Visual Stimulus Localization as a Function of Brightness

Since HAKE and GARNER's experiment[1] about absolute – or, more exactly, categorical – judgments of the position of a pointer on a line, numerous studies have demonstrated that one-dimensional information transmission is limited by the human channel capacity: information is directly transmitted up to a critical value, beyond which transmission remains constant. With stimuli on a single scale the capacity lies around 2 or 3 bits, which means that no more than about 7 values may be discriminated without confusion, in easy perceptual conditions[2].

This capacity appears to be a limit of the central identification system and not of the peripheral sensory coding system. Threshold measurements demonstrate a fairly great accuracy of sensory coding and of transmission in the afferent pathways. Nevertheless, this accuracy may be necessary for further operations. Indeed, transmitted information has been shown to be inversely related to 'noise'. In localizing a dot in a square of 10 × 10 possible locations, FAUVILLE[3] studied information transmission as a function of duration of exposure, and also as a function of distance between the locations. If durations were very short and distances very small, transmitted information increased linearly with the logarithm of each of these parameters.

In the present experiment, information transmission has been examined as a function of brightness. In addition, the number of possible locations has been varied and the effects of noise observed for several amounts of stimulus information. For this purpose it seems preferable to use one-dimensional stimuli; in this investigation locations on a horizontal or vertical bar were used.

Method. A set of 100 × 100 mm grey cards is used, supporting a stripe of white paper 6 mm broad and 18, 30, 42 or 54 mm long, in order to present respectively 3, 5, 7 or 9 equidistant possible locations. On each card 1 of these locations is marked by a 3 mm dot, drawn with Chinese ink. Considering all possible locations one obtains 24 different cards.

These stimuli are presented during 100 msec, by means of FAUVILLE's monocular tachistoscope[4]. By putting the cards in 2 different orientations, the locations may line up horizontally as well as vertically. Finally 48 different stimuli are thus available. They are presented at 3 brightness levels which are equidistant on a logarithmic scale and correspond to 0.017, 0.026 and 0.040 foot-lamberts; they will be referred to as levels A, B and C. These very low values are obtained by means of calibrated neutral filters.

Five male and 5 female subjects (Ss) with clinically normal vision served in this experiment, distributed in 4 sessions; each session started with a dark adaptation time and a training period. In each series of stimuli the dot locations are given in random order, but the number of possible locations and their orientation are constant. S localizes the dot and furnishes after each stimulus a verbal response by means of a number between 1 and 3, 1 and 5, 1 and 7 or 1 and 9. Horizontal and vertical orientations, brightness levels and stimulus information are counterbalanced for training and fatigue.

Results. Responses of all Ss are pooled into S-R matrices. Information is then calculated according to the usual procedures. For 3, 5, 7 and 9 equiprobable locations, stimulus information is respectively 1.6, 2.3, 2.8 and 3.2 bits. The transmission functions are corrected as to the amounts of observations by means of the Miller-Madow formula. It must be noted that pooling all 10 Ss into the same S-R matrices may cause an underestimation of the information transmission, due to individual differences in the response

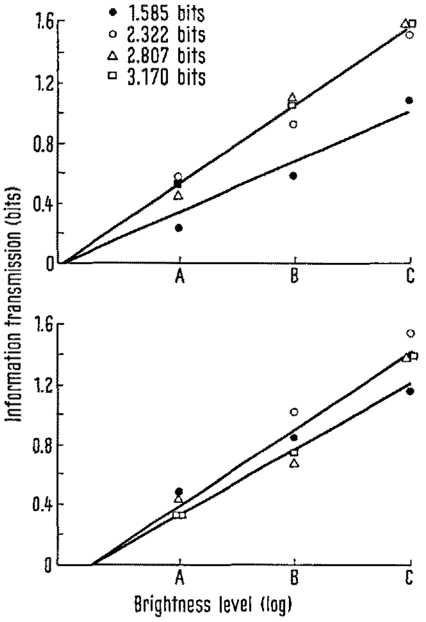

Fig. 1. Information transmission as a function of brightness level, for 4 quantities of stimulus information (top: horizontal localization; bottom: vertical localization).

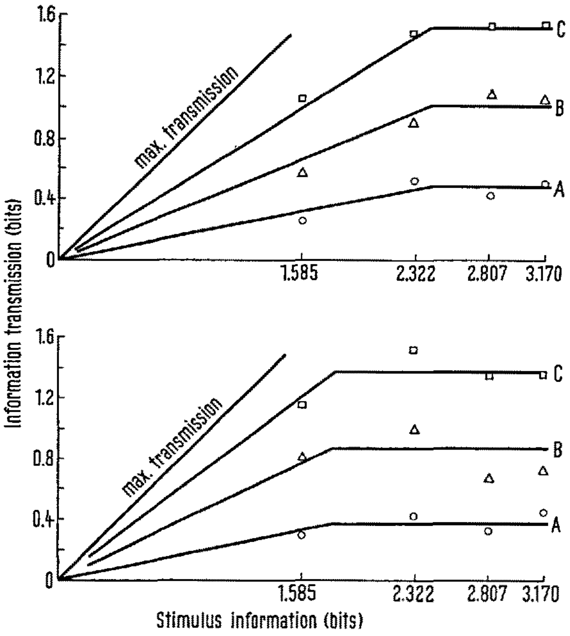

Fig. 2. Information transmission as a function of stimulus information, for 3 brightness levels (top: horizontal localization; bottom: vertical localization).

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[1] H. W. HAKE and W. R. GARNER, J. exp. Psychol. *42*, 358 (1951).

[2] W. R. GARNER, *Uncertainty and Structure as Psychological Concepts* (Wiley, New York 1962).

[3] A. FAUVILLE, *Perception tachistoscopique et communication* (Nauwelaerts, Louvain 1963).

[4] A. FAUVILLE, Année psychol. *39*, 252 (1940).

tendencies; in fact, preliminary results obtained from 5 Ss and corrected by the Miller-Madow formula did not differ significantly from the actual data. This may be explained by the fact that most of the error responses appear to be random.

From Figure 1 the transmitted information appears to be a direct linear function of the logarithm of brightness. The relation outlined by FAUVILLE may thus be extended to this type of noise. Moreover, this function seems rather independent of the number of possible locations. The single exception is the material with 3 locations, at least when they are horizontally oriented, which provides less information transmission; further inspection of Figure 1 shows that the main difference is to be found in the slope. Using the least squares procedure, a straight line has been traced through the results of each Figure; then from the obtained origin on the abscissa, 2 other lines were drawn, 1 through the points relative to 5, 7 and 9 locations, the other through the points provided by the 3-locations material.

From these data Figure 2 has been constructed, where transmitted information is plotted against stimulus information, as for usual channel capacity functions. The continuous lines join the calculated values. Like in easy viewing conditions, transmitted information reaches a plateau (it is not always very flat, unfortunately, probably because of some anchoring effects). A primary effect of noise is to lower it. In addition, when stimulus information is especially low, the transmission loss may be less important in absolute value, but remains proportionally constant. It may incidentally be noted that the dots are better localized on the horizontal than on the vertical axis.

Discussion. The inverse logarithmic relation between noise and information transmission is confirmed to be independent of the physical nature of the noise, at least for visual localization tasks. But this seems also to be true when other transmission channels are involved; similar relations were found between stimulus duration and hue identification[5], or between signal-to-noise ratio and speech intelligibility[6].

The independence of the relative loss towards stimulus information suggests that the disturbing effects of brightness reduction do not act upon the central categorization mechanisms, but upon the preliminary sensory coding operations. It may be interesting to recall here the results of an experiment by LEIBOWITZ et al.[7] on judging the inclination of a line. S was not forced to provide a response and thus had the faculty of disregarding presentations where viewing had not been satisfactory. Frequency of seeing increased roughly as the logarithm of brightness and of duration; but, provided the stimulus was seen, localization accuracy was not influenced by these factors[8].

Résumé. Dans une tâche consistant à localiser un point sur une barre horizontale ou verticale, on mesure l'information transmise en fonction de l'éclairement et de l'information du stimulus. On trouve une relation linéaire directe entre l'information transmise et le logarithme de l'éclairement. Cette relation reste valable pour diverses quantités d'information émise.

J. COSTERMANS, G. THINES
and ANNE VAN DER PLANCKE-MONTARIOL

Center for Experimental and Comparative Psychology, University of Louvain (Belgium), 12 April 1968.

[5] H. H. SOMERS, *Les attributs de la perception et leur interaction* (Doct. Dissert., Univ. of Louvain 1961).

[6] J. COSTERMANS et G. DE VALCK, J. Psychol. norm. path. 421 (1965).

[7] H. W. LEIBOWITZ, N. A. MEYERS and D. A. GRANT, J. opt. Soc. Am. *45*, 76 (1955).

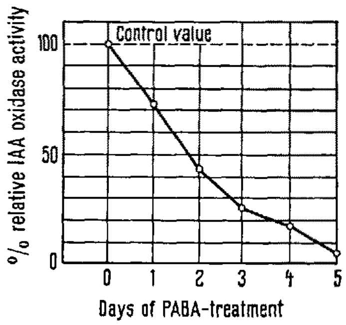
[8] Partly supported by the 'Fonds National belge de la Recherche Scientifique'.

Influence of *p*-Aminobenzoic Acid on the Activity of Indoleacetic Acid Oxidase

It is known that some benzoic acid isomers and derivatives can influence the activity of indoleacetic acid (IAA) oxidase[1], however, the effect of a biologically important compound, namely *p*-aminobenzoic acid (PABA), had never been investigated in this respect.

When PABA was added to a reaction mixture according to STUTZ[2] containing a crude enzyme extract prepared from hypocotyls of white lupine (*Lupinus albus* L.) cuttings, the manometrically measured O_2-consumption did not differ from that of the controls, even if the concentration of PABA was as high as 200 µg/ml. By contrast, when the enzyme solution was prepared from cuttings grown in 50 ppm PABA, the IAA oxidase activities depending on the duration of PABA-treatment became continuously lower, falling almost to zero on the fifth day (Figure).

Adding of boiled extracts from PABA-cuttings to IAA oxidase preparations from water-controls resulted in a lag-phase and a same inhibition, respectively, as the PABA-treatment itself. The activities of dialyzed extracts from both PABA- and water-treated plants did not exhibit any



Time course of inhibition of IAA oxidase activity in lupine cuttings after PABA administration in vivo, compared to the activities of water-treated controls.

[1] TH. GASPAR, Année biol. *4*, 437 (1965).

[2] R. E. STUTZ, Pl. Physiol., Lancaster *32*, 31 (1957).