CHAPTER 26

Feature Clustering and Prediction of Improvement in Nocturnal Enuresis

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Research has so far only inadequately addressed itself to the crucial question of whether certain kinds of treatment are more effective with certain kinds of enuretic. This paper describes a clinical trial, with a sample of bedwetters drawn from the general school population of Newcastle-upon-Tyne, which provided an opportunity to look into this question. The data were prepared in such a way as to allow predictive and cluster analyses. The latter statistical technique, though little used by clinicians, is, we believe, an important one. For the sake of simplicity, we have confined the main part of the paper to an outline account of the research design and the presentation and interpretation of the findings.

The treatment methods under consideration in this study were imipramine, ('Tofranil'), the 'buzzer' (bell-and-pad) and placebo. For the purposes of this statistical analysis, attention was concentrated on

(1) the child's status at the inception of the treatment programme;
(2) the child's status at termination of treatment (two months); and
(3) the child's status at follow-up (four months).

Research Design

Ninety-four enuretic children aged between eight and ten years were included in this intensive study. Each was allocated, using a random number technique, to one of the three treatment regimes: *viz.* imipramine (35 children), 'buzzer' (32 children) and placebo (27 children). An additional group was formed by taking the imipramine and 'buzzer' groups together.

The outcome of treatment was expressed in terms of a percentage improvement which was calculated using the following formula:

$$\frac{\text{Initial monthly frequency—final monthly frequency}}{\text{initial monthly frequency}} \times 100$$

Definitions of the independent variables used in Tables I and II are contained in the Appendix, page 274.

Features Predictive of Improvement

The prediction of improvement was considered in two ways; firstly by studying correlation coefficients and secondly by multiple regression analysis. The first is the simpler method, and involves calculating product moment correlations between the degree of improvement and each of the twenty features separately (see Table II).

The object of using multiple regression analysis is to isolate those features which are most predictive as *members of a group of features*. This second way of looking at prediction is more complex, in that it does not simply consider the correlations between the various individual features and improvement in bedwetting, but also takes account of the intercorrelations between these features. Thus, a feature might be quite highly correlated with improvement, but receive a low predictive weight in regression analysis because it is duplicated, that is, highly correlated with another feature also related to improvement.

It follows that conclusions drawn from the use of these two methods of considering prediction will not be identical or even necessarily similar. The simple correlational method considers each feature individually; the more complex regressional method considers the features as members of a group of features.

Rationale for Use of Techniques and Presentation of Data

We were more interested in measuring the relationships between improvement and various features than in simply finding out whether these relationships were statistically significant. Hence we calculated the correlation coefficients which appear in Table II rather than merely reporting levels of significance. We were particularly interested in showing the differences between the various features in respect of their relationship with improvement, and 't' tests and analyses of variance would not have been appropriate for this purpose. For example, as far as primary and secondary enuresis were concerned, we were able to compare these two forms in respect of improvement on imipramine treatment on the one hand and on 'buzzer' treatment on the other. The differences between primary and secondary enuretics in this respect were found to be significant and were accordingly more thoroughly investigated (see Table III).

A decision had to be made about whether it would be better to provide a table of standardised partial regression coefficients or to try to present the data in a more simplified diagrammatic form. In fact, we decided on the latter course, which it was felt would render the data more easily digestable for a wide audience (see Table IV). Analyses were carred out according to the standard multiple regression technique. (Details of these data are available on request from the authors.)

A transformation of the percentage improvement data to approximate a normal distribution was not carried out as the criterion was common to all the regression analyses which were undertaken, and, as these were fundamentally comparative, it made no difference to the conclusions.

Selection of Variables for Correlational and Regression Analysis

All the data were examined and those variables in which the spread was adequate were included in the initial correlational and multiple regression analyses. In the multiple regression analyses, outcome at completion of treatment (*i.e.* percentage improvement at the two-month stage) and at follow-up at the four-month stage were used as the dependent variables.

Three groups of variables were selected for further regression analysis, on the basis of three criteria: (a) having a significant partial regression coefficient on the initial

TABLE I

Independent variables for multiple regression analysis (for definitions see Appendix, page 274).

Twenty variable set	Fourteen variable set	Ten variable set
(1) Gender	Gender	Gender
(2) Three word phrases		
(3) Total number of siblings		
(4) Social class	Social class	Social class
(5) Father extrovert	Father extrovert	Father extrovert
(6) Mother extrovert	Mother extrovert	Mother extrovert
(7) Mother permissive		
(8) Family history of enuresis	Family history of enuresis	Family history of enuresis
(9) Bed sharing		
(10) Nocturnal restlessness	Nocturnal restlessness	Nocturnal restlessness
(11) Primary/secondary enuresis		
(12) Somatic complaints	Somatic complaints	Somatic complaints
(13) Mannerisms	Mannerisms	
(14) Attention span	Attention span	
(15) Obsessiveness	Obsessiveness	Obsessiveness
(16) Excitability	Excitability	Excitability
(17) Conscientiousness	Conscientiousness	Conscientiousness
(18) Vigorous/doubting		
(19) Child extrovert	Child extrovert	
(20) Initial level of wetting	Initial level of wetting	

regression analysis, (b) correlating significantly with the outcome of treatment ($p < 0.15$), or (c) being considered clinically important. Included amongst the variables selected because they were considered clinically important was the item of nocturnal restlessness; in the past it has been claimed that there is a relationship between profoundness of sleep and enuresis, and nocturnal restlessness was taken as a measure, albeit a crude one, of the profoundness of sleep.

The items included in the three regression sets are listed in Table I. The first set comprised a group of twenty variables, the second a group of fourteen variables which appeared more significantly related to outcome, and the third a group of ten key variables.

Ninety-four cases were included in an over-all regression analysis, using the twenty, fourteen and ten variable sets in the regression analysis. The analysis was then repeated for each individual treatment group (imipramine, 'buzzer' and placebo) and for the combined treatment group (*i.e.* the imipramine group plus the 'buzzer' group).

Correlation Between Percentage Improvement and Initial Frequency of Wetting

It will be seen from Table II that the correlations between percentage improvement and frequency of wetting before treatment are all negative. It might be thought that these correlations should be positive, since improvement was measured in terms of the 'initial' minus the 'final' frequency of wetting. But as we are concerned here

with *percentage* improvement, and initial frequency occurs again in the denominator of the formula given above, the correlations are negative rather than positive. The sign of the correlation is perhaps misleading, and is best ignored; this also applies to the sign of the relevant regression coefficients considered later (see Table IV).

Details of Cluster Analysis

As the children and their families had been comprehensively investigated, it seemed reasonable to use further measures to uncover complex associations between variables. It was decided to use the technique of cluster analysis rather than factor analysis. The method used was that of the *Elementary Linkage Analysis* of McQuitty (1957), which has been described by Philip and McCulloch (1966) as 'a rapid and objective method for clustering variables into types'. It is dependent on the highest level of association which any one variable has with any of the other variables.

As the families had been assessed on seventy-three variables, it seemed sensible to modify the linkage technique, and the following changes were made.

(1) Those variables on which more than 85 per cent of the patients were placed in any one scoring category were excluded. This left sixty-five variables for analysis.
(2) Where the correlation which was the largest index of association between two variables was not at a significant level, the link was not used. In practice, this entailed excluding all links with a correlational level below 0·2.
(3) If the largest level association occurred equally for a number of variables, then all of these links were used.
(4) All clusters without at least one link (correlation) above 0·3 were excluded.
(5) For the sake of brevity, closely related variables have been designated as sub-clusters.

In this way, six main clusters or groups of clusters were identified and have been labelled according to the highest correlational 'link' or 'keylink' within the cluster.

A further word of caution is necessary. Too much importance should not be attached to clusters in which relatively low correlations constitute the main link, in view of the number of cases on which the study was based. This applies especially to Cluster VI. Furthermore, other items within a sub-cluster do not necessarily relate significantly to a key item two or three links removed, especially if in another sub-cluster. For instance, in Cluster IV 'maternal introversion' has no correlations with the item 'quarrelling sibs'; and 'paternal introversion' in cluster V correlates 0·14 with 'improvement'. Of course, the higher the intra-cluster correlations, the higher the correlations, even between features several links apart; for instance, in cluster IV the correlation between 'absence of fears' and 'good attention span' is 0·26.

Findings

Correlation Coefficients

Imipramine Regime. Improvement at the end of treatment was significantly related to a higher initial frequency of bedwetting, earlier speech development, and an absence of somatic symptoms such as of headaches or abdominal pain. An absence of family history of enuresis proved almost significant.

TABLE II

Product moment correlation coefficients of selected variables with percentage improvement under different treatment regimes

Feature	Total data		Imipramine		Buzzer		Placebo		Imipramine + buzzer	
	2 months	4 months	2 months	4 months	2 months	4 months	2 months	4 months	2 months	4 months
1 Gender	0·06	0·09	-0·15	0·17	0·25	0·38*	0·23	-0·34	0·06	-0·29*
2 Early/late speaking of three word sentences	-0·09	-0·14	-0·38*	-0·12	0·23	-0·07	-0·04	-0·25	-0·11	-0·11
3 Total no. of sibs	0·07	-0·21*	-0·12	-0·25	0·07	-0·15	0·38*	-0·22	-0·03	-0·21
4 Social class	0·13	-0·14	0·18	-0·15	0·03	-0·13	0·18	-0·06	0·11	-0·17
5 Father introverted	0·14	0·01	0·21	-0·04	0·35*	0·22	-0·22	-0·16	0·28*	0·08
6 Mother introverted	0·11	0·16	0·31	0·20	0·03	-0·02	-0·04	0·35	0·18	0·09
7 Mother permissive	0·09	0·00	-0·05	0·04	0·22	0·03	-0·15	0·04	0·09	-0·02
8 Family history of enuresis	-0·23*	-0·20	-0·32	-0·25	-0·23	-0·09	-0·16	-0·21	-0·26*	-0·20
9 Bed sharing	0·12	-0·22*	0·07	-0·03	0·23	-0·19	0·23	-0·41*	-0·13	-0·14
10 Nocturnal restlessness	-0·09	0·01	-0·17	0·03	-0·30	-0·24	0·27	0·38	-0·22	-0·11
11 Primary/secondary enuresis	-0·09	-0·09	0·14	0·09	-0·41*	-0·33	0·01	-0·07	-0·12	-0·10
12 Somatic complaints	-0·21*	-0·16	-0·45*	-0·28	-0·13	-0·22	-0·02	0·07	-0·28	-0·26
13 Mannerisms	-0·13	-0·10	-0·28	-0·08	-0·02	-0·36	0·07	-0·07	-0·16	-0·18
14 Attention span	-0·16	-0·07	-0·23	0·06	-0·08	-0·14	-0·20	-0·12	-0·15	-0·04
15 Obsessiveness (CPQ)+	-0·13	-0·17	0·02	-0·26	-0·24	-0·19	-0·07	0·00	-0·10	-0·25
16 Phlegmatic/excitable (CPQ)+	0·23*	0·15	0·20	0·11	0·31	0·32	0·10	0·03	0·26*	0·19
17 Conscientious (CPQ)+	0·07	0·05	0·10	0·05	0·23	0·10	0·27	0·00	0·17	0·07
18 Vigorous/doubting	0·08	-0·01	0·06	-0·01	-0·08	0·13	-0·05	-0·13	-0·07	0·04
19 Introversion in child (CPQ)+	0·14	0·14	0·18	0·13	0·09	0·26	0·25	0·04	-0·13	0·04
20 Frequency of wetting prior to treatment	-0·20*	-0·29*	-0·35*	-0·31	0·01	-0·25	-0·31	-0·29	-0·18	-0·18
Total No. of Cases	94	84	35	30	32	28	27	26	67	58

*Significant at the p < 0·05 level.

+CPQ = feature deriving from the Catell Personality Questionnaire.

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'Buzzer' Regime. Improvement at the end of treatment or follow-up significantly correlated with the fact that the child was female, was a primary rather than a secondary enuretic and with introversion of the father. It was also associated, but not at a significant level, with a relative absence of nocturnal restlessness.

Placebo Regime. The significant correlations between the different variables and improvement on placebo treatment were not consistent, in that those found at the end of the treatment period differed markedly from those found at follow-up. They are therefore likely to be chance associations only (Table II).

Correlations Between Percentage Improvement At Two months and Four Months. These were as follows: total +0·48; placebo +0·51; 'buzzer' +0·55; imipramine +0·44. The lowest correlation is with imipramine. This provides some supportive evidence in favour of a 'rebound' phenomenon (Kolvin *et al.* 1972) after discontinuing imipramine.

Correlations in Inverse Directions with Different Treatment Regimes. The two features of early/late achievement of three word sentences and primary/secondary enuresis, have opposite and significantly different correlations with improvement at two months. The differences between the different treatment regimes as regards the three word sentences variable indicate that children who have been late speakers do better on 'buzzer', whereas earlier speakers do better with imipramine. The primary/ secondary enuresis difference suggests that the 'buzzer' is more effective with primary enuresis, but that imipramine is more effective when the enuresis is secondary. This is an important point, so this matter was investigated in more detail (Table III).

As can be seen from Table III, there was a trend for the primary enuretics to respond better to the 'buzzer' than to imipramine treatment, and the response of the primary enuretics to the 'buzzer' tended to be superior to that of the secondary enuretics, but the only significant finding was that the percentage of secondary enuretics improving 40 per cent or more on imipramine (*i.e.* nine out of nine, or 100 per cent) was significantly higher than the corresponding percentage on the 'buzzer' (two out of six, or 33 per cent). This conclusion is based upon Fisher's exact probability test (*c.f.* Siegel 1956), and thus is not invalidated by the small numbers involved. It may, be concluded, therefore, that imipramine is more effective with

TABLE III

Number of patients showing improvement at two months, according to whether they were primary or secondary enuretics

Percentage improvement	*PRIMARY ENURETICS*						*SECONDARY ENURETICS*		
	Imipramine		*Buzzer*		*Placebo*		*Imipramine No.*	*Buzzer No.*	*Placebo No.*
	No.	Per cent	No.	Per cent	No.	Per cent			
80 per cent or more	12	46	16	61	4	19	4	1	1
40 per cent or more	7	27	5	19	9	43	5	1	2
Less than 40 per cent	7	27	5	19	8	38	0	4	3
TOTAL	26		26		21		9	6	6

secondary enuretics than the 'buzzer'; this is the reason for the significant difference between the correlations in Table II. There is no clear evidence that the two regimes have different effects on primary enuresis.

Multiple Regression Analysis

From the multiple regression analyses, the best predictors of outcome have been listed (Table IV) according to whether they were favourable or unfavourable, and in order of the size of their standardized regression coefficients (*i.e.* predictive weights). Outcome was noted at the end of treatment (two months stage) and at follow-up (*i.e.* at four months, or two months after completion of treatment).

No matter how the variables were grouped, some features *consistently* proved particularly favourable predictors of outcome (Table IV).

With imipramine, the best predictors of a favourable outcome at the end of treatment were the early development of speech, an absence of somatic symptoms such as headaches or abdominal pains, and the family being in the lower social classes.

With the 'buzzer' method, an absence of mannerisms and being female were predictive of a favourable outcome at follow-up.

Taking the 'buzzer' and imipramine treatment groups together, the favourable predictors for outcome at the end of treatment were an absence of somatic complaints and the father being introverted; successful outcome at follow-up was predicted by the child being female, showing a tendency towards being obsessive, and a high frequency of wetting prior to treatment.

For the whole group of cases, irrespective of whether they had had treatment or not, the favourable predictors for outcome at the end of the treatment period were an absence of a family history of enuresis, and the child having an excitable temperament and few somatic symptoms; a high frequency of wetting prior to treatment was predictive of a favourable outcome at follow-up.

The above findings suggest that there are specific features which can be used to predict outcome of imipramine treatment at two months and 'buzzer' treatment at four months. The placebo did not show any such consistent patterns, the obvious explanation for this being that it is just an expression of a more random response.

TABLE IV

Favourable and adverse predictors of outcome according to the standardised partial regression coefficients

(a) Total series of cases

Features (and sets)	At two months			At four months		
	20V	14V	10V	20V	14V	10V
Gender: female (20, 14, 10)	O	O	O	+	O	O
Shares bed (20)	O	NI	NI	—	NI	NI
Family history of enuresis (20, 14, 10)	—	—	—	O	O	—
Somatic complaints (20, 14, 10)	—	—	—	O	O	O
Frequency of wetting prior to treatment (20, 14)	O	O	NI	—	—	NI
Excitability (20, 14, 10)	+	+	+	O	O	O

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(b) Imipramine

Features (and sets)	At two months			At four months		
	20V	14V	10V	20V	14V	10V
Early use of 3 word phrases (20)	+	NI	NI	O	NI	NI
Low social class (20, 14, 10)	+	+	+	O	O	O
Somatic complaints (20, 14, 10)	— —	— —	— —	O	O	O

(c) Buzzer

Features (and sets)	At two months			At four months		
	20V	14V	10V	20V	14V	10V
Gender: female (20, 14, 10)	O	O	O	+	+	+
Father introverted (20, 14, 10)	+	O	O	O	O	O
Primary enuresis (20)	+	NI	NI	O	NI	NI
Mannerisms (20, 14)	O	O	NI	—	—	NI

(d) Placebo

Features (and sets)	At two months			At four months		
	20V	14V	10V	20V	14V	10V
Family size (20, 14)	—	O	NI	O	O	NI
Restlessness at night (20, 14, 10)	—	O	O	O	O	O
Shares bed (20)	O	NI	NI	—	NI	NI

(e) Combined Treatment group (imipramine group + buzzer group)

Features (and sets)	At two months			At four months		
	20V	14V	10V	20V	14V	10V
Gender: female (20, 14, 10)	O	O	O	+	+	+
Father introverted (20, 14, 10)	+	+	+	O	O	O
Nocturnal restlessness (20, 14, 10)	O	O	O	—	—	O
Somatic complaints (20, 14, 10)	—	—	—	O	O	—
Fussy/conscientious (20, 14, 10)	O	O	O	+	+	+
Frequent wetting prior to treatment (20, 14)	O	O	NI	—	—	NI

20V = 20 variables in regression set	+ + = Highly favourable	+ = Favourable
14V = 14 variables in regression set	— — = Highly unfavourable	— = Unfavourable
10V = 10 variables in regression set	O = Not important	NI = Not included

An examination of Table IV reveals that with imipramine the key predictors of outcome are located at the two-month stage, whereas with the 'buzzer' they are at the four-month stage. This suggests that predictive features are only specific for imipramine while it is being used, while with the 'buzzer' the features are specific after the treatment has ceased. This supports the contention (Kolvin *et al.* 1972) that with the 'buzzer' a learning process is operative.

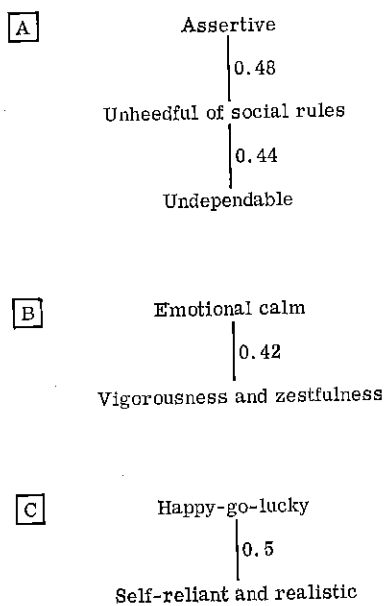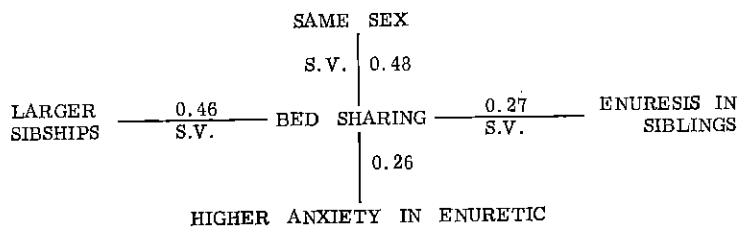An important finding is that the presence of somatic symptoms indicates a poor prognosis.

CLUSTER I

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┌─────────────────────────────┐
│  MOOD   APPROACHABILITY     │
│       (OVER-ALL  DATA)      │
└─────────────────────────────┘
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MOOD SUB-CLUSTER

APPROACHABLE

| 0.65

FAMILY SIZE ────────── CHEERFUL ────────── SOMATIC
SUB-CLUSTER   0.23   0.41   SUB-CLUSTER

SMALLER   ABSENCE OF
SIBSHIPS | 0.65   SOMATIC SYMPTOMS

FRIENDLY

| 0.38

SLEEPS DEEPLY

| 0.50   ⌐ NOCTURNAL
| ⊢   ACTIVITY
| ⌐ SUB-CLUSTER

NOT RESTLESS AT NIGHT

Fig. 1.

Cluster Analysis

The First Cluster (see Fig. 1). This cluster demonstrates the association between cheerfulness in the child and an absence of somatic symptoms (*i.e.* headaches or abdominal pain). These features are further associated with deep and sound sleep, and an absence of nocturnal restlessness. Implicit in such associations is that light sleep, nocturnal restlessness and bodily symptoms have, in enuretics, emotional origins.

The Second Cluster (see Fig. 2.) This is really a set of clusters which demonstrates the interassociations between a set of personality variables.

The Third Cluster (see Fig. 3). This demonstrates: (i) that poor social and economic circumstances are, as one might expect, associated with large families, bed sharing, and enuresis among siblings; and (ii) a higher level of anxiety in children who share beds.

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CLUSTER II

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        ┌─────────────────────┐
        │     PERSONALITY     │
        │   (OVER-ALL  DATA)  │
        └─────────────────────┘


   ┌─┐              Assertive
   │A│                 │
   └─┘                 │0.48
                       │
               Unheedful of social rules
                       │
                       │0.44
                       │
                  Undependable



   ┌─┐            Emotional calm
   │B│                 │
   └─┘                 │0.42
                       │
             Vigorousness and zestfulness



   ┌─┐             Happy-go-lucky
   │C│                 │
   └─┘                 │0.5
                       │
              Self-reliant and realistic
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Fig. 2.

CLUSTER III

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        ┌─────────────────────┐
        │  BED   ARRANGEMENTS │
        │   (OVER-ALL  DATA)  │
        └─────────────────────┘


                   SAME  SEX
                       │
              S.V.     │0.48
                       │
LARGER      0.46       │          0.27      ENURESIS IN
SIBSHIPS  ────────  BED  SHARING ────────     SIBLINGS
            S.V.       │           S.V.
                       │
                       │0.26
                       │
         HIGHER  ANXIETY  IN  ENURETIC
```
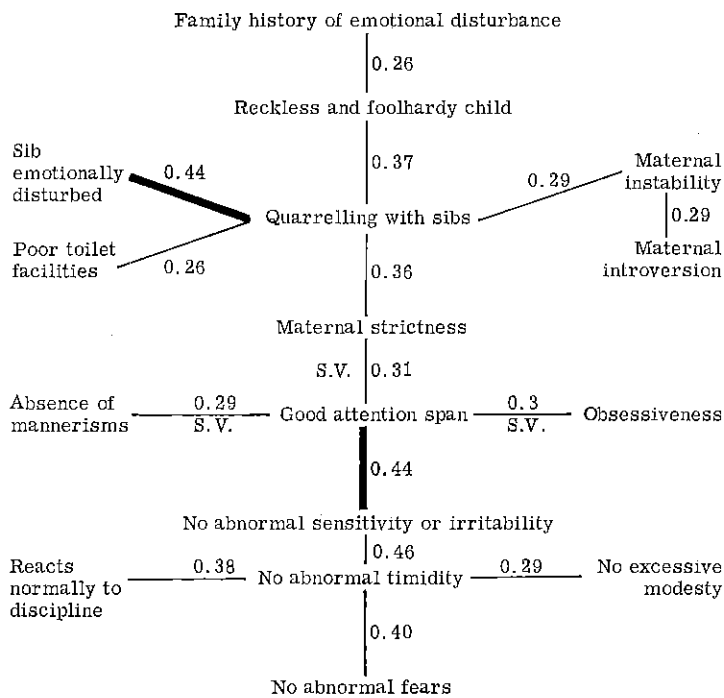
S.V. = Shortened version cluster analysis using features listed Table I only

Fig. 3.

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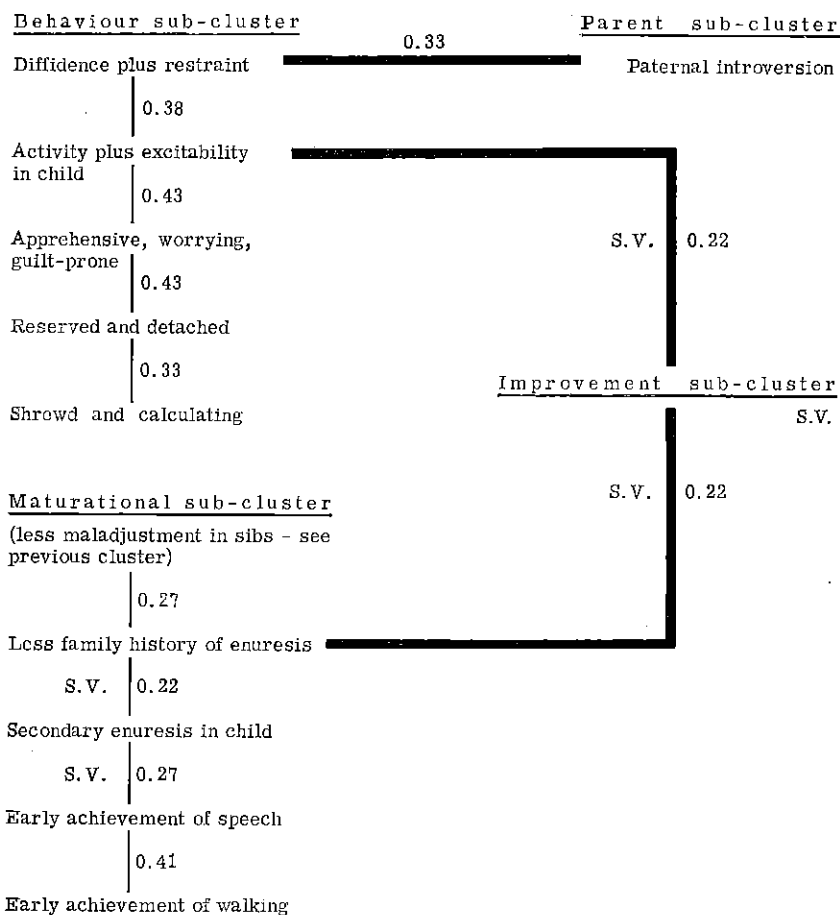DOUBLE   CLUSTER   OF   SIBLING   RELATIONSHIPS
AND   ATTENTION   SPAN

Family history of emotional disturbance

0.26

Reckless and foolhardy child

Sib
emotionally   0.44   0.37   0.29   Maternal
disturbed   instability

                    Quarrelling with sibs   0.29

Poor toilet
facilities   0.26   0.36   Maternal
                                                             introversion

Maternal strictness

S.V. 0.31

Absence of   0.29   0.3
mannerisms   S.V. — Good attention span —   S.V. — Obsessiveness

0.44

No abnormal sensitivity or irritability

Reacts   0.38   0.46   0.29   No excessive
normally to   — No abnormal timidity —   modesty
discipline

0.40

No abnormal fears

S.V. = Shortened version cluster analysis using features listed in Table I only

Fig. 4.

The Fourth Cluster (*see Fig. 4*). This cluster demonstrates firstly how a good attention span in the child is associated with more normal psychological reactions, moderation of behaviour, and a degree of obsessiveness and meticulousness; secondly it shows how serious sibling quarrelling and rivalry is associated with such features as poor social circumstances of the family, poor handling by the mother, or emotional instability in the mother. The internal associations within these two sub-clusters are hardly surprising, and plausible theories can for the most part be offered to explain them.

CLUSTER V

MATURATION + BEHAVIOUR
(OVER-ALL DATA)

Behaviour sub-cluster   Parent   sub-cluster
                                      0.33
Diffidence plus restraint ━━━━━━━━━━━━━━━━━━   Paternal introversion

         0.38

Activity plus excitability ━━━━━━━━━━━━━━━━━━━━━━━━━━━┓
in child
         0.43   S.V. 0.22

Apprehensive, worrying,
guilt-prone
         0.43

Reserved and detached

         0.33   Improvement   sub-cluster
Shrewd and calculating   ━━━━━━━━━━━━━━━━━┓   S.V.

Maturational sub-cluster   S.V. 0.22

(less maladjustment in sibs - see
previous cluster)

         0.27

Less family history of enuresis ━━━━━━━━━━━━━━━━━━━━┛

   S.V. 0.22

Secondary enuresis in child

   S.V. 0.27

Early achievement of speech

         0.41

Early achievement of walking

S.V. = Shortened version cluster analysis using features listed in Table I only

Fig. 5.

The Fifth Cluster (see Fig. 5). This contains, as a link between the two sub-clusters, the important variable of improvement. The first sub-cluster demonstrates the associations between a whole series of variables which reflect maturation; the second sub-cluster demonstrates the associations between a set of behavioural and temperamental variables, especialy related to the child's activity and excitability.

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CLUSTER VI

SOCIAL FACTORS
(OVER-ALL DATA)

FAMILY DISORGANIZATION

| 0.28

LOWER SOCIAL CLASS

| 0.29

FATHER UNSTABLE

| 0.3

PARENTS EMOTIONALLY DISTURBED
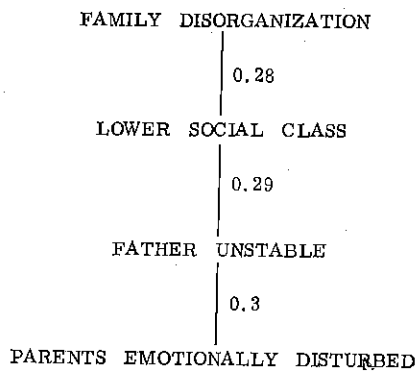
Fig. 6. (*left*)

Fig. 7. (*below*)

IMIPRAMINE IMPROVEMENT CLUSTER

ABSENCE OF SOMATIC ——0.45—— IMPROVEMENT ——0.45—— EARLY SPEECH ACHIEVEMENT
COMPLAINTS
| 0.35 | 0.35 | 0.40
LOWER SOCIAL CLASS   ABSENCE OF RESTLESSNESS

HIGHER INITIAL LEVEL
OF BEDWETTING
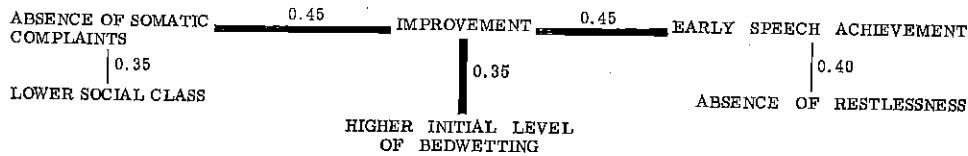
'BUZZER' IMPROVEMENT CLUSTER

RELATIVE ABSENCE   0.29   0.41
OF NOCTURNAL ————————— IMPROVEMENT ————————— PRIMARY ENURESIS
RESTLESSNESS
                                                              | 0.34

                                              ABSENCE OF SOMATIC
                                              COMPLAINTS
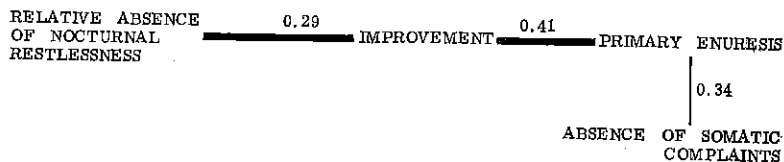
The Sixth Cluster (*see Fig. 6*). This cluster is a psycho-social one, demonstrating the links between family disorganization and low social class and parental emotional disturbance.

Clusters Relating to improvement (*see Fig. 7*). Using twenty-one key variables, additional cluster analysis was undertaken utilizing only cases included in the *Imipramine treatment* regime. We concerned ourselves only with the cluster containing the crucial variable of improvement at two months. Three sub-clusters were delineated. Improvement is clearly associated with early development of speech, absence of somatic symptoms and a higher initial frequency of bedwetting.

In a similar manner, cluster analysis was undertaken with cases included in the *'buzzer' treatment* regime. Two sub-clusters were found—the first linking improvement with primary enuresis and absence of somatic symptoms, and the second showing an association between improvement and a relative absence of nocturnal restlessness.

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Discussion

Cluster and Regression Analysis

The most clinically significant cluster emerging from cluster analysis is number five, which has been labelled 'Maturation and Behaviour'. This is because the variable *improvement* links the two sub-clusters of *behaviour* and *maturation* with an equal level of correlation at the second decimal point. The maturation sub-cluster shows an association between accelerated maturation with early achievement of milestones and secondary enuresis, which in turn correlates with an absent or almost absent family history of enuresis. The implication is that treatment is likely to be more efficacious where the enuretic's development has not been delayed, and he or she has no family history of enuresis. This appears to be particularly true in the case of imipramine treatment.

It is interesting to note that the feature *primary/secondary enuresis*, is contained in this maturational sub-cluster. Other researchers (Shaffer *et al.* 1968) have already demonstrated that secondary enuretics respond better to imipramine treatment. As has already been discussed, the data in Table III suggest that secondary enuretics tend to respond significantly better to imipramine treatment than to 'buzzer' treatment.

Both cluster and multiple regression analysis therefore provide evidence in support of a theory that nocturnal enuresis is caused by two main types of factors: familial cum maturational factors and psychological factors. Other evidence in support of this hypothesis has been advanced elsewhere (Kolvin *et al.* 1972, Kolvin and Taunch this volume Chapter 19).

It seems reasonable to conclude that some of the clusters, such as Cluster VI and most of Cluster IV, are general ones (by which is meant that similar links would occur in any series of children under examination), while other clusters are more specific to enuresis.

Explanations of Correlations

Though plausible explanations can be offered for most of the findings, for some others only speculative hypotheses can be proposed. For instance, the unfavourable outcome in cases with somatic complaints can be explained in terms of poor response, if it is assumed that these bodily complaints have emotional origins (and there is statistical evidence to support this). The unfavourable outcome in children with a family history of enuresis can be explained in terms of a genetically determined age for becoming dry, though the age of nine/ten years is rather late for normal variations, and implies at least an extremely skewed curve of variation. The favourable outcome in children who show a high degree of conscientiousness has an obvious explanation, although it has been stated that conscientiousness is characteristic of children with recurrent abdominal pain or headache (Apley and Mac Keith 1968).

The relationships between outcome and the features of excitability in the child and parental introversion are less easy to explain. The excitable/phlegmatic dimension of the Cattell Personality Questionnaire (c.p.q.) includes the traits excitable, impatient, demanding and overactive as its excitability pole. According to Eysenck's (1957) theory, poor conditionability is related to extroversion (in other words introverts learn better than extroverts), and from this it is tempting to speculate that a familial or

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constitutional pre-disposition to introversion makes it easier for a child to acquire physiological skills. An examination of Table II reveals a positive correlation, albeit a low one, between paternal introversion and improvement on all the regimes except imipramine at four months and placebo. Maternal introversion correlates only with improvement on the imipramine treatment regime but not at a significant level. So this hypothesis receives no consistent support from the parental personality data.

If a poor level of conditionability in part underlies enuresis, then it is reasonable to predict that enuretics will be more extroverted than non-enuretics. It is important to note that in our study we found no excess of extroversion on personality assessment (C.P.Q.) amongst the enuretics, and, provided the C.P.Q. and our technique of using it are reasonably valid, there is little support for the conditionability hypothesis.

Another way of studying this hypothesis is to ascertain whether introverted enuretics show a better response to conditioning treatment than extroverted enuretics. An examination of Table II reveals no significant correlations between improvement on 'buzzer' treatment and the variable of extroversion/introversion in the child. Lovibond (1964) also was unable to find evidence to substantiate the above hypothesis. What is more, from the regression analysis, it is the excitable/phlegmatic dimension of the C.P.Q. which emerges as a good predictor. However, it should be remembered that the extroversion/introversion dimension is a second order factor, and is in part a function of excitability. This provides a possible explanation for the precedence of excitability over extroversion in the regression analysis. Nevertheless, it seems fair to comment that Eysenckian theory (Eysenck 1957) receives only very limited support from this research.

Some Discernable General Themes Relating to Improvement

Some general conclusions can be drawn from the findings presented in this paper, particularly if we concentrate only on the two-month stage of the experiment.

(1) Taking both regression and correlational analysis into consideration, parental introversion, child excitability, an absence of somatic complaints, and a relative absence of restlessness at night, all have important associations with improvement on both the imipramine and buzzer regimes. Somatic complaints appear to have important psychological associations, so it is reasonable to hypothesize that a relative absence of psychiatric disorder augurs well for improvement—particularly on imipramine treatment. Increased nocturnal restlessness appears to be associated with the presence of psychological factors and poor improvement.

(2) Secondary enuretics appear to respond more specifically to imipramine.

(3) Primary enuretics respond better than secondary enuretics to the 'buzzer' regime.

(4) Children who started talking earlier appear to respond better to imipramine.

Summary and Conclusions

The main findings to emerge from the predictive and cluster analyses carried out on the data obtained from this controlled trial were as follows.

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(1) Multiple regression and correlational analyses showed certain features to be significant predictors of outcome, and accordingly three conclusions may be drawn regarding treatment.

(a) Irrespective of the type of treatment, a child of the female sex, with a high level of excitability combined with conscientiousness, and with a father inclined to introversion, is more likely to respond to therapy. If the child has somatic symptoms (headache or abdominal pains) and a family history of enuresis, the outcome is likely to be less favourable.

(b) When using imipramine ('Tofranil'), the outcome of treatment is more likely to be favourable if there is evidence of early achievement of the speech milestone, if the family belongs to the lower social classes, and if there is no history of somatic symptoms. Secondary enuretics respond better to imipramine than to the 'buzzer'.

(c) When using the 'buzzer', the outcome is more likely to be favourable if the father is inclined to be introverted and if the child is female and shows an absence of unusual mannerisms.

(2) Cluster analysis revealed a number of general clusters, and some apparently specific for enuretics. One of the latter includes as a central feature 'improvement', which links the two sub-clusters of 'maturation' and 'the behaviour of the child'.

Clusters specifically related to treatment response for the different treatments revealed

(a) that improvement on imipramine at two months links with three sub-clusters of early development of speech, absence of somatic symptoms, and a higher initial frequency of wetting;

(b) cluster analysis of the 'buzzer' data suggests that improvement is associated with an absence of somatic symptoms and an absence of nocturnal restlessness.

APPENDIX

Individual Inter-correlations Covering Total Data

Certain features appeared frequently both in multiple regression analyses and cluster analyses, and so the total correlation matrices were scanned to ascertain significant correlations with those features. It was decided to take note of those correlations which were significant at the 0·01 level. These are set out below.

Restlessness and Depth of Sleep

The definition of restlessness was based on the notion that the restless child demonstrably disturbs the bedclothes while the non-restless child's bed is almost intact in the morning. Depth of sleep was defined in terms of the intensity of stimulus necessary to awaken the child, the lightest sleepers awakening without any obvious disturbing stimuli, and the deepest being difficult to waken even with maximal stimulation. Understandably, each appears to be a function of the other (correlation: 0·5).

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Restlessness at night is associated with psychiatric abnormality in the child (0·32), and almost reaches the 0·01 level of significance with secondary enuresis (0·26). On the other hand, deep sleep is correlated with relative absence of psychiatric abnormality (0·45) and also with friendliness (0·38): similarly, it almost reaches the 0·01 level of significance with absence of somatic symptoms (0·26). Some consider that this type of data, which is entirely dependent on parental accounts, is particularly susceptible to expectation distortions, which could determine some of the associations (Kolvin *et al.* 1972). In further research, it will be imperative to make observations independent of the mothers' reports.

Somatic Symptoms

Absence of somatic symptoms, in addition to correlating with depth of sleep, significantly correlated with a series of health dimensions.

Primary/Secondary Enuresis

This proved to be an interesting variable in the various analyses. There was, however, only one correlation significant at the 0·01 level and this was between primary enuresis and relatively late achievement of three word sentences (0·27). There were also some important correlations, significant at the 0·05 level, between primary enuresis and a family history of enuresis (0·22), relative absence of nocturnal restlessness (0·26), no abnormal or unusual fears (0·22) and the obedience and conforming dimensions of the Cattell Personality Questionnaire (0·21). There were a number of other correlations which almost reached a significant level. The correlation (0·16) with absence of psychiatric disturbance in the child, though positive, was not of statistical significance. These associations were investigated further, and are described elsewhere (Kolvin and Taunch—this volume Chapter 19).

Definitions

The following are definitions of variables contained in Tables I and II. They are described in greater detail elsewhere (Kolvin *et al.* 1972).
(1) Sex: male versus female.
(2) Sentences: early versus late use of three word phrases (age of achievement in months).
(3) Family size: total number of siblings in the family.
(4) Social class: social class of breadwinner using the Registrar General's classification.
(5) Paternal extroversion: clinical rating of father on an introversion/extroversion scale.
(6) Maternal extroversion: clinical rating of mother on an introversion/extroversion scale.
(7) Mother permissive: clinical rating of mother's attitude to toilet training on a permissiveness/coerciveness scale.
(8) Family history of bedwetting: nocturnal bedwetting beyond the age of 5 years by first degree relatives.
(9) Bed sharing: sharing of the bed by an enuretic with another person.

(10) Nocturnal restlessness: crude evidence of nocturnal bodily mobility, *e.g.* covers untidy, or blankets kicked off.

(11) Primary enuresis: continuous bedwetting, versus the onset of bedwetting after a period of dryness of at least one year.

The next four variables are behavioural ratings as reported by mothers. The children were rated using four point scales partially modified from Wolff (1967)— for description see Kolvin *et al.* (1972). For the purposes of this research, only the extreme points were defined and the scale was consistently one tailed.

(12) Somatic complaints: recurrent headaches or abdominal pains.

(13) Mannerisms: unusual body mannerisms, twitches or tics.

(14) Attention span: good powers of concentration and attention.

(15) Obsessiveness: 'Not fussy or particular; no obsessive symptoms.'

(16) Excitability: score on the excitable/phlegmatic dimension of the C.P.Q. (Cattell Personality Questionnaire).

(17) Conscientiousness: score on the conscientiousness dimension of the C.P.Q.

(18) Vigorous/doubting: score on the vigorous/doubting dimension of the C.P.Q.

(19) Child introversion: score on the introversion/extroversion dimension of the C.P.Q.

(20) Initial level of wetting: frequency of wetting per month prior to treatment.

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