

genealogical data with which to test the hypothesis that the inheritance is Y-linked.

A. A. ABBIE

Department of Anatomy,  
University of Adelaide, South Australia.

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## PSYCHOLOGY

### Human Dream Processes as Analogous to Computer Programme Clearance

RECENT experiments<sup>1</sup> have led to a renewed interest in the very long-standing problem of dreams. With perhaps the single exception of the contribution of the nineteenth-century psychoanalysts, dream theories have been based on negligible experimental evidence and have never been sufficiently rigorous or explicit to attract serious scientific interest. The work of Dement, however, demonstrates what appears to be a convincing behavioural measure of dream periods and, though criticized on several counts, has had an undoubted effect from the point of view of stimulating further experimental investigations and theoretical considerations. We have ourselves recently proposed elsewhere<sup>2</sup> that the dream process might be likened in function to the systematic programme clearance which is absolutely necessary where computer programmes are being continuously evolved to meet changing circumstances. The greater the change in circumstances being programmed for, the greater must be the amount of programme evolution and the more urgent the programme clear-out. In our view, the primary function of sleep is probably to allow such a clearing process to get under way without interference from external information; 'dreams' occur when the level of consciousness shifts for one reason or another and the clearing process is interrupted. Prolonged deprivation of the opportunity to dream would inevitably produce a breakdown in human efficiency, most probably in the region where novel situations must be handled. More recently yet, Kales *et al.*<sup>3</sup> have attempted an experimental reappraisal of Dement's original findings; but, while depriving subjects of the opportunity to dream for a number of nights, they did not notice any significant deterioration in their performance in certain psychometric investigations. In substance they agree that dream-prevention leads to increased attempts on the part of subjects to dream, but noted no 'psychic changes' as the result of this deprivation. However, the apparent discrepancy between the results of Kales and those of Dement is not, we believe, serious for present theoretical interpretations of the dream-deprivation investigations, for a number of reasons which we shall consider here.

Perhaps the most important factor which needs to be considered is our proposition that the dream clearance is, in fact, an examination of novel material collected by the system in the course of the day. Thus, the degree of disorganization caused by interrupting dreaming will be a function of the amount of new material "added to the existing programmes" in the course of recent experience. As Lilly<sup>4</sup> has pointed out, when individuals are subjected to quite abnormally constant environments (for example, in a space-capsule orbiting the Earth), the required period of sleep appears to fall off dramatically and may be reduced to as little as 2 h. If we have interpreted their account correctly, Kales *et al.* have, in fact, provided a very restricted environment to their two subjects, allowing them to be generally idle in the course of the day and confining them (for purposes of observation) to a single room. Thus, inadvertently, they seem to have weighted

their experimental conditions against the possibility of there being severe psychic effects.

The second point which needs to be considered has, we believe, not been raised in any of the previous work. The view stated here, based on the early experiments, is that patterns of eye movements give a reasonably behavioural indication that an individual is dreaming when they occur. This is suggested by the fact that subjects awakened during such periods of activity report that they have been dreaming. The not unreasonable (or 'safe') assumption is that dreaming does not occur when eye movements are not present, for no dreams are reported under these conditions. We suggest, however, that the rapid eye movements which Dement *et al.* report may be indicative only of a particular type of dream, that is, one involving oculomotor accompaniment and containing marked visual imagery. Such dreams, we propose, would be easy to 'recall' or 'verbalize' when the sleeper is interrupted, and since the greatest proportion of novel information is absorbed through the visual system we might therefore consider them to be among the most important. However, the presence of 'non-visual' dreams not accompanied by eye movements would seem to be required. These would include 'dreams' involving auditory and proprioceptive information, and often with much sub-verbal emotional overtones. Thus, through our programme clearance we can imagine a set of circumstances in which interruption of rapid eye movements alone would not produce major psychic disorders—unless the interruption was prolonged excessively. A third comment, a criticism which cannot unfortunately be verified or, for that matter, answered, would relate to the obvious difficulties of ensuring that subjects did not take 'cat naps' here and there, or indulge in some really intensive 'day-dreaming'. Were subjects, for example, watched unremittingly at all times of the day: Kales's own finding that visual dreaming was reported as rapid and extremely vivid in some cases would itself suggest that in 'emergency' situations some very rapid programme clearance will be undertaken by the system at the first opportunity.

We suggest, therefore, that before the crucial nature of the function of dreams can be satisfactorily uncovered, it will be necessary to test the programme clearance hypothesis more stringently. We do not know for certain how many nights' dream deprivation will produce the kind of massive breakdown which we predict; in the appropriate circumstances it might be as little as three, perhaps more than seven. Whatever the time-interval, it will certainly be important that the individual is not given a kind of holiday in his waking hours, but subjected to a good deal of experience of novel information of biological significance; experience, in fact, that would have required modification of their normal programme.

The new view of dreaming which Dement's important work and our own interpretation of his findings have allowed may yet be of more than academic interest. The implications for the treatment of psychiatric disorders could be appreciable, though the extended Russian experiments in sleep therapy seem to run against this point. The nature of sleep induction is probably vital; it is well known that barbiturates, while provoking a very heavy sleep, do not always produce a refreshing one. Probably the 'level' to allow dreaming *qua* programme clearance to operate most effectively is critical. Too deep a sleep (that is, barbiturate induced) may inhibit dreaming greatly; too shallow a sleep (as in feverish states) produces the familiar symptoms of restless, repetitive scanning of trivia.

E. A. NEWMAN  
C. R. EVANS

Autonomics Division,  
National Physical Laboratory, Teddington, Middlesex.

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