tively low level of genetic variability would be maintained within single small and isolated breeding colonies; discontinuities in the distribution of neutral or weakly selected alleles between breeding colonies would be largely a function of the "founder effect" (*17*). At the time of its bottleneck, the effects of random drift and inbreeding on the population as a whole would have been amplified because of the small size of the remnant herd and the slow rate of recruitment. The only immigrants to the Isla de Guadalupe population would have been survivors from other populations forsaking their traditional breeding grounds. Additionally, the highly polygynous mating system of elephant seals, wherein as few as 14 percent of the males inseminate all the females, would greatly reduce the effective population size (*18*).

Dramatic reductions in genetic variability as an apparent consequence of isolation and the "founder effect" are known in natural populations of several organisms (*19*). Although genetic drift has generally been invoked to account for reduced variability in small and isolated populations, it is possible that the effect results in part from density-dependent selection or adaptation to a narrow range of environmental heterogeneity (*20*). In any event, however, the absence of protein polymorphisms in the northern elephant seal indicates that genic variability is not essential for the continued existence of animal species. Our results also suggest that the northern elephant seal, now lacking a pool of variability with which to adapt to changing conditions, is especially vulnerable to environmental modification.

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9. For the 21 proteins, except as noted, the sample size was 124 seals. Buffer systems employed in electrophoresis are indicated by numbers in parentheses assigned by R. K. Selander, M. H. Smith, S. Y. Yang, W. E. Johnson, J. B. Gentry [*Stud. Genet.* **6**, 49 (1971) (University of Texas Publ. No. 7103)]. N is the number of seals. The proteins assayed were: malate dehydrogenase (buffer system 2); two lactate dehydrogenases (2); 6-phosphogluconate dehydrogenase (9; $N = 84$); glucose-6-phosphate dehydrogenase (9; $N = 92$); sorbitol dehydrogenase (8); phosphohexose isomerase (8); phosphoglucomutase (8); glutamic oxaloacetic transaminase (5); indophenol oxidase (2); peptidase (9); leucine aminopeptidase (2; $N = 72$); creatine kinase (histidine buffer; $N = 35$); adenylate kinase (histidine buffer; $N = 35$); aldolase (histidine buffer; $N = 35$); two esterases (1 and 2); hemoglobin (presumably two loci; several buffer systems; $N = 159$); transferrin (2; $N = 159$); albumin (2; $N = 159$); two postalbumins (2); and haptoglobin (2).
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Carnosine in the Primary Olfactory Pathway

Abstract. *Carnosine (β-alanyl-L-histidine) is present in mouse olfactory bulbs and nasal olfactory epithelium at concentrations exceeding that previously reported for any brain region of any species. After peripheral deafferentation, carnosine concentrations in the olfactory bulbs decrease to less than 10 percent that of normal, while other amino compounds are unaffected. Carnosine appears to be highly localized to the primary olfactory pathway.*

Two naturally occurring dipeptides of histidine, carnosine (β-alanyl-L-histidine) (*1*) and homocarnosine (γ-aminobutyryl-L-histidine) (*2*), have been known as constituents of excitable tissue for many years. Nevertheless, virtually nothing is known of their function. While studying the effect of peripheral deafferentation on amino acid pools in the primary olfactory pathway of mice, I observed specific changes in the concentrations of carnosine measured by chromatographic and electrophoretic techniques. These observations may eventually lead to elucidation of the function of these dipeptides.

Extracts for analysis were prepared

Table 1. Amino compounds in olfactory tissues of mice. Olfactory tissue from six to eight mice was pooled; each pool of tissue (250 mg) was analyzed as described in the text. Replicate analysis agreed within 3 percent. Results are in nanomoles per milligram of tissue. The following amino compounds were present (in all samples) at less than 0.2 nmole per milligram of tissue: valine, isoleucine, leucine, tyrosine, phenylalanine, β-alanine, lysine, histidine, arginine, and ethanolamine. ND, not detected.

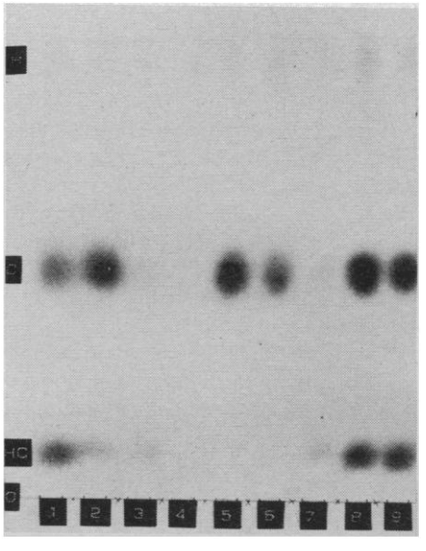
Compound	Olfactory			Whole brain†
	Epithelium	Bulbs	Bulbs after $ZnSO_4$*	
Phosphoserine	0.3	0.1	0.1	0.1
Phosphoethanolamine	1.1	1.1	1.1	1.4
Taurine	22.1	16.3	13.0	10.2
Aspartic acid	1.4	3.5	3.2	3.6
Threonine	< 0.2	0.3	0.4	0.3
Serine	0.5	0.7	0.8	0.8
Asparagine and glutamine	2.3	4.7	4.9	4.8
Glutamic acid	3.0	9.7	8.5	11.9
Glycine	1.6	0.5	0.7	1.0
Alanine	< 0.2	0.5	0.5	0.4
γ-Aminobutyric acid	< 0.2	6.1	5.5	2.7
Carnosine	2.5	2.2	ND	ND

* Twenty-four days after deafferentation with zinc sulfate. † Whole brain excluding olfactory bulbs.

from tissues dissected from female albino mice (Charles River Laboratories) that had been killed by CO_2 asphyxiation and then exsanguinated. The tissues were frozen on Dry Ice and then homogenized in 40 volumes of 75 percent ethanol at − 15°C. After centrifugation, the pellet was extracted twice more with 20 volumes of 75 percent ethanol. Portions of the pooled supernatants were taken to dryness in a stream of air. Quantitative analysis for amino compounds were performed by Eldex Laboratories (Palo Alto) on a Durrum amino acid analyzer (model D-500) with a physiological fluid elution program.

The content of amino compounds measured in the ethanol extracts of olfactory bulbs was very similar to that observed in the extracts of whole brain, excluding olfactory bulbs, with one notable exception, that is, carnosine (Table 1). This dipeptide was present in the olfactory bulb extracts at 2.2 nmole per milligram of tissue as compared to less than 0.2 nmole per milligram of tissue in the remainder of the brain. When authentic carnosine was added to the olfactory bulb extracts, it coeluted with the carnosine peak, confirming its identity. In the olfactory epithelium, carnosine was present at a concentration of 2.5 nmole per milligram of tissue (Table 1), similar to that in the olfactory bulb. Several other amino compounds were present at lower concentrations in the olfactory epithelium as compared to the olfactory bulb or brain. In particular, γ-aminobutyric acid was virtually absent in the olfactory epithelium, while glutamic acid and glutamine plus asparagine were present at lower concentrations (Table 1). In contrast, the content of taurine was slightly higher in the olfactory epithelium and olfactory bulb than in the rest of the brain.

Carnosine and homocarnosine concentrations in cerebral tissue have been measured by several investigators. In rodents the values reported for carnosine (*3*, *4*) were in the range of 0.01 to 0.2 nmole per milligram of tissue and those for homocarnosine (*4*, *5*) were in the range of 0.05 to 0.2 nmole/mg. My observation of less than 0.2 nmole of carnosine per milligram of tissue (Table 1) for whole brain, excluding olfactory bulbs is consistent with these reports. However, the carnosine content of mouse olfactory bulbs (2 nmole/mg), as reported here (Table 1), is higher than that reported for any brain region of any species.



These same high concentrations are seen in the olfactory epithelium, site of the cell bodies of the olfactory chemoreceptor neurons which synapse in the olfactory bulb.

Peripheral deafferentation was performed on mice under Nembutal anesthesia by stringent intranasal irrigation with 0.17*M* zinc sulfate solution. This procedure results in complete loss of the olfactory pathway marker protein (*6*) from both the olfactory bulb and the nasal olfactory epithelium (*7*, *8*) and concurrent selective degeneration of the synapses of the olfactory receptor neurons in the olfactory bulb (*8*).

Twenty-four days after peripheral deafferentation by zinc sulfate, the concentrations of most amino compounds in the olfactory bulb were essentially unaltered except for a small change in taurine (Table 1). Carnosine, however, decreased from 2.2 nmole/mg to less than 0.2 nmole per milligram of tissue, concomitant with olfactory neuron degeneration (*8*). The presence of high concentrations of carnosine in both the olfactory bulb and olfactory epithelium, along with the selective loss of this dipeptide from the olfactory bulb following peripheral deafferentation, suggests that carnosine is localized in the olfactory chemoreceptor neurons.

To confirm these observations and to determine whether I was dealing solely with carnosine or wtih a mixture of carnosine and homocarnosine, paper electrophoresis was performed under conditions which separate various histidine-containing dipeptides. Electrophoresis was carried out at *p*H 10 in 0.1*M* sodium borate on Whatman 3 MM paper at 25 volt/cm for 4 hours (*2*). The imidazole compounds were visualized by spraying with diazotized sulfanilic acid solution (*9*).

Fig. 1. Paper electrophoresis of tissue extracts. Ethanol extracts equivalent to 50 mg of fresh tissue were placed at the origin and were subjected to electrophoresis at *p*H 10 in 0.1*M* sodium borate buffer at 25 volt/cm for 4 hours. The positive electrode was at the top of the figure. Alkaline diazotized sulfanilic acid was used to visualize the imidazole compounds. Carnosine and homocarnosine (50 nmole each) lanes 1 and 9; olfactory bulb, lane 2; cerebral hemispheres, lane 3; lung, lane 4; olfactory epithelium, lane 5; skeletal muscle, lane 6; olfactory bulbs 15 days after peripheral deafferentation, lane 7; olfactory bulb plus 50 nmole each of carnosine and homocarnosine, lane 8; *O*, origin; *H*, histidine; *C*, carnosine; *HC*, homocarnosine.

Histidine had the fastest mobility (21 cm), followed by the peptides containing a free α-amino group: L-alanyl-L-histidine (15.8 cm), L-histidyl-L-alanine (15.3 cm), and glycyl-L-histidine (18.5 cm). The free β-amino group of β-alanyl-L-histidine caused a reduction in mobility to 9.7 cm, and the γ-amino group of γ-aminobutyryl-L-histidine resulted in a mobility of only 1.2 cm. A mixture of 50 nmole of carnosine and 50 nmole of homocarnosine gave well-separated intensely stained red spots when sprayed with the diazotized sulfanilic acid reagent (Fig. 1, lanes 1 and 9). Extracts of olfactory bulb (Fig. 1, lane 2) and of olfactory epithelium (Fig. 1, lane 5) each gave one intense spot corresponding to carnosine and in the bulb, a faint spot at the position of homocarnosine. The major spot comigrated with authentic carnosine as indicated by the intensification of the major spot (Fig. 1, lane 8) when the standard mixture of carnosine and homocarnosine was added to the bulb extract. An extract prepared from olfactory bulbs removed 15 days after the zinc sulfate peripheral deafferentation procedure gave only very faint reactions with the diazo reagent, indicating a striking decrease in the content of carnosine after deafferentation (Fig. 1, lane 7). Extracts of cerebral hemispheres lacking the olfactory bulb (Fig. 1, lane 3) gave only a very faint reaction with the diazo reagent, and extracts of lung (Fig. 1, lane 4) were essentially nonreactive. Extracts prepared from skeletal muscle (Fig. 1, lane 6), a known source of carnosine, gave a single red spot at the same position as authentic carnosine and the major spot from the olfactory bulbs (Fig. 1, lanes 1, 2, and 9).

The electrophoretic results confirm and extend the chromatographic analyses (Table 1). They demonstrate that in the olfactory pathway carnosine and not homocarnosine is the major histidine peptide. Amino acid analyses after hydrolysis overnight in 6*N* HCl at 110°C also confirmed this since histidine and β-alanine were produced in essentially equimolar amounts with only traces of γ-aminobutyric acid. In addition, the virtual absence of carnosine in the lungs (Fig. 1), a source of respiratory epithelium, further supports the concept that the carnosine in the nasal olfactory epithelium is located in the receptor neurons and not in other cell types. Strong confirmation of this postulate was the decrease observed in the carnosine content of the olfactory bulb after peripheral deafferentation.

High concentrations of carnosine were found in the primary olfactory pathway and decreased after peripheral deafferentation, a pattern that precisely matches the localization and behavior of the unique marker protein of the primary olfactory pathway (*6–8, 10*). The relation between carnosine as a possible neurotransmitter, the olfactory marker protein, carnosine synthetase (*11*), carnosinase, and the function of the primary olfactory chemoreceptor neurons remain to be determined (*12*).

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Illusory Correlation of Brightness Enhancement and Transients in the Nervous System

Abstract. *Short light flashes can appear brighter than longer flashes. This brightness enhancement has often been attributed to neural transients occurring shortly after stimulus onset. This attribution assumes an equivalence between the totality of the response to a stimulus of a given duration and the instantaneous response at a given time after stimulus onset. Recordings from* Limulus *photoreceptors indicate that this attribution is an example of illusory correlation.*

Illusions have the defining characteristic that they still elicit the illusory response from an observer even though the observer has carried out the measuring operations that reveal the illusion. Cognitive analogs of illusions occur when two classes of observations are believed to be correlated when they are not in fact related. These "illusory correlations" are often the result of associations arising from similarities between the words that describe the two classes. Illusory correlations have been so named because they share the defining characteristic of illusions, namely, that they do persist even though empirical evidence to the contrary has been provided (*1*). We now report the presence of an illusory correlation between data obtained in psychophysical and in neurophysiologic experiments on vision. This illusory correlation derives from the associative similarity of two operationally distinct parameters, namely, "stimulus duration" (a parameter in psychophysical experiments) and "time after stimulus onset" (a parameter in neurophysiologic experiments). Data which might have revealed this illusory correlation have been available for almost a half century (*2*); to our knowledge, the connection of these earlier data with the illusory correlation presently under consideration has not been noted. An analogous difficulty involving spatial rather than temporal parameters has recently been noted (*3*).

The two phenomena involved in this illusory correlation are subjective brightness enhancement and transients in the nervous system. Brightness enhancement occurs when one varies the duration of a light stimulus whose luminous intensity remains constant for the duration of the stimulus; one then finds that the subjective brightness of the stimulus varies in a complex fashion (*4*). Figure 1A illustrates the general form of the relationship between stimulus duration and subjective brightness. The overshoot of brightness at inter-