Apraxia in stroke patients
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Apraxia is a disorder affecting the purposeful execution of learned and meaningful skills. Apraxia is one of the classic neuropsychological syndromes, along with aphasia, agnosia and amnesia. A patient with apraxia has difficulty with, or is not able to perform learned and purposeful activities. By definition, these disturbances in the organisation of voluntary actions are not due to primary motor or sensory impairments. Neither are these difficulties the result of lack of motivation, attention, memory or comprehension. Other impairments may be present in the stroke patient, but these deficits are not the main cause of the inability to perform purposeful acts. Diagnosis and treatment of apraxia have as yet not been structured systematically nor investigated properly. Elaboration on, and further research in this field of rehabilitation is necessary. In the present study a program for assessment and treatment of apraxia in stroke patients was developed and evaluated.

In chapter 1 a brief introduction of the study is given. The purpose of the study was twofold. First, development of a diagnostic procedure and examination of the quality of the diagnostic instruments; and second, development of a treatment program and evaluation of the effects of treatment.

A review on apraxia is presented in chapter 2. Apraxia is frequently found in stroke patients, and occurs mostly following left-hemispheric lesions. Apraxia is sometimes associated with aphasia, because of involvement of contiguous structures. Many different classifications, taxonomies, and forms of apraxia are described in the literature; however, a generally accepted taxonomy for the apraxias is not available. Two forms of apraxia that have been the object of many studies were described in more detail: ideational and ideomotor apraxia. For the assessment of apraxia numerous testing procedures and scoring methods are found in the literature, but results are often inconsistent and confusing. Clinicians trying to diagnose apraxia are confronted with many other problems as well: clinical testing batteries for apraxia are hardly available, and clinicians mainly rely on personal experience and clinical reasoning; in addition, apraxia is frequently accompanied by several other cognitive deficits; and finally, patients with apraxia can fail when performance is requested, but may act correctly when behaviour is spontaneous. Treatment of apraxia has not been the subject of many research studies, and neither has much attention been paid to the identification of prognostic factors. So, at present few data are available.
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on methods and efficacy of rehabilitation of apraxia. Occasionally, the results of the rehabilitation of a single case are reported.

In chapter 3 the ICIDH is presented as a framework for studying apraxia. Apraxia can be studied at two conceptual levels: at the level of the impairment, apraxia can be defined as the breakdown of the concept or plan of action, or implementation of the concept into a motor program, while at the level of disabilities the patient with apraxia experiences restrictions in the ability to carry out purposeful ADL-activities (Activities of Daily Life). Next, an overview of different treatment methods in cognitive rehabilitation is given, of which in the present study strategy-training is chosen for the rehabilitation of apractic patients.

The assessment procedure which was developed is described. Two instruments are used to assess (1) the presence and severity of apraxia (i.e. a neuropsychological apraxia test at the level of the impairment) and (2) consequences of apraxia for daily life (i.e. ADL-observations at the level of disabilities). The apraxia test consists of two subtests: demonstration of object use (i.e. to test for ideational apraxia) and imitation of gestures (i.e. to test for ideomotor apraxia). The goal of this test is to differentiate between patients with apraxia and patients without apraxia, thereby offering a method to objectify the clinician's impressions. Disabilities following apraxia were assessed by means of a set of standardized ADL-observations. Guidelines were offered for the observation and assessment of four ADL-activities. Each activity is conceptualized as being composed of three aspects: initiation, execution and control. By assessing the aspects of which an activity consists and by giving an overall judgement of the level of independence, the nature of the disabilities should be identified and plans for treatment can be formulated accordingly. The principles of strategy training are incorporated into a program, designed for assessment and treatment by occupational therapists. Treatment is aimed at improving the performance of apractic patients by teaching them strategies, which enable them to function more independently, despite the probably lasting presence of apraxia. At the end of this chapter the study research questions and the research design are presented. The following research questions are answered:

- do the subtests for ideational apraxia and ideomotor apraxia measure the same underlying concept (chapter 4)?
- does the apraxia test have sufficient discriminative capacity to differentiate
between persons with and persons without apraxia (chapter 4)?
- to what extent do two observers agree when they independently observe the same patient performing ADL-activities (chapter 5)?
- do the items of the observational scales collectively measure the same underlying concept (chapter 5)?
- is the observational procedure valid in measuring apraxia and its consequences (chapter 6)?
- do changes occur in the functioning of patients who have been treated according to the guidelines of the therapy program (chapter 7)?
- what individual factors predict the outcome of the therapy program (chapter 8)?

In chapter 4 the internal consistency and the diagnostic value of the apraxia test are presented. The internal consistency was determined by computing Cronbach's alpha, and by performing Mokken scale analysis; the testscores of a group of 44 stroke patients with apraxia were used. On the basis of Cronbach's alpha (0.96) as well as the results of the Mokken scale analysis (Loevinger's H=0.72; rho=0.97) it appears that the two subtests for ideational apraxia and for ideomotor apraxia together form a strong and consistent scale. This finding indicates that the two subtests measure the same underlying concept and that it is not possible to distinguish between the two forms of apraxia on the basis of this test.

The diagnostic value of the test is expressed by means of the sensitivity, specificity and the predictive value. The diagnostic value was determined by comparison of testresults in three groups of subjects: 44 stroke patients with a clinical diagnosis of apraxia, 35 stroke patients without a clinical diagnosis of apraxia and 50 healthy nursing home residents with no prior history of stroke. The results indicate that the sensitivity and specificity of the test are good. This conclusion is illustrated by a Receiver Operator Characteristics (ROC) curve, depicting the interaction between the indices: the area under the curve represents the overall accuracy, indicating sufficient discriminative capacity. It was concluded that the test enables a differentiation between persons with and persons without apraxia. Various possible cut-off points for the apraxia test were considered; the optimal cut-off point depends on the specific aims of assessment.
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Chapter 5 describes the investigation of the internal consistency and the inter-rater reliability of the observational method for the assessment of the disabilities resulting from apraxia. The internal consistency of the ADL-observations was expressed by means of Cronbach's alpha and a Mokken scale analysis; the scores of 42 stroke patients with apraxia were used. The indices alpha (0.94), Loevinger's H (0.58) and rho (0.94) raise excellent values, which indicates that the scales of the observations together form a strong and consistent scale.

The inter-observer reliability was determined by means of percentages of agreement, Cohen's kappa, and intra-class correlation coefficients. The results showed that when two observers observe the same patient performing ADL-activities, fair to good agreement is obtained: the lowest Kappa value was 0.70, indicating fair agreement, while the reliability of the total scale was by far the best (ICC=0.98). The inter-observer reliability of the three aspects of an activity (initiation, execution and control) were not completely satisfactory. Several factors affecting the reliability were discussed: the observers, the instrument, and the subjects being observed. Training sessions are recommended in order to improve the reliability of these scores. Overall the instrument is internally consistent and a reliable method for the assessment of disabilities in stroke patients with apraxia.

In chapter 6 the validity of the ADL-observations was investigated: does the instrument display differences in scores between patients with apraxia and patients without apraxia (clinical validity or diagnostic value) and to what extent does the assessment method measure consequences of stroke which are specific to apraxia (construct validity). Comparison of the results of a group of patients with apraxia (n=45) and a group of patients without apraxia (n=36) showed that the clinical validity of the ADL-observations is good. Highly significant differences between the groups were found for the ADL-observations. The construct validity was examined by means of correlational analyses and a LISREL analysis. The ADL-observations were significantly associated with apraxia (r=0.43; gamma=0.35), but to a lesser, but significant degree with motor impairments (r=0.37); while motor impairments correlated significantly and strongly with the Barthel index (a general measure of physical disability; r=0.57; gamma=0.50), but marginally with the ADL-observations (r=0.37). The findings indicate that the ADL-observations indeed seem to measure disabilities which are caused by the presence of apraxia.
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In chapter 7 an evaluation of the therapy program for stroke patients with apraxia is presented. To determine whether the program was successful in this respect, a group of apractic patients (n=33) was treated according to the guidelines of the treatment program for a period of 12 weeks. The outcome was studied in a pre-post test design. Large improvements were found on all target measures of disability (i.e. ADL-observations, Barthel index, and ADL-questionnaire), while the improvements seen on the apraxia test and motor functioning test (i.e. the control tasks) were significant but small. The effect sizes for the disabilities were large (ranging from 0.92 to 1.06) compared to the effect sizes for apraxia (0.34) and motor functioning (0.19). These results were supported when changes in individual functioning and subjective improvement were considered. A MANCOVA for repeated measures was executed to test the change in ADL-functioning while correcting for the change in apraxia and in motor functioning, and while correcting for the time since stroke. The improvements in ADL-functioning are significant when these three covariates are taken into account. The results suggest that the therapy program is successful in teaching patients compensatory strategies, which enables them to function more independently, despite the lasting presence of apraxia.

In chapter 8 it was investigated which additional cognitive and motor impairments are present in stroke patients with apraxia and which of these factors influence the effects of treatment. The following variables were analyzed as prognostic factors: additional neuropsychological deficits (comprehension of language, dementia-like cognitive impairments, neglect, and short term memory), initial level of motor functioning, baseline severity of apraxia and ADL-performance, and some relevant patient characteristics (gender, age, type of stroke, time since stroke, and location of treatment). The results show that the presence of apraxia is associated with the presence of additional cognitive and motor impairments. However, the outcome of treatment is not negatively influenced by this cognitive comorbidity nor by motor impairments. The outcome seems to be more prominent in patients who are more severely impaired at the start of rehabilitation in terms of the degree of motor impairments, the severity of the apraxia and the initial ADL-dependence. The ADL-observations, however, display a ceiling effect, which is taken into account in discussing these results. Demographic variables, especially age, did not predict the outcome of treatment. We conclude that there is no indication that the effect of strategy-training
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is weaker in more severely disabled patients. Neither the presence of additional cognitive impairments nor the severity of motor problems nor old age should be an indication for refraining from treating patients with apraxia.

In chapter 9 some methodological issues are considered: the size of the study sample, the age of the control group, the design of the outcome study and of the prognostic study. Next, the main findings of the study are reviewed. As regards the assessment of apraxia it is concluded that two useful, reliable and valid instruments were developed, measuring apraxia as close to the impairment level as possible by means of a neuropsychological apraxia test; and the consequences of apraxia for daily life by means of standardized ADL-observations in a more ecologically valid context. This seems to be one of the first studies offering diagnostic instruments of which the quality in terms of the reliability and validity were determined. As regards treatment it is concluded that this kind of strategytraining had a strong positive effect on the level of independent functioning in patients with apraxia; this study was one of the first to show this outcome. Effects of generalization could not be established due to the research design; this remains an important issue to address in further studies. Finally, implications for clinical practice and implications for further research are discussed.