Word Stress Production in Aphasia

A.M. van de Zande

June 16, 2006

Acknowledgements

This thesis could not have been realised without the support of a range of people in- and outside of the linguistics department of Utrecht University.

First, my word of gratitude goes to my two supervisors; Esther Janse and Elise de Bree. Esther for her great support and useful tips for improvement throughout all steps of this project. Elise for her expert guidance on the encoding of the data, and for sharing her insights into metrical phonology in combination with aphasia and dyslexia.

Subsequently, my word of gratitude goes to Hugo Quené, especially for providing critics and tips on the statistical analyses.

Special thanks are due to Eline Westerhout for her useful advice on LaTeX. Co-working in the beginning of our projects was fun and fruitful; I also refer to our 'Super Mario experiences' during the lunch breaks. Initially, we started a project on aphasia together, but our master-goals proved to be too different to realise in one project. Therefore, we decided to continue to work on our own projects.

Without the participation of all aphasic patients from the Aphasia Rehabilitation Centre in Capelle aan den IJssel this project could not have been realised. Therefore, I gratefully acknowledge their participation in the Aachen Aphasia Test and the experiments, especially because it demanded a lot of their time and energy. Furthermore, I would like to thank Dr. Mia Verschaeve, clinical linguist at the Aphasia Rehabilitation Centre for her support during the testing. Janneke Wolters, speech and language pathologist, deserves special mention in connection with carrying out the Aachen Aphasia Test. She also introduced Eline and me at the Aphasia Rehabilitation Centre, so we were able to test patients there.

I gratefully acknowledge the participation of all control subjects.

Last but not least, I would like to thank all members of the thesis-seminar for providing critical assessments and interesting points of view during my presentations; chairman Sieb Nooteboom, Hugo Quené, Gerrit Bloothooft, Esther Janse, Willemijn Heeren and Frank Wijnen.

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Chapter 1

Introduction and theoretical background

1.1 Framework and motivation

The current study is focused on stress assignment to nonsense words in non-fluent aphasic language of Dutch. The system of Dutch stress has been thoroughly studied in the literature. However, stress production in aphasic language has not been covered completely so far. A few case-studies on stress assignment in aphasic language (Janssen, 2003; Galante et al., 2000; Laganaro et al., 2002; Cappa et al., 1997) indicated aphasic patients have problems reproducing marked, irregular stress patterns. The involved patients systematically produced overregularisations, if marked stress patterns had to be read aloud and or repeated. However many questions remain unanswered.

This section addresses the theoretical background that forms the basis for this study. In section 1.3 the theoretical background on Dutch stress assignment in general is provided.

Levelt et al. (1999) assume that lexical stress is not stored in the lexicon for all words in stress-assigning languages. In speech production, the most frequent stress pattern of the language is assigned by default on a sub-lexical level. Thus, stress is not stored for words with an unmarked, regular stress pattern. The metrical information is only stored and retrieved for words with marked, infrequent lexical stress patterns. On the other hand, the option (Schiller et al., 2006) that all stress patterns of real words are stored in the lexicon cannot be ruled out either. Only to new words (as in nonsense words) stress would be assigned based on sub-lexical information.

The evidence whether metrical stress is computed or stored is inconclusive at this moment (Schiller et al., 2006). However, to distinguish between stress patterns that can be derived by rules; unmarked stress, and stress patterns with more complex stress patterns; marked stress, will be extremely valuable for this study. In the studies as discussed below this distinction is clearly present.

Galante et al. (2000) investigated stress assignment in a single patient with primary progressive fluent aphasia and surface dyslexia. The task the patient participated in contained real and nonsense words that had to be read aloud. No stress problems in spontaneous speech were observed in this patient. During the reading of nonsense words that resembled real Italian words with antepenultimate stress (sumile, /symilə/ resembling símile, /'symilə/; similar) the patient produced dominant penultimate stress (sumíle, /sy'milə/). These kinds of overregularisations were also present in the reading task with real words.

A similar study was performed by Janssen (2003). Two German patients with primary progressive aphasia and surface dyslexia participated. In this study stress assignment to words of bi-, tri-, and quadrisyllabic structures was under investigation.

Patients with surface dyslexia are said to be impaired in retrieving lexical information. This implies that words with lexically specified stress patterns are sensitive to regularisation. Janssen (2003) found that penultimate and final stress patterns were overregularised based on syllable structures.

Next to reading, Laganaro et al. (2002) investigated stress assignment of a non-fluent aphasic patient in real word repetition and naming. The error pattern found in their patient consisted of regularisation of marked stress patterns. Laganaro et al. (2002) concluded that the problems with marked word stress were due to impaired access to stress representations of irregularly stressed words.

Overregularisations in different tasks involving reading, repetition and naming in aphasic language were reported by Laganaro et al. (2002); Janssen (2003). In addition, Cappa et al. (1997) reported a case of an Italian aphasic patient that systematically produced stress regularisations in spontaneous speech. In this patient, stress was selectively impaired in speech production. Their study involved spontaneous speech, reading aloud, and word naming tasks. In all tasks, errors were of a similar kind; stress shifts in favour of unmarked stress. No regularisations were found for predictable stress; which in Italian is the heavy penultimate syllable. If a heavy penultimate syllable was not present, regularisations occurred. Because regularisations occurred also in a naming task in Cappa's patient, these regularisations cannot entirely be due to problems with the lexical reading route, but more to the non-occurrence of lexical retrievement. The stress impairment concerned words in which stress was unpredictable based on syllabic structure, and was equally severe in naming and reading aloud.

The results of Janssen (2003) favoured the theory that German is a quantity-sensitive language, implicating that syllable structure determines the location of stress. Additionally, the results indicated that not only the penultimate stress location is dominant in German. Dutch also has a quantity-sensitive system based on syllable structures (discussion in the next section). It is not clear whether Dutch aphasic patients would also produce overregularisations. Are possible stress assignment difficulties related to retrieving lexical information, or do marked, marked patterns also cause problems if lexical access is not involved? Would aphasic patients produce overregularisations to marked, irregular nonsense words without lexical access? This study investigates this matter in more detail.

1.1.1 Predictions

The results of all studies discussed in this section, show that marked, irregular stress patterns are more 'error-sensitive' in aphasia than unmarked, regular stress patterns. In Dutch marked stress patterns a set of more complex phonological rules, deviant from unmarked stress rules, determines the degree of markedness (discussion in the next section).

Unmarked, phonological stress rules are still intact as indicated by overregularisations observed during reading, naming and repetition of words. It must be noted, that the studies addressed in this section mainly focused on stress assignment to real words. In this study, nonsense words are presented to the subjects. In reproduction of nonsense words no lexical activation interferes, so stress assignment can be investigated separately.

If problems occur with adhering to marked targets, aphasic patients are expected to produce overregularisations. On the other hand, if overregularisations result from assignment of unmarked stress rules, no problems are expected with reproduction of unmarked stress during nonsense word repetition.

Laganaro et al. (2002) claimed that the regularisations were due to impaired lexical access, during repetition and reading of marked stress patters. However, if regularisations also occur during reproduction of nonsense words with marked stress, the chance that lexical access causes regularisations is minimalised. No familiar stress pattern is attached to nonsense words. Therefore, in a reading task cannot be measured how well subjects adhere to specific patterns of markedness.

If considering the theories of Levelt et al. (1999); Schiller et al. (2006), the problem with marked stress lies in storing and retrieving stress markings in irregularly stressed real words. The question whether all stress patterns are retrieved from the mental lexicon or that unmarked stress is computed based on sub-lexical information will not be answered in this study. In order to investigate this matter, real words should be presented to the subjects. However, this study focuses on the reproduction of nonsense words.

The general aim of the present study is to improve the knowledge on aphasic language. More specifically, this study aims to gain insight in the way Dutch subjects with a non-fluent form of aphasia assign stress to nonsense words. Is stress production impaired in Dutch non-fluent aphasia or not, are marked stress types more problematic for these patients than for subjects without aphasia? If marked stress types are indeed more difficult to reproduce in a repetition task, will the aphasic patients produce overregularisations? Additionally, this study investigates what kind of changes the subjects may produce in syllable structure, word length, and stress pattern.

First, the subjects participate in a nonsense words reading task. This task investigates whether the aphasic patients assign stress based on sub-lexical stress rules. The second task of this study will involve repetition of nonsense words. The main hypothesis of the current study based on the discussed literature is investigated in this task:

The aphasic patients involved in this study will overregularise marked stress patterns more frequently *than the control subjects will. Changes in marked stress patterns are expected to lead to more unmarked stress patterns.*

1.2 Dutch stress assignment

1.2.1 Introduction

This section will provide a theoretical background for the current study on stress assignment to Dutch underived words. Dutch stress assignment is mainly predictable; stress is always placed at the right word edge to one of the last three syllables of the word. This is called the three-syllable window (Nouveau, 1994). Additionally, syllable structure determines the stress location which makes Dutch a quantity-sensitive language. However, lexical variation is allowed in Dutch, because some stress patterns are deviant from unmarked stress patterns. The next section, 1.3.2, discusses what the phonological generalisations are for unmarked stress in Dutch. Subsequently, section 1.3.3 analyses which kinds of marked, recessive stress patterns are tolerated in Dutch, and which violations of the dominant stress rules make a stress pattern prohibited.

1.2.2 Unmarked stress patterns in Dutch

This section first addresses the properties of the syllable structures, before discussing generalisations of unmarked stress assignment. The internal syllable structure determines the weight of the syllable in quantity-sensitive languages such as Dutch.

A syllable can be divided into two segments that are independent of each other; an onset and a rhyme. The onset is optionally present and contains one or more consonants. The rhyme determines the weight of the syllable. The internal structure of the rhyme consists of a nucleus; a short or a long vowel, and a coda; one or more consonants.

If a rhyme only consists of a long vowel and no coda (VV), the weight of the syllable is Light /-a/. If a rhyme contains a short vowel and a coda (VC), the syllable is Heavy /-ɑn/. Additionally, if a syllable contains a short vowel and a branched coda (VCC), meaning two or three consonants as in /-ɑst/, or a long vowel (a branched nucleus) and a coda /-at/, the syllable is Superheavy. If a syllable ends with a diphthong (V_iV_j) /-ɑu/ it behaves like a superheavy syllable.

The generalisations to Dutch stress assignment to underived words are the following (Nouveau, 1994). To these restrictions, almost no exceptions exist in the Dutch lexicon.

1. Main stress always falls within a three-syllable window at the right word edge. The options are therefore final stress, as in lédikant /ledi'kɑnt/; bedstead, penultimate stress, and as in propagánda /propa'xɑnda/; propaganda. Subsequently, antepenultimate stress falls on the third syllable from the right word-edge as in Jerúzalem /je'ryzalɛm/; Jerusalem. Primary stress locations further to the left are prohibited.

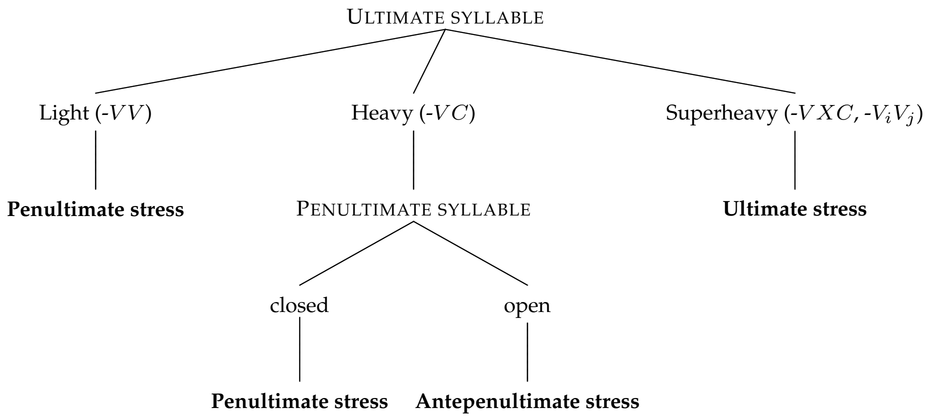
2. Main stress is never located on a syllable that contains a schwa /ə/. Per example vógel /'voxəl/; bird. Primary stress is located at the preceding syllable if that syllable contains a consonant.

3. Main stress is restricted to a two-syllable window in case of occurrence of a closed penultimate, prefinal syllable. A closed syllable contains a short vowel and a consonant; VC. In disyllabic words that end in open long vowel (VV) and closed syllables (VC), penultimate stress is dominant as in robót /'robot/; robot.

   In trisyllabic words the dominant patterns are dependent on the rhyme structures of the final and penultimate syllable. In case of a VV-final syllable penultimate stress is dominant, and in case of a VC-final syllable antepenultimate stress is dominant, only if the penultimate syllable is open. However, if the penultimate syllable is closed, penultimate stress is dominant in VC-final words. An example is báriton /'baritɔn/; baritone. Antepenultimate stress as in Pánama,/'panama/ only occurs if the penultimate syllable is open.

4. In VXC-final words (where X is either a vowel or a consonant) which are words ending with a Superheavy final syllable, final stress is the dominant pattern as in ledikánt /ledi'kɑnt/; bedstead. In addition, final diphthongal (V_iV_j) syllables are categorised as Superheavy syllables, i.e. kénau /'kenɑu/; strapper.

The figure below represents the metrical rules to which unmarked stress is bounded as stated above. It displays the dominant stress patterns of Dutch based on the internal structure of the rhyme of the final and/or prefinal syllable.



1.2.3 Markedness categories of Dutch

This section addresses the hierarchy of patterns that can be found in the Dutch lexicon based on frequency and lexical markings. Nouveau (1994) stated that mispronunciations often lead to regularisations of stress patterns as in for instance Bogotá, /bogo'ta/ realised as Bogóta, /bo'gota/. Additionally, in newly formed words a clear tendency exists towards dominant stress patterns (Nouveau, 1994). However, other stress patterns than dominant patterns are allowed if the major restrictions as stated in the previous section have not been violated. Exceptions to the generalisations as provided in the figure above are called recessive patterns. As proposed by Nouveau (1994) a markedness ranking based on regularity can be established. This regularity ranking is displayed in the next table with syllable structure and stress location.

The first pattern represents the unmarked, dominant stress pattern, followed by a second marked pattern and a third, heavily marked pattern. The partition of the patterns resulted from frequency evidence, new word formation and stress- mispronunciation by Nouveau (1994). Table 1.1 illustrates these markedness patterns.

Syllable structures	(A) Unmarked stress or regular stress	(B) Marked stress or irregular stress	(C) Heavily marked stress or residual stress
X-VV-VV	Penultimate	Antepenultimate	Final
X-VV-VC	Antepenultimate	Final	Penultimate
X-VC-VX	Penultimate	Final	
X-VV-VXC	Final	Antepenultimate	

Table 1.1: Syllable structures and stress

In addition, words that reflect the patterns as displayed in table 1.1 in the Dutch lexicon are provided with their translation in table 1.2

A = unmarked stress		**B = marked stress**		**C = heavily marked stress**	
/'pɑsta/ pásta	pasta			/ka'do/ cadéau	present
/bi'kini/ bikíni	bikini	/'ɛskimo/ éskimo	Eskimo	/para'ply/ paraplú	umbrella
/a'xɛnda/ agénda	agenda			/frikɑn'do/ fricandéau	fricandeau
/tɛlə'visi/ televísie	television	/a'merika/ Amérika	America	/kavalə'ri/ cavaleríe	cavalery
/'robɔt/ róbot	robot	/bɑ'lɔn/ ballón	balloon		
/'ɑnanɑs/ ánanas	bikini	/kroko'dɪl/ krokodíl	crocodile	/se'lebɛs/ Celébes	Celebes
/ka'rɑktər/ karákter	character	/bɔmbɑr'dɔn/ bombardón	-		
/jə'ryzalɛm/ Jerúzalem	Jerusalem	/mario'nɛt/ marionétte	marionette	/kata'marɑn/ catamáran	catamaran
/ba'nan/ banáan	banana	/'lɪxam/ líchaam	body		
/ɪn'sɛkt/ inséct	insect	/'ɛilɑnt/ éiland	island		
/telə'fon/ telefóon	telephone	/'ojəvar/ óoievaar	stork	/pro'metœs/ Prométheus	Prometheus
/presi'dɛnt/ presidént	president	/'olifɑnt/ ólifant	elephant	/a'pɛndɪks/ appéndix	appendix
/vɑl'lɛi/ valléi	vally	/'kenɑu/ kénau	strapper		
/burdə'rɛi/ boerderíj	farm	/'krakatɑu/ Krákatau	Krakatau		

Table 1.2: Dutch words with their stress patterns

A feature of Dutch stress, extrametricality, plays an important role in categorising stress patterns in A-, B- or C-types of stress. Extrametricality accounts for the observation that stress may be on the third syllable from the edge in Dutch, which has a binary stress system, if the final syllable is invisible, i.e. extrametrical (Nouveau, 1994). For instance in the word báriton, /'baritɔn/; baritone, the final syllable <tɔn> is extrametrical and therefore the antepenultimate syllable can receive stress. Because of the trochaic rhythm that is characteristic for Dutch antepenultimate stress is assigned in /'bari<tɔn>/ (the first syllable of the binary foot is stressed in trochaic rhythm i.e. /'lala/. Extrametricality is incorporated in the generalisations as stated in the previous section. Words with final VXC-syllables are, as a general rule not affected by extrametricality (only peripheral VC-rhymes). Therefore these Superheavy syllables receive primary stress in unmarked cases. However, words with recessive stress patterns contain lexical markings. As stated by Nouveau (1994), two types of lexical markings can be distinguished;

1. *Lexical stress on final or prefinal light syllables*
   - Lexical stress on final Light syllable as in Pánama /’pana<’ma>/. The last syllable gets lexical stress and therefore becomes extrametrical. (unmarked would be /’panama/).
   - Lexical stress on prefinal Light syllable as in Celébes, /se’lebɛs/ (unmarked would be /’sele<bɛs>)
2. *Lexical markings related to extrametricality*
   - no extrametricality as in pelotón, /pelo’tɔn/ (unmarked would be /’pɛlo<tɔn>/)
   - idiosyncratic extrametricality as in Nícolaas, /’niko<las>/; Nicholas (unmarked would be /niko’las/). If a Superheavy syllable becomes extrametrical it is called idiosyncratic extrametricality.

A word has ‘Marked’ stress, of type B, if it has *one* lexical marking. Words are categorised as ‘Heavily Marked’ if they get two lexical markings. The following model is adapted from Nouveau (1994).

B: Marked stress (one marking) as in each of the following cases;

- Lexical stress on final Light syllable [FLS] Pánama, /’pana<ma>/
- No extrametricality [-EXT] pelotón, /pelo’tɔn/
- Idiosyncratic extrametricality [+EXT] ólifant, /’oli<fɑnt>/; elephant

C: A word is Heavily marked if it has two markings or one/prefinal as in each of the following cases;

- Lexical stress on final Light syllable and no extrametricality [-EXT, FLS] chocolá, /sjoko’la/; chocolate
- Lexical stress on penultimate Light syllable [PLS] Celébes, /se’le<bɛs>/

An example to illustrate the markedness hierarchy as stated above is provided in the Greek word (originally pronounced as) moussaká, /musa’ka/, a Heavily marked C-type word in Dutch. If one exception marking is dropped [-EXT] it becomes /’musa<ka>/, of type B, and if two exception markings are dropped [-EXT, FLS] the stress pattern has become unmarked, A-type, as in /mu’saka/ Nouveau (1994).

For the experiments of this study as described in chapter two and three the following categorisation of markedness types will be apprehended; (A) Unmarked stress, (B) Marked stress, (C) Heavily Marked stress, (P) prohibited stress. A stress pattern is prohibited if the restrictions as stated in section 1.3.2 are violated. Thus, stress that falls out of the three-syllable window is prohibited (as in the nonsense word /’balapylo/). Additionally, antepenultimate stress in three-syllabic words with closed penultimates (as in the nonsense word /’paxɑkta/) is also prohibited because it violates the third rule that includes two-syllable window restriction if the penultimate syllable is closed.

1.3 Outline of the thesis

This section briefly discusses the following three chapters of this thesis. The subjects involved in this study participated in two experiments. In chapter two the first experiment is addressed. This task contained nonsense words that had to be read aloud by the subjects. Chapter three addresses the second experiment of this study. This experiment will provide answers to the main hypothesis of the study. The subjects had to reproduce nonsense words presented auditory. The final chapter, chapter four, contains a general discussion in which both experiments will be compared with each other and with results of other relevant studies. In addition, this chapter provides recommendations for further investigations.

Chapter 2

Experiment I: Reading nonsense words

2.1 Introduction

The current study is based on an experiment divided into two tasks: repetition of nonsense words and reading of nonsense words. This chapter provides the methodology and the results of the first task that involved reading nonsense words. The main research question of this study is:

Will the subjects, including the aphasic patients, prefer unmarked stress patterns in stress assignment to nonsense words?

Predictions:
It is expected that the subjects will display a dominant preference for unmarked stress patterns in the first task. This prediction is based on case-studies that involved stress assignment in aphasic speech (Galante et al., 2000; Janssen, 2003; Cappa et al., 1997), see also section 1.1. In addition, no prohibited stress is expected to occur in the data, and the subjects are expected to be faithful to the 'three syllable window' restriction (Nouveau, 1994). The latter prediction implies that, if four syllabic words are produced, no preantepenultimate stress locations will be observed. Additionally, no prohibited stress in three-syllable words is expected; antepenultimate stress in words with closed penultimate syllables /*'kanɑkta/. The control subjects are also expected to assign stress faithfully to these constraints, an assumption based on a closely resembling pre-test by Nouveau (1994) with 20 normal functioning adult subjects. Nonsense words are used in this task because Dutch stress assignment is assumed to be a sub-lexical feature of word production, which takes place on quantitative and metrical basis (Nouveau, 1994; Zonneveld and Nouveau, 2004). Existing words have a familiar stress pattern attached to them, which is stored in the lexicon. In order to avoid lexical access nonsense words are presented to the subjects.

2.2 Participants

In this experiment, all 12 subjects participated. The subjects were divided in two groups; the first group consisted of 6 aphasic patients, the test group, and the second group consisted of 6 non-brain-damaged functioning, mono-lingual Dutch speaking control subjects. Genders and mean ages were carefully matched, each group contained three male subjects and three female subjects of a mean age of 54;3 years. The group of aphasic patients consisted of six mono-lingual, Dutch speaking patients who daily visited a rehabilitation centre for people with aphasia in Capelle aan de IJssel: *'Afasiecentrum Rotterdam en Omstreken'*. The clinical linguist of the centre selected the aphasic patients who participated in this study on non-fluent aphasic speech. The patients did not suffer from verbal apraxia or any form of dysarthria as stated by the clinical linguist. Several patients endured right side hemiplegia of the right arm and/or leg, but no symptoms of facial paralysis were observed in any patient by the speech and language therapist. The patients all declared to have an intact hearing, and not to suffer from hearing impairments of any kind. The aphasic patients all endured a Cerebral Vascular Accident (CVA), and their speech production was non-fluent. The period post-onset (after the CVA) was over two years for all participating aphasic patients. The following table provides information on the subjects' gender and age and post-onset time. All aphasic patients and control subjects agreed to participate anonymously. Therefore, in this study specific numbers will refer to the subjects.

Aphasic patient	**Age**	**post-onset time**	**Gender**
I	47	6;0 years	Male
II	58	7;0 years	Female
III	62	5;0 years	Male
IV	51	7;5 years	Female
V	59	6;5 years	Female
VI	49	2;5 years	Male
	54.3 (mean age)		

Table 2.1: The aphasic patients with their post-onset times after the CVA, genders and ages

Control subject	**Age**	**Gender**
I	57	Male
II	54	Female
III	49	Male
IV	49	Female
V	59	Female
VI	58	Male
	54.3 (mean age)	

Table 2.2: The control subjects with their ages and genders

All aphasic patients participated in a Dutch test for aphasia to classify their language into aphasic syndromes and to determine the degree of seriousness of the aphasia. The test is called the AAT, the Aachen Aphasia Test (Greatz et al., 1992). The AAT consists of six subtests that each provides a characterisation of a specific linguistic area. The six subtests together with a short description are the following:

1. *Spontaneous Language Sample*: In this subtest, a sample of spontaneous speech is recorded during a conversation between the speech and language pathologist and the aphasic pa-

tient. Subsequently, the sample is judged on: Communicative behaviour (COM), Articulation and prosody (ART), Formulaic language (AUT), Semantics (SEM), Phonology (FON) and Syntax (SYN). All these areas were provided with a score between 1 and 5. A score of 1 means severely impaired and 5 means intact.

2. *Token Test*: This subtest is the most important subtest to investigate the comprehension abilities of the aphasic patient. The patient has to carry out short tasks with increasing difficulty, which involves manipulating objects of different shapes and colours. The score on this test consists of the number of errors.

3. *Repetition Test*: The subjects have to repeat the words provided by the speech and language pathologist. Also in this task, the items are introduced with increasing difficulty. This subtest starts with repetition of: Sounds, followed by: One-syllable words, Multisyllable words, Morphologically complex words and finally Sentences.

4. *Written Language*: In this subtest, the aphasic patient first has to read aloud words and phrases. Next, the patient has to put together syllables and later words to create words and phrases. The final component of this test consists of the patient writing down words and phrases after dictation.

5. *Naming Test*: This test contains of four tasks. In the first task objects have to be named as for instance 'table'. The second task consists of naming colours, and the third task of naming pictures that represent compounds, such as vacuum-cleaner. Finally the patients have to provide sentences to pictures that represent situations.

6. *Comprehension Test*: This final test focuses on language comprehension. The patient has to match a word or a sentence, read aloud by the speech and language pathologist, to a picture that represents the word or sentence best. The test contains 40 items. In the last 20 items the patient has to read aloud the words and sentences themselves.

A native Dutch speech and language pathologist carried out the test. The patients participated individually, and the test was carried out in a quiet room at the centre for aphasia. The spontaneous language data were recorded with Sony MD-LP of type MZ-R700 (mini-disc). The obtained test-results are displayed in table 2.3.

The data displayed in table 2.3 were fed into a computer program designed to process AAT results, called AATP (Aachener Aphasia Test Programsystem). The results indicated that none of the patients, except one: patient IV (99% Broca's aphasia), were classifiable into specific syndromes. All patients were classified with 50% Broca's Aphasia except one (patient V: scored 70% Amnestic Aphasia). Because patient V was still classified as non-fluent by the speech and language pathologist in subtest one of the AAT; the Spontaneous Language Sample (SYN=2), this patient's participation is still considered valuable for the study. All patients were very cooperative and eager to participate.

	Patient							
	I	II	III	IV	V	VI		
	Test scores							Best possible score
Spontaneous speech sample	3	3	3	2	4	3	(COM)	5
	4	4	4	4	5	4	(ART)	5
	4	4	5	4	5	5	(AUT)	5
	3	3	4	3	4	5	(SEM)	5
	3	3	3	3	4	4	(FON)	5
	2	2	2	1	2	2	(SYN)	5
Token test	30	37	25	29	10	13		0
Repetition	134	103	127	101	125	143		150
Written language	62	23	55	68	76	84		90
Naming	45	79	97	90	100	97		120
Comprehension	99	89	87	92	90	91		120

Table 2.3: Raw scores of each aphasic patient on the Aachen Aphasia Test. In the last column, the best possible score is provided to illustrate the achievements of the patients.

2.3 Methodology

2.3.1 Material

As already pointed out in the introduction of this chapter, the nonsense word reading task consists of 14 novel (nonsense) words. The words were carefully selected by Nouveau (1994) and have been used successfully in her experiments. The nonsense words should cover a wide range of properties that play a role in stress production, and that are found in the Dutch lexicon. Additionally, the words should be conceived as underived, monomorphemic words. Several conditions were taken into account. The words had to closely resemble data from the Dutch lexicon, but they should not be too similar to Dutch words (Nouveau, 1994). All items were manipulated on word length and syllable structure. The words included in the sample contained final Light syllables (syllables without coda /bo/), Heavy syllables (syllables with coda /bɔn/), Superheavy syllables (syllables with a branched coda /bɔnt/ or a branched nucleus and a coda /bot/) and Diphthongal vowels. Penultimate syllables could be either open or closed as in (/kanɑkta/ or /fenimo/).

Additionally, word length was manipulated; the words consisted of two, three or four syllables.

Dutch orthographic spelling was used, thus open syllables, which involve long vowels, are written with one vowel; for instance the vowels in /fenimo/. The words were printed on white A4 paper, with one word per page. All words were typed in Microsoft Word using /Arial/ font, size 24. Table 2.4 displays the sample data provided with the categories taken into account for the analyses.

2.3.2 Procedure

The data collection of the aphasic patients took place in a quiet room at the aphasia rehabilitation centre. Each patient participated individually. Two linguistic students attended the experiment. One took care of the recordings and the other executed the tasks. All subjects first participated in the nonsense word reading task followed by the repetition task. The subjects received a short but clear instruction before the task started.

Weight final syllable	Syllables	CV-structure	Non-word reading
L#	2	$CVV.CVV$	bola
	3	$CVV.CVV.CVV$	fenimo
	3	$CVV.CVC.CVV$	kanɑkta
	4	$CVV.CVV.CVV.CVV$	karabilo
H#	2	$CVV.CVC$	kakɔt
	3	$CVV.CVV.CVC$	dapikɔn
	3	$CVV.CVC.CVC$	talɑktɑn
	4	$CVV.CVV.CVV.CVC$	monitarɔn
SH#	2	$CVV.CVVC$	bokat
	2	$CVV.CVCC$	kadɔnt
	3	$CVV.CV(V).CVVC$	karimon
	3	$CVV.CVV.CVCC$	falidɔnt
D#	2	$CVV.V_IV_J$	katɛi
	3	$CVV.CVV.CV_IV_J$	dotifɛi
totals	14		

Table 2.4: Sample data included Weight of the final syllable, number of syllables per word and their consonant (C)/vowel (V) structure.

The data were recorded stereo by Sony MDLP of type MZ-R700 with a Sony microphone of type ECM-MS907. After the recording the MD-recordings were converted to audio files and stored on a computer. Next, the files were edited with software program Cool Edit.

The data collection of the control subjects took place in their homes. The controls participated individually in a quiet room in their homes. The data were recorded similarly as with the aphasic patients. The test lasted 5 to 10 minutes on average. The controls finished the tasks somewhat quicker, approximately 2 to 5 minutes for the reading task. After the recordings the data were transcribed phonetically. A broad transcription of the data was carried out without additive diacritical signs, stress and syllabic structures received special attention in the transcription.

During the nonsense word reading task, the subjects had to read 14 novel words, each word provided on A4 format. The subjects could turn the pages themselves when they had read the word. The subjects were instructed to read the words aloud.

2.3.3 Data Encoding & Analyses

The transcribed data in the current study on stress assignment and aphasia were encoded similarly as in the study of Bree et al. (in press). The words were encoded on several aspects. The output data were coded for (1) markedness patterns of type A-unmarked stress, B-marked stress, C-heavily marked stress and P-prohibited stress. These patterns are illustrated in four words of similar word length and structure; A/mo'nitarɔn/ B/notima'lɔn/, C/toni'marɔn/and P/'nomipalɔn/. Markedness is the most important variable in this experiment, because the markedness realisations of the subjects will provide a direct answer to the main prediction of this experiment. The main prediction yielded that the subjects will prefer unmarked stress to marked stress patterns.

Secondly, word length (2) was coded to investigate the subjects' ability in adhering to target word length. Word length of the input data contained 2, 3 and 4 syllabic words. Changes (3) in syllable structure and word shape were also coded. After the data encoding a non- parametric Chi-square analysis will be executed on the markedness data to investigate if the groups differ significantly or not in their stress assignment preferences.

2.4 Results

2.4.1 Introduction

In this section on the results of experiment I, stress assignment to nonsense word that were read aloud will be provided. In section 2.3.3 a description of the encoding of word length, markedness and suprasegmental Changes was presented. This task will provide an indication whether the subjects both controls and aphasic patients will use sub-lexical information to assign stress or not during reading. Nouveau (1994) found that this was the case for normal adult Dutch subjects. The authors of the studies discussed in the introduction, which involved Italian and German aphasic patients with surface dyslexia, claimed that also their patients relied on sub-lexical information during stress assignment (Cappa et al., 1997; Janssen, 2003).

The patients produced a total of 52 words out of 84 targets. For two patients (patient II and IV) the reading task proved to be extremely problematic. These patients almost only produced useless realisations such as lexicalisations, perseverations (involuntarily repeating parts of a word that had been read out before) or no realisations at all. Therefore, the data of patient II and IV could not be taken into account for this task. To equalise the sample, the results of two controls, also two females, were not taken into account either. This resulted in a total of 56 remaining realisations in the control group and 49 remaining realisations in the group of aphasic patients. Thus, in the group of aphasic patients 7 missing values were counted. In the discussion of this chapter a few explanations for the reading difficulties observed in the total group of aphasic patients will be proposed.

In this chapter, only raw numbers are provided and taken into account; the number of data is too small to provide percentages. Some words were changed or repeated to improve the reading quite a few times by the patients. It was decided to use the best matching response in terms of correspondence to the target structure regardless of stress placement. Considering this, assumptions and conclusions are drawn with high caution from these data, and are only suggestive of nature.

2.4.2 Word length

Before markedness is analysed, a discussion of word length is presented first, because it illustrates the profound difference between the groups.

Compared to the total input, the aphasic patients produced only 3 realisations with identical word length out of 8 input stimuli, if four-syllable target words are considered. Two out of 8 four syllable targets could not be reproduced. Additionally, 6 of the 24 realised three-syllable targets were altered, and four missing values are observed in this category.

On the contrary, the control subjects produced all stimuli with identical word length as provided in the input. These data indicate that the realisations by the aphasic patients concerning word length actually differ quite severely from the control subjects. If the data of both groups are compared to the total input of 56 stimuli, the number of useful responses decreases if word length increases in the group of aphasic patients. Thus, the number of responses seems to be related to word length.

Targets	Realisations		
Aphasics	**2**	**3**	**4**
2	19	0	0
3	3	18	3
4	0	3	3
Control subjects			
2	20	0	0
3	0	28	0
4	0	0	8

Table 2.5: Numbers of syllables in targets and realisations for the aphasic patients and the control subjects.

2.4.3 Markedness realisations

In order to provide insight in the main research prediction that this experiment investigates, markedness patterns of the subjects' realisations are analysed. In the reproductions of the aphasic patients, seven missing values have been reported. This is problematic for comparison with the control group in which all targets were realised identically. However, in both groups the proportion unmarked (A) and marked (B) realisations are more or less similar in both groups. A Chi Square analyses reveals a trend towards significance at the $\alpha .05$ level ($\chi^2(2) = 5,949, p <$ .051).

As predicted, both groups prefer unmarked stress in the majority of the cases. A smaller number of observations were counted in the category of marked stress patterns (of type B) in both groups. Heavily marked stress was clearly less preferred in both groups. In the group of aphasic patients 7 heavily marked C-types out of 49 total responses occurred in the data. The control subjects however, only incidentally produced residually 2 C-type patterns out of 56 realisations.

Figure 2.4.1 illustrates the markedness preference patterns for both groups.

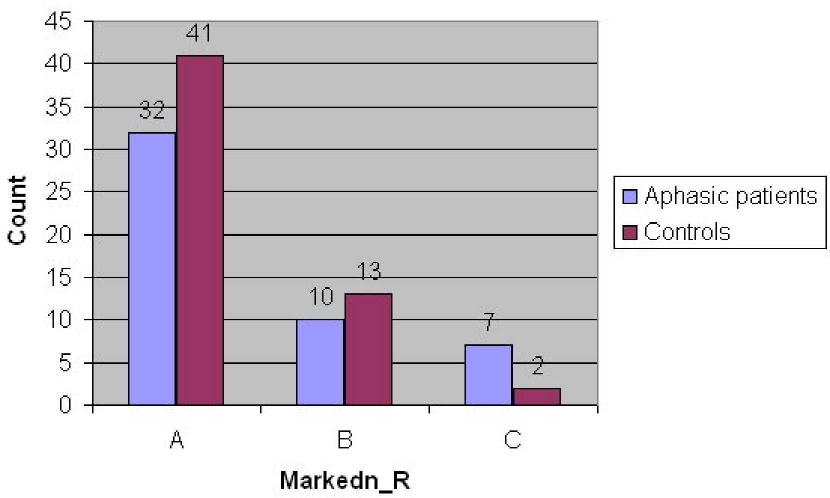


Figure 2.1: Markedness preference patterns for both groups. In the group of Aphasic patients 7 missing values were counted

These figures show that the theory of the 'three-syllable window domain' holds for both groups, because in figure 2.4.1 no prohibited stress (P-pattern) is displayed. Therefore, no pre-antepenultimate stress was assigned to four-syllabic words. Thus, the prediction that prohibited stress would be absent is confirmed. However, as shown in the analyses of word length, the aphasic patients only realised three words with four-syllables identically considering word length.

The numbers of C-type responses differs quite a lot between groups 7 C-types in the group of aphasic patients and only 2 C-type responses in the control group. When the C-type responses of the aphasic patients are investigated more closely, 5 responses out of 7 were related to changes of reduction of syllable structure and word length. For instance, /bo'kat/ was reduced to /bo'ka/ or /ka'tεi/ was changed to /ka'tə/ and were therefore realised as C-types. Considering the C-type observations, we should be reluctant to accept these markedness patterns as 'preferred stress assignment'.

2.4.4 Changes

The next section discusses whether the aphasic patients applied changes in their realisations of target stimuli to create ular stress patterns or not. The aphasics produced 18 words out of 49 realisations in which changes from their original form were observed. The changes taken into account in the analyses included syllable structure changes as weight loss (WL) /kati'po/ and weight gain (WG) /kati'pɔnt/. In addition, word length changes; syllable addition (SA) /kati'pɔnpɔn/ and syllable deletion (SD) /ka'ti/. Also lexical changes (L) /kɑr'tɔn/"paperboard" were observed in the aphasic patients' responses. In the previous discussed analyses, these lexicalisations were filtered out of the data.

In total seven items were excluded of the aphasic patients' data, of which three lexicalisations and four items that could not be reproduced by the aphasic patients. Because the control subjects did not produce any changes, their responses are not represented in the next table.

	Change			
Markedness realisation	**WG**	**WL**	**SD**	**SA**
A	5	2	0	2
B	0	3	1	0
C	0	3	2	0
Totals	5	8	3	2

Table 2.6: Numbers of change processes in word structure: Weight Loss, Weight Gain, Syllable Deletion, and Syllable Addition. The change processes are provided with the number of realisations for markedness type (A, B or C) per change category.

Table 2.6 displays that not all change processes led to unmarked stress patterns (A). Weight Loss could result in any markedness pattern, inside the three-syllable domain of Dutch stress rules, regardless of regularity. Syllable Deletion led in all cases to marked realisations, which is probably due to reading or speech production difficulties. During the reading task the patients occasionally were not able to finish a word even though they seemed to know the word was not completed yet. This could have resulted in Syllable Deletion, Weight Loss and unfinished stress patterns. For instance /ka'nɑkta/ was realised as /ka'nɑ/, in which, if the word would be completed, an unmarked stress pattern (A) would be assigned. However, the patient was not able to produce all syllables of the word, and due to the absence of the last syllable, a heavily marked stress pattern (C) occurred. In this word the last syllable is open and includes a short vowel, which is ungrammatical in Dutch stress production.

This argument strengthens the idea that the patient was not able to finish the word. Contrastively, Syllable Addition and especially Weight Gain (5 observations) led to unmarked patterns in all cases. Per example, /fenimo/ was realised as /feni'mon/.

2.4.5 Conclusions

The analyses discussed in the previous sections have confirmed the main research question: *Will the subjects, including the aphasic patients, prefer unmarked stress patterns in stress assignment to nonsense words?*

The analyses discussed in this chapter show that in both groups unmarked stress is clearly preferred above marked stress patterns. Therefore, the main hypothesis, including that all subjects would prefer unmarked stress patterns in contrast to more marked patterns, is confirmed. The control subjects were faithful to the three-syllable-window domain of Dutch stress assignment. The aphasic patients were also faithful to this theory, although this conclusion is drawn with high caution due to a very small number of realisations obtained in the four-syllable-category (also see section 2.4.2).

The expectation that no prohibited stress patterns would occur in the data is also confirmed. Control subjects performed similarly on this task as the 20 adults in the pre-test of Nouveau94. In that task that included highly comparable stimuli, a similar partitioning of markedness preferences was obtained: $A > B > C$. This observation as found in the sample of Nouveau (1994) strengthens the findings in this task.

The aphasic patients displayed severe problems concerning word length, the more syllables a word contained the more problematic the production of the word. Contrastively, the control group produced all words with identical word length. Logically, the more syllables a word contains the higher the complexity of reading and speech production.

2.5 Discussion

During testing, the reading turned out to be extremely problematic for the aphasic patients. Two explanations are conceivable. It is plausible that this difficulty related to reading nonsense words could be due to a specific form of acquired dyslexia resulting from the CVA (Southwood and Chatterjee, 2001; Links et al., 1996). In the AAT-test the subjects participated in (see section 2.2), the reading sub-test only consisted of existing words which did not seem to be very problematic to read. However, not all words were read out perfectly either. Therefore, the far greater problems these patients had during reading nonsense words were not anticipated. A specific impairment of the non-lexical reading route could be causing the reading problems.

A second explanation that cannot be ruled out on basis of the obtained data concerns speech production. A specific speech production problem that only occurs if these patients produce nonsense words could also be causing the observed difficulties.

The data obtained in the group of aphasic patients differed from the control subjects' data. Most strikingly, the aphasic patients produced more realisations with Heavily Marked stress patterns than the control group, but these realisations seem to be related to non-systematic changes. Most likely, these changes closely correspond to the previous mentioned reading or speech production complexity. The change processes Weight Loss and Syllable Deletion frequently caused these Heavily Marked stress patterns. Remarkably, the additive change processes, Weight Gain and Syllable Addition, led in all cases to unmarked stress patterns. Therefore, it could be suggested that these changes were applied systematically. However, not enough data have been collected to provide any strong arguments.

Chapter 3

Experiment 2: Nonsense word repetition

3.1 Introduction

The second experiment, the repetition task, was conducted in order to test the subjects' ability to adhere to stress targets with different stress patterns from unmarked stress to heavily marked stress and prohibited stress. The main hypothesis based on the studies of Janssen (2003); Nouveau (1994); Galante et al. (2000); Laganaro et al. (2002) that will be investigated in this study is:

The aphasic patients involved in this study will over-regularise marked stress patterns more frequently than the control subjects will. Changes in marked stress patterns are expected to lead to less marked stress patterns.

Regularisation rates and the nature of regularisations during repetition will provide information on the role of metrical rules in the subjects' repetitions. If the aphasic patients produce changes, (1) it has to be established to what extent they produce more changes in words with marked stress than in words with unmarked stress. In addition to that, (2) it should be determined if changes actually do lead to more regular, unmarked stress patterns. Also will be investigated (3) whether regularisations are systematic in nature by analysing the changes subjects may produce. In table 3.1 a working hypothesis is provided to illustrate the hypothesis above.

Table 3.1 displays a working hypothesis adapted from Nouveau (1994).

	Number of regularisations
Aphasic patients	$B < C < P$
Control subjects	No regularisations expected

Table 3.1: Working hypothesis adapted from Nouveau (1994)

In order to test this hypothesis, the subjects' stress preferences in nonsense words will be investigated.

For a detailed description of the participants, see section 2.2. During this second experiment, subjects had to repeat nonsense words that were presented auditory. After transcription, suprasegmental analyses are made of the nonsense word repetitions produced by the aphasic patients and the control group. The realisations of the participants were coded for word length in number of syllables, markedness pattern, weight of the final syllable and stress placement.

When a subject had not produced a repetition at all, the item was scored as 0 in all categories involved in this experiment. These were not taken into account in the data analysis. In total, the aphasic patients did not repeat twelve target-items. It appeared that one patient was responsible for 11 of these items. Stress assignment of new words most likely takes place through sub-lexical features, as discussed in section 1.3.2. However, if a subject realises an existing word instead of a nonsense word, a specific stress pattern belongs to that word. That stress pattern has been memorised and included in the lexicon. Therefore, stress is not assigned sub-lexically when a nonsense word is turned into an existing word. For this reason, Lexicalisations (labelled as L) were filtered out. A realisation was scored as L when a nonsense word was changed in an existing word; i.e. /'kakɔt/ became /ka'pɔt/(which means "broken" in Dutch) or /doti'fɛi/ realised as /dɔl'fɛin/ meaning "dolphin" in Dutch. Lexicalisations only occurred in a minority (2.3%) of all repetitions. Section 3.3.4 provides a more thorough discussion of the changes that occurred in the data, including lexicalisations.

3.2 Methodology

3.2.1 Material

The second experiment contains 39 nonsense words. The repetition targets were constructed in a similar way as the targets in the reading task. Thus, words were manipulated for word length and syllable structure, resulting in the fourteen words as used in the reading task. Subsequently, the words in this task were manipulated with four types of markedness. The working hypothesis as provided in the introduction of this chapter contains the following four types of markedness: [A] unmarked stress as in/no'mipalɔn/, [B] marked stress as in/nomipa'lɔn/, [C] heavily marked stress as in /nomi'palɔn/, and [P] prohibited stress as in/'nomipalɔn/. For a more thorough description of markedness patterns see also section 1.2.3.

For each markedness pattern and word length a different word was introduced to the subjects. This means that for instance /nomipalɔn/ was not presented four times with different markedness patterns in order to avoid that subjects could repeat words they heard before. For instance a four syllable word with a heavy final syllable like /nomipalOn/ was introduced to the subjects as: A: /mo'nitarɔn/, B: /notima'lɔn/, C: /toni'marɔn/and P:/'nomipalɔn/.

Because there are four categories of markedness, 4 x 14 words of similar structured words as in the first experiment had to be included in the sample of repetition words. However, some words could not be manipulated with all degrees of markedness. For instance, only two markedness patterns are possible in a word that contains two syllables. In addition, in a word with three syllables only three markedness patterns are possible. For this reason, the sample contained 39 words instead of 56 words.

The stimuli were recorded and controlled for consistency of rate, and intonation of presentation by Bree et al. (in press). A pretest for the study of Bree et al. (in press) showed that word stress of the recordings was unambiguous. Five Dutch speaking adult listeners assigned stress to the recorded 39 nonsense words, agreement (195/195, 100%).

Weight final syllable	Syllables	CV-structure	Unmarked A	Marked B	Heavily marked C	Prohibited P
L#	2	$CVV.CVV$	'bola	X	so'ta	X
	3	$CVV.CVV.CVV$	fe'nimo	'kemito	xeni'mo X	
	3	$CVV.CVC.CVV$	ka'nɑkta	X	tamɑk'ta	'paxɑkta
	4	$CVV.CVV.CVV.CVV$	kara'bilo	ta'ladilo	pawati'lo	'balapylo
H#	2	$CVV.CVC$	'kakɔt	wa'tɔp	X	X
	3	$CVV.CVV.CVC$	'dapikɔn	kati'pɔn	pa'kidɔn	X
	3	$CVV.CVC.CVC$	ta'lɑktɑn	kawɑp'tɑn	X	'panɑktɑm
	4	$CVV.CVV.CVV.CVC$	mo'nitarɔn	notima'lɔn	toni'marɔn	'nomipalɔn
SH#	2	$CVV.CVVC$	bo'kat	'kobat	X	X
	2	$CVV.CVCC$	ka'dɔnt	'taxɔnt	X	X
	3	$CVV.CV(V).CVVC$	kari'mon	'tanidom	pa'likon	X
	3	$CVV.CVV.CVCC$	fali'dɔnt	'sanitɔnt	pa'rixɔnt	X
D#	2	$CVV.V_IV_J$	ka'tɛi	'tanɛi	X	X
	3	$CVV.CVV.CV_IV_J$	doti'fɛi	'kopitɛi	po'kidɛi	X
Totals			14	12	9	4
				Total number of words: 39		

Table 3.2: The sample data; repetition targets are provided with the Weight of the final syllable which could be Light; L#, Heavy; H#, Superheavy; SH# or Diphtongal; D#. For a description of these weight categories see section 1.2.2. Additionally, table 3.2 displays the number of syllables per word, the CV-structure (consonant C/vowel V) of the words, and the markedness category of each word.

3.2.2 Procedure

The aphasic patients were tested in the aphasia rehabilitation centre in a quiet room. The control subjects participated in a quiet room in their home. The subjects were carefully instructed to repeat the word directly after they heard it. The words were played on a Sony CD-player with two boxes attached to provide a clear stereo sound. Subsequently, the spoken responses have been recorded as described in section 2.3.2.

3.2.3 Data encoding & analyses

For the repetition task the following word aspects of the realisations were encoded: (1) word length, (2) identical (referring to identical syllable structure, word length, and stress pattern, not to identical phoneme representation) or non-identical repetition, (3) markedness patterns, (4) changes in syllable structure, word shape and stress patterns. The targets were also encoded in order to establish a comparison between input and output. Identical, Same, Better and Worse could only be coded in the output.

1. *Word length*
   If word length increases, complexity increases because increasing word length is more demanding with respect to working memory and speech production. Therefore, word length is under investigation. Word length will be discussed in a subsection of the section on Changes in the next chapter. The target stimuli consisted of 2, 3 or 4 syllables. If the aphasic patients obtain difficulty with complexity of word structures, it is possible that words with more syllables will cause more problems than shorter words.

2. *Identical, Same, Better and Worse*
   If an item is repeated non-identically, the markedness of the stress pattern of the words can still be similar to the target word. For instance, the word /kati'pOn/ has a markedness ranking of B. If it is realised as /kokati'pɔn/, i.e., with syllable addition the markedness degree remains the same. The realisation is thus coded as S (Same). If the word /kati'pɔn/ with markedness ranking B is realised as /'katipɔn/, the markedness ranking changes from B to A due to stress shift. If markedness changes in the direction marked to unmarked, the realisation is coded as B (Better). Additionally, if the word /kati'pɔn/ with markedness ranking B is realised as /kati'po/, markedness increases from B to C. If markedness is increased in a realisation, it is labelled W (Worse).

   More examples are provided in table 3.3. Better realisations indicate that more unmarked stress patterns than the target pattern have been applied, and that words with marked stress patterns are harder to realise than unmarked patterns. If the aphasic patients will produce more Better realisations than the control subjects, a strong argument is established to confirm the main hypothesis.

3. *Markedness*
   The repetition data were coded for four types of markedness, A- unmarked stress, B- marked stress, C- heavily marked stress and P- prohibited stress. The data were coded in this manner, to investigate if the aphasic patients (and control subjects) could adhere to the target markedness structure, or if they would reduce markedness patterns. The working hypothesis in the introduction predicts that the aphasic patients will have more difficulty with the repetition of marked patterns than of unmarked patterns. In other words, prohibited stress patterns (type P) will be reduced in markedness more frequently than heavily marked stress patterns (type C). In addition, heavily marked stress patterns (type C) will cause more problems than marked stress patterns (type B). It is expected that the patients will adhere to target, unmarked, regular stress (type A), best.

4. *Changes*
   Several changes may be observed in the realisations, which are divided in two major categories: changes in word shape and word structure, and changes in stress pattern. Note that only suprasegmental changes are encoded, no changes on the phoneme level are taken into account.

   If the stress pattern is changed directly through stress shift, it is coded as SH as in /fe'nimo/ realised as /'fenimo/. If the target word length increases (by the number of syllables), the repetition is labelled SA; Syllable Addition, as for instance /fe'nimo/ changed into /fe'nimomo/. When the target word length decreases as in /fe'nimo/ changed to /fe'mo/ the label SD, meaning Syllable Deletion, is applied. In addition, when the weight of target syllables is changed through changes in the rhyme of a syllable, the syllables may lose weight, labelled as WL (Weight Loss) as in /fali'dɔnt/ changed to /fali'do/, or gain weight, as in /fe'nimo/ changed to /feni'mɔn/, labelled as WG (Weight Gain). It should be taken into account that subjects may apply more than one change in a word. For instance in /fe'nimo/ realised as /fenimo'mo/, Stress Shift and Syllable Addition occurred. Research questions under investigation in the analyses of changes are:

Which changes will be applied frequently, and which changes will lead to reduction of markedness? Additionally, this study investigates whether changes will be applied to reduce markedness systematically. For instance, if a specific change is observed, that in a majority of cases leads to less marked realisations; it is conceivable that this change is applied systematically.

Table 3.3 provides a schematic overview of the encoding as discussed above. The stimulus /kati'pɔn/ is taken as an example to illustrate the data encoding.

Realisation	Transcription	Identical	Change	Markedness realisation	Stress location realisation
katipón (target)	kati'pɔn	Identical	-	B	final
patipón	pati'pɔn	Identical	-	B	final
kokatipón	kokati'pɔn	Same	Syllable Addition	B	final
kapón	ka'pɔn	Same	Syllable Deletion	B	final
kátipon	'katipɔn	Better	Stress Shift	A	antepenultimate
katipónt	kati'pɔnt	Better	Weight Gain	A	final
katipó	kati'po.	Worse	Weight Loss	C	final
katípon	ka'tipɔn	Worse	Stress Shift	C	final
katíekpo	katik'po	Worse	Weight Gain & Weight Loss	C	penultimate
kápon	'kapɔn	Better	Syllable Deletion & Stress Shift	A	penultimate

Table 3.3: Adapted from Bree et al. (in press). On the first line, the target structure is displayed accompanied by its phonological transcription, its markedness structure and stress location. Per example, several realisations are displayed in the first column to illustrate possible changes and the manner in which the realisations are categorised.

After the encoding of the data, a Chi-square analysis will be executed on Identical, Same, Better and Worse the data to investigate if the participants differ significantly or not. Subsequently, markedness will be analysed with a Univariate-ANOVA. It is thereby analysed whether specific patterns cause more problems than other patterns and whether there is interaction between the groups.

3.3 Results

3.3.1 Word length

The target nonsense words contained two to four syllables. However, in contrast to their controls the aphasics also realised words with less syllables. The targets and realisations of word length are displayed in table 3.4

Considering word length, both groups repeated the targets quite faithfully to the input. The data show that the aphasic patients are capable of repeating the target word length in most cases. The four- syllable nonsense words were reduced more often than the two- and three-syllable words. The control subjects did not have any problems with word length at all. All presented targets were repeated identically for word length. However, this analysis does not show the possibility of subjects altering syllable structure or markedness.

The data indicate that word length does not seem to be causing great difficulties in nonsense word repetition. It should be noted that word length is only under investigation on the syllabic level here and that changes of target-phonemes are not taken into account.

Targets	Realisations			
Aphasic patients	1 syllable	2 syllables	3 syllables	4 syllables
2 syllables	2/54 (4%)	50/54 (93%)	2/54 (8%)	0/54 (0%)
3 syllables	0/119 (0%)	4/119 (3%)	114/119 (96%)	1/119 (1%)
4 syllables	0/44 (0%)	3/44 (7%)	2/44 (5%)	39/44 (87%)
			total:	215
Control subjects				
2 syllables	-	59/59 (100%)	0/59 (0%)	0/59 (0%)
3 syllables	-	0/126 (0%)	126/126 (100%)	0/126 (0%)
4 syllables	-	0/48 (0%)	0/48 (0%)	48/48 (100%)
			total:	233

Table 3.4: Percentages and numbers of word length in syllables: repetitions and targets.

3.3.2 Identical Same, Better and Worse

In this repetition experiment, the subjects could either realise an item as identical or non-identical, which could be realised as Same, Better or Worse.

A realisation was categorised as Identical if the item was repeated with identical stress, word length and syllable shape. Stress assignment in Dutch most likely is a sub-lexical feature based on syllable structure rules and word length. Therefore, it should be noted that substitutions on the phoneme level as /kati'pɔn/ realised as /mati'pɔt/ were not taken into account in the classifications. Syllable structure changes like Weight Loss (/kati'pɔn/ realised as /kati'po/ are more crucial for the current study, because these kinds of changes can influence stress assignment. Also, see section 2.3.3. If a realisation of a subject was non-identical it could be scored as 'Same' if the markedness pattern was equal to the target, it was labelled 'Better' when a realisation was less marked than the target and labelled 'Worse' when it was more marked than the target. For examples, see section 2.3.3.

If marked stress patterns of nonsense words are problematic for the aphasic patients, Better realisations are expected to occur more frequently than in the control group. In other words, the stress patterns will become less marked).

	ID	Same	Better	Worse
Aphasic Patients	141/217 (65%)	24/217 (11%)	44/217 (20%)	6/217 (3%)
Control	224/233 (96%)	0	8/233 (3%)	1/233 (0.5%)

Table 3.5: Frequencies and percentages of Identical, Same, Better and Worse realisations.

Table 3.5 displays different patterns for each group. In the aphasic patients data a substantially lower percentage Identical realisations (65%) was observed than in the control group data (96%). Thus, Same, Better and Worse realisations were more common in the group of aphasic patients. In the control group, Same and Worse realisations are exceptional phenomena, and less than 5 observations were tallied in both categories. Better realisations indeed occurred more frequently in the group of aphasic patients than in the control group; 20% Better realisations in the group of aphasic patients to 3% in the control group.

A non-parametric chi-squared analysis was carried out on the numbers of Identical, Same, Better and Worse per group (χ^2 (df= 3) $= 70.75$ $p < 0.001$). The main difference is caused by a substantially lower rate of Identical realisations in the aphasic group (141/217 = 65%) than observed in the control group (96%). Strikingly, most of the 35% non-identical realisations produced by the aphasic patients were Better realisations (20%).

Worse realisations did not occur as frequently, there was a low percentage of observations in both groups. However, the aphasic patients produced more Worse realisations than the control group.

The aphasic patients produced only two one-syllable realisations; apart from one syllable lexicalised realisations that were excluded from the analyses because no markedness pattern can be attached to one-syllable words. It is expected that adhering to target markedness structure will be more difficult for the aphasic patients as markedness increases. In addition, non-identical realisations are expected to lead to less marked realisations.

The next table provides the performances of both groups for every type of markedness. Type; A Unmarked stress for instance in /no'mipalɔn/, B Marked stress /nomipa'lɔn/, C Heavily marked stress /nomi'palɔn/, P Prohibited stress /'nomipalɔn/.

Identical (ID) refers to: Identical target structure and stress pattern, Same (S) refers to erroneous repetition, but similar markedness pattern, Better (B) refers to repetition with a less marked stress pattern than the target and Worse (W) refers to repetition with a more marked stress pattern than the target. See also section 2.3.3 for more examples.

Markedness targets			**Realisations**			
Aphasic Patients	ID	Same	Better	Worse	One Syllable	Totals
A *unmarked stress*	70/80	5/80	0/80	4/80	1/80	80
	88%	6%	0%	5%	1%	
B *marked stress*	41/64	7/64	13/64	2/64	1/64	64
	64%	11%	20%	3%	2%	
C *heavily marked*	26/50	12/50	12/50	0/50	0/50	50
stress	52%	24%	24%	0%	0%	
P *prohibited stress*	4/23	0/23	19/23	0/23	0/23	23
	17%	0%	83%	0%	0%	
Control Group						
A *unmarked stress*	82/83	-	0/83	1/83	-	83
	99%		0%	1%		
B *marked stress*	68/72	-	4/72	0/72	-	72
	94%		6%	0%		
C *heavily marked*	51/54	-	3/54	0/54	-	54
stress	94%		6%	0%		
P *prohibited stress*	23/24	-	1/24	0/24	-	24
	96%		4%	0%		

Table 3.6: Percentages and numbers responses in each class (Identical, Same, Better and Worse) for each target markedness type.

In both groups a similar process is observed, although in different proportions: when items were repeated non-identically, markedness reduction was very likely to occur. Additionally, for the aphasic patients there is a clear trend of more markedness reduction as the markedness of targets increases. For the category of prohibited stress (P) 83% of the realisations are Better in the aphasics group in contrast to only 4 percent in the control group.

Syllable complexity seemed to play an important role in repetitions that are labelled Worse (six realisations were Worse realisations; 3%). In the aphasic group, the Worse realisations are mainly A and B types of markedness. For instance, /kari'mon/ became /kari'mo/, and /'tanidom/ was changed into /'talindo/. In both cases, Weight Loss of the final syllable occurred through coda omission. Therefore, the markedness pattern of the word changed, but not through Stress

Shift. This coda omission in the final syllable resulted in more marked realisations. Therefore, these marked realisations did not seem to be due to some kind of strategy. Thus, the aphasic patients were probably having difficulties with the production of the words. Problems could be a plausible explanation for the Weight Loss in superheavy syllables. Additionally, some patients also reduced medial clusters, as in /'paxɑkta/ to /pa'xata/ and /tamɑkt'a/ to /tamɑk'a/. In these realisations, only clusters were reduced and no stress shift occurred. That is a strong indication for the patients' difficulties with production of clusters. In 39 cases out of the total 217 repetitions (18%) of the aphasic patients' realisations, weight loss was observed, as is discussed in more detail in section 3.3.4.

3.3.3 Markedness realisations

This section focuses on the question to what extent the subjects are able to adhere to target markedness patterns. It is investigated whether specific markedness patterns cause more problems.

As table 3.6 showed, non-identical responses often led to less marked stress patterns. Changes were analysed to see if they led to specific markedness patterns, and if there were any systematic changes displayed in the data when markedness was reduced.

To gain insight in this matter, a Univariate ANOVA was executed on the realisations, with the percentage Identical realisations in each markedness category as the dependent variable. Fixed factors were; group (aphasic patients and controls) and markedness-type (A, B, C or P), and person per group was the independent variable. An interaction effect was established for Group * markedness-type $df = 3$,$F = 36.154$,$p < .000$. The change in the percentage Identical realisations is larger for the group of aphasic patients than it is for the control group, when changing from unmarked to more marked realisations. In the figure 3.1 is displayed that for the group of aphasic patients the percentage Identical realisations declines if markedness increases, in contrast to the control group.

Next to the interaction effect, main effects were established for the factor Group; $df = 1$, $F = 37.211$, $p < .000$, Markedness type; $df = 3$, $F = 39,306$, $p < .000$, and for the persons per group factor $df = 10$, $F = 3.733$, $p < .002$.

To see what happened to the realisations that were changed to other markedness categories, table 3.7 is provided. In table 3.7 the target markedness patterns are grouped with their realisations.

The percentages show that the aphasics display slightly lower percentages on Marked (B) and Heavily marked types (C) realisations than the input. Of the targets with Heavily marked stress (C-types), 4 realisations are reduced to marked (B) patterns and, 8 are reduced to unmarked (A-type) stress patterns. Strikingly, there is not much difference between the percentages marked (B) and Heavily marked (C) patterns, as would be expected.

The larger number of unmarked A-types in the realisations of the aphasic patients is remarkable in comparison to the control group. Additionally, the group of aphasic patients produced a substantially lower percentage of prohibited stress (P-type) realisations, compared to the realisations of the control group. The control group also exhibited a larger number of A-type productions than other types of markedness. However, the percentage unmarked (A-type) stress is

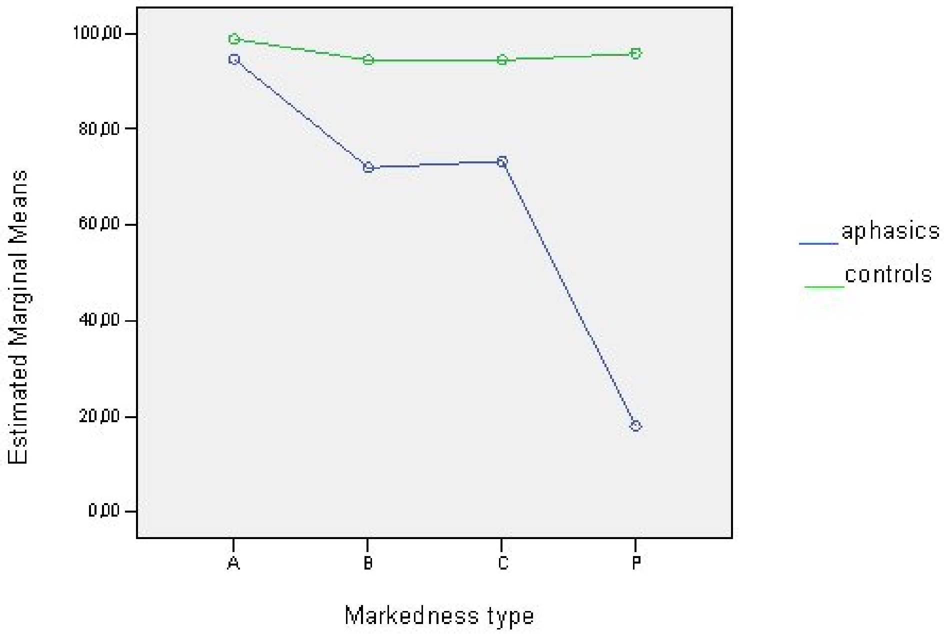


Figure 3.1: The percentages identical realisations in each markedness category are displayed for both groups

much smaller than in the group of aphasic patients.

The control group showed similar prohibited stress-type rates as were provided in the input, in contrast to the aphasics who had more difficulties with P-type repetition. They realise only (17% =4 P-type realisations) out of 23 realisations of P-type targets. Unlike B- and C-type targets, P-types were not reduced to A-types most frequently, but more often to B and C-types.

Therefore, P-types were likely to be changed to any structure less marked than Prohibited stress. Section 3.3.4 addresses the specific changes the patients produced in their realisations in more detail.

3.3.4 Changes

As discussed in section 3.3.2, the aphasic patients realised 65% of the target items identical to the targets. The control subjects on the other hand produced 96% identical realisations. If a word was not repeated identically, several changes occurred in the data. These were all put into separate categories of changes. If the target word length increased (by the number of syllables), the repetition, the word was changed through Syllable Addition, /kati'pɔn/ became /kokati'pɔn/. When the target word length decreased Syllable Deletion was applied, /katipɔn/ became /ti'pɔn/. If the original stress position in a target word changed in the repetition, the word was changed through Stress Shift, /kati'pɔn/ realised as /ka'tipɔn/. Additionally, when the weight of target syllables was changed through changes in the rhyme of a syllable, the syllables could have lost weight, /katipɔn/ realised as /kati'po/, which is called Weight Loss. A syllable could also gain weight through application of phonemes to the coda of a rhyme. This process is called Weight Gain; as in /kati'pɔn/ realised as /kati'pɔnt/. See section 2.3.3 for a more elaborate description.

The nonsense words in this experiment have been selected by Nouveau (1994), see also section

Target			Realisation		
Aphasic patients	A	B	C	P	One Syllable
A	75/80	3/80	1/80	0/80	1/80
	95%	4%	1%	0%	1%
B	14/64	47/64	1/64	1/64	1/64
	22%	73%	2%	2%	2%
C	8/50	4/50	38/50	0	0
	16%	8%	76%	0%	0%
P	5/23	8/23	6/23	4/23	0
	22%	35%	26%	17%	0%
Control subjects	A	B	C	P	One Syllable
A	82/83	1/83	0/83	0/83	-
	99%	1%	0%	0%	
B	4/72	68/72	0/72	0/72	-
	6%	94%	0%	0%	
C	2/54	1/54	51/54	0/54	-
	4%	2%	94%	0%	
P	0/24	0/24	1/24	23/24	-
	0%	0%	4%	96%	

Table 3.7: Percentages and numbers markedness realisations of target nonsense words per group.

3.2 on Methodology. Lexical resemblances were avoided as much as possible. However, some of the aphasic patients produced lexicalisations like /doti'fɛi/ changed to /dɔl'fɛin/ which is dolphin in Dutch.

Because the aim was to assess what happened in stress production of unknown words, lexicalisations were not taken into account in the analyses. For both groups lexical changes were scarce. The group of aphasic patients produced 5 Lexical changes out of 222 repetitions (2%). In the control group, only 1 Lexical change out of 234 repetitions (0.4%) was produced. Lexical changes are therefore filtered out of the following (and preceding) analyses of the data. The next table provides information about the other changes that occurred. Numbers of Same, Better and Worse realisations were added to investigate the influence of the changes. In addition, realisations were observed that included more than one change process. For instance /toni'marɔn/ became /ma'rɔn/. Therefore, in this case the target was changed through Syllable Deletion and Stress Shift.

In table 3.8 the changes will be provided per change category. Note that two items with syllable deletion were not taken into account for Same, Better and Worse, because they were reduced to one syllable realisations.

This table shows that in most cases changes, especially Weight Loss and Stress Shift, led to less marked, more regular, realisations in both groups.

Additionally, the table displays that word length was more often decreased than increased by the aphasic patients. Furthermore, when rhymes were altered, Weight Loss was a far more common phenomenon than Weight Gain. Both observations indicate that the aphasic patients have a strong preference for reducing complexity. It seems that in most cases, Weight Gain was due to production difficulties.

For instance, /'paxɑkta/ became /'paxatɔn/ in which the cluster /-kt-/ in the target was not realised (thus, also Weight Loss occurred), and a heavy syllable was realised at the end of the word through Weight Gain. In the aphasic patients' realisations stress shift led, just as Weight Loss, to a reduction of markedness in almost all cases. The majority of the realisations with

	Syllable Addition	Syllable Deletion	Weight Loss	Weight Gain	Stress Shift
Aphasics					
Same	1	6	13	5	-
Better	1	4	22	7	25
Worse	1	-	4	2	2
Totals:	3 (1,4%)	12 (5,5%)	39 (18,0%)	14 (6,5%)	27 (12,4%)
Total repetitions: 217					
Controls					
Same	-	-	-	-	-
Better	-	-	5	2	1
Worse	-	-	1	-	-
	0	0	6 (2,6%)	2 (,9%)	1 (0,4%)
Total repetitions: 233					

Table 3.8: Numbers and Percentages of changes categorised in specific change classes accompanied by numbers of same, better and worse realisations.

Weight Loss also caused a reduction of markedness.

In section 3.3.3 reproductions of prohibited markedness patterns (P-types) were discussed. The aphasic patients reduced prohibited stress patterns most frequently. Therefore, the changes that occurred in changed prohibited (P) realisations are provided in table 3.9

Types of changes	Weight Gain	Weight Loss	Stress Shift	Syllable Deletion
Unmarked A	2	3	3	1
Marked B	1	3	7	1
Heavily marked C	0	3	5	0
Totals	3/23 (13%)	9/23 (39%)	15/23 (65%)	2/23 (9%)

Table 3.9: Change processes that occurred in the realisations of prohibited stress input by the aphasic patients. These processes were Weight Gain (kati'pɔnt), Weight Loss (kati'po), Stress Shift (ka'tipɔn) and Syllable Deletion (ka'pOn). Of every change process, the number of realisations is displayed for each markedness ranking. For instance, in the change category Weight Gain, two out of three realisations resulted in unmarked (A) stress and one out of three in marked stress.

It should be noted that multiple processes could occur in one word for instance, in /kati'pɔn/ /'tipɔn/ Syllable Deletion and Stress Shift occurred. A total number of 19 (83%) out of 23 prohibited stress (P) targets was changed during the realisations. These data suggest that P-targets were systematically regularised. Prohibited stress patterns were regularised through Stress Shift or Weight Loss in most changed realisations.

Prohibited stress targets were changed to unmarked (A), marked (B) and heavily marked (C) patterns of markedness approximately just as frequently. It was expected that the patients would have significantly more difficulties with realising prohibited (P) patterns. Prohibited (P) patterns do not fit any rule-system of Dutch stress. Strikingly, P-targets that were changed to marked B- and heavily marked C-realisations depended on a correlation between final stress and syllable structure of the final syllable. This observation is displayed in the next table.

The table shows that word length was identical to target word length in almost all P-type realisations. Out of 19 changes P-types in total, a majority of 12 realisations received final stress. Targets contained either antepenultimate stress in three-syllable words or preantepenultimate stress in four-syllable words. These 12 realisations all became marked (B) and heavily marked (C) patterns.

All targets and all realisations of these prohibited (P) patterns contained final syllables with

P-targets	changed realisations	markedness	stress location	ID / Non-ID word length	weight final syllable
’balapylo	’babo	A	penultimate	Non-ID	light#
panɑktɑm	pa’nɑktɔn	A	penultimate	ID	heavy#
’paxɑkta	pa’rɑktɑn	A	penultimate	ID	heavy#
’paxɑkta	’paxatɔn	A	antepenultimate	ID	heavy#
’panɑktɑm	’palatɑn	A	antepenultimate	ID	heavy#
	totals	5A	penultimate 3/5	4/5	heavy# 4/5
	A patterns		antepenultimate 2/5		light# 1/5
’nomipalɔn	nopita’lɔn	B	final	ID	heavy#
’paxɑkta	’paxata	B	antepenultimate	ID	light#
’nomipalɔn	pati’ɔn	B	final	Non-ID	heavy#
’paxɑkta	pata’dɔn	B	final	ID	heavy#
’nomipalɔn	nomida’rɑn	B	final	ID	heavy#
’panɑktɑm	pala’tɔn	B	final	ID	heavy#
’nomipalɔn	nomipa’lɔn	B	final	ID	heavy#
’nomipalɔn	nomipa’rɔn	B	final	ID	heavy#
	totals	8B	antepenultimate 1/8	7/8	heavy# 7/8
	B patterns		final 7/8		light# 1/8
’balapylo	balapʏ’lo	C	final	ID	light#
’paxɑkta	paxa’ta	C	final	ID	light#
’panɑktɑm	pa’rotɔn	C	penultimate	ID	heavy#
’balapylo	balapy’lo	C	final	ID	light#
’balapylo	balapy’lo	C	final	ID	light#
’paxɑkta	paxɑk’ta	C	final	ID	light#
	totals	6C	penultimate 1/6	6/6	heavy# 1/6
	C patterns		final 5/6		light# 5/6

Table 3.10: Number of changed realisations of targets with prohibited stress (P). The first two columns display the P-targets with changed realisations. Changed realisations are accompanied by their assigned markedness structure. Next to markedness, a column with the stress locations is presented. Identical (ID) or non-identical (Non-ID) word length is also displayed in the table, in the fifth column. In addition, the final column shows the weight of the realisations’ final syllable.

heavy /-lɔn#/or light /-lo#/ weight. Realisations with light and heavy final syllables became marked (B) and heavily marked (C) patterns when they received final stress. Unmarked (A) patterns are not possible in Dutch with final light and heavy syllables. If the stressed final syllable was heavy as in/'nomipalɔn/ realised as /nomipa'lɔn/ marked stress (B) is applied. If the stressed final syllable was light as in /'balapylo/ realised as /balapy'lo/ heavily marked stress (C) occurred. Unmarked (A) stress was mainly observed in realisations with penultimate and antepenultimate stress as in /'paxakta/ realised as /'paxatɔn/.

3.3.5 Conclusions

The aim of the repetition of nonsense words task was to compare word stress productions of aphasic patients and controls. The main hypothesis included that the aphasic patients would produce more over-regularisations in stress production than the control group. The analyses performed on the data confirmed this expectation. As expected and shown in the analyses presented in this chapter, the groups evidently differed on several aspects. First, adhering to target structures has proven to be far more problematic for the aphasic patients than for their controls. Although the patterns observed in Non-Identical realisations are relatively similar in both groups, the main difference lies in the rates of Non-Identical observations. As stated before, these changes were 'applied to create unmarked realisations in the majority of cases, but could also be partially related to complexity of syllable structures. The working hypothesis as provided in section 2.1 predicted that the number of over-regularisations would increase with markedness.

The data confirmed that prohibited stress (P) led to most regularisations, and the aphasic patients adhered best to unmarked, regularly stressed targets (A). Apart from that, the expectation that the controls did not produce changes strategically to create unmarked stress is confirmed. However, a few exceptions were observed. However, in the group of aphasic patients, changes during repetition in Marked (B) and Heavily Marked (C) patterns did not correspond to the model of the working hypothesis. It might be that patients only distinguished between unmarked, marked, and prohibited stress patterns. Based on the results the number of regularisation pattern as stated above should be adapted to;

$$B = C < P$$

Still, marked stress patterns have proven to be more problematic for the group of aphasic patients than for the control subjects. The general assumption that stress assignment to nonsense words takes place on a basis of sub-lexical properties holds based on the results in this study.

Although the groups differed on several aspects of stress assignment, the obtained data show that the stress patterns in general were quite similar in both groups.

Non-Identical realisations were often regularised by all participants, which was indicated by the category Better (see section 3.3.2). Additionally, markedness in these Non-Identical realisations was reduced quite frequently to unmarked stress based on the three-syllable-window (Nouveau, 1994). Word length was not problematic for the control group and the group of aphasic patients adhered to target word length rather well also. Therefore, these data did not provide evidence for word length being systematically reduced.

In summary; when targets have been changed, complexity has decreased far more often than it has increased in the majority of the realisations of the aphasic patients. Change-processes as Stress Shift, Syllable Deletion and Weight Loss have generally led to better, less marked realisations. Especially Stress Shift and Weight Loss might therefore be interpreted as systematical processes that lead to reduction of complexity.

3.4 Discussion

The realisation pattern of regularised markedness structures of the aphasic patients in this study is represented as $B = C < P$. However, some questions remain unanswered about the similar proportions of realised marked (B) and heavily marked (C) stress. In the analysis of markedness, similar proportions of marked and heavily marked stress patterns were observed. However, targets with marked stress were more often repeated identically (also taking into account word length and syllable structure) than targets with heavily marked stress, see also section 3.3.2. The reason for this is that the aphasic patients produced changes to heavily marked targets, without changing the type of markedness; 'Same' realisations.

If Identical realisations are taken into account, referring to identical markedness structure, syllable structure and word length, the number of regularisations pattern could be represented as $B < C < P$. Thus, more changes were observed in realisations of heavily marked stress targets. Therefore, it could be argued that targets with heavily marked stress are more problematic to repeat for the aphasic patients than targets with marked stress. Future investigations with larger test samples would provide more insight in this matter.

In contrast to the aphasic patients, the control group reproduced prohibited stress patterns with great accuracy. The changes in prohibited stress patterns by the aphasic patients indicated that if a P-type pattern was changed, it was most likely that stress shift or weight loss caused the changes.

Strikingly, the aphasic patients produced final stress in the majority of changed P-type realisations. No unmarked stress occurred because stress was assigned to the final syllable which was light or heavy. However, the aphasic patients mainly produced unmarked stress patterns in regularisations of other marked patterns; marked (B) and heavily marked (C) patterns. Therefore, the question rises; why would the patients produce final stress in the majority of prohibited stressed (P) targets?

In targets with prohibited stress, most changes occurred of all targets. These P-type targets were complex in syllable structure, stress pattern and word length. Because patterns of prohibited stress violate Dutch metrical constraints, it is likely that extra capacity of the verbal working memory is demanded to store and retrieve the information. No existing metrical knowledge can be addressed during repetition of prohibited stress. Plausibly, repetition of word length and syllable structure demanded maximum processing capacity of the verbal working memory. This resulted in large stress shifts from the left word edge (in targets) to the right word edge (in realisations). It is possible, that the final syllable was retrieved best, because it was stored shortest in the verbal working memory. Subsequently, the final syllable received stress. In addition, unmarked stress patterns, were almost only assigned to three-syllable words. Four-syllable words did not receive unmarked stress, except in one realisation due to Syllable Deletion. In four-syllable realisations the patients were not able to assign stress based on unmarked stress rules. The patients assigned final stress which did not seem to be based on syllable structure. More evidence should be collected in future research, to investigate the verbal working memory account.

Chapter 4

Conclusion & General Discussion

4.1 Conclusion

During the reading of nonsense words, both the aphasic patients and control subjects showed a clear preference for unmarked, regular stress. Therefore, the hypothesis that both groups would favour unmarked patterns over marked patterns is confirmed. Additionally, prohibited stress was absent in all realisations. However, it should be taken into account that the aphasic patients had severe difficulties with the reproduction of the nonsense words during reading. Therefore, the results had to be interpreted with high caution.

During repetition of nonsense words, the aphasic patients obtained more problems with repetition of marked, irregularly stressed words than the control subjects did. Marked target structures were often regularised by the aphasic patients through reduction of markedness. The control subjects only produced overregularisations incidentally. These observations were all anticipated for and included in the main hypothesis of this study, which is therefore confirmed;

The aphasic patients involved in this study will overregularise marked stress patterns more frequently than the control subjects will. Changes in marked stress patterns are expected to lead to less marked stress patterns.

Although the pattern of unmarked stress being better reproduced than marked stress patterns is represented in the data of both groups, it is much stronger present in the group of aphasic patients.

No realisations with four syllables were found in the reading experiment with prohibited (preantepenultimate) stress, and no three-syllable words with prohibited stress. Additionally, if stress shift occurred in the repetition data, it moved far more frequently in the direction of the right word-edge than to the left word-edge. These observations strongly suggest the patients and their controls are faithful to the three-syllable window domain of Dutch stress.

It could be argued that some changes produced by the aphasic patients were applied systematically to reduce markedness. During repetition, in almost every realisation where stress shift occurred, it led to less marked realisations. Therefore, it is likely that stress shift is a systematical change process.

Additionally, syllable deletion and weight loss also led in the majority of observed changes to less marked realisations.

In summary, identical reproduction of markedness patterns in two-, three- and four-syllabic nonsense words becomes more problematic for non-fluent aphasic patients, if markedness increases. Errors lead to less marked realisations due to systematical change processes as stress shift, syllable deletion and weight loss. To strengthen these findings, more data should be collected in future research.

4.2 General Discussion

Unmarked stress based on sub-lexical rules did not cause any problems for the aphasic patients in this study. On the other hand, adhering to marked stress patterns during nonsense word repetition was problematic. The control subjects did not have any problems at all with repetition of nonsense words. A suitable explanation for the observations in the data of the aphasic patients is related to verbal working memory. During repetition of nonsense words, the patients had to temporarily store and retrieve properties of the targets. These properties included word length, phonemes, syllable structure, and markedness. In unmarked words, less processing capacity is demanded for storing stress patterns, because stress can be computed based on unmarked, dominant stress rules.

With increasing word length and markedness; the demand on processing capacity increases. It is likely that the patients are incapable of storing and/or retrieving all information that occurs in words with marked patterns, especially in words with prohibited patterns. This could explain why the patients had difficulties with repetition of marked structures. It is conceivable, that the verbal working memory insufficiently processed marked targets, which led to structural changes that reduced complexity. Therefore, it is assumed that unmarked stress was assigned if the properties of markedness could not be retrieved from the verbal working memory.

As stated before, unmarked stress can be computed sub-lexically. This process is less demanding on the verbal working memory. Thus, in unmarked words only word length and syllable structures have to be stored, which seems to be the maximum that the verbal working memory can process for these patients.

Strikingly, word length was reproduced quite faithfully. A prohibited stress pattern could only occur in words with three or four syllables; the longest words included in the sample. Word length of words with four syllables was reproduced less accurate than other word lengths, but still the majority of the words was reproduced with identical word length. In contrast, only a small number of words with prohibited stress patterns was reproduced with identical markedness. Similarly, in words with three syllables, almost all words were reproduced with identical word length. Again, prohibited stress patterns in three-syllable words were frequently reduced in markedness. However, it is not the case that markedness and word length influence working memory separately. Word length and markedness are strongly related. The more word length and markedness increase, the more processing capacity is required of the verbal working memory. Therefore, it is remarkable that word length is repeated more accurately than markedness.

The overregularisations as produced by the aphasic patients indicate that stress can be assigned by sub-lexical computation. Most likely, if the patients failed to store and retrieve marked stress, unmarked stress was assigned by default. Therefore, word length might have preceded stress assignment in storage in the working memory. In that case, it is conceivable that marked properties of stress could not be retrieved, because storage of longer words demanded maximum capacity of the verbal working memory.

In addition, unmarked stress was almost only assigned to three-syllable prohibited stress targets and not to words with four syllables. In the previous chapter, it was argued that the patients retrieved the final syllable of prohibited stress targets with four syllables best. Subsequently, the final syllable received stress. The assignment of final stress in realisations of prohibited targets was not rule-based, because syllable structure did not have a role in the assignment of stress. If word length increases, it is expected that markedness is reproduced worse. These observations indicate that word length correlates with markedness. A correlation between increasing word length and reduction of markedness cannot be ruled out. The existing data should be checked for such a correlation. The percentage realisations with identical markedness in comparison to word length could improve insight in this matter.

In addition, it is not clear, whether a correlation exists between identical reproduction of phonemes and target word length. In this study, reproduction of phonemes was not analysed because stress assignment takes place based on suprasegmental properties. Therefore, future investigation should provide more clarity in this matter. Additionally, other tests should be carried out to investigate the role of the verbal working memory in more detail. For instance, a digit-span task could provide insight in the working memory capacity. This kind of task investigates the maximum number of one-syllable nonsense words a subject is able to process. It would shed more light on the role of word length on verbal working memory. Besides, auditory perception is a first requirement for adequate word repetition, which should also be taken into consideration in future research.

More clarity should be provided on the role of repetition of markedness patterns of real words. Are marked stress patterns also more problematic than unmarked patterns in repetition or reading of words? In these patients, that is not likely. During the subtests of the Aachen Aphasia Test (Greatz et al., 1992) in which the subjects had to produce real words, no stress regularisations have been observed. These subtests were reading aloud, naming, repetition and spontaneous language. In this study, the aphasic patients also read aloud real words with different markedness rankings. However, these data of real words were not used for further analyses because of involvement of lexical activation and to a lack of time. In future investigation, these real words should be analysed in more detail.

In the study of Bree et al. (in press) with young three-year-old children at risk for developmental dyslexia, repetition of nonsense words was investigated. For the group of children at risk for dyslexia, marked stress patterns were more problematic to repeat than unmarked patterns. A similar effect as in the aphasic patients of the current study was obtained concerning the preantepenultimate stress items. For both control and at-risk children, preantepenultimate stress was most challenging. Another similarity between the aphasic patients and the children at risk for dyslexia is observed when non-identical stress realisations were investigated. Changes of stress patterns caused movement to the right of the word more often than to the left, in the group of the aphasic patients. Shifts to the left were rare. These observations indicated that both groups recognised stress patterns, and are able to adhere to targets that fit into the three-syllable window domain (Nouveau, 1994) of Dutch stress assignment. In summary, unmarked stress rules are mastered by both groups and are accessible. However, exceptions to these rules as in marked patterns, are much more difficult. In both groups effects of syllable complexity and word length were established. The role of verbal working memory in this group most likely also influenced the realisations of the children. Verbal working memory capacity, in this group, has not matured yet. Therefore, prohibited stress patterns might cause problems for a similar reason as proposed for the group of aphasic patients; a lack of processing capacity of the verbal working memory.

Two options were proposed for the existing difficulties of the aphasic patients, with reproduction of nonsense words during reading. The first option was that the patients suffered from a type of acquired dyslexia. However, the option that the difficulties were related to specific production problems with nonsense words, could not be ruled out on basis of the obtained data in the first experiment. In the second experiment the aphasic patients did not have such problems with repetition of nonsense words. Even the four-syllable targets were repeated quite faithfully considering word length. This argument favours the first explanation of the patients having an acquired form of dyslexia.

Former investigations, that involved aphasic patients with surface dyslexia, also reported that their patients obtained difficulties with reproduction of marked, irregularly stressed words in repetition, reading and naming tasks (Cappa et al., 1997; Janssen, 2003; Galante et al., 2000; Laganaro et al., 2002). However, these tasks consisted mainly of real words. During the testing of the patients with the Aachen Aphasia Test (Greatz et al., 1992), no remarkable difficulties with the reading of real words were observed. Thus, reading words was far less problematic for the aphasic patients than reading nonsense words.

This study showed that the data for stress assignment in aphasic speech of Dutch, match the observations as reported in the literature discussed in the introduction of this chapter (Cappa et al., 1997; Galante et al., 2000; Laganaro et al., 2002; Janssen, 2003). In aphasic speech of Dutch, similar phenomena of stress assignment as previously described for German and Italian have been reported in the current study. This study adds reproduction of nonsense words to the literature on stress production in aphasia. So far, mainly stress assignment to real words has been investigated in aphasic patients. Additionally, the results of the current study on aphasia resemble the results as found in the investigation of Bree et al. (in press) in children at risk for dyslexia. An important aspect of this study is that not only stress errors have been investigated. Changes in syllable structure, stress location and word length that led to overregularisations have been investigated in detail.

In this study, repetition and reading of nonsense words within the same subjects can be compared. During repetition, the aphasic patients produced overregularisations if markedness increased. This correlated with a clear preference for unmarked stress as observed in the reading data. In both tasks changes were observed that reduced complexity. No prohibited stress was produced in the reading task in both groups. As discussed, prohibited stress caused most problems in the repetition data of the aphasic patients. Although the control subjects did not prefer prohibited stress in the reading task, they repeated prohibited stress without any problems. Because prohibited stress is not based on any stress rule of Dutch, it requires extra processing capacity. Therefore, it is remarkable that the control subjects reproduced it so faithfully. Due to the fact that prohibited stress sounds unnatural, the control subjects might pay extra attention to them. Apparently, normal adults can store and retrieve these prohibited patterns if they have to without problems.

Thus, the current study shows that aphasic patients and control subjects prefer unmarked stress above marked patterns. During repetition, both groups adhere to unmarked stress without problems. However, exceptions to unmarked stress patterns cause problems for the aphasic patients in contrast to their controls. The results of this study do not allow assumptions concerning lexical access. On the other hand, this study proved that in stress assignment to new words, stress assignment is based on sub-lexical properties.

Bibliography

E. de Bree, F. Wijnen, and W. Zonneveld. Word stress production in three-year-old children at risk for dyslexia. *Journal of research in reading*, in press.

S.F. Cappa, M. Nespor, W. Ielasi, and A. Miozzo. The representation of stress: evidence from an aphasic patient. *Cognition*, 65(1):1–13, 1997.

E. Galante, A. Tralli, M. Zuffi, and S. Avanzi. Primary progressive aphasia: a patient with stress assignment impairment in reading aloud. *Neurological Science*, 21:39–48, 2000. `http://www.springerlink.com/media/2G271PXYVG5WM4VXJYWV/Contributions/T/C/7/4/TC74VCRXHPXRHPH1.pdf`.

P. Greatz, R. de Bleser, and K Willmes. *Aachen Aphasia Test*. Swets & Zeitlinger, Lisse, 1992.

U. Janssen. Stress assignment in german patients with surface dyslexia. *Brain and Language*, 87: 114–115, 2003.

M. Laganaro, F. Vacheresse, and U.H. Frauenfelder. Selective impairment of lexical stress assignment in an italian-speaking aphasic patient. *Brain and Language*, 81(1–3):601–609, 2002. `http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6WC0-464XXRD-1S-1&_cdi=6724&_user=3021498&_orig=search&_coverDate=04%2F30%2F2002&_qd=1&_sk=999189998&view=c&wchp=dGLbVtz-zSkWb&md5=865c42f79bfee279c31396f73487ed7a&ie=/sdarticle.pdf`.

W. J. M. Levelt, A. Roelofs, and A. S. Meyer. A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22:1–75, 1999.

P. Links, J. Feike, and R. Bastiaanse. *Afasie. Diagnostiek en therapie. Een lingustische benadering*. Bohn Stafleu Van Loghum, Houten/Diegem, 1996.

D. Nouveau. *Language acquisition, metrical stress, and optimality*. PhD thesis, UIL-OTS, University of Utrecht, 1994.

N.O. Schiller, J. Cholin, and W.J.M. Levelt. Effects of syllable frequency in speech production. *Cognition*, 99(2):205–235, 2006.

M.H. Southwood and A. Chatterjee. The simultaneous activation hypothesis: Explaining recovery from deep to phonological dyslexia. *Brain and Language*, 76:18–34, 2001.

W. Zonneveld and D.P. Nouveau. Child word stress competence: an experimental approach. In R. Kager, J. Pater, and W. Zonneveld, editors, *Constraints in Phonological Acquisition*, pages 369–408. Cambridge: Cambridge University Press, 2004.