The relative solubilities in ammonium sulfate, the respective sedimentation coefficients, and the relative mobilities with respect to rabbit serum, bovine serum albumin, and hyaluronic acid of the two major and leading electrophoretic components of alligator serum has led to identification of the leading component with the serum albumin and the second and largest components with serum α-globulin (*7*).

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2 September 1960

Alteration of Plasma Proteins at Metamorphosis in the Lamprey (Petromyzon marinus dosatus)

Abstract. Coincident with metamorphosis in the lamprey (*Petromyzon marinus dosatus*), a new, more rapidly moving plasma protein component appears. In the mature lamprey this new component is of major quantitative importance. With paper electrophoretic mobility as the sole criterion, the new component is considered to be an alpha globulin rather than albumin.

The striking anatomical alterations which occur during metamorphosis in vertebrates may be accompanied by equally striking, if less overt, biochemical changes. A number of such biochemical changes have been reported recently. These include the retinal pigments in various vertebrates, including the sea lamprey, and the serum proteins and nitrogen metabolism in the tadpole and the frog (*1*). In this communication we report another example of a biochemical change—an alteration in the serum proteins which accompanies metamorphosis in the sea lamprey, *Petromyzon marinus dosatus*.

Specimens of Petromyzon (*2*) were shipped by air to Washington, D.C. in insulated jugs containing ice water. All the animals were healthy and vigorous upon arrival. The larvae were 3 to 5 in. long, while the newly transformed adults were 5 to 6 in. long. These specimens had been obtained during the winter months. The mature adults (obtained in May) were captured as they were going upstream, and these animals were approximately 15 in. long.

The blood from the larvae and the newly transformed adults was obtained after parental administration of 50 μg of heparin to each animal. Twenty minutes after heparin injection the tail was amputated and the blood was aspirated from the caudal artery into a polyethylene tube with an inside diameter of 0.86 mm; 30 to 100 μl of blood was obtained from each animal. After the blood had been drawn into the polyethylene tube, the tube was folded in the shape of a U, inserted in a small-bore centrifuge tube, and centrifuged for 2 minutes. The plasma was separated by cutting the plastic tube just above the junction of cells and plasma. Blood was obtained from the mature adults by puncture of a caudal vessel either with a heparinized syringe or after administration of 1.0 mg of heparin to the animal. In all, samples were taken from at least ten larvae and newly transformed adults and three mature adults.

Paper electrophoresis was performed on 18-μl samples by using a Durrum-type cell and Veronal buffer (pH 8.6) with constant current of 2.5 ma for 18 hours. The resulting voltage was about 80. The strips were stained with bromphenol blue, and the density was analyzed with a Spinco Analytrol.

Paper-electrophoretic strips of plasma from a larva, a newly transformed adult lamprey, a mature adult lamprey, and a normal human being are shown in Fig. 1. In the newly transformed adult there appeared a small amount of protein with a higher electrophoretic mobility than any component seen in the larva. In the mature adult this new component constituted an important percentage of the plasma proteins. It did not, however, have the electrophoretic mobility of human albumin. In certain mature adult specimens there was a marked increase, seemingly related to hemolysis, in the amount of a more slowly moving component.

Table 1. Plasma protein components of the lamprey.

Specimen	Protein (%)				
	Albumin	Globulin			
		α-1	α-2	β	γ
		Human being			
	59	4	10	11	17
		Lamprey			
Larva	0	70		8	22
New adult	0	6	71	10	13
Mature adult	0	37	45	10	8

Human serum albumin has been used as a reference for labeling the electrophoretic components (Table 1), although it is clear that electrophoretic mobility alone is inadequate for categorizing such components. The major component in larval lamprey plasma is considered to be an alpha globulin. In adult lamprey plasma, the two strongest bands are considered to be an alpha-1 globulin and an alpha-2 globulin. In the mature lamprey the alpha-1 and alpha-2 globulins are approximately equal in concentration. It is clear that these are two separate components rather than a single large component. This scheme indicates the apparent lack in lamprey plasma of a component with the same electrophoretic mobility as mammalian albumin.

Wald demonstrated the changes in the retinal pigments which accompany metamorphosis in the lamprey (*1*). The development of the thyroid gland from an exocrine to an endocrine gland is another example of metamorphosis in the lamprey (*3*). To this can now be added the development of a new protein component in the plasma of the metamorphosing lamprey. This component has a greater electrophoretic mobility than any component in the larval animal. It is important to note, however, that even the adult lamprey lacks plasma albumin. This finding is consistent with the observation that certain elasmobranchs also lack a plasma component comparable to human

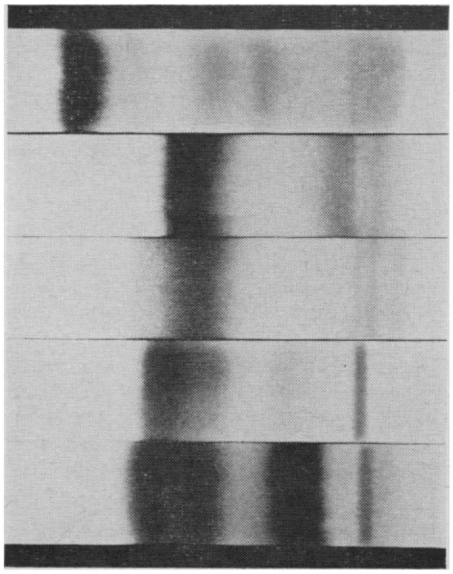

Fig. 1. Electrophoretic patterns of plasma proteins of the lamprey. The origin is to the right. The top strip represents, for comparison, 6 μl of human serum; the second strip, 18 μl of larval lamprey plasma; the third or middle strip, 18 μl of plasma from a newly transformed adult; the fourth strip, 18 μl of plasma from a mature adult lamprey; and the bottom strip, 24 μl of hemolyzed plasma from a mature adult lamprey.

albumin (*4*). It is notable that this cyclostome and certain elasmobranchs have no albumin-like component in their plasma, while teleosts in general appear to possess such an albumin-like component (*5*).

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10 October 1960

Test of Response Bias Explanation of Word-Frequency Effect

Abstract. Observers identified monosyllabic words presented in noise. It was found that controlling response bias eliminates the word-frequency effect. However, the magnitude of the word-frequency effect was greater than that predicted by a mathematical model denying stimulus words any role in producing the word-frequency effect.

The word-frequency effect refers to the finding that observers faced with the task of identifying words presented in noise or flashed briefly on a screen identify correctly more common words than uncommon words. The more common a word is (the more frequently a word occurs in the language), the greater is the probability that the word will be identified correctly (*1*).

The response bias explanation, in its most general form, denies stimulus words any role in producing the word-frequency effect. The word-frequency effect is considered to be due merely to response bias—the observer's tendency to use more words of high word-frequency as identifying responses than words of low word-frequency (*2*).

We interpret this form of response bias explanation as implying that groups of words which differ in word-frequency are random samples from the same population of acoustical or visual parameters. In other words, response bias explanation seems to imply that intervals of word-frequency which contain the same number of words are equivalent samples. Consequently, if there are n intervals, a stimulus word from one interval may be matched, in terms of physical similarity, just as adequately by a response word from one as from another of the remaining $n - 1$ intervals.

The word-frequency effect may be derived if we take the assumption of acoustical equivalence of intervals as implying two mathematical relations:

$$p_c(s,r) = kp(s,r), \qquad s = r \qquad (1)$$

where s and r indicate the interval of the stimulus word and the response word respectively; $p(s,r)$ is the probability of a particular combination of stimulus interval and response interval, given that s equals r; $p_c(s,r)$ is the proportion of $p(s,r)$ for which the response word is correct; and k is a constant between zero and unity. This equation may be interpreted as saying that when the stimulus word and the response word are in the same interval, the probability that the response is correct is independent of the interval of the stimulus.

$$p(s,r) = bp(r) + d, \qquad s \neq r \qquad (2)$$

where $p(s,r)$ is the probability of a particular combination of stimulus interval and response interval given that s is not equal to r; $p(r)$ is the probability of a response in a particular interval; and b and d are constants. This equation is mathematically equivalent to saying that a response from a particular interval will be given just as often to words from one (different) interval as to words from another (different) interval. Equation 2 further implies that

$$p(s,r) = \frac{1}{n}\, p(r) + a, \qquad s = r \qquad (3a)$$

$$= \frac{1}{n}\, p(r) - \frac{a}{(n-1)}, \qquad s \neq r \qquad (3b)$$

where n is the number of stimulus or response intervals and a is a constant. Thus, Eq. 2 mathematically determines all of the n^2 probabilities of combinations of stimulus interval and response interval to within one constant, when the $p(r)$ values are known and $p(s)$ is a constant ($1/n$). Together Eqs. 1 and 2 imply that the number of words in an interval which are correctly identified is a linear function of the number of responses in the interval. That is,

$$p_c(s,r) = k\left[\frac{1}{n}\, p(r) + a\right], \qquad s = r \qquad (4)$$

Thus, the word-frequency effect is derived in terms of $p(r)$—$p(r)$ supposedly being some monotonic function of the median word-frequency of the interval. The word-frequency effect, from the viewpoint of Eq. 4, must increase with a rate of k/n. In this sense, the magnitude of the word-frequency effect is predicted from Eqs. 1 and 2.

The above equations assume that $p(s)$ is a constant and that the intervals all contain the same number of different words in the language. In general, the equations assume that no physical aspect of words related to the threshold changes from interval to interval. Word length must be controlled since it has been shown to be positively related to intelligibility (*3*). This can be approximated by limiting stimulus and response words to words of the same number of syllables.

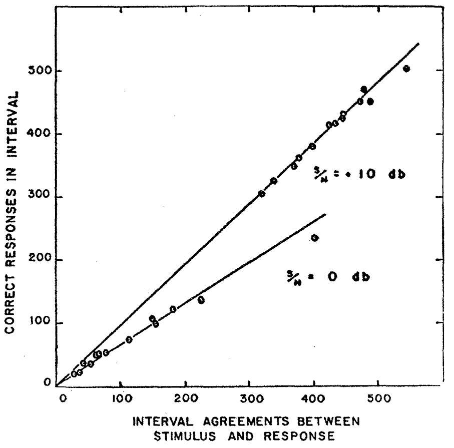

Fig. 1. Number of correct responses in an interval as a function of the number of instances where stimulus and response agree in interval [$p_c(s,r)$ versus $p(s,r)$]. In general, the greater the number of agreements, the greater the median word-frequency of the interval. The points, one for each interval, represent the sum of the data for the six observers in the group.

To test the predictions of Eqs. 1 and 4 an experiment was conducted at two speech-to-noise (S/N) ratios, 0 and +10 db. These S/N ratios resulted in an over-all probability of correct response of 0.13 and 0.68, respectively. A different group of six observers listened at each S/N ratio. Words were presented at a rate of approximately one every 10 seconds. Each observer listened for

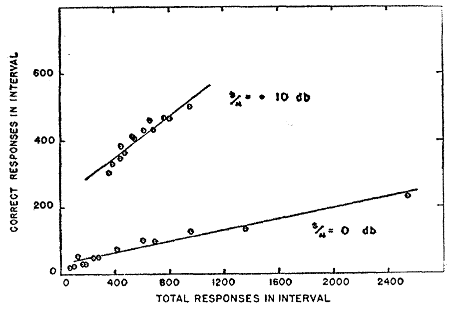

Fig. 2. Number of correct responses in an interval as a function of the number of responses in the interval [$p_c(s,r)$ versus $p(r)$]. In general, the greater the number of responses in an interval, the greater the median word-frequency of the interval. The points, one for each interval, represent the sum of the data for the six observers in the group.