about the eleventh year. The differences are so wide as to seem random, but after our experience with first impressions of "the Berger rhythm" we must hesitate to conclude that they are meaningless. About the brain it would be better to assume that nothing means nothing. Some of the records of children being made today will be interesting reading when examined in connexion with the adult achievements of those children. Meanwhile there is much to be learnt today from the variations of mature alpha rhythms.

Meaning began to emerge from what had seemed random differences of personal rhythms as soon as a sufficient number of records had been taken to show that there is a natural grouping of differentiated responses to the normal blocking by mental effort. It has already been mentioned as one of the earliest observations of EEG, that in most people the alpha rhythms, prominent when the eyes are shut and the mind is at rest, disappear whenever the eyes are opened or when the subject makes a mental effort—for example, while doing a sum in mental arithmetic. Exceptions had of course been noticed; entire absence of rhythms in some cases. But it was only in the course of war services at the Burden Neurological Institute that we were able to designate some of these exceptions as a stable group with definite characteristics. It was shown in 1943 that individuals with persistent alpha rhythms which are hard to block with mental effort, tend to auditory, kinaesthetic or tactile perceptions rather than visual imagery. In this group of persons the alpha rhythms continue even when the eyes are open and the mind is active or alert.

The group with persistent activity is known as P for short, while the larger group, whose alpha rhythms are responsive,

are known as R. A third group was further definable as those people in whose EEG's no significant alpha rhythms are found, even when taken with the eyes shut and the mind idle. This group is known as M, for minus, and consists of persons whose thinking processes are conducted almost entirely in terms of visual imagery. (See Figure 18.)

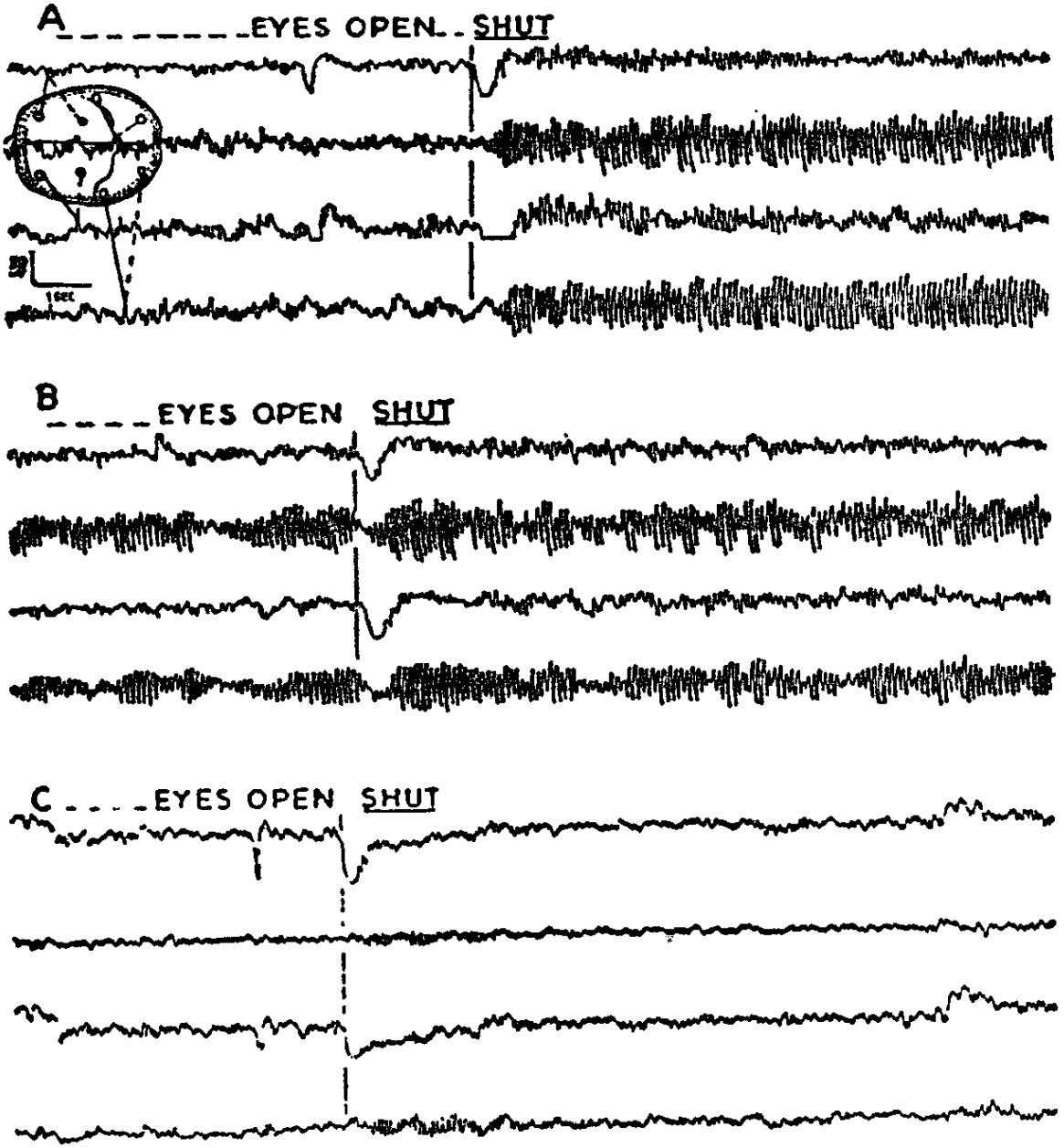

Figure 18. ". . . a discrepancy in their ways of thinking." Alpha Personality Records. (a) R type. (b) P type. (c) M type.

Several surveys have been made to find out how these types are distributed in the population; groups comprising more than 600 persons have been studied for this purpose. The proportions vary a good deal according to occupation, but, in general, about two-thirds of an ordinary normal group of people selected at random are found to be of the R type, and the remaining third are about evenly M and P. The proportion of M types is usually rather higher in science students than in arts students.

Here is a simple test by which you may be able to tell to which group you or your friends belong:

> Shut your eyes. Think of a wooden cube like a child's block. It is painted. Now imagine that you cut it in halves across one side, then cut these halves in halves, and then cut them a third time at right angles. Now, think of the little cubes you have made. How many of their sides will be unpainted?
>
> Did you work it out or did you "see" it? Then what else did you see? What colour was the cube? Did you see the sawdust falling as you cut it?

Note particularly the question about colour. Quite often, when you have put the test to someone precisely as above, the reply will be red or green or whatnot; and if you then ask, why red or green or whatever the colour mentioned, you will very likely be told that you had said it was that colour! If the picture visualised had such details as this, more details than are really necessary, the subject may be one of the M type, a visualist with few if any alpha rhythms; if he saw no picture at all, he is likely to be a non-visualist with persistent alpha activity, a P type. If he had a picture that was just clear enough for the purpose but no more, he is probably a mixed type, mostly R, with a responsive alpha rhythm.

When a solution or decision of any kind can be reached by visualising it, the performance of the M type of people is rapid and precise; but when they are faced with a problem of an abstract kind, or one in which the mental pictures required are too elaborate for them, they become sluggish and confused. On the other hand, at the other extreme, the small P group, people whose alpha rhythms persist even with the eyes open and doing a sum, do not use visual images in their thinking unless they are obliged to do so. Even then, their mind's eye is almost blind; they think in abstract terms, or in sounds or movements; they may even have to "feel" their way out of an imaginary maze. The R group, the responsives, whose alpha rhythms disappear when they do a sum or open their eyes, are intermediate between the other two groups; while they do not habitually use private pictures for their everyday thinking, they can evoke satisfactory visual patterns when necessary. Moreover, they can combine data from the various sense organs more readily than can either the M or P types. So even if you did the cube test just now by visualisation, it is possible you belong to the more adaptable and versatile R group. The test of the cubes is valid as far as it goes, but only a recording and analysis of your EEG could give you your standing in your class.

There is still a great deal to be learnt about these groups. For instance, the origin of the differences between them. When and how does the differentiation become so clearly defined? Why are the alpha rhythms so persistent when they first appear in childhood? We must be cautious about jumping to any such conclusion as that children only learn later to think in visual terms, although this is suggested by the extreme rarity of M type children. If, as seems likely, imagina-

tive thinking becomes habitual at about the age when alpha rhythms appear, the startling differences between children, and the critical influence of age on the effects of deprivation, may find an explanation in the tardy and variable development of these physiological mechanisms, which in the adult provide the consolation in exile so conspicuously lacking in the very young. We have not yet had time to follow the development of a large enough population from birth to maturity to discover how soon and how permanently these differences are established.

Evidence already available, however, both statistical and experimental, strongly suggests that the alpha rhythm characters are inborn and probably hereditary. We are also beginning to get some notion of the distribution of rhythm characteristics in the population. Alpha rhythms vary in frequency, as we have seen, from 8 to 13 cycles per second. The distribution of these frequencies in the population seems to be as normal as the variations of stature; so that, like stature, it may well depend on many factors, some hereditary and some environmental. But the way the alpha rhythms respond to mental effort, and the consequent grouping which has been described, is less straightforward in its distribution. It may be more like eye-colour or blood-group in its dependence on heredity—complicated, however, by the effects of individual experience and impressions.

Differentiation by experience can be most clearly traced in the case of identical twins. The resemblance between the alpha rhythms of uniovular twins is as close as that of their fingerprints; the resemblance of the unstimulated rhythms persists through the years. Differences soon begin to appear, however, in the details of their responses to stimulation. The

similarity of their brain mechanisms may continue to be as close as their physical resemblance when they mature, but their conditioning experience will not have been precisely alike. The differences of these imposed patterns show not in the records of their resting rhythms but in those of their responses to stimulation. They may still seem identical to casual acquaintances, as much alike as ever in form and feature; but the experimental responses of their EEG's will indicate slight differences of character which possibly only their intimates will have noticed. When we find such evidence in our records, we seem to be justified in saying that we not only detect but are also able to measure acquired differences of personality.

An appreciation of theta activity has various applications and possible uses. In what way could this information about alpha rhythms be of service? There is no doubt that the different characters of the three personality groups—P, R, M—and the effects of their different ways of thinking are constantly intruding in our daily life. Everyone is familiar with the unaccountable nature of (other people's) family squabbles and perhaps even our own lovers' quarrels. Apart from arithmetical problems, in which nobody is much concerned about how they are done as long as the answer is correct, the three different ways of dealing with any question may, and often do, lead us far apart before we reach a common destination. Here is a simple example.

Supposing Peggy and Michael at breakfast receive an invitation to a party and have to decide whether they shall go to it; and supposing Peggy is an extreme P type and Michael an extreme M type. Michael will have a whole series of vivid pictures about it all in his mind; he will see them going to the

party, the party itself, the people they will meet, and so forth; and he will compare it all with alternative pictures of what they will be doing if they do not go, perhaps a vision of somebody awkwardly asking him the day after it why they weren't there. That is the way M types literally figure things out for themselves. He will come to his decision that way very quickly, and in discussing the pros and cons with Peggy he will try to make her figure it out that way, too. But Peggy, being a P type who does not use visual images in this quick and easy way, has a more abstract method of thought, and will be considering the advantages and disadvantages of going, balancing duty and other obligations against the pleasure of an outing, the convenience of going against the effort, the number of times "we've been there without asking them here," and so on. She will be irritated by Michael's efforts to make her see his pictures, while he will be equally annoyed by her attempts to make him appreciate her heartfelt abstractions. It is not that one of them is more self-centered than the other, though if the reader happens to be of either type he may already have decided that the other one is. Worse than any adjustable blinkers of that kind, their language, their mental accents, so to say, are incompatible. Through nothing but the differences of their ways of thinking, before they can come to agreement, things may get to such a pitch that neither will give the other credit for clarity, consistency or good taste.

Fortunately extreme types are rare; but when two people display unreasonable and irreconcilable differences of approach to a question, before concluding that this is due to innate antagonism or incompatibility of purpose, a discrepancy in their ways of thinking may be worth looking into.

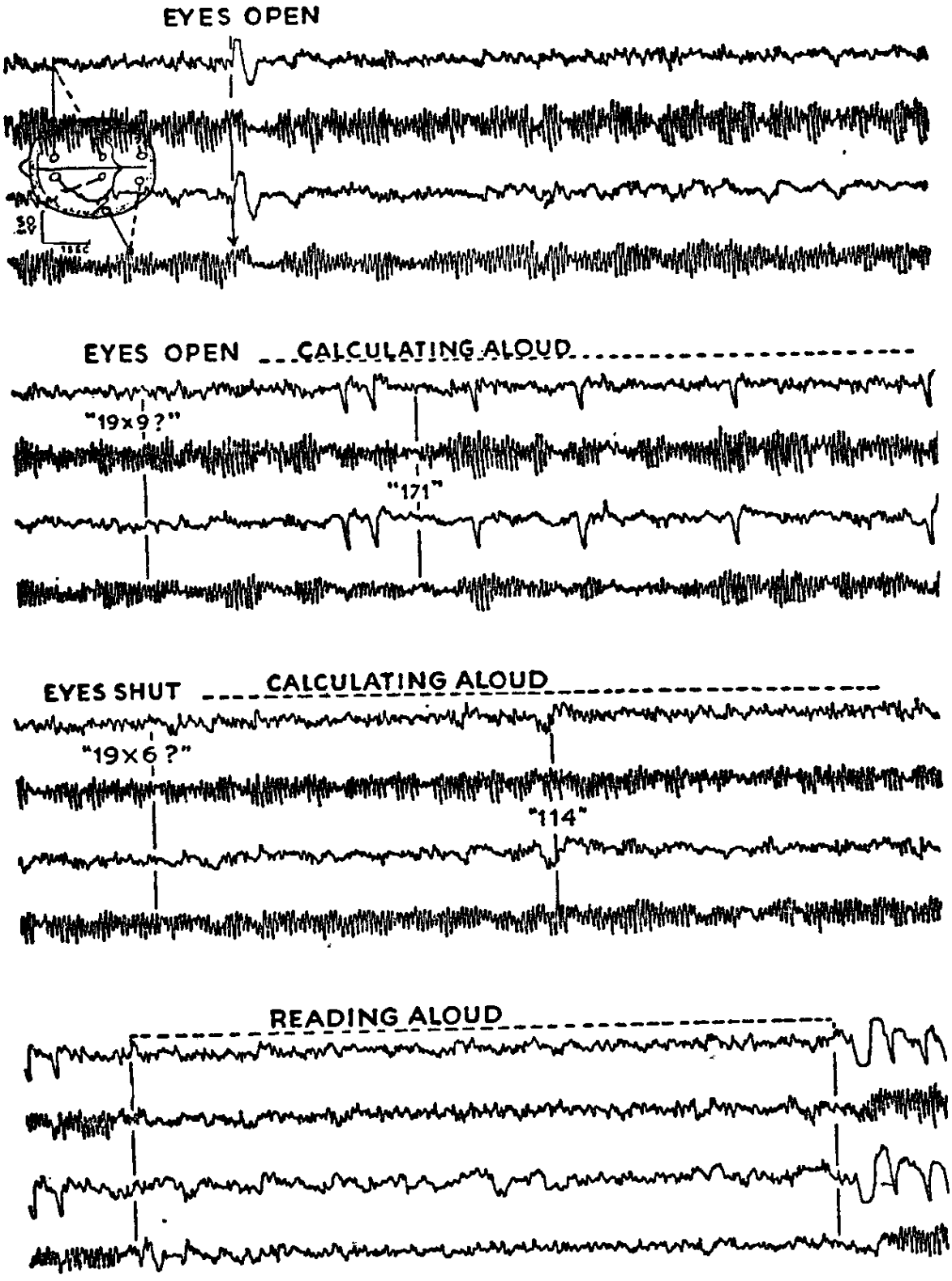

Figure 19. "Fortunately extreme types are rare." Record of Extreme P Type. So persistent were the alpha rhythms in this subject (Peggy in the fable) that the only way to stop them was to make her read aloud.

Communication between them, meanwhile, might be easier through an intermediary of the R type—who on occasion can use both ways of thinking. (See Figure 19.)

Suggestions for other applications of this knowledge about the mechanisms of the thinking brain will occur to the reader. One is obvious in these days of protracted international wrangling. How many negotiations may be frustrated simply by the fact that one of the negotiators is an extreme P type and the other an extreme M type! Like Peggy and Michael they want to agree and eventually may come to an agreement, but meanwhile the peace of the world is in jeopardy through mischance of alpha grouping, just as a man's life may be imperilled by a mistake in blood-groups. Academic examinations are designed to discover character as well as capacity, but these basic mechanisms of mental behaviour, the characteristic operations of a person's way of thinking, are masked by all manner of social and intellectual tricks. Competitive examination does not reveal them; it is not a question of one type being superior to another. Even the most extreme types are undesirable only, like matter, in the wrong place, in the wrong company. It might be well to index all politicians, and perhaps some day his alpha designation will be on the passport of every diplomat.

Occasionally disorders of thought are found associated with wildly exaggerated alpha characteristics, but mental illness is usually accompanied only by the most subtle and evanescent changes in the EEG. An alpha rhythm which persists when the eyes are open and the subject is apparently fully occupied—reading aloud for instance—is usually suggestive of some isolation from reality. In a few cases absurdly persistent alpha rhythms have been the first clear indication