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## Physiotherapy for clumsy children. An effect evaluation study

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*Document Version*

Publisher's PDF, also known as Version of record

*Publication date:*  
1992

[Link to publication in University of Groningen/UMCG research database](#)

*Citation for published version (APA):*

Schoemaker, M. M. (1992). *Physiotherapy for clumsy children. An effect evaluation study*. s.n.

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## SUMMARY

The main theme of this thesis is the question whether physiotherapy for clumsy children is effective as a means of improving their movement abilities. The motive for this study was the absence of information about the effectiveness of treatment programs for clumsy children. Knowledge about the effects of treatment is important because at the moment clumsy children often do not receive the help and understanding they need in consequence of a lack of knowledge in practice about adequate forms of help.

In this thesis, attention was not only paid to the outcome of treatment, but also to moderating and mediating factors. Moderating factors are the qualities of the child, the therapist, or the environment that determine whether physiotherapy tends to be effective or ineffective. Several characteristics of clumsy children were studied as moderating factors: age, severity of clumsiness, and three social-emotional factors: state and trait anxiety, and negative task orientation. Mediating factors are more difficult to study, because they involve the processes that are operating during treatment. One aspect of treatment, 'the process of teaching motor abilities', will be studied in more detail in this thesis.

An overview of the main problems of clumsy children, as they are described in other clinical studies, is given in chapter two. By definition, clumsy children are children whose ability to perform skilled, purposive movements is impaired, despite normal intelligence and normal findings on a conventional neurological examination. The following characteristics of clumsy children were found. The movement problems of clumsy children are expressed in all kinds of activities in daily life, especially in complex tasks and tasks in which fast and accurate movements are required. Clumsiness is to be found in about 5% of the population of regular schools, and its presence is more common in boys than in girls. There is not sufficient evidence to attribute clumsiness to a dysfunction of the central nervous system, although minor neurological signs are found in some children. Clumsiness is not an isolated problem, but is accompanied by cognitive and social-emotional problems. Besides, more than half of the clumsy children keep various problems at least until puberty. Several factors appear to hamper timely identification of these children, such as the vague definition of clumsiness and the lack of age appropriate measuring instruments.

In chapter three, it was described how clumsy children were selected for participation in the present study. A group of potentially clumsy children were screened by school doctors. Eventual selection depended on performance on the Test of Motor Impairment (TOMI) and a neurological examination. Only children without a neurological disorder were selected who belonged to the 5% worst performing children on the TOMI. The matched control group consisted of children without movement problems. Before the start of treatment, movement abilities and aspects of social-emotional functioning were assessed in both clumsy and control children. In accordance with other studies, clumsy children especially appeared to have problems with fine motor skills requiring speed and accuracy, paper and pencil skills, and

skills addressing balance or the coordination of complex movements. Clumsiness was not restricted to motor problems, but a range of social-emotional problems was found: clumsy children showed significantly more signs of state and trait anxiety, judged themselves to be less competent in physical and social skills, and were found to be more isolated and insecure compared to age matched controls.

So far, product-oriented instruments were mainly used in effect evaluation studies. The use of instruments aimed at studying processes underlying movement organisation is scarce in this respect. Process-oriented assessment is based on a theoretical model, the information processing approach, which is described in chapter four. According to this approach, movements consist of a movement preparation phase and a movement execution phase. Several processes take place during movement preparation: stimulus perception, response selection, movement programming, and movement initiation. Furthermore, an overview was given of the results of previous process-oriented studies in clumsy children. With respect to the movement preparation phase, the conclusion was that deficits were found in input, central and output related processes of the information processing chain. Generally, goal-directed movements consist of two movement phases. A distance covering phase in which the hand is brought to the vicinity of the target, and a feedback-based homing phase to reach the target. The results of studies about movement execution in clumsy children indicated that clumsy children have a slower and more irregular distance covering phase than children without movement problems, followed by a time-consuming correction phase.

Three process-oriented tasks were used to assess the problems of clumsy children before the start of treatment. In chapter five, two of these tasks were presented. They involved response selection and programming of control parameters during movement preparation as well as the execution of single, goal-directed movements.

Response selection was studied in a goal-directed movement task. The nature of the movement a child had to make depended on the direction and pitch of an auditory stimulus. The complexity of stimulus information was manipulated by varying the spatial compatibility between stimulus and response and by varying the number of response alternatives. The conclusion of the results was that clumsy children reacted much more slowly and made more errors than controls in the tasks in which stimulus and response were incompatible and in which the number of response alternatives was high. Programming was investigated by determining the influence of advance knowledge about either direction or extent as a control parameter on reaction time. No differences between groups were found. Both groups needed the same amount of time to program either direction or extent.

Movement execution was studied in a task in which goal-directed arm movements had to be made over two distances, 24 and 36 cm, to different target widths (1.25 and 5.00 cm). The conclusion of this study was that clumsy children had a slower first movement phase in discrete, goal-directed movements. No differences were found between groups with respect to the duration of the homing phase.

In chapter six, the problems of clumsy children were studied in a complex task, a drawing task. Children had to draw zigzag figures of increasing complexity by heart. These figures were presented as stimuli on a video screen. Complexity was varied by manipulation of the number of movement elements. Reaction time, movement time, pause duration, fluency, and accuracy were the dependent variables.

The conclusion of this chapter was that no differences were found between clumsy children and controls with respect to the duration of movement preparation. However, movement preparation in clumsy children appeared to be more global. Consequently, additional preparation was needed during movement execution, resulting in larger pause durations compared to control children. More differences were found regarding movement execution, especially in interaction with movement complexity. Clumsy children drew more slowly, less fluent, less accurate, and with longer pauses between strokes compared to their controls. Indices were found for biomechanical differences between clumsy children and controls. Clumsy children employed less mature, proximal motor control, whereas distal motor control was employed by the control children. The movement execution problems of clumsy children, reflected in dysfluent and slower movements, hampered on-line programming of subsequent strokes. This resulted in long pauses between strokes. Controls, on the other hand, were able to adopt a parallel programming strategy, due to their more efficient motor control.

The design of the effect evaluation study was described in chapter 7. All clumsy children were treated individually by a physiotherapist twice a week, during three months. Treatment was based on the Bobath method and on sensomotor training. The clumsy group was tested twice before the start of treatment with a time lag of three months to assess spontaneous improvement. Before and after treatment, or a period of three months without treatment for the control group, all children were tested by means of product- and process-oriented measuring instruments. The results obtained by the product-oriented instruments were presented in chapter 7. The influence of five moderating factors on the effectiveness of treatment was investigated as well. After the end of treatment, clumsy children were tested again after three months without treatment, to determine the long-term treatment effects.

The results indicated that physiotherapy for clumsy children resulted in important improvements in motor skills of all clumsy children. Various sub-tests of the TOMI and the ABC revealed improvements, like moving fast with the whole body, ball catching, and static balance. The effects of treatment were maintained over a three-month period after the end of treatment. Trait anxiety appeared to be a moderating factor influencing treatment outcome. Clumsy children with trait anxiety appeared to benefit more from treatment than children with less trait anxiety.

The process-oriented instruments of chapters five and six were used to evaluate effects of treatment on components of movement organization, and the results were presented in chapter eight. The use of process-oriented measuring techniques has been very fruitful in this effect evaluation study. After treatment, the rate and accuracy of the response selection process during movement preparation had improved in

clumsy children. The control group had hardly improved. No effects were found regarding the duration of single goal-directed movements, but large improvements were found in more complex movement tasks, like drawing. After treatment, clumsy children drew faster, more fluently, and with less time-consuming pauses between strokes. Negative task orientation was found to be an important moderating factor in treatment. Children with a negative task orientation showed large performance gains on response selection after treatment compared to children with a less negative task orientation.

In order to gain more insight in the content of treatment one aspect of treatment, the process of teaching, was studied in chapter nine. An observation scheme was developed for this purpose. The use of observational techniques to investigate the verbal activities used by a physiotherapist to teach motor skills to clumsy children has proven to be very useful. First, it was investigated whether the therapist acted according to the principles of sensomotor training. Secondly, the results were compared with research findings about motor learning in literature. According to sensomotor training, a child has to discover the feeling for correct movements by itself. This implies that very few directions are given during treatment. The results indicated that this was what was actually happening. The child was urged on a lot by many instructions. Only verbal instructions were given, because demonstrations do not fit in with the notion that the child itself should discover how to move. Demonstrations have received a lot of attention in motor learning research, but the results are not quite conclusive. The use of extrinsic feedback, which is found to be an important learning variable in motor learning research, was restricted to general feedback on positive results. Finally, the concept of teaching strategies was discussed, but its usefulness for clinical practice still remains unclear. Although no causal connections can be inferred, the way of treatment used by the physiotherapist was accompanied by improvements in motor abilities of all clumsy children.

Evaluation of the use of important principles derived from motor learning theory and research, such as demonstration, feedback, and strategy learning, provided future directions for research. Application of such methods may enhance the effects of therapy even further.

In chapter ten, the conclusion of this study was described, and some implications for practice were given. The general conclusion of this study was that physiotherapy for clumsy children led to favourable outcomes on both motor tests and measures of aspects of movement organisation. However, some problems still have to be solved. Firstly, future studies will have to rule out the possibility of a placebo effect underlying treatment effectiveness. Secondly, the generalizability of the results is still limited because only one therapist was involved. The effects of physiotherapy will have to be investigated on a larger scale in the future. Regarding the implications for practice, we hope that the results of this thesis will help to change the attitude occurring in practice that treatment is pointless. Consequently, more clumsy children may receive the help and understanding they need. Furthermore, this study may confirm therapists in their views that physiotherapy for clumsy children is meaningful.