this technique to the light microscope, perhaps to counter any mistaken impression that there is rivalry between the two instruments. Some fine optical micrographs of metal-shadowed replicas of paint surfaces were displayed.

Analysis by microscopical examination is rarely a straightforward matter of immediate recognition of structure or crystal form but requires the building up of an index by correlation with the results of other methods of examination. This is true not only of the identification and estimation of the constituents of a product (the subject of several exhibits from the metallurgical, ceramic, textile, paper, biological and pharmaceutical industries), but also of the investigation of the causes of defects. This latter duty of microscopy was well demonstrated by an exhibit showing the methods used in examining the crystalline inclusions in glass. This exhibit, by the Glass Technology Department of the University of Sheffield, was supported by many photomicrographs and sections of identified crystal forms, which are often quite different in shape from the crystal growths in their free state. Such a bold and extensive display of the range of defects possible in a single product could perhaps only have been staged by an impartial body; so, to gratitude for the instruction received is added the prayer that the wrath of the glass industry may not have descended upon the University of Sheffield.

From accidental defect we may descend to adulteration and downright swindle. A most interesting exhibit by the Pharmaceutical Society of Great Britain showed how fraudulent substitutes for the basic crude drugs may be detected.

Metallurgy owes much to the microscope, and as new methods—phase-contrast, interference and electron microscopy—have been perfected they have naturally been applied to metallography, though perhaps 'naturally' is not quite appropriate for the last of these, since the electron microscope requires a transparent object; for examination at the highest magnifications the metallurgist must therefore rely on transparent replicas of the surface conformation. Among the several examples of replica technique was a photographic demonstration of the remarkable fidelity of reproduction by the replica; optical and electron micrographs of the same area of a metal specimen showed identical features, though the resolution of fine detail was clearer in the electron micrograph since at the magnification used (× 4,000) some empty magnification was being obtained with the light microscope.

Many special devices were on show, headed by the historic microscope specially ordered by the firm of Whitbread and Co. for Pasteur's use in his investigation of the brewing process. Three reflecting microscopes were shown, one with a long working-distance for use with a furnace; the other two were for infrared spectrometry, which has become a valuable method of micro-analysis. Several other exhibits of apparatus for special purposes and techniques for measuring physical quantities must, for lack of space, be passed over, but a final word must be spared to note the concentration of microscopical technique being brought to bear by the National Coal Board on the problem of disease due to airborne dust.

The exhibition was well attended, and it is to be hoped that further opportunities will be given to microscopists to display the versatility of their noble instrument.

K. M. Greenland

PROBLEMS OF THE LEFT-HANDED

STUDIES have been made of the probable 'handedness' of prehistoric man by investigating the various relics of his tools and weapons. It appears from the way they are carved that prehistoric man was preponderantly right-handed. The choice of one hand, usually the right but occasionally the left, and not either hand indiscriminately, is characteristic of man. It would seem that ambidexterity is an animal rather than a human characteristic. These and related problems have recently been discussed by M. M. Clark (*Health Education*, 9, No. 3; July 1951).

Clark suggests there is no adequate explanation why man should choose one hand and become proficient with it, while his animal ancestors usually used both. Nor can any adequate reason be put forward to explain men's preference for the right hand; and although to be left-handed in a right-handed society has numerous disadvantages, in spite of attempts to stamp it out in Britain, Greece, the United States and France, approximately 4–6 per cent of the population are still left-handed. Why should this be?

Left-handedness appears to be inherited; how is not known. In certain families there seems to be a high incidence of left-handedness. Some investigators have found that such families also have more than the usual number of twins, so that there might be some connexion between twinning and left-handedness.

That more males than females are left-handed seems to be agreed by investigators and raises the interesting question of whether this is the original distribution, or whether it is a result of the pressure of society. Are more boys than girls born with a tendency to left-handedness, or is it that, while girls are more willing to bow to convention, boys are more inclined to be independent, or stubborn? It would be revealing to carry out a detailed study of the personality traits of left-handed writers, and compare the results with the personality traits of those who were naturally left-handed, or had a tendency to left-handedness, but did not hold out against the pressure of society. Many difficulties lie in the path of such an investigation, most important of all being the difficulty of finding a reliable test which will measure native handedness. Existing tests do not enable us to distinguish truly right-handed people from those who are naturally left but for some reason use their right. There must be a considerable number of such cases.

The majority of infants prefer one hand to the other, if not at once, then within a few months after birth. It is clear that in a right-handed society the right will be preferred rather than the left. Thus, if a child is born slightly left-handed, the chances are that he will become right-handed. Imitation, training and the right-handed nature of everyday objects are all inducements to his adoption of the right hand.

An ambidextrous child, or rather one who has no preference for either hand, will quickly appear to be right-handed for similar reasons. These are children who could have been good with either hand. If everyone else had used the left, they, too, would probably have done so, and been equally successful.

There is another group which has been given little consideration until recently. Rather than ambidextrous, they might be described as 'ambisinistrous' or poor with either hand. They, too, will veer to right-handedness.

Thus, the left-handed writer will be only the extreme case of left-handedness.

The study of 'eyedness' has developed as an outgrowth of the study of handedness. Preference for one eye is not evident to the casual observer; but the majority of people are right-eyed, and the minority left-eyed, though there are far more people left-eyed than are left-handed.

To-day it is believed there is no connexion between eyed preference and handedness, though some believe that it is better to be right-eyed and right-handed or left-eyed and left-handed than of crossed dominance.

The preferential use of one foot is evident in leisure occupations involving kicking, hopping and the like. There is a trend similar to that in handedness, the majority being right-footed, and a small minority left-footed.

Various tests have been used in studies of handedness, and these seem to fall into five classes. These are tests for speed, which are devised to measure the relative speeds of the two hands; accuracy, where a measure is made of which hand is the more accurate in its movements during a controlled test situation; strength, in which early investigators used a dynamometer or some similar measure and compared the strength of the two hands; preference, which involves the finding of the "preferred" hand. A satisfactory method of deciding handedness preference is to decide on a limited number of important activities where one hand is used in preference to the other. The next stage is to devise tests whereby this preference can be measured. Preferably, this should be done without the subject realizing what is actually being tested, or results may be distorted. For example, one may wish to discover which hand a person uses in throwing. A question may not produce the true answer, especially with children. Alternatively, the investigator could say, "Take this ball and throw it. I want to see which hand you use". The danger here is that the child may choose one or other to oblige, or because he suspects that the investigator would like him to use it though it may not be the one he usually uses.

The third method is to say, perhaps: "Here are three balls. I want to see if you can throw them all into that basket". Here the investigator notes which hand is chosen.

The fifth type of test for handedness was devised about 1930 by Van Riper in the United States, who decided that an adequate test should fulfil certain requirements: it should show striking differences, and little overlapping; have a high degree of reliability; avoid so far as possible the skills susceptible to previous environmental training and show degrees of laterality if these exist.

His original test involved drawing a pattern with both hands at the same time on opposite sides of a vertical board.

The Van Riper 'laterality board' is an elaboration of that idea. The principle of the method is that, if a person is asked to draw a design with both hands at the same time, and is not allowed to watch what he is drawing, then one or other of the hands finds the task impossible and draws a mirror image of the design. This is the non-dominant hand.

This test appears to be able to pick out those who are natively left-handed, even if they have been forced to use their right. It is extensively used in America, and several clinics in Glasgow also possess the apparatus. An interesting development made possible by this test was the discovery of a group who might be termed equipoised. Though they use their right hand, it has not achieved a definite dominant lead over the other. This group may have considerable educational difficulties.

Much discussion has taken place about the connexion between speech and handedness, and more especially between "changed" handedness and stuttering. Discussion usually centres on whether or not a left-handed child should be forced to use his right hand and the possible dangers resulting from such action. It appears doubtful whether the mere fact of changing from use of the left to use of the right hand will, in itself, be sufficient to cause stuttering. The danger seems to arise from the methods adopted in bringing about the change, and the emotional stress which usually results. The old-fashioned method of tying the left hand out of reach or of hitting it every time the child attempts to use it—a method still in vogue to-day—is extremely dangerous.

It appears that a tendency towards stuttering may be present in certain families; but, provided there is little emotional stress, the child may never stutter. In some children it would not affect their speech to change their handedness, whereas with those nearer the borderline of stuttering, the emotional stress might be sufficient to begin stuttering.

Certain periods appear to be critical with regard to speech development, and attempts to change handedness at these ages may have adverse effects on speech. It would seem desirable for the child to develop dominant handedness as early as possible, and anything which delays that is bad. Where children are late in speaking, it has been found that they have not developed dominant handedness. In such cases both Orton and Travis, two Americans who have studied the problem, advocate training handedness as an important factor in assisting speech development. Speech and handedness appear to be closely connected.

The educational implications of left-handedness are considerable, and statements have been made that left-handed children are inferior in all types of ability. It is certain that many difficulties confront the left-handed children, including the mechanics of writing. Lack of expert tuition, or even guidance of any kind, means that a left-handed child merely copies with the left hand the motions of the other children, many of which should be reversed.

The direction of motion, with reference to the body axis, involved in writing is an awkward one for the left-handed child. The motion for the right-handed child is away from the body, while it is in towards the body for the left-handed one. Without suggesting the motion, if a left-handed child is asked to rule a line he will almost invariably rule from right to left, revealing his natural directional movement.

A comfortable position for pencil or pen, in preparation for writing, is easy to acquire with the right hand; this is not so for the left unless one writes from right to left.

One has to be left-handed to realize the difficulties which face a sinistral in writing in ink—especially with a plain pen. The inkwell is on the wrong side of the desk and, when writing, a left-handed child has to draw his hand across what he has already written. The sharp-pointed nibs commonly used in schools are quite unsuitable for left-handed children, who push a pen where a right-handed child would pull, and are therefore inclined to make holes in the paper. Yet, although 4 per cent of the population is left-handed, little attempt is made to help them with writing.