Interference in Visual Recognition

Abstract. *Pictures of common objects, coming slowly into focus, were viewed by adult observers. Recognition was delayed when subjects first viewed the pictures out of focus. The greater or more prolonged the initial blur, the slower the eventual recognition. Interference may be accounted for partly by the difficulty of rejecting incorrect hypotheses based on substandard cues.*

Under ordinary conditions, visual recognition operates effortlessly and with no discernible interference. If the clarity of the display is diminished in some manner, however, recognition understandably takes longer. Moreover, studies indicate that if a subject is *initially* exposed to a blurred image that he cannot recognize, subsequent recognition of the image in clearer form is substantially delayed (*1*). The present report is concerned with the further investigation of this interference phenomenon.

We varied both the range of blur to which subjects were exposed and the length of time of the exposure. Undergraduate subjects were shown eight ordinary color photographs, projected one at a time. The pictures were initially exposed in a state of blur and brought continuously into better focus. The initial point of focus was varied, as was the amount of time the changing picture was in view. Under all conditions, the picture being exposed was stopped at the same point of focus, regardless of its starting point and its rate of change of focus. At this common terminal point, the projected picture was turned off and the subject was asked to report what it was.

Three starting points of focus and the common stopping point were determined as follows. Thirteen subjects were run individually as a standardizing group and were presented the pictures in gradually increasing focus, starting from almost complete blur (very blurred, or VB). The point at which they reported correctly the identity of the picture was recorded. For each picture, the point at which it was first recognized by any subject was obtained (light blur, or LB), and likewise the point at which a quarter of the subjects recognized the objects (first quartile, or FQ) (*2*); this latter was the stopping point used with all later groups. A fourth point was computed for each picture that was about four-fifths of the way from the out-of-focus point (VB) to the point of first recognition (LB). This point we refer to as medium blur (MB). Each of these points varied, of course, from picture to picture, since some pictures in fact required more clarity for recognition than did others. Each picture, changing toward clearer focus, was exposed for one of three lengths of time, the exposure intervals being chosen in the following manner. A slow but constant rate of change was first selected such that the time between VB and FQ (the stopping point) averaged 122 seconds per picture (range from 92 to 145 seconds). At this same rate of change, the average time from MB to FQ was 35 seconds (range from 26 to 49 seconds), and the time from LB to FQ was 13 seconds (range from 4 to 25 seconds).

Eighty-nine new subjects were now divided into nine groups of approximately equal size. Three of these groups began their viewing of each picture at VB; of these three, one group covered the course from VB to FQ in the long exposure averaging 122 seconds, one covered the same course of focus in the medium exposure of 35 seconds, and one in the short exposure of 13 seconds. Likewise, three other groups viewed the pictures moving from MB to FQ with the same three exposure times. And a final three groups started at LB and were given the same three times of viewing, thus completing a 3 × 3 design.

The pictures, 35-mm Kodachrome slides, were of a dog standing on grass, a bird in the sky, an aerial view of a cloverleaf intersection, a pile of bricks, a fire hydrant, silverware on a rug, glass ashtrays piled on a desk, and a set of brass fire irons. A Sawyer projector, model 500 EE, was used in a dimly lit room to project the pictures onto a non-glare screen 4.5 m away. A variable-speed motor controlled the excursion of the lens barrel, allowing focus to be changed at a wide range of rates. Subjects were run in groups up to 12, seated in two semicircular rows averaging 3.5 m from the screen. All subjects had normal vision or corrected normal vision as tested by a Snellen chart. They wrote their responses to the pictures on prepared sheets.

The results are shown in Table 1, and an analysis of variance is given in Table 2, based on the number of pictures (out of eight) recognized by each subject (*3*). Viewing time has a systematic effect: on the average, the longer the viewing time permitted, the more frequently a picture is recognized. Although the interaction between time and focus is not significant, there is a suggestion in Table 1 that viewing time has a greater effect on recognition in the range LB to FQ than in the other focal ranges. Consider next the recognition scores of the groups that began viewing at different starting levels of focus. Here the interfering effect of viewing on subsequent recognition is striking, ranging from slightly less than a quarter of the subjects recognizing pictures when they began their viewing with a very blurred image, to well over half achieving recognition when viewing began with light blur.

One way of dramatizing the striking interference effect that comes from early exposure to the blurred version of visual displays is to compare two groups of subjects who were exposed to the same focal range, one group shifting from medium blur (MB) to the terminal point (FQ), and the other group shifting at the same rate but in the opposite direction, from FQ to MB. There were nine and ten subjects respectively in the two groups. The group that viewed the pictures coming *into* focus recognized them in 44 percent of the cases for the eight pictures. The group that viewed the pic-

Table 1. Percentage of pictures recognized under various conditions of time and focal range. Each subject had eight pictures.

Average viewing time per picture (sec)	Focal range			
	VB–FQ	MB–FQ	LB–FQ	Mean
122	25.0 ($N=8$)	50.7 ($N=9$)	72.9 ($N=9$)	49.5
35	25.4 ($N=14$)	44.4 ($N=9$)	63.8 ($N=10$)	44.5
13	19.4 ($N=10$)	39.1 ($N=8$)	42.7 ($N=12$)	33.7
Mean	23.3	44.7	59.8	

Table 2. Analysis of variance of number of pictures recognized by each subject with different viewing times and focal ranges.

Source	*df*	Mean square	*F*	*p*
Time	2	1.252	5.70	.01
Focal range	2	6.463	29.43	.001
Interaction	4	.283	1.29	n.s.*
Error	80	.2196		

* Not significant

tures going *out* of focus over the same range succeeded in 76 percent of the cases—a highly reliable difference.

Do individual subjects differ in their ability to recognize pictures? Kendall's measure of concordance, *W*, was used to test the consistency of recognition scores of the 13 standardizing subjects. The result was not significant ($W = .116$, $p > .50$), suggesting that there is no general recognition ability under these experimental conditions.

In summary, exposure to a substandard visual display has the effect of interfering with its subsequent recognition. The longer the exposure and the worse the display, the greater the effect. Examination of the responses of the standardizing subjects, who reported aloud from the start of each picture, provides a clue as to the nature of the interference effect. Hypotheses about the identity of the picture are made despite the blur. The ambiguity of the stimulus is such that no obvious contradiction appears for a time, and the initial interpretation is maintained, even when the subject is doubtful of its correctness.

An incorrect interpretation of the picture may occur either in the primary figural organization of the picture (for example, an inhomogeneity is seen as concave, whereas it is convex in the full picture when correctly identified), or in the assignment of identity to a visual organization (the convexity is recognized, but is seen as a pile of earth rather than correctly, say, as a dish of chocolate ice cream). The amount of exposure necessary to invalidate an incorrect interpretation seems to exceed that required to set up a first interpretation, so that at any particular clarity of the display, those who see it for the first time are more likely to recognize the objects than those who started viewing at a less clear stage.

When one views a picture going *out* of focus, both initial clarity and resistance to change of interpretation are pitted in favor of correct recognition, which accounts for the great superiority of this condition. Indeed, it is striking how long one can "hang on" to the identity of a picture which is going out of focus, considering the difficulty of recognizing the same picture when it is seen for the first time coming into focus.

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References and Notes

1. D. Galloway, unpublished thesis, University of California, Berkeley (1946); D. Wyatt and D. Campbell, *J. Abnormal Soc. Psychol.* **46**, 496 (1951); P. Gump, unpublished thesis, University of Colorado (1955); A. Crowell, unpublished thesis, McGill University (1961).
2. Since 13 subjects were used in the standardizing group, the point at which the fourth subject recognized the object was taken as the "first quartile."
3. Since there were unequal numbers of subjects in the various conditions, a method of approximation described by Walker and Lev (*4*) was used.
4. H. Walker and J. Lev, *Statistical Inference* (Holt, New York, 1953), pp. 381–382.

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Myocardial Infarction: A Response to Social Interaction among Chickens

Abstract. *A study of male and female chickens caged alone, in male-female pairs, in groups of four males and in heterosexual groups of 6, 12, and 24, with a proportion of two males to one female, suggests that coronary arterial disease with myocardial infarction may be a response to social interaction, especially interaction that relates to sexual behavior. Myocardial infarcts were limited to males of heterosexual pairs and groups and to females of groups that contained 24 chickens. The lesion was found in males that died at 16 to 44 weeks of age, and in females at 32 to 43 weeks.*

Coronary arterial disease with myocardial infarction was found in about 15 percent of mammals and 10 percent of birds that died in the Philadelphia Zoological Garden from 1 January 1954 to 31 December 1963. These values represent an increased frequency of about tenfold for mammals and fivefold for birds over corresponding records of 1944–1953. Earlier encounters with this disease complex were extremely rare.

This animal collection has been fed the same high-quality diets since 1935, about 20 years before the incidence of myocardial infarction began to increase. However, a life-span of 20 years has more often been a maximum than a mean for many types of animals. Thus, while improved nutrition has increased longevity, neither age nor diet may be related to the increased frequency of myocardial infarction (*1*).

Instead, increased frequency of this disease complex has followed an attempt to establish and maintain breeding pairs and breeding groups of many species of mammals and birds. This departure from earlier practices has also set in motion complex behavioral responses (social interactions) inherent to maturation and reproduction, especially of captive wild animals. Apparently, then, frequency of myocardial infarction in this animal collection reflects intensity of social interactions (*1*).

Tests of this assumption with chickens demonstrated that intensity of social interactions, measured directly by frequency of conflict and indirectly by weights of adrenals and gonads, is a function of group size (groups of 6 as opposed to groups of 12). Further, these chickens developed advanced grades of coronary arterial disease within 35 weeks (*1, 2*). Hence, in our experiment heterosexual groups of 6, 12, and 24 (with a proportion of 2 males to 1 female) were compared with groups of 4 males each, with male-female pairs, and with males and females caged alone. This is a report of the mortality pattern and the occurrence of myocardial infarction that resulted under these conditions.

Birds from a closed, pullorum-free flock of single-comb Hy-line White Leghorns were hatched in one lot, brooded as one flock until they were 7 weeks of age, and then assigned randomly to cages in one large room with 15 hours of light per day. The birds were vaccinated and the sharp edges removed from their beaks at appropriate intervals. Cage assignments and number in each were as follows: 32 males caged alone; 32 females caged alone; 32 male-female pairs; 32 males, 4 to a cage; and heterosexual groups (2 males to 1 female), 12 groups of 6, 10 of 12, and 8 of 24 (total, 544 birds).

Two-tiered commercial battery cages were divided by wooden partitions to allow 2 ft^2 (0.186 m^2) per bird. Continuous food troughs were attached to the cage fronts, and automatic water cups assured continuous access to food and water. Commercial rations were fed. Water was pumped from a deep well. Sexual maturity occurred between 18 and 21 weeks of age, when males weighed about 5.5 lb (2.5 kg) and females about 3.5 lb (1.5 kg).

The experiment was ended during week 45 when survivors were killed for study. Birds that died were examined within 10 hours of death for abnormalities of hearts, livers, spleens, kidneys, gonads, adrenals, and gastro-intestinal