ratios so difficult, and is sustained by reason of the fact that cold air sucked in during a half cycle is heated up and driven out at increased volume. Crudely, it may be supposed that the condition for sustained oscillation is that $\Delta T/T$ should be greater than $3r^2h/4R^3$, where ΔT is the temperature increase of the air, r and R are the radii of tube and bulb respectively and h is the length of stem. It is probable that the frequency is proportional to the rate of heat transfer from the hot bulb per unit volume of air, and hence inversely proportional to the radius. A bulb of 20 mm. diameter gives a low note near the limit of audibility, so that the production of audible frequencies is limited to tubes of small dimensions.

SHAUN M. COX.

The Laboratories,
Wear Glass Works,
Sunderland, Co. Durham.

Relation between Dissonance and Context

ACCORDING to Helmholtz's well-known theory[1], the consonance or dissonance of a chord depends on the extent to which its component fundamental tones and their overtones produce beats. Even a cursory study of the methods of musicians, however, and the experience of listening to music, make it seem possible that in actual practice the degree of harshness of dissonances varies considerably according to the way in which they are used and on their context of surrounding chords. A short experiment was planned to test this possibility.

A set of twelve dissonances was devised, of varying harshness and complexity, and each was provided with six different contexts or settings. Each setting consisted of two chords, one before and one after the test chord. In settings A and B a variety of chords were employed which had been chosen in the hope that they might produce some effect on the degree of dissonance of the test chord; in settings C and F the test chord itself was simply transposed one tone in sequence, passing the test chord downwards in set C, and, with otherwise identical notes, upwards in set F; in settings D and E arbitrarily chosen chords were employed, passing from complex combinations through the test chord to simple combinations in set D, and using the identical sets of chords taken in reverse order in set E.

The subjects of the experiment were forty-eight students who had some experience in psychological laboratory work; there were forty women and eight men. They were asked to listen to the groups of chords, which were played on the piano in the order A 1 to 12, B 1 to 12, and so on, and to assess the dissonance of the middle or test chord of each group on a scale ranging from -3 (very dissonant) up to $+3$ (very consonant). They did not find any difficulty in the task. It seems odd that positive assessments were used, though less freely than negative, but this is understandable to us, because, though all technically dissonances, some of the test chords formed very sonorous clangs of sound, and this may be one way in which Helmholtz's theory tends to break down. Two trial sets of chords were used to explain and demonstrate the aim and technique of the experiment to the subjects, and it was made clear that the experiment was not concerned with liking and disliking but only with consonance and dissonance.

The assessments for each chord in each of its settings were converted into scores by multiplying the totals by the corresponding ranks. Correlations were then worked out by the product-moment formula between the scores for each chord in settings A and B, C and F, and D and E. This gave thirty-six correlations, of which, according to the technique explained by Fisher[2], eight differed significantly from zero. These correlations are shown in the accompanying table. If there were no factor at work tending to make the chords sound equally dissonant (or consonant) whatever their context, we should expect no positive correlations. If there was a strong factor tending to make them sound quite different according to the context although they were the same chords, we should expect a large proportion of negative correlations. The fact that we find a small proportion of positive correlations enables us to draw the inference that there is some tendency for the chords to maintain their dissonance- (or consonance-) levels in spite of their changing contexts, but that those contexts have a very marked effect on the chords, tending to alter their level of harshness. The same conclusion is reached from the small magnitude of the correlations, only two of which were above 0·6.

Chord number	Pairs of settings correlated and probability of correlations					
	AB	p	CF	p	DE	p
2	0·50	$<0·01$	0·56	$<0·01$	—	
6	0·48	0·01	—		0·46	0·02–0·01
9	0·45	0·02	0·50	$<0·01$	—	
10	0·61	$<0·01$	—		—	
11	—		0·65	$<0·01$	—	

From these data it must be inferred that the dissonance of a chord depends even more upon the relation in which it stands to its surrounding chords than on the nature of the chord itself. The objection might be raised that the subjects were simply judging the dissonance (or consonance) of given chords in comparison with more (or less) dissonant chords on either side of them. This objection, however, is met by the results for settings C and F, which consisted of the test chord itself, transposed one tone up or down. In these settings there should, on the usual theory, be no contrasts of dissonance at all. It is perhaps surprising that settings D and E, which were arbitrarily chosen, should have produced fewer correlations than either A and B or C and F. It is clear that the experiment should be repeated with more adequate material composed by an experienced musician.

We are indebted to Mr. Joseph F. Simpson for calculating the correlation coefficients.

P. A. D. GARDNER.
R. W. PICKFORD.

Psychology Department,
University of Glasgow.

[1] Myers, C. S., "A Text-book of Experimental Psychology" (3rd Ed.), Pt. 1, 52–55 (1928).

[2] Fisher, R. A., "Statistical Methods for Research Workers" (8th Ed.), 186–187 (1941).

A Y-linked Inheritance of Asynapsis in *Rumex Acetosa*

GENICALLY inherited asynapsis is sometimes met with in a number of plant species, according to observations made by various workers during the last ten years. The most remarkable cases were recently reviewed by Prakken[1]. In a number of the cases observed it was, however, not possible to say with any certainty if the lack of chiasmata at meiosis really was genically determined or not. One of these