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RECURRING THEMES AND IMAGES IN A SERIES OF CONSECUTIVE REM DREAMS[1]

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Summary.—A consecutive series of REM dreams were collected from one subject over a period of four nights and examined for recurring themes and images. Analysis suggested a nonrandom pattern of dreaming consistent with the proposition that the themes and images are held as elements in a limited capacity storage system from which they can be recycled. One such system can be described by means of a simple testable mathematical model. Some of the implications of this are discussed.

Since laboratory monitoring procedures made possible the study of nightly dream sequences, surprisingly few researchers have directed their attention to this area. Dement and Wolpert (1958) were the first to make the observation that the dreams of a single night are related. They advanced two broad classes of explanation to account for this. (a) The interruptions to ongoing dreams required by the REM monitoring procedure led to an unnatural continuity by forcing each dream in a series to carry on from where its predecessor left off. (b) The continuities observed are reflections of the natural pattern of dreaming.

Offrenkrantz and Rechtschaffen (1963) in a further study noted the similarities in the events from night to night and suggested the presence of a cyclical relationship as a general characteristic of sequential dreams. The presence of similarities across nights does much to discount the artifact hypothesis (mentioned above) but the preoccupation with collecting nightly dream sequences primarily for purposes of interpretation has meant that the implications which such continuities between dreams may have for a model of dream formation have not been seriously considered. Given the period of time when these experiments were performed, this is perhaps not surprising but it is somewhat disappointing that this work has not been followed up. Kramer, Hlasny, Jacobs, and Roth (1976) collected dreams from college students over 20 consecutive nights as part of a larger study and were of the opinion that the question of whether there was order amongst the dreams of a given night was 'a point worth pursuing.' They were content to conclude, however, only that dreams evidenced nonrandom processes. Their failure to show that the dreams of a single night are related in a linear fashion leaves open the possibility what cyclical associations may be. The present study

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aims, using a single-subject design, to pursue the question of whether dream sequences exhibit cyclical relationships via an examination of those themes and images which occur on more than one occasion during the course of a series of dreams. The question of how such repetition (if it occurs) can be explained from the perspective of modern cognitive psychology is addressed.

METHOD

One subject only, a 19-yr.-old male undergraduate student who volunteered to take part, participated. An SLE 10-channel electroencephalograph was used for sleep monitoring. Standard electrode placements as indicated by Rechtschaffen and Kales (1971) were used. The subject spent five consecutive nights in the laboratory, sleeping undisturbed on the first night to become adapted to the laboratory environment. On each of the succeeding nights awakenings were made several minutes (on average 7 min., 40 sec.) into each period of REM sleep. Following the procedure specified by Foulkes (1962), the subject was questioned on the nature of any mental activity which had been occurring prior to being awakened. From 19 such awakenings over the four nights, a total of 18 dream reports (94 7%) were obtained. These reports were initially tape-recorded and subsequently transcribed. The experimenter and the subject later went through the transcribed reports together and noted the presence of any elements (images or themes) which were repeated.

RESULTS

Six elements were identified as present on more than one occasion in the series of dream reports. These were (a) motor vehicle, (b) television screen, (c) river/water, (d) presence of sinister atmosphere, (e) tree/garden, and (f) girl. The frequencies with which these appeared over the four nights are shown in Table 1. Analysis of variance indicated no significant difference between nights ($F_{3,15}$ = 1.18) or elements ($F_{5,15}$ = 0.71)

TABLE 1
FREQUENCIES OF RECURRING ELEMENTS AND THEIR POSITIONS IN DREAM SERIES

Element	Night 1	Night 2	Night 3	Night 4	Σ
a. Motor Vehicle	ooxox	xxoo	oooxo	ooxx	7
b. TV Screen	oxooo	oxoo	ooxoo	ooxo	4
c. River/Water	xxooo	oxoo	ooxoo	oooo	4
d. Sinister Atmosphere	xxxoo	xooo	oxxoo	oooo	6
e. Tree/Garden	ooxxo	oooo	xoooo	ooox	4
f. Girl	ooxoo	ooxo	xxooo	ooxo	5
Dream No.	12345	1234	12345	1234	
f	11	6	8	4	

Note.—x and o denote presence or absence of element.

There are two main questions to be answered concerning this series. (i) Does the above series provide any evidence of a pattern in the nature of the dreaming process? (ii) If the answer to the above is in the affirmative, how might this best be explained?

Two sources of evidence point to a pattern being present. First of all, elements are present in clusters at levels which would be expected by chance, as illustrated in the following analysis.

In the dream series, elements occurred either singly or in groups of two, three, and four. It is a simple matter to calculate the probabilities of any particular combination of elements within any of these groups. From Table 1, the dreams of the series can be coded in the form dream 1 = cd, 2 = bcd, 3 = adef, etc., as recurring elements appear.

Given N different objects (here $N = 6$ elements) one can find the number of combinations of R objects by the formula:

$$^{N}C_{R} = \frac{N!}{(N - R)\,!R!} \qquad [1]$$

For $R = 1$ the number of combinations is 6, for $R = 2$ it is 15, for $R = 3$ this value is 20, and for $R = 4$ there are 15 combinations. The observed combinations of elements within each group appear in Table 2. The probability of obtaining at least the observed frequency (f) of the most commonly occurring combination can now be calculated using the binomial theorem (Siegel, 1956).

TABLE 2
OBSERVED COMBINATIONS OF ELEMENTS

	No. of Elements Appearing Together				No.
	1	2	3	4	
Elements Observed in Each Group	a	ad	bcd	aedf	
	a	cd	abc		
	e	ef	bcd		
	f	fd	abf		
		ae			385

$$\sum_{i=0}^{F} {}^{N}C_{I} \times P^{I} \times Q^{C - R} \qquad [2]$$

where N = frequency of most common combination, I = group, P = 1(number of combinations), and $Q = (1 - P)$. There are only two groups of obvious interest here. These are Group 1 in which the element a appears twice, and Group 3 in which the elements *bcd* occur in combination twice. The probabilities of obtaining a frequency equal to or greater than these amounts are for Group 1, $F = 2$ ($p = .13$) and for Group 3, $F = 2$ ($p = .01$). This indicates that the combination *bcd* occurring twice in the series given the number of three-element combinations is unlikely to have happened by chance. One may hypothesise that their appearance together results from the action of a nonrandom process. A plausible reason for these elements occurring so frequently may well lie in their symbolic referents. Further consideration of this is, however, outside the scope of the current paper.

The second reason for attributing patterning is that from close inspection of the data presented in Table 1, it can be seen that the last recurring element to appear in the dreams of one night is always in the first dream of the next night in which recurring elements appear, even if several dreams have intervened inbetween without recurring elements being present.

TABLE 3

RELATIONS BETWEEN RECURRING ELEMENTS ACROSS NIGHTS

	Nights		
	1 to 2	2 to 3	3 to 4
Last Recurring Elements	a(5)	f(8)	a(13)
First Recurring Elements	ad(6)	fe(10)	aef(17)

Note.—Numbers in parenthesis refer to the number of the dream in the series in which the element or element group appeared.

The probability of this occurring across each of the three nights can be calculated *post hoc*. From Nights 1 to 2 this probability is 1/3 (two out of the six elements appear on Night 2). For Nights 2 to 3 it is also 1/3 and for Nights 3 to 4 it is 1/2. The probability of this occurring on all of the three nights is therefore $1/3 \times 1/3 \times 1/2$ ($p = .06$). Taken together these two sources seem reasonable grounds for concluding that the data exhibit nonrandom patterning. One could argue that this is an artifact of the monitoring procedure. However, several grounds exist for doubting this. (a) On only one occasion do all of the recurring elements present in one dream appear in the dream succeeding it. (b) On only one of the three successive nights (see Table 3) does the next recurring element actually appear in the very next dream. If the laboratory monitoring procedure is producing unnatural continuity by forcing the dreamer to carry on from where the last dream stopped, one would surely expect the occurrence in the first available dream. Between Nights 2 and 3, one dream with no recurring elements intervened, whilst between Nights 3 and 4 three such dreams intervened. So, in 4 of the 18 (22%) dream reports collected, no recurring elements whatsoever appeared. (c) The widely separate interval between the initial appearance of the combination *bcd* in Dream 2 and its reappearance in Dream 12 likewise is not consistent with the view that the monitoring procedure is inducing artificial continuity between successive dreams.

DISCUSSION: PART ONE

The evidence thus far suggests a nonrandom process underlies the appearance and pattern of appearance of recurring dream elements. Accordingly, what must be explained is the transition between the contents of successive dreams in the series. The reappearance of recurring elements across nights is consistent with their being recycled in some as yet unknown manner. If the relation between successive dreams can also be shown to arise via the recycling of previous dreams' contents, then much greater confidence can be given to this idea as a plausible candidate for explaining what is really going on. Below a formal model using the mathematical theory of sets is elaborated, based upon this very notion. This proposed application of set theory is coherent, testable, and provides a parsimonious approach to the problem.

A Set Theory Model of Recurring Dream Elements

The contents of any dream can be described as $n(R)$ + $n(Un)$ where R is the class of recurring elements, Un the class of elements unique to one dream only, and n the number of elements of each class present in the dream. In concentrating on recurring dream elements, the series of dreams can be designated as the series of sets $R_1 + R_2 + R_3 \ldots R_{18}$.

The problem of explaining this series can be approached from the perspective of the operations required to transform set R_n into set R_{n+1}. This can be done as follows:

For each dream

1. Let $M_n = R_n$ (the contents of the manifest dream).
2. Let S_n = the set of remaining recurring elements in the series.
3. Let $C1_n$ be the subset of M_n to be deleted between M_n and M_{n+1}.
4. Let $C2_n$ be the subset of S_n to be added to M_n.

In fact, $C1_n$ and $C2_n$ can be precisely defined in retrospect as:

$$C1_n = (M_{n+1} \cap S_n) \qquad [3]$$

$$C2_n = (S_{n+1} \cap M_n) \qquad [4]$$

Therefore at the beginning of the series (n = 1), $M_n = \{c,d\}$ and $S_n = \{a,b,e,f\}$. We can now envisage the transition between any two dreams in the series M_n to M_{n+1} as involving the transfer of items into and out of Set S. Between Dream 2 (b,c,d) and Dream 3 (a,d,e,f) for instance elements b and c are deleted from set M_2 ($C1_n = b,c$) and elements a, e, and f are added from set S_2 ($C2_n = a,e,f$). Each such transition between dreams can be seen as involving the following set theoretic operations.

TABLE 4
CONTENTS OF POSTULATED SETS AT DIFFERENT STAGES OF THE DREAM SERIES

Dream No.	M_n	S_n	$C1_n$	$C2_n$	I
1	cd	abef			
			/	b	1
2	bcd	aef			
			bc	aef	5
3	eadf	bc			
			adf	/	3
4	e	abcdf			
			e	a	2
5	a	bcdef			
			/	d	1
6	ad	bcef			
			d	bc	3
7	bca	def			
			bca	f	4
8	f	abcde			
			f	/	1
9	/	abcdef			
			/	e	1
10	fe	abcd			
			e	d	2
11	fd	abce			
			f	bc	3
12	bcd	aef			
			bcd	a	4
13	a	bcdef			
			a	/	1
14	/	abcdef			
			/	/	0
15	/	abcdef			
			/	/	0
16	/	abcdef			
			/	abf	3
17	abf	cde			
			bf	e	3
18	ae	bcdf			

$$M_n = M_n - C1_n \quad [5]$$

$$S_n = S_n + C1_n \quad [6]$$

$$M_{n+1} = M_n + C2_n \quad [7]$$

$$S_{n+1} = S_n - C2_n \quad [8]$$

The transformation $M_n \rightarrow M_{n+1}$ can thus be expressed as:

$$M_n - (M_{n+1} \cap S_n) + (S_{n+1} \cap M_n) = M_{n+1} \quad [9]$$

Additional points worth noting are:

A. That the sum of M_n and S_n are constant [10].

$$n(M_n) + n(S_n) = k \quad [10]$$

B. The total number of items (I) transferred to and from M_n is given by:

$$I = n(C1_n) + n(C2_n) \quad [11]$$

If we apply this to the actual dream series, we obtain entries in Table 4.

Given that once a dream series has been obtained and that the relations among recurring elements from dream to dream can be expressed in an orderly way, one is entitled to ask what this transition between sets constitutes in psychological terms.

First of all, it lends weight to Offenkrantz and Rechtschaffen's belief in a cyclical relationship between dream elements. In mathematical terms alone the recurring elements are being recycled between two sets, M and S. It is proposed that this process of transferring elements between sets is a mathematical analogue of the information-processing operations occurring between dreams. The possible psychological means of this is discussed below. However, if there is a psychological reality to this, then one might expect a relation with one or more variables associated with the subsequent dreams. To investigate this possibility the measure I (the number of items transferred between sets) was compared with the lengths (in words[3]) of the dream reports D. The comparable data are presented in Table 5.

It was decided to compare the natural logarithmic transformations of these data. There are two reasons for this. (a) As it stands the data violate homogeneity of variance ($F_{2,17} = 1961.00$). The log transformed data, however, do not ($F_{2,17} = 1.11$). (b) In the light of the report by Cohen (1980, p. 17) the relation between the log duration of REM sleep and the log duration of the preceding period of NREM sleep is reliable (as $\log_e x$ is not computable if $x = 0$, x was set to 0.01). The linear correlation performed on the log transformed data was statistically significant ($R_{I,D} = 0.586$, $.01 < p < .02$). There seem to be reasonable grounds for believing these set

[3]The lengths of the dream reports were counted in terms of the number of words in the report. Comments were excluded which were (i) repetitions, (ii) which contrasted or associated elements from the dream with those in real life, and (iii) which were exclusionary (saying what something was not). See Winget and Kramer (1979, p. 15).

TABLE 5
COMPARISON OF LENGTH OF DREAM REPORT WITH NUMBERS OF ITEMS TRANSFERRED BETWEEN SETS

Dream	Items Transferred (I)	Report Length (D)
2	1	93
3	5	202
4	3	89
5	2	68
6	1	57
7	3	101
8	4	102
9	1	173
10	1	43
11	2	153
12	3	177
13	4	57
14	1	64
15	0	49
16	0	37
17	3	268
18	3	111
M	2.2	108.7

theoretic operations describe a recycling process which does comprise one aspect of dream production.

DISCUSSION: PART TWO

Here we focus on three principal issues arising from this experiment. (a) Is the model testable? (b) To what does the mathematical consistency of this model actually refer? (c) How do these operations relate to other levels of processing assumed to be involved in dream production?

Testability.—The question of what it means to model the behaviour of a system mathematically has been raised in other quarters, notably in connection with Thom's catastrophe theory (Saunders, 1980; Woodcock & Davis, 1980). Models of this type do not usually enable quantitative predictions to be made, and this is true in the present case. The nature of the relations between the sets of elements, exact though they are, is not predictive. However, the relations exhibit some order. Hitherto such order has not been clearly modelled in dream psychology. In fact, it has long been doubted whether dreams even exhibit order. The question of the testability of the model relates more to the psychological models which can be constructed on the basis of the mathematics. In this sense the model very readily permits refutation. In obtaining any dream series one merely needs to calculate the numerical value for I between each pair of successive dreams and then correlate these values with empirically obtained data from REM dream reports.

Psychological reality.—The presence of statistically significant correlations between aspects of the model and empirically specified variables derived from dreaming suggests that the relationships implicit in these set theoretic formulations have some correspondence with those occurring in real psychological processes. The titles of the sets were in fact chosen with this possibility in mind. (a) Set M refers to the recurring contents of the manifest dream. (b) Set S functions in the model as storage for future elements. It is almost inevitable that this should lead to the proposal that it represents a human memory store. Moreover the relationship embodied in Equation [10], $n(M_n + n(S_n) = k$, could refer to the maximum capacity of this store. The psychological proposal is that recurring dream elements have been recycled from a limited capacity store. (c) Sets $C1$ and $C2$ function in the model to transport elements between the storage set and the manifest dream set. These could represent a pathway or channel between the two or perhaps a buffer.

As it stands the detailed mechanics of how this model would function have not been spelt out. How, for instance, are the elements transferred between sets? In information-processing terms this could occur in a serial or parallel manner. The author has in fact constructed a computational model of this process with the addition of several features. This assumes processing is linear and sequential. Items are transferred between sets one at a time rather than all at once. This leads to correlations between the computational process and the dream report data of a magnitude comparable to that obtained with the mathematical model. Further details are described by Roberts (1986).

Levels of processing.—The model presented here sounds like a rather mechanical affair. However, it is obvious from these data that psychological factors must play a part in (i) the selection of the set of elements in this particular series and (ii) the moment at which they make their reappearance. Nevertheless, this argument is not valid against the utility of such a model. Where complex phenomena, such as dreaming, are considered, many interlocking levels of explanation may well be required. This is essentially the position adopted by Foulkes (1978, 1982b). The contents of dreams are amenable both to an analysis in which they are treated as purely formal abstract elements, as is the case here and to a '*psychoanalysis*' in which their meaning and style is of paramount interest.

Addendum

One could raise a number of objections against the present conclusions. First, it might be said that a sample of one is too small a base from which to make any valid generalisations applicable to the population. There are several grounds on which one could challenge this objection.

(i) The nature of the mathematics involved has produced a formalism that *a priori* describes and is applicable to any series of elements drawn from a limited pool and produced in various combinations over a series. In this case the series refers to recurring dream elements. Of course, the psychological model derived does not enjoy the same protection from this argument. It does, however, enjoy the benefit of having statistically significant relations in its favour. This is as has been noted, easily open to experimental verification or refutation in any subsequent study.

(ii) The history of psychology is replete with examples in which quite valid theoretical frameworks have been elaborated on the basis of a single subject. Ebbinghaus' famous work on memory is one such instance. The general acceptance of the framework as a useful one must, of course, come from work with other subjects. The chief point which the author would stress in defense of this approach is that to make progress in dream theory methods of this sort (i.e., single subject) may need to be explored. Foulkes (1982a, p. 270) makes a similar point in arguing that "the traditional group-sampling methods of experimental psychology may simply be scientifically inappropriate in any serious attempt at understanding dreams."

(iii) The data in the present model derive from REM dreams. Fontana (1985) comments that such a model would need to make reference to how mentation in NREM sleep affects matters. This is a valid point. One has to accept that by sampling only REM dreams one is missing potentially valuable data. However, REM sampling has been shown to be the most favourable (from a statistical point of view) methodology for obtaining dream reports in number. Until a system is devised which involves sampling from both REM and NREM sleep during the same night and which yields higher report rates the problem will remain.

There are other issues concerning NREM mentation. It could well be the case that elements are reappearing in NREM dreams as well. The same process may be taking place throughout sleep but under different general conditions. The implication of the model however, is that it takes time to plan and produce dreams. Accordingly they will only arise periodically. Perhaps herein lies the reason for the association with REM sleep. Both are periodic phenomena contingent upon processes which though different in themselves proceed at similar rates.

(iv) The final question to be asked is whether the patterns in the data are artifactual, arising from the interruption to REM dreams, with each dream being forced to continue from where the previous one left off. Arguments have been presented against this possibility, but even should there be some truth in it, surely dreams do sometimes continue the work of earlier ones anyway and this needs explanation.

After this lengthy consideration of the recurrent contents of dreams, curiosity naturally arises as to how unique elements make their way into a dream. The author holds the view that the categorisation of unique dream images is not the simple task it might at first be thought. It does, of course, depend on the time span within which one wishes to study a dream series. The longer this is, the more accurate will be the classification of elements, assuming that much recycling of dream material takes place within a short period. Although repeated elements have been given a separate treatment, there are no grounds for thinking that they serve different functional needs to unique ones. All dream elements must begin as unique elements, and for this reason alone if for no other it seems reasonable to suppose that repeated elements are those which place greater processing demands upon the person. The repeated routines of waking life revolving around reproduction, friendships, vocations, food-gathering, etc., emphasise very important aspects of our lives. Why should this not also be the case with dreams?

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ERRATUM

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A small number of minor errors in the original manuscript require correction.

(a) The sentence at the end of the second paragraph on p. 769 should begin "First of all elements are present in clusters at levels which would not be expected by chance . . ."

(b) Beneath Equation [2] on p. 769 P should be given as P = 1/(number of combinations).

(c) In Table 3 on p. 770 the first recurring element group for Night 4 should read abf(17) and not aef(17).

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