorienting to the visual stimulation.

Thus, the present study incorporated McCall's suggestion that speakers be positioned so that the locus of auditory stimulation would be discriminable. This procedure allowed the experimenter

to observe whether the child fixated the source of visual stimulation, the source of auditory stimulation, or both in turn, thereby permitting the differentiation of modality-specific from generalized orienting processes. It was expected that not only would lateral fixations to speakers be observed, but that this orienting would habituate from the repetition of the auditory stimulation which produced it, and would show recovery with change in the source of auditory stimulation. It was also expected that generalized recovery of attention to the visual stimulus would be observed with the addition of auditory stimulation.

The sample for this study included 14 infants in a longitudinal intervention program. Infants were tested on three occasions separated by 3 days, with 5 infants entering the study at 4 months of age, 5 infants at 6 months of age, and 4 infants at 9 months of age.

All sessions were conducted within a plywood enclosure of 3 walls and ceiling. Visual fixations were recorded from button switches with leads to a Grass polygraph in an adjoining room. One button's lead was also connected in series between the shutter and a cassette tape player located in the equipment room. The tape player's operation was modified so that relays delivered auditory stimulation simultaneous with the slide during auditory + visual trials.

Infants faced an opaque screen mounted in the enclosure's rear wall onto which visual stimuli were rear-projected. All infants

were shown a slide of a toy cat during visual and visual + auditory trials.

Auditory stimulation was delivered by 2 speakers mounted on the testing chamber's exterior at 90° angles to left and right from the infant's head. The speaker was mounted behind a faintly visible matrix of holes, at a right angle to the screen which the child faced. Auditory stimulation consisted of the opening measures of Tchaikovsky's "Dance of the Sugar-Plum Fairy" recorded on a continuous-loop tape. Ambient noise within the testing chamber with music playing ranged from 53 to 67 dB re 49 dB of ambient noise when music was not playing.

A presession nursery check was made before an infant was removed to the testing room, to insure that the subject had received the morning feeding or had had a nap and lunch. Diapering was performed as necessary, though with reluctance.

While a subject was being seated in the high chair, a matrix of flowers was projected on the screen to the infant's right as a starter stimulus. A pacifier on a cord about the infant's neck was offered to the infant before positioning of the chair within the testing chamber.

Two observers seated on either side of the screen recorded looks to screen and looks to active speaker, with visual access to the infant provided by small holes covered with mesh. A third experimenter monitored fixation duration and controlled stimulus programming in the adjoining room.

A session, as shown on part A of the handout, consisted of at least 5 visual trials, followed by at least 8 auditory + visual trials and an auditory + visual recovery trial. As outlined in part B of your handout, during visual trials, infants were shown the slide for 6 trials, and until 2 consecutive trials were obtained for which the fixation time was less than the mean fixation on the first 2 trials. Auditory + visual trials immediately followed the visual series, using the same procedure except that the music was delivered simultaneous with the slide. After the infant reached the habituation criterion during auditory + visual trials, the active speaker side was changed from left to right or vice versa, and an auditory + visual recovery trial was given. Active speaker side for the first session was randomly assigned as left or right, and was alternated on subsequent sessions.

The infant controlled stimulus duration on each trial, in that stimulation continued until the infant looked away from the screen during visual stimulation, or away from the speaker and screen during visual + auditory stimulation for 2 consecutive seconds. One of the observers initiated and terminated trials with the button linked to shutter and speaker operation. The stimulus was reintroduced after an intertrial interval of 3 seconds.

A session was terminated if the infant's state changed from awake and alert to a state of drowsiness or agitation, with the latter defined as loud and prolonged crying. Infants were retested on the following day until a completed session was obtained. That

uncooperative subjects were not discarded from this sample may be a unique feature of the procedure used in this experiment.

Before presenting fixation data relevant to generalized and modality-specific attention, a few preliminary remarks are in order. First, the mean number of attempts necessary to obtain a completed session was 2.3 for the 42 completed sessions. Fewer attempts were required on second and third monthly testing occasions than on the first occasion.

Second, averaged across sessions, subjects reached the habituation criterion in 3.4 visual trials and in 8.9 auditory + visual trials. The maximum number of trials required to complete any session was 24.

Third, observer reliability was obtained by summing over successive half-second intervals of fixation for each trial. Agreement divided by total agreement + disagreement was summed over trials to obtain reliabilities for each session. Averaging over all sessions, observer reliability for duration of screen fixations was 91.9, and for duration of speaker fixations was 76.1.

All results to be reported here are collapsed across age of infant at testing. Two lines of reasoning support this decision. First, preliminary one-way analyses of variance failed to show substantial attentional differences between infants in the 3 age groups. Thus, of 11 tests conducted to examine age group differences in duration of first fixations and response decrement during visual and auditory + visual stimulation, the only reliable age group

effect demonstrated that the 4-month group exhibited a significantly greater decrement than the 9-month group in screen fixations during visual stimulation of the second session. Second, since all infants were habituated to an individually determined criterion of response decrement, effects attributable to auditory stimulation—the primary concern of this report—can be expected to be comparable across age groups.

For the results which follow, significance refers to a .05 level of confidence; "approached significance" or "marginally significant" refers to a .06 level of confidence.

Insert Figure 1 about here

The pattern of screen fixation decrement during the 3 sessions collapsed across age groups is shown in Figure 1. Seconds of fixation duration are plotted on the figure's ordinate, and trial blocks are represented on the abscissa. Session 1 data are presented in the upper panel; Session 2 in the middle panel; and Session 3 in the lower panel. Using the McCall-Appelbaum approach to repeated measures, linear orthogonal polynomial contrasts of trial block means were analyzed for decrement within the 3 sessions. The decrement obtained to the visual stimulus was significant for all 3 sessions. Thus, habituation to the visual stimulation was reliably demonstrated, replicating Horowitz' findings concerning infant control of stimulus duration.

Insert Figure 2 about here

Figure 2 demonstrates the effect of adding auditory stimulation to the previously habituated visual stimulus. The solid line in each panel of Figure 2 represents screen fixation; the broken lines represent speaker fixations; the first set of data points represent the mean duration of screen and speaker fixations on the last trial of visual stimulation; the second set of data points represent the duration of screen and speaker fixations on the first trial of visual + auditory stimulation.

The visual impressions from Figure 2 clearly demonstrate the dual effect of auditory stimulation. First, as found by Horowitz, the addition of novel auditory stimulation reliably re-elicited infants' attention to the previously habituated visual stimulus. However, the introduction of auditory stimulation also resulted in infants' turning away from the source of visual stimulation and fixating the source of auditory stimulation.

In each of the 3 sessions, 9 of the 14 infants fixated the speaker on the first visual + auditory trial for up to 160.1 seconds. The mean duration of these active speaker fixations, as compared with mean speaker fixations on the last trial of visual stimulation, approached reliability in the second session and was reliably different from the preceding visual trial in the third session. That novel auditory stimulation increased fixation of the visual

stimulus does replicate the results reported by Horowitz and her students. However, that infants turned away from the visual stimulus and fixated the speaker suggests that infants were orienting to both the visual and auditory stimuli.

Insert Figure 3 about here

Figure 3 appears to raise further doubt concerning the monograph's interpretation of visual fixation recovery. If infants were orienting to the event which apparently re-elicited attention; namely, the auditory stimulus, then presumably looks to the speaker as well as to the screen should habituate. The data in Figure 3 suggest that the infants did indeed habituate their fixations of both the visual and auditory stimulus. First, note the decrement in fixations of the visual stimulus--represented here by the solid lines. All three of these decrements, like those during visual stimulation, were reliable. Notice, however, that speaker fixations also appear to habituate. Unfortunately, only the observed decrement during Session 3 was reliable, thereby causing one to be judicious in the interpretation that screen and speaker fixations habituated simultaneously.

Insert Figure 4 about here

Recovery of screen and speaker fixation on the final trial in the session, for which the active speaker side changed, is presented

in Figure 4. Recovery of attention to the screen, shown by the solid lines, was less dramatic with a change in the source of auditory stimulation than screen fixation recovery obtained with the addition of auditory stimulation. Related t-tests indicated significant recovery for the first session and marginally significant recovery for the third session.

Recovery of attending to the speaker when the active speaker side was changed was marginally significant for the third session. Five infants demonstrated recovery in Session 1, 4 in Session 2, and 8 in Session 3, with fixations ranging up to 39.4 seconds.

The challenge to habituation of visual fixation as a measure of visual information processing posed by the finding of Horowitz has been qualified with the present study's findings. First, by placing speakers at right angles to the screen, we observed that most infants turned away from the source of visual stimulation and fixated the source of auditory stimulation for durations ranging up to 160 seconds. In addition, the ability of novel auditory stimulation to recruit visual attention did generalize to recover fixation to the slide. Second, the orienting to the source of auditory stimulation, like that to the visual stimulation, appeared to decline with repeated stimulation; by the third session this decrement in speaker fixations was reliable.

In summary, introduction of novel auditory stimulation reliably elicited orienting to both auditory and visual stimulation, and both of these orienting responses appeared to habituate with

repeated stimulation. It would seem to follow that infants tested in this paradigm visually orient to both visual and auditory events, thereby, as McCall puts it, availing themselves "in every modality of the particular event which set off the orienting response."

References

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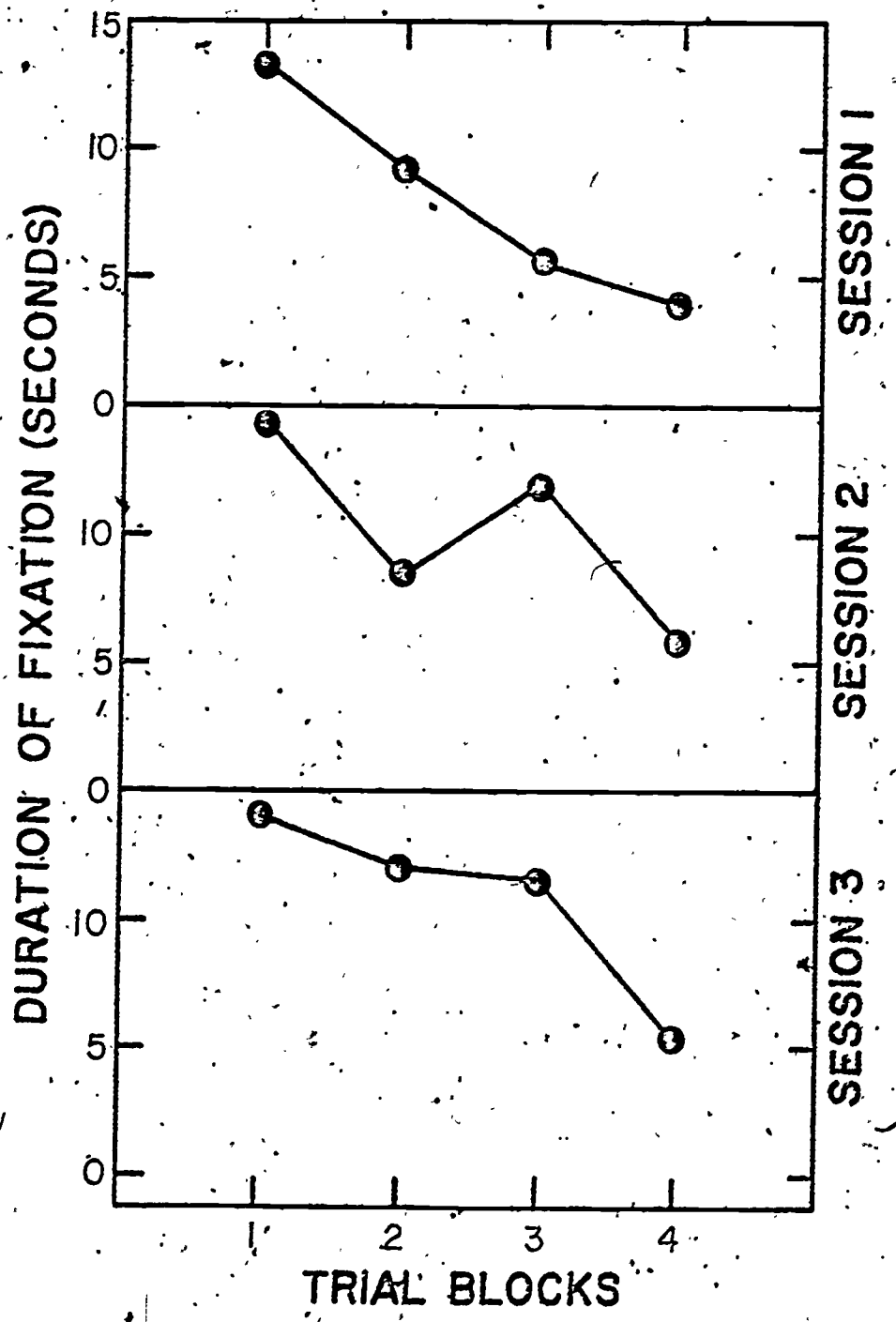

FIGURE 1. DECREMENT IN SCREEN FIXATION DURING VISUAL STIMULATION.

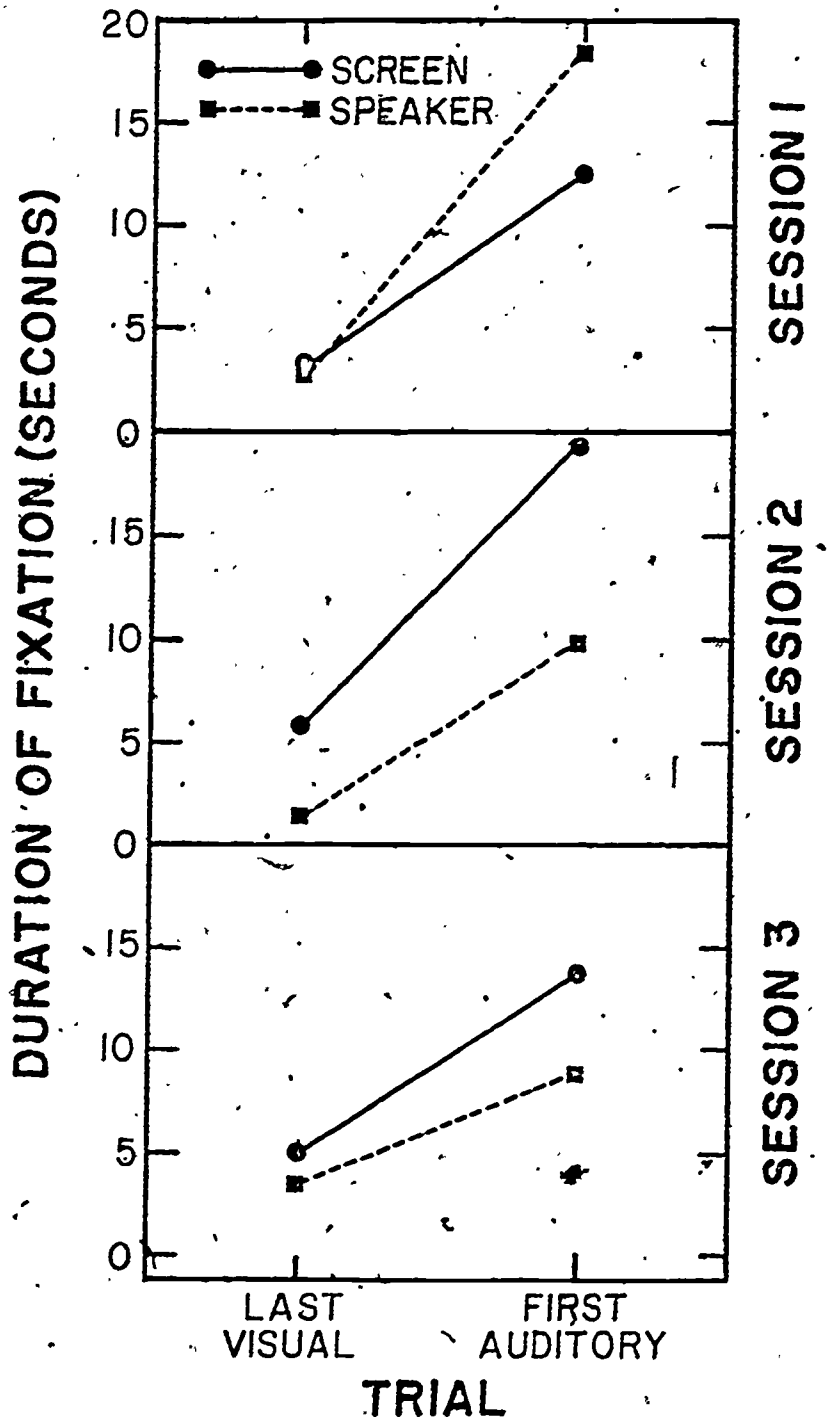

FIGURE 2. EFFECT OF ADDING AUDITORY STIMULATION ON SCREEN AND SPEAKER FIXATIONS.

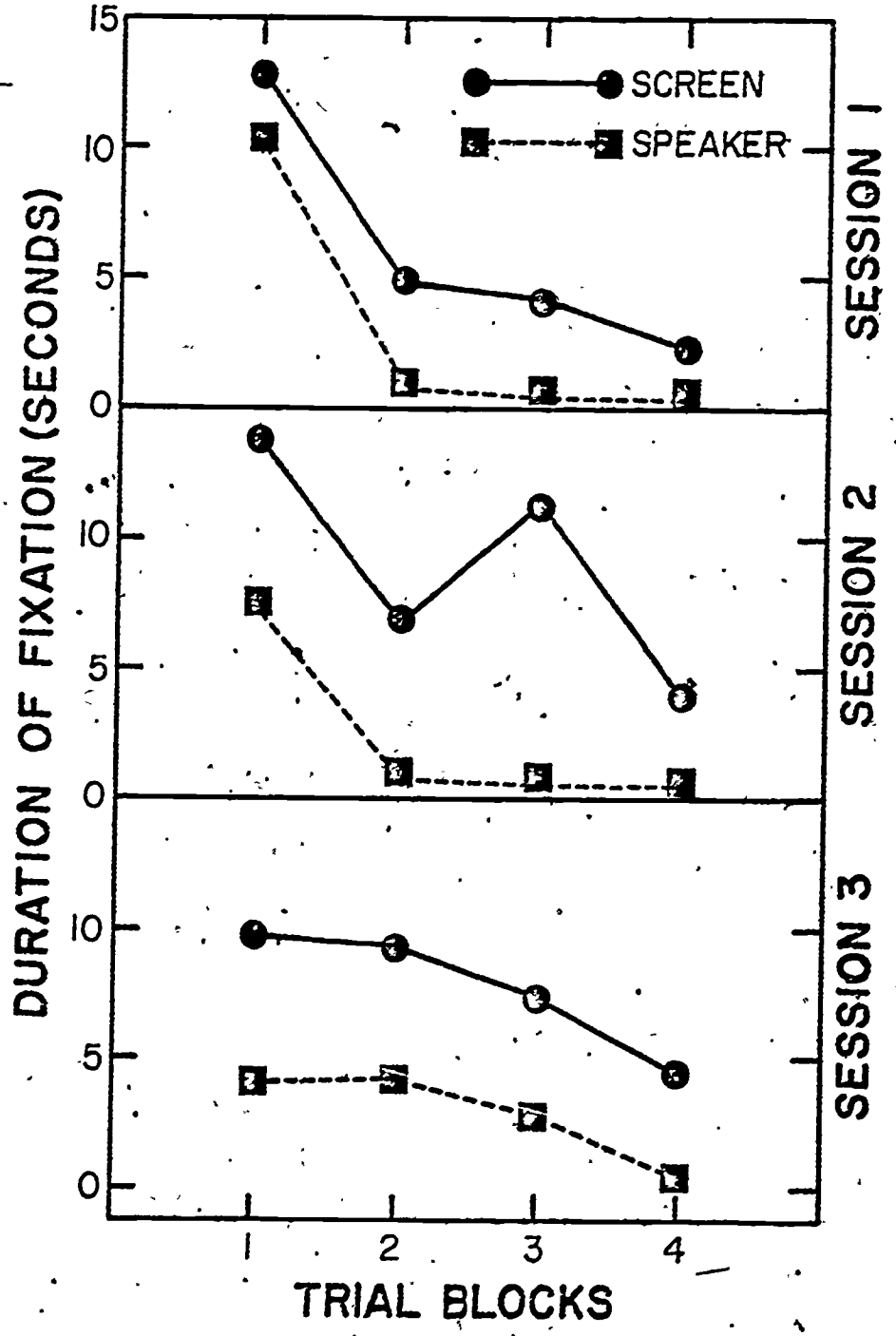

FIGURE 3. DECREMENT IN SCREEN AND SPEAKER FIXATIONS DURING VISUAL AND AUDITORY STIMULATION.

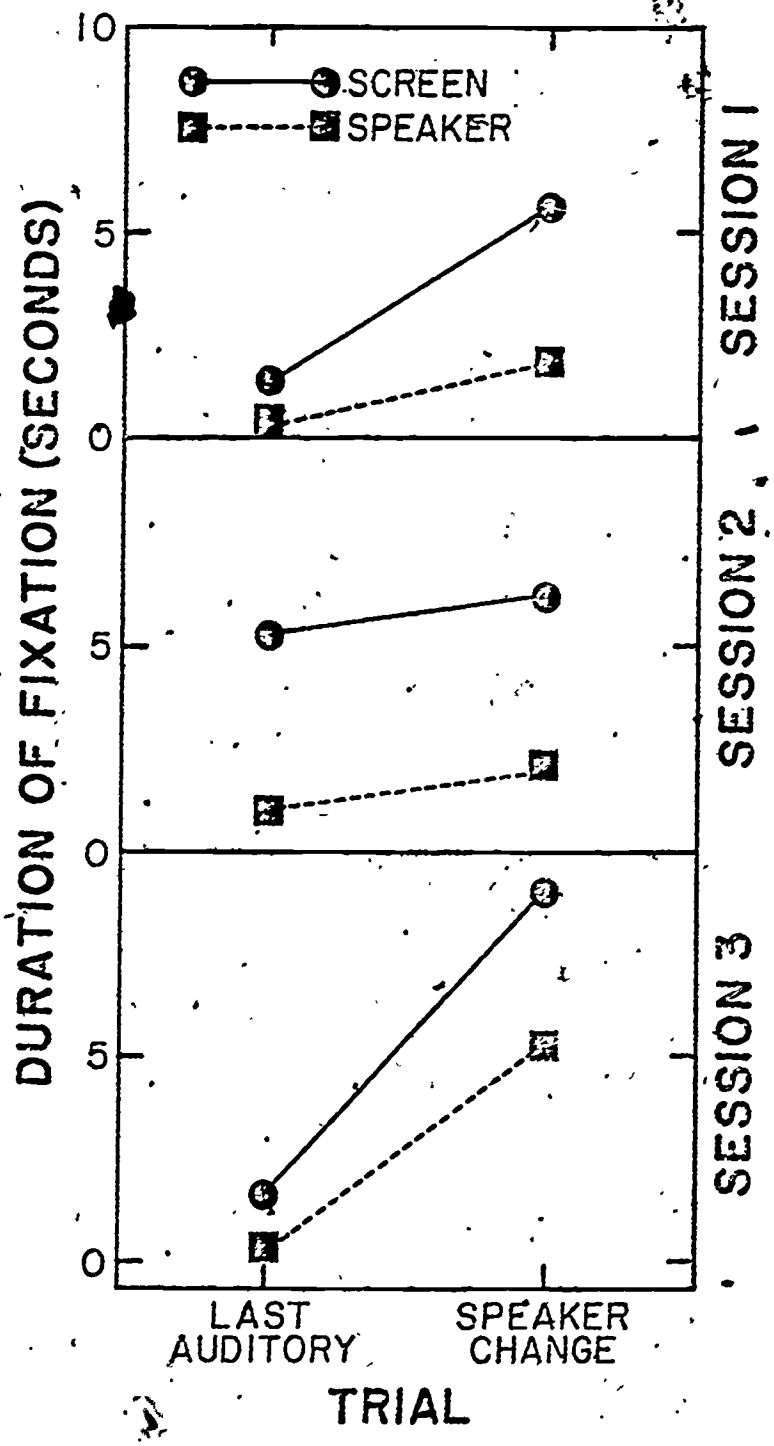

FIGURE 4. EFFECT OF CHANGE IN SOURCE OF AUDITORY STIMULATION ON SCREEN AND SPEAKER FIXATIONS.