WORDS IN ACTION

Retrieval errors in aphasia, a topic for therapy

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Woorden in actie

woordvinding bij afasie, een reden voor therapie

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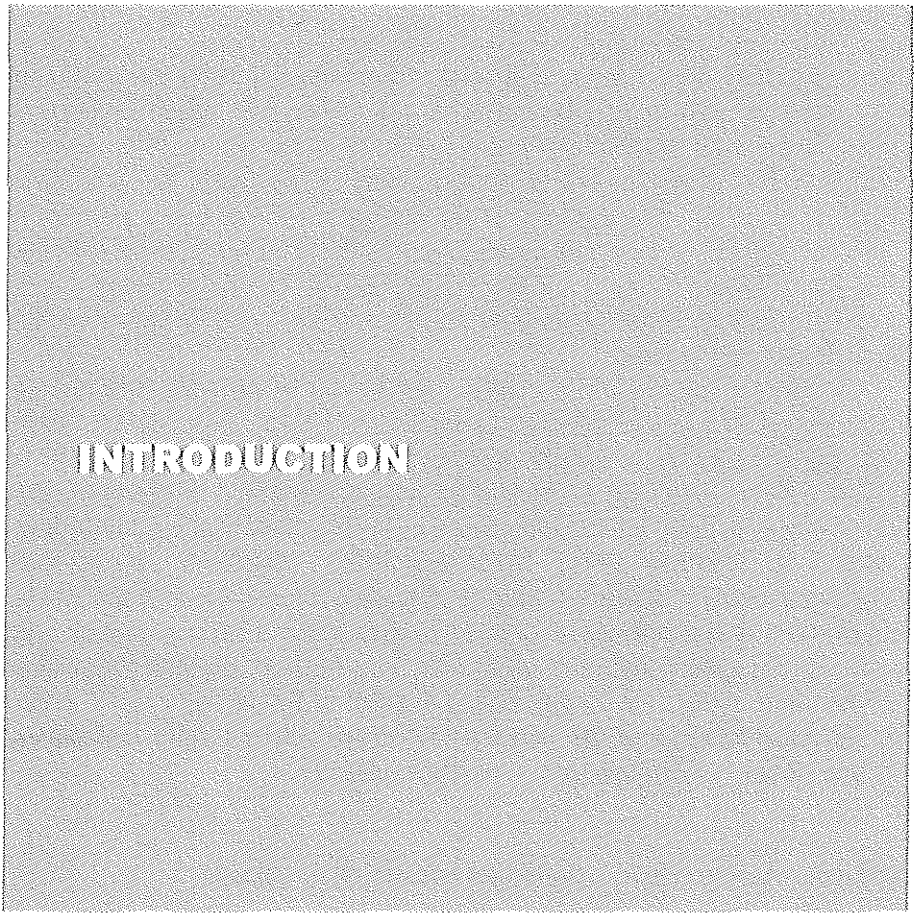
Voor mijn moeder, Mart Brink

Two formidable questions clamour for an answer before any truly scientifically based therapy can be attempted. First, what is the exact nature of dysphasia? Second, what is the speech therapist's target in undertaking these cases for treatment?

Frances M. Hatfield, 1971

CONTENTS



Introduction

An aphasia is defined as an acquired impairment of language based on brain damage (Benson & Ardila 1996). All modes of language use may be involved: spontaneous speech, writing and comprehension of written and spoken language. Therefore, aphasia is labelled as a supramodal language disorder. The nature and severity of the disorder in each language mode may vary between and within individual patients.

The most common etiology is a cerebrovascular accident (Tonkonogy 1986). The incidence of aphasia is about 20% of the total amount of patients with a stroke (Pedersen et al. 1995; Hier et al. 1994), 5000 patients a year in the Netherlands (Blomert 1994). Of the 279 patients referred to the Rotterdam Stroke Data Bank during 1998, 60 patients had aphasia (21,8%).

Recovery mainly occurs in the first weeks to months and decreases gradually up to one-year post onset (Benson & Ardila 1996). The initial severity of aphasia is the most reliable outcome measure (Pedersen et al. 1995; Kertesz 1998): an initial prognosis can be made as early as the fourth day post onset (Biniek et al. 1992). The accuracy of the predictions for recovery are closely connected with the tests or rating scales used. In the acute stage, these tests and rating scales should be short and easy to administer. The disadvantage is that they lack specificity about the nature of the disorder and consequently about the linguistic recovery pattern.

A persistent aphasia will put severe restrictions to daily life functioning. For patients with a severe aphasia communication may be impossible in nearly every aspect, even in a well-known environment (De Renzi et al. 1991). Aphasic patients with a moderate to mild aphasia confirmed in interviews that their problems in daily life functioning are caused by their language disabilities (Ledorze & Brassard 1995). Their complaints concerned mainly their expressive problems, which are more obvious than comprehension impairment. Patients with a rest aphasia frequently complain about their problems with conversational speech and with social talk. Very seldom, patients can resume their previous duties. They often find it difficult to follow the current events and the newspapers and the news on television are not fully understood. Reading a book or writing a letter is nearly impossible.

Linguistic characteristics of spontaneous speech in aphasia

Irregularities in spontaneous speech are the most prominent markers of aphasia both for patients and their conversational partners. The initial clinical observation of the patient concerns the quality of the informational content of the patient's speech in terms of 'does the message get across?' The aphasia scale of the Scandinavian Stroke Scale (SSS) (Pedersen et al. 1995) illustrates that speech production is the focus of the first clinical evaluation. According to this scale a patient 'who can say only "yes" and "no", or less' is rated as severe aphasia. A patient 'who can say more than "yes" and "no", but not longer sentences' is rated as moderate aphasia and a patient who 'has limited vocabulary or incoherent speech' is rated as a mild aphasia.

To get an idea about the quality of auditory comprehension, the clinical observer asks the patient: 'Point to the window', 'Give me a hand' etc. An experienced clinical observer should be able to classify the patient into one of

the main aphasia types (see below) based on the clinical picture as obtained by a short interview of the patient.

The majority of patients with a chronic aphasia will receive language therapy. Therefore, the underlying language deficit has to be uncovered by a more detailed analysis of the spontaneous speech and further testing. Words and sentences are the main focus of the spontaneous speech analysis. Words may be distorted by errors in the word sounds (phonemes), or by errors in the word meaning. Sentences may be deformed by grammatical or word finding deficits. In patients with a severe aphasia, words and sentences may be distorted in such a degree that they are unrecognisable. In addition to the errors on word and sentence level, the linguistic behaviour of the patient like error awareness, has to be analysed.

The following error types and linguistic behaviour are considered to be characteristic for aphasic patients:

Word level

Phonemic paraphasias, non-existing words with a recognisable target, 'crocodile' becomes 'cocorcile'. The speech sounds are mixed up or erroneous (Buckingham 1986).

Phonic verbal or formal paraphasias, existing words with phonemic similarity to the target, 'table' becomes 'lable' (Blanken 1990).

Neologisms, phonologically induced (most common sense), non-existing words for which it is impossible to discover the target (Buckingham & Kertesz 1976), 'mumpaling' (Dutch neologism)

Neologisms, semantically induced, circumlocutory words, 'white snakethings' (spaghetti).

Neologisms, perseverative, non-existing words, built on a semantic paraphasia, 'dikkes holgert *woggebij* and finally *waggebee*' (Dutch neologisms), Buckingham 1981).

Semantic paraphasias, wrong words that are related in meaning to the target, 'radio' for 'television'. The critical features that mark the meaning of the word are not completely available (Butterworth et al. 1984).

Circumlocutions, substitution of a word by a description, 'interpreter' becomes 'many people visit me and ask for a foreign language'.

Sentence level

Agrammatism, telegraphic style, function words (grammatical words such as articles, prepositions, pronomina, auxiliaries) are omitted: 'December Christmas tree man children' (Kolk & Heeschen 1990).
Paragrammatism, disturbed grammatical structure. Different structures are mixed up: (Question: how long have you been there?) 'How very long I was have been there?' (Heeschen 1985).
False starts, the patient does not finish the sentence, because of word finding difficulties. 'Yesterday I..., I went to...., My friend and I....'
Empty speech, content words are omitted or replaced by generalisations. 'He takes the things to do with him'.

Beyond word and sentence level

Jargonaphasia, most words in the spontaneous speech are neologisms or semantic paraphasias (Kertesz & Benson 1970).
Recurring utterances, repetitive sounds, words or parts of speech. 'do.do.do.' 'moosj moosj moosj' 'better tomorrow better tomorrow' (Code 1989).

Linguistic behaviour

Selfcorrections, a sign of error awareness. 'My uncle, brother came yesterday'.
Conduite d'approche, repeated selfcorrections (Kay & Ellis, 1987). Sometimes the correct word comes up the patient is not aware of it and makes a mistake again, 'I was in Alia, Austar, Laria, Australia, Larstia'.
Press of speech, talkativeness with no attention to the conversational partner (Damien Martin 1981).
Nonfluent, the patient talks slowly, the speech tempo is less than 90 words a minute in contrast with normal fluent speech: over 150 words a minute (Wagenaar et al. 1975).

Classical aphasia typology

Together with the patient's functioning in the other language modalities, in particular comprehension, the characteristics of the spontaneous speech determine the aphasia type. The following syndromes, related to different neuro-anatomical lesion localisation, are worldwide assumed to be relevant in clinical practice (e.g. Goodglass & Kaplan 1972, 1983).

Broca aphasia

Effortful, nonfluent, monotonous, often agrammatic speech, phonemic paraphasias, articulatory difficulties. Speech comprehension: reasonably good. Communicative ability: moderate.

Clinical picture: The patient needs much time to express his intentions. The hearer might be embarrassed by the overt struggle of the patient in bringing the message across. Generally the message is comprehensible, as in particular the content words (nouns, verbs, adjectives) are preserved.

Wernicke aphasia

Fluent melodious speech with a lack of adequate content words. They are substituted by generalisations (empty speech) or distorted by phonemic and semantic paraphasias or neologisms (neologistic jargon). Press of speech. Self-referential speech. No error awareness. Speech comprehension: bad. Communicative ability: bad.
Clinical picture: The patient has much communicative drive, but adequate information is lacking. He/she is not aware of it and keeps talking.

Amnesic aphasia

Fluent speech with pauses, false starts and circumlocutions, caused by a prominent word finding deficit. There might be formal paraphasias and conduite d'approche (not always successful). The presence of selfcorrections indicates error awareness. Speech comprehension: reasonably good. Communicative ability: good.
Clinical picture: The patient resolves his/her overt wordfinding problems by rather successful verbal strategies. Word recognition is preserved: often the patient asks the hearer to assist him/her in the word search.

Global aphasia

Nonfluent or fluent recurring utterances, no speech at all, or neologisms with a sparse high frequent concrete word. Comprehension: bad. Communicative ability: bad.
Clinical picture: A severely handicapped patient without much intention and possibilities to communicate.

Conduction aphasia

Fluent with phonemic paraphasias and selfcorrections, often conduite d'approche. There might be a slight agrammatism. Comprehension: reasonably good. Communicative ability: good.

Clinical picture: The patient gets entangled in his own words by his phonological impairment, especially in repetition of multisyllabic words and needs to slow down his speech rate to reduce the phonemic distortions. Because the non-existing words are recognisable, generally the message is understood.

Diagnostic assessment of aphasia

The diagnostic tests used to classify aphasia according to the above-mentioned subtypes, generally consist of an interview, object naming, repetition, reading aloud, comprehension of spoken and written language. All tasks require responses on the level of words and sentences. Commonly used diagnostic tests in the English-speaking community are: the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan 1972, 1983), the Western Aphasia Battery (Kertesz 1982), and in Europe the Aachener Aphasia Test (Huber et al. 1983; Graetz et al. 1992). The assessment of aphasia according to type and severity is their primary aim. The average time of administration is one to one-and-a-half hour. A relatively stable stage of aphasia is required for an adequate interpretation of the results.

Linguistic levels in aphasia: diagnosis

The traditional typology is inappropriate for the selection of patients with respect to linguistic therapy, because the aphasia type gives no or very few clues for the underlying linguistic deficit. The aim of linguistic therapy is the amelioration of those linguistic skills, which are required for being an adequate communicator. Language can be described in terms of different levels of organisation (see Lesser, 1989). Disruptions on those levels are not bound to a specific aphasia type. However, restoration of the patient's functioning within those linguistic levels is extremely important as the base for the development of functional communicative strategies. In linguistic theory and in clinical aphasiology the following linguistic levels are distinguished:

Phonology, the organisation of sounds to convey differences of meaning: the features 'voiced' versus 'voiceless' distinguishes the phonemes /b/ and /p/ in 'bath' and 'path'.
Main speech characteristics of patients with a phonological impairment: phonemic paraphasias, phonic verbal paraphasias, phonologically induced neologisms, perseverative neologisms, recurring utterances.
Aphasia types: Broca aphasia, Wernicke aphasia, Conduction aphasia.

Semantics, the patterns of meaning: the combination 'the sun shudders' is abnormal, because the noun and the verb do not share the semantic feature 'human'.
Main speech characteristics of patients with a semantic impairment: semantic paraphasias, empty speech, semantic jargon, perseverative neologisms.
Aphasia types: Wernicke aphasia, Global aphasia.

Syntax, the word sequence within sentences: 'it is impossible to visit Denver, because there something is wrong with the engine' is ungrammatical.
Main speech characteristics of patients with a syntactic impairment: agrammatism, paragrammatism.
Aphasia types: Broca aphasia, Wernicke aphasia.

Descriptions of the patients' functioning on those levels are of vital importance for rehabilitation (see Lesser & Milroy 1993; Visch-Brink & Bastiaanse 1997). Different linguistic disorders imply different treatments.

However, none of the aforementioned diagnostic tests is equipped to establish a linguistic disorder. To measure impairments at the various linguistic levels, specific tests are developed. For the detection of phonological disorders, the Dutch adaptation of the PALPA (Kay et al. 1992, Bastiaanse et al. 1995) is very useful. For the assessment of semantic disorders the Semantic Association Test (in press), described in Visch-Brink & Denes (1993) and the semantic subtests of the PALPA are suitable. For a syntactic impairment the Syntactic Test Battery (Bastiaanse et al. in press) will be available.

No data are available about the frequency of occurrence of linguistic level disorders separately or in combination. An estimation of the clinical relevance of a specific linguistic level diagnosis is impossible at the moment.

Linguistic levels in aphasia: therapy

The primary goal of aphasia therapy is to maximise the patient's communicative abilities. A basic distinction in therapy is the functional - linguistic one. Functional therapy is directed at the amelioration of the strategies required to participate in daily life with the aphasic handicap. The aim of linguistic therapy is to improve the disordered skills on a specific linguistic level: the word sound, the word meaning or the grouping of words to sentences. Generally the patient will receive both kinds of therapy.

The positive influence of therapy on the aphasic symptoms remains under discussion, particularly among the medical profession. There are only a few randomised trials in aphasia research, which evaluate the efficacy of aphasia therapy, with rather negative results. Lincoln et al. (1984) did not find a difference between a treated and an untreated group of patients. Counselling appeared to have the same effect as aphasia therapy (Hartmann & Landau 1987). However, data about the therapy methods and the patient selection are not presented (Van Harskamp & Visch-Brink 1998).

More specificity about the therapeutic approach and the selection criteria is given in the large amount of single and multiple case reports (a.o. Springer & Willmes 1993; Mitchum & Berndt 1994). Most evaluative studies, with promising results, concern linguistic therapy (see further). Functional therapy is less explicitly described and therefore more difficult to evaluate.

The aim of linguistic therapy is to heighten the patient's abilities within the linguistic levels via their structural elements: phonemes (phonology), semantic features (semantics) and content and function words (syntax).

The main goal of phonological therapy is to facilitate the selection and seriation of speech sounds in speech production. A successful therapy should reduce the number of phonemic distortions in the patient's speech. Therapeutic tools described in the literature are: naming with phonological cues, rhyme judgement, reading aloud and repetition (e.g. Nettleton & Lesser 1991; Raymer et al. 1993).

The aim of semantic therapy is a better recognition of the semantic features of content words. The therapy has been effective if it enhanced the amount of adequate content words in spontaneous speech. This is accompanied by a better comprehension. Word discrimination directed at the aspects of meaning is reported to be the most suitable therapy (Butterworth et al. 1984). Useful techniques are auditory/written word-picture matching, word categorisation, judgement of semantic relatedness, antonym/synonym judgement for auditory

word pairs (e.g. Nettleton & Lesser 1991; Ledorze et al. 1995; Nickels & Best 1996a, 1996b; McNeil et al. 1997).

The objective of syntactic therapy is the improvement of sentence production. Therapy methods vary from the heightening of the patient's awareness of the sentence structure by an external visual scheme (Van de Sandt-Koenderman et al. 1998) to an explanation of the 'sentence semantics' ('who does what to whom?') (Nickels et al. 1991). Another opposite approach is the stimulation of the agrammatic production in conversation (Kolk & Heeschen 1990; Schlenck et al. 1995; Van de Berg & Kolk 1996).

Generally structural linguistic therapy is applied in the initial stage of rehabilitation (see van Harskamp & Visch-Brink 1991). The aim is two-fold:

a. to enlarge the patient's insight in his main deficit.
b. to improve the patient's abilities in the most distorted linguistic level.

After the period of structural linguistic therapy, the patient is stimulated to use his linguistic skills to exchange information in different communicative settings (Marshall 1998).

Word finding disorders: what kind of therapy?

Disorders in wordfinding constitute the most basic obstruction in communication in aphasic patients. The patients are either able to communicate to some extent by means of circumscriptions or they cannot communicate at all. Often, the listeners lose attention. The patient will either be frustrated or remains unaware of the meaninglessness of his message. Phonological and/or semantic disorders are reported to be mainly responsible for word finding deficits in aphasia and require a selective structural linguistic therapy (see Nickels1997).

During the last two decades a number of papers appeared on naming performance as an evaluation of some kind of semantic or/and phonological intervention (Seron 1979; Howard et al. 1985a, 1985b; Pring et al. 1990; Marshall et al. 1990; Nettleton & Lesser 1991; Nickels & Best 1996a, 1996b). Compared with phonological therapy, semantic therapy proves to be a better facilitator in naming: both a long term effect and a generalisation effect to untrained objects have been observed. In contrast with phonological therapy, semantic therapy aims at the central level of language-processing models and therefor influences both language production and comprehension.

However, neither in the Netherlands nor in other countries, elaborate phonological and semantic therapy methods, with various degrees of difficulty

are available. The development of such therapeutic tools with the emphasis on semantic therapy seems to be justified with the following premises:

a) Lexical semantic processing, the functional interpretation of words, has to be distinguished from visual semantic processing, the functional interpretation of pictures versus objects. The semantic tasks used in the above-mentioned evaluative studies consist for the greater part of word/picture matching tasks. However, there is much discussion about whether or not there is a relationship between visual and lexical semantics (Shallice 1993). As long as this issue is not resolved, it seems to be justified to restrict semantic therapy to one of both components. Since making semantic decisions about words is stressed in the literature as being the pivot of lexical-semantic therapy (Butterworth et al. 1984), a pure lexical semantic therapy programme would be preferred.
b) The critical ingredients for a lexical semantic and a phonological therapy program are largely unknown. Semantic tasks, mentioned in the literature, generally appeal to visual and lexical semantic processing. Phonological therapy is generally restricted to repetition or/and reading aloud. To elicit relevant therapeutic tasks, patients with lexical semantic and phonological disorders have to be observed.
c) Since generalisation to daily life situations is the ultimate goal of aphasia therapy (Lesser & Milroy 1993; Van Harskamp & Visch-Brink 1991), the efficacy of semantic and phonological therapy has to be proved in verbal communication. Progress on a naming task does not automatically imply that the patient can use those abilities in daily life.

Aim of the thesis

The aim of the thesis is to explore semantic and phonological disorders in aphasic patients to be able to develop and evaluate appropriate therapeutic methods with a preference for lexical semantic therapy.

Approach

To introduce the reader in the field of aphasia therapy, an overview is given of the aphasic patient's route through the diagnostic and therapeutic stage. The rehabilitation of the aphasic patient entails utilising a variety of related

measures to help guide the patient towards functioning as near as possible his or her premorbid level. Language therapy is only one of those measures.

The main topics of interest were phonology and semantics. Two explorative studies have been conducted with single-case descriptions of patients with phonemic distortions to get acquainted with their disorders, their behaviour in blockades during speech, and their resolving strategies. Those observations were needed as a base for the development of a phonological therapy, which is used now as a control therapy in the current Rotterdam Aphasia Therapy Study. In a group study patients with the most severe phonological deteriorations: recurring utterances, are described.

To figure out the need for lexical semantic therapy, the occurrence of semantic disorders in aphasia was investigated in a group study. Lexical semantic therapy is primarily suitable for patients with verbal semantic disorders. Therefore, verbal semantic disorders (failures in word meaning) were distinguished from visual semantic disorders (failures in the interpretation of objects). To get more insight in the relationship between the visual and verbal component of the semantic system, a longitudinal multiple case study was performed in which the deterioration of both components was examined.

Based on those observations, a lexical semantic therapy was developed, and subsequently evaluated in two pilot studies as a preparation for the randomised trial, which is currently running. In the first pilot study we examined whether the therapy program could improve semantic processing. Two patients were treated with the program. In both patients semantic processing improved. This could not be explained by spontaneous recovery as they were treated more than one-year post onset. To minimise the influence of general factors on the success of therapy, a second multiple case pilot study was performed in which lexical semantic therapy was compared with phonological therapy. In addition to semantic tasks, a general evaluation measure was used to get an impression of the influence of the therapy on the quality of everyday communication.

Objectives

What is the value of linguistic diagnosis and therapy in the management of aphasic patients? (chapter 1).

What is the underlying linguistic mechanism of recurring utterances in a patient with a Broca aphasia (chapter 2) and in patients with a global aphasia (chapter

3)? Is it possible to unblock spontaneous speech in a Broca patient with recurring utterances (chapter 2)?
How does a persistent selective phonological disorder manifest itself during course in a patient with a conduction aphasia? What is the contribution of a neurolinguistic speech processing model for the interpretation of the disorder? (chapter 4)?
What is the frequency of verbal semantic disorders in aphasia due to a cerebrovascular accident? Do the verbal semantic disorders interact with visual semantic disorders? What is the relation with aphasia type and aphasia severity (chapter 5)?
What is the clinical picture of verbal semantic disorders in four patients with a semantic dementia? Can a process of deterioration give insight in the relationship between verbal and visual semantic processing? (chapter 6).
What should be the content of a lexical semantic therapy programme, suitable for patients with a moderate to mild aphasic disorder? Is it possible to improve verbal semantic processing in patients with a chronic aphasia with lexical semantic therapy? (chapter 7).
What is the efficacy of lexical semantic therapy for everyday communicative abilities in comparison with phonological therapy? (chapter 8).

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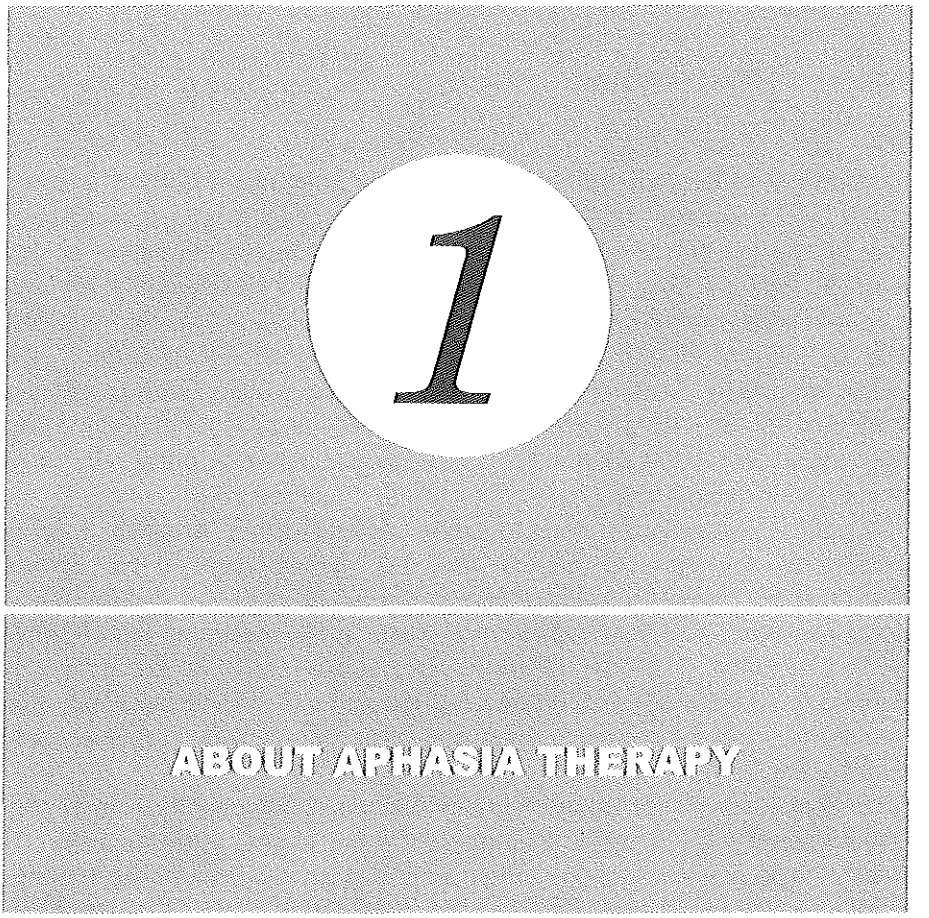

Introduction

The approach described here is based on our experience with aphasic patients referred to the Rotterdam Aphasia Foundation[1]. Up to 1995, this organisation was a co-operative effort of all nursing homes in the area and the department of Neuropsychology of the Institute of Neurology, University Hospital Rotterdam-Dijkzigt. Patients were investigated for their clinical complexity, for theoretical interest, but mostly to assess prognosis for therapy and to determine the content of therapy.

[1] Stichting Afasie Rotterdam (SAR), Rehabilitation Centre "Rijndam"

Routes to aphasia therapy

70% - 80% of the aphasic population consists of stroke patients. What are the possibilities in management for the general practitioner (GP) of a stroke patient? The greatest amount of aphasic stroke patients appeared to have been in hospital before admission to a nursing home, rehabilitation or day treatment centre (75%). High-aged patients with good care facilities are kept at home. Admission to a nursing home does not mean a permanent stay. The staff of nursing and paramedical personnel attempts to rehabilitate the patient maximally. They aim for discharge from the nursing home to either a residential or the patients' home. At home, neurological rehabilitation can take place in a day-treatment centre annex nursing home or in a rehabilitation department.

Cognitive impairment due to stroke usually plays a minor role in determining the type of facility that the patient requires for further rehabilitation. Patients are placed largely on the basis of age and degree of motor handicap. The Dutch Consensus about stroke treatment (Van Crevel 1991) concluded: "The use of healthcare facilities by a stroke patient is incorrectly determined by factors such as age and motor handicap rather than type and severity of cognitive impairment and the presence of behavioural disturbances".

Patients over 65 are admitted to nursing homes for rehabilitation or they spend several days a week in a day-treatment centre. Patients under 65 usually go to a rehabilitation centre, with a maximum stay of six months. Outpatient therapy is also available in rehabilitation centres or outpatients clinics.

In using the term 'aphasia therapy', it is important to distinguish between 'guidance', defined as the provision of supportive measures, and 'systematic therapy', henceforth called 'structural therapy', as a structured approach to achieve a certain goal. The two terms not only differ in their objectives but they also differ with regard to the patients addressed. Supportive measures are indicated for all aphasic patients from the beginning; to receive structural therapy, certain conditions must be fulfilled (Van Harskamp & Visch-Brink 1991).

The inpatients of the nursing homes mostly will receive guidance. They are relatively old, and a great proportion of these patients exhibit severe aphasia, often complicated by other neuropsychological disturbances. The outpatients, who receive structural therapy in the outpatient service, tend to be younger, and less severely handicapped.

Diagnostic procedure

Stepwise diagnosis

The diagnostic team consists of a neurologist, a neuropsychologist, a clinical linguist and a speech therapist. Speech therapists in nursing homes provide guidance and therapy and also refer patients to the diagnostic team. The Rotterdam Aphasia Foundation uses 'stepwise diagnosis', so that only patients who are suitable candidates for treatment receive an extensive diagnostic assessment (Figure 1.1).

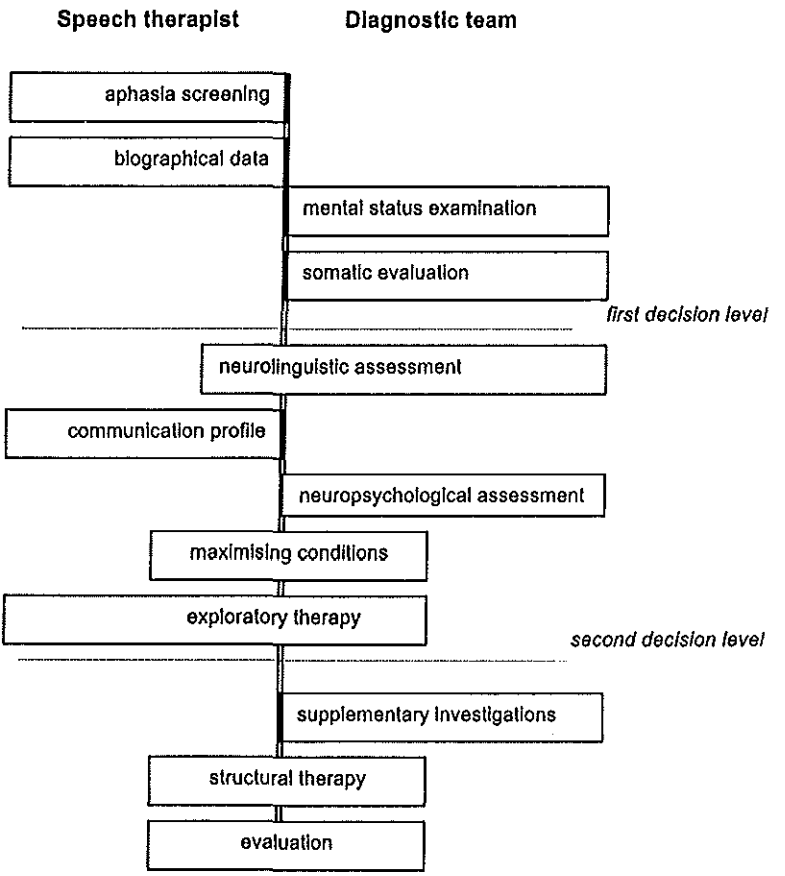

Figure 1.1. Diagnostic assessment aphasic patients

After aphasia screening, biographical data and family data are gathered. The neurologist carries out a mental status examination with a judgement about the somatic status in terms of prognosis and complications to be expected: the first decision level. Communicative abilities are assessed, and neurolinguistic and neuropsychological investigations are conducted.

An attempt is made to maximise learning conditions by trying to change factors that might interfere with progress. Exploratory therapy is conducted: the second decision level. Sometimes more than two decision levels are needed before structural therapy is begun; supplementary investigations help to define the precise goal of therapy.

The Axes System

The information gathered during the pre-therapeutic assessment is structured along five axes analogous to the DSM III-R system (Van Harskamp & Visch-Brink 1991).

Axis I *Aphasia syndrome*
Here data in relation to the aphasia syndrome are mentioned such as the aphasia type and severity, the patient's performance on the various linguistic sublevels, the communicative behaviour.

Axis II *Physical condition*
Patients are categorised regarding the underlying disease together with prognostic factors concerning life expectancy and morbidity, especially the occurrence of somatic complications. The medical history of the patient is important to ascertain concomitant diseases and risk factors such as hypertension, diabetes mellitus.

Axis III *Neurological and neuropsychological disturbances*
The existence of neurological disturbances are described such as hemiplegia, hemianopia, sensory problems of eyes and ears, together with neuropsychological disturbances such as ideomotor apraxia, visual-spatial problems, attention and memory disorders.

Axis IV *Psychosocial stressors*
On this axis those factors in the psychosocial environment are considered, that can either inhibit or disturb treatment such as the occurrence of recent

life events or problems, which could arise due to (premorbid) personality traits of the patient.

Axis V Social circumstances
Important distinctions here are: financial status, housing, and the social network of the patient.

The axes system provides information about general features, which are important to the selection for structural therapy and the choice of a therapeutic approach. The intention of the system is to give an overview and a check on the important variables, which determine prognosis and course of the aphasia. This implies that before treatment is undertaken the patient is assessed on the basis of this information and an expectation is formulated about the chance in success. It might occur that during therapy problems come to surface which were not known earlier or which are denied by the family but which have led to discontinuation of treatment. When evaluating treatment it is not only important that one does notice improvement in communication of the patient or a change in the patient's behaviour but also that one checks out the complications and problems, which occur during treatment and which were not foreseen. One should continue determining the therapeutic aim or goal only for those patients for whom a chance of success is present.

Pre-therapeutic assessment

Pre-therapeutic assessment includes: Disease-oriented diagnosis, Therapy-oriented diagnosis, Maximising conditions, and Exploratory therapy. The observations in those stages will lead to the planning of Structural therapy. Each stage is described below.

I Disease-oriented diagnosis
The mean duration of the stay in hospital is relatively short. The activities of the neurologist in the acute stage are centred on diagnosis and treatment of the disease, to prevent and overcome complications. Important is the extent and localisation of the lesions and associated lesions such as old infarcts, lacunes and leucoaraiosis. Essential in the planning of a rehabilitation program is the delineation of the prognostic factors concerning the ultimate outcome especially with regards to mortality and morbidity.

Van Harskamp (1989) found a positive correlation between the complications occurring in the hospital and later on during therapy.

The initial aphasia diagnosis is made as part of the mental status examination, often bedside. The diagnosis concerns rather the presence and the severity of the aphasia than the aphasia type. The initial severity grade appeared to be a relevant outcome predictor for the prognosis (Wallesch et al. 1992; Basso 1992; Pedersen et al. 1995). The ability to communicate in a spontaneous speech interview was a better predictor for the degree of recovery than the other subtests of the Aachener Aphasia Test (Wallesch et al. 1992). An important prognostic factor is the degree of recovery in the first two weeks (Pashek & Holland 1988). However, there is a lack of linguistic tools suitable to measure this recovery, both in spontaneous speech and in the various language levels.

A classification of the aphasia according to the traditional aphasia types should be preliminary; in the acute stage the clinical picture can change rapidly and the patient is often not in the shape to perform a lengthy diagnostic procedure. It takes several weeks (two weeks for a mild aphasia, ten weeks for a severe aphasia) to reach a more stable language level (Pedersen et al. 1995). For some patients towards the end of the hospital stay there is a need to make a more firm decision about the future. In that case an extensive aphasia examination and judgement of cognitive abilities take place, sometimes on an outpatient basis shortly after discharge. As known the importance of establishing an aphasia syndrome in order to localise the lesion is clearly diminished (Willmes & Poeck 1993).

The activities of the speech therapist concern guidance of the family and the enhancement of the communicative interaction between patient, nursing staff and family members. Useful techniques are stimulation in which various communicative channels are used simultaneously or the employment of deblocking techniques, which elicits responses in a disturbed modality (Springer 1989).

II Therapy-oriented diagnosis

Mostly this part of the diagnostic procedure takes place after the hospital stay. The core is an analysis of the communication problem by the identification of the specific disabilities in relation to the severity and type of aphasia. The degree of functional communication has to be assessed. An outline of the concomitant disorders is given.

Formal Language Assessment

The first step is to establish the nature and the severity of the aphasia by examining the diverse language modalities: spontaneous speech, naming, repeating, reading aloud, auditory comprehension, and reading comprehension. The Akense Afasie Test (Graetz et al. 1992) is the most useful instrument. The psychometric characteristics are outlined in Graetz et al. 1991, Willmes et al. 1991 and in De Bleser et al. 1991. There are norms for German, English, Italian and Dutch, providing the possibility to compare patients with the international literature and to co-operate to a cross-linguistic group study.

Byng et al. (1990) criticise the use of aphasia batteries resulting in anatomically based diagnostic categories. They argue that the diagnosis will be based on surface symptoms, while the same symptom can be a result of different underlying deficits. They suggest to use a "hypothesis driven" assessment by choosing the relevant tasks for a particular patient (see also Lesser & Milroy 1993; Mitchum & Berndt 1995; Seron 1997). The development of speech processing models in the eighties according to cognitive neuropsychological and/or neurolinguistic assumptions (see for an overview Butterworth 1993) gave new prospects for a fine-grained analysis of the disorder.

For a number of patients it will indeed be necessary to conduct a more detailed psycholinguistic investigation to specify the underlying deficit. Such an approach is extremely useful for those patients having a relatively bad performance in one of the language modalities, f.i. in reading or a selective disorder in one of the linguistic levels: phonology, semantics, and syntax. The therapeutic methods, which are available, are mainly directed to the various linguistic levels.

Extensive case studies, for the greater part published by British groups have shown that model-based and sufficiently detailed location of the deficit can be vital to plan successful therapy methods (a.o. Nickels & Best 1996). In the United Kingdom Kay et al. (1992) developed the Psycholinguistic Assessment of Language Processing in Aphasia (PALPA), an extensive set of tests to investigate separately the psycholinguistic levels, that can be used for such a hypothesis-driven assessment. In co-operation Dutch research groups from Groningen and Rotterdam developed a Dutch version of the PALPA (Bastiaanse et al. 1995). Especially the tasks for the assessment of phonological disorders are extremely useful. The performance on those tasks is critical for the assignment of FIKS, a phonological therapy program (Van Rijn et al. in press).

For disorders of semantic processing the Semantic Association Test (SAT; Visch-Brink & Denes 1993; Visch-Brink, Denes & Stronks, in press) is developed in international EC-co-operation[2]. This test will be standardised in several languages. The test is to be used as a clinical tool to detect disorders in semantic processing and dissociations in input and output channels. For patients with a bad performance on the SAT, a lexical-semantic therapy: BOX (Visch-Brink et al., 1997; Visch-Brink & Bajema, in press) is available.

Patients showing syntactic problems in spontaneous speech can also benefit from more detailed linguistic assessment. For those patients, a syntactic test (Van de Sandt-Koenderman et al. 1997; Bastiaanse et al. in preparation) is suitable to measure disorders in syntactic production and comprehension. Both tests fit in with syntactic therapy: respectively the Visual Cue Program (Van de Sandt-Koenderman et al. 1997) and a verb production therapy (Bastiaanse et al. 1996).

Assessment of Functional Communication

In addition to the tests suitable to measure the neurolinguistic background of the speech disorder, assessment of functional communication is needed to get a picture of the communicative activities and possibilities a patient has, given this language disorder.

Functional assessment should be an integral part of the therapy-oriented diagnosis and the evaluation of therapy (Taylor-Sarno 1969; Seron 1979; Holland 1982; Lomas et al. 1989; Herrmann et al. 1989; Blomert 1990; Manochioping et al. 1992; Crockford & Lesser 1994). The goal of therapy lies within the functional appliance of what is learned in therapy. Standard aphasia batteries are not fit to evaluate this properly. For a full understanding of patient's communicative abilities in daily life, one would like to follow the patient around for a couple of days, as Holland (1982) did. In clinical practice this would be a hazardous enterprise both practically and financially impossible.

This leaves us with the problem of designing an instrument that gives us relevant, valid and reliable information. In the Netherlands, two instruments are developed to give insight in the communicative behaviour of aphasic patients in daily living: the 'Communication Profile' (Wielaert & Visch-Brink 1990) and the Amsterdam-Nijmegen Everyday Language Test,

[2] ESCAPE: Cross-linguistic Assessment.

ANELT (Blomert et al. 1991, 1994, 1995). The Communication Profile appeared to be useful as a checklist of daily language use and enables the therapist to give a detailed profile of the patients' communicative behaviour. The scoring on an 11-point scale is based on an observation period, which is carried out during the first two or three weeks after the patient was referred to the speech therapist. Experience, both in using the instrument and in dealing with aphasia, is mirrored in a consistency of use of such an observation scale. This includes one of the main objections that are made against this kind of scales.

The ANELT consists of a controlled set of 10 daily life scenarios trying to elicit oral verbal output. The answers are judged on understandability (informational content, scale A) and intelligibility (clarity of speech, scale B) both on a 5-point scale. The test is explicitly designed as an instrument for the assessment of verbal communicative abilities and for the assessment of change. With the ANELT, a reliable tool for the assessment of functional oral language in a semi-structured setting is created. A German-language and an English-language version of the test are available. The ANELT A-scale 'understandability' relates strongly to 'communicative behaviour', the first rating scale of the AAT-spontaneous speech analysis.

A useful addition to the ANELT is the Partner Communication Questionnaire, described in Blomert 1995. This Questionnaire mirrors the ANELT: the partner is required to rate the communicative abilities of the aphasic in various everyday life situations on a 5-points-scale. The reliability of partners (in long-standing aphasic families) appeared to be high: their judgements reflected the performance on the ANELT.

Neuropsychological assessment

Aphasia may be embedded in a complex of cognitive disorders. The presence of aphasia might even have an unfavourable effect on general cognitive functioning, since language is nearly inextricably bound up with human mental activity (Hochstenbach et al. 1998). Consequently, those authors have shown that the presence of aphasia had a 'disruptive effect' on cognitive functioning, measured with verbal and nonverbal response tests.

Neuropsychological testing, including assessment of intelligence, concentration, memory, arithmetics and executive control should be part of the diagnostic process for aphasic patients.

The screening of those functions would give more insight in the predictors for the outcome of therapy. Moreover, a neuropsychological examination before therapy might detect a post stroke dementia or an ongoing process of

Alzheimer disease, both contra-indications for an intensive structural therapy. De Koning et al. (1998) denoted 23.7% of a consecutive series of 300 patients as having a dementia.

One of the few studies having examined the influence of neuropsychological factors on the success of therapy, is the study of Goldenberg et al. (1994). The authors found that recall of nonverbal material should be strongly related with the success of therapy. Their explanation illustrates the test problems in aphasia: the nonverbal memory tasks should have a more narrow relationship with the memory of linguistic knowledge than the verbal memory tasks. The performance on the verbal tasks was thwarted by the patients' aphasia.

An aphasic patient's success in developing strategies and learning to make abstractions and generalisations in the newly acquired way of communicating might depend for a part on intelligence. Patients with a low score on the Raven Progressive Matrices are excluded from structural therapy by Legh-Smith et al. (1987). However, in our data no relationship can be detected between intelligence as measured by RCPM and the outcome of therapy as judged by the speech therapist.

Previously learned information is assumed to be the basis upon which new material is learned. Slowness of information processing should be the most prominent neuropsychological disorder in stroke patients (Hochstenbach et al. 1998) and may impede the learning process. The generalisation of that what the patient learns in therapy might be restricted by disorders in the executive functions: the amount of initiative, self-monitoring behaviour, concept shifting and flexibility. This behaviour should be independent of the patient's linguistic deficits; the severity or the nature of the linguistic disorder is reported as not being related to the executive control functions (Glosser & Goodglass, 1990).

It is not self-evident that aphasic patients choose the easiest, for them most effective response for a particular situation. Many problems emerge, such as an inability to explore a variety of options concerning a given task and the lack of flexibility in shifting from one response mode to another. Some patients may be 'stuck' in a response set, such as gesturing and might not profit from the therapists' modelling. Others may never use what they learn outside the therapist's room, a problem frequently seen in those using augmentative speech resources. The patients' learning patterns will differ, and this will influence the mode and the duration of therapy. A productive learner may invent new applications and require therapeutic assistance only in refining his technique. The counterpart of the productive learner is a

patient who learns a particular skill stepwise without automatic elaboration to new material or untrained situations; it is not self-evident for this patient that the trained skill is useful in a communcative situation.

Having insight in a creative use of communicative abilities is extremely important in the case of global aphasia. Usually much time is spent in therapy on communication aids, such as a communication board or a language pocket book. However, the use of that speech supporting means in everyday life remains a large problem for the greatest part of the patients. A diagnostic protocol, especially suited for patients with a global aphasia, is developed by Van Mourik et al. 1992: the Global Aphasic Neuropsychological Battery (GANBA). Selection of patients with a global aphasia for therapy is one of its main aims. Regularly there is a discrepancy between formal testing and the functional situation. Ecological valid tests are one step to cover these functional performances but these remain limited to the therapist's room during a test session. A functional scale, with the same complementary role the functional scales have in linguistic research, could give additional information about the mnestic, executive and attentional abilities of the patient during therapeutic sessions and daily life activities.

In conclusion, there is no full understanding yet of the mechanisms underlying aphasia and cognitive impairments in terms of coexistence, cause-consequence and dissociability of functions. Nevertheless, it seems valuable to integrate the knowledge of cognitive rehabilitation in the setting of the speech therapist since the problems the disciplines have in common require a united approach. The knowledge of cognitive rehabilitation is still based mainly on trauma patients and less on the aphasic population. Occupational therapists have a lot of experience in the field of cognitive rehabilitation. These experiences are very useful when we consider maximising conditions. In this regard co-operation may be fruitful.

III Maximising conditions

The aim is to arrange conditions under which optimal therapy can take place (see Van Harskamp & Visch-Brink 1989). There might be severe problems in basic abilities required for a successful therapy such as disorders in vision and hearing. One has to be attentive, where correction of those deficits by the adjustment of mechanical aids is possible. An inappropriate set of dentures f.i. may reduce the clarity of speech.

Factors such as a lack of motivation or/and a serious depression will also impede structural therapy; intensive guidance during some months is often required to help the patient in improving his mental state (see also Benson &

Ardila 1996). For some patients, an adaptation of the language therapy with the focus on successful tasks might give support.

Especially patients with an anterior nonfluent aphasia would be susceptible to depression, partly caused by the mismatch between the intention to communicate and the poor way they can express themselves. Patients with a posterior fluent aphasia might be not motivated for therapy by an anosognosia: an unawareness of their speech problem. Their aphasia is rather a problem for the family than for themselves. The speech therapist should cautiously heighten the patient's attitude, if improvement from structural therapy is expected. Maximising conditions can be a major effect of the guidance and support of the patient.

IV Exploratory therapy

The definite decision on the goal of therapy and the method of intervention needs an exploratory stage. Therapy as an interactive process between therapist and patient requires an experimental stage in which therapist and patient can check their expectations by practical experience. The patient has to be introduced to the conditions of structural therapy before it actually starts. The speech therapist has to become acquainted with the patient in a therapeutic situation. For maximum effectiveness, techniques, methods and material used in therapy must be matched to the patients' specific problems and personality. Even in case of an already selected therapy program, it is important to assess the degree of difficulty within the therapy program. Tests are predominantly made to detect the disorder; seldom their specificity is such that they fit in seamlessly with the therapy (Lesser & Milroy 1993).

Systematic observations in therapeutic situations may reveal how a task is performed, what kind of cueing technique is useful, what material of which difficulty grade is appropriate, and which communicative channel should be relied on. The patients with aphasia, for their part, 'should, severity of communication disorder permitting, be involved actively in the decision about the focus of therapy, and insights offered should be interpreted and taken seriously' (Byng 1995).

The dynamics of the interaction between patient and therapist is another aspect, which should be paid attention. Experience with the patient's performance on the tasks required may give the therapist clues for the most useful feedback, f.i. repetition or semantic elaboration. Such observations are the more important since the consistency of giving task-directed feedback might be an important variable for the therapy outcome (Nickels 1997).

The shaping of the general feedback, the way the therapist react in appreciating the patients' performance, is another aspect of the interaction, which should be evaluated in the exploratory stage. Time and nature of general feedback is described as determining the structure of the therapeutic sessions (Simmons-Mackie et al. in press).

Trial and error in diverse therapeutic situations is needed to develop a detailed therapy planning. Such an exploratory therapy is necessary to avoid being too self evident in choosing a treatment method and a therapeutic approach.

Structural therapy

Goals and levels

Communicative goals must be specified before structural therapy is begun. The specification must be functional: "In all things related to rehabilitation, however, one must stay in touch with the pragmatics and constraints of the real world" (Howard & Patterson 1989). An essential part of goal setting is a description of the patient as an interactive partner in language during daily life situations. The patient's wishes (e.g. to shop on his own), and the therapist's expectations are both taken into account. Evaluation of functional communication is an important part of the Therapy-oriented diagnosis.

At the same time such a description of the expected communicative behaviour after therapy is extremely complex. That is why the formulation of the expected level has to be restrictive, leaving a blank for modification.

In Structural Therapy one can recognise three levels: specification, integration and generalisation (Figure 1.2). These substages reflect the therapeutic approaches until the moment the patient has developed the best possible personal and communicative strategy in various situations. The aim is to maximise the possibilities at a linguistic level or to teach the patient how to use communication means, which are complementary to speech (specification). At a later stage, the patient must be assisted in handling verbal and nonverbal strategies to exchange information (integration). Strategies, which are not successful, are corrected and the patient should be prepared to communicate with a naive partner (generalisation).

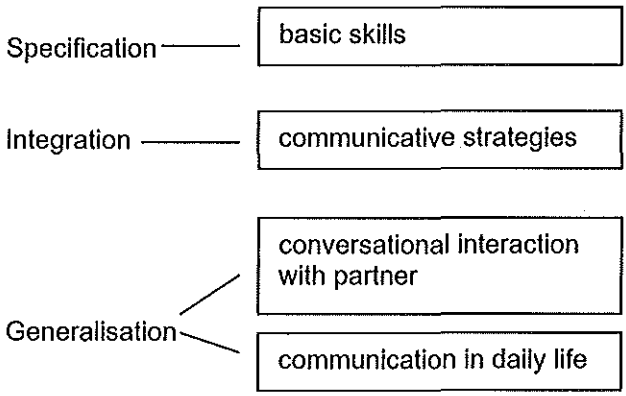

Figure 1.2. Levels in structural therapy

From the 267 patients with a stroke-induced aphasia, who were under the care of the Rotterdam Aphasia Foundation during its first years, an advice for structural therapy was given for 151 patients (57%). For the remaining patients the advice was restricted for guidance and support, a small proportion of patients received therapy later on.

From the total group receiving therapy, therapy was completed in 94 patients. From the other group of patients the therapy was stopped due to serious illness, death or diminished motivation.

Structural Therapy pursues goals in the following areas: basic skills, communicative strategies, conversational interaction with partner, and communication in daily life.

Basic skills

Improvement of skills, which may be relevant to the patient as a communicator in daily life, is the main goal. The patient must become aware of his abilities at the level of the linguistic components of speech: syntax, phonology, semantics and/or at the level of augmentative speech resources: gestures, drawing, writing, pointing to pictures or written words. If the goal of therapy is to restore spontaneous speech, linguistic skills are emphasised. Augmentative speech resources are introduced only when speech as a channel of information transfer is expected to remain highly defective.

The use of augmentative speech resources may well be unfamiliar to the patient and impose restraints on the expression of individual needs and feelings. This concerns especially those communication aids, which have fixed notions as a communication board or a language pocketbook. This is also true for more productive channels such as gestures, drawing, and writing; an aphasic patient is not able to learn f.i. a fully developed gestural language because of its highly complex grammar. Moreover, concomitant disorders such as loss of motor skills, which are required for the use of augmentative speech resources, may impede adequate use.

The choice of therapeutic approaches directed to linguistic components or augmentative speech resources depend for a great deal on the severity of the aphasia; the level of the comprehension disorder seems to be decisive.

When the therapy focuses on linguistic skills, assessment that is directed toward uncovering the underlying deficit is often required (see Formal assessment). However, an in-depth analysis of the disorder in terms of cognitive neuropsychology is not always a guarantee for finding a therapy design (Howard & Patterson, 1989).

Communicative strategies

The patient must integrate his basic communicative skills to produce an information-carrying message. The speech therapist arranges various situations that permit patients to develop strategies for facilitating information transfer. Patients must become aware of their abilities through experience. Therapy leads to optimising verbal strategies or alternative systems in the context of a structured communicative situation, as advocated in PACE therapy (Davis & Wilcox 1981; Carlomagno 1994). The main objective is to increase success in exchanging information. Functioning at discrete linguistic or nonlinguistic levels is of value only in relation to the information value of the utterance. F.i. a syntactically ill-formed utterance with adequate semantic structure might be successful in a functional context (see Kolk & Van Grunsven 1985); numerous syntactic self-corrections or a slow and effortful production of complete sentences may decrease the listener's attention.

The aim of this therapeutic level is to change unsuccessful communicative strategies. The role of the speech therapist is to arrange communicative situations to optimise patients' use of their abilities, to observe patients' communicative behaviour, and to model effective communication strategies. However, there are some pitfalls. The 'unproductive learner' patients often simulate modelling the speech therapist

without really choosing that kind of behaviour, with the result that they use this behaviour even in situations in which another strategy would be better. The therapist must help them to develop flexibility in selecting communicative strategies appropriate to the particular situation. The time required for information transfer and the clarity of the message are measures of the success of therapy. Successful therapy essentially means that a patient knows his communicative limits and tries to find the best strategies to convey his message and to receive messages from his conversational partner.

Conversational interaction with partner

As the patient and his conversational partner adjust to the linguistic handicap, they learn how to resolve blockades during conversation. Therapy leads to mastery of verbal strategies or alternative systems in the context of a structured communicative situation. During this stage of therapy, the partner may actually be more involved in the therapy than the patient. Better communication in daily life often has its roots in the changed behaviour of the partner. Therapy may increase the understanding of family members and friends of the nature of the patient's problems. Perceptions of spouses' problems were more concordant in a treated than in an untreated group (Shewan & Cameron 1984). The treated group also appeared to have learned more ways to communicate with aphasic patients, such as rewording sentences and assisting with word retrieval problems, than the untreated group.

In our experience, guidance and counselling is not enough to facilitate the communicative interaction between the partner and the patient. Many observations of patient and spouse in a verbal communicative interaction are necessary to assess the problems, which may arise, and to determine the limits and the terms of adequate assistance. The recently developed methods for Conversational Analysis are in tune with this functional goal (Booth & Perkins, in press).

Communication in daily life

In daily life situations, speech therapists may guide patients in situations such as shopping, using the telephone, and writing or reading a letter or a postcard. Therapists also can help people to use communication aids creatively in everyday life. Clinical experience has suggested that there is a great discrepancy between the use of augmentative speech resources in therapeutic settings and in natural environments. Patients sometimes do not recognise the communicative value of a communication aid, and further,

lack flexibility, not necessarily a consequence of the aphasic disorder, but possibly a consequence of brain damage (Verschaeve & Van Mourik 1992). F.i. in the Netherlands a Language Pocket Book ('Taalzakboek', de Vries 1989) and a Conversational Book ('Gespreksboek' Verschaeve 1998) are developed as aids for communication in daily life. These books provide words and pictures organized by semantic categories. For an adequate use, the aphasic person's conversational partner must play an active role, asking questions about the patients' intention (see Verschaeve & Wielaert 1994).

The limits of therapy

When a patient achieves less in therapy than had been expected, the therapist should try to figure out why, beginning with a re-evaluation of the choice of therapy. In reference to the results the initial decisions about goal and method of therapy have to be reconsidered, f.i. in a single case description (Wielaert 1997). The failure of model-inappropriate therapy has been demonstrated by Nettleton and Lesser (1991), who provide a strong argument for a detailed model-based language assessment as a prerequisite for planning therapy. However, an analysis of the language deficit alone is not necessarily sufficient. Extralinguistic factors also influence the effectiveness of Structural Therapy. Thus, multi-axial evaluation is necessary, both to reconsider any disturbing circumstances and to refocus the patient's clinical picture. Such a review should be conducted at each turning point during the course of Structural Therapy to prevent at the end of therapy a bewildering gap between expectations and the actual level of progress.

As important as specifying the skills that respond to treatment is the enumeration of unreachable speech levels. Patients must be guided in both directions: Their awareness of optimum communicative skills and acceptance of the fact that some situations will be too difficult to manage without help. The wish to read the newspaper or a book is unrealistic for most patients, even those who are labelled as nonaphasic by a diagnostic test battery.

Concluding remarks

Our approach to aphasia rehabilitation is presented, resulting from many years of clinical experience. The Aphasia Foundation Rotterdam was designed to simplify diagnostic procedures and to stimulate the development of new therapeutic techniques. With the extension of diagnostic tools in the domain of cognitive neuropsychology and neurolinguistics, test results began to influence therapeutic decisions. Newly developed therapeutic approaches required specific selection criteria, which were then reflected in assessment. Our enthusiasm for Structural Therapy based on formal analysis of the language disorder initially diverted our attention from the patients' psychosocial and medical realities. However, in clinical practice the impact of psychosocial factors on the success of therapeutic methods was so great that we were required to affirm the importance of checking these essential features.

The axes system provides a starting point for the selection of aphasic patients for Structural Therapy. The complex of features described on the various axes might predict the effect of remediation on the patient's communicative level in daily life.

The assessment of the aphasia syndrome (Axis I) has been well developed since the founding of the Aphasia Foundation Rotterdam, because standardised test batteries and tests for subcomponents of the aphasic disorder have become available. Detailed assessment in terms of cognitive neuropsychology often leads to a hypothesis about the effect of model-based therapy.

Clearly somatic condition and neurological status (Axis II) influence the course and duration of therapy. Well-described systematic speech therapy that is directed at improving the patient's communicative level succeeds only if therapy is not frequently interrupted by illness.

Knowledge about which neurological and neuropsychological disturbances (Axis III) are relevant for aphasia therapy is limited. F.i. we lack clear insight into the impact of neuropsychological disorders on speech therapy. As a first step, the Rotterdam Aphasia Foundation has directed attention to patients with global aphasia, to determine the weight of neuropsychological factors for several types of treatment.

One of the most difficult factors to assess accurately is the extent to which psychosocial stressors, personality, and social circumstances (Axes IV and V) affect selection of patients for Structural Therapy and development of appropriate approaches to therapy. We recognise that it is hard to make

generalisations. It is not always easy to detect relevant features such as depression, which may greatly influence both the patient's motivation for therapy and his functioning on cognitive tasks, including language.

Despite its uncertainty the axes system appears to be clinically useful. Using this method of describing patients, we are in a better position to identify favourable conditions for Structural Therapy. Previously, the decision-making process was opaque for people who did not know the patient personally. It became clearer when pre-therapeutic assessment was divided into well-described subcomponents and subgoals of therapy were recognised. For insiders, the system gives structure to the stream of information and provides an opportunity to note the patient's life situation. For outsiders, the system clarifies the arguments that supported the decision for a specific therapeutic approach.

New developments in pre-therapeutic assessment will be reflected in the system; executive control functions (Glosser & Goodglass 1990) may be an indispensable issue in relation to the success of Structural Therapy. Refinements in the selection criteria for specific therapeutic approaches will also be incorporated in the axes system for individual patients.

The main goal of evaluation and of aphasia therapy is to establish adequate communicative abilities in daily life. However, our knowledge about the essential aspects of communication is limited. We believe that "Still there are very few tools to measure the ability to communicate" (Frattali 1992). The available scales for measuring functional communication do not provide an in-depth analysis of important communicative features. The most devastating aspect of aphasia is its resultant difficulties with the transactional and interactional functions of language (i.e., the content-bearing aspect and the social aspect, respectively; see Brown & Yule 1983). A realistic therapy program must take those functions into account. To that end, aphasic patients must be observed in different communicative situations. Patients with residual aphasia, however minimal, continue to complain about their inadequate functioning in conversation. Knowledge of why they fail might help us to elaborate on a workable definition of functional communication. At the same time we must realise that, especially in the field of communication, remediation has its limits. "The linguistic meaning of an uttered sentence falls short of encoding what the speaker means" (Sperber & Wilson 1986). Aphasia Therapy may relieve the *impairment* on a linguistic level and the *disability* to use recognizable words, the *handicap* of not being able to enjoy language as a sensitive speaker and hearer will often remain.

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2

MELODIC INTONATION AND RECURRING UTTERANCES: THE INFLUENCE OF ' DO RE MI' ON '/ʁo/,/to/' AND '/ʁito/'

Introduction

The appearance of recurring utterances (RU), repetitive invariant speech units, should be the most significant linguistic marker of the expressive speech of patients with a global aphasia (Stachowiak et al. 1977; De Bleser & Poeck 1984; Haas et al. 1988; Van Harskamp et al. 1995). This is especially true for Consonant Vowel Consonant Vowel (CVCV) RU f.i. /mumumu/ or /to.to.to./ (Poeck et al. 1984; De Bleser & Poeck 1985). Other types of RU are: repetitive neologisms, real words and short utterances (Blanken & Marini 1997).
RU as concomitant with a Broca's aphasia are mentioned by Alajouanine (1956), Code (1982), Stevens (1989) and by Blanken, Wallesch and Papagno (1990), and date right back to the patient Leborgne with the repetitive utterance 'tan tan', described by Paul Broca himself.

For a number of those patients, this classification may be due to a flattered picture of language comprehension, merely based on clinical perception (Lebrun 1986).

RU do not seem to occur exclusively in patients with a pure aphasia. An additional speech motor disorder such as oral apraxia[1] and speech apraxia[2] is also reported as a possible source of CVCV-RU in aphasic patients (Poeck et al. 1984; Stevens 1989; Blanken et al. 1989; Blanken et al. 1990). The RU of patients with an oral apraxia in combination with a Broca's aphasia should be superficially similar to the CVCV-RU of patients with a global aphasia, but show more phonemic variation (Poeck et al. 1984). Patients with RU and speech apraxia should have a relatively preserved writing (Blanken et al. 1989; Blanken et al. 1990). The fact that the RU of the patients described by Blanken, Wallesch and Papagno (1990), did not arise in writing led to the suggestion that non-lexical speech automatisms in Broca's aphasia were generated at the level of modality-specific planning of articulatory movements.

The RU of patients without a dissociation between oral and written language, more often observed in patients with global aphasia than in patients with Broca's aphasia, may be due rather to a lexical deficit than to a phonetic planning disorder. The disorder should be localised at a more central linguistic level. Even in those patients, the involvement of an apractic component in the origin of RU is not excluded (Blanken et al. 1989; Blanken et al. 1990). An argument in favour of the contribution of speech apraxia to the occurrence of RU might be that there is neurolinguistic evidence for an increase of motorically easier articulations in RU together with a reduction of articulations which are motorically more complex (Code 1989).

It is commonly agreed that RU may only minimally improve even by intensive speech therapy (Stachowiak et al. 1977; Poeck et al. 1984). The existence of apraxia as a concomitant disorder is mentioned as a negative factor in this respect. Alajouanine (1956) pointed to the combination of RU, aphasia, and oral apraxia in non-improving cases.

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[1] 'disturbed voluntary movements of the jaw, lips, face, and tongue' (Johns & Lapointe 1976).

[2] 'a specific difficulty in performing the oral acts in articulating speech sounds and ordering them sequentially into words' (Darley 1964).

More recently, Stevens (1989) indicated that severely apractic aphasic patients are considered not to be appropriate for traditional treatment methods. However, previous experience showed the effectiveness of Melodic Intonation Therapy (MIT; Albert et al. 1973) as a therapy with a restraining influence on RU (Van Eeckhout et al. 1981; Van der Lugt-Van Wiechen & Visch-Brink, 1989).

The traditional goal of MIT is to elicit comprehensible spontaneous speech in patients with a nonfluent Broca aphasia and no evidence of bilateral brain involvement. Other criteria: diminished articulatory agility, effortful initiation of speech production, poor repetition even for single words, and relatively good auditory comprehension (Report Therapeutics and Technology Assessment Subcommittee 1994). The basic idea is that activation of the right hemisphere via intoned sequences and rhythmic handtapping would facilitate the left hemispheric functions for the production of propositional speech. The intoned sequences are based on spoken sentences.

Clinicians have been reported to use the technique as an intervention for speech apraxia (Sparks 1981). In the treatment of patients with an isolated speech apraxia, it has been shown that success of MIT can be found in the efficacy of pacing and rhythmic stimuli on the temporal ordering of articulatory movements (Dworkin et al. 1988). For severely apractic-aphasic patients, locked into a verbal motor loop, another therapy method, in which some elements of MIT were involved, such as rhythmic handtapping, appeared to be useful too; Stevens (1989) reported successful application of Multiple Input Phoneme Therapy (MIPT). Repetition of intoned sentences is involved in several procedures, developed for the treatment of patients with speech apraxia, labelled as Melodic Apraxia Training (Smith & Engel 1984) and Prosodic Subsystem Treatment Hierarchy (Dworkin 1991). Rhythmical handtapping accompanies the Multiple Input Phoneme Therapy, designed by Stevens (1989) for the severely apractic-aphasic patient.

Since the presence of a speech apraxia as an additional disorder is denoted as being responsible for the occurrence of RU in aphasic patients (Blanken et al. 1990), the MIT as a therapy for RU might be useful. Van der Lugt-Van Wiechen and Visch-Brink (1989) found various recovery patterns after application of MIT in patients with a nonfluent global aphasia accompanied by RU (N = 6). In five out of six patients the RU disappeared. In two patients the disappearance of RU was followed by the appearance of spontaneous speech, consisting of frequently used concrete content words. In the context of adequate volitional speech both patients showed some

signs of a speech apraxia: groping articulatory behaviour and struggle for the first consonant.

The MIT seems to be promising for aphasic and apractic aphasic patients in relation to the disappearance of RU. However, no detailed case report is available where the change in the patient's oral speech by the application of the MIT in the chronic stage is represented in the results of a linguistic test battery. In the case description we present, MIT was successfully administered to an aphasic patient with exclusively RU in the context of relatively preserved writing and moderately disturbed language comprehension. The RU were still present 10 months post onset. After four weeks of MIT the RU disappeared entirely to be replaced by comprehensible speech with phonemic paraphasias. A detailed description of the patient's linguistic performance before and after the intonation therapy may provide evidence on the origin of RU and contribute to the refinement of the selection criteria for the application of MIT.

Case Report

The subject of the study is patient AL, a right-handed 62-year old retired chartered accountant. After eight months the patient visited our outpatient clinic for the first time. The neurological, neuropsychological and biographical data are represented following a multiaxial evaluation system, described by Van Harskamp and Visch-Brink (1991) and by Visch-Brink et al. (1993). The system is used to consider the therapeutic possibilities not only with regards to the aphasia but also to other factors that may influence the efficacy of therapy.

Axis I *Aphasia syndrome*

Initially, the patient was mute, spontaneous writing was his only channel for communication, which is unusual. There was a severe language comprehension disorder. The patient could not answer yes/no questions accurately. At the point of discharge from the hospital (after three weeks), auditory comprehension had improved. Responses to yes/no questions were more reliable than in the initial stage. In spontaneous speech the patient started to develop repetitive sounds, denoted as RU. The aphasia was initially classified as a global aphasia. A more detailed description of the patients' performance on the different linguistic tasks showed that the

qualification 'Broca's aphasia with oral apraxia and speech apraxia' was a more precise description of AL's language disorder.

Axis II *Physical condition*

The CT scan showed an infarction of the median cerebral artery, which also affects the basal ganglia, the outer part of the putamen and a part of the nucleus caudatus (Figure 2.1).

Axis III *Neurological and neuropsychological disturbances*

A complete right-sided hemiparesis disappeared rapidly, leaving only a slight disturbance of skilled movements and a slight right-sided facialis paresis and a mild buccofacial apraxia. Detailed neuropsychological examination took place eight months post onset. His motor behaviour on the left side and his performance on constructional tasks were slightly disturbed. RU distorted counting from 1 to 10 and naming of the months of the year and days of the week. Raven's IQ was 115. Calculation was correct, which is remarkable. Visuo-spatial functions and non-verbal memory were intact.

Axis IV *Psychosocial stressors*

The patient's wife died two years before.

Axis V *Social circumstances*

The patient had one child. There were only a few social contacts; the patient was characterised as a man who spent a lot of his free time on his job. A few years before his stroke the patient stopped working and lived on his means, being active in investments.

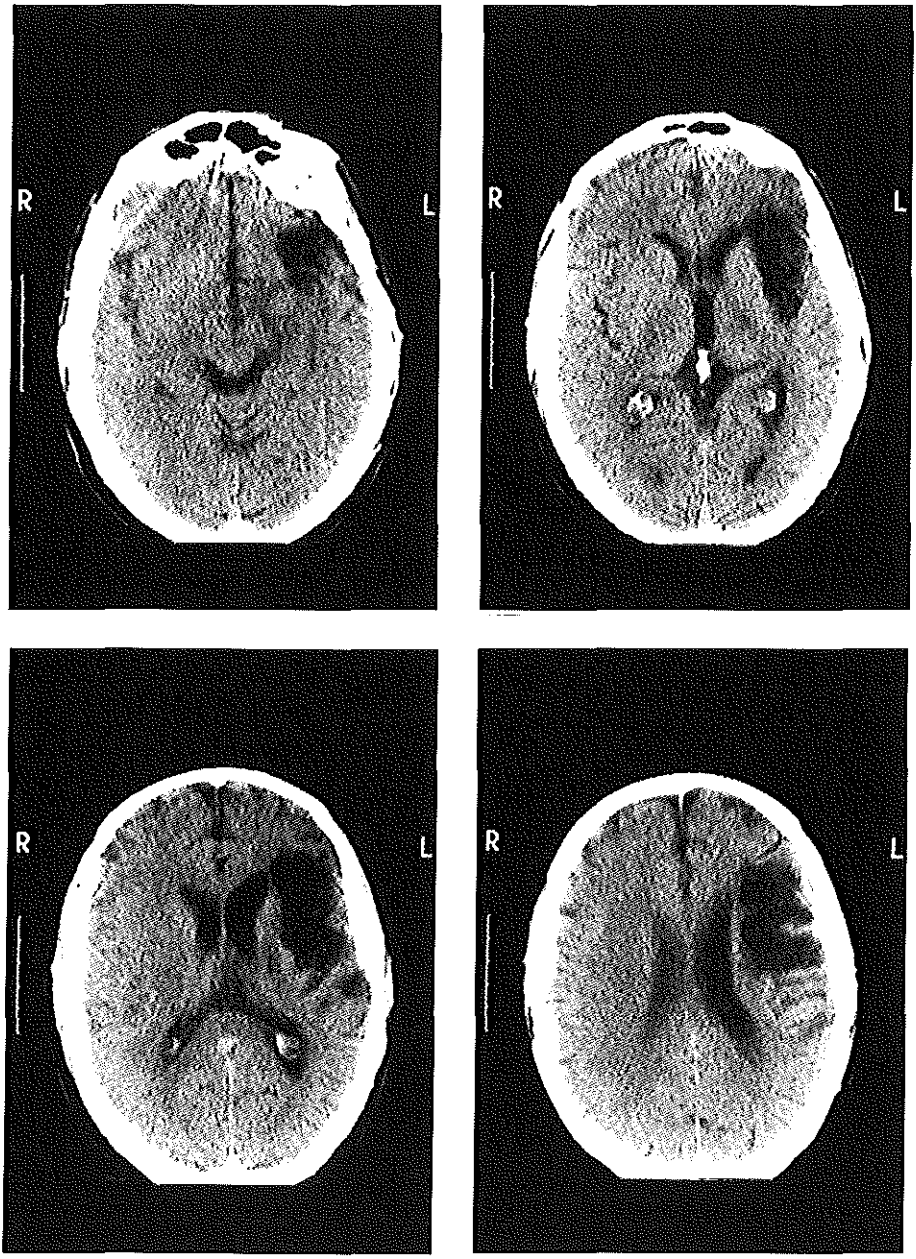

Figure 2.1 CT scan data AL, one year post onset

First Language Examination

The severity and type of aphasia was measured eight months post onset, with the Akense Afasie Test (AAT; Graetz et al. 1992). The results are presented in Table 2.4. The AAT has subdivisions for all major language components: Spontaneous Speech, Repetition, Written Language, Naming, and Comprehension. Also the Token Test forms a separate part of the AAT. Spontaneous Speech is rated on six scales with six points each: communicative ability, articulation and prosody, language automatisms, semantics, phonology, and syntax. The subtest Written Language consists of reading aloud (W1), putting together words and sentences to dictation from letters and words (W2), and writing to dictation (W3). The Comprehension subtest includes auditory and visual comprehension. For each item in the linguistic subtests four-point scales are used, the scale points being defined by linguistic categories.

In all oral verbal tasks RU appeared with a stereotypic intonation contour, mostly non-meaningful concatenations of CV or CCV syllables with some variation in vowels and consonants. When the RU are considered as linguistic units at word level, AL's speech may be characterised as nonfluent, because of his effort saying the first consonant, pauses between the RU, and the limited number of RU in a response. The patient was annoyed by the fact that he could express himself only by RU and usually gave up trying after two or three attempts to fulfil the task. The best results were achieved in Oral Reading (W1: 18%), followed by Repetition (9%). Some responses in Reading aloud and Repetition resembled the target; the initial consonants were particularly likely to be wrong: e.g. Reading aloud 'paal / pa.l /' (pole): / tra.l, tra.l, tra.l/; 'dienster / di.nstər /' (servant): / tri.nstər /; Repetition 'mond / mɔnt /' (mouth): / o trɔn trɔnt /; 'kwarts / kvɑrts' (quartz): / trɑrts, trɑs /; 'kano / ka:no: / ' (canoe): / tra:to: /; 'piloot / pi:lo.t /' (pilot): / ti:tro.t /. As is shown in these examples, the word initial consonants were nearly always without exception replaced by /tr/ or /t/. Words of more than two syllables were totally deformed. Some examples: 'voetbalschoen' / vutbɑlsχun / (footballboot) became / ti:to:trɔto: / (Oral reading); 'telefoon' / te.ləfo.n / (telephone) became / tətətɔtɑ / (Repetition).

In Spontaneous Speech the patient said one single understandable content word to complete the question from the examiner: 'You are born in.....' /Amsterdam/. The remaining answers consisted of 'yes'/'no' or RU, which showed less variability than in Reading aloud or Repetition. An example of the Spontaneous Speech before therapy is given in Figure 2.2.

Int. *Woont u hier? (Do you live here?)* **AL** nee (No)
Int. *Waar komt u vandaan? (Where are you from?)*
AL /ɔt ɔto:tɔto: tɔto:/
Int. *Rotterdam?*
AL. /tɑuto:/
Int. *Dat niet (Not rightly)*
AL /a: tɑuto/ (emphasized)
Int. *Moet ik even kijken? Uit Mijdrecht? (Shall I have a look? From Mijdrecht?)*
AL /tɔtɔtɑm/
Int. *U bent geboren in...? (You are born in...?)*
AL Amsterdam
Int. *Prima ja, daar heeft u uw jeugd doorgebracht*
(Yes okay, there you spent your early youth)
AL ja ja (yes)
Int. *En wat is uw beroep? (And what is your profession?)*
AL /rɔt ət rɔto: hɑt tə tɑuto: tɑ ti: tɑuto:/
Int. *hm...Hoe lang heeft u last met het spreken? (Since when do you have speech problems?)*
AL /tɔto: tɔtɔ te: to: tɔtɔtɔ/
Int. *ja ja (yes)*
AL /ɑ tɔdo: ɑ tɔto:/
Int. *Kunt u het opschrijven? (Are you able to write it down?)*
AL ja (yes) (writes: 'een maand nog 7') ('a month still 7')
Int. *Even kijken hoor...zeven maanden (Let's have a look...seven months)* **AL** ja (yes)
Int. *Heeft u meteen therapie gekregen? (Did you got therapy immediately?)* **AL** ja (yes)
Int. *In Mijdrecht of eerst ergens anders? (In Mijdrecht or initially elsewhere?)* **AL** nee (no)
Int. *Niet in Mijdrecht? (Not in Mijdrecht?)* **AL** nee (no)
Int. *Nu ook niet in Mijdrecht? (And still not in Mijdrecht now?)* **AL** nee (no)
Int. *Waar nu? (Where now?)*
AL /trɔ to:to: trətɔ: to:/
Int. *Kunt u het opschrijven? (Can you write it down?)*
AL (writes: 'Dordrecht')
Int. *Ik zie het al, Dordrecht (I already understand, Dordrecht)* **AL** ja (yes)
Int. *Ja, en wat is de naam van de logopedist?*
(Yes, en wat is de naam van de speech therapist?)
AL (writes: 'Niem')
Int *Niem lees ik (I read Niem)*
AL nee (no) (writes: 'Siem, Myra') (correct)

Figure 2.2 Spontaneous Speech AL, before MIT-therapy, eight months post onset.

/to:/ and /tɔ/ were the most frequently occurring syllables, respectively 31% and 25% of the total number of syllables (55) in non meaningful utterances, but not the only ones. Other consonants were /r/ and /d/, other vowels /ə/, /a:/, /ɑ/, /ɑu/, /i:/, /e:/. The responses in Naming were similar to the RU in Spontaneous Speech: 'koffer / kɔfər /' (suitcase) became: /tra:tɔtɔto:to:/ nee (no)/. It was noticeable that in all tasks requiring oral speech nearly every response started with a /t/, as in the attempts to say single monosyllabic words.

The best performance was obtained on tasks, which did not, or only partly, require oral verbal output: the Token Test, Comprehension, and Writing (that includes Reading aloud). A psychometric comparison between the AAT-subtests showed that Naming and Repetition were most severely disturbed, indicating a severe disorder. There was a significant difference between both of these tasks and Comprehension, Writing, and the Token Test respectively. The Token Test results pointed to a mild disorder, Writing and Comprehension were moderately disturbed. Without doubt Spontaneous Speech was severely disturbed similar to Naming and Repetition.
The patient was classified (ALLOC) as 100% Global aphasia.

Diagnostic Problems

Considering the fact that the patients' speech disorder was denoted (AAT-ALLOC diagnosis) as a global aphasia, it is remarkable that there is a discrepancy between the tasks, which require oral output and the other parts of the AAT. Generally, the classification 'global aphasia' is reserved for patients with a severe output disturbance (nonfluent), an equally severe disturbance of comprehension, and little or no ability to repeat, read, or write (Benson 1979). A search in the literature revealed that the patient's results on the Token Test, Comprehension, and Writing were not comparable with "Globals with CV-RU" (Poeck et al. 1984) and "Globals with speech automatisms (RU)" (Blanken et al. 1990) (Table 2.1).
In both groups of patients with RU, there is not a single patient who equals AL in the performance on the AAT-subtests Token Test, Writing, and Comprehension. This is especially true for the Token Test and Writing.

Table 2.1. Comparison of AL's performance on subtests AAT with global aphasics with RU, mentioned in the literature (percentiles)

		Token Test	Writing	Comprehension
CV patients*	median	13	8	15
(N=8)	range	(6-29)	(8-27)	(1-24)
Globals with	median	16	5	15
speech automatisms**	range	(2-31)	(5-23)	(4-38)
(N=22)				
AL (8 months post onset)		67	44	42

AAT = Akense Afasie Test, RU = Recurring Utterances
* Poeck et al. 1984, ** Blanken et al. 1990

If we put the results of AL on those AAT-subtests next to the data of Broca's and Global aphasics from the Dutch AAT standardisation (De Bleser et al. 1991), we have to conclude that the AAT-results of AL are more comparable with the Broca's than with the Global group (Table 2.2).

Table 2.2. Comparison of AL's performance on subtests AAT with the Dutch norms for Broca's and Global aphasia (raw scores)

		Token Test*	Writing	Comprehension
		(50)	(90)	(120)
Broca aphasia	median	34	42	83.5
(N=30)	range	(1-50)	(5-85)	(55-114)
Global aphasia	median	48	3	62.5
(N=30)	range	(20-50)	(0-50)	(0-94)
AL		22	44	79

AAT = Akense Afasie Test
* Number of errors

A plausible explanation of the appearance of RU in the context of relatively good performance on verbal Comprehension and Writing may be the presence of an apraxia as a concomitant disorder to Broca's aphasia. The neurological examination of our patient revealed a slight oral apraxia. The performance of AL in non-verbal oral movements in a series of orders from

'Stick out your tongue' to 'Click your tongue', described by De Renzi, Pieczuro and Vignolo (1966), was easy to assess, all the more since his auditory comprehension was only moderately disturbed. The observed variation in AL's RU should be typical for an oral apraxia combined with a Broca's aphasia (Poeck et al. 1984). Such a disorder should lead to the production of 'a very limited set of phonological neologisms, which have a superficial similarity to CV RU'. The authors emphasise that the RU of patients with a Broca's aphasia and an oral apraxia show more variety of vowels and consonants than the RU of global aphasics, which is true for our patient.

The presence of speech apraxia seems hard to establish in patients with well-articulated nonpropositional speech in a variety of linguistic tasks. The main clinical signs of speech apraxia are: articulatory breakdowns, inconsistent errors with substitutions and distortions, slowness of speech, dysprosody, visible and audible groping articulary behaviour, frequent errors in the initial consonant(s) of the word, and self-corrections (Dworkin 1991; Rosenbek 1993). However, both in oral and in speech apraxia there is a disparity of performance between the production of automatic and volitional oral behaviours (Darley 1982; Square-Storer & Roy 1989). Consequently the signs of speech apraxia that can be found in communicative words are not necessarily present in automatic speech like RU. So far as the AAT-scores are concerned, AL is comparable to a patient (case VI), described by Blanken, Wallesch and Papagno (1990), with speech automatisms and speech apraxia, denoted by the ALLOC classification system as 100% Broca's aphasia (Table 2.3).

Table 2.3. Comparison of AL's performance on AAT with a patient with a Broca's aphasia and a verbal apraxia, mentioned in the literature (percentiles)

	Token Test*	Repetition	Writing	Naming	Compre-hension
case VI *(Blanken et al. 1990)*	74*	16***	54**	19***	41**
AL	67*	9***	44**	4***	42**

AAT = Akense Afasie Test
* = mild impairment, ** = moderate impairment, *** = severe impairment

Like patient VI, described by Blanken, Wallesch and Papagno (1990), AL performed Writing to dictation (word level) rather well (Table 1), no RU were observed here. Moreover, in Spontaneous Speech, AL sometimes succeeded in writing a correct content word instead of a spoken RU, e.g. he wrote down 'registeraccountant' (chartered accountant), responding to the question "What is your profession?" after the oral production of / rɔt ət rɔto: hɑt tə tɑuto: tɑ ti: tɑuto: /.

A discrepancy between Writing and Oral speech in favour of Writing is one of the features that figure in the diagnosis of speech apraxia (Lebrun 1989). Also the tendency of AL to start his RU with a /t/ may be interpreted as a sign of his speech apraxia. Sugishita et al. (1987) observed this behaviour in two patients with a pure speech apraxia. The patients could not prevent the tip of the tongue from rising up to the alveolar and post-alveolar region. Their conclusion was that problems with the inhibition of the tongue were a specific feature of speech apraxia.

Summarising, we may conclude that AL shows in broad outline the characteristic profile of Broca's aphasia. Verbal Comprehension is mild to moderately disturbed in contrast to the severe disorder on tasks that require oral verbal output. Those tasks elicit RU. Several observations point to the fact that an apraxia (see discussion for interpretation) in combination with an aphasia is the source of AL's defective oral output: the observed variation in the CV-sequences together with the relatively good performance on Writing and the preference of AL to start his words and utterances with an "easy to articulate" consonant as the /t/.

Therapy

Therapy pre-MIT

In the first months post onset, the main topic of therapy was family guidance, given by a private speech therapist. A therapy in which the patient had to read and to repeat minimal pairs of words, often used for the rehabilitation of speech apraxia (Deal & Florance 1974) appeared to be unsuccessful. Up to eight months, aphasia therapy was directed towards alternative modes of communication such as gesturing, pointing and writing, to give the patient the opportunity to communicate without the use of oral speech. Writing in particular was preserved relatively well and therefore useful as a communication aid.

However, the patient refused to consider those communicative channels as a real possibility for communication.

MIT

The patient's primary wish was to achieve adequate oral speech, frustrated as he was by his defective utterances and ashamed by his inadequate verbal production. The level of AL's comprehension strongly gave the impression that the patient should be able to express himself more adequately, if he could get rid of the RU. Therefore our goal in therapy was the deblocking of adequate content words in spontaneous speech by elimination of RU. The expectation was that MIT-therapy (see Figure 2.3) would diminish the influence of speech apraxia on AL's oral speech, which would possibly imply that the RU should disappear and agrammatic speech should arise.

Level I
Clinician hums melody pattern, aids patient in handtapping the rhythm.

Level II
Clinician hums melody pattern and intones the sentence.
Patient hums, sings in unison participation, repeats the stimuli (with handtapping).

Level III
Clinician intones sentence, patient repeats the stimuli with delay (with handtapping).
Clinician intones question about the sentence, patient answers.

Level IV
Clinician presents intoned sentence, sentence in "Sprechgesang" and in normal speech. Patient joins in unison and repeats stimulus with delay (handtapping disappears).
Clinician asks some questions about the topic of the sentence, patient answers.

Figure 2.3 Melodic Intonation Therapy, structure
Sparks, Holland, 1976

Method

The Dutch version of MIT was used (Van der Lugt-Van Wiechen & Verschoor 1987). The outline of the program corresponds on the whole with the original MIT, designed by Sparks, Helm and Albert (1974) and described extensively by Sparks and Holland (1976). The patient's tasks go from humming of the presented melodic sequence to the answering of questions in spontaneous speech. Steps in between are repetition of intoned sentences, repetition of sentences in "Sprechgesang", and repetition of sentences with a normal intonation contour. The program consists of four levels of difficulty. The Dutch version differs in some points from the American original:

Although Sparks (1981) maintains that predetermined sentences are not preferable, sentences with a prescribed intonational contour are included. To prevent perseveration in the patient's speech, the sentences have been ordered with a great variety in intonation contour, informational content, and syntactic structure.

The sentences within each level are thematically related. Topics are daily life situations. Preceding the intoned sentences, the clinician reads aloud a short introductory text.

Complex consonant clusters are avoided. There is a limited number of syllables with a "schwa", which phoneme frequently occurs in spoken Dutch. Sonorants are built in as much as possible.

During the first presentation of the sentences by the clinician, all words are intoned with lengthened vowels. This appeared to have a positive effect on repetition (Laughlin et al. 1979). The sentences are constructed with as few articles as possible. This will facilitate repetition by agrammatic speakers.

Course of Therapy

The MIT started ten months post onset, with a 30-minute session three times a week. The duration of the first period of MIT therapy was four weeks (12 sessions).

Week I

Sentences of level I were presented: clinician hums melody pattern, aids patient in handtapping the rhythm. The patient could immediately, nearly flawlessly, imitate the melodic pattern. The first session was spent getting used to the melodic pattern of a set of ten sentences.

In the following two sessions the patient was requested to: listen to the melodic pattern, hum with the therapist, hum after the therapist, listen to an intoned sentence, and sing the intoned sentence with the therapist.
During the second session the patient appeared to be helped by written sentences, an aid, which was applied during the rest of therapy. Both the sentence and the melodic contour were visually presented. In three sessions, Level I of MIT was finished and the transition to level II was made: patient sings in unisone participation the intoned sentence and repeats the stimuli with handtapping. When intoned sentences with words were presented, the patient could sing together with the therapist 9/10 sentences flawlessly.

Week II

This week was spent on excercising the sentences of level II. The patient appeared to have problems with two succeeding consonants, even if they belonged to succeeding words.

Week III

It was decided to build in words with sequences of CVCV syllables to facilitate the pronunciation of consonants. Pauzes between words led to a struggle with the initial phonemes of the next words and had to be avoided. During the application of those CVCV sequences the patient appeared to have difficulties with the function words, even in short sentences of three words. The function words were perseverated in the following sentence or omitted. At the end of this week the patient could repeat the presented sentences rather well with retention time with the exception of some function words.

Week IV

Because of the patient's Broca's aphasia, only multisyllabic content words and agrammatic utterances were presented to facilitate generalisation to spontaneous speech. However, the therapist had to avoid the presentation of two succeeding content words starting with the same consonant, because this led to perseverations.

Week V

The patient suffered an epileptic attack, for which he was admitted to the hospital for one week.

Summarising: after four weeks of MIT-therapy, the patient reached level II (repeating the sentence), and the first step of level III (repeating the sentence with delay). Utterances were adapted to the patient's capacities in speaking i.e. agrammatic utterances and multisyllabic words. Repetition was possible for AL in singing, in "Sprechgesang", and speaking. Therapeutic cues were written presentation of the sentence with marked stressed syllables and visual presentation of the melodic pattern.

Evaluation of Therapy

After therapeutic intervention with MIT (six hours in four weeks), the patients' progress was evaluated using the AAT, administered at 11 months post onset. His performance was compared with the results of the first language examination, eight months post onset (Table 2.4). Within a period of six weeks, between the first administration of the AAT and the start of the MIT, the patient did not receive any form of speech therapy because of organisational reasons and AL's holiday.

Table 2.4. Performance AL on AAT during recovery (percentiles, except Spontaneous Speech)

	Spontaneous Speech (30):	Communicative ability (5)	Articulation (5)	Automatisms (5)	Semantics (5)	Phonology (5)	Syntax (5)
8 mpo	2:	1	0	1	0	0	0
11 mpo	14:	2	3	3	3	2	1
16 mpo	14:	2	3	3	3	2	1
43 mpo	18:	2	3	5	4	2	2

	Token Test	Repetition	Writing:	W1	W2	W3	Naming	Compre-hension:	Auditory	Visual
8 mpo	67	9	44:	18,	56,	59	4	42:	35,	47
11 mpo	60	16*	54:	30*,	66,	59	26*	33:	46,	26**
16 mpo	60	16	49:	22,	66,	59	32	19:	26,	16
43 mpo	63	34*	63*	38*,	62,	76*	43*	50:	49,	51*

AAT = Akense Afasie Test, mpo = months post onset
* significant improvement in relation to the preceding examination
** significant decline in relation to the preceding examination

The AAT psychometric evaluation showed that pre- en post MIT, AL's performance on almost all subtests that he could fulfil without speaking, was equal; the Token Test, auditory Comprehension and Writing to dictation remained at the same level, moderately disturbed. There was a significant decrease in visual Comprehension, which is difficult to interpret in view of the auditorily and visually presented MIT-sentences.

These results contrasted sharply with the patient's functioning in the tasks that required oral verbal output; the patient's performance improved significantly in Repetition, Naming, and Reading aloud (W1). However, in spite of the observed progress, Repetition and Naming remained severely disturbed, Reading aloud changed from a severe to a moderate disorder. In Repetition of words (Figure 2.4) improvement consisted of more items (N=20) correct: before MIT only one item was correct, after MIT six items were correct.

	Before MIT	*After MIT*
oost /o.st/ (east)	correct	correct
vla /vla:/ (custard)	/tɔ trɔɑ trɔɑ/	/v(?)a:?
mond /mɔnt/ (mouth)	/ɔ trɔm trɔnt/	correct
glas/ɣlɑs/ (glass)	/ɑ trɔɑ trɔɑ tra.t/	correct
storm /stɔrm/ (storm)	/trɔ tɑtrɔtə trɑutə/	/rɔ trɔnt s (correct) trɔm/
worst /vɔrst/ (sausage)	/tro: trɔst trɔst/	correct
spreuk /sprɸ.k/ (saying)	/tru tro:tə trɔt/	/bro.ts tro.p/
kwarts /kvɑrts/ (quartz)	/trɑrts trɑs/	/krɑrts krɑtst/
psalm /psɑlm/ (psalm)	/tru trɔɑrt tr/	/strɑm srɑn/
stronk /strɔŋk/ (stump)	/trɔŋkə/	/bo.t/
kitsch /ki.tʒ/ (kitsch)	/tru tra:/	/si.t si.ts/
kano /ka:no:/ (canoe)	/tra:to:/	correct
puree /py:re:/ (mashed potatoes)	/ti:t trɑti:/	/mm pi:je: tu di:je:/
piloot /pi:lo.t) (pilot)	/ti:tro.t/	correct
compagnie /kɔmpɑɲi:/ (regiment)	no response	/kɔmbɑtri:/
telefoon /te:ləfo.n/ (telephone)	/tətətɔtɑ/	te:ləso.n/
chokolade /ʒo:ko:la:də/(chocolate)	/tɔtɑti:tu/	/ko:la:dən/
moderator /mo:dəra:tɔr/ (moderator)	no response	/no:dədatər/
hepatitis /he:pa:ti:tls/ (hepatitis)	no response	/se:tɔtasls/
metamorfose /me:ta:mɔrfo:sə/ (metamorphosis)	no response	/se:na:to:sə/

Figure 2. 4 Repetition AL, before MIT-therapy, eight months post onset and after MIT-therapy, eleven months post onset

Moreover, there was more phonemic resemblance between the stimulus and the response after the application of the MIT; four- and five-syllabic words, that the patient refused to repeat during the first examination, were more or less recognisable. However, the most important improvement was that /tr/ and /t/, AL's "recurring" initial phonemes, observed in nearly every response during the first examination, had disappeared. In Repetition before MIT 15 of the 20 words produced by the patient started with /t/, after MIT not one response was observed, starting with /t/.

Improvement in Naming was seen particularly with monosyllabic words and colour naming. However, the most impressive recovery was observed in Spontaneous Speech (Figure 2.5). Some appropriate content words appeared as an answer to wh-questions. During the first interview the patient only produced 'Amsterdam' as an appropriate content word. Except in utterance nr. 5, the wh-questions of the second interview all elicited a comprehensible answer. Some content words were correct (utterance nr. 3, 4, 8, 9 and 14), one answer was neologistic. AL's conduite d'approche in utterance nr. 11, 12, 13 and 14 is noticeable, which illustrates the patient's error awareness with phonemic paraphasias. The RU disappeared for the most part. The patient gave the impression of being able to stop them in time. Instead he had developed a sort of smacking sound with his tongue (utterance nr. 10 and 11) and he was obviously searching for the right articulatory movements; this may be characterised as articulatory groping.

Int. *Wat bent u van beroep? (What is your profession?)*
AL (1) /is χu/ (?)
(2) /sɛst | χtənɑkɑuntənt/* (chartered accountant χ | stərɑkɑuntənt/)
Int. *Ja, en waar heeft u het laatst gewerkt? (Yes, and where did you work recently?)*
AL (3) Rotterdam
Int. *In Rotterdam. Bent u altijd registeraccountant geweest? (In Rotterdam. Have you always been a chartered accountant?)*
AL (4) Altijd (always)
Int. *En altijd bij hetzelfde bedrijf? (And with the same company all the time?)*
AL (5) /dɑti: a:tər na:tər/ (?)
Int. *En hoe heette dat bedrijf? (And what was the company called?)*
AL (6) /Di: yko:/, /Di: y ko:/ (tries to say the company's name)
Int. *Ja, en waar woont u? (Yes, and where do you live?)*
AL (7) /Drɛidrɛχt/* (the name of the city, /Mɛidrɛχt/)
Int. *Waar heeft u als kind gewoond? (Where did you live as a child?)*

AL (8) Oh, Amsterdam
Int. *In Amsterdam. Kwam u uit een grote familie? (In Amsterdam. Are you from a big family?) Had u veel broers en zusters? (Did you have many brothers and sisters?)*
AL (9) Nee, een zuster (no, one sister)
Int. *Een zuster (one sister). Heeft u zelf kinderen? (Do you have children?)*
AL Een (one)
Int. *Heeft u ook hobbies? (Do you have hobby's?)*
AL (10)Oh, ehm, (smacking) /pustən/* (cats, /puzən/) (smacking) /kustən/* (cats)
Int. *Ehm?*
AL (11)(smacking) Ik /nustən/* (I cats) /stunzu/* (cats) (smacking twice) /tusən/* (cats)
Int. *Is het een sport? (It's a sport?)*
AL Nee (No)
Int. *Iets wat u binnenshuis doet? (Something that you do inside?)*
AL Ja ja (yes)
Int. *In huis...niet iets als postzegels verzamelen of zo? (In the house...not something like collecting stamps?)*
AL Nee nee (No)
Int. *Fotografie? (Photography?)*
AL Nee (No)
Int. *Lezen? Heeft het iets met lezen te maken? (Reading, has it to do with reading?)*
AL Nee nee nee (No)
Int. *Besteedt u er erg veel tijd aan? (Do you spend a lot of time to this?)*
AL Ja ja (Yes)
Int. *Computers? (Computers?)*
AL Nee nee (No)
Int. *Is het een vrij algemene hobby? (Is it a common activity?)*
AL Ja (Yes)
Int. *Veel mensen doen het wel? (A lot of people do it?)*
AL Ja ja ja ja ja (Yes)
Int. *Kruiswoordraadsels? (Crosswordpuzzles?)*
AL Nee (No)
Int. *Dat zijn 't niet (That's not correct)*
AL Nee nee nee (No)
Int. *Gewone puzzles ook niet? (And ordinary puzzles?)*
AL Nee nee nee (No)
Int. *U maakt het me moeilijk (I'm in trouble here)*

AL Ja (Yes) nee (no)
(12) /kustu/* (cats /puzən/) /kuzən/* (cats) smacking /pustən/* (cats) /pustən/* (cats) smacking
Int. */pustən/? (tries to repeat the patient)*
AL (13)/pi:/* (/pus/ cat) /po:stən/* (cats) smacking
Int. */po:stən/ versta ik...poezen (I understand /po:stən/...cats)*
AL Ja (Yes)
Int. *Poezen, ja. U heeft zelf poezen? (Cats, yes. Do you have any cats yourself?)*
AL Ja (Yes)
Int. *Hoeveel? (How many?)*
AL (14)Oh.../θri:/* (Oh.../dri:/ three) drie drie (three)

* phonological distortions

Figure 2.5 Spontaneous Speech AL, after MIT-therapy, eleven months post onset

Comparing the same amount of syllables (except yes and no) in the two speech samples before and after MIT, we found the following (Table 2.5). After MIT there were twice as many different syllables as before MIT which is reflected in the Type Token Ratio (the number of different syllables divided by the total number of syllables). The syllables /to:/ and /to/, the most frequently used syllables in the first speech sample disappeared completely. The total number of appropriate content words after MIT was 18, with nine different words.

Table 2.5. Spontaneous Speech AL before and after MIT: syllables and content words

	Before MIT	After MIT
syllables*	58	58
different syllables	19	45
Type Token Ratio of syllables	0.32	0.78
Syllable initial /t/	44	11
RU /to:/	17	0
RU /to/	14	0
content words**	1	18
different content words		9

MIT = Melodic Intonation Therapy
* without 'yes' and 'no'
** recognisable content words with less than half of the phonemes distorted

Therapy post-MIT

Due to the success and conform to the wishes of the patient, MIT was continued up to three months, but no major changes were observed after a second period of six weeks MIT- application. When we observed that the application of the MIT had stopped improving the level of the patient's Spontaneous Speech, we changed our goal in the therapy. We repeated the forms of therapy, which were given before the use of the MIT. Firstly, we tried to work on his communicative abilities in daily life, by paying attention to verbal and non-verbal aspects of information transfer. The PACE method was used here (Davis 1981; Davis & Wilcox 1985); the communicative use of oral speech, written speech and gestures were the focus of therapy.

Secondly, we applied a traditional therapy for verbal apraxia, in which the patient was required to produce minimal pairs. Both therapeutic methods failed. The AAT results of 16 months post onset confirmed the lack of success of the continuation of MIT and the subsequent therapy; no progress is found between 11 and 16 months post onset (Table 2.4).

Half a year after MIT had been finished, the patient came into the daily care of a nursing home, three days a week, where he was encouraged to communicate with other patients. During this period he received no structured speech therapy. The duration of his stay in the day-care center was a year. After that, he went home and he was treated for half a year with the Visual Cue Program (VCP: Van de Sandt-Koenderman 1986, 1987). This is a therapy program for patients with a Broca's aphasia, observed to improve the syntactic structure of their utterances by visual representation of the words in a sentence. After this period the AAT was administered again (43 months post onset) and significant progress was found in Repetition, Writing, Naming, and visual Comprehension. Unfortunately we did not have the opportunity to administer the AAT before the intervention with the VCP. Therefore, it is unclear whether the progress can be ascribed to the syntactic therapy.

Summarising: only the MIT and the Visual Cue Method were applied successfully. The MIT made the RU disappear and cleared the way for the agrammatic spontaneous speech, characteristic of Broca's aphasia. The therapy was in line with the profile of the patient, described on the axes. The patient liked the didactic aspect of the MIT, which fitted with his personality and lifestyle. During the period before the therapy, the patient was extremely distressed by his meaningless utterances, and the immediate confrontation of his errors during MIT heightened his motivation.

Discussion

In the present case description MIT was administered to the patient AL with a nonfluent aphasia and RU. AL used nearly exclusively RU, which still remained ten months post onset. A comparison with patients described in the literature showed that AL's performance on tasks which did not require speech, i.e. Comprehension, Written language and the Token Test, reached the level of patients with a Broca's aphasia. However, such a deterioration of oral speech, as we found in the case described here, could not be reconciled with the speech characteristics of a Broca's aphasia (Goodglass & Kaplan 1972; Saffran et al. 1989). Therefore it was assumed that an apraxia as an additional disorder was primarily responsible for AL's RU. Oral apraxia was observed in our patient on neurological examination. The characteristics of speech apraxia were only clearly noticeable in AL's speech after the disappearance of the RU, caused by the application of the MIT. Observable signs of speech apraxia were: the groping behavior of the mouth preceding the production of content words, the weight of errors in word initial phonemes together with many selfcorrections. Supporting the diagnosis of speech apraxia was that there was a discrepancy between AL's written and oral speech in favor of the first output channel and no RU were found in the patient's writing.
After six weeks MIT adequate spontaneous speech arose in connection with the disappearance of the RU.

Localization of RU in a Speech Production Model

Patients with a speech apraxia often suffer from a co-occurring oral apraxia (Miller 1986; Dworkin 1991). Some authors assume that oral nonspeech movements and speech movements are under different patterns of motor control with a specific influence on oral speech (Rosenbek 1993). However, in clinical practice, oral apraxia and speech apraxia are difficult to disentangle regarding their impact on spoken language.

A similar discussion is going on concerning the relationship between aphasia and speech apraxia. The clinical picture of speech apraxia as an additional factor of aphasia is rather easy to assess: groping articulatory behavior and errors on word initial consonants. However, it is difficult to point to the errors in oral speech that are unequivocally caused by speech apraxia; phonetic errors may result in phonemic changes (Lesser 1989; Miller 1989).

The fact that pure apraxia of speech from the onset is seldom observed makes the differentiation between aphasic and apratic symptoms more complex. Taking this for granted, we would leave aside this, partly terminological, discussion about the linguistic or nonlinguistic underlying mechanism of speech errors and assume that there is a stage during the production of speech in which the planning of articulatory movements is required. After the retrieval of the phonological form of a lemma, the speaker has to construct an articulatory program for the utterance (Levelt 1989).

A disorder on this subphonemic level is said to be responsible for the generation of nonlexical RU in the context of a Broca's aphasia (Blanken et al. 1990; Blanken 1991). According to those authors, such RU arise beyond the lexical and segmental level of processing and are due to a disorder in the modality-specific planning of articulatory movements; writing might be relatively preserved. However, the discrepancy between writing and speech does not seem to be an adequate argument. Cases have been described with disorders in the phonemic buffer and correct writing (Lhermitte & Derouesné 1974; Visch-Brink et al. submitted).

The invariance of RU in contrast to the variance of other nonlexical speech units such as neologisms, may be a better indicator for the localization of the underlying mechanism in a speech production model. Nonlexical speech without automatisms is described as caused by a disorder in the phonemic buffer. The degree of access to the phonological form influences the nature of the phonemic distortions (Butterworth 1985). A defective phonemic buffer with a preserved phonological output lexicon would lead to phonological resemblance between the neologisms and the target word (Butterworth 1985; Panzeri et al. 1987). The inavailability of the phonological wordform in addition to a defective phonemic buffer would result in neologisms that do not resemble the targetword but each other. The patient's strategy is to fill the lexical gap by randomly generated phonemes, stored in a buffer. There is a slow decay of the spoken form. As the interval of time between the succeeding neologisms diminishes, more phonological resemblance between them is shown.

Several case-descriptions are available with observations of such perseverative neologisms (Buckingham & Kertesz 1976; Butterworth 1985; Buckingham et al. 1979). These would function as fillers of the lexical gap, where the patient fails in his word retrieval. These neologistic sequences

would basically consist of unmarked, overproductive syllabic structures, as in most cases of nonaphasic glossolalia[3]" (Nespoulous et al. 1987). However there is much more variation in those target-free neologistic strings than in RU, which remain more or less the same in different speech tasks. This larger degree of invariability might be caused by the fact that the underlying mechanism, causing RU, is located at a later stage in the speech production model than the phonemic buffer. "Automaticy" (Keller 1987) would separate the speech motor process from the linguistic processes: within the motor speech process there is a computational complexity. The establishment of coordinate structures of articulatory movements may reduce this complexity. The planning of articulation requires transmission of phonemes in articulatory patterns. Accordingly as more peripheral processes are involved in the process of speech production, time constraints are more important. The planning of articulatory movements requires a selection of speech segments from stored articulatory movements. A lesion-induced difficulty in programming the complex and time-critical transitions may result in automatic speech; overreduction and simplification of articulatory movements.

Such a disorder in the planning of articulatory movements may be involved in both nonlexical, and lexical RU. According to Blanken, Wallesch and Papagno (1990) lexical speech automatisms may occur at the stage of whole word activation. However, from the group of stroke patients (N=267), who came over a period of five years to the Aphasia Foundation Rotterdam, RU were found in 17 patients (with a global aphasia). All patients were investigated with the local standard aphasia battery: the SAR test, comparable to the BDAE (Goodglass & Kaplan 1972)[4]. From this group all patients with utterances, other than RU, in any modality, had phonological paraphasias, both phonemic paraphasias and neologisms. In some patients, the paraphasias appear during recovery. Those phonological paraphasias were not only found in the patients with nonlexical RU, but also in patients with lexical RU. A plausible interpretation is that the

[3] The term 'glossolalia' is used for utterances, which occur spontaneously in a religious context and which are simpler and more repetitive than utterances in ordinary language (Crystal 1987).

[4] SAR: Stichting Afasie Rotterdam (Aphasia Foundation Rotterdam). In addition to the ratings of Spontaneous Speech, the test includes the following subtests: Token Test, Repetition, Reading aloud, Writing, Naming, Auditory and Visual Comprehension.

development of RU requires both a disorder in the phonemic buffer and a disorder in motor planning. Access to the phonological form may be intact or not. When no phonological form is available, perseverative neologisms to fill in the lexical gap may underlie the RU. With correct access to the phonemic forms, recognizable words with phonemic distortions will appear after the disappearance of RU.

MIT-efficiency

An interpretation of the efficiency of the MIT-method within the framework of the disorder and the nature of the therapy program in this case is not self-evident. It is questionable whether the positive influence of MIT on AL's speech production was due to the interaction of the method with the aphasia or with the disorder in the planning of articulatory movements. Assuming the first possibility, an explanation for the effectiveness of the MIT in our patient may be the following: MIT-therapy accentuates the underlying phonological forms by melody, a suprasegmental feature. According to the theories about the speech production process in normals, prosody is related to the phonological output lexicon, rather than to the phonemic buffer (Roelofs 1991), thus access to the phonological form may be facilitated by MIT. However such an effect is not plausible since cases are described with only disappearance of the RU without the revival of recognizable content words in spontaneous speech (Van der Lugt-Van Wiechen & Visch-Brink 1989).

The explanation that MIT interacts with the apractic disorder seems more plausible. The therapy breaks through the automatic speech and exposes the remaining linguistic skills of the patient. The main subpart of the MIT for AL was repetition of intoned sentences or multisyllabic words, together with handtapping in the initial sessions. Both the singing of sentences and rhythmical handtapping may be interpreted as intersystemic facilitators for motor speech disorders. The effect of the MIT on the planning of articulatory movements is explained as offering a temporal scheme for the organization of multiple speech movements (Square-Storer 1989). The exaggerated intonation and the rhythmic handtapping should support the temporal organization of the patients' articulatory movements. In this respect the facilitating influence of lengthened vowels within the MIT-sentences on the speech production of the patient, observed by Laughlin, Naeser and Gordon (1979), has to be mentioned. Consonants are most susceptible to deterioration in speech apraxia: the lengthening of the vowels may give room to formulate the surrounding consonants. Rhythmic

handtapping may have on the one hand an effect on timing (Tonkovich & Marquardt 1977), and on the other hand serve as a distractor "removing some of the volitional aspects of the motor speech act in apractic speakers" (Square-Storer 1989).

The final effect of MIT is that the therapeutic method interrupts the automatic speech and enhances voluntary control by the connection of linguistic and nonlinguistic units: phonemes and handmovements, managed by the prosodic contour. AL seems to regain facility of expression in control of intonation (see also Van Lancker 1987): the different orally presented prosodic contours apparently cannot be combined with the patient's RU; when he succeeds in singing the presented intonational contour, he looses his perserative CV-combinations. The presented intonational contour apparently cannot be combined with nonpermutable units like RU, but only with phonologically controlled units. Alajouanine (1956) describes a similar course in recovery; variations in RU are a consequence of variations in intonational patterns.

Initiated through prosody the final output control over the speech articulators was regained. The immediate and long-term effect of the method on non-fluent RU (see also Van der Lugt-Van Wiechen & Visch-Brink 1989) may point to a permanent deblocking of spontaneous speech. A condition is that the patient is able to repeat and to integrate the presented intonational contour. Some investigations revealed that both hemispheres should be involved in prosodic processing of language (Joanette et al. 1990). However, a recent PET-study showed that MIT reactivated essential motor language zones in the left hemisphere (Belin et al. 1996): an argument for the unilateral localization of speech prosody.

Future research may indicate which elements of the MIT-method are decisive for the blocking of RU. The positive effect of Multiple Input Phoneme Therapy with respect to the disappearance of RU in apractic-aphasic patients (Stevens 1989) shows that prosody may be not indispensable. In this kind of therapy only rhythmic handtapping was involved, together with verbal linguistic tasks. However, Hadar (1989) described the positive effect of psychomotor treatment, including handtapping, on the reduction of neologisms, produced by a patient with conduction aphasia. Intriguing here is the function of handtapping, as a facilitator of a linguistic speech function: the selection and ordering of phonemes. A similar effect of nonverbal motor therapy on linguistic and motor speech functions illustrates the complexity of the relationship between speech and language.

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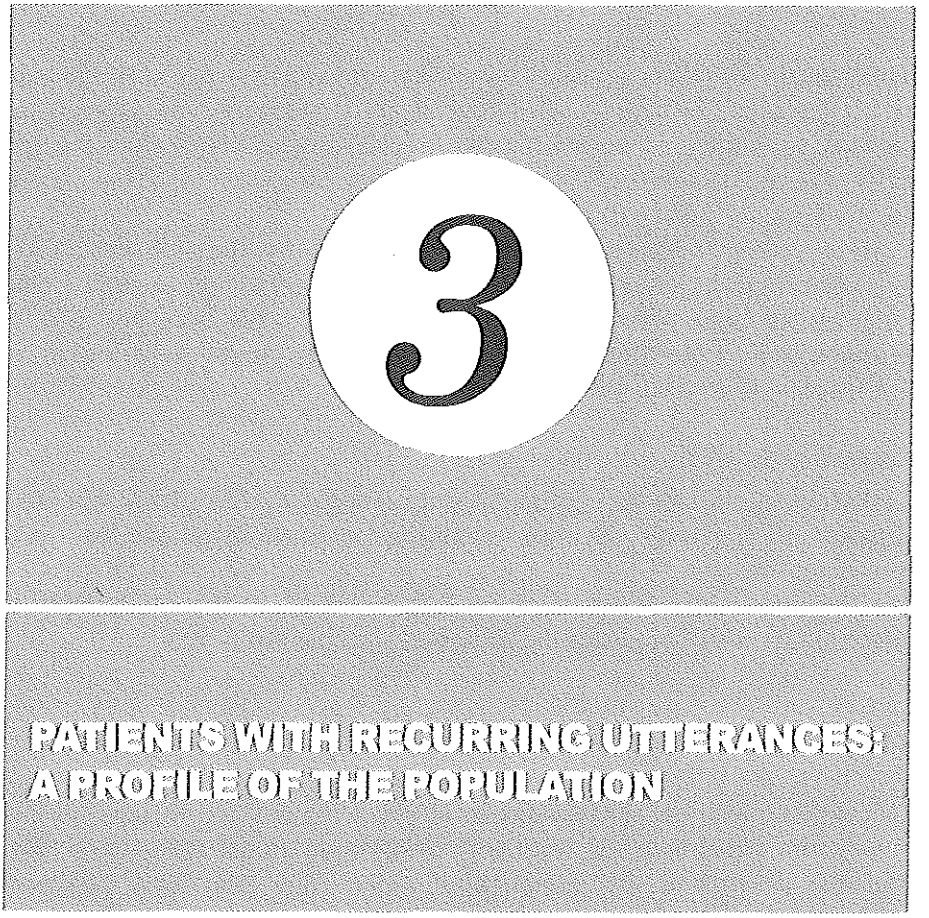

Introduction

Recurring utterances (RU), repetitive strings of speech, are a sign of global aphasia (De Bleser & Poeck 1984; Haas et al. 1988). Adequate words are scarcely found in the spontaneous speech in contrast to neologisms (Blanken et al. 1988). The linguistic structure of RU may vary; 'real word recurring utterances' (RWRU) are more frequently used than 'non meaningful recurring utterances' (NMRU) (Code 1982). The level of naming and repetition is very low (Alajouanine 1956; Blanken et al.1988).

Data about the frequency of occurrence of patients with RU within a group of aphasic patients or within a group of patients with a global aphasia are scarce. The study of Alajouanine in 1956 who reported about 24 RU-patients from a group of 317 consecutive aphasic patients (8%) was never

replicated. In his follow-up study the author observed recovery of RU in half of his patients. He distinguished four stages of recovery: an increase in prosodic variability (1), an amelioration of checking behaviour (2), variation in RU (3), the occurrence of volitional agrammatic speech (4). This pattern has not been verified by further studies.

It is unclear whether RU-patients differ from global aphasics without RU on neurological, linguistic and neuropsychological parameters. One subgroup is described in this respect: patients with invariant CVCV concatenations (De Bleser & Poeck 1984). The lesion localisation is discussed by Haas et al. 1988.

Purpose of the study.

Global aphasics with RU (group A) are compared with global aphasics without RU (group B) on neurological, neuropsychological and neurolinguistic data.
The linguistic performance of group A is described, as this information is important for the detection of the underlying mechanism of RU.

Subjects

267 patients with an aphasia due to stroke were referred to the Aphasia Foundation Rotterdam. RU were only observed in global aphasics (N=85). Eighteen patients of this group, nine women and nine men, produced predominantly RU; mean age 69.16, range 48-86. 67 patients (28 women and 39 men) showed a global aphasia without RU; mean age 66.97, range 31-85.

Methods

The patients were examined by a behavioural neurologist, a neuropsychologist and a neurolinguist.
The aphasia was classified not earlier than one month post onset (mean 5.6 months, range 1-20).
All patients were assessed with the local standard aphasia battery: Spontaneous speech, Repetition, Reading aloud (all three tape-recorded), Token test, Writing, Naming, Auditory and Written Comprehension.

All patients of group A were classified following the stages of recovery, presented by Alajouanine.

Results

In this consecutive series 7% of all aphasic patients appeared to produce RU; 21% of the global aphasics.
Somatic condition: During course less patients of group A showed worsening of their clinical condition (e.g. a second stroke) than in group B. Less patients of group A died within five years post onset than of group B (Mann-Whitney U = 32: p<.02). Duration of the stay in a nursery home was shorter for Group A than for Group B (group A: mean 15.4 months, range 1-62; group B: mean 25.7 months, range 2-87; Man Whitney U = 165: p<.03).

Neurological and neuropsychological data

There was no difference between both groups concerning the presence of hemiplegia, bucco-facial apraxia and ideomotor apraxia. Raven IQ was equal too.

Linguistic data

Only in naming group A (mean .37, SD .88) was significantly worse than group B (mean 1.56 SD 2.59) Mann Whitney U = 223: p<.03. Linguistic data group A: NMRU appeared to occur more frequently (n=12) than RWRU (n=6). Two patients were observed with invariant CVCV-concatenations. In one patient repetition did not elicit RU, two patients did not produce RU in naming. In spontaneous speech, eight patients produced adequate content words beside their RU. Severity of aphasia, as measured by the Token Test, showed no significant relation with naming, repetition and the presence of content words in the spontaneous speech. However, the ability to repeat some words was significantly associated with the presence of adequate content words in the spontaneous speech (Goodman & Kruskal Tau = .28: p<.03). Several variables, concerning neologisms, were related: the presence of neologisms and correct items in repetition (r= .547: p<.03), the presence of neologisms in spontaneous speech and in naming (Goodman & Kruskal Tau = .346: p<.02) and the presence of neologisms in naming and repetition (Goodman & Kruskal Tau = .622: p<.001).

There was no correlation between the stages of recovery, mentioned by Alajouanine and time post onset, expressed in months.

Discussion

The incidence of RU-patients, reported by Alajouanine, was in accordance with the observed frequency in Rotterdam. RWRU were less frequent than is suggested in the literature. The severity of aphasia, measured by the Token Test, is not a reliable predictor for the amount of adequate content words in the spontaneous speech or repetition. However, a good performance on repetition is a clue for the ability to produce adequate content words in spontaneous speech.

It seems to be an important finding, that the presence of adequate content words in repetition is associated with the occurrence of neologisms in the same task. This, together with the fact that the occurrence of neologisms in one productive task is related to the occurrence of neologisms in the other productive tasks, supports the idea that a dysfunction of the phonemic buffer constitutes a part of the speech problem in RU patients. A future comparison between group A and group B concerning the presence of neologisms in oral tasks, will give insight in the specificity of a disorder in the phonemic buffer for RU-patients.

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4

REPRODUCTION CONDUCTION APHASIA AND PRESERVED WRITING OF CONTENT WORDS

Introduction

Over the last two decades conduction aphasia has been described in detail. Two underlying mechanisms are probably involved in this syndrome: the first is characterised by an auditory verbal short term memory (STM) deficit, the second by a disorder in the planning of the phonemic structure of words. The nature of the underlying deficit is assumed to be responsible for the linguistic features. An auditory verbal STM deficit is responsible for repetition conduction aphasia. This syndrome is associated with a poor performance in repetition of words and digits combined with a relatively spared word production in other linguistic tasks requiring oral speech (Shallice & Warrington 1977; Caramazza et al. 1981; McCarthy & Warrington 1984; Caplan et al. 1986; McCarthy & Warrington 1987).

Repetition deficits without significant output problems such as phonemic paraphasias should be due to such a disorder (Shallice & Warrington 1977; Caramazza et al. 1981).

The primary deficit in reproduction conduction aphasia is a disorder in the seriation and selection of phonemes. Phonemic paraphasias are present in all linguistic tasks requiring spoken content words such as spontaneous speech, naming, repetition, and oral reading (Caplan et al. 1986). Phonological STM storage is preserved. Because oral reproduction of digits may be phonologically disturbed, matching span and pointing span tasks are used to measure STM in cases of reproduction conduction aphasia (Berndt 1988). However, since experimental and clinical examination of phonological output problems do not usually involve STM-tasks, the relation between an impaired auditory-verbal STM and a phonemic output deficit has not yet been clearly established (Kohn & Smith 1992). Although case-descriptions showing both subtypes of conduction aphasia are available, most patients with conduction aphasia are reported to be somewhere between those subtypes (Shallice & Warrington 1977).

Patients with a conduction aphasia whose results on the linguistic tasks point to a phonemic output disorder were discussed by Dubois et al. (1973), Yamadori & Ikumura (1975), Caplan et al. (1986), Caplan (1987), Pate et al. (1987), Kohn (1989), Kohn & Smith (1991), Palumbo et al. (1992), Caplan & Waters (1995), and Wilshire & McCarthy (1996). In one case, naming, repetition, and oral reading were quantitatively compared (Kohn 1989). In the presence of exclusively phonological errors, the author did not find any influence of the task on the amount of correct answers. Only the patients described by Caplan et al. (1986), Caplan (1987), Pate et al. (1987) and Wilshire & McCarthy (1996) were explicitly characterised as having reproduction conduction aphasia and a detailed report was given of the linguistic performance and STM function. Those patients' auditory verbal STM - measured through pointing responses (except the patient described by Wilshire & McCarthy 1996) - exceeded the results of the reported cases with conduction aphasia of the repetition type.

The phonological disorder is reported to be located at a post-lexical level (Kohn 1989; Kohn & Smith 1991); the observed conduite d'approche behaviour can be seen as evidence for intact access to the phonological form. That the inner phonological representation of words may be available, is explicitly shown by Feinberg et al. (1986), who reported about five conduction aphasics with a correct performance on tasks directed to judgement about wordlength, rhyming word-ends, and homophony with

pictures as input material. The notion that a disorder in the phonemic output buffer should be responsible for the phonemic paraphasias, is supported by the fact that wordlength is mentioned as influencing the oral production of words in these patients (Caplan et al. 1986; Berndt 1988; Kohn 1989). The frequency of the phonemic paraphasias produced by such patients increases in multi-syllabic words (Buckingham 1989).

Writing disorders in conduction aphasia should accompany the errors in oral speech; the realisation of content words in writing should be as much distorted as it is for spoken words (Dubois et al. 1973; Gandour et al. 1982; Kohn 1989). There should be 'a constant relationship between the severity of the disturbance of spontaneous speech and that of writing' (Kohn 1989), which continues throughout recovery (Dubois et al. 1973). A detailed analysis of phonological errors in writing and speaking in reproduction conduction aphasia showed that phonemically close letters are being substituted in writing (Kohn 1989). The consistency between oral and orthographic production led the author to caution for the effect that a speech deficit may have on orthographic processing in general. The opinion is based on the assumption that, during a writing task, early stages of word production are simultaneously and automatically activated. In spite of the damage to the phonological route, distorted phonemic strings should be automatically activated during writing and they should influence the graphemic strings via phoneme/grapheme conversion. This interaction should result in phonologically based writing errors. Consequently, according to Kohn (1989), phonological mediation is a necessary step in the production of written words. Oral and written output should both arise from the same defective phonology in conduction aphasia (Goodglass 1992). Caramazza et al. (1983) had claimed earlier that even if one were to assume a direct graphemic route, this route would have to be refreshed through a phonological rehearsal loop to prevent it from quick decay.

However, it has also been suggested, based on observed discrepancies between oral speech and writing, that there might be a direct connection between lexical-semantics and the graphemic output route without any interference from the phonology (e.g. Hier & Mohr 1977). A recently proposed architecture for the writing process only uses the graphemic output route, without activation of the phonemic output buffer, which would then only be involved in the writing of non-words (Caramazza et al. 1986). According to this theory, written spelling errors may be explained as an isolated deficit to the graphemic route. An example is given in Miller and Ellis (1987). Their explanation for the spelling errors in the written words of two patients with a

neologistic jargon aphasia is based on the weak activation of the orthographic lexical units and, as a consequence, the weak activation of grapheme units. Since the authors argue that, in these patients, similar deficits are afflicting two distinct output lexicons, they also predict the existence of patients with spelling errors without neologisms in oral speech. Such patients have indeed been described (Miceli et al. 1987; Schonauer & Denes 1994). Miller and Ellis (1987) also predict the existence of the reverse dissociation: meaning a patient with neologisms and intact writing, who 'has not, as far as we are aware, yet been reported'. Later on, such a patient has been described in Semenza et al. (1992). In this patient reading aloud and written naming were clearly better than the neologistic spontaneous speech.

The data in the literature concerning patients with conduction aphasia seem to support the idea that there is an interaction between overt speech and writing in terms of the presence of phonemic paraphasias. All nine patients with reproduction conduction aphasia described by Palumbo et al. (1992) showed impaired writing. Furthermore, in most of the described cases with information about writing and oral speech, the quality of writing is comparable with the other oral speech tasks (Dubois et al.1973; Yamadori & Ikumura 1975; Gandour et al. 1982; McCarthy & Warrington 1984; Mendez & Benson 1985; Feinberg et al. 1986: case 3 and case 4; Caplan et al. 1986; Tanabe et al. 1987: case 1 and case 3; Kohn 1989; Gandour et al. 1991; Kohn & Smith 1991; Wilshire & McCarthy 1996). Case reports of patients, denoted as a conduction aphasia, with a relatively intact written performance combined with a vast amount of phonemic paraphasias in the spontaneous speech and any other tasks requiring oral speech are hard to find. Only Feinberg et al. (1986), case 5, and Tanabe et al. (1987), case 2, described cases where a discrepancy between oral speech and writing was observed. However, on the level of phonemic constructions, spontaneous speech and writing seem to be equivalent in these cases. In spontaneous speech, phonemic paraphasias or neologisms seem to occur only occasionally.

Time post onset during follow up is variable, though a large group of patients is described within the first three weeks (N=10). Most of the patients are lost for follow up. As far as the localisation of the lesion is concerned, the patients in general fit into the descriptions given by Green and Howes (1977) of 25 patients with conduction aphasia. In the pre-CT period, the lesions of these patients are interpreted according to surgical and post-mortem examination. The above-mentioned authors found a lesion in the supramarginal gyrus in 22 out of the 25 patients; 15 out of the 25 patients had a lesion in the posterior part of the first temporal gyrus.

Lesions occurred less frequently in the angular gyrus (six out of the 25 patients) or in the insula (partial damage in six out of the 25 patients). The nine patients described by Palumbo et al. (1992) appeared on CT-MRI scans to have lesions in half or greater than half of at least one of the three following areas: (a) the anterior supramarginal gyrus area or the white matter deep to this area, (b) the angular gyrus area and the white matter deep to this area, (c) the insular cortex area'.

Various authors have observed patients who have not been labelled as having a conduction aphasia with a better performance on the written tasks than on the oral ones (see Table 4.1.). The type of aphasia varies greatly. Most of the patients show aspects of Wernicke aphasia: Michel (1979) mentioned a 'surdité verbale' and Blanken et al. (1989) a global aphasia. The patients described in Table 1 show a great diversity in age: 21 (Lhermitte & Derouesné 1974; case 1) - 76 years (Patterson & Shewell 1987); the follow-up, one week (Michel 1979) - nine years (Blanken et al. 1989); the etiology, trauma, (Lhermitte & Derouesné 1974; Michel 1979), encephalitis (Hier & Mohr 1977), infarction according to CT (only Bub & Kertesz 1982; Blanken et al. 1989). Bub and Kertesz (1982) explicitly mentioned the lesion, which comprises the inferior parietal lobe, the posterior portion of the superior temporal gyrus and the supramarginal gyrus.

Only Lhermitte and Derouesné (1974) and Semenza et al. (1992) found phonemic paraphasias in combination with intact writing in a naming task. The other patients are not reported to produce phonological paraphasias in oral tasks. The case described in Semenza et al. (1992) is classified as a jargon aphasia. Although the aphasia type of the patients presented in Lhermitte and Derouesné (1974) is not mentioned, it seems plausible from their detailed account that the patients' condition may be characterised as having reproduction conduction aphasia. Their auditory and visual comprehension are reported to be normal whereas their oral output (including spontaneous speech, naming, repetition, and reading aloud) is pervaded with neologisms and perseverations.

Table 4.1. The occurrence of phonological distortions in patients with superior written over oral performance

Authors	Patients (N=8)	Gender	Age	Spontaneous speech	Oral reading	Repetition	Oral naming	Writing
Lhermitte and Derouesné, 1974	Case 1	F	70	Paraphasies phonémiques	+	+	Néologisms; paraphasies literales	Dénomination par écrit aucune erreur
"	Case 2	M	21	Néologisms	Unknown	+	Néologisms	44/55 correct
Hier and Mohr, 1977	AF	M	28	Empty speech; no literal paraphasias	Unknown	Unknown	No response	In spontaneous writing and naming some paragraphic errors
Michel, 1979	Unspecified	M	46	Peu de paraphasies phonémiques	Unknown	Pas de paraphasies	"Jargonnante"	Dénomination par écrit satisfaisante
Bub and Kertesz, 1982	MH	F	66	Empty sentences (omissions)	Disturbed	Relatively good	No phonemic paraphasias	Correct choice of content words in descriptions of line drawings
Patterson and Shewell, 1987	GA	F	76	Many neologisms; empty of content words	Jargon; some paraphasias	Paraphasias; jargon; very perseverative	Few paraphasias; many omissions	Sometimes successful writing on occasions when she fails to communicate in any other way
Blanken et al., 1989	FL	M	61	Recurring utterances	Not possible	Single sound level	Recurring utterances	Written naming retained to a large extent
Semenza et al., 1992	Unspecified	F	65	Neologistic jargon aphasia	Almost unaffected	?	Impossible, neologisms	Written naming fairly well preserved

+ The authors mention the occurrence of a vast amount of phonological distortions

A new case with reproduction conduction aphasia and preserved writing is presented here. CT and MRI describe both the site and the extension of the lesion. Phonological paraphasias occur in oral speech: spontaneous speech, naming, reading aloud and repetition. Spontaneous writing of content words and written naming are both almost entirely devoid of any phonological distortions. This case illustrates that, in reproduction conduction aphasia, the graphemic route may function adequately without interference from the phonological representation. Compared with the patients described in Lhermitte and Derouesné (1974), there is a difference in aetiology and in the course of recovery. Their cases suffered from a traumatic aphasia and recovery was achieved within one month. The aphasia of our patient, where complete recovery did not take place, was the consequence of an infarction.

The patient has been investigated by means of neurolinguistic examinations from three months on with a follow-up of four years. The purpose of the present study is to describe the recovery pattern of the patient's aphasic symptoms during course, to present a neurolinguistic analysis of the disorder in the chronic stage and to relate the neurolinguistic disorder to the neurological data.

Case report, initial examination

Patient WvW, right-handed, was the director of a trading company that transported beef, until the age of 49, when cardiac problems caused him to stop working. Five years after a by-pass operation, at the age of 54, he developed attacks of angina pectoris, which failed to disappear in spite of full medication. During a heart catheterization, which resolved the angina problems, he suffered a stroke. After the operation, the patient exhibited aphasia and a right-sided hemiplegia. The hemiplegia disappeared within one day. The aphasia persisted. The neuropsychological and neurolinguistic examination took place at three months post onset.

CT verified the infarction and the location of the lesion. The precise localisation was obtained by MRI with brain sections according the stereotactic atlas of Talairach and Tournoux (1988), (see Figure 4.1.). The lesion spreads out over the superior and medial temporal gyrus, the upper border of the inferior temporal gyrus, then rises obliquely behind the lateral fissura by way of the rear part of the supramarginal gyrus and a part of the inferior parietal lobe.

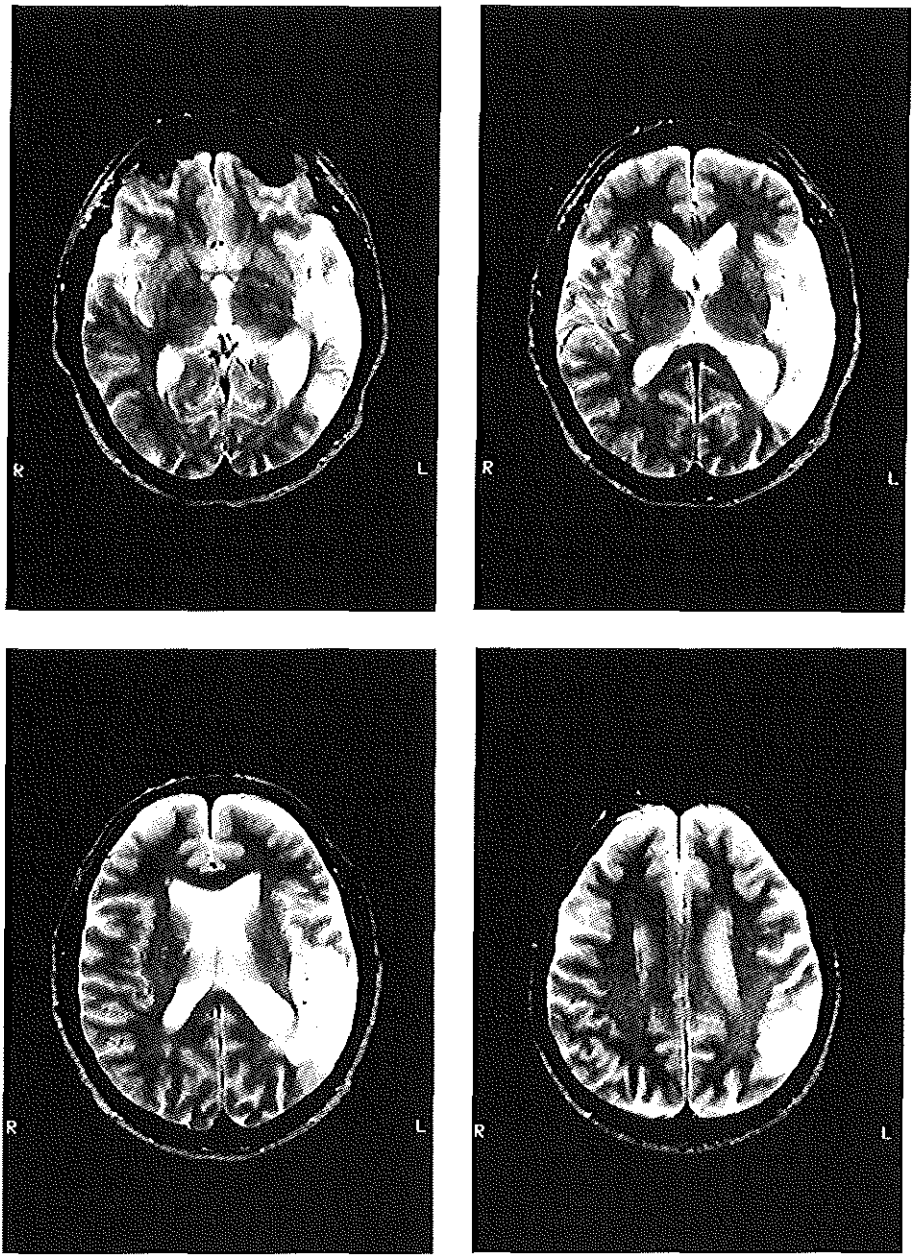

Figure 4.1 MRI of patient WvW with brain sections according to the stereotactic atlas of Talairach and Tournoux (1988), 39 months post onset.

The lesion ends at the lower side of the angular gyrus, extending in the frontal direction to the insula and even to the precentral gyrus, but the external capsule is free.
Horizontal slides show that the lesion stretches towards the ventricular wall, involving the arcuate fasciculus on a level at the inferior parietal lobe and medial temporal gyrus of the posterior horn. In addition the MRI shows some atrophy of the frontal poles and some widening of the lateral ventricles.

Neuropsychological Examination

The *neurological* examination showed that the aphasia was the main disorder. Although fine motor movements seemed to be impaired, the patient's motor behaviour was normal. There were no signs of buccofacial or ideomotor apraxia. Sense of pain, touch, and vibration was slightly decreased on the right side. The results of a test for auditory sensation with pure tone stimuli showed a slight symmetrical loss in frequencies below 2000Hz at 10dB, normal for his age. Naming of the days of the week and the months of the year was phonologically distorted. The patient could count from one to 10.

The results of the *neuropsychological* examination were as follows: The profile score and the screening score on The Rivermead Behavioural Memory Test (Wilson et al. 1985) fell within the normal range. Digit span forward was measured with an oral reproduction task. Although WvW's oral output in this task was distorted by phonemic paraphasias, he could repeat three digits flawlessly. Measured by the Raven Progressive Matrices the patient's IQ was 130. Written calculation was intact in contrast to oral calculation. The patient could perform subtraction and addition of three digit numbers. He could write down numbers of two digits on dictation. In numbers of three digits or more, he occasionally wrote down a wrong digit. His performance on constructional tasks was normal.

Language Examination

The Dutch version of the Aachener Aphasie Test[1] (Akense Afasie Test, AAT; Graetz et al. 1992) was administered (see Table 4.2. and Table 4.3.,

[1]The AAT has subdivisions for all major language components: Spontaneous Speech, Repetition, Written Language, Naming and Comprehension. Also the Token Test is a separate part of the AAT. Spontaneous Speech is evaluated on six rating scales with six points each: communicative ability, articulation and prosody, language automatisms, semantics,

first examination). As supplementary tasks, the patient had to perform written Naming and a written version of the Token Test. The nature of the patient's errors on the AAT incited us to examine the semantics and the phonology with more specific tasks.

- *Akense Afasie Test (AAT)*

Spontaneous Speech: Many of the content words in WvW's Spontaneous Speech were phonologically distorted, resulting in neologisms or phonemic paraphasias. Yet, in a conversational situation, the patient was highly motivated to make his intentions clear. He was aware that what he said was not always clear to his audience. Therefore, his strategy was to accompany the phonologically distorted content words with correct orthographic realisations in capital letters during speech (see appendix). The patient wrote down the content words rapidly and nearly without phonological errors. In fact, this was one of his main strategies for taking part in a conversation. Thus, he was capable of transmitting information and participating in a discussion. He sometimes broke off a sentence to write down the word that he intended to say, without trying to pronounce it first. In other instances, his writing accompanied his utterances, but in most cases this had no facilitating effect on his speech. Often he tried to make selfcorrections by reading what he had written down earlier, which was not always successful for listeners: e.g. he said 'diert' / di:rt /, wrote down 'Ierland' / I:rlɑnt / (Ireland) correctly, and than said 'diert' again. Or he said 'trans' / trɑns /, wrote down 'transport' / trɑnspɔrt / (conveyance) correctly, and said 'trappons' / trɑpɔns /. In other instances he stopped making phonemic paraphasias after he had finished writing the word down, and continued his sentence until another phonemic paraphasia or neologism came up. Sometimes a correctly pronounced monosyllabic word was nevertheless written down. This could indicate that he was not adequately monitoring his spoken output. On the other hand, he was often aware of his neologisms and tried to search for the correct word by slowing down his speech rate, mostly without success. Conduite d'approche also occurred after the correct word had been written down. Often, WvW did not finish his sentences or inserted pauses, generally caused by his word

phonology and syntax. The subtest Written Language consists of reading aloud (W1), putting together words and sentences to dictation from letters and words (W2) and writing to dictation (W3). The Comprehension subtest includes auditory and visual comprehension. For each item of the linguistic subtests four-point scales are used, the scale points being defined via linguistic categories. In behalf of an individual diagnosis, an ALLOC-program is available.

production deficit. As a strategy of delay in spoken speech, he inserted iterations of function words or pauses before content words. There was a slight tendency to agrammatism.

Repetition: Quite a number of phonemic paraphasias occurred, even in monosyllabic words (see appendix). Multi-syllabic words were often not recognisable. There were a few unsuccessful selfcorrections: 'puree' / py:re: / (mashed patatoes) became 'peru / pe:ry: / nee (no) peruruuk / pe:ry:ry.k /'. The patient was unable to repeat sentences adequately. Due to the phonological distortions of the content words, the meaning of the sentences became obscure.

Object Naming (oral): In mono- and bi-syllabic words, perseverations of phonemic paraphasias occurred, induced by the response to the first item (see appendix). All multi-syllabic compound words were phonologically distorted, varying from phonemic paraphasias, 'schrijfmachine' /sχrɛifmɑʒI:nə/ (typewriter) became 'schraafmachine' / sχra.fmɑʒI:nə /, to neologisms: 'veiligheidsspeld' /vɛiləχhɛitspɛlt/ (safety pin) became 'beslekker' / bəslɛkər /, wherein the targetword was unrecognisable. Just as in the other oral speech tasks, many self-corrections were observed. In naming complex pictures, the pattern observed in spontaneous speech returned: many phonological paraphasias in combination with relatively well-preserved syntactic constructions. In nearly all sentences (N=10), the function words were correctly produced. A function word was omitted only once; in some instances, the main verb was also phonologically deviant (see example).

e.g. 'de man zat / zɑt / in de bank / bɑŋk / de krant / krɑnt / te lezen / le.zən /' (the man sat on the couch reading the paper) became 'de man zand / zɑnt / ('sand': verbal phonemic paraphasia; auxiliary replaced by noun) in de bamok / ba:mɔk / (neol) de krank / krɑŋk / (phonemic paraphasia) schelen / sχe.lən / (verbal phonemic paraphasia).

Object Naming (written): In comparison to WvW's poor oral Naming, correct score 5/30 items, written Naming (of the same pictures) was excellent, correct score 26/30 items (see appendix). Errors: a verbal phonemic paraphasia in a part of a compound noun 'schroevedraaier' / sχru:vədrajər / (screwdriver) became 'schroevejager' / sχru:vəja.χər / (screwhunter); a verbal semantic paraphasia 'veiligheidsspelden' (safety pins) became 'punaises' (drawing- pins); two morphological errors in compound words

'schrijfmachine' (typewriter; schrijf = stem of the verb) became 'schrijvenmachine' (schrijven = infinitive). Without hesitation, the patient quickly committed the words to paper in capital letters.

Reading aloud: A small number of words were presented to the patient. In this task WvW managed to pronounce a three-syllabic word with only one distorted phoneme (see appendix).

Writing to dictation: The patient made some errors: a phonemic verbal paraphasia: 'montage' (assembling) became 'moraal' (moral); a reduction: 'dapperheid' (courage) became 'dapper' (brave); an exchange of word parts: 'luchtpostbrief' (airmail letter) became 'luchtbriefpost'. The quality of the syntactic structures was worse than in 'naming complex pictures' which was probably due to the lack of content words in the sentences.

e.g. 'Wanneer zal zij het mij sturen?' (when she is going to send it to me?) became 'het samen zij' (it together she).

Auditory and Visual Comprehension: The AAT-ALLOC psychometric individual diagnosis showed a significant difference between Auditory and Visual Comprehension. Auditory Comprehension of words and sentences with three distractors was moderately disturbed, whereas Visual Comprehension in a similar task was only slightly disturbed. Within both modalities, no difference was found between the levels of word and sentence comprehension.

Token Test: The score on the Token Test in auditory form pointed to a severe aphasia (correct score: 12/50 items). However, the results of the test in its written presentation (correct score: 42/50 items) were much better. The written orders were hidden once WvW had read them. This better performance of WvW in the visual version is in line with the results of Auditory and Visual Comprehension.

- *Semantics*

The Pyramids & Palmtrees Test (Howard & Patterson 1992) was administered. The test is used as a tool to measure the retrieval of semantic representations. Various input channels are used to determine possible modality-dependent differences in decoding the target. WvW managed to perform perfectly on all versions of this test (each 52 items): pictures, spoken word/pictures, written word/pictures and written words.

- *Phonology*

Oral Spelling: Frequently used monosyllabic (5) and bisylllabic words (5) were auditorily presented and the patient's task was to spell the words orally. The patient succeeded in only one item. The same task was administered with pictures as input material, but this made no difference to the results.

First phoneme and first letter identification: After the presentation of a picture, the patient had to give the first phoneme of its name, and, in a separate task, the first letter. His written output, 18/20, exceeded highly his oral output, 4/20, which was severely disturbed.

Identification of number of syllables: Items were presented as pictures. WvW was able to give the correct number of syllables in most of the items, 14/20 correct, even of multi-syllabic words like 'vingerhoed' (thimble) and 'piramide'(pyramid).

Production of non-words: The reading, repeating, writing to dictation and copying of non-words were tested with four similar sets of mono-syllabic items. Except in copying (10/10 items correct), the patient completely failed to perform any of these tasks (resp. 0/10, 0/10, 0/10). He made existing words out of the items, e.g. 'go' (/ χo: /, a non-existing word in Dutch) became 'school' / sχo:l / (school). During the task, WvW developed abhorrence towards non-words because of their lack of semantic value.

Summary of performance on the initial examination

Phonological paraphasias and neologisms occurred in all AAT-tasks requiring oral production of content words. Most of the content words, even monosyllabic words in spontaneous speech like 'zoon' (son), were distorted by phonological paraphasias in the context of a relatively good comprehension. The observed conduite d'approche in the speech output, illustrating difficulties in selecting and seriating phonemes, indicated that the lexical form was often, at least partially, available. This is confirmed by the results of the identification of the number of syllables of words, presented in the form of pictures. Tasks requiring phoneme selection and ordering without an underlying lexical form, such as the oral and written production of nonwords, were extremely difficult for the patient.

In comparison with the other AAT-subtests, language Comprehension, especially comprehension of written words, was relatively spared.

The difference between Auditory and Visual Comprehension of the AAT in favour of the last one was found again in the Token Test. Spontaneous writing seemed to be better than writing to dictation. A remarkable aspect was the excellent quality of written naming and the use of writing during spontaneous speech as a way to bypass the naming impairment. The often unsuccessful conduite d'approche in spontaneous speech after the correct writing of the word, the defective oral spelling of words and the discrepancy between oral and written production of the first phoneme of a word belonging to a picture, they all point to the fact that WvW did not profit from his intact writing in speech.

Recovery

The AAT was administered six times over a period of two years, starting at three months post onset, in order to evaluate the patient's linguistic performance during recovery. In the course of examinations, the phonological distortions occurring in the AAT subsections Naming of objects and Repetition of words were analysed in order to measure changing patterns of phonological deviations in time. Finally, four years post onset the patient was examined on AAT again. Over a period of three years samples of spontaneous speech were analysed to observe the distribution of phonological and verbal paraphasic errors during the course of the aphasia.

Table 4.2. Spontaneous speech WvW during recovery (AAT)

Post onset		months					years	
		3	6	8	13	16	2	4
SPONTANEOUS SPEECH								
Total score	(30)	17	20	21	22	22	23	24
SUBLEVELS								
Communicative ability	(5)	2	3	3	3	3	3	3
Articulation and prosody	(5)	3	3	3	4	4	5	5
Speech automatisms	(5)	5	5	5	5	5	5	5
Semantics	(5)	3	3	4	4	4	4	4
Phonology	(5)	2	3	3	3	3	3	3
Syntax	(5)	2	3	3	3	3	3	4

AAT = Akense Afasie Test

Recovery pattern, performance on AAT

The quality of Spontaneous Speech during recovery, according to the AAT rating scale, is represented in Table 4.2.

Spontaneous Speech showed improvement during recovery at ten months post onset, all the subparts that were measured in the Spontaneous Speech module had been upgraded one point, except for 'automatic speech', which never occurred in our patient and therefore had a top-level score from the beginning. The most disturbed modules at onset were communicative ability, phonology and syntax. This clinical picture remained the same at two years post onset. At four years post onset, syntax was less deviant than phonology according to the AAT scoring system.
Table 4.3. shows the results of WvW on the other subtests of the AAT: Token Test, Repetition, Written Language, Naming and Comprehension.

Table 4.3. Performance WvW on AAT during recovery (percentiles)

Post onset	months					years	
	3	6	8	13	16	2	4
Token test	39	75*	77	79	86	75	69
Repetition	20	38*	40	50	55	55**	56
Written language	55	66*	67	70	75	75	72
Reading	43	60	60	88*	88	88	71
Composition	53	62	58	56	69	76*	66
Dictation	59	65	69	69	69	65	73
Naming	33	56*	71	90**	79	97	88
Comprehension	59	79	75	86	91*	94	97
Auditory	35	85*	77	74	74	85	96
Visual	79	67	67	93	97	96	96

AAT = Akense Afasie Test
* significant improvement in relation to the first examination (3 months post onset)
** significant improvement in relation to the second examination (6 months post onset)

If we approach WvW's recovery by taking the results of the first AAT as a starting point, we observe a significant improvement in performance in all the main subtests over the course of two years. However, the recovery pattern within the different tasks is inconsistent over time. Between three and six months post onset the patient's performance on the Token Test,

Repetition, Written Language, and Naming improved significantly. The Token Test results indicate a development from a moderate to a mild impairment, an improvement that took place in the first three months and then persisted. At that time, the patient's results on the oral version of the Token Test equalled his performance on the written version.

Further improvement was only found in Repetition and Naming, the tasks that were most severely disturbed at onset. In spite of the fact that WvW's performance on Repetition improved during the first two years, Repetition remained, significantly, the most disturbed task during recovery from six months post onset. Initially, Naming was as severely disturbed as Repetition (Psychometric individual diagnosis following the ALLOC-procedure). However, in contrast to Repetition, Naming improved to a normal level within two years. At that time, all target words were recognisable in WvW's naming responses; phonemic paraphasias that occur in the Naming of objects must not be included in the error scores following the AAT procedure.

For Comprehension, the figures show a significant improvement from 59% to 94% at two years post onset, especially due to an improvement of Auditory Comprehension (*see* results 16 months post onset). The score on the subtest Visual Comprehension was already relatively high at the beginning of the period.

There was no significant improvement in the AAT subtests between two and four years post onset.

The pattern of phonological errors in Naming and Repetition

The phonological deviations of the patient's responses in Naming and Repetition were analysed by means of the 'Indice de Similarité Phonémique' (I.S.P.; Lhermitte & Derouesné 1974)[2]. This measuring device is only useful when the target word is known. Therefore, calculations in every successive examination were only made for the AAT sections Naming of objects (20 items) and Repetition of words (30 items) in every succeeding examination. The patient's performance up to two years after onset was collected for

[2] I.S.P. = identical phonemes divided by the number of phonemes in the stimulus + the number of phonemes in the response. Each phoneme in the response, which is identical and found in the same place in both stimulus and response has a value of 2. Each phoneme, which is identical and not found in the same place, has a value of 1. Each phoneme in the response, which is a reiteration of an identical phoneme, has a value of 0.5. Below the value of 0.41, an item is considered as neologistic.

analysis; this covers the period in which progress was observed. Semantic paraphasias were totally absent in the patient's speech, which increased the value of the method of analysis. Only some verbal phonemic paraphasias were found: e.g. 'boek' / buk / (book) became 'broek' / bruk / (trousers). Two judges, independently of each other wrote down the neologisms and phonemic paraphasias. Cases of disagreement were resolved through discussion. The I.S.P. was calculated for all responses. If the patient made more than one attempt to say the word, we took the median. Correct responses were calculated too, they received a score of 1. The results of the analysis of the patient's responses within the Naming task are presented in Table 4.4., the data from Repetition in Table 4.5.

Table 4.4. Indice de la Similarité Phonémique in naming WvW during recovery and influence of word frequency and word length

	I.S.P.				
Time post onset	Mean	Median	Range	Word frequency	Word length
3 months	0.5 (0.24)	0.46	0-0.89	NS	NS
6 months	0.72* (0.23)	0.72*	0.26-1	p<0.005**	p<0.001**
8 months	0.81* (0.17)	0.78*	0.53-1	p<0.05**	NS
13 months	0.81* (0.21)	0.88*	0.44-1	p<0.05**	NS
16 months	0.84* (0.17)	0.86*	0.44-1	p<0.05**	NS
2 years	0.89* (0.22)	1*	0.18-1	NS	NS

SDs are given in brackets, NS = not significant,
* significant improvement in relation to the first examination (Wilcoxon Signed Ranks)
** significant influence of word frequency or word length on I.S.P. (Spearman Rank Correlation)

The data of Table 4.4. and 4.5. show that between the third and the sixth month post onset a significant improvement took place in the resemblance of the phonological deviations to the target words. After this period, performance stabilised, while for every test period a significant change with the first test results remained. A statistical analysis - Two-sample Wilcoxon Ranksum - showed that at no point in time did this difference in the I.S.P. between Naming and Repetition become significant (Spearman Rank Correlation 0.0271 - n.s.).

Table 4.5. Indice de la Similarité Phonémique in repetition WvW during recovery and influence of word frequency and word length

Time post onset	I.S.P. Mean	Median	Range	Word frequency	Word length
3 months	0.66 (0.28)	0.72	0.08-1	NS	p<0.01**
6 months	0.73* (0.29)	0.82*	0-1	p<0.01**	p<0.01**
8 months	0.8* (0.28)	1*	0.25-1	p<0.01**	p<0.01**
13 months	0.79* (0.29)	1*	0.09-1	p<0.01**	p<0.001**
16 months	0.77* (0.31)	1*	0.17-1	NS	p<0.001**
2 years	0.81* (0.26)	1*	0.15-1	NS	p<0.001**

SDs are given in brackets, NS = not significant,
* significant improvement in relation to the first examination (Wilcoxon Signed Ranks)
** significant influence of word frequency or word length on I.S.P. (Spearman Rank Correlation)

In view of the underlying deficit, the effect of word length and word frequency on the extent of the phonological distortions in Naming and Repetition was examined. Word length was expressed in number of syllables. Word frequency was measured according to CELEX[3] norms (Burnage 1990). Table 4.5. shows that Repetition is significantly influenced by word length: at all times there appeared to be a high correlation between the number of syllables and the value of the I.S.P. (the longer the word, the lower the I.S.P.). In Naming, we found exactly the reverse: except for the second period, word length did not correlate with phonemic similarity (see Table 4.5.). In contrast to word length, word frequency does not offer a clear-cut picture. In Repetition, in three out of six examinations, there is no significant correlation between the frequency of occurrence and the measured I.S.P. of the items. In Naming, word frequency appears to be related to I.S.P in four out of the six examinations; low frequency words elicited more severe phonological deviations than high frequency words.

Paraphasic errors in Spontaneous Speech

The rate of decrease of paraphasias in Spontaneous Speech during recovery is presented in Table 4.6. The speech samples belonging to the AAT

[3] Dutch Data Base, release N3.1. Computer Software. Nijmegen: Center for lexical information, 1990.

examinations at three and six months and at three years post onset were transcribed for an analysis of the occurring paraphasias. On the AAT rating scale for the judgement of Spontaneous Speech the patient moved from '2' to '3' on the phonological level, which is expected to be reflected in a more accurate analysis of the phonological errors. After six months post onset the scoring on phonology remained the same. As an example of the chronic stage we took an interview at three years post onset, held according to AAT directions. Paraphasic errors were categorised às neologisms and phonological paraphasias, according to the criteria of Butterworth et al. (1984) [4]. Furthermore, we counted the number of verbal paraphasias [5] with either a phonological or a semantic relation to the target word (Green 1973): e.g. 'wafel' / ʊa.fəl / (waffle) in case of 'tafel' / tafəl / (table), 'stoel' (chair) in case of 'tafel' (table). Finally, we categorised unrelated verbal paraphasias (Green 1973) e.g. 'aap' (monkey) instead of 'schip' (ship), where both a phonological and semantic relationships between response and its target are loose or absent. Although some phonological paraphasias were also observed in other content words, like verbs and adjectives, the analysis took into account only nouns, as in Naming and Repetition. In all samples of Spontaneous Speech, verbal paraphasias with a semantic relation to the target word were absent, which indicates that we can exclude a semantic disorder as a source of the observed neologisms (Buckingham 1981) [6]. A comparison of the first and the second interview reveals an interesting fact: During the first interview (three months post onset), the number of neologisms and phonemic paraphasias exceeded the number of correct nouns, a tendency which is also found in other tasks requiring the oral production of content words. Three months later, a reverse relation was found; most of the nouns were produced correctly. Neologisms and phonemic paraphasias were still produced during the last interview, showing that the phonological

[4] Phonological paraphasias were considered to be all words that showed a total of one or less phonemic (i.e.segmental) metatheses, additions, deletions or substitutions relative to the target word. Neologisms were all nonwords not classified as phonological paraphasias.

[5] Verbal paraphasias are all distortions, which are real words.

[6] However, within the AAT scoring system of Spontaneous Speech semantics was rated as 3 in the first two interviews (maximum score: 5). This was mainly due to the observed gaps where the patient wrote down the word instead of uttering it, and the number of empty sentences in which specific content words were avoided.

distortions are an essential feature of the patient's disorder in the chronic stage. Between each point in time, there was a difference in the ratio correct nouns/total number of nouns with phonological distortions, especially between three and six months post onset.

Table 4.6. Recovery pattern of paraphasias in spontaneous speech WvW

Post onset	3 months	6 months	3 years
Nouns*	85	120	281
Correct nouns	23 (27%)	72 (60%)	202 (72%)
Total number of nouns with semantic distortions	4 (5%)	1 (1%)	0
Verbal semantic paraphasias	0	0	0
Verbal unrelated paraphasias	4	1	0
Total number of nouns with phonological distortions	58 (68%)	47 (39%)	79 (28%)
Neologisms	46	32	57
Phonological paraphasias	11	10	19
Verbal phonological paraphasias	1	5	3

* all nouns are counted, including nouns with paraphasic errors, and selfcorrections

Table 4.7. shows that selfcorrections, which we already observed three months post onset, are present in all speech samples. The number of phonological paraphasias per target word seemed to increase slightly, especially between three and six months post onset. The more WvW recovered, the more longer and infrequent words were produced prone to phonological distortions. However, the number of successful selfcorrections increased during recovery. During the first interview at three months post onset, writing was a necessary tool for WvW to get the message across.
The majority of the phonologically distorted nouns were written down correctly. The number of correct nouns in writing is much higher than in speaking. At six months post onset, the used writing as a communication aid in spontaneous speech had decreased; the phonologically distorted content words were more recognisable. Instead of writing, the patient tried to correct, often successfully, his deviations of the target word, which made the instances of conduite d'approche increase.

Sometimes WvW got stuck to the same word: 'het laatste nieuws / nius /' (the last news), became 'het laatste deeuws / deus / deeuws, deeuw / deu / nee deeuws' (the last x x x, no x).

Table 4.7. Selfcorrections of phonological paraphasias in spontaneous speech WvW

	Post onset	3 months	6 months	36 months
SPEAKING				
Targets*		37	27	30
Phonological paraphasias		58	47	79
Mean number of phonological paraphasias per target		1.57	1.74	2.63
Targets with successful selfcorrections		0	10 (23%)	18 (60%)
WRITING				
Written targets		27	NA	NA
Correctly written targets		23	NA	NA

NA = not available
* number of different nouns, distorted by phonological paraphasias

Summary of performance during recovery

According to AAT measures, the period in which the performance on most test modules improved significantly, was before the sixth month post onset. The discrepancy both between the performance in the written and oral version of the Token Test and between Visual and Auditory Comprehension of the AAT is balanced between three and six months post onset. This runs parallel to a significant improvement in performance on Writing to dictation. On the tasks which were the most disturbed at the first examination, such as Naming and Repetition, the patient still made significant progress after six months post onset. However, Repetition remained the most severely disturbed task in all successive examinations. Between two years and four years post onset the aphasic symptoms stabilised. The overall pattern of the test results after six months post onset shows a good comprehension in combination with phonologically distorted verbal output. WvW's excellent spontaneous writing makes him an exceptional case.

In terms of the I.S.P., denoting the phonological similarity of the targetword and the response, no difference was found between Naming and Repetition. However, within tasks the influence of word frequency and word

length was different. For Repetition, word length is a dominant factor, whereas for Naming, frequency was more important in relation to the I.S.P. The improvement of Repetition is probably due to a better functioning at the level of the phonemic output buffer; word length is described as a factor that influences especially the selection and seriation of phonemes. A greater accessibility to the phonological word form might possibly explain the better Naming results.

The analysis of the paraphasic errors in spontaneous speech shows that a semantic disorder as an underlying deficit is not plausible explanation for the patient's word finding problems. The rarely observed verbal paraphasias have a phonological relation to the targetword, which may denote that the underlying mechanism which causes those deformations is likely not to be semantic, but rather a disorder in the selection of the phonological form.

During recovery, the phonological paraphasias and neologisms disappeared to a large extent in those tasks that require oral production of prescribed content words, such as Repetition, Naming and Reading aloud. Improvement of Spontaneous Speech became apparent from the decrease in the number of neologisms in favour of an increase in the number of phonological paraphasias, paired with a higher number of successful selfcorrections. However, the frequency of occurrence of phonological paraphasias in Spontaneous Speech at three years post onset indicates that a disorder in the construction of phonological strings was still present in the chronic stage.

The chronic stage

In the chronic stage of WvW's aphasia, which was the period between two and four years post onset, we examined the specific psycholinguistic problems of the patient. The main focus was the location of the phonemic disorder in a speech-processing model. The analysis of the patient's disorder in the chronic stage was based on the word processing model, described in Ellis and Young (1988) and subject to the design of the PALPA, a set of Psycholinguistic Assessments of Language Processing in Aphasia (Kay et al. 1992). A number of tasks, which were presented to the patient in the chronic stage, are derived from the preliminary version of the Dutch PALPA (Bastiaanse et al. 1995).

The psycholinguistic analysis was aimed at the following modules of processing: the lexical-semantic system (abstract words), the verbal auditory

memory, and the phonological input route to the lexical-semantic system, the phonological output route and the graphemic output route. Since WvW's performance on the AAT subtest of Visual Comprehension was normal at one-year post onset, suggesting an intact silent reading, there was no reason to investigate the intactness of the graphemic input route to the lexical-semantic system.

Psycholinguistic analysis

Lexical-semantic system

The patient's results on the Pyramids & Palm Trees Test (Howard & Patterson 1992) in the first examination already showed no indication of a semantic impairment. This test is only concerned with concrete words. In order to verify WvW's processing of abstract words, we administered Synonym Judgement (PALPA). The patient had to judge if two words were synonymous or not. There were wordpairs with a high imageability and wordpairs with a low imageability. The interpretation of abstract words did not present any difficulties for this patient: Synonym Judgement, auditory: high imageability 29/30 items correct (controls, n = 21: Mean 29.7 SD 0.6), low imageability 27/30 items correct (controls, n = 21: Mean 28.5 SD 1.5).

Verbal auditory memory

Digit span: In a task where the patient had to reproduce three auditorily presented digits in serial order, less than half of the items were correct both in oral and in written reproduction. The results of the oral and written reproduction did not differ. The patient was incapable of reproducing four digits. These results improved strongly once serial pointing to digits was requested after oral presentation. The patient now reached a production of six digits. Going from three to six digits, his performance remained the same. Consequently, his span performance was considerably better in the absence of spoken or written reproduction (see Table 4.8.). WvW's results in pointing to digits after auditory presentation approximate the performance of normals. The mean performance of 12 controls in the study of Vallar et al. (1992) is 5.95.

Pointing span for noun-verb sequences (pictures) (PALPA): This task makes use of four uninflected verbs and four nouns in pseudo-sentence arrangements which are semantically anomalous but carry prosodically supported sentence structures (SV-SVO), for instance SVO SVO 'scissors boil mouse, hat knock pen'. The words are presented auditorily.

The number of words included in a sentence increases from two to seven. There are two sequences consisting of the same number of words. The patient has to select the denoted pictures. WvW reached the level of six-word structures; 50% of the items were correct, which falls within the normal range.

Table 4.8. Performance WvW on auditory verbal memory

Auditory verbal memory	Patient WvW			Controls (N=21)
DIGIT SPAN	Oral reproduction	Written reproduction	Pointing	Oral reproduction
3 digits	5 (12)	3 (12)	27 (34)	Mean 10
4 digits	0 (12)	1 (12)	20 (34)	Mean 9.86 (10) SD 0.35 Range 9-10
5 digits	NA	NA	24 (34)	
6 digits	NA	NA	26 (34)	
				Controls (N=24)
NOUN-VERB SEQUENCES				**Pointing**
2-7 words			7 (14)	Mean 9.92 (14) SD 2.08 Range 6-13

NA = not appropriate, Maximum number of items correct is given in parentheses

Phonological and auditory lexical input processing

Discrimination of minimal pair words/nonwords (PALPA): The stimulus pairs consisted of monosyllabic words or nonwords with a CVC structure. Minimal differences according to voice, manner or place of articulation occurred in either initial or final positions. In some pairs the order of sounds was reversed. The words were presented auditorily with a one-second interval of flat intonation. WvW has to indicate if the stimulus pairs sound different or not. All the sameness judgements in pairs of words and pairs of nonwords were correct; errors were only made in the different judgements (see Table 4.9.). In words as well as in nonwords the scores of the different judgements were below the normals' level.

Phonological segmentation: word initial, word final (PALPA): Monosyllabic words and nonwords were presented to the patient auditorily. The patient had to select the first or the last letter of the word out of four written letters. The results fell in the normal range (see Table 4.9).

Table 4.9. Examination of phonological input route WvW

Tasks	Patient WvW	Controls (N=21)		
		Mean	SD	Range
DISCRIMINATION OF MINIMAL PAIRS				
Words, same judgements	36 (36)	35.1	1.3	32-36
Words, different judgements	30 (36)	34.9	1	33-36
Nonwords, same judgements	36 (36)	35.4	0.8	33-36
Nonwords, different judgements	24 (36)	35.6	0.6	34-36
PHONOLOGICAL SEGMENTATION				
Words, initial	29 (30)	29.9	0.4	29-30
Words, final	28 (30)	29	0.9	27-30
Nonwords, initial	10 (15)	13.6	1.5	10-15
Nonwords, final	10 (15)	13.5	1.6	10-15
AUDITORY LEXICAL DECISION				
Words	78 (80)	78.5	1.5	74-80
Nonwords	70 (80)	78.3	1.7	74-80

Maximum possible score is given in parentheses

Auditory lexical decision (PALPA): This task investigates the effects of imageability and frequency on lexical decision about spoken words. There are four word-sets: High Imageability-High Frequency; High Imageability-Low Frequency; Low Imageability-High Frequency; Low Imageability-Low Frequency. Words are matched across groups as far as possible for grammatical class and number of letters, syllables and morphemes. Nonwords are derived from words by changing one or more letters, while preserving orthotactic and phonotactic regularity. The results show that the phonological input lexicon is fairly intact (see Table 4.9.). There was no effect of imageability. Nonwords were recognised less accurately than words.

Phonological output route
The intactness of the phonological output lexicon was measured clinically (a-e) and by 'pseudohomophone decision', a PALPA subtest. In the remaining tasks (repetition and oral reading of words and nonwords) the phonemic buffer was relevant. Grapheme/phoneme conversion was also examined.

Rhyming pictures (a): In each trial four pictures were presented, two of which had rhyming names. Monosyllabic 'kam' / kɑm / (comb), 'lam' / lɑm / (lamb) and bi-syllabic 'sigaar' / si.χa:r / (cigar), 'gitaar' / ɤita:r / (guitar) words were incorporated. There was no semantic relationship between the rhyming words. A semantically and phonologically unrelated distractor accompanied the targets. WvW had to indicate which of the pictures formed a rhyming couple. Although the task was not easy, he performed quite well (20/25 items correct).

Homophone decision (b): From a sample of written wordpairs, the patient had to decide which word pairs were homophones e.g. 'hausse' / ho.s / (rise) and 'hoos' / ho.s / (spout). No mistakes were made (40/40 items correct); in order perform adequately this task, the patient has to make a phonological representation of the graphemic string.

Identification of number of syllables (c): We presented the patient with pictures from mono- and multisyllabic words. The multisyllabic words varied from two to four syllables. The patient had to decide the number of syllables contained in the words that the pictures represented. The patient performed well on this task (22/25 items correct).

Rhyming nonwords (d): Pairs of nonwords were presented in written form and WvW had to decide whether they rhymed. The rhyming pairs were not orthographically similar e.g. 'teiks' and 'lijx' (both / tɛiks /). The patient made the correct decision in most of the items (18/20 items correct).

Identification of first and final phoneme (e): We presented the patient with pictures of a Dutch version of the Boston Naming Test (Kaplan et al. 1978) existing of 40 items with frequent and infrequent mono-and multisyllabic words. During the first presentation the patient had to say the initial phoneme of the word, during the second presentation the final phoneme.

The patient performed rather well on the first task (37/40 items correct). The last task displayed slightly more errors (32/40 items correct).

Pseudohomophone decision (PALPA): The patient had to decide whether a written nonword would sound like a word if pronounced. WvW had to make a phonological representation to be able to make a lexical decision. In most items, the patient succeeded in this task and his performance was nearly normal (see Table 4.10.).

Repetition of words/nonwords (PALPA): The set of words that the patient had to repeat varied according to the parameters 'imageability' and 'frequency'. Imageability particularly affected WvW's performance, indicating that the patient used the semantic route in word repetition (see Table 4.10.). Words with a high imageability were repeated more successfully than words with low imageability. The patient's accuracy in repetition of words with a high imageability did not differ from the results of normals. In contrast, WvW's performance on repetition of words with a low imageability was lower than in normals. There was no difference between high frequency and low frequency words. However, performance was disturbed with both word classes. High imageability was clearly a facilitating factor. In contrast with the rather good results in word repetition, the repetition of nonwords was severely defective. The results were far below the normal range. The length of the stimuli in this task varied from one to three syllables. WvW could only repeat one mono-syllabic word out of a sample of nonwords controlled for the number of syllables (see Table 4.10.).

Reading aloud of words/nonwords (PALPA): The patient had to read aloud words and nonwords that varied in length. In contrast with near perfect performance on words, only half of the nonwords were read correctly (see Table 4.10.). In comparison with normals, the oral reading of words was intact whereas the oral reading of nonwords was significantly disturbed.

Table 4.10. Examination of phonological output route WvW

Tasks	Patient WvW	Controls (N=21)		
		Mean	SD	Range
PSEUDOHOMOPHONE DECISION				
Pseudohomophones	11 (15)	13.4	1.5	10-15
Nonhomophones	13 (15)	14.7	0.6	13-15
REPETITION OF WORDS				
High imageability	38 (40)	39.9	0.5	38-40
Low imageability	29 (40)	39.8	0.4	39-40
High frequency	35 (40)	39.9	0.3	39-40
Low frequency	32 (40)	39.8	0.5	38-40
REPETITION OF NONWORDS	8 (80)	77.8	2.4	71-80
REPETITION OF NONWORDS, CONTROLLED FOR NUMBER OF SYLLABLES				
Monosyllabic	1 (10)	9.8	0.5	8-10
Bisyllabic	0 (10)	9.7	0.4	9-10
Three-syllabic	0 (10)	9.9	0.4	9-10
ORAL READING OF WORDS, CONTROLLED FOR LETTER LENGTH				
Three-letter words	6 (6)	6	0	6-6
Four-letter words	5 (6)	6	0	6-6
Five-letter words	6 (6)	6	0.2	5-6
Six-letter words	6 (6)	6	0	6-6
ORAL READING OF NONWORDS, CONTROLLED FOR LETTER LENGTH				
Three-letter nonwords	4 (6)	6	0.2	5-6
Four-letter nonwords	3 (6)	6	0	6-6
Five-letter nonwords	3 (6)	5.9	0.4	5-6
Six-letter nonwords	2 (6)	6	0.2	5-6
GRAPHEME/PHONEME CONVERSION, LOWER CASE	16 (26)	25.6	0.6	24-26

Maximum possible score is given in parentheses

Grapheme/phoneme conversion (PALPA): The patient was requested to pronounce letters as phonemes. All the letters of the alphabet were presented in a random order. This task was very difficult for the patient and the results lay below the normal level (see Table 4.10.). The patient often required more than one attempt in order to produce the correct phonemic realisation of the grapheme. He did not always succeed.

The graphemic output route
Written naming after auditory definition: Auditory descriptions belonging to infrequent words (12 concrete, 12 abstract items) were presented. Examples of the last category are: 'plagiarism', 'equator', 'optimist'. WvW had to write down the matching word.
The results show that the route from the lexical-semantic component to the graphemic output lexicon was fairly intact, as well as the selection and ordering of graphemes for written output (see Table 4.11.).

Writing words/nonwords to dictation (PALPA): The patient had to write words and nonwords on dictation, varying from three to six letters. The writing of words was normal. The writing of nonwords was severely disturbed. WvW only succeeded in writing correctly two three-letter nonwords (see Table 4.11.).
To analyse the disorder in more detail, we presented the patient with five sets of words, which he had to write down (see Table 4.11.).

- words of two phonemes, CV (e.g.'os' / ɔs / means 'cow') and VC (e.g.- 'la' / la: / means 'drawer') (set a).
- monosyllabic nonwords with the same structure, only the consonant has been changed (set b).
- real words of four phonemes, CCVC ('trein' / trɛin / means 'train') and CVCC ('melk' /mɛlk / means 'milk') (set c).
- nonwords with the same structure, and only one phoneme changed (set d).
- nonwords of four phonemes, from which more than one phoneme had to be changed to make an existing word out of it (set e).

The patient only made errors in writing nonwords. Moreover, the numbers of errors increased as the deviations from existing words were enlarged. There was no difference on the two-phoneme level between words and nonwords. On the four-phoneme-level both in the nonwords that varied with one phoneme and in the nonwords that varied with two phonemes from existing words, a defference between words and nonwords was found.

Three nonwords where the deviations from of existing words were minimal (set d) were changed by the patient into real words: ('kloem' / klum / became 'knoet' / knut / 'knout'). In the last task, which included nonwords with strong deviations from an existing word (set e), many errors were made: 'skaus'/ skɑus / became 'tsok' / tsɔk /. Errors occurred both in vowels and in consonants and the last consonant was more often incorrect than the first consonant.

Influence of imageability and frequency on writing: In the writing of low imageable and low frequent words, the patient's performance was below the level of normals (see Table 4.11.).

Naming letters: All letters of the alphabet were presented in a random order. The patient had to name each letter. WvW could perform this task quickly with only a few errors.

Oral spelling: We presented auditorily monosyllabic and multi-syllabic words, varying from two to four syllables. The patient had to spell the word, but this task appeared to cause him great difficulties.

Summary of performance in the chronic stage

Lexical semantic processing of concrete and abstract words was intact, in accordance with the earlier findings. The facilitating influence of high imageability on the repetition of single words and the writing of single words on dictation may be an indicator of the use of the lexical-semantic route in both tasks.

The auditory verbal STM, measured by pointing span for digits and noun-verb sequences, was preserved: the patient's results were in the normal range. The requirement of the oral or written reproduction of digits did decrease the patients' performance to under the normals' level.

The results on the phonological segmentation show that phonological analysis of auditorily presented words and nonwords was intact just as was phoneme/grapheme conversion. WvW's performance on the discrimination of minimal pairs, specifically the different judgements and the recognition of nonwords, was slightly disturbed, which may point to the use of a lexical-semantic strategy in those tasks.

Rhyming pictures, homophone decision, identification of number of syllables, pseudohomophone decision and the identification of the first and the final phoneme of words belonging to pictures presented few difficulties,

Table 4.11. Examination of graphemic output route WvW

Tasks	Patient WvW	Controls (N=24)
WRITTEN NAMING AFTER AUDITORY DEFINITION	20 (24)	NA
WRITING WORDS TO DICTATION, CONTROLLED FOR LETTER LENGTH		
Three-letter words	6 (6)	
Four-letter words	5 (6)	
Five-letter words	5 (6)	
Six-letter words	6 (6)	
Total score	22 (24)	Mean 23.7 SD 0.6 Range 22-24
WRITING NONWORDS TO DICTATION, CONTROLLED FOR LETTER LENGTH		
Three-letter nonwords	2 (6)	
Four-letter nonwords	0 (6)	
Five-letter nonwords	0 (6)	
Six-letter nonwords	0 (6)	
Total score	2 (24)	Mean 22.2 SD 2.1 Range 15-24
WRITING WORDS, CONTROLLED FOR CV-STRUCTURE		NA
Monosyllabic words with CV (5) and VC (5) structure	10 (10)	
Monosyllabic nonwords of the same structure	8 (10)	
Monosyllabic words with CCVC (5) and CVCC (5) structure	10 (10)	
Monosyllabic nonwords of the same structure with one phoneme changed	3 (10)	
two phonemes changed	1 (10)	
WRITING WORDS TO DICTATION		
High imageability	18 (20)	Mean 19.6 SD 0.8 Range 17-20
Low imageability	13 (20)	Mean 19 SD 1.2 Range 15-20
High frequency	19 (20)	Mean 19.7 SD 0.7 Range 17-20
Low frequency	12 (20)	Mean 18.8 SD 1.4 Range 15-20
NAMING LETTERS		
Upper case	24 (26)	
Lower case	23 (26)	
Total score	47 (52)	Mean 50.7 SD 5.2 Range 38-52
ORAL SPELLING, CONTROLLED FOR SYLLABLE LENGTH		NA
Monosyllabic words	7 (10)	
Bisyllabic words	4 (10)	
Three-syllabic words	5 (10)	
Four-syllabic words	2 (10)	
Total score	18 (40)	

NA = not available, Maximum possible score is given in parentheses

which shows that the phonological output lexicon is intact and accessible to the patient.

The high performance on written naming after auditory definition proved the relative sparing of the graphemic output route. Grapheme/phoneme conversion in the context of nonwords, without pronunciation, was possible (see the results of 'rhyming nonwords'), in contrast with grapheme/phoneme conversion of separate letters, where the production of the phoneme was required. Although the naming of letters was intact, oral spelling was defective (see discussion). Repetition, writing and oral reading of nonwords was nearly impossible. The analysis of WvW's writing of nonwords showed that the more deviant the nonword was the worse the response. WvW's problems with nonwords point to a disorder in the phonemic buffer as being the main locus of his impairment.

Discussion

Aphasia type

The remarkable aspects of WvW's aphasia during course are twofold. Firstly, in the context of a relatively good comprehension, phonological errors are found in all oral tasks requiring the production of content words. The phonemic paraphasias even persisted as comprehension reached the normal range. Secondly, the writing of content words was not influenced by the phonological distortions and appeared to be nearly flawless. The occurrence of phonological distortions in oral speech, independently of the task, is considered to be the most prominent linguistic marker of the syndrome of reproduction conduction aphasia (Kohn 1992). The analysis of WvW's phonemic paraphasias in naming and repetition by means of the I.S.P. (Lhermitte & Derouesné 1974) revealed no difference between the tasks as far as the resemblance of the phonemic errors to the target words was concerned. This method was selected because the authors described patients with a similar clinical picture in the same way: a defective phonological system with a relatively spared graphemic output. Likewise, most of the phonological deviations of our patient were described in terms of the I.S.P. as phonemic paraphasias.

A comparison between spontaneous speech and constrained oral tasks in terms of the degree of phonological errors is difficult. In spontaneous speech, the knowledge of the degree of contextual appropriateness is crucial for the recognition of the target word (Visch-Brink & Van de Sandt-Koenderman 1984). Moreover, the responses to the stimuli in the different tasks require different processes; the nature of phonemic paraphasias in relation to the diverse eliciting tasks and their underlying processes still has to be determined (Caplan & Waters 1992). However, the occurrence of phonemic distortions in WvW points clearly to the classification of his case as reproduction conduction aphasia, to the extent that this characteristic was most remarkable in all the oral speech task.

Conduite d'approche behaviour which should accompany the phonological distortions, is a secondary obligatory deficit of patients with a conduction aphasia. The speech samples of WvW show that selfcorrections are constantly present. During course, there is an increase in the number of successful selfcorrections (see also Pate et al. 1987; Kohn 1992). This favourable effect of attempts at a flawless wordproduction is probably related to the recovery of comprehension. According to Joanette et al. (1980), increasingly closer approximations to a target are only found in the context of a good comprehension.

WvW's self-corrections on the segmental phonemic level interrupted the fluency of spontaneous speech. This breakdown in fluency distinguishes a reproduction conduction aphasia from a mild Wernicke aphasia with lexical-based phonemic distortions (Kohn 1989). Broca aphasia is excluded as appropriate aphasia type because of the fact that periods of disfluency were bound to phonologically distorted words. An analysis of spontaneous speech showed that the impression of slight agrammatism gathered from the initial spontaneous speech sample was due to WvW's wordfinding difficulties. The percentage of WvW's omissions and substitutions of function words appeared to be equal to those of normals (Vissers 1992; Kolk & Heeschen 1992).

Finally, it has to be mentioned that a kinetic impairment like verbal apraxia was apparently not responsible for the speech errors, either predominantly nor as an additional impairment. A groping articulatory behaviour was never observed in the patient's history.

In the differentiation between the reproduction and the repetition type of conduction aphasia, the state of the auditory verbal STM is considered one of the most crucial features (cfr. Berndt 1988). WvW's performance on digit span tasks displayed a significant divergence between oral or written

production and pointing, in favour of the latter. With pointing as a response modality, the patient's results approximated the normal range. His pointing span for noun-verb sequences expressed on pictures did not deviate at all from the results of normals. The patients in the literature who were explicitly labelled as reproduction conduction aphasia (Caplan et al. 1986; Pate et al. 1987; Caplan & Waters 1995; Wilshire & McCarthy 1996) are reported to have an impaired auditory verbal STM. Yet an intact auditory verbal STM is one of the defining features of this aphasia type. The bad performance on the oral reproduction of digits seems to be due to the response modalities; a disorder in the phonemic and in the graphemic buffer (see further) might cause problems with the oral and written enumeration of digits.

One of the most interesting aspects of WvW is his writing capacity in lexical tasks. WvW's writing of words was significantly better than his spoken output. This is not only exceptional among patients with reproduction conduction aphasia, but also in patients with an other classification. Most authors report that writing is disturbed in conduction aphasia (see Benson 1988; Berndt 1988; Palumbo et al. 1992). Table 4.1. contains described cases with a relatively preserved writing component. Basso et al. (1978) stress the rarity of this linguistic profile. Within a series of 500 patients with aphasia, they found only two patients with fluent aphasia and a remarkably spared writing. The discrepancy was restricted to spontaneous speech and spontaneous writing and the other speech tasks were nearly flawless.

Unfortunately, writing is one of the least described modalities in aphasia. In view of the history of the architecture of speech and writing, more attention should have been paid to this task. Lichtheim, the precursor of the recent model makers, hypothesised two possible routes in writing, one via Broca's area, the other via Broca's and Wernicke's areas. The intact writing of patients with a conduction aphasia and paraphasic speech (as was the case in our patient) would, according to the author, exclude the involvement of the Wernicke area in the writing process. This was the case for our patient.

The performance of WvW on speech and writing is a strong argument for the partial independence of the graphemic and phonological output routes on the postlexical level. WvW is the counterpart of the patients described in Miceli et al. (1987) and in Schonauer and Denes (1994) who made errors in written spelling while having an intact oral speech.

Neurolinguistic analysis

The main disorder of WvW seems to be a post-lexical deficit, located in the phonological output route. Any task that involves activity of the phonemic output buffer is impaired. The lexical and the nonlexical route to speech production meet each other in this module. It's the pre-articulatory stage where the lexical form receives its segmental phonological specification whereafter the articulatory realisation can take place. The participation of the phonemic output buffer seems to be in the following tasks, which were disturbed in WvW: oral speech requiring words and nonwords, the writing of nonwords and the grapheme/phoneme conversion of separate letters. Particularly on the oral and written reproduction of nonwords there was bad performance. According to Caramazza et al. (1986) both tasks require that the phonological representation is held in the phonemic output buffer, until the phonological segments are mapped into articulatory patterns (in speech) and the phonemes are converted in graphemes (in writing). The phonological output lexicon is intact, shown (among other tasks) by WvW's performance on homophone decision and on pseudohomophone decision.

As far as the post-lexical localisation of the disorder our patient agrees with the case described by Kohn in 1989. However, in support of the assumed post-lexical deficit, this author postulates, that there should be no lexical effect to the phonemic distortions. The description of her patient with reproduction conduction aphasia shows that repeating words elicited the same number of phonemic paraphasias as repeating nonwords, which was not true for our patient. The prediction according to which a disorder in the response buffer should have a similar effect on words and nonwords fits in the serial models of speech production as f.i is promoted by Levelt (1989). The segments of the phonemic strings to be produced are prone to damage, independently of the foregoing steps in the processing of those utterances.

In our patient there is large discrepancy between the realisation of words and nonwords both in oral speech and in writing. In this respect WvW resembles the cases described by Caplan et al. (1986), Caplan (1987), Caramazza et al. (1986), Bub et al. (1987) and Wilshire and McCarthy 1996. Caramazza et al. (1986) explain a good performance of words in contrast with nonwords by assuming a direct mapping of lexical-phonological representations to lexical articulatory representations without participation of the phonemic buffer. Bub et al. (1987) presume that in the processing of words aphasic patients may use compensatory lexical and semantic information to facilitate the activation of phonemes. Such an explanation falls within the scope of the language models that assume spreading

activation. Those parallel network models (Stemberger 1985; Dell 1988) would clarify the influence of the lexical bias and eventually the semantic representation in segmental phonological processing by the positive feedback of the higher level representations.

This approach appeared to be wonderfully suited to WvW. With such a bottom-up strategy reaching into the lexical semantic representation, WvW tried overtly to compensate for his phonemic disorder. Struggling with a suffix he could only pronounce the word in spontaneous speech after a connection with the semantic representation: he wanted to say 'natuurlijk' (of course), he did not succeed, then he connected the suffix '-lijk' as a homophone with 'lijk' (corpse) and he succeeded in the pronunciation. In the same way he pronounced the word 'Gorbatsjov' in oral reading after expressing the sentence: 'Cor' (proper name) 'gaat' (goes) in 'bad' (bath) 'met een slof' (with a slipper). This overtly expressed semantic strategy agrees with the observation that WvW (in the initial stage already) converted nonwords into existing words. The above-mentioned example clearly illustrates that WvW uses the lexical-semantic route as a strategy to assist him during the phonological realisation.

In the context of a defective phonemic output buffer, the intactness of auditory verbal memory is peculiar. Generally a defective phonemic output buffer is associated with a defective auditory verbal memory (Campbell & Butterworth 1985; Kay & Marcel 1981). Subvocal rehearsal, the common part in both modules, is denoted as responsible for this association (Campbell & Butterworth 1985; Caplan & Waters 1995). Not phonological manipulation should be influenced by an impaired subvocal rehearsal, but the role of the buffer in holding the phonological segmental information available to the mapping in the articulatory realisation (Levelt 1989; Bisiacchi et al. 1989; Cohen & Bachoud-Levi 1995).

There is some support for an intact subvocal rehearsal: WvW could judge the similarity of auditory presented nonwords and in behalf of phonological segmentation he could hold in his memory an auditorily presented nonword. The damage of the phonemic output buffer might involve the 'active' part, the manipulation of phonemic segments into a form suitable for pronunciation.

Another possibility is that subvocal rehearsal is partly intact. It may be suggested that the self-monitoring process is broken at the moment where the articulation of the word starts. The activity of the motoric realisation may rule out the activity of a higher node in speech processing and cause an

accelerated decay of the segmental phonemic representation. In line with the adaptation theory WvW uses syllabification as a facilitating strategy.

In future research the relation of phonemic paraphasias to phonological manipulation (tasks belonging to the buffer) and to verbal auditory STM should be investigated. The occurrence of phonemic paraphasias is not bound to a disorder in auditory verbal memory. Such a disorder is characteristic of aphasia, independent of the type (Vallar et al. 1992). Pointing and repetition digit span tasks are reported by these authors to differentiate patients classified as conduction aphasics, Broca aphasics and Wernicke aphasics from normals. Pointing to digits was even more difficult for the aphasic group than repetition in contrast with normals, where the reverse was found.

The graphemic buffer may be slightly impaired also. The test results pointed to a problem in the writing of low imagery and low frequency words with some errors in the selection of graphemes. Moreover, WvW has bad performance on oral spelling. The intactness of the graphemic output buffer would imply a good performance in oral spelling (Hillis & Caramazza 1989; Kirk et al. 1991), which is not true for WvW. Maybe we can apply the hypothesis of Miceli et al. (1987): the articulatory wordforms are directly connected with the lexical wordforms to the graphemic output route. The velocity of WvW's writing, immediately the whole word seems to reflect the mapping of the graphemic output lexicon in the motoric act without interference of the graphemic output buffer. During recovery WvW was observed to write less easily during oral speech.

If we take the decrease of phonemic paraphasias as a measure for the amelioration of the phonemic buffer, we have an explanation for the fact that later on the not completely functioning phonemic buffer hindered the patient during writing. The phonemic output buffer might work as a 'jamming station' in an already developed strategy. Participation of the phonological route in writing would require some reasonable activity of the phonological representation. A similar suggestion may clarify the discrepancy between the data presented in the case-reports. For instance, the patient of Kohn (1989) with reproduction conduction aphasia was moderately disturbed, both in writing and in oral production tasks (correct score in oral and written naming respectively 11/15 and 12/15). In other patients, on the basis of whose performance in speaking and writing an independent orthographic route was suggested, the results in the various tasks differed widely. E.g. Patient 2 of Lhermitte and Derouesné (1974) obtained a correct score of 3/50 in oral naming and 44/50 in written naming. The patient of Hier and Mohr (1977)

was denoted with a percentage of 4% correct in oral naming and 52% correct in written naming. Perhaps we may conclude that integration of the phonological and graphemic route will only take place when the performance on both components is above a certain level.

Recovery

There is an important difference between WvW and the patients described by Lhermitte and Derouesné (1974). Their patients were free of aphasic symptoms within a month; the recovery of oral speech was in line with the recovery of the other tasks. In WvW, the production of phonemic paraphasias and neologisms was a persisting deficit, which did not completely recover like comprehension and naming.

Quite unknown are the linguistic characteristics of the recovery pattern of patients with a conduction aphasia; Gandour et al. (1991) published the only extensive longitudinal study wherein various linguistic aspects of the disorder during course are described. Unfortunately data about auditory short-term memory are lacking.

Generally the prognosis of conduction aphasia is described as favourable; Kertesz in 1984 followed nine patients with conduction aphasia during one year. Three patients recovered completely, six patients remain anomic. The three patients described by Tanabe et al. (1987) recovered within one week. The lesion was almost restricted to the arcuate fasciculus. Poncet et al. (1987) also described a patient with conduction aphasia and a lesion, affecting the arcuate fasciculus, which was verified by MRI two months post onset. However it's not clear from the description of the patient's linguistic performance, if the clinical signs of conduction aphasia are still present at that time. In the longitudinal study of Gandour et al. (1991), precise information about the localisation of the lesion is lacking but the parietal cortex seems to be involved. The localisation of the lesion of our case confirms the assumption that cortical structures, notably the supramarginal gyrus in addition to a lesion in the arcuate fasciculus is responsible for long-lasting conduction aphasia (Van Harskamp & Visch-Brink 1997). Future longitudinal studies with a synchronous description of the aphasia and the lesion localisation may provide further insight into the relation between the linguistic symptoms and the neuro-anatomical data.

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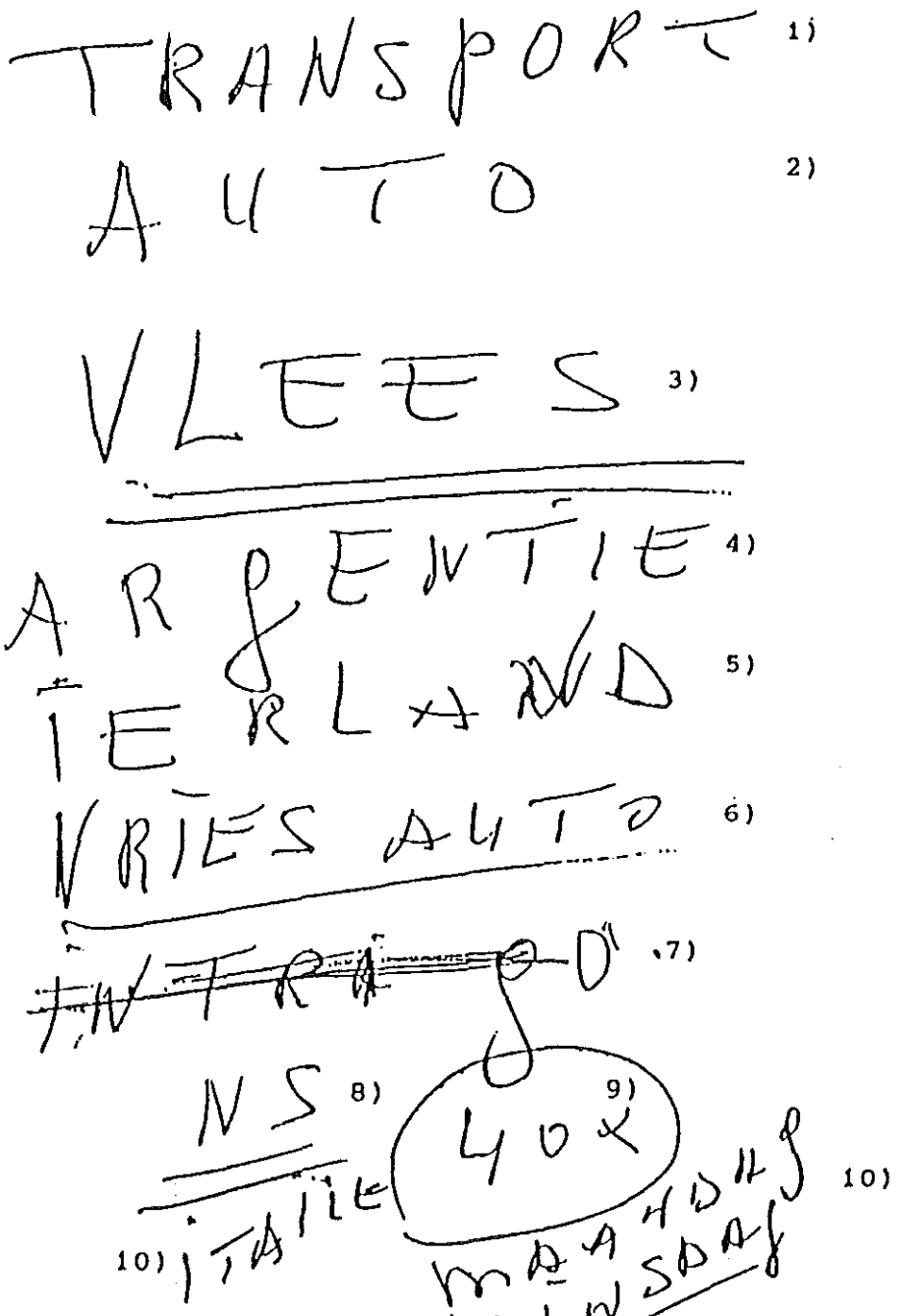
Appendix

Int. *Wat is uw beroep? (What is your profession?)*
WvW Ik ik doe nu niks meer (I I don't work anymore)
Int. *Nee, maar wat heeft u gedaan? (No but what was your profession?)*
WvW Ik heb /ɑlt/ (?) in eh ja in /o.t/ (/o:to:/ car) in /trɑns/
(unfinished, /trɑnsport/ conveyance)
(writes: transport** nr. 1) /trɑpons/ (/trɑnsport/ conveyance)
(I have x in eh yes in x in x x)
Int. *Transport (Conveyance)*
WvW Met auto's (writes: auto** nr 2, car) (With cars)
Int. *Ja, alleen in Nederland? (Yes, only in the Netherlands?)*
WvW Nee nee nee nee nee /he:ɬɑl/ (?) met (writes: vlees** nr 3, meat) met vlees en die kwamen uit /kɛntərnɛnzi:jə/ (/ɑrχənti:ni:jə/ Argentina) (writes: Argentie nr. 4, written Dutch: Argentinië) ja? (No, x with with meat and those came from x, yes?)
Int. *Argentinië (Argentina)*
WvW Ja en van /di:rt/ (/I:rlɑnt/ Ireland) (writes: Ierland** nr. 5) /di:rt/
(Yes and from x x).
Int. *Ierland (Ireland)*
WvW Ja nou en die kwamen met auto met /fri:kʉs/ (?), da's of met ja met eh hoe heet die dingen? Nou ja, wij zeiden dit al (writes: vriesauto** nr. 6, refrigerator car). (Yes, right and those came with car with x, that's or eh with yes with how do you call those things? Right, yes we said this already)
Int. *Vriesauto's (Refrigerator cars)*
WvW Ja (Yes)
Int. *Koelwagens (refrigerator cars)*
WvW En ook een hoop /vɸl/ (?) met eh /i.tvəl/ (?) (writes: intrigo, nr. 7) nee van de (writes: NS** nr. 8, Nederlandse Spoorwegen, Dutch Railcompany) van de /spo:r/ (unfinished, /spo:rwe:χən/ railcompany). Maar ik weet winter…nou dat weet ik niet meer.
Da's een tijd geleden. Ik weet het ook niet zo goed meer. Maar ging het zo, zo'n /ve:r/ (unfinished, /ve:rtəχ/ forty) (writes: 40 nr. 9) /twa:/ (/ma.ndɑχ/ Monday) (writes: maandag** nr. 10) maandag, en dan hier en die (writes: dinsdag** nr. 11, tuesday) en die gingen allemaal naar /pi:ja:na:/ (/I:ta:li:jə/ Italy) (writes: Italie, nr. 12, written Dutch:
Italië, Italy). And also a lot x with eh x no of the of the rail…, but I know winter…I don't know anymore. That's a long time ago. I don't remember. But was it like that, such a x x, Monday and then here and they and they went all together to x.

Spontaneous Speech WvW, three months post onset, ** = correct written word



Writing WvW during Spontaneous Speech

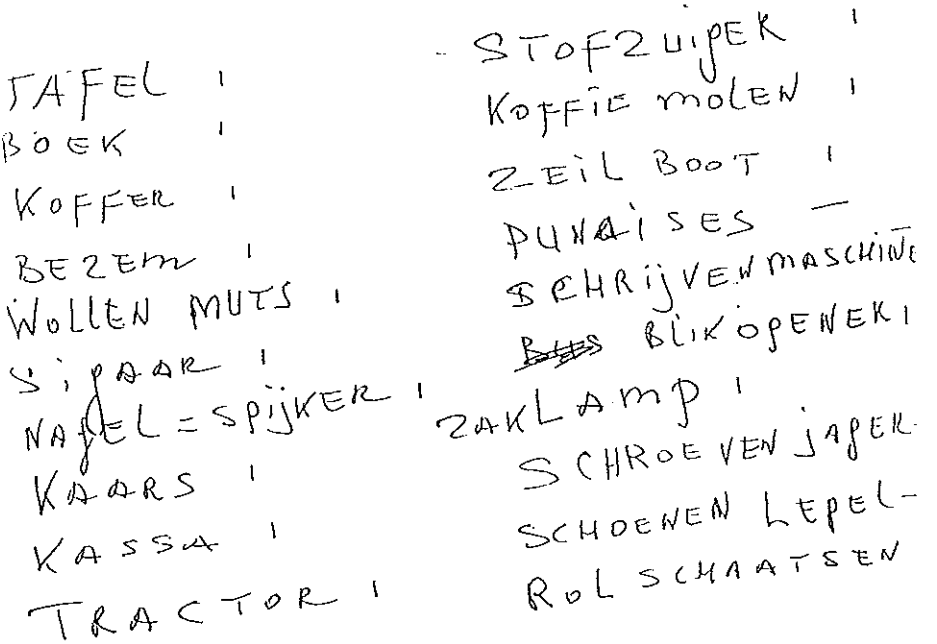
oost /o.st/ (east)	correct
vla /vla:/ (custard)	/vla.n/
mond /mɔnt/ (mouth)	correct
glas/ɣlɑs/ (glass)	/χlaaχ/, *glans* (shine) nee (no)
storm /stɔrm/ (storm)	correct
worst /vɔrst/ (sausage)	/vɔrs/
spreuk /sprɸ.k/ (saying)	/sχrɸ.k/
kwarts /kvɑrts/ (quartz)	*kruit* (powder)
psalm /psɑlm/ (psalm)	/pfɑlm/
stronk /strɔŋk/ (stump/	/sprɔŋk/
kitsch /ki.tʒ/ (kitsch)	/kri.s/
kano /ka:no:/ (canoe)	correct
puree /py:re:/ (mashed potatoes)	/pe:ry:/ nee (no) /pe:ry:ry.k/
piloot /pi:lo.t) (pilot)	/ka:la.n/
compagnie /kɔmpɑɲi:/ (regiment)	*kan* (can)
telefoon /te:ləfo.n/ (telephone)	/pɛlɛk/
chokolade /ʒo:ko:la:də/ (chocolate)	/ky:na:lɛk/
moderator /mo:dəra:tɔr/ (moderator)	/mo:to:ra:tərə/

italics: verbal paraphasia with phonological relation to the target

Repetition of words (AAT) WvW, three months post onset.

tafel /ta:fəl/	(table)	/ka:fəl/
boek /buk/	(book)	*broek (trousers)* correct
koffer /kɔfər/	(suitcase)	/kɔfəl/
bezem /be:zəm/	(broom)	beet (bite) nee (no) /bəne:/ /knɑrp/ /kəmɛrk/
muts /mʉts/	(cap)	/vʉl/ /pɛp/ /mənʉtsəl/
sigaar /si:χa:r/	(cigar)	/sə/ /a.lt/ /sχa:təl/
spijker /spɛikər/	(nail)	/spa:kəl/
kaars /ka:rs/	(candle)	/ka:fəl/
kassa /kɑsa:/	(cash-desk)	/kɔsi:/ /kɔsa:/
tractor /trɛktɔr/	(tractor)	/ka:fəl/
stofzuiger /stɔfzʌyχər/ (vacuumcleaner)		/stɛχtər/ /sχʉpər/
koffiemolen /kɔfi:mo:lən/ (coffee-mill)		/ko.f/
zeilboot /zɛilbo.t/	(yacht)	/zʌylər/_
veiligheidsspeld /vɛiləχhɛitspɛlt/ (safety-pin)		/bəslɛkər/
schrijfmachine /sχrɛifmɑʒI:nə/ (typewriter)		/tʌy/ /sχra.fmɑʒI:nə/
blikopener /bl ǀ ko:pənər/ (tinopener)		/bl ǀ kəlo:pənər/
zaklamp /zɑklɑmp/ (torch)		/klɑmp/ /kla.mp/ correct
schroevendraaier /sχru:vədrajər/ (screwdriver)		/sχu:tərvra:χələr/
schoenlepel /sχu.nle:pəl/ (shoehorn)		/χlɔlo:pəl/
rolschaats /rɔlsχa.ts/ (roller-skate)		/sχa:/ /drɔlsχa:tən/

Oral Naming (AAT) WvW, three months post onset.



! = correct
— = erroneous

Written Naming (AAT) WvW, three months post onset

paal /pa.l/ (stake)	correct
slijk /slɛik/ (mud)	/slɛip/
schoft /sχɔft/	correct
dienster /di.nstər/ (waitress)	/di.ntstər/
blamage /bla:ma:ʒə/ (disgrace)	/sla:ma:ʒə/
ijdelheid /ɛidəlhɛit/ (vanity)	/kɛivəldɑunt/
voetbalschoen /vutbɑlsχu.n/ (football boot)	/ʃutbɑlʃul/ /ʃul/

Reading aloud (AAT) WvW, three months post onset

5

DETECTION OF DEFICITS IN VISUAL AND VERBAL SEMANTIC PROCESSING IN APHASIA

Introduction

It has frequently been observed that aphasic patients having suffered damage in the left brain hemisphere (LBD-patients) suffer from disorders in lexical and visual semantic processing (Messerli & Tissot 1974; Bisiacchi et al. 1976; Cohen et al. 1980; Gainotti et al. 1986; Saffran & Schwartz 1995; Dalla Barba et al. 1996). The markers of a lexical semantic deficit are semantic paraphasias[1] and errors in the comprehension of content words[2].

[1] A 'crocodile' is called as a 'duck'.

[2] The word 'television' is understood as a 'radio'.

A disorder in visual semantic processing is characterised by errors in the functional interpretation[3] and in the categorisation[4] of objects or pictures of objects.

The lexical semantic and the visual semantic system, reflecting the linguistic interpretation of the extra-linguistic reality, are brought together at the core of language processing models (Patterson & Shewell 1987; Ellis & Young 1988). Those systems are assumed to be part of a multiple sensoric system, whose components are activated depending on the situation. They do not have to be necessarily equally dominant (Damasio 1990). The body of the systems is complementary: in the lexical semantic component the abstract properties of the object that the word refers to are stored, whereas the visual semantic component contains information about the perceptual features of a concept (Paivio 1971; Shallice 1993).

There has been much discussion about the interaction between the visual and the lexical semantic systems, and the presence or absence of error-consistency in the interpretation of words and pictures by aphasic patients has been an important argument in this discussion. Shallice (1987, 1988, 1993) argues that visual and verbal semantics are separate modality-specific semantic systems. Modality-congruent semantic information is primarily activated within both systems, and information expressed in one system can only be accessed indirectly from the other system. This view is disputed by Caramazza et al. in 1990, who propose a unitary amodal semantic system with privileged accessibility of different parts for respectively perceptual and verbal predicates. Such a unitary system is conceived as a conceptual component shared by language and thought: a visual semantic disorder in the context of a linguistic impairment should find its origin in damage to this component (Lyon 1995).

In the ongoing discussion concerning a unitary versus a multiple semantic system, the processing of nonlinguistic symbols by aphasic patients has played a crucial role. Since 1967, a relatively small amount of experiments, has been published about this subject, if compared to purely linguistic studies. Aphasic patients are reported to have difficulties in the matching of objects with a specific mode of representation: objects with their colours (De Renzi & Spinnler 1967; Basso et al. 1976), objects with sounds

[3] A 'screwdriver' is taken for a 'hammer'.

[4] A 'violin' is categorized as belonging to the class of 'wind instruments'.

(Spinnler & Vignolo 1966; Faglioni et al. 1969), objects with their pictures (De Renzi et al. 1969).

The expression of objects through nonverbal means may be disturbed too. Aphasic patients are described as having trouble with the drawing of objects from memory (Gainotti et al. 1983; Kirk & Kertesz 1989; Goldenberg 1995) and in the use of gestures (e.g. Duffy & Duffy 1981). In accordance with the unitary semantic system, there is the opinion that a failure in the above-mentioned tasks in combination with a linguistic impairment as verbal paraphasias should reflect a disordered conceptual thinking, 'the root of aphasia' (Bay 1974). More in line with the 'multiple semantics' approach is the assumption that disorders in the processing of nonverbal material should arise in addition to aphasia (Goodglass 1974, 1993). A linguistic impairment should optionally but not obligatory be accompanied by impairments in the functional interpretation of nonlinguistic material.

Although it's questionable whether empirical data from aphasic patients will ever solve the problem, some attempts have been made to provide evidence for either of the above approaches, by means of comparison between the performance of aphasic patients in linguistic and in nonlinguistic tasks. Parallel achievement on both kind of tasks is used as evidence for a unitary semantic system. The results showed that receptive lexical-semantic tasks (Gainotti et al. 1983) and auditory comprehension tasks (Kirk & Kertesz 1989) are closely connected with the drawing of objects from memory in aphasic patients. Errors in colour selection, on the other hand, were related to disorders in naming and comprehension (Goldenberg 1995).

Case-descriptions of patients with an optic aphasia offer strong support for the encapsulation of visual and verbal semantic processing in separate components with only a loose connection. These patients are characterised by a selective disorder in the transfer from visual to verbal processing. The functioning of the separate components is intact. According to Shallice (1988) and Goodglass (1993), the most 'pure' case is described by Warrington (1975) and by Warrington and Shallice (1979): only a verbal semantic prime and not a picture was effective for a verbal task in this patient.

Semantic matching tasks with pictures are frequently used in order to detect disorders in visual semantic processing in aphasia. A double dissociation in picture matching between patients with a Broca aphasia and patients with a Wernicke aphasia was considered as an argument for the relatively isolated position of visual semantic processing without

implications for a general intellectual impairment (Bisiacchi et al. 1976; Semenza et al. 1980). Patients with a Broca aphasia were selectively disturbed in the matching of pictures with thematic relations (e.g. 'bridge' and 'river'), whereas patients with a Wernicke aphasia were selectively disturbed in the matching of pictures with class relations (e.g. 'airplane' and 'balloon'). The experimental results of Cohen et al. (1980) were contradictory: both aphasia types performed within the normal range on the thematic association of pictures. But the patients could not match pictures of objects according to specific features (e.g. 'chimney sweeper' and 'raven'), which is confirmed by Gainotti et al. in 1986.

The grouping of objects by specific features should, according to Cohen et al. (1980), make use of the same abilities as are required by the Token Test, which is a measure of the severity of aphasia. A relationship between visual semantic processing and the Token Test could possibly point to a shared visual and verbal semantic knowledge base, since the Token Test was originally designed as a tool to detect subtle linguistic disorders (De Renzi & Vignolo 1962).

Lexical semantic impairments should occur particularly in patients with a Wernicke aphasia and patients with a global aphasia (Albert et al. 1981; Davis 1983; Goodglass 1993; Akhutina & Glozman 1995). However, there is no evidence of differences in aphasic subtypes in lexical-semantic tasks in Butterworth et al. (1984); Varley (1991) or Hough (1993). Rather than a relation between lexical-semantic disorders and aphasia type, Butterworth et al. suggest an influence of the severity of aphasia on lexical-semantic processing, a reasonable prediction in view of the central position of the semantic system in language processing models.

Various productive and receptive tasks have been used to investigate the visual and lexical semantic system. However, patients performed equally on both modalities only in case-reports (Warrington 1975; Howard & Orchard-Lisle 1984; Howard & Franklin 1988; Schnider et al. 1994; Feinberg et al. 1995). Group studies are not available. Since verbal semantic therapy has been proved to be one of the most effective therapeutic interventions (Seron et al. 1979; Howard et al. 1985a, 1985b; Nettleton & Lesser 1991), it is important to find out what the incidence of visual and/or verbal semantic disorders in aphasia is in relation to the therapy. In addition, the distribution of disorders in visual and/or verbal semantic processing in a group of aphasic patients may bring more insight into the interaction between both systems.

The present study investigates visual and lexical semantic processing in aphasic patients by means of a Semantic Association Test (SAT). Two versions of the SAT are administered: a visual semantic association task, which requires the matching of pictures, and a lexical semantic association task, requiring the matching of written words. Since a lexical-semantic impairment will necessarily influence the performance on naming and comprehension (see e.g. Howard & Franklin 1988), both tasks are compared with the performance on naming and comprehension.
The prediction is that the occurrence of selective impairments in the verbal or visual semantic system may point to a loose connection between both modules, which may be strengthened by a selective relation of the verbal semantic task with naming and repetition. The results of both semantic tasks are related to aphasia type and severity.

The aim of this study is to investigate

1a Whether the extent to which verbal and visual semantic processing impairments as measured by the SAT were typical of LBD aphasic patients as opposed to RBD non-aphasic patients and normal controls;
1b. Whether the mean verbal and visual scores on the SAT differ significantly across groups;
1c. Whether the mean verbal and visual scores on the SAT differ significantly across aphasia types;
2. The extent to which the verbal and visual scores on the SAT could be predicted from the scores on the AAT subtests in naming and comprehension;
3. The extent to which the severity of aphasia as measured by the Token Test was predictable from the performance on the visual and verbal score on the SAT;
4. Whether the presence of a disorder in one or in both tests was significantly related to the aphasia type, age, time post onset, naming, comprehension and/or the Token Test.

Methods

Subjects

The patients were referred to the University Hospital Rotterdam-Dijkzigt, the Rotterdam Aphasia Foundation Rijndam, the Rehabilitation Center 't Roessingh and the Clinica Neurologica del Universita Padua. 78 aphasic LBD-patients having suffered a cerebrovascular accident were examined. The mean age of the aphasic group was: 64.87, sd 12.03. Time post onset varied from 0 to 60 months, with a mean of 9.63, sd 12.27. The aphasia type were diagnosed as Broca aphasia (N=15), global aphasia (N=13), anomic aphasia (N=15), Wernicke aphasia (N=21), unclassified (N=10), and rest aphasia (N=4).
The control groups were a. 10 nonaphasic right-brain-damaged (RBD) patients having suffered a cerebrovascular accident, mean age: 60, sd 15.87 and b. 96 normals without neurological damage, mean age: 59.23, sd 11.48.

Neurolinguistic Assessment

The Semantic Association Test[5] (SAT, Visch-Brink & Denes 1993; Visch-Brink 1993) was developed as a tool for detecting disorders in lexical and in visual semantic processing. The test is based on the principles of the Pyramids and Palm Trees Test (Howard & Patterson 1992). The patient is required to make a semantic association with the target by grouping the relevant information from the distracters (Figure 5.1.). The picture version of the SAT, the visual SAT, is used to measure visual semantic processing. The written word version, the verbal SAT, is used to measure lexical semantic processing. Each version contains the same items in a different order (N=30). Half of the targets are animate, half inanimate. There is a thematic relationship between the target and the response. There are three distracters, two of which are semantically related to the target, but more distant than the correct response. One distracter is not semantically related to the target. The test was administered to the aphasic patients and to both control groups. Patients with a right or leftsided homonymous hemianopia and/or a visual neglect were excluded as well as patients with visual perceptual errors or errors in the reading of the lexical form. Whether a patient was in state to take the test was established during a preliminary examination of word and picture matching.

[5] The test was developed as part of the EEC ESCAPE-project 'Cross-linguistic Assessment of Aphasia'.

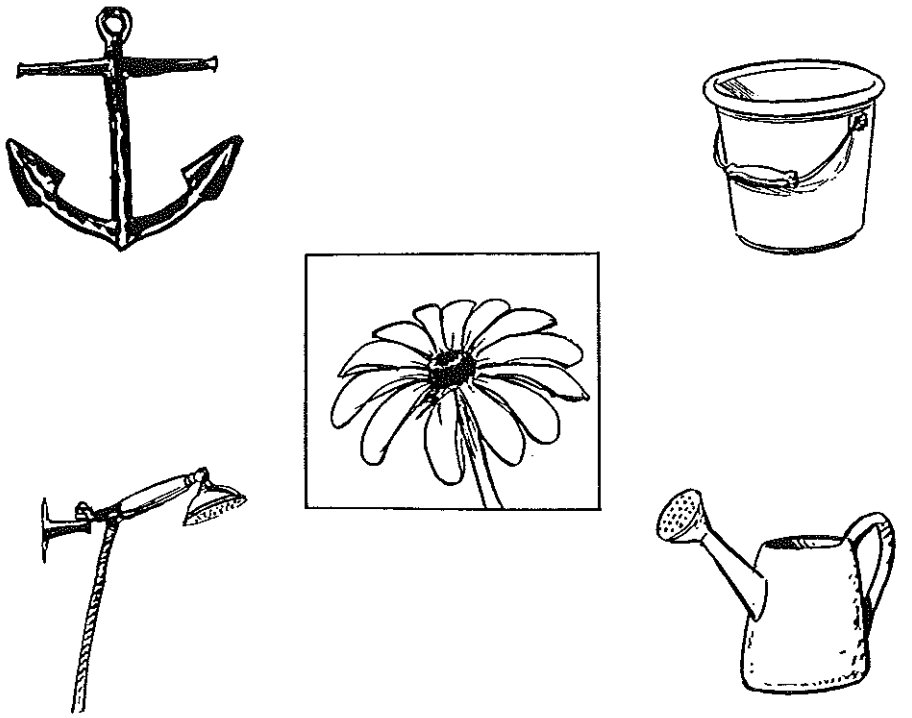


Fig. 5.1. Example visual SAT. Correct response: watering can; first semantic distractor: bucket; second semantic distractor: shower; unrelated distractor: anchor.

The aphasia type was determined by the ALLOC-classification system of the Dutch version of the Aachener Aphasia Test (Akense Afasie Test: AAT; Graetz et al. 1992). Performance on the AAT-subtests (Naming, Comprehension with Auditory and Visual Comprehension, together and separately, and the Token Test) was compared with the performance on the verbal and visual SAT. Naming involves the naming of objects with single and compound nouns, the naming of colours and the description of a situational picture with a short spoken sentence. Auditory and Visual Comprehension consists of words and sentences to be matched with one of four pictures. The distracters are phonologically and/or semantically related to the target. The Token Test is used as a measure of the severity of the aphasia. The AAT-version was developed by Orgass in 1976a,b.

Data transformation and statistical analyses

1a. The logistic regression method of analysis with backward elimination was used to establish whether the performance on the SAT could predict group membership of LBD-patients and normals. Being a LBD-patient (yes/no) was the criterion variable, and the visual and verbal score on the SAT as well as the age were used as the predictor variables. The discriminative ability of the SAT was depicted in a receiver-operator characteristic (ROC) curve, using each score as a cut-off point;

1b. A one-way ANOVA, using the Modified least Significant Difference Test, was performed to test whether there was a significant difference in mean age between the normals, the RBD-patients and the LBD-patients. Subsequently, a one-way analysis of variance pairwise was conducted, this time using age as covariate. This was done in order to test whether there was a significant difference in the mean verbal and visual score on the SAT between the groups;

1c. A one-way analysis of variance was conducted, using the Modified Least Significant Difference Test (alpha=.05) to test whether there was a significant difference in mean age between the various aphasia types. The same procedure was used to detect whether there was a significant difference in the mean verbal and visual score of the SAT across aphasia types;

2. Two multiple linear regression analyses (method stepwise) were applied in order to investigate whether the verbal or the visual score on the SAT could be predicted from the scores on the AAT subtests Naming and Comprehension. In the first analysis the verbal score on the SAT was the dependent variable and Naming, Visual and Auditory Comprehension separately and together (Comprehension) were entered as predictor variables. The second analysis was similar to the first, only now the visual score on the SAT was the dependent variable;

3. A multiple linear regression analysis (method stepwise) was applied to check whether the severity of aphasia as measured by the Token Test could be predicted from the performance on the visual and the verbal SAT. The Token Test was the dependent variable and the visual and verbal score on the SAT were entered as predictor variables;

4. According to the height of the scores on the visual and verbal SAT, the LBD-patients were divided in four groups. Group 1: low performance on verbal and visual SAT; Group 2: high performance on verbal SAT, low performance on visual SAT; Group 3: high performance on visual SAT, low performance on verbal SAT; Group 4: high performance on verbal

performance on visual SAT; Group 3: high performance on visual SAT, low performance on verbal SAT; Group 4: high performance on verbal and visual SAT. As a measure of a relatively low performance on visual and verbal semantic processing, the median of the LBD-patients (n=78) was taken as cut off score. A one-way analysis of variance was used to determine whether there was a significant difference in age between-groups. The differences between the mean scores of the groups on all variables (AAT-subtests) were analysed with a one-way analysis of variance. The one-way analysis of variance using the Modified least Significant Difference Test was conducted again pairwise on the subtests, which appeared to be significantly related to age, but this time using age as covariate.

Results

1a. The visual SAT and age were assessed as irrelevant variables for classification because they did not contribute to the ability to discriminate between the LBD-patients and the normals. They were removed. Therefore, only the score on the verbal SAT was depicted in the ROC-curve. Figure 5.2. shows the sensitivity weight and specificity weight for the score on the verbal SAT in discriminating between LBD patients and normal controls, using each verbal score as cut-off point. We found that, in our sample a cut-off point of 25/26 yielded the best discrimination. At this cut-off point the verbal score on the SAT was 79% sensitive and 94% specific in detecting aphasic patients;

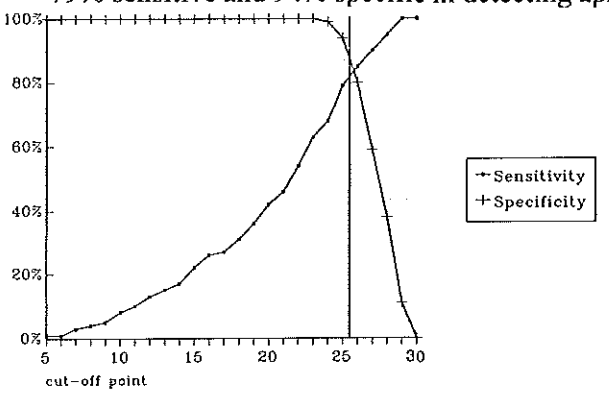


Fig. 5.2. Sensitivity and specificity for the verbal score on the SAT using each score as a cut-off point.

1b. There was a significant age difference between the LBD patients and the normals, $F(2,181)=4.31;p=.015$. With age as a covariate, the visual score on the SAT was significantly different between the LBD-patients and the normals, $F(1,171)=52.4;p<.001$ and between the LBD-patients and the RBD-patients, $F(2,180)=28.4;p<.001$ (Table 5.1.). A significant difference in the verbal score on the SAT with age as a covariate was also found between the LBD-patients and the normals, $F(1,171)=114.3;p<.001$ and between the LBD-patients and the RBD-patients $F(2,180)=61.7;p<.001$ (Table 5.1.). The risk of a false difference between groups because of capitalisation of the p-value is neutralised by the low p-values. There was no significant difference between the verbal and visual SAT-scores of the normals and the RBD-patients;

Table 5.1. Mean and standard deviations of Visual and Verbal SAT

	Normals (N=96)		RBD (N=10)		Aphasics (LBD) (N=78)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Visual SAT (30 items)	28.03*	(1.73)	27.7°	(1.8)	23.21*°	(5.66)
Verbal SAT (30 items)	27.81*	(1.45)	27.1°	(2.0)	20.54*°	(6.15)

SAT = Semantic Association Test, RBD = right-brain-damaged patients, LBD = left-brain-damaged patients
*,° significant difference between groups, p<0.001

1c. There was no significant age difference between the groups with various aphasia types. Mean verbal and visual scores on the SAT were not significantly different between those groups (Table 5.2.).

2. Naming, Auditory Comprehension and Visual Comprehension were removed as irrelevant. The score on Comprehension predicted the performance on both the verbal SAT, ($\beta = .617$, $T = 6.331$, $p < .001$) and the visual SAT ($\beta = .547$, $T = 5.279$, $p < .001$) in a significant number of cases. The comprehension score accounted for 37% of the variance on the verbal SAT-score (adjusted R square .371) and for 29% of the variance on the visual SAT-score (adjusted R square .289);.
3. Only the verbal SAT contributed significantly to the prediction of the severity of aphasia, as indicated by the Token Test ($\beta = -.325$, $T = -3.005$, $p < .004$). The verbal score on the SAT predicted only 9% of the variance in the Token Test results (adjusted R square 0.944);.

Table 5.2. Performance of aphasic subtypes on Visual and Verbal SAT

	Visual SAT (30)		Verbal SAT (30)	
	Mean	(SD)	Mean	(SD)
Aphasia type[1]				
Broca (N=15)	24.33	(5.43)	19.47	(5.54)
Wernicke (N=21)	23.00	(7.02)	21.10	(6.35)
Anomic (N=15)	23.53	(4.36)	22.67	(4.27)
Global (N=13)	22.92	(5.35)	19.54	(8.85)
Not to classify (N=10)	20.20	(5.39)	17.90	(5.20)
No/rest (N=4)	27.25	(2.22)	23.50	(2.89)

[1] Classification according to the AAT-ALLOC norms
SAT = Semantic Association Test

4. Patients with a score equal to or lower than 25 items correct on the visual SAT (total of 30 items) are assumed to have a relatively low performance on visual semantic processing. A relatively low performance on verbal semantic processing is said to occur when the score is equal to or lower than 22 items correct on the verbal SAT. A grouping of patients according to the level of performance on both SAT-versions did not reveal a relation to aphasia type either, chi square = 8.7; df = 9; p = .46 (see Table 5.3).

Table 5.3. Distribution of patients with aphasia main type according to their performance on SAT-versions

	Performance on SAT-versions			
	1. visual- verbal- (N=25)	2. visual- verbal+ (N=8)	3. visual+ verbal- (N=8)	4. visual+ verbal+ (N=23)
Aphasia type[1]				
Anomic	7	3	1	4
Broca	6	0	4	5
Wernicke	7	2	2	10
Global	5	3	1	4

[1] Classification according to the AAT-ALLOC norms
SAT = Semantic Association Test, visual -/+ = bad/good performance on visual SAT, verbal -/+ = bad/good performance on verbal SAT

There was a significant difference in age between group 1 and group 4. It was therefore investigated which AAT-subtests were significantly correlated with age. There was a significant correlation only between auditory comprehension and age. A one-way analysis of variance with post-hoc, pairwise performed, Modified Least Significant Difference showed a significant mean difference in comprehension between groups 1 and 2, groups 1 and 4, groups 3 and 4 ($p<.05$) and in auditory comprehension between groups 1 and 4 and between groups 3 and 4 ($p<.05$). Because of the significant correlation between auditory comprehension and age, the one-way analysis of variance was conducted again, now using age as a covariate. The results were similar (see Table 5.4).

Table 5.4. Mean and standard deviation of aphasic patients according to their performance on SAT-versions

	Performance on SAT-versions							
	1. visual- verbal- (N=33)		2. visual- verbal+ (N=10)		3. visual+ verbal- (N=9)		4. visual+ verbal+ (N=26)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Visual SAT (30)	18.12	(4.90)	23.80	(1.23)	26.67	(1.12)	28.23	(1.39)
Verbal SAT (30)	15.7	(5.37)	24.80	(2.10)	18.00	(3.32)	25.92	(1.90)
Mpo	7.35	(10.76)	4.44	(3.68)	12.44	(14.12)	12.27	(13.98)
Age	68.15*	(10.99)	68.60	(12.06)	63.11	(13.10)	59.00*	(12.31)
Naming (120)	51.33	(30.59)	48.60	(37.77)	56.22	(33.64)	70.35	(33.98)
Comp. (120)	69.15*°	(16.41)	85.30*	(15.49)	69.22^	(17.55)	91.19°^	(15.42)
Auditory comp. (60)	35.92*	(7.20)	42.43	(7.50)	36.22°	(12.14)	46.12*°	(8.74)
Visual comp. (60)	32.81	(11.26)	42.14	(11.65)	33.00	(10.89)	43.04	(13.28)
Token Test[1] (50)	34.03	(10.43)	27.60	(11.64)	35.00	(16.82)	27.27	(15.80)

[1] Error score
SAT = Semantic Association Test, mpo = months post onset, comp. = comprehension, visual -/+ = bad/good performance on visual SAT, verbal -/+ = bad/good performance on verbal SAT
*°^ significant difference between groups, $p<0.05$

Comments

The performance of LBD-patients on both the visual and the verbal Semantic Association Test was inferior to the performance of RBD-patients and normals. Impairments in visual and verbal semantic processing seem to be inherent to left-brain damage. The relatively small number of patients with a right-hemispheric lesion is partially neutralised by the homogeneous pattern of the results.

Entirely on the basis of the verbal version, the SAT is a possible selective tool for aphasic LBD patients. The visual SAT seems to be irrelevant in this respect. However, the verbal SAT predicts only 9% of the variance on the Token Test. Just like the Token Test, the verbal SAT does not give clues as to the aphasia type and vice versa, which seems to be an inherent property of tests with a relatively high discriminative power.

If the patients are divided in groups according to the level of performance on the visual and/or verbal SAT, we can see an equal distribution for each aphasia main type.

The predictability of the SAT-results from the AAT-subtests was focussed on the relation between both SAT-versions and Comprehension with a higher correlation for the verbal SAT. The other AAT-subtests, Naming, the Token Test and Auditory and Visual Comprehension separately were dropped out because of the high correlation with Comprehension. Between the groups of patients with a good and a bad performance on the verbal SAT, there was also a significant difference in Comprehension. The performance on the visual SAT was not related to a changing pattern on the AAT-subtests.

Discussion

This investigation shows that impairments in verbal and visual semantic processing are specific for aphasic LBD-patients as opposed to RBD-patients and normals. Although both semantic tasks, parallel in content, elicit errors in aphasic patients, there is no equivalence between the visual and verbal SAT in terms of sensitivity and specificity. The discriminative power of the verbal SAT exceeds to a large extent that of the visual SAT. This finding is supported by Varley (1991), who showed that lexical semantic tasks are more effective than visual semantic tasks in differentiating between aphasic and non-aphasic brain-damaged patients. There is only a slight correlation

between the performance on the visual SAT and Comprehension, as measured by the AAT. The required interpretation of pictures in the AAT Comprehension test may be responsible for this relation. The loose connection between the visual SAT and Comprehension is illustrated by the fact that, in our data, no linguistic measure was found, which could correspond to a difference in visual semantic processing: the results on Comprehension and Naming of patients with intact and disturbed visual semantic processing were equal. But a difference in the verbal SAT implies a different score on AAT-Comprehension, which is due particularly to Auditory Comprehension. The role of Auditory Comprehension in relation to this highlights the fact that the verbal SAT which consists of written words, measures primarily semantic abilities, independently of the input channel.

In contrast with the verbal SAT, the visual SAT remains relatively isolated within the language area. Our study confirms Saffran and Schwartz' (1995) conclusions that a disorder in visual semantic processing is an additional symptom of left-hemispheric damage which can be disturbed separately. An impairment in verbal semantic processing seems to be a rather central deficit.

The present study does not offer much support for the existence of a unitary disorder in verbal and visual semantic processing. Impairments in these functions do not necessarily coincide. Selective disorders in either visual or verbal semantic processing are not rare in the aphasic group; 13% of the patients appeared to have a relatively low score on the visual SAT and 12% on the verbal SAT. The assumption of Goldenberg (1995) that a loss of visual semantic knowledge should be the cause rather than the sequel of the language impairment in aphasia is not confirmed by our data: if it is true that verbal semantic processing originates from visual semantic processing, patients with a selective disorder in visual semantic processing should not exist.

However, an equal performance in visual and verbal semantic processing does not appear to be a sound argument for a unitary semantic component either. Two different modality-specific semantic systems may be activated by the same stimulus. The word 'cat' in the verbal SAT should refer rather to 'domesticity' and 'company' than to 'size' and 'nails' and vice versa in the visual SAT. Both association modes may induce the patient to match the item 'cat' with 'basket'. The modality of presentation defines which associations should primarily be activated. If necessary, the information from one modality can be complemented by information from another modality.

A combined disorder in word-picture matching and naming have often been considered as the diagnosis of a semantic deficit (Butterworth et al. 1984; Hillis et al. 1990). The lack of congruence in our group between verbal semantic processing and naming confirms that in addition to lexical-semantic disorders other disorders are involved in naming, such as a word production or word selection deficit (Benson 1979).

Our data show that the thematic association between pictures and words may be disturbed in aphasia, independently of the aphasia type, which contradicts Cohen et al. (1980) and Gainotti et al. (1986). It is a remarkable fact that patients with a global aphasia and patients with a Wernicke aphasia do not differ concerning their results on the SAT from patients with a Broca or Amnesic aphasia. Generally, lexical-semantic disorders are assumed to be particular of patients with severe disorders in word comprehension: patients with a Wernicke aphasia and patients with a global aphasia (a.o. Benson 1979). Particularly in word fluency tasks, Wernicke patients should have difficulties with ordering members within one semantic field (Grossman 1981). In our study, the distribution of patients with a relatively good performance on the SAT-versions is even slightly in favour of the group with a Wernicke or global aphasia (41% against 30%). This observation points to the presence of lexical semantic disorders in patients with a Broca or Amnesic aphasia, rather than to a lack of such disorders in Wernicke or Global aphasia.

The Token Test seemed to have a very weak value as predictor of the verbal SAT and there is no relation between the Token Test and the visual SAT. The Token Test is proved to be an essential part of the aphasia diagnostics as far as the selection of aphasic patients and the degree of severity are concerned. The verbal SAT seems to have the potential to become also a relevant diagnosticum. Both tasks require the analytical isolation of single features of objects. However, they do not elicit the same level of performance in aphasic patients. In the Token Test, only a few, and always the same, lexical items are involved. The patient is required to select the given size, colour and form in the correct combinations in a word -Token matching task. The SAT-test demands that the patient combines words or pictures in order to elicit the shared features and to select the combination with the most narrow semantic relationship. The critical feature is implicitly present. The patient has to consider at least three combinations at the same time to be able to make the correct choice. With a similar task, Feinberg et al. in 1995, showed that increasing the number of comparisons necessary to make a correct match did decrease the matching abilities in a patient with an

associative visual agnosia. A group study is not suitable for an analysis of the decision process of individual patients. Obviously, the errors of different patients will have different backgrounds. Error eliciting factors may be inherent to the semantic interpretation of the word or picture, the selection of the (covert) associative features or the amount of knowledge from competing words or pictures for the final selection.

The general conclusion is that visual semantics and verbal semantics seem to be separate entities, which can be selectively disturbed. Further research is required to establish the relevant parameters that make verbal and visual semantic processing difficult for LBD-patients. Both tests require identification of individual aspects of the involved objects, forcing the patient to isolate the common attributes. The verbal SAT appears to be a valuable clinical tool in the diagnosis of aphasia. The relevance of an instrument to detect disorders in verbal semantic processing is indirectly defined by the favourable results of verbal semantic therapy. The visual SAT may detect an additional disorder in visual semantic processing, which is only loosely related to the language performance. Whether there is a connection with other nonlinguistic characteristics of the left hemisphere remains to be established.

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6

A DISSOCIATION BETWEEN VISUAL AND VERBAL SEMANTIC PROCESSING: A FOLLOW-UP STUDY OF PATIENTS WITH A SEMANTIC DEMENTIA

Introduction

Within the verbal semantic system, as the core of language processing models (Patterson & Shewell 1987), the extralinguistic reality is reflected by linguistic units: words are connected with their referents. Disorders of the verbal semantic system would give rise to errors in language production and language comprehension, because of its indispensable intermediate function in between. Semantic paraphasias, elicited by picture naming combined with erroneous word picture matching should be indicative for a verbal semantic deficit; the selection and recognition of the correct word is impeded by a lack of information about the semantic features of the word (Benson 1979; Butterworth et al. 1984).

However, a mismatch between word and picture should not necessarily have a linguistic background. A lack of knowledge about the defining characteristics of an object is also assumed as a possible source of a word–finding deficit. Although it might be hard to separate the role of linguistic and nonlinguistic factors in the word–finding process (Caplan 1993), according to the multiple semantics hypothesis the distinction between visual and verbal semantic processes is generally accepted. In the visual semantic system, the functional interpretation and categorisation of non-verbal units, objects, and situations should be localised (Morton 1985). The production of a gesture or a drawing is inherent to its output channel.

The diagnosis of verbal and visual semantic disorders is valid only if they are established independently of disorders in the graphemic and pictorial input routes to the semantic system. To be able to assess a pure semantic deficit, it has to be stated that the presemantic analysis of pictorial and graphemic features is preserved.

The interference between a visual and verbal semantic system elicited much discussion in the literature (see for a review paper: Saffran & Schwartz 1995). The crucial question is: in which degree the mode of presentation does evoke modality–specific semantic associations and when does the linkage with another modality occur? Advocates of the dual–code theory assume that verbal semantic processing has to be differentiated from visual semantics (Shallice 1993). The relation between both components is supposed to be coordinative (Shallice 1993; Goodglass 1993). The authors describe the semantic system operating with two relatively independent components, which are only interactive if necessary. Disorders in the processing of non-verbal material may arise in addition to aphasia (Goodglass 1974,1993; Goldenberg 1995). Impairments in the functional interpretation of nonlinguistic material might occur in the context of a linguistic impairment, but not necessarily (Goodglass 1974, 1993). Other authors plead for a unitary semantic system with a strong interference between both components (Caramazza et al. 1990; Lyon 1995). Within this unitary semantic system there should be a privileged accessibility for perceptual and verbal predicates (Caramazza et al. 1990). This accessibility is supposed to be asymmetrical in favour of the perceptual predicates.

Arguments for one of those theories are found in the errors in tasks directed to both components in patients with cerebral damage. Similar results in the interpretation of words and pictures should point to the existence of a unitary semantic system.

Different results in both tasks are described as an argument for distinctive components, being relatively independent.

Patients with a 'semantic dementia', a subgroup of patients with a progressive aphasia, are reported to have a multimodal breakdown of meaning: "the patients progressively lose their knowledge about the world, regardless of the nature of the material and input modality" (Snowden et al. 1995). Patients with a semantic dementia described in the literature support this hypothesis; they appeared to have an equivalent disorder in tasks that measure verbal and visual semantic processing (Snowden et al. 1994; Patterson et al. 1994; Snowden et al. 1995; Hodges et al. 1995; Funnell 1995). An observed consistency in their performance on semantic tasks should be evidence for a degradation of the semantic store (Shallice 1993; Caplan 1993; Funnell 1995; Snowden et al. 1995).

The characteristics of this group of patients are (Snowden et al. 1995): impaired word–comprehension and naming in the context of fluent speech and intact repetition; preserved syntax and phonology; impaired semantic memory, relatively intact episodic memory.

A follow–up of patients with a semantic dementia seems to be pre-eminently suitable to contribute to the discussion about the semantic system. First, the semantic disorder is the most prominent sign of their cognitive decline. Second, an investigation of the pattern of deterioration of verbal and visual semantic processing should be more valuable to determine their relationship than a single examination at a certain stage of the disease. A prerequisite is that equivalent tasks are applied with the same objects in different modes of representation: pictures and words.

The purpose of the study is to get insight in the interference between verbal and visual semantic processing by a longitudinal study of four patients with a semantic dementia. The patients have to match pictures and written words according to their semantic relationship. A similar performance on both tasks during course might be considered as suitable for a strong relationship between both components, an argument for a unitary semantic system. Differences in the presence or/and severity of impairments in visual and verbal semantic processing at the same time of examination and/or a different pattern of deterioration is at least in line with the dual–code theory.

Case Reports

The major clinical features of the patients are presented in Table 6.1.

Patient 1

A 70–year–old technician, presented with a 2–year history of progressive difficulty in word–finding, which started after a flu. Initially, he did not appear to have comprehension deficits. There were slight problems in reading and writing, characterised as surface dyslexia and surface dysgraphia. No other problems related to cognitive functions or daily life activities were mentioned. Episodic memory was intact. His wife reported a diminished initiative. Because of the language problems, there was a tendency for social isolation. He became depressive.

Past medical history revealed hypertension. On neurological examination no abnormalities were found. His language was fluent with empty speech and generalisations. There were no signs of buccofacial or limb apraxia. Examination of blood and cerebrospinal fluid (CSF) revealed no abnormalities. The EEG was normal. A computed tomography (CT)–scan showed atrophy of the temporal horns, on the right side more than on the left. Furthermore, there was some calcification in the basal ganglia. Magnetic resonance imaging (MRI) showed the same picture, an asymmetrical atrophy of the temporal lobes. On the Single Photon Emission Computed Tomography (SPECT)–scan, there was a diffuse supratentorial disturbance of perfusion, more pronounced in the left temporal lobe.

Follow–up

His language functions deteriorated gradually. His surface dyslexia and surface dysgraphia increased. Orientation and visual perception remained intact. In the nursing home, he was still well oriented and he exactly knew the time schedule. He developed hypochondrical behaviour.

Patient 2

A 54–year–old female sales manager, presented with progressive complaints about word–finding since three years and more recently with problems of language comprehension. Past medical history and neurological examination were unremarkable. Her language was fluent with semantic paraphasias and apparent word–finding difficulties. Memory functions appeared to be normal, although she could not reproduce a simple sentence after an

interferential task. Calculation was intact. Abstract verbal reasoning was disturbed. Episodic memory was intact. Routine laboratory investigations were normal. The EEG and the CT–scan were normal. MRI showed atrophy of the left temporal lobe and a SPECT–scan showed a diminished perfusion in the left fronto-temporal region.

Table 6.1. Clinical features of four patients with semantic dementia

Patients/ methods	Patient I	Patient II	Patient III	Patient IV
AGE/GENDER	70/M	54/F	56/F	58/M
LENGTH OF HISTORY	2 years	3 years	6 years	1 year
SPONTANEOUS SPEECH	fluent	fluent	fluent	fluent
SURFACE DYSLEXIA	+	+	+	+
SURFACE DYSGRAPHIA	+	+	+	+
BEHAVIOUR	depressive mood, loss of initiative	depressive mood	nervous/ depressive mood	N
ORIENTATION	N	N	N	N
NEUROLOGICAL EXAMINATION	N	N	N	N
CT-SCAN	bilateral temporal atrophy R > L	N	N	N lacunar infarcts
SPECT	left temporal hypoperfusion	left fronto-temporal hypoperfusion	left temporal hypoperfusion	left temporal hypoperfusion
MRI	bilateral temporal atrophy R > L	left fronto-temporal atrophy	NA	left temporal atrophy, bilateral lacunar infarcts

M = male, F = female, N = normal, + = present, NA = not available, R = right, L = left

Follow–up
There was a slowly progressive deterioration of language functions together with behavioural changes. During course, she developed surface dyslexia and a surface dysgraphia. Orientation and visual perception remained intact.

Her behaviour became childish with some characteristics of an automated behaviour (Lhermitte 1983). For example, she buttoned up the shirt of the examiner, immediately after she had noticed that the collar did not totally fit.

Patient 3

A 56–year–old woman, the manager of a youth hostel, presented with discourse problems; she complained about difficulties in verbal reasoning. Also, she had problems in recognising people. Activities in daily living were undisturbed. She was very nervous, partly because her complaints caused much distress in the family. Past medical history revealed an operation due to a breast carcinoma with subsequent chemotherapy, four years earlier. On neurological examination, no abnormalities were found. Her language was fluent with empty speech, stereotypes, and an "injured" intonation. She did not always understand the questions. Memory functions were intact. Routine laboratory investigations were normal. The EEG was normal. The CT–scan showed no abnormalities. According to the SPECT–scan, a diminished perfusion in the left temporal lobe was found.

Follow–up
Cognitive functioning slowly deteriorated. She developed surface dyslexia and a surface dysgraphia. She had a severe naming and word–comprehension deficit, yet she was able to report with adequate city names the travel in China covered by her eldest son. Three years after the first visit, she was not able to fulfil her job anymore and she needed help with household activities.

Patient 4

A 58–year–old owner of a restaurant, presented with complaints about his memory since one year. He could not remember the faces and names of his guests; some of them he had known for years. Past medical history was unremarkable. There was no alcohol abuse or head injury. Neurological examination revealed no abnormalities. His language was fluent with empty speech and generalisations. Some utterances were not finished because of his

apparent word–finding deficit. Speaking about his own experiences in the past, e.g., in the Second World War, facilitated his way of expression. Blood biochemistry findings including thyroid functions and serum vitamins were normal. There was no evidence of vascular of systemic disease. The EEG and the CT–scan were normal. MRI showed a clear–cut local atrophy of the left temporal lobe with bilateral old lacunar infarcts. The SPECT–scan showed a diminished perfusion of the left temporal lobe.

Follow–up
His complaints gradually grew worse, for the main part due to his language problems. He developed surface dyslexia and surface dysgraphia. Finally, he was unable to perform his daily activities in the restaurant. However, he could give still an account of the daily routine in the restaurant.

Methods

At the initial examination the Akense Afasie Test (AAT, Graetz et al. 1992) measured linguistic performance. In addition, the patient was presented the following neuropsychological tasks: Verbal Fluency (animals, professions), Trail–Making Test A and B, Digit Span, Raven Progressive Matrices, Rey figures (copying and recall), and the Rivermead Behavioural Memory Test (see Table 6.2).

The four patients were followed and examined during four years with an interval of approximately one year. To measure verbal and visual semantic processing, the Semantic Association Test[1] (SAT, Visch–Brink & Denes 1993; Visch–Brink et al. 1996) was administered. The test is based on the principles of the Pyramids and Palm Trees Test (Howard & Patterson 1992). The patient is required to make a semantic association between pictures or words. The picture version of the SAT, the visual SAT, is used to measure visual semantic processing. The written word version, the verbal SAT, is used to measure verbal semantic processing. Each version contains the same items in a different order (N=30). Half of the targets are animate, half of the targets are inanimate. There is one target with four possible response items. The correct response shows the narrowest semantic relatedness with the target. There are two distractors with a less narrow semantic relationship.

[1] The test is developed as a part of the EEC ESCAPE-project "Cross-linguistic Assessment of Aphasia.

One distractor is not semantically related with the target. The relation between the target and the semantically associated responses is a thematic one. Mean score of a normal sample (N=96) on visual SAT (30 items): 28.03 (SD = 1.73), mean score of a normal sample (N=96) on verbal SAT (30 items): 27.81 (SD = 1.45). For both tests, a correct score of 24 or less (more than 2 SD's under the mean score of the normal sample) is considered as subnormal. Reliable criterion for statistically significant difference between the scores of two moments of measurement is "the critical difference" based on the Cronbach's alpha reliability of the (sub)tests (Allen & Yen 1979): Visual SAT .88, verbal SAT .84. For the visual SAT the critical difference turned out to be 6, for the verbal SAT 7 (alpha = .05).
The performance on the verbal and visual SAT was compared with the AAT–subtests Naming and the Token Test. The Naming Test consists of object–naming with single and compound nouns, colour naming, and picture description with a short-spoken sentence. The Token Test version used in the AAT is developed by Orgass (1976a, b) and is meant as a measure for the severity of aphasia. The tests were administered to explore whether a decrease of the verbal and/or visual score on the SAT could be related to an increase of the naming deficit and/or the severity of aphasia.

A shortened version of Object Decision (Riddoch & Humphreys 1993) is administered as an indication for the presence of visuo-perceptual disorders. The patient has to sort existing and non-existing objects. The non-existing objects are derived from existing objects: one feature is added or replaced. The test consists of 48 pictures with both animate and non-animate items. Mean score of normal sample (N=96): 46.54 (SD = 1.74). A correct score of 42 items or less (more than 2 SDs under the mean) is considered subnormal.

Test Data Initial Examination

According to the characteristics described by Snowden et al. (1989) and Hodges et al. (1992), all patients appeared to respond to the clinical picture of semantic dementia on neurological, neuropsychological, and linguistic variables.

Hypoperfusion in the left temporal lobe was present in all patients. Atrophy was visible on CT/MRI in three patients. The bilaterally situated lacunar infarcts of patient 4 were clinically silent, confirmed after extensive questioning of the relatives. Four years later, the MRI was repeated and showed the same infarcts, but an important increase of the left temporal

atrophy. Moreover, there was atrophy of the right temporal lobe. The findings of the second MRI compared with the first one indicate that the atrophic process is responsible for the clinical features and that the lacunar infarcts must be viewed as stable concomitant findings.

The performance of the patients on neurolinguistic and neuropsychological tasks at the first examination is shown in Table 6.2.

Table 6.2. Neuropsychological and linguistic test data of four patients with semantic dementia

Patients/ methods	Patient I	Patient II	Patient III	Patient IV
AAT				
Token Test* (50)	26 (M)	49 (N)	36 (L)	44 (N)
Repetition (150)	145 (N)	148 (N)	124 (L)	148 (N)
Written language (90)	86 (N)	84 (L)	86 (N)	90 (N)
Naming (120)	79 (M)	84 (M)	47 (M)	84 (M)
Compr. (120)	91 (L)	79 (M)	56 (S)	95 (L)
VERBAL FLUENCY				
VF animals	7, SSc 15	11, SSc 18	5, SSc 12	15, SSc 20
VF professions	4, SSc 14	5, SSc 12	NT	5, SSc 14
TRAIL MAKING				
Test A	35 (p.>90)	37 (p.50-75)	54 (p.10-25)	35 (p.50-75)
Test B	103 (p.75-90)	74 (p. 75-90)	99 (p. 25-50)	90 (p.50-75)
NON-VERBAL PROBLEM SOLVING				
Raven (RPM)	p. >95	100 IQ	118 IQ	108 IQ
VISUAL SPATIAL SKILLS				
Rey copy	36 (p.100)	36 (p.100)	36 (p.100)	36 (p.100)
MEMORY				
Digit span Forw./backw.	4/4, T = 46	5/4, T = 45	4/3, T = 29	4/3, T = 31
Rivermead scr.	S	N	M	M
prof.	M	N	M	L
Rey recall	NA	NA	15 (p.10)	16 (p.10-25)

AAT = Akense Afasie Test, Compr. = comprehension, S = severe disorder, M = moderate disorder, L = light disorder, N = normal, p. = percentile, NT = not testable, SSc = standard score, RPM = Raven Progressive Matrices, forw. = forward, backw. = backward, scr. = screeningsscore, prof. = profilescore, NA = not available, T = T-score, * correct score

The results on verbal fluency show an impoverished vocabulary. Each patient appeared to have problems with the generation of words within a requested semantic field. Trailmaking, a measure for executive functions, was only disturbed in patient 3. The performance of all patients on Raven Progressive Matrices was normal to above normal[2]. The results on auditory Digit Span were relatively low. Compared with Digit Span forward, Digit Span backward was well done, which shows that the patients' working memory was not exceptionally disturbed. The performance on Rivermead was slightly to moderately disturbed in all patients except in patient 2. Trailmaking elicited only an erroneous score in patient 3. Visual spatial skills according to Rey copy were normal. The two patients to whom the Rey recall could be administered reached a low score.

Spontaneous Speech was fluent with anomia as the most striking feature; generalisations and successful circumlocutions replaced specific content words. The spontaneous speech analysis, according to the AAT–scheme, shows that syntax and phonology were intact in the context of impaired semantics. Compared with Naming and Comprehension, Repetition was well preserved.

Patient 3 appeared to be the most severely disturbed on linguistic and neuropsychological tasks: Token Test, Repetition, Comprehension, and in Word–Fluency and Trail–Making, respectively.

Results of Follow–up Study

Performance on Verbal and Visual SAT

The results of the follow–up study are shown in Table 6.3.

Patient 1

On initial examination, the patient was found to be unimpaired on the visual SAT and slightly impaired on the verbal SAT. The good performance on the visual SAT became worse at Time III. The results on the verbal SAT deteriorated already at Time II and subsequently at Time III, and became worse than the results on the visual SAT on the same examinations. This discrepancy is found on Time IV as well with a correct score of 50 percent on the visual SAT and being not testable with the verbal SAT.

[2] To patient 1 the Coloured Raven is given because of his age; only percentile score is possible. The Raven-score of the other patients is converted to an IQ (see Table 2).

Table 6.3. Follow-up visual and verbal processing in four patients with semantic dementia

	Time/test	I	II	III	IV
Patient I	Visual SAT (30)	26	26	18*	15
	Verbal SAT (30)	24	16*	6*	NT
	Object decision (48)	47	46	46	43
	Naming (120)	79	46*	31	45
	Token Test[1] (50)	26	15*	2*	0
Patient II	Visual SAT	26	18*	14	6*
	Verbal SAT	24	11*	8	NT
	Object decision	44	48	48	NT
	Naming	84	69	51*	26*
	Token Test	49	41*	14*	8*
Patient III	Visual SAT	18	15	NT	NT
	Verbal SAT	22	12*	NT	NT
	Object decision	37	37	NT	NT
	Naming	47	48	23*	NT
	Token Test	36	19*	0*	NT
Patient IV	Visual SAT	22	18	13	16
	Verbal SAT	18	16	13	11
	Object decision	45	44	45	43
	Naming	84	87	62*	51
	Token Test	44	32*	33	22*

[1] correct score
SAT = Semantic Association Test, NT = not testable
* significant difference with the preceding examination

Patient 2
The results on the first examination were comparable with patient 1. At Time II, for both SAT versions, there was a significant decrease. At the last examination, the visual SAT could be administered, but the patient was not able to perform the verbal SAT. The overall performance on the verbal SAT was worse than the performance on the visual SAT.

Patient 3
The patient's initial performance on both SAT versions was erroneous. She appeared to have the most rapid deterioration in time on both tests. At the last two successive examinations, she was unable to perform both tests. However, a different pattern of decrease was found; at Time II, there was a significant decrease in the results only of the verbal SAT.

Patient 4
Like patient 3, this patient showed a verbal and visual semantic disorder on the first examination. However, the results on the visual and verbal SAT remained relatively stable with a slow deterioration. Between successive examinations, for each test, there was no significant decrease. At the same time of examination, nearly no difference in the performance on both tests was found. However, the patient's performance at Time IV showed that the verbal SAT version tended to deteriorate earlier than the visual SAT.

Performance on Object Decision, Token Test, and Naming
The performance on Object Decision of patients 1, 2, and 4 remained within the normal range. Patient 2 was not testable with Object Decision on Time IV because of the required yes/no response.
In patient 3, Object Decision was disturbed and remained stable to Time III, when she was unable to perform the test.

Patients 2 and 4 were initially found with an unimpaired Token Test. The Token Test appeared to most consistently reflect the deterioration of language during course. On each time of examination, in all patients, there was a significant decline, except in patient 4 at Time III.

Object–naming showed a more whimsical profile. Initially, object–naming was moderately disturbed in patients 1, 2, and 4. Patient 3 presented with a severe naming disorder. In patient 1 there was only a significant deterioration at Time II. Thereafter, the performance on Naming remained stable in contrast with the verbal SAT and the Token Test. In patients 2, 3, and 4, there was no significant change of scores between Time I and Time II.

Discussion

This follow–up study of patients with a semantic dementia showed a deterioration of visual and verbal semantic processing. Initially, the results of the verbal and visual SAT were more or less comparable, which might be conceived as supporting a unitary semantic system. However, the pattern of decrease was not the same in each patient. First, there was a difference in speed of decline. Patient 1 and patient 2 are comparable with each other in being able to perform only the visual SAT at the last examination. Patient 3 is already unable to perform both SAT versions at Time III and Time IV. It might be inferred from the duration of the complaints before the first testing, and from the relatively low scores at the initial examination (repetition, naming, comprehension, word–fluency) that this patient seemed to be in an advanced stage of the disease. With regard to the initial SAT scores, patient 3 is comparable with patient 4, who showed the opposite pattern: a significant difference with the preceding tests is found in none of the examinations.

Second, patients differ in the degree of similarity between visual and verbal processing. In one patient (patient 4), there was no apparent discrepancy between the performance on both tests. In three patients (patients 1, 2, and 3), the decrease of the correct score on the verbal SAT was more pronounced. The results of patient 1 clearly demonstrate a dissociation between picture– and word–association. Initially, only the performance on the visual SAT fell in the normal range. After one year the discrepancy between both tests was more obviously present and remained so through the last examination. Both the decline during course and the test results at the same time of examination were indicative for the difference between verbal and visual semantic processing in patient 1. In patients 2 and 3, this discrepancy is only demonstrated by the pattern of decline. The differences between the patients in their performance on both SAT versions might be an expression of the course of the atrophic process (Hodges, personal communication). The deterioration of the verbal and visual SAT in relation to the findings of MRI and SPECT at follow–up will be discussed in a separate paper.

It does not seem to be obvious that a bad performance on both SAT versions originates from disorders in the preceding input routes. In patients 1, 2, and 4, Object Decision remained normal (Table 6.3), which makes a disorder of visual perception unlikely. A disorder in the graphemic input

route was ruled out by requiring the patients to match the same written words and to read them aloud; these tasks were fulfilled reasonably well[3].

A relation with the phonological output route, expressed in the results of the naming task, is not always clearly present either. The results show that a decline in verbal semantic processing does not always imply a reduction in object–naming, as was suggested by Butterworth et al. in 1984. This is specifically illustrated by a lack of congruence between the performance on the verbal SAT and naming in patient 3. This may be partly due to the fact that according to the AAT norms, some credit is given for rather unspecific descriptions in the naming task, e.g., leading to another object from the same semantic field. According to the SAT procedure, the patient is required to make his choice out of three members of the same semantic field and an unrelated object. The choice of an erroneous but semantically related response is not estimated.

The SAT results are related to the performance on the Token Test more than to naming. Every significant decrease of the visual and verbal SAT scores is coupled with a decline in the Token Test results. However, this similarity between both SAT versions is not true for the reverse direction. The results of patient 1 and patient 3 show that a significant lower score on the Token Test points rather to a deterioration of the verbal than of the visual SAT. The same discrepancy is found in another study, in which 78 patients with an aphasia as a consequence of a stroke are examined with the Token Test and both SAT versions: only the verbal SAT appeared to predict the variance in the Token Test results (Visch–Brink et al. submitted). This might be taken as an argument for the separability of both semantic systems. The relation between the verbal SAT and the Token Test accentuates the linguistic impact of the Token Test. These observations add new material to the old discussion about the clarification of the effectiveness of the Token Test (Cohen et al. 1980).

Summarising, it can be stated that in three out of four patients a more explicit difference is found between visual and verbal semantic processing than in the patients with a semantic dementia described in the literature. In patient 1 the difference was clearly present at the same time of investigation and during course. In patients 2 and 3, the discrepancy between both tasks was demonstrated by the deterioration. The pattern of verbal semantic processing seems to be different from visual semantic processing.

[3] In Dutch, irregular words are rarely found. Only a few irregular words were incorporated in the test; the observed surface dyslexia is not expected to influence the interpretation.

Visual semantic processing is more robust to deterioration as it is more preserved in time. If there is a visual semantic deficit, a verbal semantic disorder might be expected. The reverse pattern, a more pronounced deterioration of the visual semantic system, is not found. The relation between both systems might be interpreted rather as hierarchical than as coordinative, which confirms the assumption of Goldenberg (1995) that a disorder in visual semantic processing is the cause rather than the sequel of a deficit in verbal semantics. Yet, the results are insufficient to solve the problem: 'unitary semantic system' vs. the dual-code theory. Our observations seem to fit well with both the Privileged Access Unitary Content Hypothesis (P.A.U.C.H; Caramazza et al. 1990) with an asymmetrical privileged accessibility for perceptual predicates, and the dual-code theory where verbal and visual semantic processes are viewed not as totally autonomous but as coupled subsystems (Shallice 1990).

Clinically, a chance performance on the visual SAT is a sign of a grave cognitive deterioration of the patient: Communication with new information is nearly impossible. The patient is unable to perform the tests. It is not easy to rule out the possibility that the verbal SAT is more difficult to perform than the visual SAT, but this seems to be unlikely, because at least in normals, there appeared to be no significant difference between both tests.

Whether the observations are specific for semantic dementia or inherent to other degenerative diseases with a semantic disorder, might be shown by a comparison with f.i. patients with an Alzheimer type of dementia. Moreover, in an ongoing longitudinal study of brain-damaged patients, both SAT versions are administered during recovery. A more rapid recovery of the visual SAT will give further support to a hierarchical relation between both semantic components.

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Introduction

The occurrence of lexical semantic disorders in aphasic patients is frequently observed (Caplan 1993), although its expression may vary. Signs of a semantic disorder in severe aphasia are the inability to understand content words in daily life situations, restricted output to highly frequent words, and semantic paraphasias. Mild aphasics may express their semantic deficit through difficulties with infrequent words leading to misunderstandings of essays and lectures and to problems with discussions about abstract topics. The essential problem for patients with a lexical semantic deficit is that the features of a word signifying its meaning are not completely available at the moment when language comprehension or production is required. At the language comprehension side, a lexical semantic deficit becomes apparent through faulty comprehension of both orthographically and auditorily

presented speech, provided that the comprehension problems are not caused by deficits in the input channels. Language production of patients with a lexical semantic deficit may be revealed by the occurrence of omissions, generalisations, and semantic paraphasias. Semantic paraphasias may arise through errors in the word selection process due to a lack of information about the semantic features of the word that the patient is trying to produce (Butterworth et al. 1984). Consequently, the patient utters a word that does not cover his intention, without error awareness. Mostly, the semantic features of the word are partly available to the patient; therefore, the word-substitution is often semantically related to the target (Rinnert & Whitaker 1972; Huber 1981). Because of phonemic distortions, semantic paraphasias may not always be recognisable (Buckingham 1981).

Word paraphasias are not unique for a lexical semantic disorder; they may also occur as a result of a disorder at another level in the word production process: the inability to select the phonological form of the word. Crucial for the differentiation between a word selection disorder and a semantic disorder is the state of verbal comprehension. A word-selection disorder (Benson 1979; Kay & Ellis 1987) is characterised as a one-way deficit, restricted to word production. Semantic cueing will not trigger the word form because the patient already knows all the semantic features of the word and his problem lies beyond this level of processing. The word is immediately recognised at oral and written presentation. A lexical semantic deficit is characterised as a two-way deficit (Benson 1979), incorporating production and comprehension, provided that this is not caused by separate input and output processing deficits. Therapy, requiring the patient to distinguish words on their semantic features, is likely to be effective (Howard et al. 1985a; Howard et al. 1985b; Pring et al. 1990).

The purpose of this paper is to present a therapy programme directed to the remediation of a lexical semantic deficit. Firstly, the attention is drawn to the diagnosis of such a disorder and the proven effectiveness of lexical semantic therapy. Secondly, a detailed description of the newly developed therapy programme BOX is given. Tasks within this therapy program are centered on the judgement of semantic relatedness of written words, sentences, and texts. Thirdly, the results of a pilot study are presented. In two patients improvement in lexical semantic abilities could be established after the application of BOX in the chronic stage of the aphasia (more than one-year post onset).

Lexical Semantic System

Linking input and output

The lexical semantic system is assumed to be the indispensable intermediate between language production and language comprehension. The involvement of both modalities was the topic of several studies (a.o. Goodglass & Baker 1976; Butterworth et al. 1984; Hart & Gordon 1990) and seems to be decisive for the recognition of lexical semantic disorders. The occurrence of semantic errors in language production is not enough to diagnose a central lexical semantic disorder; the language production deficit has to be combined with bad performance in auditory and written language comprehension on subtle semantic discrimination tests (Lesser & Milroy 1993). Together with the development of theories on the nature of the lexical semantic deficit, three major points of view on this subject matter arose.

1. Originally, both a quantitative and a qualitative relationship between deficits in naming and comprehension were claimed. Most frequently cited in this respect are Goodglass and Baker (1976) who conclude that the capacity of naming word *x* depends on the integrity of the semantic field to which word *x* belongs. Within their theory, a word selection deficit arises together with a comprehension disorder of the same word, because of impoverishment of the shared semantic representation. Such a disorder may point to semantic degradation. The naming errors should be consistent because the semantic representation is irreversibly disturbed (McCarthy & Warrington 1990).
2. In time, the quantitative aspect surpassed its qualitative counterpart. For instance, Butterworth et al.(1984) describe a correlation between the severity of the impairment in naming and comprehension, yet without item specificity. Their explanation was that the access to the lexical semantic representations was shortcoming, which means that word x may be correctly produced or interpreted at one point in time, yet not at another. The deficit may be labelled as a processing disorder; it was assumed that the semantic representation was intact.
3. The relationship between language production and comprehension was completely denied (Hart & Gordon 1990). Those authors did not find a correlation between the number of semantic paraphasias in a naming task and the level of the language comprehension deficit. However, a misleading aspect of their research is that they did not take into account other aspects of aphasic language production than semantic paraphasias.

The occurrence of semantic paraphasias is not the only characteristic of a lexical semantic deficit in language production, nor are those speech production errors exclusively bound to such a disorder.

Approaching the Semantic System

Apart from the intermediate role the semantic system plays between language comprehension and production, the system itself may also be separated into distinctive components. Advocates of this dual-code theory assume that lexical semantics has to be differentiated from visual semantics (Warrington & Shallice 1979). Visual semantics should deal with the functional interpretation and categorisation of pictures, objects, and situations, preceded by a perceptual analysis, another stage of processing. The lexical semantic part of the semantic system is involved, if words are connected with their referents in the real world or with other words in a verbal context (Caplan 1993). When visual processing is adequate, the right word in a naming task is chosen if the lemma is correctly specified by the semantic features (cf. Levelt 1989). In the attachment of the semantic features to a word, both visual and lexical semantics should be involved. Abstract properties of the object that the word refers to would be stored in the lexical semantic component, whereas the visual semantic component would contain information about perceptual features of a concept (Paivio 1971; Shallice 1993). There is much discussion about the interference between the visual and lexical semantic system, in which the presence or absence of error-consistency in the interpretation of words and pictures by aphasic patients functions as an argument (a.o. Riddoch et al. 1988; Caramazza et al. 1990; Shallice 1993).

The lexical semantic system as such is difficult to get hold of. Whereas phonology and syntax are topics that have rather clear boundaries, making it possible to describe them adequately in terms of an exhaustive rule-system, the most central level of language functioning seems to be the hardest to capture in detail. The semantic system is highly individually defined, based on the mental encyclopaedia, developed on individual associations. It is also flexible because its concepts may change over the years in relation to real world developments. Consequently, even when we try to consider the lexical semantic system as a system that can be described with explanatory adequacy, many problems arise. There are a number of dimensions by which sense-relations (semantic relations between words) can be described such as: antonymy, synonymy, paradigmatic and syntagmatic relationship. However, an exhaustive system does not as yet exist. The boundaries between words

within the same semantic fields and between words from different semantic fields may be fuzzy. Formally, a distinction between words, belonging to the same semantic category, should be possible through degrees of prototypicality. However, the question remains if this measure reflects its membership of a superordinate category. The assignment of a word to a semantic category is independent of its prototypicality within that category (cf. Jackendoff 1983).

The descriptive problems of the semantic system are reflected by the scanty means of diagnosing a semantic deficit. The research into language comprehension initiated by the development of the Token Test (De Renzi & Vignolo 1962) brought along an affluence of tasks for the detection of lexical semantic disorders for both left and right hemisphere lesions. Unfortunately, these tasks have only left a minor impact on aphasic test batteries. In the language comprehension parts of well-known test batteries, where the patient is required to match a spoken and/or written word with a picture, the semantic relations between the correct response and the distractor are generally not controlled. Apart from subtests of large diagnostic aphasia examinations, only a few specifically lexical semantic tests are available. As we already mentioned, most of these are exclusively developed for research paradigms. Pizzamiglio and Appiciafuoco (1971) made one of the first tests for clinical practice with controlled distractors. Nowadays the Pyramids and Palmtrees Test (Howard & Patterson 1992) is often used: it separates lexical and visual semantics, and it examines the various input routes (orthographic, auditory, and visual). Other recently developed tests used for research and in clinical settings are the Synonym Judgment Test and the Semantic Matching Test, subtests of the Psycholinguistic Assessment of Language Performance in Aphasia (Kay et al. 1992). In all these tests only nouns are incorporated.

Lexical Semantic Therapy

Efficacy

As the most central part of language processing models (Patterson & Shewell 1987; Ellis & Young 1988), the lexical semantic system is often the point of reference in aphasia therapy. The efficacy of lexical semantic therapy for various groups of aphasic patients has been established repeatedly, following model-oriented assessment of language functions. One of the first studies in this respect was that of Howard et al. (1985a) who

compared the effects of semantic therapy and of phonological cueing. As semantic tasks were used 'matching spoken words with pictures', 'matching written words with pictures' and 'answering yes/no questions about the semantic category or semantic aspects of an object'. Phonological cueing consisted of 'saying the first phoneme', 'saying the entire word' and 'rhyme judgement'. The results showed that the phonological cueing effect disappeared within minutes, whereas the effect on naming of semantic therapy lasted 24 hours. In another study (Howard et al. 1985b), semantic therapy was reported to have a lasting effect of one week. A "within items" effect over a period of one year was found by Pring et al. (1990), evaluating a lexical semantic therapy conducted by Marshall et al. (1990). Unfortunately, testing long-term effects is often not a part of therapy evaluation studies.

A true therapy effect consists of a generalisation effect to untreated items, and even better, to other linguistic modalities (Blanken 1989). In the study of Marshall et al. (1990) a generalisation effect was found in non-treated, but semantically related items (see also Seron et al. 1979). Generalisation from one linguistic modality to another, for example from the written to the oral mode, would imply activity of the semantic component (Hillis 1989). However, Deloche et al. (1992) claimed that such a generalisation effect might be the result of a repair strategy, by readdressing the cognitive system via covert written naming if oral naming failed.

The choice for a lexical semantic therapy has to be guided by a model based hypothesis about the impairment. To confirm this assumption Nettleton and Lesser (1991) applied lexical semantic therapy not only to patients with semantic disorders, but also to patients with purely phonological problems. It appeared that the two patients with lexical semantic disorders made progress in contrast to the other group, a plea for model-appropriate therapy.

Goal

The goal of lexical semantic therapy is two-sided: it aims at influencing both language production and comprehension, i.e. at a modality independent effect. Generally the patient's performance on naming and auditory and written comprehension is used as a measure to assess the effectiveness of lexical semantic therapy. However, there may be a discrepancy in wordfinding difficulties within a naming task and in spontaneous speech (Lesser & Milroy 1993). Some patients have more difficulties in producing the correct word within object naming tasks than in real life situations, or

even within the context of a sentence. Others show just the opposite (Lesser 1987). A patient, whose lexical semantic system is relatively intact, revealed by his performance on word comprehension and naming tasks, may yet talk incoherently, or not at all. This may be due to the fact that spontaneous speech requires the speaker to integrate various linguistic levels within a language user situation and this aspect of his language may be distorted. Of course, lexical semantic therapy is not useful in overcoming this deficit.

Nevertheless a generalisation from language therapy to spontaneous speech is aimed at. The final goal of nearly every aphasia therapy is the improvement of verbal communication in a natural environment. Quite a number of difficulties arise from this assumption. One of the most important points here is again the problem of analysis. Only a few studies are written about the evaluation of the informational content of spontaneous speech. A recent example is given by Nicholas and Brookshire (1993), using as an evaluative measure, the number of information units related to the speech-eliciting context. However, even if progress on a systematically gathered speech sample seems to be present, it is not self evident that there is generalisation to a daily life situation. Moreover, the impact of a lexical semantic therapy on the patient's functioning in real life situations is difficult to assess; numerous factors may influence the patient's linguistic behaviour. Elegant attempts to simulate a daily life situation in a testing room are made by the devisors of the CADL (Communicative Abilities in Daily Life, Holland 1980) and the ANELT (Amsterdam-Nijmegen Everyday Language Test, Blomert 1990). Only the last one is applicable to Dutch patients.

BOX: Lexical Semantic Therapy Program

Developing BOX

Out of our experience with the speech therapists of the Aphasia Foundation Rotterdam, we gathered that quite a number of patients received some kind of lexical semantic therapy by use of e.g. Logotherapia (Engl et al. 1983; Dutch version: Bonta & Sistermans-Theunisse 1993), the Multicue Program (Van Mourik & Van de Sandt-Koenderman 1992) and by the use of therapy items the speech therapists made up themselves for particular patients. In most of these tasks the point of reference consisted of pictures. BOX provides in a lexical semantic therapy, focusing on the interpretation of written words, sentences and texts without the reference to pictures. The use of written words has the benefit that the dimension concrete-abstract may be

built-in, fulfilling a need for patients with moderate to mild forms of aphasia. Moreover, in contrast to auditorily presented words, written words give the patient the opportunity of processing the words over a considerable time. If the patient's effort results in a correct response, we may conclude that within the time spent to the decision process the lexical semantic system is adequately addressed. A similar processing effort may facilitate in the long run the access to the lexical semantic system. The intactness of the graphemic input route seems to be obligatory for a useful application of BOX. However in case of slight problems within this route, the speech therapist may read aloud the items to be sure that the graphemic wordform is recognised.

In developing BOX, we set ourselves the following aims:

1. We wanted the program to be useful for aphasic patients with varying degrees of lexical semantic impairment.
2. The exercises had to cover a large number of topics, to meet individual points of interests.
3. There had to be considerable variation in the tasks to strengthen the generalisation effect.
4. We not only wanted tasks on word level, but also on sentence and text level, plus a possibility of switching between these levels.

BOX: Final Form

A pilot version of BOX was distributed among thirteen speech therapists of the Aphasia Foundation Rotterdam, who worked with the programme for six months. We made some adjustments according to their comments. In its final form, the programme now consists of more than 1000 exercises on word, sentence, and text level. All the exercises follow a pattern in which the patient has to make a choice out of a number of alternatives, or a false/correct decision. It is stressed in the literature that making semantic decisions is the pivot of lexical semantic therapy: "Practice in semantic word discrimination may improve the accuracy of word-finding more than therapy aimed specifically at output itself" (Butterworth et al. 1984). Silent reading is sufficient, language production is never required. However, it can be very unsatisfactory for the patient to go through a therapy-session without contributing by oral speech to the tasks. Consequently, the speech therapist should be encouraged to read the items aloud together with the patient, and discuss the patient's choice.

There are eight different types of exercises: **I**: Semantic Categories, **II**: Syntagmatic and Paradigmatic Relationship, **III**: Semantic Gradation, **IV**: Adjectives and Exclamations, **V**: Part Whole Relationship, **VI**: Anomalous Sentences, **VII**: Semantic Definition, **VIII**: Semantic Context.
Examples of each type of exercise with their description are shown in the appendix. Most of the exercises contain three levels of difficulty.

In creating different levels of difficulty, the following factors were taken into account:
Word choice: imageability, frequency, word length, and abstractness were considered. Because of the large amount of words involved in the programme, those variables were not ordered by means of norms, because this would have left us with too many missing values to be of statistical relevance.
Number of distractors: in general, the level of difficulty increases by adding more distractors.
Semantic relatedness: there are mostly unrelated distractors at the easy level, and only related distractors at the most difficult level.
Ambiguity: incorporated in the difficult level are ambiguous words, the task is to survey both word meanings at the same time.

Because of the vast amount of items, the speech therapist has a large number of exercises to choose from; within one therapy session different parts of the programme may be dealt with the same level of difficulty. The patient's behavioural characteristics and neuropsychological functioning may define whether variety of exercises or uniformity is needed. The programme also offers the possibility to switch from word to sentence level and vice versa, while dealing with the same word or category. These additional tasks may either serve as facilitation, or as a means to progress to a more difficult level. For patients with a moderate semantic disorder, enough material is available for approximately six months of therapy, with therapy sessions of 90 minutes a week. We aimed at the involvement of a considerable amount of items on each level of difficulty to be sure that the speech therapist is able to spend enough time to the tasks, corresponding to the patient's needs. Too much variety within a therapy programme may prevent a learning effect (Prins 1987).

Box and it's effectiveness: A pilot study

During the final stages of the development of the programme, BOX was applied to two patients with a chronic aphasia. This pilot study served as a preliminary evaluation of the programme's effectiveness, and as a preparation for a more extensive evaluation study that is presently conducted. Both patients were tested before and after therapy by the Aachener Aphasie Test (AAT, Graetz et al. 1992) with subdivisions for all major language components, and by the Semantic Association Test[1] (SAT, Visch-Brink & Denes 1993) to evaluate visual and lexical semantic processing . Finally, to compare the function word/content word ratio in spontaneous speech before and after therapy, we used the Spontaneous Speech Analysis, developed by Joanette and Goulet (1990).

Patient A: diagnosis and therapy

Patient A was a left handed 79-year-old man, who had been a road paver. The neurological, neuropsychological and biographical data are represented following a multiaxial evaluation system, described by Van Harskamp and Visch-Brink (1991).

Axis I *Aphasia syndrome*

The linguistic disorder was diagnosed as a severe Broca aphasia (ALLOC-classification, AAT) with slight agrammatism. Many utterances remained unfinished, partly caused by syntactical problems, partly by a word finding disorder. Auditory and Visual language Comprehension were severely disturbed, in line with the results of the Token Test. Naming was moderately disturbed. There was both a visual and lexical semantic disorder. Only mirror writing was possible: in writing to dictation he had a slight disorder. The patient had been aphasic for two and a half years.

[1] The SAT is based on the same principle as the Pyramids and Palm Trees Test (Howard and Patterson 1992) and developed within the EC Escape Project: Cross Linguistic Assessment. The patient has to judge pictures and/or words on semantic relatedness. There are four versions with each 30 items: a. pictures, b. written words, c. pictures with a written word, d. pictures with a spoken word. SAT-data of normals (N=30): Pictures, mean 28.03 SD 1.73; Written words, mean 27.81 SD 1.45.

Axis II *Physical condition*
CT scan showed a left temporal infarction.

Axis III *Neurological and neuropsychological disturbances*
The patient had a right hemiparesis. Visuo-spatial functions and visual perception was intact. The patient could reproduce four digits by auditory presentation. There was an acalculia. His visuo-spatial functions were intact, just as visual perception. His intelligence was average. The tasks were performed slowly but precisely.

Axis IV *Psychosocial stressors*
Not present

Axis V *Social circumstances*
The patient was married and had three children. He was living in a nursery home in the city centre, in the neighbourhood of his wife and children. His social life was reasonably well. During weekends he lived at home. He was an amiable and cheerful man.

Table 7.1. Performance of patient A on AAT and SAT, before and after lexical semantic therapy

Akense Afasie Test (percentiles except Spontaneous Speech)			
	before therapy	**after therapy**	
Spontaneous Speech	19/30	22/30	
Token Test	48	48	
Repetition	74	75	
Written Language	46	59	
Naming	34	36	
Language comprehension:	17	37	
Auditory comprehension	21	18	
Visual comprehension	15	58*	
Semantic Association Test			
	before therapy	**after therapy**	
Pictures (30)	17	18	crit. diff. > 5
Written words (30)	12	19*	crit. diff. >6
Pictures/written words (30)	14	21	
Pictures/spoken words (30)	10	21	

* significant improvement in relation to the preceding examination

During six months he received lexical semantic therapy by means of BOX, in two weekly sessions of one hour. Tasks consisted of: Semantic Categories (I), Syntagmatic and Paradigmatic Relationship (II) and Adjectives and Exclamations (IV) (see appendix). These tasks were started on level 1 at the beginning of therapy, but the patient gradually developed to level 2. The test results before and after therapy (Table 7.1.), show an improvement of visual comprehension, subpart of the AAT, and of the lexical semantic abilities, reflected in the performance on the SAT: version 'written words' , 'pictures/spoken word' and 'pictures/written words'. The patient's performance on the SAT-version 'pictures', requiring visual semantic processing, remained the same.

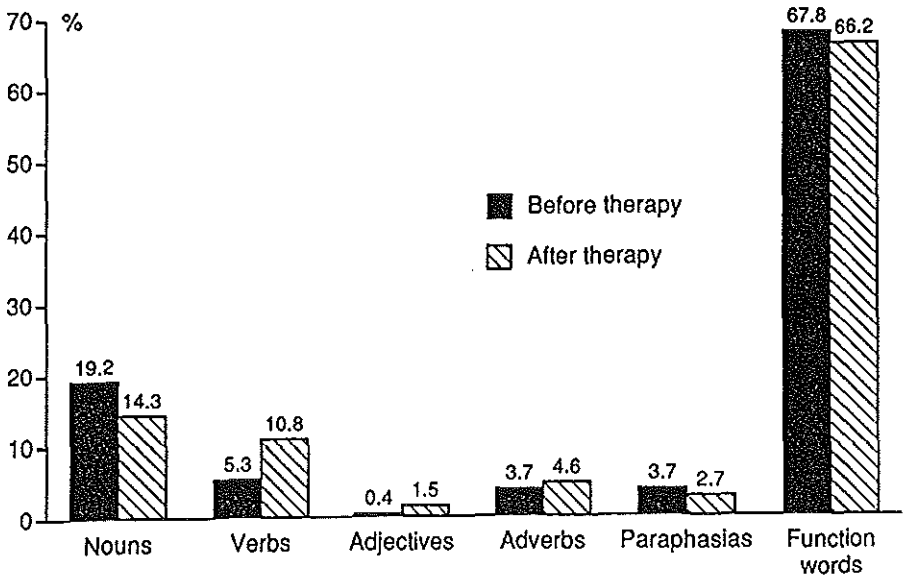

Fig. 7.1. Patient A. Distribution of word categories in spontaneous speech (Joanette & Goulet, 1990).

According to the Spontaneous Speech Analysis (Joanette & Goulet 1990) the words of the spontaneous speech samples (AAT) were counted and divided into nouns, verbs, adjectives, adverbs, paraphasias, and function words (Figure 7.1.). The obtained profile showed a difference over time. There was no difference in the ratio content/function words before and after therapy. However within the category content words, after therapy, the number of nouns decreased, whereas the number of verbs increased (i.e. content verbs, excluding copulas, auxiliaries, and modal verbs).

Patient B: diagnosis and therapy

Patient B was a 71-year-old right handed housewife.

Axis I *Aphasia syndrome*

Semantic and phonemic paraphasias occurred in her spontaneous speech and in naming. There was a bad performance on auditory and visual comprehension and on the Token Test. Naming was severely disturbed too. Repetition was relatively spared. Clinically she was classified as a transcortical sensory aphasic (ALLOC-classification, AAT: 'not classifiable'). The results on the SAT show the presence of a visual and lexical semantic disorder. The patient was one year aphasic.

Axis II *Physical condition*

CT scan showed a haemorrhagic infarction in the left area of the insula, due to a cardiac embolism.

Axis III *Neurological and neuropsychological disturbances*

There was a right-sided hemiplegia without hemianopsia. There was no evidence for neuropsychological disorders such as memory and learning disabilities. Visuo-spatial functions were slightly disturbed. The patient was quickly fatigued

Axis IV *Psychosocial stressors*

Not present

Axis V *Social circumstances*

The patient is a married housewife with three children. She has accepted her stay at the nursery home, where she is often visited. Regularly she spends a day with her children.

Lexical semantic therapy started one-year post onset of aphasia, and continued for two months with a frequency of two weekly sessions of one hour. The patient asked for an elaboration of the items to oral speech: the speech therapists integrated 'small talk' about the content of the items. Parts of BOX that were used are: Semantic Categories (**I**) , Syntagmatic and Paradigmatic relationship (**II**), Semantic Gradation (**III**), Adjectives and Exclamations (**IV**), and Part Whole Relationship (**V**) (see appendix). Most of the exercises were chosen from level one (easy). The test results, before and after therapy, are shown in Table 7.2. The AAT results failed to show improvement, but there was a increase of the SAT-results, especially of the performance on the verbal versions. The improvement seemed to be independent of the input channel (written or spoken words).

Table 7.2. Performance of patient B on AAT and SAT, before and after lexical semantic therapy

Akense Afasie Test (percentiles except Spontaneous Speech)			
	before therapy	**after therapy**	
Spontaneous Speech	15/30	17/30	
Token Test	30	43	
Repetition	57	52	
Written Language	42	42	
Naming	23	27	
Language comprehension	20	23	
Auditory comprehension	26	28	
Visual comprehension	18	22	
Semantic Association Test			
	before therapy	**after therapy**	
Pictures (30)	12	17	crit. diff. > 5
Written words (30)	2	14*	crit. diff. >6
Pictures/written words (30)	11	19	
Pictures/spoken words (30)	10	20	

* significant improvement in relation to the preceding examination

The distribution of the various word groups in the spontaneous speech samples (AAT), collected before and after lexical semantic therapy and analysed following Joanette and Goulet 1990), followed the same pattern as in patient A (Figure 7.2.). After therapy the total number of meaningful verbs increased slightly. However, in contrast to patient A, patient B produced also more nouns in the second speech sample.

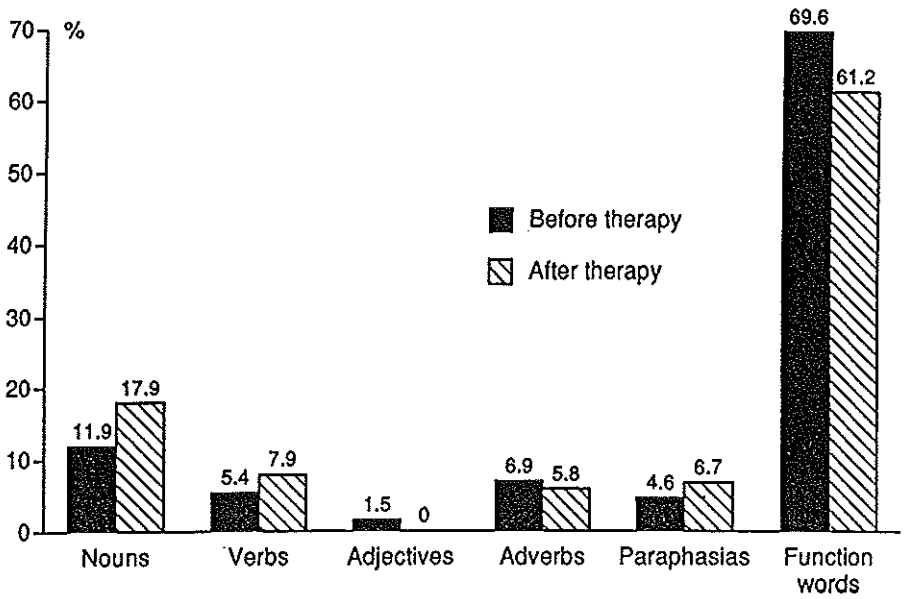

Fig. 7.2. Patient B. Distribution of word categories in spontaneous speech (Joanette & Goulet 1990).

Discussion

The reference group

The case studies described in this paper show that lexical semantic therapy was useful in two aphasic patients with a severe aphasia and a lexical semantic deficit, who were both more than one year post onset CVA. The patients profile on the Axes system revealed that both patients satisfied to general selection criteria, concerning psychosocial and neuropsychological state. General neuropsychological requirements for patients before entering into semantic therapy are: a good physical condition, an acceptable level of concentration, relatively preserved memory and executive control, and good motivation. The visual verbal input channel has to be relatively intact.

The effectiveness of BOX in patient A is reflected by a better performance on lexical semantic categorisation measured by the SAT, together with an improvement of Visual Comprehension (subpart AAT). The SAT shows a generalisation effect from the graphemic to the phonological input route and therefore seems to be more sensitive to measure progress in lexical semantic processing than the AAT subpart 'Language Comprehension'. Patient B too provides evidence for this sensitivity of the SAT. In patient B the performance on the verbal SAT-versions post therapy was better than pre-therapy, in contrast to the results of the AAT subparts Auditory and Visual Comprehension. Even there was a tendency to an amelioration of visual semantics, which was initially more disturbed than in patient A. Consequently semantic processing seems to be reflected better by a semantic association task than by a word-picture matching task, where the word labels the picture.

Both patients show the tendency that not only in a formal test situation, but too in a rather unstructured interview situation BOX influences favourably the amount of content words in the spontaneous speech. The effect of BOX on the availability of verbs in patient A, a Broca aphasia, is surprising, while nouns are more incorporated in the programme than verbs. This leads to the interpretation that a specific wordfinding disorder for verbs was one of the factors that contributed to his agrammatism. The application of BOX may have augmented the insight of the patient in the semantic features of the verb. The verb defines parts of speech, incorporated in the sentence; as its arguments they are attached to the verb (Black et al. 1991). Before therapy the amount of nouns in the speech sample is higher than after therapy. The production of verbs by patient A post therapy seems to impede integration of nouns in the sentence, which may be explained by a pure

syntactic disorder. In patient B, not a Broca aphasia, there is a trend that the amount of all content words in the spontaneous speech is higher after therapy, which may to be more clearly explained as a pure effect of lexical semantic therapy. In relation to the short period of application, the effectiveness of BOX in patient B in terms of a better performance in semantic association tasks is remarkable. This contradicts the conclusion of Basso et al. (1979), who took as a minimal period for effectiveness: six months with three sessions a week.

As the progress of both patients shows, the programme seems to be meaningful for patients with severe aphasia. However the severity of the aphasia may be an exclusion criterion for the application of the programme. Lexical semantic therapy seems to be less suitable for patients with a global aphasia. Van Mourik et al. (1992) found that a selected group of patients with a global aphasia are considered for structural language therapy: the group with a maximum score on GANBA, a neuropsychological test battery for patients with a global aphasia. Because the therapy for those patients should not only aim at verbal speech but too at the use of augmentative speech resources, we question the possibility if this group would benefit from the lexical semantic therapy on the levels, as are incorporated in BOX. For those patients, lexical semantic therapy should rather involve pictures and words than only words.

On the other side of the severity scale is a group of aphasic patients with only minor lexical semantic problems. BOX's level 3 provides therapy material on an abstract level that was not available up to now. However this may be insufficient for patients with slight wordfinding and comprehension disorders. To explore the restrictions of the programme, in addition to our pilot study, a larger evaluation study is in progress with severely to slightly language-disturbed patients. Criteria for participation into BOX, entrance level, and the way of evaluating the patient's progress will become more straightforward after the ongoing evaluation study has been finished. It involves a group of patients with various aphasia types and different severity grades (diagnosed according to AAT), who are more than one-year post onset CVA. We have chosen for a crossover design in which we compare the results of semantic with phonological therapy. The severity of the lexical semantic disorders in our subjects varies; the programme has different levels of difficulty. For the evaluation we have chosen for a large number of tests, directed to phonological and semantic processing. E.g. relatively easy (SAT) and more difficult tests for semantic processing are involved (the Synonym Judgement Test, PALPA). Moreover to assess the quality of spontaneous

speech pre- and post therapy, we use a more structured elicitation procedure than an interview.
The results of the evaluation study will indicate which tasks are suitable to select patients for a hypothesis-driven lexical semantic therapy.

Lexical Semantic Therapy: When and in combination with what?

Our two cases were both more than one year post onset of CVA. Both for our pilot study and for the evaluation study we specifically requested aphasic patients who had entered the so-called chronic phase, to exclude spontaneous recovery. However, in practice we expect BOX to initiate or speed up spontaneous recovery in patients in the first year post onset. The most appropriate therapy for patients with a lexical semantic disorder in the first months post onset seems to be a therapy which is directed at speech comprehension, provided that recognition of spoken and written words is intact. The level of language comprehension denotes generally the availability of content words in naming tasks or in spontaneous speech. Moreover on the level of comprehension, the degree of the semantic disorder and the level of entrance for the programme may be more straightforwardly detected than in spoken speech. The latter is entangled in disorders inherent to the output route, such as phonological paraphasias, verbal apraxia, problems with the phonological word form, etc. In structural language therapy, the focus may be on production when the patient has to integrate his lexical semantic skills in a communicative situation, when he wants to get across an information-carrying message (Visch-Brink et al. 1993).

Intriguing is the possible influence of lexical semantic therapy on syntax and phonology. The production of more main verbs by patient A after lexical semantic therapy might in the long run, when it is a long lasting effect, improve syntax, consisting of a better grouping of the arguments round the verb. The semantic system has also been claimed because of its central position in the model, to influence the phonological level by means of a cascade effect. Consequently, Hadar claims that semantic therapy may reduce neologisms (1989). However, in other recent linguistic models, the semantic system and the phonological system function as two separate entities (e.g. Levelt 1989), which would contradict any influence of one system to the other. This point of consideration could not be described according to the results of the patients from the pilot study, but we will address this subject in our evaluation study.

BOX: its contents and what may be missing

Most of the tasks from BOX deal with nouns and adjectives. Being the typical carriers of semantic contents, they prove to be an ideal subject for therapy. It is possible that they are the most useful tools to administer the semantic system at the input side, but the output side is not helped by an enrichment of nouns and adjectives only. Perhaps a need exists for tasks with for instance verbs, and locatives. However, the results of the pilot study show that there is a generalisation effect to another grammatical category. Both our patients produced more meaningful verbs in spontaneous speech after a period of lexical semantic therapy not specifically directed to the output of verbs. Yet it is not unthinkable that patients exist who would benefit from e.g. verb centred therapy, and if so, we would gladly consider filling this gap.

A recurrent remark of speech therapists who use the programme is that after a while their patients start complaining about the little verbal output that is requested from them. We deal with this issue by encouraging them to discuss the patient's choice in a task, whether correct or incorrect. However, it is conceivable to add some parallel word production tasks to the programme, for instance by making "question-answer" tasks around semantic concepts, which would give the patient more opportunities for verbal output. Other possibilities would be: filling gaps of content words in sentences or texts; completing texts that are presented with missing information.

A related subject matter is the availability of scoring forms in order to control the responses of the patient during each therapy session. This we object to on principle, because it interferes with the communicative situation in which the therapist has to react immediately on the patient's responses. The execution of therapy may not be disturbed by the scoring act. The therapist's concern is choosing out the tasks and adding variability to maintain the patient's attention. In short, the therapist has to create a situation in which the patient is challenged to perform the tasks. Scoring responses diverts the attention of both the patient and the therapist, moreover, the therapeutic situation in which the therapist has to cue the patient in various ways is disturbed. Another possibility is to build in short tests at the various levels of difficulty within the subparts of BOX. This could help the speech therapist in her decision to switch to another level of difficulty. However, one of the advantages of BOX is that it brings in an amount of variability for the patient, and structural testing could prevent its dynamics. Testing during therapy should only be used as guidance for the speech therapists if it is

uncertain if the patient's performance agrees with the levels of difficulty, and at the beginning of therapy to adjust the entrance level. For the experienced speech therapist, the patient's reaction is probably more valuable than his score on a 10 items test. Moreover the reactions of the patients and the speech therapists, participating in the evaluation study will give information about the (in) equivalence of the subparts and the value of the degrees of difficulty, built-in in the various subparts.

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Appendix

BOX: description of exercises.

I Semantic Categories

Task description

A number of semantically related words is given, together with one word that belongs to a different semantic category. The patient has to pick the odd one out. Furthermore, each level of difficulty has its own additional task, which may either be used separately, or enable the patient to find the solution to the initial task. At the first level, three categories are given, one of which presents the category to which the semantically related words belong. At the second level, a sentence is given which relates to all the words in the previous task, except for the distracter. At the third level, two sets of five semantically related words are mixed up, and the patient has to separate them according to category.

Levels of difficulty

The degree of difficulty varies according to the number of words in the word task (four, five, and six words at levels 1, 2, and 3, respectively) and the semantic relationship the distracter has with the other words (no relationship at level 1, some degree of similarity at levels 2 and 3). Going from level 1 to 3, the words within the exercises become more abstract, longer, and less frequent.

Number of exercises

50 exercises at each level, with the same number of additional tasks.

II Syntagmatic and Paradigmatic Relationship

Task description

A word has to be matched with another word (two or three possibilities are provided). The match either constitutes a syntagmatic or paradigmatic relationship. If the patient needs help, a sentence is provided which explains the relationship of the two words.

Levels of difficulty

At the first level a choice has to be made out of two semantically unrelated words. At the second level, the two possibilities share a semantic similarity, although only one of them matches with the target word. At the third level, the patient has to choose one out of three semantically related words.

Number of exercises

Each level comprises five semantic categories with 20 items, half of which is paradigmatically related, the other half is syntagmatically related.

III Semantic Gradation

Task description

Words have to be matched with one of two antonyms.

Levels of difficulty

There is only one level of difficulty: level 1 (easy)

Number of exercises

There are 20 pairs of antonyms. Each of a range of words (15) has to be matched with one of the antonyms.

IV Adjectives and Exclamations

Task description

A sentence implies the meaning of an adjective, which is presented in a number of sentences. The patient has to pick out the alternative that goes with the stimulus sentence. This form of exercise is modified at level 3 in which the alternatives consist of exclamations.

Levels of difficulty

At the first level, the alternatives consist of two sentences with opposite adjectives. At the second level, the patient has to choose from three sentences, each of which could be compared with the stimulus sentence, though only one is implied from it. The exclamations in level 3 are the most abstract items in this part of the programme.

Number of exercises

Each level has 50 exercises.

V Part Whole Relationship

Task description

A target sentence gives an example of a part whole relationship between two content words. The alternatives consist of a number of content words, one of which has the same sort of relationship with the stimulus content word.

Levels of difficulty

At the first level there are five possibilities to choose from, and the distracters are semantically unrelated to the correct items. There is variability in the number of words that is correct. At the second level there are four semantically related words only one of which is the correct choice. The third level has three semantically related possibilities. The difficulty of this level is established through the semantic ambiguity of the target word (the patient has to switch from one meaning to another).

Number of exercises

There are 40 exercises at each level.

VI Anomalous Sentences

Task description

Sentences are presented to the patient that are either semantically correct or incorrect. The patient has to make a yes/no decision.

Levels of difficulty

Only levels 1 and 2 are represented in this task. Sentences of level 2 are longer and more complicated than those of level 1.

Number of exercises

60 sentences per level.

VII Semantic Definition

Task description

At the first level a word is given which can also be used in compound words. Eight possibilities follow of which the patient has to decide whether the combination makes a legal compound, yes or no. At the second level, compound words are given followed by two definitions, one correct and one false. At the third level, a list of words is presented, followed by three short definitions, some of which apply to more than one word.

Levels of difficulty

Level 1 features no more than a word decision task. Level 2 gives two definitions of one word, whereas level 3 gives one definition of two or more words. Because of the semantic ambiguity, level 3 is the most difficult.

Number of exercises

25 exercises per level

VIII Semantic Context

Task description

This part of the programme contains only exercises on text level. At the first level, fairly short texts are presented with one or two sentence anomalies in them. In an additional task, the patient is presented with a similar text without anomalies, and has to make a decision as to what kind of text he is confronted with. At the second level, a text is given together with two summaries. At the third level, a newspaper text is presented, with erroneous content words, which the patient has to spot.

Levels of difficulty

The texts vary according to length and subject matter. The anomalies vary from slight too extensive.

Number of exercises

Each level has 50 texts.

LEVEL 1	LEVEL 2	LEVEL 3
I SEMANTIC CATEGORIES		
letter postcard *sigar* bill	comma *number* question mark semi-colon parentheses	greatness superiority importance power *motivation* authority
mail cutlery clothes	The editor of the local newspaper complains about the inaccurate writing style of his correspondents.	*greatness* *superiority* frequency *importance* continuity *power* periodicity *authority* repetition recurrence
II SYNTAGMATIC AND PARADIGMATIC RELATIONSHIP		
CRISPS	THEATRE	INTERPRETER
popcorn / towel	*musical* / home movie	actor / *translator* / courier
Let's have something to go with our drinks.	It appears that the show is sold out.	The Russian ambassador is coming to Holland.
III SEMANTIC GRADATION		
SPRING OR AUTUMN		
blossom mushroom *first cuckoo* *lamb* fall of the leaf *Easter*	*cleaning* chestnut September *bird's nest* harvest-time acorn	
IV ADJECTIVES AND EXCLAMATIONS		
The boy from next door is playing in the mud.	**That piano makes a terrible noise.**	**I've got my driver's license!**
1. The boy from next door is dirty. 2. The boy from next door is clean.	1. The piano is white. 2. The piano is new. *3. The piano is out of tune.*	1. Oh dear. *2. Congratulations!* 3. Is that so?
V PART WHOLE RELATIONSHIP		
The towels are in the linen-cupboard.	That painting has a nice list.	A cat's tail.
dishcloth grassmower *handkerchief*	*portrait* *aquarelle* film	*frock* dress coat

BOX subparts with examples from each level. Level 1 = easy, level 2 = moderate, level 3 = difficult. Correct responses in italics.

LEVEL 1	LEVEL 2	LEVEL 3

VI ANOMALOUS SENTENCES

The sun rushes through the country.	Dior's newest perfume smells like a fresh spring morning.	
The towel falls into the bath water.	*The church tower gradually grew upset in 1667.*	

VII SEMANTIC DEFINITION

ROPE	**evening dress** 1. *dress that can be worn at a dinner party* 2. kind of pyjama	queen key-board chicken horse jack mouse
ropedancer ropeladder *ropemidday* ropewalk ropequoit *ropemap* *ropeyard* *ropegrease*	**evening star** 1. *planet, seen after sunset* 2. rock singer who starts his performance after 10 p.m.	**which one is:** part of a computer an animal part of game of chess
	evening paper 1. banknote 2. *newspaper published after midday*	

VIII SEMANTIC CONTEXT

Aquarius 25 April - 1 May

You are doubting and wavering, but the stars predict there will soon be an end to all your problems. Visit your friends, go shopping. You will meet someone interesting at a birthday-party. *There's a chance you may even win the presidential election!* Beware of a jealous woman. Also take care of your health.

Is it:

a prize contest

a horoscope

a dietary advice

A well known pianist was addressed by a lady and her nine year old son, just after a concert. The lady wanted the pianist to listen to the boy's playing. The pianist said he really was too busy to give an audition, however, the mother managed to get an appointment for the following day. The son played a Waltz by Chopin. When he had finished, the pianist said it was the most horrific piano-playing he had ever heard. Quite satisfied the mother said to her son: "See! Now will you finally stop your lessons and start playing football?"

WHICH IS THE RIGHT SUMMARY?

1. A famous pianist was addressed by a lady and her nine year old son. The lady wanted the pianist to listen to her son's playing. The pianist said he played very badly. The mother was furious and went to another musician.
2. *A famous pianist was addressed by a lady and her nine year old son. The mother wanted the pianist to listen to her son's playing. When the pianist said he played very badly, she was quite satisfied.*

Napoleon forbidden to walk around

Coventry - The City Council of Coventry has decided that tom-cat Napoleon is no longer free to walk around. The cat was the fright of the neighbourhood. *It suffers from a kidney disease because of its diet.* Not content with its daily meals, it walks into neighbourly houses to steal away food from other cats. When they protest, Napoleon beats them up. The owner of three other cats complained to the police, and thus Napoleon got grounded.

BOX subparts with examples from each level. Level 1 = easy, level 2 = moderate, level 3 = difficult. Correct responses in italics.

8

LEXICAL SEMANTIC THERAPY: A TOOL TO RESTORE VERBAL COMMUNICATION

Introduction

The effectiveness of semantic therapy in restoring word finding abilities in aphasia has been extensively described in the literature (a.o. Seron et al. 1979; Howard et al. 1985a; Howard et al. 1985b; Hillis 1991; Pring et al. 1990; Marshall et al. 1990; Nettleton & Lesser 1991; Nickels & Best 1996a). In 1985, the studies of Howard and his colleagues have broken new ground in the area of semantic therapy (Howard et al. 1985a; 1985b). Compared with phonological therapy, semantic therapy proved to be a better facilitator in naming since both a long term effect and a generalisation effect to untrained material have been observed (see for an excellent overview: Nickels & Best 1996b). The surplus value of semantic therapy for patients with general word finding difficulties might be due to the central location of semantic processing in a word production model.

A lexical-semantic therapy should be useful for patients with a disorder in the comprehension and the production of content words, which is not due to defective spoken or/and written in- or/and output routes. A phonologically-based treatment should be primarily useful for patients with a disorder in the post semantic processing route to oral speech: the selection and ordening of phonemes. Compared with semantics, a phonological problem arise from a more peripherally located disorder in a speech processing model. Phonological therapy tasks that are applied successfully are f.i. repetition, oral reading, cueing with the first phoneme or with a rhyming word (Beard & Prescott 1991; Thompson et al. 1991; Cubelli et al. 1988).

The semantic therapies that were applied mostly involve word-picture matching tasks with semantic distracters. A semantic therapy without the use of pictures has seldom been described: one exception is the lexical-semantic activation inhibition therapy (L-SAIT), (McNeil et al. 1995; McNeil et al. 1997). After auditory presentation of predicative adjectives, the patient has to produce either an antonym or a synonym for the word or phrase.

A lexical-semantic therapy has the advantage that a concrete-abstract dimension can be built-in, fulfilling a need for patients with moderate to mild forms of aphasia and for the therapists who have to treat them. Therefore BOX[1] was developed, a therapy aimed at the remediation of lexical-semantic deficits (Visch-Brink et al. 1997). The patient is required to make semantic decisions about written words, sentences and texts without any reference to pictures. In contrast to auditorily presented words, written words give the patient the opportunity to process the words over a considerable period of time. The oral production of content words is not required. BOX has proved to be useful in two stroke patients with chronic aphasia (more than one year post onset) (Visch-Brink et al. 1997). However, there was no control therapy to compare with.

Data concerning the restoration of communication after lexical-semantic therapy are scarce. An exception is the above-mentioned study of McNeill et al. (1997). Those authors checked the generalisation to spontaneous speech by the use of the Correct Information Unit Analysis for speech samples, collected with a telling-a-story task (Nicholas & Brookshire 1993).

[1] BAX was the name of the first patient who received the therapy. The vowel has been changed to refer to the semantic component, localized in the centre of a word processing model and largely unknown.

In contrast with the improvement of naming, the L-SAIT therapy did not result in improved informational content of spontaneous speech.

The purpose of this study was to measure the effectiveness of BOX for daily life communication in patients with chronic aphasia. Using a cross-over design, BOX therapy is compared with a phonological therapy as a control therapy. Both therapeutic methods are intended to heighten the communicative abilities, though on a different linguistic level. Both spontaneous speech in daily life situations and the performance on different language modalities and linguistic levels are used as evaluative measurements.

Subjects

Eight aphasic stroke patients, five men and three women, with unilateral lesions in the left hemisphere completed the therapy. The demographic and medical data are shown in Table 8.1.

The neurolinguistic inclusion criteria used were (i) a disorder in naming and comprehension, as measured by selected subtests of the Aachener Aphasia Test (Akense Afasie test: AAT, Graetz et al. 1992), (ii) the absence of any significant difference between the AAT Auditory and Visual Comprehension, according to the ALLOC-psychometric analysis, and (iii) the presence of a disorder of the semantic and phonemic structure, as measured by the AAT-Spontaneous Speech analysis.

The patients were at least one year post onset. According to the AAT-ALLOC-classification procedure, the patients were classified as having a Broca aphasia (N=3), an Anomic aphasia (N=2), a Wernicke aphasia (N=1), a Global aphasia (N=1) and an unclassifiable aphasia (N=1). They all received treatment previously.

Method

BOX consists of eight subdivisions, with three levels of difficulty each: Semantic Categories, Syntagmatic and Paradigmatic Relationships, Semantic Gradation, Anomalous Sentences, Adjectives and Exclamations, Part Whole Relationships, Semantic Definitions, and Semantic Context. Examples are given in Visch-Brink et al. (1997). A large number of exercises with varying degrees of difficulty was devised, enabling the clinician to choose suitable

items in terms of difficulty and subject matter for each patient. There are 1200 exercises in total. All the exercises follow a pattern whereby the patient has to either make a choice out of a number of alternatives, or to make a yes/no judgement.

Table 8.1. Demographic and medical data

	Age	Gender	Handedness	Occupation
Case 1	72	M	Righthanded	Furrier
Case 2	69	M	Righthanded	Fishmonger
Case 3	65	M	Righthanded	Chief mate
Case 4	52	F	Righthanded	Cashier
Case 5	46	M	Righthanded	Bricklayer
Case 6	59	M	Righthanded	Railwayguard
Case 7	45	F	Righthanded	Pub-keeper
Case 8	72	F	Righthanded	Teacher

	Months post onset	Aetiology	Lesion site	Aphasia type[1]
Case 1	13	Infarction	Left middle cerebral artery	Broca
Case 2	24	Infarction	Left middle cerebral artery	Not to classify
Case 3	18	Infarction	Left middle cerebral artery	Broca
Case 4	15	Haemorrhage	Left parieto-temporal	Wernicke
Case 5	20	Infarction	Left temporo-parietal	Broca
Case 6	14	Haemorrhage	Left parietal	Anomic
Case 7	33	Infarction	Left middle cerebral artery	Global
Case 8	13	Haemorrhage	Left fronto-temporal	Anomic

[1] Classification according to the AAT-ALLOC norms
M = male, F = female

The phonological programme is directed at the selection and ordering of phonemes, and is based on an approach by Cubelli and colleagues in 1988. Four steps with increasing difficulty are as follows: (i) selection of existing words, (ii) compiling words out of syllables, (iii) analysing words into phonemes and (iv) making pronounceable sequences out of separate letters. At every stage the patient has to pronounce the word.

No fixed order of exercises was prescribed for either of the therapeutic programmes. All speech therapists decided which exercises were most suitable at any given time for the patient being treated.

Diagnosis and evaluative tests

Language modalities

The severity and type of aphasia was measured with the Aachener Aphasia Test (AAT; Graetz et al. 1992). The AAT has subdivisions for all major language components: Spontaneous Speech, Token Test, Repetition, Written Language, Naming, and Comprehension. Spontaneous Speech is rated on six scales with six points each: communicative ability, articulation and prosody, language automatisms, semantics, phonology, and syntax. The subtest Written Language consists of reading aloud, putting together words and sentences to dictation from letters and words, and writing to dictation. The subtest Comprehension includes auditory and visual comprehension. For each item in the linguistic subtests, four-point scales are used, the scale points being defined by linguistic categories. The results of the Token Test, Repetition, Written Language, Naming and Comprehension were recorded both before and after BOX and the phonological programme.

Communicative abilities

The Amsterdam Nijmegen Everyday Language Test (ANELT, Blomert et al. 1990, 1994) was used to measure the patient's functioning in everyday language situations. The patient's spontaneous speech is requested in ten different situations. The responses are assessed by two judges on two 5-points scales. Scale A, understandability, is a measure of the adequacy of the message; Scale B measures intelligibility, that is the clarity of speech, independent of its content.

Lexical-semantic processing

The Semantic Association Test (Visch-Brink & Denes 1993) involves sorting of concrete written words according to their semantic relationships. The test is based on the principles of the Pyramids and Palm Trees Test (Howard & Patterson 1992). Half the targets are animate, the other half inanimate. There is a thematic relationship between the target and the response. There are three distracters, two of which are semantically related to the target, although fairly distant from the correct response. The third distracter is not semantically related to the target.

For the Synonym Judgement of written word pairs (Psycholinguistic Assessment of Language Performance in Aphasia: PALPA, Kay et al. 1992; Dutch version: Bastiaanse et al. 1995). the patient has to judge whether two

words are synonymous or not. There are word pairs with a high and low imageability.

Phonological processing

The Auditory Lexical Decision Test (PALPA) checks for effects of imageability and frequency in lexical decision about spoken words. Nonwords are derived from words by changing one or more letters, while preserving orthotactic and phonotactic regularity.

For Minimal pairs of existing and nonexisting words (PALPA), the patients are required to judge the similarity. The words are presented auditorily with one-second interval with flat intonation. The stimulus pairs consist of monosyllabic nonwords or words with a CVC structure. Minimal differences in voice, manner or place of articulation occur either in initial or final position. In some pairs the order of sounds is reversed.

In the Repetition of nonwords (PALPA), the length of the stimulus varied from one to four syllables.

Design

Four patients first underwent BOX, and then the phonological programme, and four patients underwent the therapy programmes in reverse order. Each programme was applied for 20 hours with a minimum of one-and-a-half and a maximum of three hours a week. The tests were administered before, after and in-between both therapy methods.

Results

Language modalities

The results of the AAT before and after both therapeutic methods are presented in Table 8.2. The ALLOC psychometric analysis was used to assess whether there was a significant change in scores.

Table 8.2. Performance on AAT, pre- and post therapy (raw scores)

	Token[1] Test (50)	Repetition (150)	Written language (90)	Naming (120)	Compre-hension (120)
CASE 1					
Pre-therapy	39	93	28	52	88
Post PHON	40	96	35	61	79
Post BOX	42	97	39	57	102*
CASE 2					
Pre-therapy	37	(143)	80	71	83
Post PHON	30	(148)	(85)	58	72
Post BOX	35	(149)	79	55	75
CASE 3					
Pre-therapy	32	117	9	79	75
Post PHON	40*	111	9	86	90
Post BOX	40	113	12	82	(107)
CASE 4					
Pre-therapy	45	119	8	46	65
Post PHON	34*	126	27*	57	78
Post BOX	35	130	18	49	78
CASE 5					
Pre-therapy	47	92	46	59	63
Post BOX	48	105	51	58	71
Post PHON	47	124*	49	57	65
CASE 6					
Pre-therapy	37	113	82	91	73
Post BOX	32	114	(88)	89	90
Post PHON	38	114	(88)	(110)*	84
CASE 7					
Pre-therapy	47	10	17	36	84
Post BOX	44	10	17	52	77
Post PHON	47	0	19	52	79
CASE 8					
Pre-therapy	34	129	72	71	93
Post BOX	17*	(144)	82	93*	88
Post PHON	17	137	84	96	85

[1] = Error score
AAT = Akense Afasie Test, PHON = phonological programme, ( ) = normal range
* significant difference with preceding score

In Repetition (case 5) and in Written language (case 4), a significant improved performance was only reached after the application of the phonological programme. An improvement in Comprehension was found only after BOX (case 1). Performance on the Token Test and in naming increased significantly after both therapy programmes: Token Test, case 4 (after phonological programme), case 8 (after BOX); Naming, case 6 (after phonological programme), case 8 (after BOX).

Communicative abilities

Progress on the A-scale of the ANELT, understandability, is noted for by the therapeutic effect of BOX. (table 8.3.). After BOX, the linguistic responses to every day situations of cases 1, 4, 5 and 8, were more adequate in content than before. This improvement was found independently of the order of application of the therapy programmes. The results on the B-scale were less equivocal: after the application of the phonological programme, a decrease in performance was found twice (case 3 and case 8) and an increase once (case 5). After BOX, an improvement on this scale was found in cases 3 and 5.

Semantic processing

No significant progress on the Semantic Association Test was found for any subject (table 8.3.). The initial score of four out of eight patient's fell in the normal range (cases 1, 6, 7, and 8). Synonym Judgement, on the other hand, was initially disturbed in every participating patient (table 8.3.). After semantic therapy, case 1 had significantly better results on this test , together with Case 4, who was not testable before.

Phonological processing

The performance of the patients on phonological tasks, pre and post therapy , is expressed in table 8.4.

Auditory lexical decision improved both after BOX for case 2 and for case 5, and after the phonological programme for case 4. The same pattern was found in Minimal pairs of words and Minimal pairs of nonwords: in the first task, an improvement was found after BOX in case 1, and after the phonological program in case 2. In the second task, cases 1 and 2 improved after BOX, and case 8 after the phonological programme. The performance on Repetition of nonwords deteriorated after phonological therapy in case 6.

Table 8.3. Performance on ANELT and lexical semantic tests pre- and post therapy

	ANELT A-scale (50) crit. diff.>7	ANELT B-scale (50) crit. diff.>5	SAT (30) crit. diff.>6	SYN (60) Mean NC 59.43 SD 1.12
CASE 1				
Broca[1]	19	40	(25)	34
Post PHON	20	35	(26)	38
Post BOX	29*	36	(27)	53
CASE 2				
Not class.[1]	22	(48)	13	38
Post PHON	19	43	19	41
Post BOX	25	(48)	12	41
CASE 3				
Broca[1]	33	32	23	NT
Post PHON	27	22*	24	NT
Post BOX	34	42	(27)	NT
CASE 4				
Wernicke[1]	30	(50)	18	NT
Post PHON	32	(48)	21	NT
Post BOX	43*	(50)	23	44
CASE 5				
Broca[1]	NT	NT	15	39
Post BOX	18*	28*	18	38
Post PHON	16	(47)*	19	37
CASE 6				
Anomic[1]	36	(47)	(29)	52
Post BOX	30	(50)	(29)	54
Post PHON	28	(48)	(29)	49
CASE 7				
Global[1]	NT	NT	(27)	43
Post BOX	NT	NT	(28)	42
Post PHON	NT	NT	(29)	41
CASE 8				
Anomic[1]	30	(49)	(25)	45
Post BOX	40*	(50)	(27)	50
Post PHON	35	42*	(27)	53

[1] Classification according to the AAT-ALLOC norms.
ANELT = Amsterdam Nijmegen Everyday Language Test, SAT = Semantic Association Test, SYN = Synonym Judgement, crit. diff. = critical difference, N = normals, PHON = Phonological Programme,
not class. = not to classify, ( ) = normal range, NT = not testable
* significant difference with preceding score

Summary of results

The tests with a positive change of scores in relation to the application of only one of the therapeutic methods were: (i) AAT-Repetition and AAT-Written Language, in relation to the phonological programme, and (ii) AAT-Comprehension, ANELT-Scale A and Synonym Judgement in relation to BOX.

If only the therapy-specific tasks with a positive change are included, the following pattern can be observed:

In cases 2, 3, 6, and 7 no improvement was found after both therapeutic methods.

Cases 1 and 8 improved only after BOX. Case 1 showed progress on the ANELT, Scale A; AAT-Comprehension; and Synonym Judgement. Case 8 appeared to have a better performance on the ANELT, Scale A.

Cases 4 and 5 improved after both therapy programmes. In case 4 an increase of scores on ANELT, Scale A and Synonym Judgement was found after BOX, and on Written Language after the phonological programme. Case 5 had a better performance on the ANELT, Scale A, after BOX and on AAT-Repetition after the phonological programme.

Discussion

Aphasia rehabilitation means guiding the patient towards functioning as close as possible to his/her premorbid level. The final goal of aphasia therapy is to improve communication in daily life. The main finding of the study was that four out of eight patients made progress on the ANELT-Scale A after BOX-therapy (case 1, case 4, case 5 and case 8). There was no carry-over effect. In view of the excellent psychometric quality of the ANELT (Blomert 1990; Blomert et al. 1994), it seems reasonable to assume that progress on scale A implies improvement in verbal communication. According to the author, the ANELT measures the adequacy with which information is verbally communicated in everyday life situations, relatively independent of the linguistic form of the utterances used. The measurement of changes over time is a second explicit goal of the test. From the improvement of the four patients on Scale A of the ANELT, it might be inferred that lexical-semantic therapy is a valuable tool to restore verbal communication. Additional therapeutic therapy with the focus on integration of linguistic skills in communicative situations seems to be superfluous.

Table 8.4. Performance on phonological tasks, pre- and post therapy

	Auditory lexical decision (160)	Minimal pairs words (72)	Minimal pairs nonwords (72)	Repetition nonwords (30)
	Mean NC 158.25 SD 2.27	**Mean NC 70.8 SD 1.94**	**Mean NC 70.05 SD 1.64**	**Mean NC 29.75 SD 1.3**
CASE 1				
Pre-therapy	149	57	NT	5
Post PHON	151	59	58	6
Post BOX	148	(69)	(69)	4
CASE 2				
Pre-therapy	124	46	48	(27)
Post PHON	110	57	42	(28)
Post BOX	136	65	57	(28)
CASE 3				
Pre-therapy	150	(71)	66	18
Post PHON	150	(68)	(70)	19
Post BOX	152	(70)	(70)	22
CASE 4				
Pre-therapy	144	(70)	(71)	24
Post PHON	(155)	(70)	(70)	25
Post BOX	151	(72)	(71)	(29)
CASE 5				
Pre-therapy	124	57	57	15
Post BOX	139	65	54	16
Post PHON	133	66	(68)	19
CASE 6				
Pre-therapy	135	(70)	(67)	26
Post BOX	144	(71)	(69)	24
Post PHON	143	(71)	(69)	15
CASE 7				
Pre-therapy	135	(67)	(67)	0
Post BOX	137	(68)	62	0
Post PHON	137	(70)	64	0
CASE 8				
Pre-therapy	152	56	44	24
Post BOX	147	64	49	26
Post PHON	(155)	64	61	24

NC = normal controls, PHON = Phonological Programme, ( ) = normal range,
NT = not testable

The four patients who improved on the ANELT Scale A did not show a similar profile on the other semantic tests. Two of them performed within the normal range on the Semantic Association Test (Cases 1 and 8) which requires associating concrete words, but they had a defective score on Synonym Judgement, which requires judging wordpairs, consisting of concrete and abstract words. Cases 4 and 5 performed poorly on both lexical-semantic tests. Synonym Judgement might be more sensitive in measuring a lexical-semantic deficit. Therefore, the performance of the patients on the various semantic tasks seems to reflect the degree of severity of the lexical-semantic disorder. Patients with moderate to severe disorder should have relatively low scores on the Semantic Association Test and on Synonym Judgement, while patients with a mild disorder should perform poorly only on Synonym Judgement. However, progress on scale A of the ANELT was found in both groups after lexical-semantic therapy, meaning that BOX can be useful for patients with different degrees of disturbed semantic processing, thereby fulfilling the programme's intended function.

Progress in naming was not better on BOX than on the Phonological programme or vice versa. Both therapeutic methods appeared to result in a significant change of scores in AAT-naming. This effect was expected, in view of the fact that both lexical-semantic and phonological disorders, present in all patients, cause naming deficits. Only a specific error-analysis of the improvement of phonology and semantics separately could reflect the effectiveness of BOX, as compared to that of the phonological program. Such an analysis still has to be performed.

Patients with varying types of aphasia (Broca, Wernicke and Anomic) and different severity grades did benefit from BOX-therapy. This finding is in line with the fact that in a large group of aphasic patients (N=78), the performance on the verbal (and visual) Semantic Association Test was not related to aphasia type or severity, as measured by the Token Test (Visch-Brink et al. 1996).

Our primary intention was to develop a therapy, which had the potential to be fruitful for a lot of aphasic patients. This 'formal-semantic' therapy, presenting the lexical-form and the semantically associated words (see also Le Dorze et al. 1994), is directed towards the activation of features that distinguish between semantically related items. In all the exercises, especially at word- and sentence level, the patient is required to select written word forms, depending on their common and divergent aspects of meaning with other words from the same (or related) semantic field. Variation in the nature and difficulty of the exercises provides the patient

with the opportunity to practice semantic differentiations between words in different contexts. The main goal of the program is to facilitate semantic processing in patients with a 'general' lexical-semantic disorder (Franklin 1993), which should have a positive influence on semantic processing in new situations (Nickels 1997). The observed progress on the ANELT is in line with this assumption.

However, not all cases in this study benefited from the BOX-therapy. The test data do not seem to be sufficient in detecting why the lexical-semantic therapy did not work in those patients. Their initial test performance was not deviant from the performance of the patients for whom BOX appeared to be successful with exception of Synonym Judgement in case 3 and the ANELT in case 7 (who could not speak at all).

Increased understanding of why the materials were appropriate for some and not other patients should become apparent as a result of a forthcoming large-scale multicentered study whose aim is to differentiate appropriate candidates for BOX treatment. Patients diagnosed as having a 'semantic deficit' may have a number of explicit problems which can not be detected by traditional testing (see Marshall, 1996). A detailed description of the patients during the course of therapy can give more insight in which aspects of BOX are the most essential for success in which patients.

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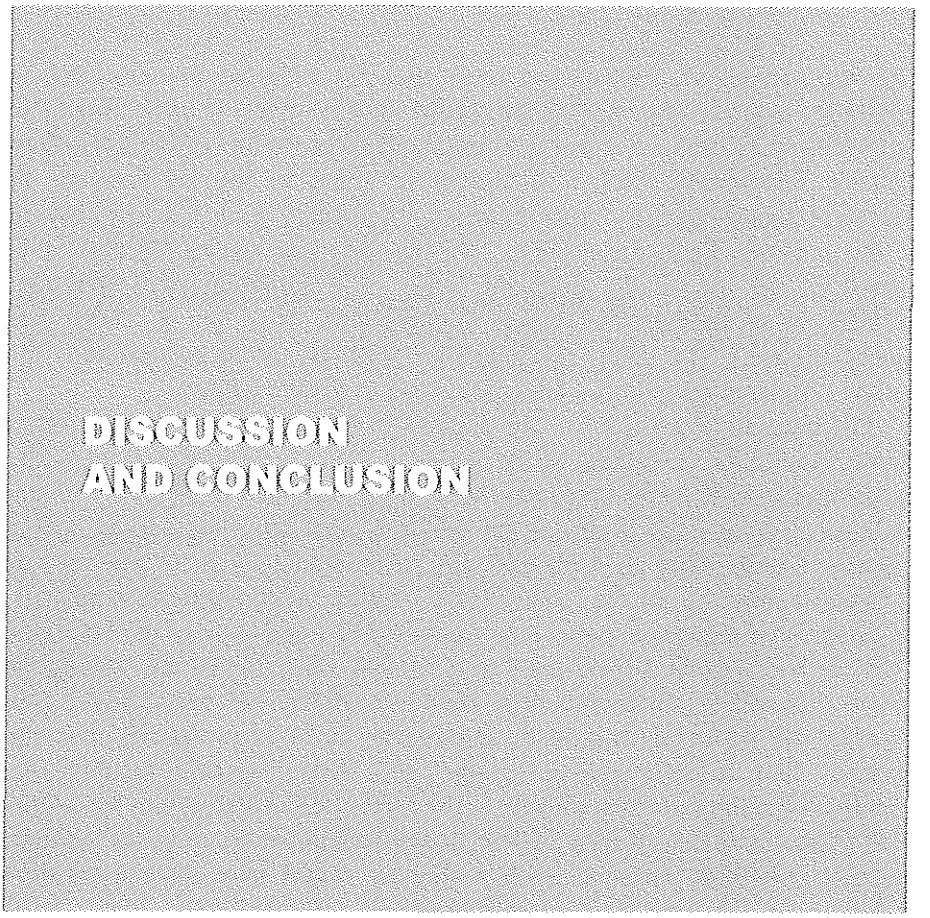

Chapter 1

In chapter 1, a scheme for aphasia diagnosis and therapy is presented. It is argued that there should be a direct linkage between the diagnostic instruments and the therapeutic goals and tools (see also Van Harskamp & Visch-Brink 1991; Visch-Brink et al. 1993). The aim of pre-therapeutic assessment is to decide whether structural therapy is suitable for the patient. The establishment of aphasia type and severity does not provide enough information. For the assignment of therapy to patients with a mild to moderate aphasia, a linguistic level assessment is needed. Their communicative deficit might be due to a disorder on the level of phonology, syntax or/and semantics.

The majority of the therapeutic tools that are reported to be useful in (multiple)-case reports, is directed at the improvement of basic linguistic skills (Edwards 1995). According to the standard procedure of the Rotterdam Aphasia Foundation, such a treatment is given in the initial stage of structural aphasia therapy: 'specification'. Its primary goal is the improving of the patient's linguistic abilities. During the next stages the patient is guided in the use of the linguistic skills in a communicative situation, initially in a therapeutic setting (integration), later on in daily life (generalisation). The better the linguistic abilities, the more resources the patient will have for being an adequate communicative partner.

Dividing aphasia therapy (and diagnosis) into successive stages allows us to evaluate the usefulness of the stages in the overall management of the aphasic patient. The advantage of a scheme as presented in chapter 1 is that the speech therapist is aware of the decisions that have been taken during therapy. Finally such an approach will have impact on the economics of aphasia therapy. In our view, for patients with a moderate to mild aphasia, linguistic level therapy should come first. For the integration of the linguistic skills in a communicative situation, a second stage of therapy should be given, directed to communication. However, it has not been proved yet, whether this order of therapeutic approaches is more preferable than the reverse: first communicative therapy, and then linguistic therapy. An example of communicative therapy is the Supported Conversation for Adults with Aphasia (SCA, Kagan 1998), a conversational training for aphasic patients and their partners. Such a therapy might have such a positive influence on the patient's everyday language communication, that a more artificial linguistic therapy is unnecessary.

However, in chapter 8, the opposite is demonstrated. A linguistic therapy, directed to semantics, is shown to have such a positive impact on everyday language use, measured by the ANELT, that communicative therapy seems to be superfluous.

Chapter 2 and chapter 3

The Melodic Intonation Therapy is 'one of the few language therapy techniques sufficiently formal in presentation to be critically evaluated' by the American Academy of Neurology in 1994. However, a therapy may be effective without knowing why. In chapter 2, the MIT-therapy is applied to a patient is described with recurring utterances, repetitive strings of speech,

in the context of a relatively good comprehension. This combination of symptoms makes this patient an exceptional case. Generally, recurring utterances are indicative for a global aphasia. This patient is classified as a Broca aphasia. The underlying mechanism of recurring utterances in this case might be a combination of a phonological disorder and a verbal apraxia.

A deficit in the selection and ordening of phonemes is combined with a deficit in the programming of articulatory movements, the final stages in the phonological output route. According to Keller (1987), the more peripheral processes are involved in the process of speech production, the more important time constraints are. It has been hypothesised that the patient resorts to a reduction and simplification of articulatory movements, recurring utterances, after his/her unsuccessful phonological and articulatory search. The Melodic Intonation Therapy (Albert et al. 1973) appeared to be able to diminish the repetitive utterances in a relatively short period both in patients with Broca's aphasia and in patients with a global aphasia.

The patient described in chapter 2 is required to repeat sentences with an exaggerated intonational contour. The 'singing' of the sentences is accompanied by handtapping. The disappearance of the recurring utterances in this patient is explained as being due to the effect of the Melodic Intonation Therapy on the verbal apraxia. The temporal scheme of the utterance is supported by rhythmic handtapping and prosody, and therewith the planning of articulatory movements is facilitated. After the application of the MIT, the recurring utterances disappeared and were replaced by adequate recognisable content words with phonemic paraphasias. This immediate and long-term effect is difficult to explain. In addition the relation between speech apraxia and phonological processing is still unclear (Code 1998). However, the dramatic amelioration of spontaneous speech after the application of MIT seems to justify a study in which the effectiveness of the MIT on nonfluent recurring utterances is evaluated in a large group of patients.

In patients with a global aphasia, a phonological disorder is assumed to be one of the underlying mechanisms of recurring utterances too (chapter 3). The linguistic context of the repetitive strings of speech gave a clue for the underlying disorder. Phonological neologisms -the most severe phonemic distortions- were observed in the immediate context of recurring utterances. The neologisms were associated with the occurrence of adequate words. The quality of repetition appeared to have a predictive value for the number of adequate words in spontaneous speech.

Chapter 4

A persistent phonological disorder was found in a patient with a conduction aphasia during a four years follow up, described in chapter 4. Conduction aphasia is characterised by a defective repetition in the context of a relatively adequate spontaneous speech. A short term memory deficit and a phonological disorder are held as responsible for the bad quality of repetition in conduction aphasia. Patients with a repetition conduction aphasia should have mainly a short term memory deficit. The phonological disorder is reported to be a dominant symptom in reproduction conduction aphasia. In the case described in chapter 4, phonemic paraphasias were observed in all tasks requiring the oral production of content words. The auditory short term memory is relatively spared. The patient is classified as a pure example of a reproduction conduction aphasia. A very distinctive characteristic of the patient is his intact written naming and writing to dictation. The paraphasic output is restricted to the speech channel. A selective phonological disorder is assumed to be the primary symptom of his aphasia. During course, comprehension recovered completely. The phonological deficit persisted: the spoken output remained distorted by phonemic paraphasias and neologisms, although the selfcorrections became more successful. A neurolinguistic analysis revealed that the other levels of speech processing were relatively preserved. The patient is exceptional because of the selective and persisting phonological disorder.

Chapter 5 and chapter 6

The semantic system is the core of language processing systems. Disorders in semantic processing may result in semantic paraphasias in speech production and in errors in speech comprehension. In the Netherlands, there is a lack of tests for the diagnosis of verbal semantic disorders in aphasia. In chapter 5, the Semantic Association Test is presented, based on the principles of the Pyramids and Palm Trees Test (Howard & Patterson 1992). The test is developed as a tool for detecting disorders in semantic processing. Measured with the Semantic Association Test, 54% of the aphasic patients appeared to have a verbal semantic disorder. However, only concrete words are involved in the test. The percentage of patients with a verbal semantic disorder will probably turn out to be higher if abstract words were also included (in preparation). Aphasic patients are said to have also difficulties

in visual semantic processing: the functional interpretation of objects. A common assumption is that the semantic system is a unitary component, shared by language and thought (Lyon 1995). According to this assumption, impairments in the processing of words should be accompanied by impairments in visual semantic processing. However, in our group of patients a strong relation between verbal and visual semantic disorders, measured with a word and with a picture version of the Semantic Association Test was not found. In addition to patients with a combined verbal and visual semantic disorder, patients were described with either a verbal or a visual semantic disorder. Verbal semantic tasks were more effective than visual semantic tasks in differentiating between aphasic and non-aphasic brain-damaged patients. There was no relation with aphasia type and only a slight relation with the severity of aphasia, measured with the Token Test. The examination of a linguistic level deficit, semantics, in terms of semantics appeared to be valuable, because it could not be predicted on the base of aphasia type or severity.

The relative independency of verbal and visual semantic processing is confirmed by the process of deterioration during course in patients with a semantic dementia, described in chapter 6. A semantic disorder would be mainly responsible for their deterioration with an equivalent disorder in verbal and visual semantic processing (Snowden et al. 1996). Semantic processing is examined during course in four patients with a 4-year follow-up. The nature of semantic decline during course, measured with the Semantic Association Test showed a different pattern of deterioration of visual and verbal semantics. Visual semantic processing appeared to be more preserved in time than verbal semantic processing. A visual semantic disorder appeared to imply a verbal semantic disorder; the reverse is not true. The inability to categorise pictures according their semantic relationship appeared to be indicative for a severe deterioration of communication. The performance of the patients with a degenerative disease, denoting rather a hierarchical than a coordinative relation between visual and verbal semantic processing might be different from that of the patients with a cerebrovascular disorder because of the course of the atrophic process.

Chapter 7 and chapter 8

The detection of semantic disorders in aphasia has a high priority, because lexical semantic therapy is reported to be one of the most effective therapeutic approaches. In the Netherlands and also abroad there was a need for an elaborate therapeutic program, directed to semantics. Therefore BOX has been developed, a lexical semantic therapy, described in chapter 7. It was assumed as a guiding principle for BOX therapy, that visual and verbal semantics are relatively separate entities and therefore require a modality-specific approach. The main ingredients of the lexical semantic therapy program are written words, sentences and texts. The patient is forced to make decisions about words, depending on the word meaning. Two patients with a chronic aphasia (more than a year post onset) made progress on tasks for semantic processing.Some authors, who discussed the value of BOX, argue for the integration of pictorial material (Shelton 1997; Mazzoni & Vista 1997) to enlarge the group of patients who could benefit from working with BOX and because of its value as an additional stimulus in the decision procedure concerning the meaning of a word. However, it is extremely difficult to express in drawings or photographs all the subtle variations which occur in the verbal component. Only a minor part of BOX, the concrete words, will be suitable for the adding of pictorial material. The advantage of the written input channel is that abstract words can be used. The content of the therapy program exceeds the range of the Semantic Association Test, in which only concrete words are involved. A similar test with abstract words is in preparation.

A preliminary evaluation of the BOX-therapy is described in chapter 8. In a cross-over study, the BOX-therapy is compared with a therapy method on another linguistic level: phonology. Lexical semantic therapy seemed to be more effective for daily life communication, measured with the ANELT (Blomert et al. 1995) than phonological therapy. Progress in daily life communication was found both in patients with a verbal semantic disorder for concrete and for abstract words and in patients with a verbal semantic disorder only in abstract words. This means that BOX can be useful to patients with different degrees of disturbed semantic processing, which was the programme's aim. The main goal of the program is to facilitate semantic processing in patients with a 'general' verbal-semantic disorder (Franklin 1993), which should have a positive influence on semantic processing in new situations (Nickels 1997). Nickels rightly emphasises naming and spontaneous speech as suitable tasks to measure the effect of BOX.

With regard to naming and the spontaneous speech, only a specific error analysis regarding the improvement of phonology and semantics separately might reflect the effectiveness of BOX compared with the phonological programme, which will be done.

Wordfinding disorders and therapy

In this thesis, patients with phonological and semantic disorders were described in detail to gain insight in the nature of their word finding disorder. The analysis had strong implications for the development of semantic and phonological therapy methods. The semantic therapy is described with a preliminary evaluation in chapter 7 and in chapter 8. The phonological therapy is developed more recently (FIKS, Van Rijn et al. in press). The method involved in the cross-over study (Cubelli et al. 1988) did not satisfy our requirements for a high standard phonological therapy.

Phonological disorders and therapy

Concerning phonological disorders, there seems to be a mismatch between the achievement of research in the diagnosis and its implications for therapy. The case described in chapter 4 is one of the patients with specific disorders in the phonological in- and/or output route (a.o. Wilshire & McCarthy 1996). They all are unique which provided the reason to describe them (see Van Harskamp & Visch-Brink 1997). The case of WvW, a pure reproduction conduction aphasia, is exceptional in the sense that his handicap was restricted to his spoken language. The patient suffered from a selective chronic phonological disorder which restricted him considerably in daily life communication. Although the occurrence of phonemic paraphasias is one of the most characteristic markers of aphasia, no phonological therapy method was available in the Netherlands. WvW's explicit explanation at the moments of his blockades together with the observations of the strategies he used, was a starting point for the development of the recently developed phonological therapy programme FIKS. A phonological disorder may also be partly responsible for one of the most severe forms of inadequate language use, recurring utterances (chapter 3 and 4).

The Melodic Intonation Therapy appeared to have the power, even in chronic patients, to resolve the patients of their repetitive utterances. Some essential elements of the Melodic Intonation Therapy f.i. exaggerated stress patterns, are also part of the FIKS therapy.

Semantic disorders and therapy

Disorders in verbal semantic processing appeared to be more closely related with aphasia than disorders in visual semantic processing (chapter 4). The development of the lexical semantic therapy programme BOX was one of our primary goals (chapter 7). Verbal semantic disorders, measured with the Semantic Association Test, occur in 54% of the aphasic patients and have a devastating effect on language production and comprehension. Lexical semantic therapy aims at influencing both language modalities. Its goal is to improve the basic linguistic ability 'verbal semantic processing'. Additional therapy directed towards the improved use of semantic abilities in a communicative situation, f.i. with PACE (Davis & Wilcox 1981) may be required. However, on account of the centrality of the semantic system in speech processing models, lexical semantic therapy may have such a strong effect on every mode of language use, that an additional communicative therapy is unnecessary. The results of the pilot study (chapter 8) were promising in this respect: a generalisation from BOX to everyday language use, measured with the ANELT, was found in four out of eight patients.

Future research

The newly developed lexical semantic therapy BOX aims at the restoration of verbal semantic processing in patients with a 'general semantic disorder' (Franklin 1993; Nickels 1997). The main advantage of BOX is its variation, expressed in the large range of stimuli on word, sentence and text level, and in the different grades of difficulty. The therapist is able to create a situation in which the patient is challenged to perform the tasks. Patients might have different needs. It is up to the therapist to 'taste' how the patient feels about the frequency of shifts to other subsections and/or other degrees of difficulty. This approach which aims at the patient's alertness for verbal semantic processing seems to have the best chance of internalisation.

It is our primary aim to demonstrate the effectiveness of BOX in a large group of aphasic patients. A randomised controlled clinical trial is the most suitable to prove the evidence of the therapy. A multi-centre randomised trial to the effectiveness of BOX is currently running with the participation of over thirty clinical centres in the Netherlands. As the control therapy, FIKS is used (Van Rijn et al. in press), which is more equivalent to BOX concerning variability and degree of difficulty than the phonological programme used in chapter 8. The ANELT, measuring communicative

ability in daily life (Blomert et al. 1995), is the primary outcome measure. Patients with both verbal semantic and phonological disorders are included. During half a year the patients receive either BOX or FIKS for at least one and a half hours a week. All patients will be described on the multidimensional axes system (Van Harskamp & Visch-Brink 1991), see chapter 1, to get an impression of the negative and positive factors, that influence the efficacy of therapy. Pre- and post therapy, detailed information will be available concerning neurological status, neuropsychological disorders and language functions. The most important objective of the study is to establish the value of lexical semantic therapy as a tool to improve the aphasic patient's communicative ability both for the speech therapists and for the physicians who refer the patients.

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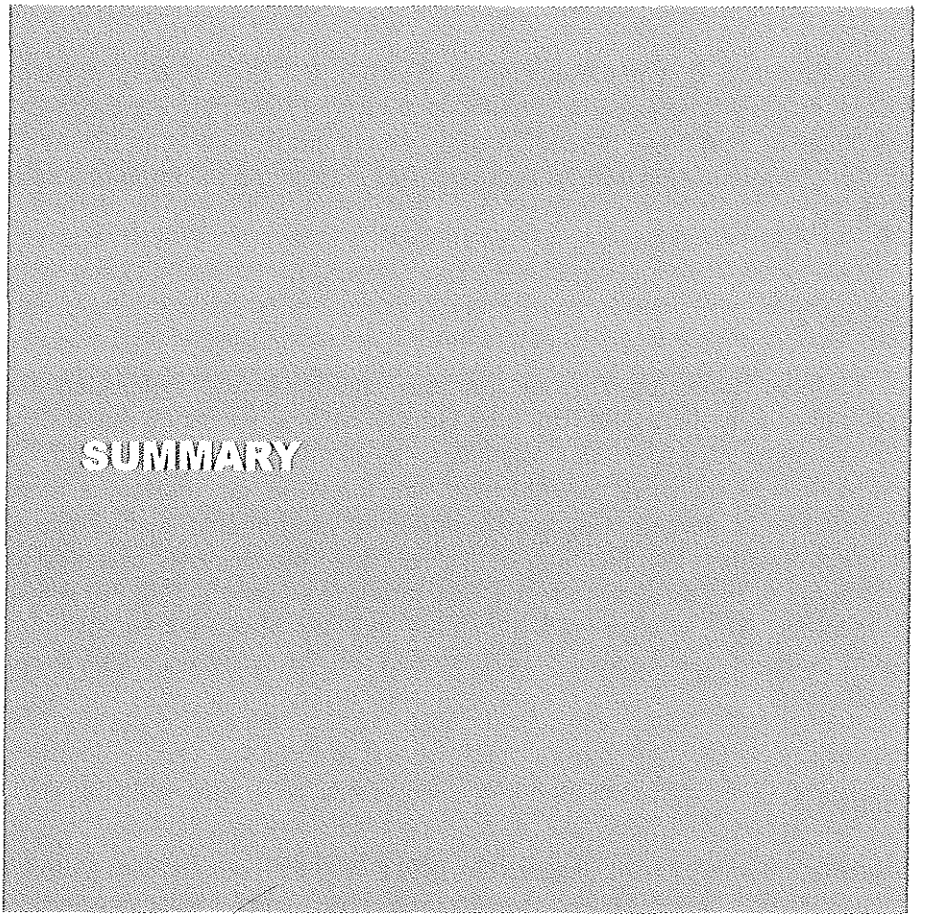

Chapter 1

This chapter gives an outline of the setting for aphasia therapy. Stages in both the diagnostic procedure and the structural therapy are presented. The usefulness of linguistic diagnosis and of linguistic therapy in the flowchart of an aphasic patient is discussed. Aphasia therapy is described as a multidimensional process. A distinction is made between guidance and structural aphasia therapy. For the application of structural therapy patient selection and goal recognition are necessary prerequisites. The delineation of the final therapeutic goal requires a multiaxial description of the patients analogous to the DSM III-R system, reflecting the underlying disease, the language disorder, the concomitant neuropsychological and speech disorders and the responsiveness to therapeutic intervention.

An improvement of communication in real life, the final goal of aphasia therapy, requires a succession of methods in view of the following subgoals: knowledge of verbal and nonverbal skills, communication with an informed partner, communication with an inexperienced partner and communication in real life.

Chapter 2

The Melodic Intonation Therapy did arise intelligible and understandable speech in an aphasic patient with long-lasting nonfluent recurring utterances. The language disorder was classified as a Broca's aphasia with a concomitant apraxia. It's hypothesised that the recurring utterances were generated by a defective phonemic buffer in combination with a motor planning disorder. The blocking of the repetitive utterances is assumed to result from an interaction of the Melodic Intonation Therapy with the apractic disorder. The exaggerated intonation and the rhythmic handtapping should support the temporal organisation of the patient's articulatory movements.

Chapter 3

Recurring utterances were observed in 21% (N=18) of patients with a global aphasia (N=85). Besides their recurring utterances, eight patients appeared to have adequate content words in the spontaneous speech. A relatively good performance in repetition was a predictor for this communicative ability. The presence of adequate words in repetition was associated with the occurrence of neologisms. This association was explained as being an indicator for a segmental phonological disorder as one of the underlying mechanisms of RU in global aphasia. The severity of aphasia, measured by the Token Test, was neither related with the occurrence of recurring utterances, nor with the performance on repetition and the presence of adequate content words in the spontaneous speech.

Chapter 4

A patient with reproduction conduction aphasia has been described with a four-year-follow-up. The dominant symptom is: a vast amount of phonological distorted content words in the context of a relatively spared auditory verbal Short Term Memory. An aspect in which our patient deviates from the cases, described in the literature, is the preserved writing of content words. The dysfunctioning of the phonemic output buffer seems to be for a large part responsible for the aphasic symptoms of the patient. There is some evidence that the dissociation between the graphemic and phonemic output route occurs at the postlexical level. During course the patient evolves from repetition conduction aphasia to reproduction conduction aphasia. Four years post onset the symptoms of reproduction conduction aphasia are still present, which is ascribed to the involvement of the parietal cortex.

Chapter 5

Measured by the Semantic Association Test, impairments in lexical and visual semantic processing were specific for aphasic left-brain-damaged patients (N=78) as opposed to right-brain-damaged patients (N=10) and normals (N=96). The performance on the visual and verbal Semantic Association Test was not influenced by the aphasia type. Only the results of the verbal Semantic Association Test were slightly related with the severity of aphasia, measured by the Token Test, and with comprehension, measured by the Aachener Aphasia Test. The linguistic abilities did not predict the performance on the visual Semantic Association Test. Both patients with a selective disorder in visual semantic processing and in lexical semantic processing were observed. The main conclusion was that visual and lexical semantic processing seems to be separate entities, which can be selectively disturbed in aphasia. A test for lexical semantic processing should be part of the diagnostic assessment battery. Disorders in visual semantic processing seem to be additional symptom of left-hemispheric damage.

Chapter 6

The deterioration of visual and lexical semantic processing, measured by the Semantic Association Test is observed in a 4-years follow-up of four patients with a semantic dementia. The patterns of decline in both SAT-versions were different. Two patients showed to have a stronger decrease in lexical semantic processing than in visual semantic processing. A correlation with the Token Test, a measure for the severity of aphasia, was only found for the verbal Semantic Association Test. The observations give support for a hierarchical relation between the lexical and visual semantic system in this group of patients. Visual semantic processing in semantic dementia seems to be a more elementary capacity than lexical semantic processing: a bad performance on the visual Semantic Association Test seems to be a sign of grave cognitive deterioration.

Chapter 7

A lexical semantic therapy 'BOX' has been developed, focusing on the interpretation of written words without reference to pictures. Therapy tasks consist of judgement of semantic relatedness between words separately, words in sentences and words in texts. The use of written words has the benefit that the dimension concrete-abstract may be built in, fulfilling a need for patients with moderate to mild forms of aphasia. Results of a pilot study of two patients (a 79-year-old male and a 71-year-old female) are presented. The findings indicate that the patients' improvement in lexical semantic abilities could be established after the application of BOX in the chronic stage of the aphasia (one year post onset). The improvement is measured by the Semantic Association Test and by a spontaneous speech analysis.

Chapter 8

In a cross-over design in which a lexical semantic therapy program (BOX) is compared with phonological-oriented therapy, both therapeutic methods are applied to eight patients, (more than) one-year post CVA. The performance of the patients was measured by the AAT, ANELT, and phonological and semantic tasks. After BOX, four patients reached a significant improvement on verbal communication in everyday language situations. BOX appeared to be useful for aphasic patients with different degrees of disturbed lexical-semantic processing, with varying types of aphasia, and different severity grades.

Samenvatting

Er zijn maar weinig gerandomiseerde onderzoeken bekend, waarbij de effectiviteit van afasietherapie onderzocht wordt. Het resultaat is in het algemeen negatief. In deze onderzoeken wordt de therapie van vrijwilligers vergeleken met die van logopedisten of behandelde met niet-behandelde patiënten. De taalstoornis wordt niet geanalyseerd, de gehanteerde therapie is onbekend, er wordt geen informatie gegeven over de patiëntenselectie. Een evaluatie van afasietherapie heeft alleen zin als dit gebeurt bij patiënten die een specifieke welomschreven therapie hebben gekregen die aansluit bij een diagnose die verder gaat dan de traditionele afasietypologie. Het uiteindelijke herstel moet uitzicht bieden op een betere communicatie in het dagelijks leven. Dit proefschrift is een voorbereiding tot een dergelijk onderzoek.
Afasie is een taalstoornis. De verschillende linguïstische niveau's waarop de taal gestoord kan zijn: semantiek, fonologie en syntaxis, zijn onlosmakelijk met de diagnostische procedure en met de te hanteren therapie verbonden. Dit proefschrift richt zich op de eerstgenoemde twee niveau's. Semantische en/of fonologische stoornissen zijn desastreus voor de woordvinding, een steeds weer terugkerende blokkade voor de afasiepatiënt.
De plaats van de linguïstische diagnose en - therapie wordt geschetst in hoofdstuk 1. Om meer inzicht te krijgen in de essentie van een fonologische stoornis, worden in hoofdstuk 2 en 4 twee patiënten uitvoerig beschreven. Een ernstige vorm van fonologisch derailleren, zinloze repetitieve uitingen, worden beschreven in hoofdstuk 3.

In een groepsstudie werd vervolgens het voorkomen van semantische stoornissen bij afatische patiënten nagegaan door middel van een nieuw ontwikkelde test (hoofdstuk 5). Het verloop van semantische stoornissen bij een degeneratieproces gaf meer inzicht in de achtergronden van een dergelijke stoornis. (hoofdstuk 6).

Op basis van bovengenoemde observaties werden twee therapiemethoden ontwikkeld, een fonologisch en een lexicaal semantisch therapieprogramma. Beide programma's worden nu geëvalueerd in het kader van de Rotterdamse Afasie Therapie Studie, NWO-Chronisch Zieken. De lexicaal semantische therapie wordt in dit proefschrift uitvoerig toegelicht met twee pilot studies (hoofdstuk 7 en 8)..Deze therapie lijkt zinvol vanwege een gunstig effect op de alledaagse communicatie. De fonologische therapie wordt in dit proefschrift niet besproken.

Hoofdstuk 1

De plaats van afasietherapie in het geheel van de zorg voor de afatische patiënt wordt hier beschreven. De pre-therapeutische fase kent diverse diagnostische niveau's, waarbij de informatie van verschillende disciplines: neurologie, neuropsychologie, logopedie en linguïstiek samenkomt. De doelstelling van de therapie is gebaseerd op een karakteristiek van de patiënt op een assensysteem, analoog aan de DSM III-R methode. Op AS I wordt het afasiesyndroom weergegeven en eventuele bijkomende spraak-stoornissen, op AS II de fysieke conditie van de patiënt, op AS III de neuropsychologische en neurologische stoornissen, op AS IV de psychosociale stressors en op AS V de sociale omstandigheden waarin de patiënt verkeert en zijn persoonlijkheidskenmerken. De therapeutische fase kent eveneens verschillende dimensies. Een eerste onderscheid wordt gemaakt tussen begeleiding en structurele taaltherapie. De verbetering van de functionele communicatie, het uiteindelijke doel van structurele taaltherapie, vereist een opeenvolging van therapeutische methoden met de volgende subdoelstellingen: kennis van verbale en nonverbale basisvaardigheden, communicatie met een deskundige, communicatie met niet-deskundigen, communicatie in het dagelijks leven.

Hoofdstuk 2

In dit hoofdstuk wordt een voorbeeld gegeven van de succesvolle toepassing van de Melodische Intonatie Therapie bij een patiënt met een chronische afasie. Na een kortdurende toepassing van deze therapie verandert het zinloze repetitief taalgebruik van deze patiënt (recurring utterances) in uitingen met herkenbare inhoudswoorden. Het functionele taalgebruik komt op gang; de patiënt kan zelfstandig beter communiceren. De onderliggende stoornis wordt gekarakteriseerd als een Broca afasie met een bijkomende verbale apraxie, een stoornis in het programmeren van de articulatoren. Recurring utterances behoren eerder bij een globale afasie dan bij een afasie van Broca. Op basis van een linguïstische analyse van het taalgebruik voor en na de therapie wordt verondersteld, dat de recurring utterances bij deze patiënt ontstaan uit een combinatie van een stoornis in de foneemselectie en een verbale apraxie. Verondersteld wordt dat de gunstige werking van de Melodische Intonatie Therapie vooral de verbale apraxie betreft. Het overdreven intoneren van zinnen en het ritmische bewegen van de hand,

essentiële kenmerken van deze therapie, kunnen de temporele ordening van de articulatorische bewegingen faciliteren.

Hoofdstuk 3

Het voorkomen van recurring utterances wordt nagegaan bij een groep afatische patiënten (N=267), aangemeld bij de Stichting Afasie Rotterdam. Deze taaluitingen worden uitsluitend geobserveerd bij patiënten met een globale afasie en wel bij 18 van de 85 patiënten. Bij acht patiënten van deze groep worden naast de recurring utterances adequate inhoudswoorden in de spontane taal geobserveerd. Er blijkt geen verband te bestaan tussen de ernst van de afasie, gemeten met de Token Test, en het voorkomen van recurring utterances. Ook de kwaliteit van het nazeggen en het voorkomen van adequate inhoudswoorden in de spontane taal is niet gerelateerd met de Token Test resultaten

De kwaliteit van het nazeggen blijkt een goede predictor te zijn voor de aanwezigheid van functioneel taalgebruik in een interviewsituatie. Een andere bevinding is dat de aanwezigheid van goede inhoudswoorden bij het nazeggen geassocieerd is met het voorkomen van neologismen in dezelfde taak. Dit geeft aanleiding te veronderstellen dat een stoornis in de foneemselectie een van de onderliggende oorzaken van het ontstaan van recurring utterances kan zijn.

Hoofdstuk 4

In dit hoofdstuk wordt een casus met een conductie afasie beschreven met een follow-up van 4 jaar. Tijdens het verloop evolueert de patiënt reeds na een half jaar van een repetitie conductie afasie naar een reproductie conductie afasie. Een dergelijke afasie wordt gekarakteriseerd door fonematische parafasieën in de gesproken taal in de context van een redelijk goed taalbegrip en auditief verbaal korte termijn geheugen. De goede kwaliteit van het schrijven echter maakt de patiënt bijzonder. De stoornis wordt toegeschreven aan de defectieve werking van de fonologische outputbuffer, waar de selectie en ordening van fonemen plaatsvindt. Er lijkt een dissociatie te bestaan tussen de fonologische en grafematische outputroute op postlexicaal niveau. Vier jaar na onset zijn de symptomen van een reproductie conductie afasie nog steeds aanwezig.

Dit wordt toegeschreven aan de betrokkenheid van de parietale cortex bij de lokalisatie van de lesie.

Hoofdstuk 5

Om een semantische stoornis bij afatische patiënten te kunnen vaststellen, is de Semantische Associatie Test ontwikkeld, gericht op de detectie van verbale en visuele semantische stoornissen.. De test wordt afgenomen bij afatische patiënten met een lesie in de linkerhemisfeer (N=78), niet-afatische patiënten met een lesie in de rechterhemisfeer (N=10) en bij controle proefpersonen zonder hersenbeschadiging (N=96). Gemeten met deze test, blijken stoornissen in de visuele en verbale semantische verwerking specifiek te zijn voor de afatische groep. Meer dan de helft van de patiënten heeft hier last van. De aanwezigheid van semantische stoornissen is niet gerelateerd met het type afasie, en slechts in geringe mate met de ernst van de afasie. Wel is er een correlatie tussen een verbale semantische stoornis en het taalbegrip. De linguïstische vaardigheden zijn minder gerelateerd met de visuele semantische verwerking. Selectieve stoornissen in hetzij de verbale, hetzij de visuele semantische verwerking komen beide voor. Het lijken aparte componenten te zijn, die bij een afasie selectief kunnen worden aangetast. Onderzoek naar een verbale semantische stoornis zou in een diagnostische afasie testbatterij thuishoren. Stoornissen in de visuele semantische worden eerder gezien als een additioneel symptoom van linkerhemisfeer letsel.

Hoofdstuk 6

Om meer inzicht te krijgen in de relatie tussen de visuele en de verbale semantische component, is longitudinaal onderzoek verricht tijdens een degeneratie proces. Vier patiënten met een semantische dementie worden gedurende vier jaar vervolgd. De patronen van achteruitgang, gemeten met de visuele en verbale Semantische Associatie Test zijn verschillend. Bij twee patiënten blijft de visuele semantische verwerking langer gespaard dan de verbale semantische verwerking. De ernst van de afasie, tijdens het verloop gemeten met de Token Test, blijkt alleen gerelateerd te zijn met de verbale semantische verwerking. Deze observaties passen bij een hiërarchische relatie tussen het verbale en het visuele semantische systeem.

De visuele semantische verwerking lijkt een meer elementair vermogen te zijn dan de verbale semantische verwerking: slechte resultaten bij de visuele Semantische Associatie Test lijken te duiden op een ernstige cognitieve achteruitgang.

Hoofdstuk 7

In dit hoofdstuk wordt een lexicaal semantische therapie voor afatische patiënten beschreven (BOX), gericht op de interpretatie van geschreven woorden zonder afbeeldingen. De therapeutische taak bestaat uit het beoordelen van de semantische betrekkingen tussen woorden afzonderlijk en tussen woorden in zins- en tekstverband. Het gebruik van geschreven woorden zonder afbeeldingen heeft het voordeel dat de dimensie concreet/abstract kan worden ingebouwd, hetgeen in een behoefte voorziet voor patiënten met een matige tot lichte vorm van afasie. De resultaten van een pilot studie worden gepresenteerd. Het programma is toegepast bij twee patiënten met een chronische afasie, meer dan een jaar post onset. Bij beide patiënten is een vooruitgang gevonden in de semantische verwerking, gemeten met de Semantische Associatie Test en met een Spontane Taalanalyse.

Hoofdstuk 8

Het lexicaal semantisch therapieprogramma BOX wordt geëvalueerd in vergelijking met een fonologisch therapieprogramma. Beide therapieprogramma's worden toegepast in een cross-over design bij acht patiënten met een chronische afasie (meer dan een jaar post onset). Voor en na iedere therapie worden de patiënten getest met de Akense Afasie Test, de ANELT, een maat voor de taalvaardigheid in alledaagse situaties en met fonologische en semantische taken. Alleen na de toepassing van BOX, de lexicaal semantische therapie, wordt een verbetering gevonden in de alledaagse communicatie. BOX lijkt geschikt voor afatische patiënten met een verschillend type afasie van een verschillende ernstgraad en met verschillende gradaties van lexicaal semantische stoornissen.

List of publications related to the studies described in this thesis

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This thesis

Chapter 1
See list of publications

Chapter 2
Revised version submitted to
Journal of American Speech and Language Pathology

Chapter 3
See list of publications

Chapter 4
Revised version submitted to
Brain and Language

Chapter 5
Submitted

Chapter 6
See list of publications

Chapter 7
See list of publications

Chapter 8
Revised version submitted to
Aphasiology

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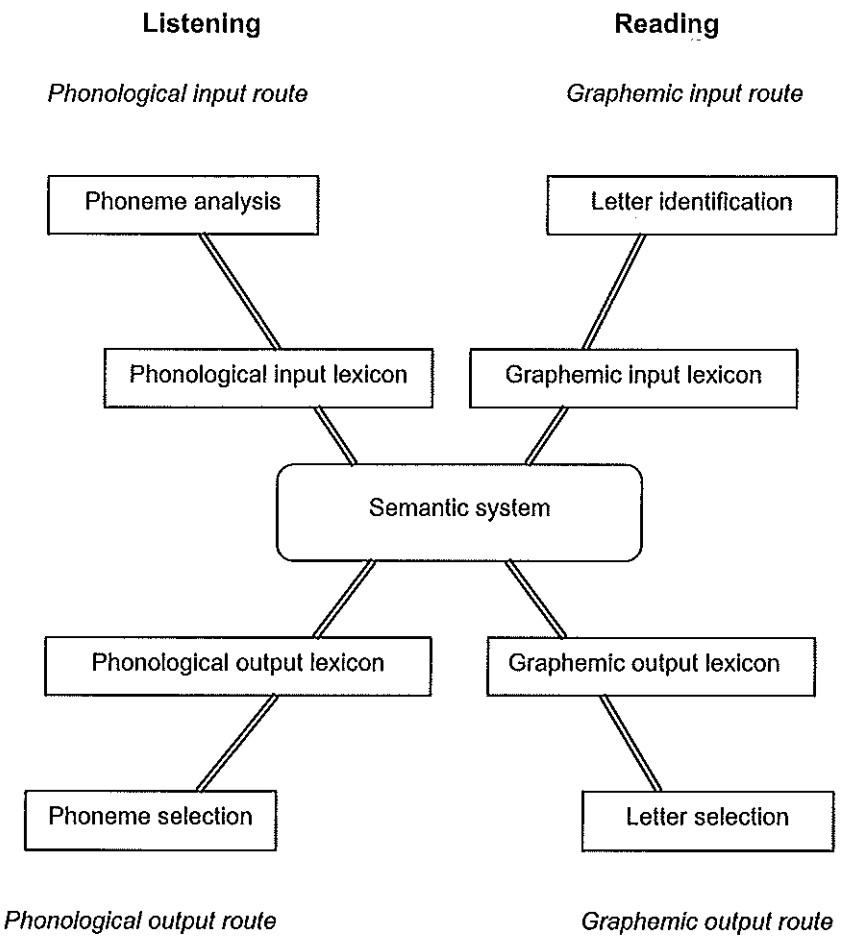
Curriculum vitae

Evy Brink werd een tijd geleden in Amsterdam geboren. Zij leerde in Nederland en België en deed in 1965 staatsexamen Gymnasium α.
Hierna studeerde zij Nederlandse Taal- en Letterkunde aan de Universiteit van Amsterdam, waar zij in 1969 kandidaatsexamen deed. Op weg naar het doctoraal examen zwaaide zij om naar Algemene Taalwetenschap, toen een nieuwe studierichting. In 1973 studeerde zij af in theoretische en toegepaste taalwetenschap.
Inmiddels trouwde zij met Leo Visch. In 1971 werd Valentijn geboren
In 1973 kwam Evy Visch-Brink in dienst van het Academisch Ziekenhuis Rotterdam – Dijkzigt bij de afdeling neuropsychologie onder supervisie van F. van Harskamp, neuroloog. In afwachting van een ZWO-onderzoek aldaar liep zij gedurende een half jaar stage in Boekarest bij Dr. Voinescu, neuroloog en gespecialiseerd in afasie.
Na het ZWO-onderzoek (onderwerp: Token Test) kwam zij in vaste dienst (0.5) bij de afdeling neurologie.
In 1976 werd Guido geboren.
In 1975 startte zij als docent afasiologie bij de opleiding logopedie (nu Hogeschool Rotterdam).
In 1980 werd Eva geboren.
In 1986 heeft zij samen met Roelien Bastiaanse en Zsoka Bonta de Vereniging voor Klinische Linguïstiek opgericht, waarvan zij 10 jaar voorzitter is geweest. Zij is kernredactielid van het tijdschrift Stem- Spraak en Taalpathologie.
Sinds 1993 is zij coördinator van de post-HBO opleiding Neurologische Taal- en Spraakstoornissen en sinds 1996 extermal examiner van de Ms. Sc. Course Neuropsycholinguistics, University of Newcastle upon Tyne.

Speech processing model



Main routes in language processing model