

NOTES ON LINGUAL GYMNASTICS

Frequency of Tongue Rollers and Pedigrees of Tied Tongues in Japan*

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IN 1946 the writer published in the *Japanese Journal of Genetics* a short paper on two hereditary characters of the human tongue. The one character was concerned with the ability of rolling up the lateral edges of the tongue, and the other was a slight abnormality in the structure of frenulum linguae. This paper was reprinted in the popular journal of genetics, *Iden* in 1947, and seems to have been read with interest by many people. Since then, several amateur geneticists, mostly school teachers, worked on the character mentioned first, and reported their results to the writer. The first part of this paper is a kind of summary of these reports. The second part deals with the hereditary abnormality of frenulum linguae.

1. The Ability to Roll up the Lateral Edges of the Tongue

Incidence of the Lack of this Ability

As shown below, the incidence of the lack of this ability considerably differs according to age. It is very high among young children, it decreases inversely with age, and reaches a fixed value at about twelve. Since all children in the middle and high schools are about twelve years of age, data obtained from them may be considered as representing the fixed value. In Table I are shown the data obtained in schools in various parts of Japan by different observers. The data are divided into two groups, those presented in the first part obtained by direct observation, and those in the second part secured by the questionnaire method. In direct observation each child was examined by the investigator in regard to his ability to do the trick, while the questionnaire method consisted of giving each child a printed card on which he was to record the presence or absence of this ability in himself and in the members of his family. The writer was able to compare the results obtained by these two methods on the same material. He examined for this ability the students in the high school and college in the town of Sasayama in Hyogo Prefecture, where about a half year before

members of the biology study group in that high school had been examined by the questionnaire method. The direct observation gave $26.09 \pm 2.00\%$ and $17.70 \pm 1.66\%$ percent non-rollers respectively for boys and girls, while the questionnaire method had yielded $24.80 \pm 1.92\%$ and $19.73 \pm 2.08\%$ percent for the two sexes. This difference between the results obtained by the two methods is not statistically significant in either sex. There is, however, to be seen in this table, a tendency for the data obtained by the questionnaire method to show somewhat lower frequencies of non-rollers than are obtained by direct observation. When the whole data obtained by both methods are compared with each other, they show differences in the two sexes which are statistically significant. It is not known which datum is nearer the reality. Generally speaking the direct observation seems to surpass in accuracy the questionnaire method, because of the more conscientious attitude of the recorder. At any rate, the former is undoubtedly more suitable than the latter for the purpose of making comparisons between different races as regards the character in question, because all the available data for other peoples were secured apparently by direct observation.

Sexual Difference

In Table I the sexual difference in the frequency of the ability is clearly shown: the male group almost invariably shows a higher incidence of non-rollers than the corresponding female group. This difference is not large enough to be statistically significant in some cases. The overall totals, however, show significant sexual difference in both the direct observation group and the questionnaire group. The same kind of sexual difference has been observed in Americans of European origin by Sturtevant,⁴ and by Urbanowski and Wilson⁵ and among Chinese by Liu and Hsu.²

Are There Racial Differences?

In the Americans of European origin Sturtevant⁴ has found the incidence of non-rollers to be $37.1 \pm 3.9\%$ in males and $32.8 \pm 4.1\%$ in females. His material apparently includes some children below twelve. Urbanowski and Wilson⁵ give $34.38 \pm 2.19\%$ percent males and $28.36 \pm 1.96\%$ percent females, all of whom are college students. These figures, accordingly, seem to be more suitable

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†Standard error.

for comparison with the corresponding figures for Japanese. As shown above, the latter obtained by direct observation are: 29.30 ± 0.80 percent for males and 25.49 ± 0.81 percent for females. The difference found between the two peoples is not statistically significant in either sex, thus:

$$\begin{aligned} \sigma & 34.38 - 29.30 = 5.08 \pm 2.31, 5.08 < 2.31 \times 3. \\ \phi & 28.36 - 25.49 = 2.87 \pm 2.12, 2.87 < 2.12 \times 3. \end{aligned}$$

When, however, the data obtained by the questionnaire method are used for Japanese, the racial difference becomes statistically significant:

$$\begin{aligned} \sigma & 34.38 - 26.09 = 8.29 \pm 2.82, 8.29 > 2.82 \times 3. \\ \phi & 28.36 - 20.68 = 7.68 \pm 2.52, 7.68 > 2.52 \times 3. \end{aligned}$$

It is likely that if more extensive material were obtained, especially for Americans, some racial difference like that found for blood groups or for taste deficiency would definitely be shown to exist for this character also.

Liu and Hsu² examined college students from Middle China in respect to this character. They found that the ability was lacking in 40.88 ± 1.82 percent of the boys and in 30.58 ± 2.60 percent of the girls. These figures, as compared with the corresponding figures given above for Japanese, are higher, and the difference found in boys is statistically significant, thus:

$$\begin{aligned} \sigma & 40.88 - 29.30 = 11.58 \pm 1.99, 11.58 > 1.99 \times 3. \\ \phi & 30.57 - 25.49 = 5.08 \pm 2.72, 5.08 < 2.72 \times 3. \end{aligned}$$

It is desirable that more material regarding this character also be accumulated from among Chinese people.

Difference According to Age

Previous to the writer's paper, Yamaura⁷ published a study on this problem carried out

on children in several schools of various grades in Tokyo. He found that the relative frequency of the persons who cannot do the trick, shows a considerable age difference. Nearly 50 percent of first-grade children in primary schools cannot roll the tongue. The proportion of non-rollers gradually declines in older children, until the sixth grade when the frequency nearly reaches the fixed value. In Table II are incorporated together the data relating to this problem which were obtained by seven different investigators from primary schools in various parts of Japan. Yamaura's data are also included. It is clearly shown in this table that the incidence reaches nearly 50 percent in boys of the first grade, and decreases gradually to below 30 percent in boys of the sixth grade. In girls the incidence is somewhat lower than in boys of the corresponding age, and it shows a regular decrease inversely with age, exactly as in boys.

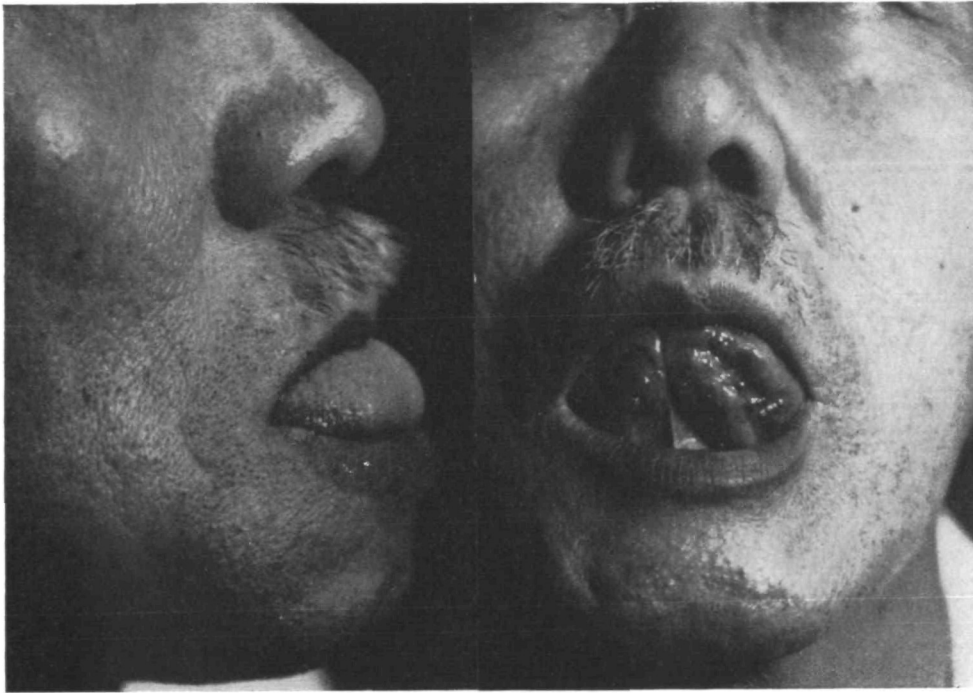
There are also some differences among the data presented in the same table accumulated apparently by identical methods though by different investigators, and the difference is fairly large in some cases. It is difficult to judge whether this difference is due to the difference in materials or simply to the sampling error. Only further investigation on more extensive material will settle this question.

Mode of Inheritance of the Character

Sturtevant⁴ first suggested that the presence or absence of this ability was determined on a monogenic basis, the gene for the presence being dominant over the gene for the absence. Yamaura⁷ and the writer¹ arrived

TABLE I. Relative frequency of individuals of above the age of twelve who lack the ability of rolling up the lateral edges of the tongue mostly among high and middle school children in various districts of Japan.

Male		Female		Source of Material	Method	Examiner
No.	Total	No.	Total			
125	504	72	365	Sasayama High School	Direct	Komai & Yano
(24.80%	100%)	(19.73%	100%)	and Hyogo College	observation	
197	597	175	696	Fukutiyama High School	"	Fujita
(33.00%	100%)	(24.60%	100%)	and Nanryo Middle School	"	
285	862	153	592	Ooki High School	"	Ito, et al.
(33.06%	100%)	(25.84%	100%)	(Kyoto)	"	
222	829	182	664	Rakuhoku Middle School	"	Teachers of the
(26.78%	100%)	(27.41%	100%)	(Kyoto)	"	school
206	741	164	610	Taiho Middle School	"	Okuno
(27.80%	100%)	(26.89%	100%)	(Kyoto)	"	
126	483	94	531	Sasayama High School	Questionnaire	Biology Study Group
(26.09%	100%)	(17.70%	100%)			
231	866	218	966	Schools in Kyoto	"	Komai
(26.67%	100%)	(22.57%	100%)			
512	1951	403	2295	Schools in Kyoto	"	Yamaura
(26.24%	100%)	(17.56%	100%)			
104	548	145	659	Osaka First Normal	"	Aoki
(23.21%	100%)	(22.00%	100%)	School	"	
230	806	185	767	Kanse Middle School	"	Tabaru
(28.53%	100%)	(24.15%	100%)	(Kuma-gun, Kumamoto)	"	
383	1424	330	1430	Soto High School	"	Hibino
(26.89%	100%)	(23.08%	100%)	(Seto, Aiti Pref.)		
Average values: — Male — — Female — — Sexual difference —						
By direct observation:		29.30 $\pm$ 0.80		25.49 $\pm$ 0.81		29.30 — 25.49 = 3.81 $\pm$ 11.4.
By questionnaire method:		26.09 $\pm$ 0.57		20.68 $\pm$ 0.50		26.09 — 20.68 = 5.41 $\pm$ 0.76.
Difference due to method: Male 29.30 — 26.09 = 3.21 $\pm$ 0.98.						
Female 25.49 — 20.68 = 4.81 $\pm$ 0.95.						



TIED TONGUE

Figure 5

The frenulum joining the tongue and the floor of the mouth is extended farther forward than in normal persons. The tongue can be protruded only to the extent shown. The movement of the tongue is somewhat hindered by this abnormality. This causes difficulties in pronouncing the sounds *r* or *l* or in playing on such musical instruments as the harmonica.

independently at the same conclusion, each on a different basis. In Table III are shown the data concerning various combinations between parents and children as regards this ability. In this, only the children above the age of twelve are included, in order to avoid complications due to age difference. The data were derived from children in Kyoto schools of various grades from the middle school up, obtained by the questionnaire method. The

incidence of the recessive type, i.e. of the persons who do not have this ability, according to these data, is 22.22 percent, so that the rela-

TABLE III. Number of children possessing (+) or lacking (—) the ability of rolling up the lateral edges of the tongue borne from parents of various combinations in respect to the ability. The material has been derived mainly from school children of various grades and their families living in Kyoto; the children of the age below twelve are not included.

P/F	+X+	♂+X♀	♀+X♂	—X—	Total		
+	♂ 338 ♀ 590	928	66 159	87 225	14 243	48	1444
—	♂ 54 ♀ 50	104	42 49	54 91	39 126	92	413
Total	♂ 392 ♀ 640	1032	108 208	141 316	53 369	140	1857

Proportion of recessives in the population: $413/1857 = 22.22\%$

Proportion of recessive gene: $q = \sqrt{0.2222} = 0.47$.

Incidence of recessive children:

from +X+ parental combination: expected $10.28 \pm 0.30\%$

observed 10.08%

from +X— parental combinations: expected $31.97 \pm 0.43\%$

observed 31.68%

TABLE II. Relative frequency of individuals who lack the ability of rolling up the lateral edges of the tongue among primary school children in Japan. Here are incorporated the materials from various districts of the country: Tokyo (Yamaura), Kawagoe (Suzuki), Gifu (Yamamoto & Kuno), Seto (Hibino), Kyoto (Komai), Nisinomiya (Komai) and Kumamoto (Tabaru).

Age	No.	Male		Female		Total
		No.	%	No.	%	
6-7	881	49.24 $\pm$ 1.18*	1792	792	43.77 $\pm$ 1.17	1809
7-8	792	42.28 $\pm$ 1.14	1873	698	37.27 $\pm$ 1.10	1915
8-9	683	37.86 $\pm$ 1.13	1804	610	34.42 $\pm$ 1.13	1772
9-10	534	32.48 $\pm$ 1.15	1644	442	27.92 $\pm$ 1.13	1583
10-11	565	32.10 $\pm$ 1.11	1760	450	27.49 $\pm$ 1.10	1637
11-12	488	27.63 $\pm$ 1.06	1766	346	19.58 $\pm$ 0.95	1738

* Standard error.

tive frequency (q) of the recessive gene among this population is $\sqrt{0.2222} = 0.47$. On the basis of this value of q , the expected incidence of the children who lack this ability has been computed according to the usual formulae:

$$R = \frac{q^2}{(1+q)^2} \pm \frac{0.6745(1-q)}{(1+q)^2} \sqrt{\frac{q^2}{N(1-q^2)^2}}$$

$$S = \frac{q}{1+q} \pm \frac{0.3373(1-q)}{1+q} \sqrt{\frac{1}{N(1-q^2)}}$$

where R is the proportion of recessives to be expected in the offspring of random matings of dominants together, and S the proportion of recessives to be expected in the offspring of random matings of dominants with recessives.⁸ The value of R expected here is 10.28 ± 0.30 percent, while the observed value is 10.08 percent. Next, the expected value of S is 31.97 ± 0.43 percent, the observed value being 31.68 percent. Thus in both cases, the observed value is within the limit of the probable error of the corresponding expected value. It seems accordingly safe to decide that the presence or absence of this ability is determined on a monogenic basis, and the gene for its presence is dominant over the gene for its absence. The penetrance of the dominant gene, however, is incomplete. This is clearly shown in the cases where both parents lack this ability. Only 65.71 percent of the children of such parents are devoid of the ability where all of them are expected to be so.

2. Abnormality in Frenulum Linguae

In some people the frenulum linguae which connects the base of the tongue to the floor of the throat, extends forward nearly to the tip of the tongue. In such tongue-tied individuals the movement of the tongue is hindered more or less, and the degree of this hindrance corresponds with the degree of the forward extension of the frenulum. In most cases the tongue can be protruded only a little beyond the lips at most, and it cannot be curved upwards, so that the person who has such a tongue finds difficulty in pronouncing the sound symbolized by the consonants r or l .

The writer has been able to collect three pedigrees of this small defect from among Japanese people. In the first family the propositus is an apprentice in the sericulture experiment station in Ayabé near Kyoto. He is twenty years of age, and had not realized this defect until he recently began to learn to play on the harmonica, when he found himself unable to blow the bass sound of the instrument. His mother and two younger brothers are similarly affected. Mr. Ichikawa, geneticist at the same station, kindly supplied the writer with this information.

The second is a physician's family named Okubo living in Tokushima in Sikoku. Dr. Okubo and his two sons of whom the elder is

a graduate student in the Medical Department of Tokyo University, have this defect. Dr. Okubo states that the front end of his frenulum is at about 1.5 cm. from the tip of the fully stretched tongue, so that he can protrude his tongue hardly beyond the lips, and he finds some difficulty in pronouncing the r or l sound. His two daughters do not have this defect. The writer is indebted to Dr. Okubo for this information and for the photograph reproduced here.

In the third family, Mrs. U., wife of a professor of biology at the Kyūshū University, and her father are affected, while her mother and brother are both normal. This material has been provided to the writer by her husband Dr. U.

These pedigrees show that this slight abnormality is due to a simple dominant gene. Weiss⁶ reports a family of an "adherent tongue." "The patient could not elevate the tongue to make contact with the palate, particularly in the posterior portion, as occurs in producing the sounds of k , g , hard c and hard g . The patient could protrude his tongue quite freely, but in trying to elevate it, it seems to be drawn into the throat and would elevate only slightly." This abnormality appeared in a man and his four sons, and probably in the man's brother too, the four daughters all being normal. This case is similar to, though apparently not identical with, the cases here reported. Probably both belong to the category called 'ankyloglossia.'

Summary

1. The incidence of the lack of the ability of rolling up the lateral edges of the tongue among Japanese people is about 29 percent in males and 25.5 percent in females. The incidence thus shows a distinct sexual difference. It also shows a considerable difference according to age. The incidence is higher in small children, approaching 50 percent in seven-year old boys, and decreases inversely with age until it reaches the fixed value at about twelve. The girls always have lower incidence values than boys of corresponding age. It is also likely that the incidence shows some difference in different human races.

2. The presence or absence of this ability is determined on a monogenic basis; its presence is due to a dominant gene, but its penetrance is incomplete.

3. Some people have their frenulum linguae more forwardly extended than in normal persons. This gives some hindrance to the free movement of the tongue, which is manifested in the pronunciation of some sounds or in playing on a blowing musical instrument. This defect is caused by a simple dominant gene. Three pedigrees showing this character are presented.

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GENETICS OF THE COLOR VARIETIES OF HORSES

A Spanish geneticist and agricultural expert has recently published an excellent exposition of color variation among horses and the genetic constitution of the various color varieties.*

Based on twentieth-century genetic theory, it is the most comprehensive work on this subject which has yet been published. It is an example of beautiful book making, with reproductions in color of famous paintings of horses, and numerous other illustrations. The work is well indexed and includes a very complete bibliography, which alone would make it indispensable as a tool of research to future students of the genetics of the horse.

The work is divided into four parts. Part one deals with the basic color varieties; black, brown, bay, chestnut and gray. These are discussed in much detail as regards their occurrence, morphological character, and biochemical basis.

Part two deals in a similar way with "other colors"; a chapter each being devoted to roan, pinto, buckskin-and-Palomino, and white.

Part three deals with the "modes of interpretation" of physiological processes involved in color production.

Part four deals with "genetic interpretations." This is of especial interest to geneticists. Its ten chapters have such suggestive headings as mosaic pelages, dilution, silvering, horses and rodents, horses and hypotheses, attributes of the wild color type.

The author postulates the occurrence among horses of seven different basic genes, each having two or more alleles, and associated in several combinations with a number of hypothetical modifiers. The genes in question are:

1. A^L , A , a^t , a = wild pattern, bay, brown, black
2. C , c^{cr} = full color, dilute color
3. E , e = extended black color, restricted black color (red)
4. G , g = gray, not gray
5. R , r = roan, not roan

6. S , s = self, minor white spotting
7. W , W' , W'' = all-white, white areas extensive, white areas less extensive

The author recognizes the existence of a wild coat pattern seen in the Prejvalski horse, still wild in Mongolia, and regards it as analagous with the agouti pattern of rodents, designating it by the same symbol, A . He suggests that it has undergone mutations resulting in four recognizable alleles; one, the wild type, a second found in bay and chestnut horses (most like the wild pattern), a third found in brown (bocifuego) horses (less like A and regarded as comparable to a^t —the black-and-tan pattern of rabbits), a fourth found in black horses shows total absence of the A pattern.

In the reviewer's opinion the assumption of a special mutation of A to produce a phenotype popularly called brown is needless, as browns are demonstrably some modified bays (AB), others modified chestnuts (Abb) and none are true breeding for a brown phenotype.

Combinations of genes recognized by the author as resulting in the basic color types of horses are shown in Tables I and II columns 1 and 2. This layout differs from that of most mammalian geneticists in two particulars.

(1) Odriozola regards all eumelanin of horses as black, and explains the difference between bay and chestnut as due to a quantitative difference in black pigment. Others regard the difference as qualitative, the eumelanin in one case being black, in the other brown. This difference is expressed by Odriozola in terms of genes, by alleles E , e . By others the difference is expressed in terms of the alleles B , b .

(2) Odriozola regards dilution as due to a genuine albino allele, c^{cr} (cream). Heterozygotes with the allele for full color, C c^{cr} are intermediate in depth of color, as seen in buckskin and Palomino varieties, while homozygotes c^{cr} c^{cr} are really a type of albino, as

**A los Colores del Caballo*. [On the colors of the horse, a guide to their varieties and an inquiry into the mode of their origin]. By Miguel Odriozola. 435 pp, 8 colored plates and numerous other illustrations. Publication of the National Syndicate of Livestock, Madrid, 1951.