

AN ASSOCIATION BETWEEN TONGUE-ROLLING PHENOTYPES AND SUBJECTS OF STUDY OF UNDERGRADUATES

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Summary. The distribution of phenotypes in the tongue-rolling polymorphism in two samples of university undergraduates, totalling 1066 individuals, shows no difference between the sexes but large differences between groups drawn from different faculties and particularly between the life sciences and the arts. There are also indications of a difference in distribution between arts students living in halls of residence and those living elsewhere.

The genetics of tongue-rolling is not yet critically established but, on the assumption that most of the phenotypic variation observed has a genetic basis, the data suggest that the loci governing this character may also contribute to variation in personality characteristics which influence choice of subject of study.

Introduction

Sturtevant (1940) reported that among white Americans two distinct phenotypes existed with respect to ability to roll the tongue longitudinally into a tube. Although some intermediate phenotypes were detected and a few individuals appeared able to learn how to roll the tongue, he concluded that the two major phenotypes ('rollers' and 'non-rollers') were essentially genetic. From subsequent work it appears that:

- (i) in the white populations of the United Kingdom or United States 95% of individuals can be classified clearly into roller or non-roller phenotypes;
- (ii) most adult individuals do not believe that rolling can be learnt (only one claimed this in the sample of Reedy, Szczes & Downs, 1971). Sturtevant (1940) claims 'numerous cases' of acquisition by practice, particularly in children, but gives no further details;
- (iii) the genetics of tongue-rolling are not yet critically established, but they are almost certainly more complex than originally envisaged with probably two loci involved. Both seem to be polymorphic with intermediate allele frequencies at the first (R) locus and more extreme frequencies at the second (A) locus.

In a small study of 60 undergraduates in Swansea by Mrs Nicole Booth, classifying simply into roller and non-roller phenotypes, only three out of 27 undergraduates reading sciences but sixteen out of 33 arts-based undergraduates,

were non-rollers; this difference is statistically significant ($\chi^2_1 = 9.58$, $P < 0.01$). These findings suggested that groups of university students reading different subjects might be characterized by different frequencies of the tongue-rolling phenotypes. This suggestion called for a larger study, reported here.

Method

Students at the University College of Swansea provided the material. In the first sample, students were approached individually and randomly as they circulated in an area immediately around the main doors of the refectory building at the University College of Swansea. The sample totalled 566 and was collected in a period of 4 weeks in May 1975, mainly during the periods 12.00–14.00 and 17.00–16.00 hours. The second sample consisted wholly of incoming freshmen: 200 were approached randomly during registration procedures in October 1975, and another 300 were approached individually and randomly in their rooms in the halls of residence of the university. Both samples comprised only native-born British students. In the first sample, information was collected on sex, nationality, course, year of study, and age; in the second sample details of university residence, intending Honours course, and first year subjects were also collected.



Fig. 1. Schematic representation of end-on view of tongue-rolling phenotypes.

The students were divided according to subject of study into four major divisions. The life sciences included oceanography and psychology; the physical and applied sciences included pure mathematics and statistics; the social and economic sciences included geography; the arts included American studies. Classification by discipline presented few problems in the first sample, where the majority of students were second year or more senior. The first year students in sample 1 and all students in sample 2 were classified by the subject they intended to read in the subsequent years. Each of the relatively few students intending to read for Joint Honours in two subjects not in the same subject group was asked to name the subject he preferred.

Each student was asked to roll the tongue. Classification of the results was into one of four categories (Fig. 1): roller (R) in which an almost complete tube could be formed; shallow (S) where the sides of the tongue could be elevated slightly above the flat centre; hemiroller (H) where a single side could be so elevated; non-roller (r) where there was no rolling.

For statistical analysis, phenotypes R, S and H are pooled into a category 'R'. This appears the best method of treatment as the pedigree investigations (unpublished) suggest that the S phenotypes have the R gene, and the H phenotype is very uncommon.

Results

Table 1 shows the distribution of the phenotypes by sample and sex. The very low χ^2 values confirm the conclusion drawn by Sturtevant (1940) that sex is not a significant variable in this polymorphism, and in all subsequent discussion the data from the two sexes are pooled. There is, however, significant heterogeneity between the two samples, with the proportion of the true roller phenotype (R) being higher in the second sample. The phenotype frequencies show significant differences among the four subject groups in the total material combining both samples (Table

Table 1. The distribution of tongue rolling phenotypes in males and females in two samples of undergraduates

	R	S	H	Total 'R'	r	Total
Females						
Sample 1	142	4	4	150	72	222
Sample 2	132	8	0	140	52	192
Total	274	12	4	290	124	414
Males						
Sample 1	227	11	2	240	104	344
Sample 2	210	22	4	236	72	308
Total	437	33	6	476	176	652
Males and females						
Sample 1	369	15	6	390	176	566
Sample 2	342	30	4	376	124	500
Total	711	45	10	766	300	1066

Sample 1 : Sex, $\chi^2_1 = 0.305$, $P > 0.50$.

Sample 2: Sex, $\chi^2_1 = 0.871$, $P > 0.30$.

Samples 1 and 2: 'R':r, $\chi^2_1 = 5.20$, $P \approx 0.02$.

2). There are fewest non-rollers in the life sciences, and most in the arts. The same pattern appears in both samples, despite the generally higher proportion of rollers in the second sample. This difference is seen in all four groups of disciplines, although the intersample difference is statistically significant only in the physical and applied sciences group.

The frequency of the 'R' phenotype, which includes all grades of rolling ability, ranges from 80% in the life sciences to 65% in the arts, and there is highly significant heterogeneity among disciplines in these proportions ($\chi^2_3 = 16.12$, $P \approx 0.001$). Comparisons of all pairs of the four discipline groups produce significant χ^2 values except between life sciences and physical and applied sciences, and between arts and the social and economic sciences (Table 3). It appears there-

Table 2. Distribution of tongue rolling phenotypes in the two samples in four subject groups

Subject group	R		S		H		Total 'R'		r		Total		'R' ratio		P
	1*	2†	1	2	1	2	1	2	1	2	1	2	1 + 2	χ^2_{11}	
Life sciences	97	72	2	7	1	0	100	79	29	16	129	95	0.799	1.08	>0.20
Applied and physical sciences	94	115	6	11	2	2	102	128	47	31	149	159	0.747	5.90	<0.02
Social and economic sciences	87	95	4	5	1	2	92	102	43	45	135	147	0.688	0.05	>0.80
Arts	91	60	3	7	2	0	96	67	57	32	153	99	0.647	0.64	>0.30

* Sample 1.
† Sample 2.
‡ For the tests of homogeneity of distribution of phenotypes in the two samples.
Test of 'R':r in the four groups (two samples combined): $\chi^2_3 = 16.12, P \approx 0.001$.

Table 3. Pair-wise comparisons of distribution of roller phenotypes in four subject groups

	Physical and applied sciences	Social and economic sciences	Arts
Life sciences	$\chi^2 = 0.28$ $P > 0.50$	$\chi^2 = 5.80$ $P < 0.02$	$\chi^2 = 6.24$ $P < 0.02$
Physical and applied sciences		$\chi^2 = 5.06$ $P < 0.03$	$\chi^2 = 5.44$ $P < 0.02$
Social and economic sciences			$\chi^2 = 0.08$ $P > 0.70$

Table 4. Distribution of the roller phenotypes in arts-based and science-based students living in halls of residence and elsewhere (Sample 2)

Phenotype	Arts-based		Science-based		Total		Total
	Hall	Non-hall	Hall	Non-hall	Hall	Non-hall	
'R'	144	25	145	62	289	87	376
r	57	20	30	17	87	37	124
Total	201	45	175	79	376	124	500

'R':r in total hall and non-hall, $\chi^2_1 = 2.24$, $P > 0.10$.

'R':r in arts hall and non-hall, $\chi^2_1 = 4.43$, $P \approx 0.03$.

'R':r in science hall and non-hall, $\chi^2_1 = 0.69$, $P > 0.30$.

fore that students studying science disciplines are more likely to be tongue rollers than those studying arts subjects.

Examining the material in the second sample on residence, there is a slight suggestion that the frequency of rollers among students living in halls of residence is higher than among those in other types of accommodation, though not significantly so (Table 4). However, dividing the data according to discipline, the arts-based students show a significant association, with fewer non-rollers living in halls. Among the science-based students the proportion of rollers is very similar in both types of residence.

Discussion

From Sturtevant's (1940) initial study he concluded that the two major phenotypes (rollers and non-rollers) were probably controlled by a pair of alleles at a single locus with the dominant allele (R) conferring rolling ability. This conclusion was endorsed by Urbanowski & Wilson (1947) and Whitney (1949). Liu & Hsu (1949) concluded from a sample of 1043 individuals that there may be interaction between the R locus and a second locus termed F on the expression of tongue

folding, i.e. the tongue folded back so that the tip points towards the back of the mouth. They did not, however, deduce that the genotype at the F locus influences the tongue-rolling phenotype. Similar results were observed by Gahres (1952) in a sample of 865 subjects. Lee (1955) investigating 1890 US blacks, found the frequency of rollers to be about 82%, and suggested that there is no interaction between the R and F loci on rolling. Hirschhorn (1970) in a family study reached the same conclusion.

Following the report by Matlock (1952) it became clear that, as discordance is observed between identical twins in some twin pairs, the character must be modified in part by environmental influences. That discordance between identical twins exists was confirmed by the larger study of Reedy *et al.* (1971), where concordance of 88.5% was observed, by Vogel (1957) who found 76 pairs concordant out of 92 (82.6%), and by Martin (1975) in a small study showing a concordance of 71.5%. Combining the four studies gives an overall value of about 82% for concordance, though Vogel's data make it evident that, in young people, concordance increases with age up to 19 years.

Information about the intermediate phenotypes referred to by Sturtevant (1940) is found only in the paper by Reedy *et al.* (1971) where these were seen in nineteen of the 386 individuals examined. Of these nineteen individuals, Reedy *et al.* considered those nearer the clear-cut non-roller phenotype to be non-rollers, and those nearer the roller phenotype to be rollers. The present data show that 55 individuals of 1066 display intermediate phenotypes, and this frequency (5.2%) agrees well with that found by Reedy *et al.* The genetic basis of these phenotypes remains unclear. Our investigations lead us to believe that some, and perhaps most, adult tongue rollers learn to do so during childhood, but it is also clear that some children are totally unable to do so in spite of repeated attempts over long periods of time. Family studies, now in progress in collaboration with Dr J. Reedy, should help to resolve the problem.

Irrespective of the genetics of the polymorphism, however, the present results suggest that there may be biological differences between students following grossly different courses. It is unlikely that the results are due to systematic errors of classification, as all individual phenotypes were scored by a single observer. It is also unlikely that appreciable numbers of students in arts-based subjects potentially able to tongue-roll had not yet learned to do so. Each student was asked whether he had been taught to roll his tongue, and only one positive case was found, of a shallow-roller who had learned to do so. The students were approached in an informal way and responded freely to questions, so that the possibility that arts-based students differentially refrained from rolling the tongue when asked to do so is remote.

It appears therefore that although the genetics are not yet firmly established, there is sufficient evidence to indicate an appreciable genetic component to the procedure. The present results suggest that the genes influencing tongue rolling may be involved pleiotropically with aspects of personality important to the choice of subject of study. This does not account for the differences between the two samples, with the proportion of rollers higher in the second, for there is clearly no greater representation of science-based students in the second sample, where indeed

they form a slightly smaller proportion. The one difference in experimental procedure between the two samples was that in the first, students were approached in a public area, through which not all students would necessarily pass with the same frequency. In the second sample, selection of students was random except with respect to residence, students living in halls of residence being slightly over-represented. As there is a large element of personal choice in the allocation of student accommodation in the University College of Swansea, it would not be surprising if the personalities of those living in halls of residence differ from those living in other accommodation, though there is no direct information on this point.

The variables with which the phenotypes appear to be associated in this study, namely discipline and choice of residence, both suggest an association with personality. Clearly more work is needed to analyse the nature of the association, but it is most unlikely that it arises from any stochastic process and there appears no way in which sampling bias can be responsible. The differences in those aspects of personality (divergent/convergent) between arts and science students to which Hudson (1966) drew attention, may be useful pointers for future work.

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Received 24th June 1978