Effect of acoustics on auditory and visual autokinesis*

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An experiment measured visual and auditory autokinesis under two acoustical conditions. The visual stimulus was a 2-mm light source, the auditory stimulus a 2,000-Hz sine wave. Both stimuli were presented singly and simultaneously in a reverberation room and in an anechoic room. More visual than auditory movement was reported, and statistical analysis showed a significant interaction between mode of stimulus presentation and kind of environment: visual autokinesis was greater in the anechoic room, but auditory autokinesis was greater in the reverberation room. The interaction was interpreted within frame-of-reference theory.

Inspection of the literature on visual autokinesis reveals a multiplicity of variables, methodology, and issues (Royce, Carran, & Aftanas, 1966). Far less is known about autokinesis in other sense modalities. If the phenomenon does exist in other sense modalities, audition appears to make the strongest claim. Bernadin & Gruber (1957), using pure tones of various frequencies, found that all Ss experienced spatial displacement of the sound when listening in a totally dark room. They used the tone with and without a small light on top of the loudspeaker. When the with-light group was compared with the group that had only tone, the number of auditory movements was somewhat greater in the with-light group, but not significantly so. In a similar study by Anderson & Moss (1964), auditory movement was observed by 28 of the 36 Ss. Anderson (1965) also investigated correlational relationships between visual and auditory autokinesis. Using reported changes in pitch and loudness as auditory criteria, he found positive correlations, but not all of them were significantly different from zero. The auditory pitch effect correlated more highly with the visual effect than did the autokinetic loudness effect. Extreme visual autokinetic scores did not affect any auditory scores for loudness and pitch.

Any study with sound stimuli should consider acoustics as a relevant variable. It is conceivable that acoustical differences have a differential effect upon the extent of auditory autokinetic movement and that, when auditory stimuli are used in conjunction with visual stimuli, they may have a differential effect upon the extent of visual autokinesis. If it can be assumed that an auditory stimulus has a more distinct quality of singleness in an anechoic room than the same stimulus (corrected for loudness) in a reverberation room, the former situation should most closely resemble the single light source condition of visual autokinesis.

An experiment was conducted in anechoic and reverberation rooms. A light stimulus and a sound stimulus were presented separately and simultaneously.

METHOD

The experiment measured the duration of visual and auditory autokinetic movement during a given period under two stimulus conditions, a small light and pure tone. The sound used in the experiment was a 2,000-Hz sine wave 50 dB above threshold that came from a 7-cm speaker placed 2.2 m directly in front of S, 92 cm above the floor. Two nonfunctional speakers were located 30 cm on each side of the speaker and served to suggest that the sound source would actually move. The Ss were told that a green spot would appear 5 cm on the left of the functional speaker. A small oscilloscope was present in that location, but in reality it did not work; the light came from a stationary bulb 2 mm in diam, filtered green (luminous intensity of 6 x 10^{-6} cd), positioned immediately below the oscilloscope. Data were collected from each S in an anechoic chamber (5.4 x 8 m) and in a cement-surfaced reverberation room (3.6 x 6.6 m). Except for this stimulus, nothing about or in the room was visible once the experiment had started. The auditory stimulus in the reverberation room was matched for loudness with the auditory stimulus in the anechoic room by taking the average judgment of six Ss. In the latter room, S was seated one-third of the distance from one end of the room and the equipment was placed one-third of the distance from the other end. All control and data recording equipment were located in a separate room.

Eight naive male graduate students took part in the experiment. After being seated and having his head placed in a semicircular support stand, S was told to remain as motionless as possible and instructed to press a push-button switch (held in hand) when the light or the sound began to move. He was also instructed to stop pressing when movement stopped and to ignore apparent changes in pitch. Audition was binaural and vision monocular with the dominant eye. After 5 min of dark adpatation, S's first two trials consisted of 4-min single presentations of the light and the tone. During the next three trials, light and sound were presented simultaneously for 4-min periods and S responded to the light, the tone, or both. The sixth and seventh trials were single-stimulus presentations, like the first two trials. Before each session, S was told to memorize to which stimulus or stimuli he was to respond in each of the three double-stimulus situations, e.g., first light, then both, then sound. The S used the same push-button switch in all conditions. To minimize the number of conditions S had to commit to memory, the three double-stimulus trials were not counterbalanced, but randomized only. Either light or sound was presented randomly and counterbalanced on Trials 1, 2, 6, and 7. Half the Ss started in the reverberation room, the other half in the anechoic room.

RESULTS AND DISCUSSION

Visual movement was reported by all Ss during all appropriate trials. Auditory movement was also reported by all Ss, although one S gave no response during one of his appropriate trials. The duration means for the various conditions are presented in Table 1.

The data were subjected to three analyses of variance. The first one tested for differences between visual and auditory autokinesis (A) and the two environments (B) as main sources of variation. For this analysis, the responses to the double-stimulus conditions were omitted. The results showed that autokinesis (A) was significant [$F(1,7) = 7.25$, $p < .05$] and that interaction between autokinesis and environment was significant [$F(1,7) = 14.78$, $p < .01$]. The Ss constituted a random factor which also proved significant. The second analysis of variance included the single and simultaneous presentation of stimuli as a main source of variation (C) and the same two factors of the first analysis: autokinesis (A) and environments (B). None of the main factors reached

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Table 1
Visual and Auditory Autokinesis Under Conditions of One and Two Stimuli in Two Acoustically Different Environments

		Light	Tone	Light + Tone
Reverberation	One Stimulus	119.9	100.3	—
Room	Two Stimuli	107.5	100.9	100.0
Anechoic	One Stimulus	148.7	79.5	—
Room	Two Stimuli	124.4	98.0	143.2

significance. However, statistical significance was obtained for Ss and two interactions: A by B ([F(1,7) = 7.49, p < .01] and A by C [F(1,7) = 11.59, p < .025]. The first interaction concerned visual/auditory autokinesis and reverberation/anechoic environment and the second concerned visual/auditory autokinesis and the single/simultaneous presentations.

The third analysis of variance was limited to the data of the three simultaneous-stimulus conditions in which S responded to light, sound, or both. The results gave no evidence of a significant difference between these three conditions [F(1,7) = 1.22]. Only Ss reached significance, as was the case in the previous analyses.

An interesting finding was the very significant interaction between autokinesis and environments: more visual autokinesis in the anechoic room (as compared with the reverberation room) was paired with less auditory autokinesis. The most remarkable aspect of this interaction is perhaps the fact that light was affected more (i.e., varied more) than tone. The difference between the condition of light-reverberation room and light-anechoic room was significant, but the comparison between tone-reverberation room and tone-anechoic room was not. This means that the tone variable, which was employed in acoustically different ways, was not sufficient to explain the A by B interaction. It could mean, for instance, that the difference found in visual autokinesis was due to other sounds, such as S's clearing of the throat, the movement of his foot on the floor, etc., which made for a different orientation about each room. In that case, tone must have had the same influence in those situations where it preceded the light stimulus. When visual responses of Trials 1 and 2 were compared with visual responses of Trials 3 and 4, only rooms (environment) was statistically significant [F(1,7) = 4.60, p = .05], suggesting that the effect started early in each session, probably the minute S walked into the room and heard his own footsteps and some last-minute instructions from E. If this was indeed what happened, it means that S's visual performance interacted with a set rather than with sound itself.

A comparison between one- and two-stimulus presentations showed no evidence of a significant difference. Very significant, however, was the interaction between one- and two-stimulus presentations and visual and auditory autokinesis. In the two-stimulus condition, visual autokinesis decreased when compared with visual autokinesis in the one-stimulus condition, whereas auditory autokinesis increased in the two-stimulus condition when compared with auditory autokinesis in the one-stimulus condition (see Table 1). The presence of an auditory stimulus apparently decreased visual autokinesis and the presence of a light stimulus apparently increased or left unaffected auditory autokinesis. From this result, and the results of the previous analyses, it seemed reasonable to conclude that the presence of a tone had a negative influence upon visual autokinesis.

An important question still remains as to the nature of this negative effect. A possible answer was provided by the data of the three conditions where both stimuli were presented and Ss responded to light, tone, or whichever one of the two seemed to move (see Table 1). Although there was no difference between the three conditions, the reader's attention is called to the means of the conditions where Ss responded to light and/or tone. The mean for the reverberation room was 100.0 sec, and the corresponding mean for the anechoic room was 143.2 sec. These means were neither larger nor smaller than the highest or the lowest single-stimulus mean of the corresponding environmental condition. The results are congruent with the previous data in that sound seemed to act as a depressor of visual autokinesis. As such, one possibility is that Ss paid more attention to tone in the reverberation room than in the anechoic room, and that this happened at the expense of attention to the light stimulus. If so, this suggests that, whether auditory autokinesis was a response bias or a perceptual modification, an increase in attention to auditory stimulation decreased visual autokinesis.

The finding that certain nonvisual stimulation can detract from the visual autokinetic effect neither supports nor rules out the possibility that visual autokinesis is caused by eye movement, muscular strain, or satiation. According to the frame-of-reference theory, the results must mean that the anechoic room provided more auditory reference than the reverberation room, because the former condition showed less auditory autokinesis than the latter. The apparently inconsistent feature of this conclusion is, however, that the difference in auditory frame of reference had a converse effect upon visual autokinesis: more auditory frame of references, more visual autokinesis. Because several studies of visual autokinesis (e.g., Edwards, 1954) have demonstrated less apparent visual movement with more visual information (more frame of reference), it would have been more in line with expectations had the results of the present study shown less visual autokinesis with an increase in auditory reference. A solution to this apparent inconsistency suggests itself if spatial orientation rather than auditory autokinesis is taken as a frame of reference. If so, the reflections in the reverberation room contributed more to Ss' spatial orientation (frame of reference) than the direct sound in the anechoic room. This explanation means that the environmental difference in visual autokinesis was contingent upon spatial orientation rather than upon the sound stimulus itself.

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