

## THE FUNCTIONAL SIGNIFICANCE OF COMPLEX HAND MOVEMENT STEREOTYPES IN THE SEVERELY RETARDED

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Stereotyped behaviours have been defined as "highly consistent and repetitious motor or posturing behaviours, the adaptive consequences of which, if any, are not immediately apparent" (Forehand and Baumeister, 1971). As such the term includes a range of topographically dissimilar behaviours such as rocking, swaying, whirling, mouthing, hand weaving and complex hand movements in front of the eyes. Studies from both human and infra-human subjects suggest that these behaviours can enter into complex relationships with subjects' external, and internal (psychophysiological) environments.

Work with mentally handicapped people suggests that many of these behaviours can be classed as self-stimulatory in that they occur when there is little else available in the environment, and decrease when alternative activities are provided (Berkson and Mason, 1963, 1964; Kaufman and Levitt, 1965). This has been demonstrated mainly with behaviours such as rocking and swaying, whereas people who engage in complex hand movements have been found to be far less responsive to the presence of objects for manipulation (Berkson and Mason, 1964).

These kinds of behaviours occurring in autistic children have been related to factors in the child's internal environment. Using both behavioural and psychophysiological measures, it has been suggested that autistic children are in a chronically high state of "arousal," and that their hand stereotypes have the effect of decreasing this arousal (Hutt and Hutt, 1970; Hutt, Forrester and Richer, 1975).

Although these researches have been with different client groups, both lines of enquiry seem to indicate that stereotyped behaviours serve some kind of self-regulated function for the individual, in that they occur at times when the level of stimulation is either too low or too high. The work of the Hutt's suggests that in studying environmental relationships, psychophysiological measures may be as important as measures of the external environment. These kinds of measures have however, rarely been used in work with the mentally handicapped.

In addition, previous studies have tended to look at the effect of simple environmental manipulations (e.g., presence vs. absence of toys), on single stereotyped behaviours within the individual. They have not taken into account that such behaviours may be linked to other responses within an individual's repertoire, and that intervention on one response may have effects on non-target responses. However, a limited number of recent clinical studies have shown that interventions which decrease stereotyped or self-injurious responses, may be accompanied by increases in other undesired behaviours, often in unpredictable ways (Epstein *et al* 1974; Rollings *et al* 1977; Clements and Dewey, 1979).

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The present study sought therefore to replicate and extend previous findings with the mentally handicapped using multiple measures for individuals retardates. People were selected who showed high frequency complex hand movement stereotypes, but in addition, for each person, measures were taken of other overt motor behaviours, as well as measures of psychophysiological functioning (cardiac arrhythmia i.e., heart rate variability (H.R.V.) and heart rate). More specifically the aims were:-

- (1) To study the relationship of the behaviours monitored to environmental settings by comparing their occurrence in a restricted environment as opposed to one offering the opportunity and reinforcement for alternative activities. This replicates the earlier work of Berkson and Mason (1963, 1964) but extends it by monitoring the effects on multiple response systems, i.e., other motor and psychophysiological responses.
- (2) To study the effects of a brief version of the overcorrection procedure known as Functional Movement Training (Foxy and Azrin, 1973; Azrin *et al* 1975). This again extends previous work by measuring the effects on a variety on non-target responses, both behaviourally and with psychophysiological measures.

## METHOD

### Three people.

Three severely mentally handicapped children served as the subjects for the present study. All had been inpatients on a childrens' ward for no less than seven years, and all exhibited high levels of stereotyped behaviour, in particular complex hand movements. The specific behavioural categories for the study were devised from four, half-hour observational periods at random times throughout the day. This enabled the selection of people who exhibited both high levels of complex hand movements and also a variety of other stereotyped behaviours. Table I. gives the details.

TABLE I

Person	Age	Length of Institutionalisation	Additional Information
I.W.	15	7 years	Severely subnormal and epileptic. No cardiac abnormalities. No speech but able to attend Hospital School and complete simple tasks.
M.S.	13	13 years	Severely subnormal and semi-ambulant. No cardiac abnormalities. No speech, and remains on the ward for the entire day either in wheelchair or crawling around. Plays with simple toys.
W.H.	17	9 years	Severely subnormal. No cardiac abnormalities. Some speech i.e., simple phrases. Able to attend Hospital School and complete simple puzzles, etc.

## MEASURES

Throughout the study, multiple measures were collected on each individual:

### (i) Behavioural Observations

The children were selected on the basis of showing complex hand movements as described above. The categories were:-

- (A) **Complex Hand Movements (CHM)** - movements of the hands in front of the face.
- (B) **Additional Gross Motor Behaviours** - walking, jumping, etc.
- (C) **Rocking** - body rocking whilst remaining seated or stationary i.e. not walking about.
- (D) **Playing** - any handling of available toys.
- (E) **Other Specified Stereotyped Behaviours** - specified on an individual basis e.g., ear pulling, etc.

In addition, the category of "Treatment" was used for the periods when the children received Overcorrection.

### (ii) Psychophysiological Measures

Cardiac functioning was assessed telemetrically, with the receiving equipment being placed outside the experimental room. The transmitter was attached to the person's skin, and the ECG signal received by the Receiver Unit was used to trigger an Instantaneous Ratemeter. The heart rate and ECG signal were then displayed by a two channel pen recorder. From this, measures of HR and HRV were derived. Further details of the equipment are included in the "Equipment Note." <sup>(1)</sup>

All behavioural categories were given detailed definitions, and inter-rater reliability was assessed by a third observer during nine observational periods (five for the behavioural data, four for the psychophysiological). Reliability for the behavioural data was calculated on the number of intervals in which there was agreement and expressed as a percentage of the number of intervals of agreement plus disagreement. For the data relating psychophysiological measures to overt behaviour reliability was calculated in a similar fashion for the behavioural codes marked on the M2R print-out (see later). The overall reliability ranged from 89% - 98% for all behavioral categories (mean 94%) with the exception of playing, whose reliability was 69%.

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#### (1) EQUIPMENT NOTE

The equipment consisted of Devices disposable, stick-on electrodes which were attached to the subject's chest, and their exact repositioning in subsequent sessions ensured by marking their location with Gention Violet. The transmitter, Dynamic/Devices SNR120F, was attached to the subject's skin by means of Blenderm Tape. The ECG signal was received by a Dynamic/Devices NR112R FM Receiver, and was amplified by a specially designed unit (Forrest, 1974), which also eliminated artifacts due to movement. The R-Wave in this modified signal was then used to trigger a Devices Instantaneous Ratemeter Type 2751, and the rate so derived, together with the modified ECG signal, was then displayed by a Devices M2R, two-channel Pen Recorder. Subject's beat to beat variability and changes in mean rate were recorded via this telemetry link.

## Design and Procedure

All three children received six individual 40 minute sessions under each of three experimental conditions. The experimental conditions were presented to each person in a random order. The sessions took place in an experimental room (9ft. x 9ft.), with which the children had been familiarised but to which they did not have regular access during the day. The persons were observed from an adjoining room connected by a one-way mirror. During each session, behaviour was recorded at 5 second intervals for periods of 90 seconds, followed by a break of 30 seconds before beginning again. This meant that during a 40 minute experimental period, observations were made for 30 minutes. The relationship of overt behaviour to psychophysiological functioning was plotted by a second observer, marking the exact initiation and cessation of the specified behaviours on the M2R paper print-out.

The three conditions were as follows:-

(1) **Restricted Environment.**

The children remained alone in the experimental room with an unfamiliar adult present, but not interacting with them. A few toys were available. In Berkson's studies this situation led to high rates of stereotyped behaviour.

(2) **Enriched Environment.**

The children remained in the experimental room, with a familiar adult with them, and a range of play materials, i.e., jigsaws, dolls and animals. The adult was instructed to prompt the children to play with the toys and praise them whenever they did so. If stereotypies were self-stimulatory, this condition should elicit low rates of response, but high rates if the behaviours were "de-arousing" for the individual.

(3) **Treatment.**

The children were present in the experimental room, but the adult was instructed not to actively encourage play activities. Instead, the adult administered a brief form of the Functional Movement Training procedure every time the child engaged in complex hand movements. The treatment consisted of forcefully saying "No" to the children, then taking their hands, placing them on their sides, and holding them there for approximately 10 seconds. A verbal instruction "hands to your sides" accompanied this. During the next 10 seconds, hands were placed in the air, the following 10 seconds on their heads, and finally 10 seconds with their hands together. Although this was shorter than the original treatments (Foxy and Azrin, 1973), it has been suggested that brief but frequent sessions may be as or more effective than longer sessions (Rollings *et al*, 1977). On the basis of previously mentioned clinical studies, some increase in non-target stereotypies were predicted.

The relationships between behavioural and psychophysiological measures expected from previous studies would suggest that increased activation in the person is accompanied by decreases in heart rate variability and increases in heart rate. Thus the predictions for the data would depend on whether the stereotyped behaviour were 'self-stimulatory' or 'de-arousing.'

## RESULTS

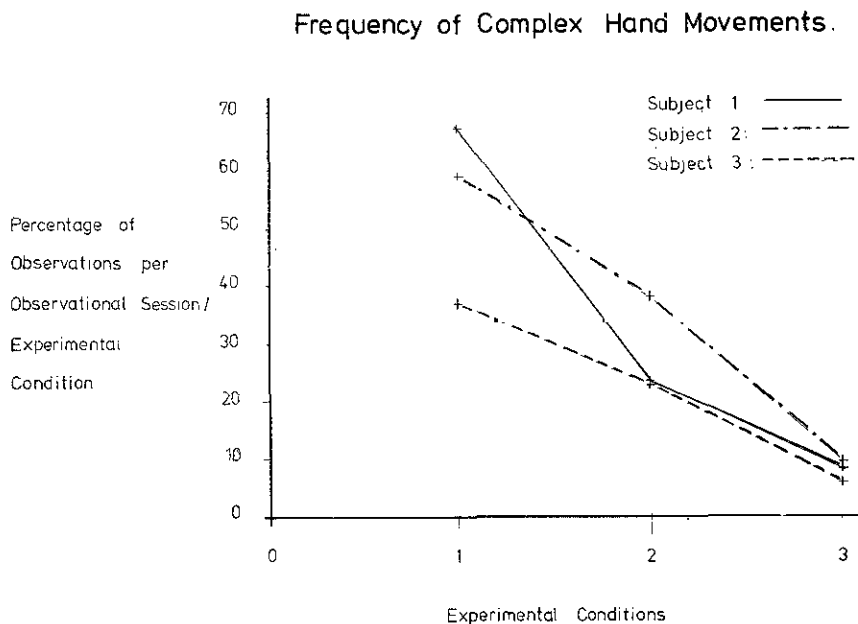
### Behavioural Observations.

Each category of behaviour was compared across each experimental condition, and Wilcoxon Matched-Pairs Signed-Rank Tests calculated for the data on each child.

#### (1) Complex Hand Movements.

Figure 1. shows that the proportion of time spent engaging in complex hand movements was highest in Condition 1. (small, restricted environment), and markedly reduced in both Conditions 2 (enriched environment) and 3 (Treatment). This was true for all children, and Wilcoxon Tests calculated on the difference scores indicated that these were significant in all comparisons i.e., 2 versus 1., 3 versus 2., and 3 versus 1 at  $p < 0.025$ .

FIGURE 1



#### (2) Rocking.

This was a high probability behaviour as indicated in Table 2. A significant increase in frequency was shown in Condition 3 (Treatment) as compared to Condition 1. Wilcoxon Tests indicated this to be significant for two children at  $p < 0.05$ . No other comparison was significant.

TABLE 2 — BEHAVIOURS

		CHILD i (I.W.)					
		Gross Motor Behaviours	Complex Hand Movements	Rocking	Playing with Toys	Treatment (over correction)	Other Stereotypy (specified)
Experimental	1	14.6	67.3	5.5	12.6	0	0
Conditions	2	9.1	23.7	15.9	51.1	0	0.2
i	3	4.6	8.2	30.6	10.0	45.9	0.7

		CHILD ii (M.S.)					
		Gross Motor Behaviours	Complex Hand Movements	Rocking	Playing with Toys	Treatment (over correction)	Other Stereotypy (specified)
Experimental	1	10.0	59.2	30.4	0	0	0.4
Conditions	2	12.1	38.1	27.6	21.0	0	1.2
ii	3	15.3	9.4	35.0	0.4	32.2	7.7

		CHILD iii (W.H.)					
		Gross Motor Behaviours	Complex Hand Movements	Rocking	Playing with Toys	Treatment (over correction)	Other Stereotypy (specified)
Experimental	1	44.9	37.0	5.7	6.0	0	6.4
Conditions	2	17.1	22.8	8.2	42.0	0	9.9
iii	3	23.8	5.7	20.4	12.7	20.6	16.8

Figures represent total number of observations per Category/Experiment Condition, expressed as a percentage of the total number of observations per category.

(3) **Other Stereotyped Behaviours.**

The frequency of these behaviours varied between children, but all three children showed a significantly increased frequency of such behaviours in the treatment condition, as compared to condition 1. (see Table 2). Wilcoxon Tests indicated this significance to be  $p < 0.25$ . This is despite the fact that the time available for such behaviours was necessarily restricted, as they could not occur whilst the person was being treated.

(4) **Playing.**

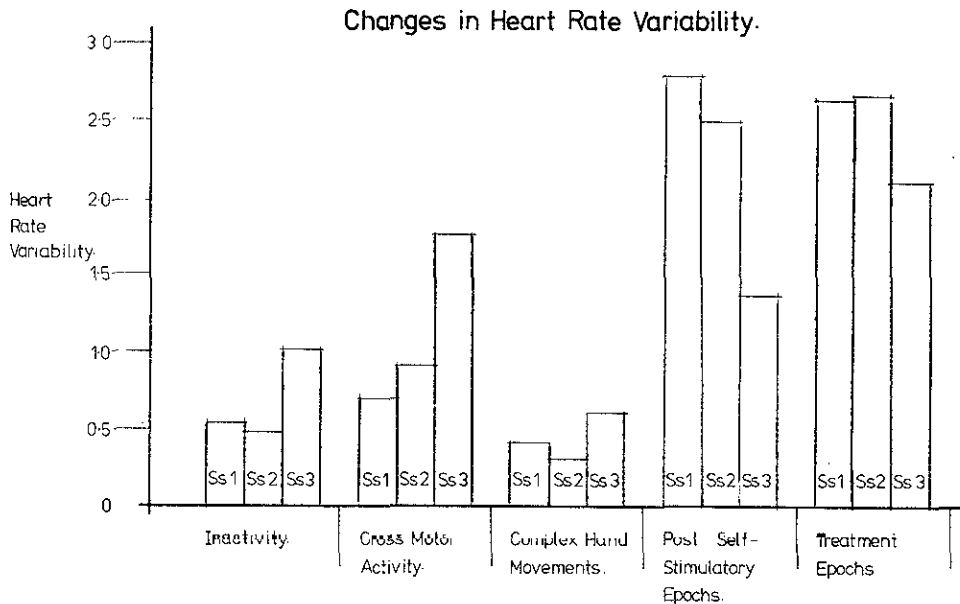
Whilst those children engaging in complex hand movements have been characterised as generally less responsive to their environments, all three children showed significantly higher levels of object manipulation in condition 2, as compared to condition 1. Wilcoxon Tests indicated this to be significant at  $p < 0.025$ . These results should be interpreted with caution in view of the poor inter-rater reliability for this category.

**Psychophysiological Data.**

The model of stereotyped behaviour proposed by Hutt, is that complex hand movements serve a homeostatic function, to reduce levels of physiological arousal under stressful situations. It was suggested that stereotyped behaviour may be associated with increased heart rate variability (HRV), which would differ significantly from both epochs when the people were inactive, and from periods of gross motor movement. In fact, contrary to predictions, all three children showed a significantly decreased HRV whilst engaged in complex hand movements, as compared with periods of inactivity and gross motor behaviours. Wilcoxon tests

indicated this significance to be  $p < 0.05$ . Moreover, during epochs following stereotypy, all three children showed significantly increased HRV ( $p < 0.05$ ), again as compared with periods of inactivity and gross movement. These results are presented graphically in Figure 2. The effects of treatment were to increase HRV, compared with periods of stereotyped behaviour, gross motor movement and inactivity. All children showed significantly reduced heart rate during treatment, compared to periods of complex hand movement.

**FIGURE 2**



It would perhaps be expected that all stereotyped behaviour would be characterised by similar psychophysiological effects. Both complex hand movements and rocking were associated with increased heart rate. However, rocking in contrast to complex hand movement behaviour was associated with increased HRV. This cautions against any simple model to cover all 'stereotyped' behaviour.

#### **Treatment Effects.**

The design of the present study makes it difficult to determine the efficacy of the overcorrection. For example, children received experimental conditions in a random order, and moreover, the observational data obtained is merely the number of times at five second intervals that a child was observed receiving treatment. An examination of this data using the Wilcoxon Test suggests that there was no significant reduction in the number of observations of treatment application during observation sessions, 4, 5 and 6, as compared with sessions 1, 2 or 3.

## DISCUSSION

The present results would seem to urge, therefore that caution must be exercised when interpreting the significance of behaviours labelled as 'stereotyped.' Whilst the present children showed complex hand movements, which were topographically similar to those behaviours seen in autistic children, their response to environmental conditions and the psycho-physiological concomitants of such behaviours suggested that complex hand movements stereotypies might serve an opposite function to those proposed for autistic children. In other words, in this case they appeared *self-stimulatory in function rather than 'de-arousing.'* This distinction between topographical and functional classes of behaviour is of course, obvious from an applied behavioural view-point, but it is sometimes suggested that autism is a continuum, and that mentally handicapped people who show bizarre mannerisms have 'autistic' tendencies. The result of the present study would suggest that such generalisations are not justified, and that careful study of the functional significance of such behaviours is required.

The results also indicate the value of monitoring several behaviours within one individual, rather than simply focusing on one target behaviour. The psycho-physiological data proved a useful adjunct in assessing functional significance. Moreover, monitoring several motor behaviours demonstrated the complex inter-relationships which can exist between them. For example, as complex hand movements were prevented during treatment sessions, so there were increases in rocking and other idiosyncratic mannerisms. Of even greater interest was the fact that the psycho-physiological data indicated rocking to be accompanied by effects opposite to those observed during complex hand movements. Whilst this finding requires replication and further investigation, it again suggests considerable caution should be exercised in merely labelling all 'repetitious behaviours' as 'stereotypies' as though they form a single functional class. The findings here suggest that whilst there are relationships between behaviours monitored in the study, this is not to say that they are functionally equivalent. It might be interference with one behaviour set up a stimulus situation discriminative for the occurrence of other behaviours. Exactly what such a stimulus might be, and the reinforcement relationships of the various behaviours cannot be derived from the present study. However, the present data would appear to provide sufficient evidence to merit further investigations particularly with respect to treatment interventions and the appearance of unexpected 'side-effects.'

The findings would appear, therefore, to question the concept of stereotyped behaviours as a single class, and argue for considerable caution in equating topographical and functional characteristics. The complex inter-relationships between responses indicate that single behaviours need to be viewed as part of a system, and that if this is not done, then unwanted effects may occur as a result of the treatment intervention on a single response. It might be suggested that future treatments may need to adopt multiple response monitoring as a matter of routine before conclusions about the utility of a treatment can be made.

## SUMMARY

The present study examined complex hand movement stereotypies in three severely retarded people. Both gross behavioural and psychophysiological measures were recorded during 3 experimental conditions for each personbare environment,

enriched environment, treatment (overcorrection). The results did not support the model of these behaviours as being 'de-arousing,' rather, they appeared stimulatory in function. However, the prevention of these stereotypies did lead to increases in other stereotyped behaviours. The results are discussed in terms of the various models proposed, and are seen as requiring further studies which sample several behaviours simultaneously.

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