Improvement after cerebellar injury achieved by coordination dynamics therapy

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Coordination dynamics therapy of changing intensity was administered at home for nearly 8 years (at the beginning at low intensity) to a patient who had suffered a severe injury of the cerebellum (and of the cerebrum). Motor functions improved markedly during the first year of rather intensive therapy (by 42%), but there was but little improvement in the 5 following years (by 27%). An intensive 3-week coordination dynamics therapy was administered after 4 years of quantified therapy at an up-to-date therapy place under optimal conditions. The motor functions improved strongly (by 29% in 13 days). Therapy under professional conditions was shown to be much more efficient (by the factor of 150 as quantified by low-load coordination dynamics values) than that at home. A comparable patient with a brain (cerebral) injury improved slightly more under optimal conditions (by the factor of 390). In the patient with the injury of the cerebellum, the largest improvement concerned speech and higher mental functions.

The strong improvement during the 3-weeks of optimal therapy may have partly been due to the enhanced training of CNS symmetries. It thus seems that not only phase and frequency coordination between neuron firings has to be improved by the therapy, but also symmetries in CNS organization.

Key-words: Cerebellum – Injury – Coordination dynamics therapy – Repair – Mental functions

Introduction

Schalow Coordination Dynamics Therapy has been shown to be able to improve the central nervous system (CNS) functioning after stroke (1), traumatic brain injury (2, 11), spinal cord injury (3, 5), cerebral palsy (7, 9), in Parkinson's disease (6, 8), and after hypoxic brain injury (10). In two previous papers it was shown that impairment of the CNS functioning caused by severe injury of the cerebellum could partly be quantified by surface electromyography (electrophysiology) and coordination dynamics measurements (kinesiology). When exercising on a special coordination dynamics therapy and recording device with different combinations of arms and legs in forward and backward direction, right-left, rostral-caudal, and forward-backward symmetry impairments of CNS movement organization could be quantified (12, 13). This paper contains a report on the improvements of CNS functioning achieved by treating the patient with the severe injury of the cerebellum. As the treatment was administered with increasing and decreasing intensity over 8 years, information could also be obtained on the long-term therapy of this condition. The outcome of the long-term treatment will be compared with an optimal therapy approach at an up-to-date therapy place in patients with cerebellar and cerebral injury.

Method

Schalow coordination dynamics therapy was administered to the patient with cerebellar injury.

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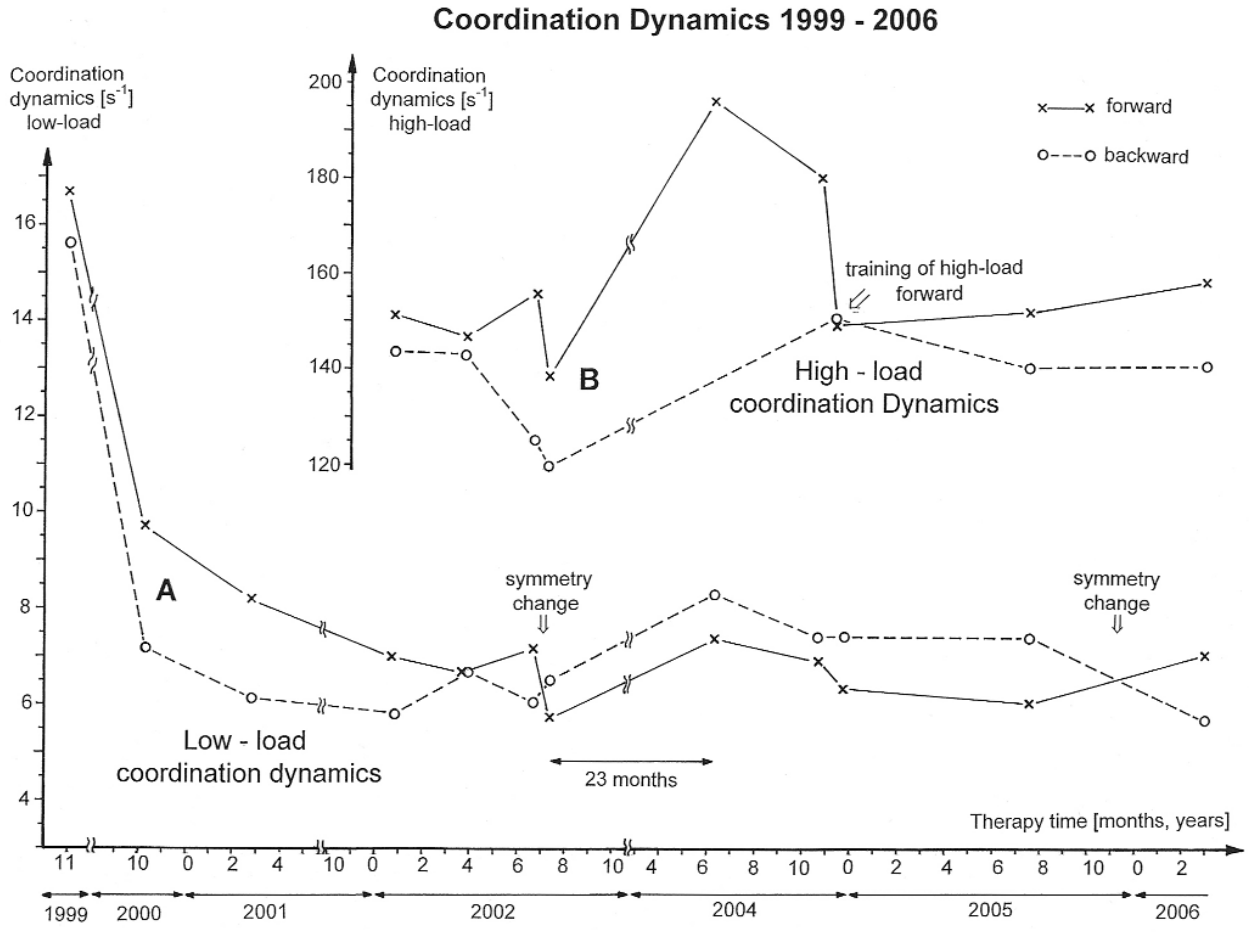

Fig. 1. – Relation of coordination dynamics to therapy length. Low-load coordination dynamics between 1999 and 2006, and high-load coordination dynamics between 2002 and 2006. Crosses and solid line = exercising in forward direction, open circles and dashed lines = exercising in backward direction.

After 3 weeks of diagnostic and therapy update in 2004, it was tried to exercise all the movements in combination with their symmetric counterparts (because of the learning transfer) to enhance therapy efficiency. For further details of the therapy methods, see Ref.12 (previous paper).

Results

Values of coordination dynamics measured between 1999 till 2006

In the patient who had suffered a severe injury of the cerebellum, improvements in the CNS functioning were quantified by the coordination dynamics values for low-load and high-load (between 1999 and 2006, and between 2002 and 2006, respectively) (Fig. 1). The administered coordination dynamics therapy was not regular and was performed at home under the supervision of the author. At occasions, the intensity of the therapy was high for up to one month, sometimes there was nearly no therapy at all. The patient however did exercise nearly regularly on the special coordination dynamics therapy device.

As can be seen from Fig. 1, at the beginning of the therapy during 1999 to 2001, there was a strong improvement (reduction) in the values of the low-load coordination dynamics for exercising in the forward and backward direction followed by only little changes over 2002- 2006. At the beginning of the therapy (until 2002), the values of coordination dynamics for exercising in backward direction were better than those measured for exercising in forward

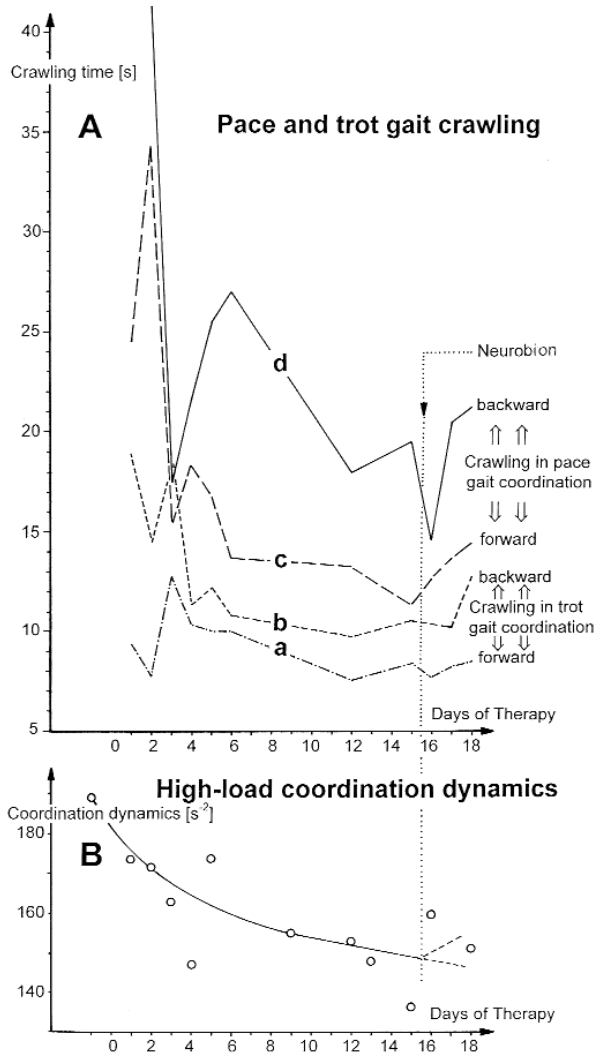

Fig. 2. – A. Relation of high-load coordination dynamics to days of therapy. B. Relation of forward and backward crawling in pace and trot gait to days of therapy. Note that Neurobion administration was associated with worsening in the different kinds of crawling and in high-load coordination dynamics.

direction. After high-load exercising on the special coordination dynamics therapy device was started and the intensity of the therapy was increased, the symmetry of the CNS organization changed (Fig. 1). Better values could be obtained for exercising in the forward than in the backward direction. From July 2002 onwards, the patient exercised only little for the next 23 months. The values for low-load and high-load coordination dynamics worsened (increased) again. The organization of the patient's CNS worsened with respect to movements. With an optimal therapy at an up-to-date therapy place for 3 weeks at the end of 2004, movements, low-load and high-load (Fig. 2B) coordination dynamics improved. The progress faded again, as soon as the intensity of the therapy diminished. A further symmetry change occurred for the low-load coordination dynamics between 2005 and 2006 (Fig. 1).

Between 1999 and 2006, the values of low-load coordination dynamics improved from 16.6 to 7.0 s^{-2} (58%). In the first year, the value improved from 16.6 to 9.6 (42%), and in the following years from 9.6 to 7.0 (27%). The value of high-load coordination dynamics did not improve (Fig. 1B), probably because of the interruption of the therapy for 23 months.

In conclusion, the values of coordination dynamics could not be further reduced substantially from 2002 onwards, probably because the therapy was not sufficiently intensive and continuous. Coordination dynamics improved when the patient received more therapy, and worsened again when the patient exercised only little or not at all. With this patient, a principle problem was encountered. Because of a severe problem with keeping balance, the improved movements could only little be used and trained in everyday life.

Since motor functions like walking improved only little, there is indication that in this patient after severe injury, the values of coordination dynamics are a quite good reflection of the quality of the CNS organization with respect to movements.

Intensive therapy under optimal conditions

When there was no substantial progress any more the question arose (as earlier in severe cerebral injury (11)), whether the patient had reached his limits of improving CNS functioning with respect to coordination dynamics therapy or not? To clarify this important therapy issue, a 3-week therapy under optimal conditions was administered to the patient at an up-to-date therapy place.

The results of this intensive 3-week-therapy are shown in Fig. 2. During the 13 days of optimal therapy, the values of high-load coordination dynamics improved by 26% (Fig. 2B). The value of low-load coordination dynamics (not shown) improved by 29%. When the patient was taking one tablet Neurobion® (containing mainly 100 mg Vitamin

B_1 + 200 mg Vitamin B_2 + 20µg Vitamin B_{12}) the movements and the coordination dynamics worsened: the value of high-load coordination dynamics worsened by 8%.

Before this 3-week-therapy period, the patient could only crawl a bit forward in trot gait coordination. He could not crawl in pace gait coordination and could not crawl backwards. To enhance the efficiency of the treatment by inducing learning transfer from movements to their symmetry movement counterpart, crawling in pace and trot gait was trained now in forward and backward direction. Fig. 2A illustrates the improvements in crawling. The mean crawling times in trot and pace gait coordination for forward and backward movement improved by 48% in 14 days. Administration of Neurobion was associated with a worsening of crawling times by 28%.

In conclusion, the functioning of the CNS in this cooperative patient might still be much more improved if coordination dynamics therapy is administered intensively, over longer periods of time (for several months), and at an up-to-date therapy place.

Comparison of home therapy and therapy under professional supervision

The value of low-load coordination dynamics improved by 58% between 1999 and 2006. The improvement seen between 2000 and 2006 was 27%. During the 13 days of optimal treatment, the value for low-load improved by 29%. The efficiency of optimal and home therapy differs by the factor of 84, when considering the 6 years (29%/13 days = 2.23%/day; 58%/365•6 = 0.0265%/day; 2.23/0.0265 = 84) and by the factor of 149 when considering the last 5 years (29%/13 days = 2.23%/day; 27%/365•5 days = 0.015%/day; 2.23/0.015 = 149).

Improvement of higher mental functions, speech, and writing

The coordination dynamics therapy the patient was receiving was far from being optimal. As a consequence, improvement in coordination dynamics and movements were limited. It is nevertheless sure that the therapy was worthwhile since considerable improvements could be achieved in higher mental functions and the speech. At the beginning the patient showed scanning speech and it was difficult to listen to him over longer periods of time. Over the years, a normal discussion became possible. The patient also received speech therapy, mostly during the exercising on the special coordination dynamics therapy device. Hyper-salivation subsided already after 6 months of therapy.

Improvements of higher mental functions became partly reflected in the improved impression of the patient's face (Fig. 3). Before the accident (a), the face shows mental strength. Four months after the accident (b), the face seems to be that of another person: as if everything was lost. Seven (c) and 10 months after the accident (d), the impression of the face partly recovered, but there is a strong over-emphasizing of the feelings reflected in the face. Nineteen (e) and 20 months after the accident (f), a further recovery in the impression is distinguishable. Still, a slight over-emphasizing of the feelings can be seen. Forty months after the accident (g), some of the old impression of the face is back. Forty-four months after the accident, the face became really similar to that seen before the accident; the face still misses mental strength. Ten years after the accident (i), also some of the mental strength re-appeared in the face.

In reality and as suggested by his appearance, the patient is still not the old one. His mental strength has not been fully repaired. He himself says that before the injury he could do two things at the same time: "Listening to somebody and developing at the same time a strategy against the opponent person. This is not possible any more". In practical life he has still problems; he additionally suffered a frontal lobe injury (Fig. 1 of Ref.12).

After the accident that caused the severe cerebral and cerebellar injury, the patient's wife was advised to place the patient in a place, where human bodies are kept until they die. Instead of following the advice, the wife was fighting for her husband's future; having learned about coordination dynamics therapy, she organized to start it approximately 2 years after the accident.

Dr. Cwienk's (the patient) intellect recovered that much that the author sometimes asks him for advice, since the patient has much more expertise than the

Color?

Fig. 3. – Therapy-related improvement of the impression of the face of the patient who suffered severe cerebellar injury: before the accident (a), after the accident (1995) till 2006 (b-i).

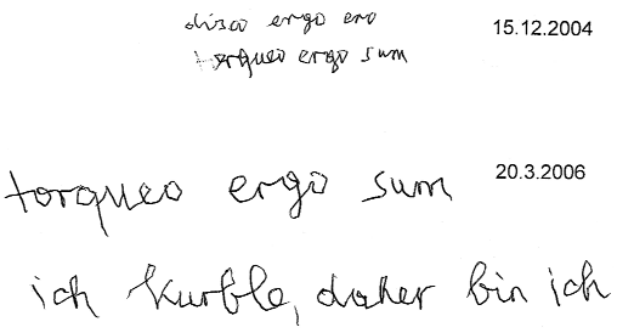

Fig. 4. – Handwritings of the patient who suffered severe cerebellar injury as a reflection of goal-oriented movements (the task of cerebrum-cerebellum).

author in certain fields. This is actually a bit of a dream of a research worker who tries to repair the human CNS. One gets a patient after CNS injury, who has been given up by the school medicine, and after treatment the patient's intellect partly exceeds that of the research worker himself. It was this Dr. Dieter Cwienk (Austria) who asked in the past why we don't let patients who suffer severe brain injury die if we are not giving them the proper available treatment. To leave the patient to vegetate until the remaining functions of his body die is undignified for the humans (10).

The goal-directed movements (cerebrum-cerebellum) in this patient are still limited and were not specially trained. His writing is still poor (Fig. 4) and he does not train it. For written communication, he mainly uses computer. A small improvement in hand-writing may have occurred between 2004 and 2006 (Fig. 4). In 2006, the letter "o" in 'torqueo ergo' has more corners (mostly 5) than in 2004 (mostly 3) (Fig. 4). It thus seems that the hand-writing has become smoother, even though the size of the letters is larger in 2006.

Discussion

Difference between home training and professional therapy

It could be shown here that motor functions of a patient after severe cerebellar injury improved. However, the improvement was only little when related to the 6 years of therapy. It was shown further in a 3-week trial that the motor functions improved strongly (between 29% and 48%) when the therapy was administered at a professional place. A 6- to 12-month treatment at a professional place would have been needed to substantially improve the CNS functioning in this patient. It has been reported earlier that in severe brain injury (cerebral injury) the efficiency may even differ up to a factor of 390 (11) between home therapy and professional therapy at an up-to-date therapy place. Professional therapy means that the therapy is based on human neurophysiology data, based on the theory on the repair of the human CNS, and is based on scientific publications in international journals. For the time being, the major problem in relation to CNS repair is not a scientific but an organizational one.

Problems of keeping balance in severe cerebellar injury

The therapy administered at home was only a part of the problem of the limited progress. Another significant problem was that the patient had a primary severe problem with keeping balance because of the severe cerebellar injury. Due to this, improvements of movements could not be transferred to everyday life's movements and could not be trained in everyday life. In everyday life, essentially balance (vestibulocerebellum) is needed to be able to perform movements, antagonistic muscle activation (spinocerebellum) is needed, and goal-directed movements (cerebrocerebellum) are needed. All these attributes were impaired in this patient.

Schalow coordination dynamics therapy and neurogenesis

Schalow coordination dynamics therapy claims to be able to help to repair CNS functioning by enhancing functional and structural repair. Structural repair means building of new nerve cells, growing of new connections, and functional integration of the new cells and connections into existing networks. Why, then, no structural repair did take place in these 6 years of treatment? So far it seems that substantial structural repair does only occur if intensive therapy lasts for periods exceeding 6 months. The patient could not receive continuous therapy of such length because of organizational reasons. Also,

the cooperative patient (aged about 65 years) was arguing that he also wanted to live rather than spend his life training only. The argument of the author that the time spent on therapy will provide a longer period of life with a higher quality did not sufficiently impress the patient.

Comparison between cerebral and cerebellar injury

Both, the patient with predominantly a cerebral injury (11) and the patient with predominantly a cerebellar injury (this paper) improved strongly at the beginning of the therapy. Both patients received optimal therapy at an up-to-date treatment place after home therapy ceased to induce very much further improvement. Under professional treatment, strong improvements (by approximately the factor of 100) could be noted in both patients. There was slightly a stronger improvement in values of low-load coordination dynamics in the patient with severe cerebral injury (by the factor of 390) than in the patient with cerebellar injury (by the factor of 150). It seems therefore that injuries of the cerebellum may also impair motor learning (14).

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