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Effects of Neurodevelopmental Therapy on Motor Performance of Infants with Down's Syndrome

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Introduction

One of the most widely-accepted methods of treatment used by pediatric physical therapists working with the developmentally disabled is the neuro-developmental treatment approach developed in England (Bobath and Bobath 1976, Bobath 1980). Although originally developed for use with cerebral-palsied children (Semans 1967), elements of the Bobath method have been recommended for use in a wide variety of developmental disabilities (Ellis 1967).

Down's syndrome, or trisomy 21, has long been recognized as one of the most common forms of mental retardation (Kirman 1976, Coleman 1978), and accounts for at least 10 per cent of the moderately to severely retarded population (Robinson and Robinson 1976). Profound motor delays have also been documented within this population, especially during the first few years of life (Carr 1970, Cowie 1970). A marked decline in the rate of mental and motor development with age has also been recorded in Down's syndrome infants and young children (Fishler *et al.* 1964, Carr 1970, Donoghue *et al.* 1970, LaVeck and LaVeck 1977).

The present study examined the effects of the neurodevelopmental treatment approach to physical therapy on minimizing the expected decline in motor and mental development among a sample of Down's syndrome infants. Although specific intervention programs have been developed to minimize the intellectual and language deficits associated with Down's syndrome (Rynders and Horrobin 1975, Hayden and Haring 1976), there have been few reports of controlled studies specifically directed at improving motor performance of Down's syndrome children (Kantner *et al.* 1976).

Method

Participants

Twenty Down's syndrome infants participated in the study (11 female, nine male), ranging in age from 2·7 months to 21·5 months at the time of pre-testing. 18 of the infants were enrolled in the Down's Syndrome Infant Learning Program at the Experimental Education Unit of the Child Development and Mental Retardation Center at the University of Washington, Seattle. The other two were also from the Down's Syndrome Learning Program and

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were enrolled in other infant intervention programs, with goals and curricula similar to those of the Experimental Education Unit's program.

Two possible candidates were excluded from the study because cardiac surgery was scheduled during the period of the study. However, at least two of the infants included in the study were known to have serious heart defects but were not excluded because their physicians' referrals did not contra-indicate physical therapy. As is characteristic of the syndrome, all the infants had clinical evidence of varying degrees of hypotonia.

Testing procedures

The infants were tested before and after the treatment period by means of the Bayley Scales of Infant Development (Bayley 1969) and the Peabody Developmental Motor Scales (Folio and DuBose 1974). The Bayley mental and motor scales were used for each infant. Although the Bayley Scales were standardized on a sample of normal children, they have been used repeatedly to assess Down's syndrome infants (Dameron 1963, Carr 1970, LaVeck and LaVeck 1977) and have been specifically recommended as the instrument of choice for research with such infants (Eipper and Azen 1978). They were particularly appropriate for this study because they provide both mental and motor scores.

The Peabody Gross Motor Scales were also administered to each infant. They allow for a thorough and comprehensive assessment of both gross and fine motor development during the first seven years of life. Although these scales have not yet been standardized, it is expected that they will be in the near future (DuBose, personal communication).

Objectives of therapy

After pre-testing, and before random assignment to groups, four individual therapy objectives were written for each infant in the study. They were based on the results of individual assessments and were developed with the assumption that each infant would receive neurodevelopmental therapy for a nine-week period. While each objective was written individually so that it would be appropriate to a particular child's development, the objectives generally were directed toward the over-all goals of neurodevelopmental therapy. For example, a set of objectives for one infant was:

(1) S will maintain prone on elbows with head at 45° for 15 seconds.
(2) S will bring head past midline when tipped laterally to left and to right, two out of three times in each direction.
(3) S will sit propped with weight on hands for 10 seconds.
(4) S will demonstrate forward protective extension when rolled forward on therapy ball three out of four times.

During post-testing, the assessing therapist evaluated the objectives for each infant, but was unaware of their treatment group. Each objective was scored as a pass or fail. A second therapist did a covert reliability evaluation of the individual objectives for the two infants on whom post-test inter-observer reliability checks were performed, and achieved perfect agreement with the primary assessing therapist.

Groups

In order to remove sources of error from the experiment, equivalent groups were created. Before random assignment to the experimental or control groups, the infants were grouped according to age, sex and pre-test Peabody scores. Because previous studies have shown a decline in developmental quotients with increasing age among Down's syndrome infants (Dameron 1963, Carr 1970, Dicks-

Mireaux 1972), the first classification variable selected was age. Melyn and White (1973) and La Veck and La Veck (1977) have suggested that female Down's syndrome infants tend to score higher than males, especially in motor development, so the aim in classifying by sex was to have nearly equivalent numbers of boys and girls in each of the two groups. The pre-test Peabody scores were used because it was assumed that they would correlate highly with the post-test scores. The infants were rank-ordered on the pre-test Peabody scores, since this was expected to be the most sensitive dependent variable reflecting motor performance.

After the infants had been assigned to the groups, t tests were performed for group means on the three pre-test measures and on pre-test age, in order to ascertain whether significant differences existed between the groups before treatment began. No significant differences were found (Table I). There were five males and five females in the experimental group and four males and six females in the control group.

Treatment

All treatment took place at home, except for one infant who received therapy at the Experimental Education Unit after his morning pre-school sessions. Therapy sessions, each lasting about 40 minutes, were carried out three times weekly for each infant in the experimental group over a nine-week period. Infants in the control group received no additional intervention, other than their weekly involvement in their respective infant learning programs.

Parents were encouraged to observe the therapy sessions but were not directly instructed in specific techniques, since it was felt that the amount of time the parents would spend on the techniques would vary so greatly that a confounding variable might be introduced. However, if specific advice was requested by parents it was given without hesitation.

While each infant received individual treatment based on the specific objectives written after pre-testing, there were three common goals for all the infants receiving therapy: facilitation of normal postural tone; facilitation of righting, equilibrium and protective responses; and enhancement of normal patterns of movement.

Specific neurodevelopmental techniques used to increase postural tone included joint approximation through the spine and extremities, bouncing, tapping and resistance to movement (Semans 1967). Righting, equilibrium and protective responses were facilitated in prone and supine for the younger infants, and in quadruped, sitting and standing for the older ones. Developmentally appropriate movement patterns were shaped and facilitated after the activities to increase postural tone. They included pivoting in prone, rolling prone to supine and supine to prone, prone progression on abdomen, reciprocal creeping, and moving into and out of the sitting position using trunk

TABLE I
Pre-test data

	Experimental		*Control*		*t*
	Mean	*SD*	*Mean*	*SD*	
Age (mths)	10·91	7·64	9·45	6·66	—0·457
Bayley Mental DQ*	82·19	20·10	83·40	14·20	0·157
Bayley Motor DQ	69·19	26·20	70·61	16·50	0·145
Peabody Gross Motor DQ	66·76	22·00	64·61	23·40	—0·212

*Developmental quotient

rotation.

After the intervention phase of the study, all 20 infants were tested again on the same measures used for pre-testing: the Bayley and Peabody Scales. The therapist who did the pre-test assessments also did the post-testing. This therapist also evaluated the attainment of the four individual treatment objectives written for each infant.

Results

In order to test the hypothesis that the Down's syndrome infants who received neurodevelopmental therapy would show greater improvement in motor performance than those who had not, the mean gain scores on the Peabody Gross Motor Scales and the Bayley Motor Scales were compared for the two groups. To evaluate whether there was greater improvement in mental performance among the infants who received therapy, the mean gain scores on the Bayley Mental Scales were also compared for the two groups (Table II).

There was no statistically significant difference between the two groups in either motor or mental performance. While the control group exceeded the treatment group in each of the three dependent measures, analysis of developmental age gains on the Peabody Developmental Gross Motor Scales revealed that eight of the 10 treatment infants showed developmental gains equivalent to at least 90 per cent of their chronological age achieved during the course of treatment, but only five of the control infants showed comparable gains.

The fourth dependent measure used to test the main hypothesis—that greater improvement in motor performance would occur in the experimental group—was the set of four individual therapy objectives written for each infant. The statistically significant difference between the groups in attainment of these objectives (Table III) lends susbtantial support to the main hypothesis.

Discussion

The failure to find significant differences

TABLE II
t-test for gain score differences

	Experimental		*Control*		
	Mean	*SD*	*Mean*	*SD*	*t*
	(n = 10)		*(n = 10)*		
Bayley Mental DQ	—6·03	6·89	—0·75	12·40	—1·174
Bayley Motor DQ	—3·30	17·10	2·24	10·60	—0·870
Peabody Gross Motor DQ	4·00	10·20	6·93	10·90	—0·622

TABLE III
t-test for between-group differences on individual therapy objectives

	Experimental		*Control*		
	Mean	*SD*	*Mean*	*SD*	*t**
	(n = 10)		*(n = 10)*		
Individual therapy objectives* (N = 4)	3·20	0·79	2·30	1·25	—1·924

*p = 0·05

between the two groups of infants on three of the four dependent measures used suggests that this study had several limitations. The obvious one is the size of the sample. The relatively small number of infants in each group contributed to greater sampling error, as well as to lower reliability in the statistical tests used for analysis (Isaac and Michael 1971, Runyon and Haber 1976). As is true of much research on handicapped populations, it was not possible to assemble a larger group, which is always a difficulty when working with a severely handicapped population within a limited age-range. The opportunity to conduct research with as many as 20 Down's syndrome infants probably would not occur outside a large university-affiliated facility such as the Child Development and Mental Retardation Center at the University of Washington, so the small sample size was an unavoidable limitation.

Another limitation was the incongruence between the results of the three dependent measures on the Peabody and Bayley Scales and the results of the fourth measure, the individual therapy objectives. However, since very few of the Bayley motor items and less than a dozen of the Peabody items represent activities which would serve as objectives of neurodevelopmental treatment, it is not too surprising that this discrepancy occurred Nevertheless, this lack of congruence is a major limitation in evaluating the efficacy of our treatment strategy.

Because the neurodevelopmental treatment approach involves a careful assessment of the sequence and patterns of neuromuscular performance, followed by the setting of specific objectives aimed at facilitating small increments in motor abilities, a fine assessment tool able to measure these subtle changes needs to be developed. One of the main aims of neurodevelopmental therapy is the facilitation of normal postural tone, but it is extremely difficult clinically and objectively to assess precise degree of postural tone. With the exception of electromyographic procedures, which are too costly and complicated for the average pediatric treatment setting, there are no well-quantified, objective procedures for measuring changes in muscle tone. It is hoped that the present study will contribute to remedying this deficiency and will encourage further research into the important and rapidly growing speciality of pediatric therapy.

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SUMMARY

A group of 20 infants with Down's syndrome, aged between two months and 21 months, was tested initially on the Bayley Scales of Infant Development and the Peabody Developmental Motor Scales. Four treatment objectives were developed for each individual infant, and they were then randomly assigned to an experimental or control group. The experimental group were given an individual neurodevelopmental therapy program three times a week in their own homes for a period of nine weeks.

When the infants were post-tested on the Bayley and Peabody Scales, no significant difference was found between the two groups. However, there was a statistically significant difference in favour of the experimental group in attainment of individual treatment objectives.

RÉSUMÉ

Les effects d'une thérapeutique neurodevelopmentale dans l'amélioration des performances motrices chez des nourrissons mongoliens

20 nourrissons mongoliens âgés de deux à 21 mois ont été testés initialement avec les échelles de développement de Bayley et les échelles de développment moteur de Peabody. Quatre objectifs thérapeutiques ont été décidés pour chaque nourrisson et ceux-ci ont été ensuite assignés au hasard dans un groupe expérimental et un groupe contrôle. Le groupe expérimental reçut un programme de thérapeutique neurodévelopmental individuel, á domicile, trois fois par semaine, durant une période de neuf semaines.

Lorsque les nourrissons furent testés à nouveau, sur les échelles de Bayley et de Peabody, il ne fut trouvé aucune différence significative entre les deux groupes. Cependant une différence statistiquement significative en faveur de groupe expérimental fut notée dans la réalisation des objectifs thérapeutiques individuels.

ZUSAMMENFASSUNG

Erfolge einer neurophysiologischen Therapie zur Verbesserung der Motorik bei Kindern mit Down Syndrom

Eine Gruppe von 20 Kindern mit Down Syndrom im Alter zwischen zwei und 21 Monaten wurde zu Beginn der Studie nach den Bayley Scales für die Kindliche Entwicklung und den Peabody Developmental Motor Scales getestet. Für jedes einzelne Kind wurden vier Behandlungsziele festgesetzt und die Kinder wurden dann willkürlich einer Behandlungsgruppe oder einer Kontrollgruppe zugeordnet. Die Kinder der Behandlungsgruppe wurden über einen Zeitraum von neun Wochen dreimal wöchentlich zu Hause nach einem individuell abgestimmten neurophysiologischen Behandlungsplan behandelt.

Als die Kinder erneut nach den Bayley und Peabody Scales getestet wurden, fand sich kein signifikanter Unterschied zwischen den beiden Gruppen. Es fand sich jedoch ein statistisch signifikanter Unterschied zu Gunsten der Behandlungsgruppe hinsichtlich des Erreichens der individuellen Behandlungsziele.

RESUMEN

Efectos de la terapia neuroevolutiva sobre la mejoría de la realizacioín motora en niños con síndrome de Down

Un grupo de 20 lactantes con síndrome de Down, de edades entre dos meses y 21 mes, fueron examinados inicialmente según las escalas Bayley de desarrollo del lactante y las escalas de desarrollo motor de Peabody. Para cada niño individualmente fueron decididos cuatro objetivos terapéuticos, los cuales fueron asignados a un grupo control experimental. Al grupo experimental se le aplicó un programa de terapéutica neuroevolutiva individual tres veces por semana en sus propios domicilios, durante un período de nueve semanas.

Cuando los lactantes fueron examinados de nuevo con las escalas de Bayley y Peabody, no se observaron diferencias significativas entre ambos grupos. Sin embargo, había una diferencia estadísticamente significativa a favor del grupo experimental en lo que concierne a conseguir los objectivos individuales del tratamiento.

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