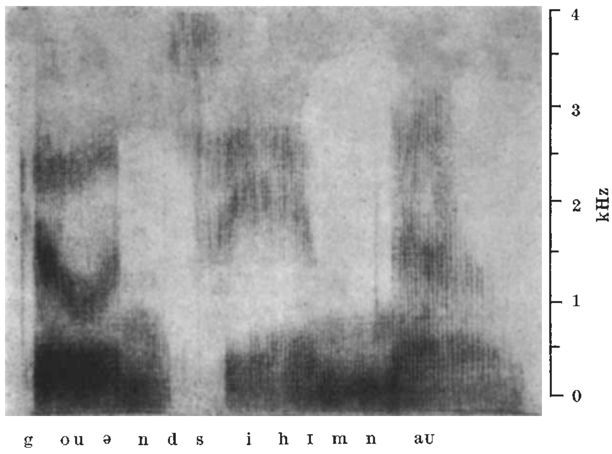

Fig. 4. Oral and nasal signals mixed. Compared with Fig. 3 the first formant is more constant in intensity during /ou/ and is more intense throughout /aʊ/. This shows that the energy seen at the frequency of the first formant in the nasal output (Fig. 2) is not insignificant. Similarly the energy between the first and second formants, due to the characteristic nasal resonance, is present in both oral and nasal signals.

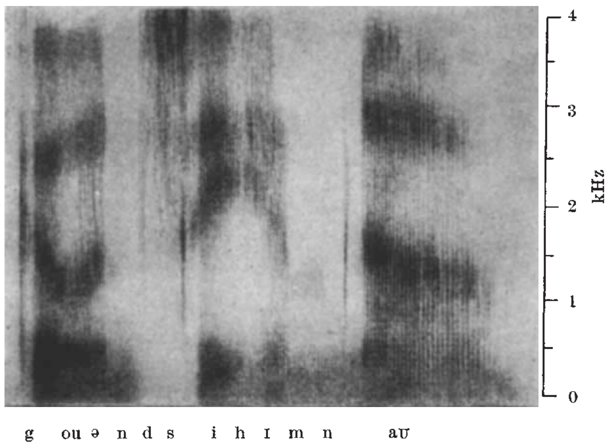

Fig. 5. The same text recorded on a separate occasion using a single microphone and no separator. This is very similar to Fig. 4 although the low frequency components during nasal consonants are slightly less intense. Again velar coupling to the nasal cavity begins during /ou/ causing a drop in the first formant intensity, but on this occasion the second occurrence of velar coupling is delayed until just before /ɪ/.

nasal resonance near 1 kHz are visible in both the nasal and the oral outputs (Figs. 2 and 3 respectively).

Another use for the apparatus is in the production of stimuli for perceptual experiments where the separate signals can be used alone, or separately subjected to spectral modification before being mixed. Thus in studies of nasal consonants the perceptual significance of transitions in the oral signal and of various spectral features of the nasal signal can easily be tested.

The analysis of speech by a number of talkers is being undertaken at present; the results of these investigations will be published at a later date.

I thank various members of JSRU for their assistance in the construction of the apparatus, the performance of the experiments and the preparation of this communication.

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Received June 14, 1968.

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GENERAL

Naming the Units

There is a general agreement among the different languages in naming large numbers up to and including one million, that is, 1,000,000 or 10^6. But one enters the tower of Babel looking for the name of 1,000,000,000 or 10^9. In the United States it is known as one billion, in France as un trillion, in Germany as eine Milliarde, and in Russia as odin milliard. Great Britain, Italy and Spain have no special name for that number since the British billion, the Italian bilione, and the Spanish bicuento mean 1,000,000,000,000 or 10^{12}. This fact causes great inconvenience, because in modern science a great many things are measured in the 10^9 unit. This includes the age of the universe (expressed in years), the cosmic distances (expressed in light years), the temperatures during the early stages of the universal evolution and inside of the exploding stars (expressed in degrees Kelvin), and the energies of modern particle accelerators (expressed in electron volts).

I should like to propose here a unified terminology which may help to remove ambiguity. Leaving alone the misleading names such as billions, trillions, milliards, and so on, one should in each case choose special units based on the factor 10^9. It is already becoming practice to speak about eons, which are 10^9 years each. I suggest the introduction of a unit of distance equal to 10^9 light years to be called one hubble in honour of the American astronomer, Edwin Hubble, who was the first to use it for measuring the distances between the galaxies of stars. Conveniently, in these units one hubble per eon becomes the speed of light in vacuum. I also propose tentatively that we use the term one inferno (°I) for the temperature of 10^9 Kelvin.

There remains, however, a difficult problem concerning the energy of 10^9 electron volts and greater, produced in particle accelerators. For the Americans it is Bev (as in Bevatron), for the French Tev (trillion), and for the Germans and Russians Mev (Milliarde) which will be confused with a million electron volts and therefore will be unacceptable. The British, Italians and Spaniards have no special name at all for 10^9, and the situation will be still more confusing. I do not think that the presently accepted term Gev is very fortunate. My suggestion would be to name 10^9 electron volts after a great nuclear physicist, one rutherford. It is true, of course, that all the principal achievements of Lord Rutherford were made in the field of classical nuclear physics, involving only millions of electron volts. But, on the other hand, this man had a sufficiently great stature to be able to shoulder a thousand times larger load.

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Received July 22, 1968.

Anxiety and Economic Growth

I should like to report the discovery of a remarkably high correlation between national levels of anxiety and economic growth rates. The discovery was made as a result of the following train of reasoning. The rate of economic growth of a nation is the rate at which it is getting richer. Many factors may influence this rate, but there is fairly widespread agreement among economists that one is probably the efficiency of the population as a working force. Obviously a nation with an efficient working force is likely to create wealth more rapidly than one whose working force is less efficient.

Thus the ball is in the psychologist's court. What are the personality factors which make for efficiency at work ? I have demonstrated[1], and so have Furneaux[2] and Kelvin, Lucas and Ojha[3], that one such factor is neuroticism, a central concept in the personality theory built up by Eysenck[4]. All of us have found that university students and sixth formers who have high levels of neuroticism do better in examinations than those with lower levels of neuroticism. The person who scores high on neuroticism tends to be tense, highly strung, irritable and moody.

Doing well in examinations is a particular kind of work efficiency. Thus it seemed reasonable to ask whether there might be national differences in neuroticism which could account for differences in economic growth rates. If the association between neuroticism and work efficiency in students holds for other kinds of work, then it seemed possible that populations with high levels of neuroticism might work with greater efficiency, which would show itself in a high economic growth rate.

Unfortunately there is little information on the levels of Eysenck's neuroticism factor in different countries. There is, however, quite considerable information on Cattell's concept of anxiety, and this is extremely similar to Eysenck's neuroticism and highly correlated with it[5]. National levels of anxiety have been collected from eleven countries between 1955 and 1968. The relation between the anxiety levels and the economic growth rates is shown in Fig. 1. The tendency of the high anxiety countries to have better economic growth rates is statistically significant (rho $= 0{\cdot}715$, $P < 0{\cdot}01$).

The scores were obtained as follows. Economic growth rates are taken from the United Nations Statistical Tables. The derivation of the anxiety scores is more complicated. Scores on Cattell's 16 personality factor (PF) test were obtained from Japan, Germany, Australia, Ireland, New Zealand, Canada, the United States and Britain. These scores have been collected by workers in the different countries and are obtainable from the files in Cattell's laboratory. Anxiety scores can be calculated from 16 PF scores using the appropriate formula. This calculation places the countries in the order given, with Japan having the highest score and so on.

In addition, Cattell and Schier have published scores, based on a different anxiety test for six advanced western countries. These, in their rank anxiety order from high to low, were France, Japan, Italy, Norway, Britain and the United States. We therefore have the problem of integrating this order with that obtained from the 16 PF. The only possibility is ranking. Some of the ranks can be settled without dispute. France must come first, followed by Japan. The United States and Britain must come in places ten and eleven. The two studies are in contradiction in the relative placing of these two, and reliance is therefore placed on the later and more extensive investigation of Cattell and Warburton[6] which puts the United States as more anxious than Britain. This leaves Italy and Norway to be fitted into the seven places, ranks 3–9, in the middle of the scale. The best thing seems to be to put Italy into rank 4 and Norway into rank 8. This procedure was adopted partly because of the finding that anxiety scores in Italy are only a little lower than those in France (Cattell and Schier, page 274). This result is preserved in our ranking.

While it may be felt that there is a certain degree of arbitrariness in the rank order given, it may be pointed out that the ranks allotted to the countries in the middle section of the scale make little difference to the correlation. The correlation is high principally because the exceptionally low growth countries, Britain and the United States, have the lowest anxiety scores; while Japan, an exceptionally high growth country, has a very high anxiety score. These facts have been established in two independent studies using two different questionnaires. So long as the rank orders of the other countries in the two investigations are preserved, they can be fitted together in several ways. All final rankings will yield high and statistically significant correlations between anxiety levels and economic growth rates.

It should perhaps be stated that anxiety scores are also available for some underdeveloped countries, such as India, and from one communist country, Poland. These have been excluded because of the impropriety of lumping advanced capitalist countries together with countries at very different stages of economic development and with communist forms of economic organization. The anxiety scores from the countries have in all cases been derived from male university students. Though not a sample of the working population, university students are not an unreasonable sample. Their personality is likely to reflect the personality of the general population; they represent a straightforward sample in making comparisons between different countries; and they represent the countries' leadership, whose attributes are likely to be especially important for economic growth.

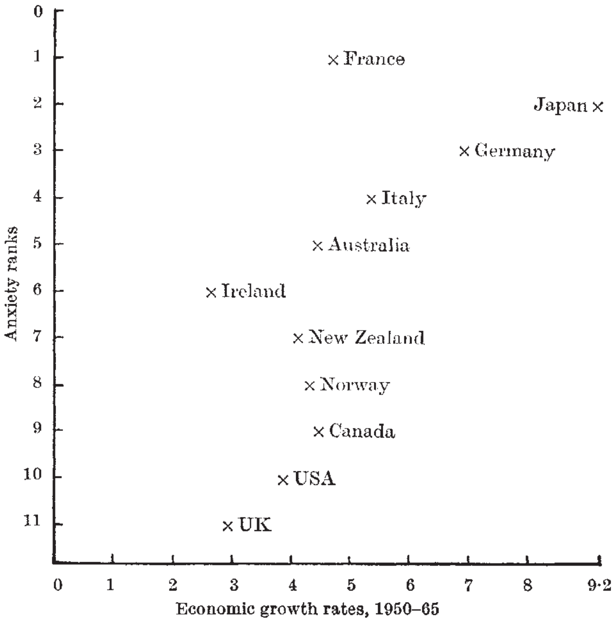

Fig. 1.

Such a high correlation demands explanation. Justice could not be done to such a complex matter in this communication. But it may be said that there are good reasons, to be found in the references cited, for believing that anxiety is a causal factor in the motivation of efficient work and not simply a by-product or the result of some common underlying factor. Thus it seems reasonable to suggest that the correlation reported in this letter could represent an important advance in our understanding of the psychology of economic growth.

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Received June 19, 1968.

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