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Light intensity and judged duration

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Judged duration as a function of stimulus intensity was studied for both audition and vision, with loudness and luminance output equated. More intense sounds and lights were judged longer than less intense auditory and visual durations, and this intensity effect was greater for vision. The judged-duration/stimulus intensity relationship appears to represent as stable a psychophysical phenomenon as the fact that judged intensity grows as a function of stimulus duration.

This is a study of the effects of both light and sound intensity upon judged duration. Intensity was equated across the two senses (Stevens, 1955), permitting cross-modal comparisons, and prior reports of an intensity/judged-duration relationship with vision are unknown to us.

The importance of stimulus factors in the judgment of duration has been established; for example, time perceived is a function of sense mode stimulated and stimulus rate (Goldstone, Boardman, & Lhamon, 1959; Matsuda & Matsuda, 1974). There has been especial interest in the intensity-time relationship; perceived intensity enlarges with increased duration, temporal integration, and perceived duration grows with intensity. Previous studies generalized about the intensity/judged-duration relationship almost exclusively from audition (e.g., Berglund, Berglund, Ekman, & Frankenhaeuser, 1969; Goldstone & Lhamon, 1974; Treisman, 1963; Zelkind, 1973). Only two studies employed a sense other than hearing, finding the same intensity/judged-duration relationship with electrical (Ekman, Frankenhaeuser, Levander, & Mellis, 1966) and vibrotactile stimulation (Ekman, Frankenhaeuser, Berglund, & Waszak, 1969). Since auditory-visual differences in time judgment are commonplace (Goldstone & Lhamon, 1971), it is necessary to demonstrate with vision what has been shown with audition and touch, two senses of similar origin, to view the intensity effect as a general property of temporal processing.

METHOD

Procedure

Using pair comparison, subjects judged variable durations of lights or sounds as shorter or longer than a preceding standard light or sound. Auditory and visual tests were separate and successive with sounds and lights of two intensities, higher (H) and lower (L). Duration pairs for both senses consisted of: (a) H-standard, H-variable; (b) L-standard, L-variable; (c) H-standard, L-variable; and (d) L-standard, H-variable. Subjects judged the variable as shorter or longer than the standard using a 5-category response scale: 1, shorter; 2, slightly shorter; 3, equal; 4, slightly longer; 5, longer.

Stimuli

Durations were on magnetic tape to control timing of auditory and visual signals, interstimulus (2.00 sec), and interpair intervals (10.00 sec) with accuracy and reliability of better than 1.0% and .2%, respectively; the tape contained 100 pairs of durations distributed on two channels, one for each intensity. The standard duration was 1.00 sec, followed by either .70, .85, 1.00, 1.15, or 1.30 sec. The pairs were assembled haphazardly to permit five presentations of each of the five standard-variable combinations and the four intensity sequences (H-H, L-L, H-L, L-H). Auditory durations were 1-kHz sine waves presented dichotically through headphones at either 64 dB (L) or 76 dB (H) re 2×10^{-6} N/m^2. The light was a light-emitting diode (LED) with peak emission at 655 nm (red) and luminance of 14.0 and .8 cd/m^2 (76 and 64 dB re 3.18×10^{-7} cd/m^2), pulsed at 100 Hz, with viewing distance of 91 cm; target size was 4.6 mm at .3 deg. Subjects were in a sound-treated chamber with ambient sound level pressure at 40 dB and luminance at 59 dB. The H and L lights and sounds were equated for output (76 and 64 dB) and appeared equivalent with crossmodality matching.

Subjects and Measures

Ten young adults were divided into two equal groups to counterbalance order of auditory and visual testing.

The average category response (ACR) or mean response to each standard variable and intensity sequence pairing was calculated, yielding the measures of magnitude of judged duration. The ACR data were examined with ANOVAs that included sense mode (audition and vision), sense mode order (audition followed by vision and vice versa), intensity of duration judged (H and L), same (H-H and L-L) or different (H-L and L-H) intensities paired, and variable durations (.70, .85, 1.00, 1.15, 1.30 sec) as factors.

RESULTS

The ACR data were combined over sense mode order to display the significant components of the Intensity Judged by Sense Mode by Same or Different Stimuli Paired by Variable Durations interaction [$F(4,52) = 5.67$, $p < .005$] in Figure 1. Higher intensity durations were judged longer than identical intervals of lower intensity for vision and audition. Although point-to-point comparison revealed a significant intensity effect for three of the five variable durations for audition, and

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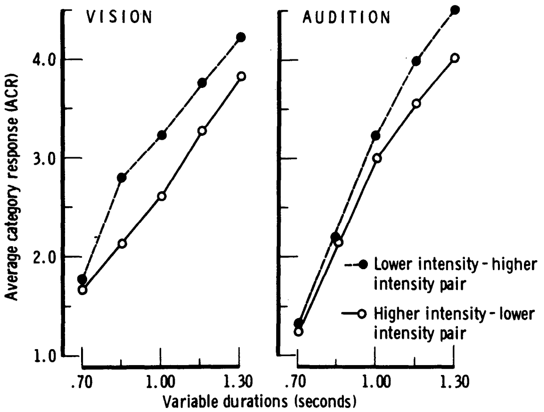

Figure 1. Mean average category response (ACR) for higher intensity standard/lower intensity variable duration pairs, and lower intensity standard/higher intensity variable duration pairs for vision and audition combined over sense mode order.

four of five for vision, this intersensory difference is not striking.

DISCUSSION

This experiment establishes an intensity/judged-duration relationship for vision similar to that of audition and touch, suggesting that this is a general property of temporal as well as intensive processing. Apparently, the fact that magnitude of perceived time grows when intenstiy is increased is as general a principle as the reverse, temporal integration, and it is reasonable to assume that the two phenomena are related.

It may be that intense stimuli have longer decay times in sensory storage than weak stimuli, compatible with the notions of those who see time judgment as constructed from nontemporal content, such as greater activation of memory and increased storage size (Frankenhaeuser, 1959; Ornstein, 1969). It is also possible that higher intensity increases arousal, speeding the hypothetical internal or biologic clock, as with stimulant drugs, fever, and increased metabolic rate (Goldstone, Boardman, & Lhamon, 1958; Hoagland, 1933; Kleber, Lhamon, & Goldstone, 1963; Treisman, 1963; Zelkind, 1973).

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