There is growing recognition that functional self-controlled mobility during early childhood is essential for the optimal development of children with locomotor disabilities (Rosenbloom 1975, Bleck 1977). Deleterious effects of severely restricted mobility during early childhood have been documented in non-disabled children whose mobility is restrained for medical or other reasons and in children with neuromusculoskeletal disorders. The most frequent outcome is a persistent pattern of apathetic behavior, and specifically a lack of curiosity and initiative. Studies by Beckwith (1971), Yarrow and Pederson (1976) and White et al. (1979) found that even intermittently restricted locomotion of normally developing infants produced depressed motivation and a state of apathy, with long-term effects. Becker (1975) concluded from his extensive review of therapeutic restraint that 'long-term physical restriction (instituted for whatever reason) during the neonatal, infancy or early childhood period can significantly alter and menacingly disrupt the entire subsequent course of emotional or psychological development in the involved child' (p. 239).

A passive, dependent life-style is also a commonly reported problem with motor-disabled children and adults (Oswin 1967, McDermott and Akina 1972, Gordon and Schwartz 1976, Minde 1978). Oakland and Sherman (1969) studied the behavior of 29 children with myelomeningocele and characterized them as 'strikingly poorly motivated and dependent, with an absence of curiosity about and exploration of their environment even in circumstances where their disability did not interfere with performance potential' (p. 1). Onset of this passive, dependent pattern coincided with failure of the normal development of locomotion about 12 months of age, and was increasingly manifested as inhibited locomotion progressively interfered with normal childhood activities.

Theoretically, inability to engage in successful mastery experiences in early childhood, many of which depend on locomotion, arrests the development of self-initiative and achievement motivation, leaving the child with a sense of helplessness and incompetence (Bijou and Baer 1967, Harter 1978). A generalized expectancy of helplessness extinguishes further mastery attempts and over-all activity level is reduced. Erikson’s theory of affective development (Maier 1978) specifies that locomotion is the major physical modality through which a sense of initiative is achieved. Children with severely delayed or restricted locomotion
therefore need a substitute form of locomotion, beginning as near to age one as possible. This mobility must be functional, i.e. so that spontaneous initiative to explore and achieve is not hampered by the effort of moving.

The purpose of this study was to find out whether independent mobility, achieved with a motorized wheelchair, increased the activity level of self-initiated, exploratory behaviors through communication or physical interaction with people, inanimate objects and space.

Method
The effects of independent powered mobility on three aspects of self-initiated behavior was investigated with a single-subject research design, multiple baseline across subjects (Hersen and Barlow 1976) (see Fig. 1). The two conditions of the independent variable were (a) no powered mobility in the baseline phase, and (b) independent powered mobility in the treatment phase. The dependent variables were frequency of self-initiated (a) physical interaction with objects, (b) communications with caregiver, and (c) changes of location in space. The last measure determined the degree of spatial exploration and was included because walkers, parapodiums, manual wheelchairs and other mobility aids do not necessarily result in children being significantly more mobile or exploratory. Movement may still require too much effort or motivation may be lacking.

Six children aged between 23 and 38 months were sequentially observed in a natural, free-response setting in their own homes. Their disabilities included myelomeningocele, spastic quadriplegic cerebral palsy, congenital malformation of limbs, arthrogryposis multiplex congenita and osteogenesis imperfecta. The degree of locomotor restriction is described in the Results section. All had normal intelligence and adequate upper-limb function to use a joystick control. Three two-hour samples of behavior were videorecorded at 10-day intervals to establish an estimate of the natural frequency of the target behaviors and to provide a baseline against which subsequent behavior changes were evaluated. Following baseline data collection the children received a motorized wheelchair and learned to use it to a level of proficiency defined by pre-established criteria (Butler et al. 1984). When they became independently mobile (after one to three weeks) the observation schedule was repeated. Target behaviors were coded from the videorecordings by the author and an assistant; mean interobserver reliability was 93 per cent.

Treatment effect was analyzed by observing changes in the level of behavior, i.e. the number of data points falling above and below the mid-rate level of performance (Figs. 2, 3, 4). Assuming no effect, there would be equivalent distribution of data across phases. Magnitude of individual change (Table I) was determined by comparing median scores for each phase. Magnitude of group change was assessed with a one-tailed, dependent t-test. Logarithms of the rate-minute values were used in all calculations to allow assessment of relative changes in behavior. Confidence in this type of analysis is strongest when there is (a) no overlapping distribution of data, (b) a large magnitude of change, and (c) change is replicated over all subjects.

Results
The results failed to support the hypothesis that increased frequencies would be seen in all aspects of self-initiated behavior for all the children (Table I). Nevertheless, it is important to note that while some children decreased in two of the behaviors, the treatment was effective in part with all six. Moreover, the decreases in communication were positive outcomes, in spite of the hypothesis (see Discussion). Increased change in location was both clinically and statistically significant for the whole group. The
Fig. 2. Effects of powered mobility on frequency of self-initiated changes in location. (In Figs. 2-4, the horizontal line denotes the mid-rate of the combined data for both phases; i.e. it divides the data into two equal parts. The four-cell table summarizes the number of data points in each phase above and below the mid-rate line.)
Fig. 3. Effects of powered mobility on frequency of self-initiated communication.
Fig. 4. Effects of powered mobility on frequency of self-initiated interaction with objects.
TABLE 1
Change in self-initiated behaviors based on median rates per minute

<table>
<thead>
<tr>
<th>Subject</th>
<th>Phase A rate</th>
<th>Phase B rate</th>
<th>( t^{\text{dep}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes of location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.02</td>
<td>1.74</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.03</td>
<td>1.06</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.001</td>
<td>0.97</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.50</td>
<td>1.97</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.16</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.38</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td>3.57*</td>
</tr>
<tr>
<td>Interaction with objects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2.55</td>
<td>2.05</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.85</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.29</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.92</td>
<td>1.14</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1.59</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1.84</td>
<td>2.91</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td>-0.86**</td>
</tr>
<tr>
<td>Communications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.83</td>
<td>1.06</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.60</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.73</td>
<td>1.04</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.38</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.70</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.20</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td>0.80***</td>
</tr>
</tbody>
</table>

\( p<0.05; **p<0.21; ***p>0.22. \)

group change was sufficiently large that the obtained \( t \) value was significant at the \( p<0.05 \) level, despite the small sample size.

Three of the children did have increased frequencies in all behaviors. Subject 2, a 38-month-old girl with spastic quadriplegia who was totally dependent for movement became independently mobile within 10 days. Formerly her play with the many toys provided by her mother was listless. In the wheelchair, rate of interactions with objects increased by 0.3 per minute as she explored drawers and cabinets and helped her mother with household tasks. Communications increased by 0.25. Change in experience with movement and space was the most remarkable; changes of location from one place to another in her home and outside in her yard increased by 1.03. Her parents volunteered the comment that her increased activity and heightened curiosity was 'dramatic'.

Subject 4, a 27-month-old girl with malformation of all four limbs, scooted freely but was restricted to the floor. She was generally passive and spoke in- frequently. With powered mobility there was an 0.22 rate-per-minute increase in interactions with objects, an 0.09 increase in communications, and an 0.3 increase in changing location. Her parents said she was more curious and exploratory. A 35-month-old boy with myelomeningocele (subject 6) was an active child who manipulated objects in play and crawled about slowly, but he had the lowest rate of communication. With powered mobility, both spatial exploration and communications doubled. Rate of interactions with objects increased by 1.07 per minute as he found and explored novel objects not available at floor level. His mother commented: 'His whole understanding of his surroundings has changed; he is getting into everything'.

One child increased in two aspects of self-initiative but decreased in one. At 23 months, this girl with myelomeningocele (subject 1) seldom moved, dragging herself short distances with great effort. However, she verbalized frequently and busily engaged herself with a rich variety of objects provided by her mother. With powered mobility her rate of communication increased by 0.23 per minute. Spatial experience changed drastically, up by 1.72. Although she continued to be busily involved with object play, frequency of interaction decreased by 0.5 per minute.

Two children had increases only in spatial exploration. Subject 3, a 33-month-old boy with osteogenesis imperfecta, was unable even to roll or pivot, but was extraordinarily verbal and commanded his mother's almost constant attention with crying, tantrums and demands to be nursed or carried. She provided a variety of toys which he actively manipulated. An extraordinary 9.7 rate-per-minute increase in changing location occurred with independent mobility. However, interaction with objects decreased (0.62), as did communications (0.69). The latter was positive, despite the hypothesis. Diminished talking and other demanding behaviors made him much more pleasant. Subject 5, a 28-month-old with arthrogryposis multiplex congenita, spent most of her time rolling about to touch objects on the floor. She also demanded her mother's
attention with verbal banter, but to a lesser extent than subject 3. Her mother was quite anxious about her using the wheelchair, so it only crept about and frequently stalled because the mother allowed only the slowest speed setting. Changes of location did increase, but only by 0.3 per minute. There was a 0.11 decrease in communications, and the observers perceived this to be a positive change. Interactions with objects decreased by 1.41 per minute.

Discussion
There are several possible explanations for the unexpected decreases in behaviors. Although powered wheelchairs allowed access to more of the environment and at a new level, the children were restricted to objects that could be reached from the wheelchair. The child with the greatest decrease in interaction with objects had a lower seat-height than the other children, and was further restricted because she could not reach for objects, and her mother refused to give her toys while she was in the wheelchair. The two children whose communications decreased were the most verbal and demanding, so in fact these decreases were positive outcomes. It is possible that increased independence through locomotion lessened the need for control by means of speech. An alternative explanation is that achievement of locomotion temporarily depresses some children’s interest in communication and objects in favor of moving through space.

The families were convinced that powered mobility was safe and had a favorable impact upon their child’s behavior, with no negative effects. They described improved psychosocial behaviors, as well as locomotor behaviors.

While offering tantalizing insights into possible effects of mobility, this study provides only preliminary data. The sample was small and the observational phases minimal. Longer-range effects need to be studied. Phases allowing the environment to be made more accessible to wheelchairs or to help parents promote physical independence should also be included in research design.

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Author’s Appointment

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SUMMARY
This study reports the effects of powered mobility on the self-initiated behavior of six children with various disabilities who, between 23 and 38 months of age, learnt to use motorized wheelchairs in less than three weeks. Using a multiple baseline design, two-hour observation periods were videorecorded at 10-day intervals before and after they achieved independent mobility. Frequency of self-initiated interaction with objects, spatial exploration and communication with care-giver were analyzed. Three children increased all three types of behavior, one increased in two types but decreased in interaction with objects; and two increased in spatial exploration only.

RÉSUMÉ
Effets de la motorisation sur l’initiative comportementale de très jeunes enfants présentant une incapacité de locomotion
Cette étude rapporte les effets du déplacement motorisé sur l’initiative comportementale de six enfants présentant des déficits variés, ayant appris à utiliser un fauteuil électrique en moins de trois semaines, à un âge variant entre 23 et 38 mois. Utilisant l’enregistrement à plusieurs données, des périodes d’observation de deux heures ont été enregistrées sur magnétoscope, à 10 jours d’intervalle, avant et après qu’ils eurent acquis une mobilité indépendante. La fréquence des interactions auto-initiées avec les objets, de l’exploration spatiale et de la communication avec l’éducateur ont été analysées. Les trois types de comportements ont présenté une fréquence accrue chez trois enfants; chez un enfant la fréquence s’est accrue pour deux types d’activité mais a décru pour l’interaction avec les objets; deux enfants accroissent seulement l’exploration spatiale.
ZUSAMMENFASSUNG
Der Einfluß motorisierter Mobilität auf das Verhalten sehr junger Kinder mit Bewegungseinschränkungen
Diese Studie berichtet über den Einfluß motorisierter Mobilität auf das Verhalten von sechs Kindern mit
verschiedenen Behinderungen, die im Alter zwischen 23 und 38 Monaten in weniger als drei Wochen
lernten, motorisierte Rolloßhüle zu benutzen. Anhand eines multiplen Basiskonzeptes wurden im Abstand
von 10 Tagen jeweils zweistündige Beobachtungen auf Videoaufzeichnung und zwar vor und nachdem
sie sich unabhängig fortbewegen konnten. Die Häufigkeit einer spontanen Interaktion mit Gegenständen,
einer räumlichen Exploration und einer Kommunikation mit dem Betreuer wurden analysiert. Drei Kinder
besserten sich in allen drei Verhaltensparametern, eins verbesserte sich in zwei Parametern und zwei
verbesserten sich nur bei der räumlichen Exploration.

RESUMEN
Efectos de la motorización sobre los comportamientos autoiniciados de niños muy jóvenes con dificultades
 locomotoras
Este estudio aporta los efectos de una movilidad motorizada sobre el comportamiento autoiniciado de seis
niños con diversas discapacidades que entre los 23 y 38 meses de edad, aprendieron a utilizar sillas de ruedas
motorizadas en menos de tres semanas. Utilizando un esquema de múltiples líneas basales, se graven en
vídeo periodos de observación de dos horas con ontellvals de 10 días antes y después de alcanzar
la independencia móvil. Se analizaron la frecuencia de la interacción autoiniciada con objetos, la exploración
espalial y la comunicación con el cuidador. Tres niños aumentaron los tres tipos de comportamiento; uno
aumentó en dos tipos pero disminuyó en su interacción con objetos y dos aumentaron únicamente en la
exploración espacial.

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