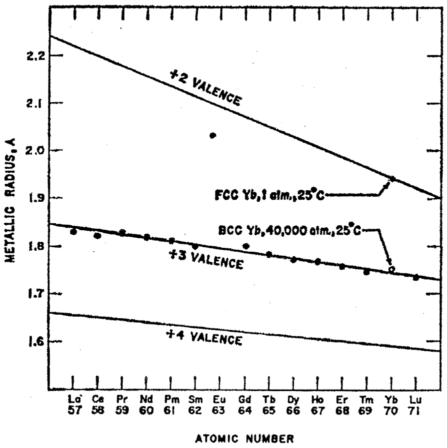

Fig. 2. Values of metallic radii of rare earths plotted against atomic numbers.

atomic numbers for the rare-earth atoms (Fig. 2) throws additional light on the nature of the transition. Note that most of the values for the radii of the rare-earth atoms fall very close to a straight line which represents a valence of +3. Europium (Eu) and Yb having anomalously large radii, deviate significantly from the line. The valence of Yb is +2. However, the value of the metallic radius of BCC Yb (1.75 Å) at 40,000 atm is very close to the line where the valence is +3. Thus under the conditions of high pressure Yb has become a "normal" rare-earth metal! The electronic structure of the rare-earth elements is unique in that, as the charge on the nucleus increases in passing from element of atomic number 58 to atomic number 71, the balancing electrons fill in the inner, incomplete $4f$ subshell. The probable electronic configuration for the "outermost" shell of Yb is $4f^{14}\ 5d^{0}\ 6s^{2}$—a situation in which the $4f$ and $6s$ levels are completely filled and the $5d$ is empty. Since this is the case, it seems logical to conclude from our data on atomic radii that the transition from FCC to BCC in Yb is "electronic" in nature and is accompanied by the promotion of a $4f$ electron to the $5d$ level. In the solid, the two $6s$ electrons and the single $5d$ electron would enter the valence band; thus a valance of +3 would be the result.

When an atom changes its valence, it becomes a "different" atom with different bonding properties. Consequently, after a valence change the crystal structure may be entirely different from that of the untransformed material. We anticipate that additional high-pressure x-ray diffraction research will show that the electronic transition from close-packed to non-close-packed structure will be found to occur in many substances if they are subjected to sufficiently high pressures.

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References and Notes

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18 December 1962

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Discrimination of Successiveness: A Test of a Model of Attention

Abstract. *Interpreting attention as a periodic phenomenon, we show its relevance to discriminating the successiveness of signals presented to separate sense modalities. Experiments confirm the expected linear relation between the probability of discriminating pairs of successive from pairs of simultaneous signals and make it possible to infer the period of attention.*

A study was made to develop and test the hypothesis that the sensory systems consist of independent channels which can be attended only one at a time. Attention is conceived of as a periodic phenomenon. The period of attention, M, is assumed to be a fixed value. When attention is directed at one channel it may be signaled to switch to a second channel by an input arriving over the second channel. Attention can switch only at the end of a period, although it may remain on a channel for multiples of M. The periodicity of attention is internally controlled; it is independent of sensory input.

Along with these assumptions, which already imply that some inputs may have some effects when they are not attended, it can be asserted further that the temporal ordering of input signals in experience or behavior, or both, will be influenced by the switching order of attention. Let us consider vision (V) and audition (A) and assume that they, at least, cannot both be attended during a single period of attention. If attention is directed at V and inputs arrive simultaneously in the "display areas" of V and A, they will be coded in order VA—that is, in adjacent periods of attention, even when the individual asserts that the signals were perceived simultaneously. To be discriminated as successive they would have to arrive in the display areas sufficiently separated in time to be attended in nonadjacent periods. The probability that this will occur will depend upon the degree of difference in time of arrival of the inputs in relation to M. The symbol t refers to the difference in time of arrival of the V and A inputs in the display areas. If, under ideal conditions, attention switches reliably after the first input is scanned, then the probability that the inputs will be scanned in nonadjacent periods will be a linear function of t. The probability will be zero when $t = 0$ and will be unity when $t = M$, under the condition that attention is directed initially to the channel over which the first input arrives. If attention is directed to the channel of the second input when the first arrives, then for all values of t between zero and M the inputs will be scanned in adjacent periods.

The difference in times of arrival at the receptor surface (T) for auditory and visual stimuli should not be the same as the difference in times of arrival at the display areas (t), since conduction times differ for different modalities. There is some non-zero value of T, called x, for which $t = 0$. Positive values of T mean that the visual stimulus precedes the auditory, and negative values mean that the auditory precedes. Many lines of evidence suggest that conduction is more rapid in the auditory system, at least for stimuli of moderate intensity. Hence, for the inputs to arrive simultaneously in the display areas the light stimulus should precede the sound—that is, x would be expected to be positive.

Measurement of the probabilities of discriminating successiveness is accomplished by presenting two light-sound pairs on each trial and requiring the subject to indicate the pair for which the likelihood is greatest that the light preceded the sound. In one pair, the standard pair, T is the same for all trials and is set at a value less than x by an amount less than M. Since attention is directed to light, the signals should be attended always in adjacent periods for the standard pair. The other pair on each trial, the variable, may have any of several values of T greater than x. Under these conditions the

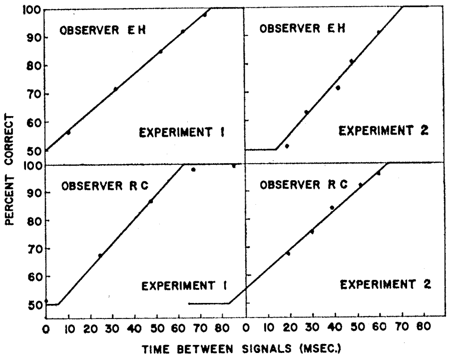

Fig. 1. Percentage of trials on which the variable pair, rather than the standard pair, was designated "more successive" plotted against the time interval between the terminations of the light and of the sound that comprise the variable pair.

function relating the probability of indicating the variable as the successive pair to T should be linear, intersecting the chance level (.50) at $T = x$ and rising to 1.00 at $T = x + M$.

In the experiments reported here, values of x and M were first estimated by means of a method of limits. The value of T for the standard pair in the forced-choice procedure was determined from these estimates. The forced-choice data were then obtained in daily sessions of 120 trials each, 24 for each of five values of the variable.

A neon lamp provided the visual signal, and a pure tone, delivered over a speaker, was the auditory signal. The observer was instructed to indicate the pair in which the likelihood was greatest that the light terminated before the sound. Termination rather than onset was used in order to define the relevant channels as unequivocally as possible for the observer. The stimuli came on together and remained on for about 2 seconds before termination of the first one.

The data obtained are presented in Fig. 1. Two experiments, each consisting of 12 sessions, were completed for each of two observers. The number of responses determining each point in the graphs is 288.

Experiment 1 for observer R.C. provided only two data points within the range of primary interest. Least-square lines were fitted to each of the other three sets of data; omitted from the analysis was one point which did not exceed chance expectancy for observer E.H. in experiment 2.

These data are clearly consistent with the hypothesis in that they are described adequately as linear functions. The mean absolute deviation of the points from the lines in the vertical direction is 0.74 percentage unit. Testing goodness of fit by chi-square yields values of chi-square having associated probabilities of .55 to .90.

The inferred difference in conduction time x for auditory and visual stimuli averages 6.9 msec for observer E.H. and -1.1 msec for observer R.C. Positive values of x imply more rapid conduction in the auditory channel.

The mean period of attention, M, calculated for observer E.H. is 66.4 msec; for observer R.C. it is 63.8 msec. There is no indication of a directional change in M from experiment 1 to experiment 2 in these limited data. For E.H. the values are 74.5 and 58.3, respectively; for R.C. they are 56.5 and 72.2. The difference in M for the two experiments is fairly large for both observers, but the differences are of opposite sign.

Psychophysical data are almost invariably described by cumulative normal distribution functions. The data presented here do not appear to require any hypothesis more complex than the linear hypothesis. However, it is extremely difficult to choose between these types of function (see, for example, *1*), and the data obtained so far are not adequate for that purpose.

The theory discussed has much in common with theories proposed by several other workers in recent years (*2*). It has frequently been suggested, by us and by others, that a physiological correlate of periodic attention may be the alpha rhythm of the electroencephalogram. If this is so, M would be expected to fall within a range of 77 to 110 msec. Results for the two observers in this study do not satisfy that expectation, but experiments are being conducted with additional observers to establish this point more convincingly (*3*).

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3. This report summarizes part of a doctoral dissertation to be submitted to the Graduate School of the University of Cincinnati by one of us (M.W.S.). We thank the Graduate School for its support of parts of this research.

22 October 1962

Natural Triploidy in Salamanders Related to Ambystoma jeffersonianum

Abstract. *Female salamanders with large erythrocytes and erythrocyte nuclei produced triploid larvae; females with small erythrocytes and erythrocyte nuclei produced diploid larvae. Larval chromosome counts, dimorphism in cell size, and sex inheritance indicate distinct, persisting populations of triploid females in parts of the range of the* Ambystoma jeffersonianum *complex.*

During an investigation of the biology of salamanders of the *Ambystoma jeffersonianum* complex, 13 experimental matings, involving individuals from Massachusetts, Michigan, and Ohio, were made. The salamanders were confined in wire baskets placed in natural ponds. After courtship and egg deposition, the parents were removed. When the larvae hatched, they were brought into the laboratory and reared. The chromosomes were counted in epidermal nuclei from tail fins that were fixed, stained, and squashed in orcein and acetic acid. Regenerating tissue was found to be more satisfactory for this purpose than the original tail fin because of the increased number of mitotic figures and the decreased amounts of melanin in the regenerating tissue.

Chromosome counts for larvae of five matings (Table 1) indicate that two matings produced diploid larvae ($2n = 28$), while three matings produced triploids ($3n = 42$). Photomicrographs and camera-lucida drawings of diploid and triploid mitotic figures are shown in Fig. 1. In many of the preparations, not all the chromosomes could be disentangled, hence enumeration of all those present was not possible. In the offspring of matings that produced triploid larvae, many of these incomplete counts were above the diploid number but none was above the triploid number. In offspring of matings that produced diploid larvae, incomplete counts were consistently less than the diploid number.

The parents of the larvae from which chromosome counts were made were collected in Delaware and Lorain counties, Ohio, and in Washtenaw County, Michigan. Females of the *Ambystoma jeffersonianum* complex in Lorain and Washtenaw counties are dimorphic with respect to size of erythrocytes and erythrocyte nuclei; females in Delaware County are uniformly small-celled. The males at all three localities are consistently small-celled. The females that