PHONOLOGICAL/PHONETIC ASSESSMENT OF AN ENGLISH SPEAKING ADULT WITH DYSARTHRIA

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by

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Abstract

This thesis investigates errors made by an English speaking dysarthric adult within a nonlinear phonological framework, assuming a phonetics/phonology interface model. The question to be investigated is how dysarthria fits within linguistic theory, more specifically, within the nonlinear phonetics/phonology interface model. 25 taped-recorded, phonetically transcribed and acoustically analyzed statements served as the database. The subject produced longer voiced fricatives, longer lax, low and [ɪ] vowels. Statement, schwa length and intensity were normal, but the subject produced smaller standard deviations and relative range frequencies (flattened intonational patterns). Weakly articulated consonants were more likely to be voiced and not equally spread among different places or manners of articulation. Consonant omissions were more likely to occur in coda position but this has a phonetic explanation. Dysarthria is a superficial disorder at the level of motor implementation that affects phonological and phonetic implementation rules alike. The output of categorial rules, language-specific phonemic and phonetic rules are equally (and mildly) deviant.

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CHAPTER 1
Introduction

1.1 Thesis Objectives

This thesis investigates errors made by an English speaking adult with dysarthria from a phonological/phonetic perspective. The question to be investigated is how dysarthria fits within linguistic theory, more specifically, within the nonlinear phonetics/phonology interface model. Dysarthria has been defined as a speech disorder resulting from an impairment in muscular control of the motor processes involved in the production or execution of speech (respiration, phonation, resonation and articulation). Dysarthria does not, however, involve a disorder in programming of articulation (Rosenbek & McNeil 1991, p. 290). Dysarthria can appear as a symptom of several disorders such as Parkinson's disease, stroke, traumatic brain injury, amyotrophic lateral sclerosis (ALS) and cerebral palsy (Yorkston 1996, p. S46).

Patients with dysarthria can be described as producing covert contrasts. That is, patients are able to discriminate phonemic contrasts, but are unable to reliably produce them (Scobbie, Gibbon, Hardcastle and Fletcher 1998, p. 147). That is, patients with dysarthria display errors resulting from motor impairment (McNeil, Weismer, Adams & Mulligan 1990, p. 255; Rosenbek & McNeil 1991, p. 290; Langmore & Lehman 1994, p. 28; Ackermann, Hertrich & Scharf 1995, p. 1252). These errors include: (1) phonetic contrast errors (phonetic errors which obscure phonological contrasts) such as sound omissions, substitutions and distortions (Riddel, McCauley, Mulligan & Tandan 1995, p. 304; Odell, McNeil, Rosenbek & Hunter 1991, p. 67; Kent, Weismer, Kent & Rosenbek 1989, p. 482; Ansel & Kent 1992, p. 296; Kent, Kent, Rosenbek, Weismer, Martin, Sufit & Brooks 1992, p. 724). (2) prosodic errors (Odell et al. 1991, p. 67; Hertrich & Ackermann 1993, p. 177; Gentil 1990, p. 438; Liss & Weismer 1994, p. 45). (3) articulatory timing errors (Ackermann & Hertrich 1993, p. 75; Gentil 1990, p. 438). The three types of errors will be discussed later in Chapter 1: Introduction (p.1).

This study analyses the speech of one English speaking adult afflicted with dysarthria who has been assessed by a speech-language pathologist (SLP). The tape recorded results of an assessment test served as the data base for the study. More methodological details are provided in Chapter 3: Method and Analysis (p. 29).

In this study, the subject's phonetic system will be analysed within a nonlinear phonological framework that assumes a phonetics/phonology interface model (Cohn 1993; Keating 1988). The question to be investigated is how dysarthria fits within linguistic theory, more specifically, within the nonlinear phonetics/phonology interface model.

1.2 Theoretical Assumptions

1.2.1 Nonlinear Phonology

It has been suggested that knowledge from fields such as linguistics can benefit the practice of speech-language pathology. Linguistic theory, specifically nonlinear phonology, has been applied to speech-language pathology because it can describe disordered speech as a coherent phonological system. Knowledge of linguistic theory is thus essential in the practice of speech-language pathology and motivates change in assessment methodology and intervention approaches. More specifically, nonlinear analysis within the phonology/phonetics interface model provides a useful methodology for defining goals for phonological intervention (see Bernhardt & Gilbert 1992, p.123; Bernhardt 1992b, p.283). For parallel reasons, I employ concepts from nonlinear phonology in this paper.

This paper will use nonlinear phonology in the analysis of dysarthria in order to confirm the locus of the disorder. The use of nonlinear phonology will illustrate that dysarthria is not a phonological disorder; rather it is a phonetic disorder resulting from motor impairment. The analysis will identify the areas of speech that are the most affected i.e. segmental (feature geometry) or suprasegmental (prosodic hierarchy) or both. These concepts are outlined in the next section.

1.2.1.1 Review of Nonlinear Phonology

The main difference between classical and nonlinear generative phonology is that nonlinear phonology focuses on representations instead of rules or processes (Bernhardt 1992a, p. 259). While classical generative phonology is strictly sequential, nonlinear representations are hierarchical and multitiered, and include both prosodic structure and subsegmental details. In hierarchical representations (tree structures), prominent elements dominate other elements (Bernhardt 1992a, p. 262). Elements on different tiers are unordered and are related to each other via association lines, while elements on the same tier are sequentially ordered (Clements & Hume 1995, p. 247). Principles of association between the autonomous tiers result in and constrain phonological rules or processes. Types of rules include: spreading, which involves the linking of information from different domains, delinking, which involves removing information from different domains (Bernhardt 1992a, p. 261), insertion and deletion. Nonlinear phonology was first used in the representation of prosodic or suprasegmental speech properties such as tone, stress and intonation but later it became clear that segmental properties could also be accurately represented using nonlinear theory (Clements & Hume 1995, p. 247). Prosodic (or suprasegmental) versus segmental tiers are overviewed below.

1.2.1.2 Prosodic Tiers

Prosodic units are represented on separate tiers from vowel and consonant segments (Clements & Hume 1995, p. 247). At the prosodic level, the prosodic word dominates feet. Feet dominate strong and weak syllables. Syllables and moras organize elements on the segmental tier (sometimes called the melodic tier) possibly through an intermediate skeletal tier. Segments are composed of hierarchically ordered feature complexes. All tiers are joined using association lines (Bernhardt 1992a, p. 262), see example (1) (McCarthy & Prince 1986 and Selkirk 1978).

(1) Prosodic Tiers

```
                IP          (Intonational Phrase)
                |
                φ           (Prosodic Phrase)
                |
                ω           (Prosodic Word)
                |
                F           (Foot)
               / \
      σ strong    σ weak        (Syllables (strong and weak))
         |          |
         μ          μ           (Onset vs. rhyme (moras))
         |          |
         •          •           (Segmental/Melodic tier)
         |          |
        [F]        [F]          (Segmental Features) (not further detailed)
```

The prosodic hierarchy consists of the following tiers: the intonational phrase, prosodic phrase, prosodic word, foot, syllables and moras. In contrast, the segmental feature geometry consists of the segmental/melodic tier and segmental feature tiers (details are not shown). It is proposed that the subject in this study is experiencing an impairment in the realization of units both above and below the segmental tier.

1.2.2 Phonology/Phonetics Interface Model

The speech of a patient with dysarthria will be analysed within a nonlinear phonological framework that assumes a phonetics/phonology interface model. This thesis agrees with the clinical literature on dysarthria which states that dysarthria is a superficial disorder that affects phonetic implementation more than phonological competence. It is hypothesized that, because the disorder is superficial, it should affect the output of both deep phonological rules and surface phonetic rules in a similar manner. To test this hypothesis, this thesis assumes the distinction between phonological and phonetic implementation rules using the phonology/phonetics interface model.

Current views of the relationship between phonology and phonetic implementation suggest that the difference between phonological and phonetic rules is not always obvious. Nevertheless Cohn (1993) suggests a principled way to distinguish the two types (overviewed below).

1.2.2.1 Overview of Phonology/Phonetics Interface Model

This section will describe the phonology/phonetics interface model in general by examining the traditional and current view of phonological and phonetic implementation rules and how they relate to the physical output level.

1.2.2.1.1 Traditional View

Generative phonology originally assumed that phonological representations and derivations were a part of linguistic grammar while phonetics was "outside the grammar". Phonological rules were language-specific or universal while phonetic rules were mechanical, automatic and strictly universal. This view is represented in (2), (Cohn 1993, p. 44):

(2) Traditional view:

Phonological rules

↓

Universal phonetic
implementation rules

↓

Physical output

The "physical output" level in (3) is the level at which motor implementation takes place. Thus, the "physical output" level is the locus of the motor impairment in dysarthria.

1.2.2.1.2 Current View

Recently, it has been proposed that some phonetic rules are also language-specific; for example, prosodic feet are realized differently from language to language. In general, a syllable is made more prominent than others through the use of pitch, loudness, duration and vowel quality. However, different languages use these parameters in a different way to realize syllable prominence, or to mark prosodic feet (Laver 1994). Cohn (1993) thus suggests that some phonetic rules are part of the linguistic grammar of a language and are not universal. If so, then language-specific phonetic realizations (such as prosodic feet) are not universal implementation rules. The revised model incorporating this assumption is represented in (3):

(3) Current view:

Phonological rules	X (see below)
↓	
Language-specific phonetic implementation rules	Y (see below)
↓	
Universal phonetic implementation rules	Y (see below)
↓	
Physical output	

Cohn (1993) claims that phonetic rules (language-specific or universal) can be distinguished from phonological rules. Phonetic rules have gradient effects. These rules assign segments only part of some property or assign an amount that changes over time during the segment. In contrast, phonological rules have categorial (on/off or presence/absence) effects and manipulate discrete, timeless segments. Phonological, categorial rules assign segments a property that does not change over time during the segment (Cohn 1993, p. 45). In implementing both types of rules, the target-interpolation model is used, as described below.

The mapping of phonology to phonetics (i.e. between levels X and Y) involves translating timeless abstract phonological representations into quantitative phonetic ones realized in time and space via a mechanism known as target-interpolation. In the target-interpolation model, feature specifications leave the phonology and are translated into phonetic realizations (Cohn 1993, p. 47). Essentially, segments with a minus (-) value have less of a physical value than those with a plus (+) value, and segments with no value for a feature have an increasing or decreasing amount of a physical value.

For example, in English, phonetic implementation results in gradient patterns of nasal airflow. The quality of vowels before nasal consonants in English is different from vowels in other environments. English has a phonetic rule of Anticipatory Nasalization in which vowels before nasal consonants become nasalized. Nasal consonants (e.g. [n]) have a plus value of the feature [nasal] while vowels (e.g. [ɛ]) are unspecified for the feature [nasal] at the output of the phonology. The phonetic rule of Anticipatory Nasalization has gradient effects in that the [+nasal] consonant affects only a part of the vowel. As a result of target interpolation, the [+nasal] feature of the consonant leaves the phonology and assigns the preceding vowel segment an increasing amount of the nasal feature. This interpolation results in a cline-like pattern of nasalization throughout the duration of the oral segment. The phonetic rule of Anticipatory Nasalization in English is represented in (4) (Cohn 1992, p. 59-60):

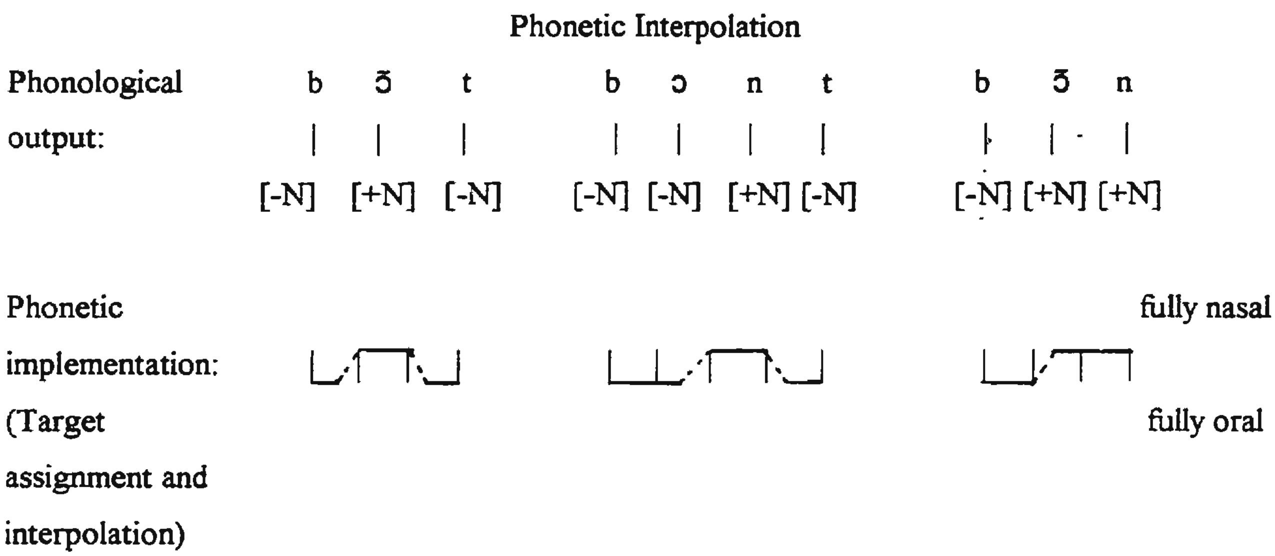
(4) Phonetic Interpolation

Phonological output: d ɛ n
| |
[-nasal] [+nasal]

Phonetic implementation: fully nasal
(Target assignment
and interpolation) fully oral

In French, phonological output also results in categorial patterns of nasal airflow while phonetic implementation results in gradient patterns of nasal airflow. Like English, at the output of the phonology, French has consonants that have a minus value for the feature [nasal] as well as consonants that have a plus value for the feature [nasal]. Unlike English, in which all vowels are unspecified for the feature [nasal], French has vowels that have a minus value for the feature [nasal] as well as vowels that have a plus value for the feature nasal, at the output of the phonology. Example (5) illustrates how phonological output results in categorial patterns of nasal airflow and phonetic implementation of segments unspecified for [± nasal] results in gradient patterns of nasal airflow:

(5)



In [bɔ̃t], [b] and [t] consonants both have minus values for the feature [nasal] while the [ɔ̃] vowel has a plus value for the feature [nasal] at the output of the phonology. Nasal airflow occurs significantly during the production of the vowel but not during the production of the oral consonants. In [bɔnt], the consonants [b] and [t] and the [ɔ] vowel have minus values for [nasal] in the phonological output while the consonant [n] has a plus value for [nasal]. Nasal airflow occurs during the production of [n] but not during the production of the other segments. In [bɔ̃n], the consonant [b] has a minus value for [nasal] while the consonant [n] and the [ɔ̃] have a plus value for [nasal] at the output of the phonology. Nasal airflow occurs during the production of [õ] and [n] but not during the production of [b]. In all these examples, categorial patterns of nasal airflow occurs when there is specified phonological output (Cohn 1993, p.51-52).

The target-interpolation model makes it possible to quantitatively evaluate the output of both phonetic (gradient) and phonological (categorial) rules in order to test the hypothesis that dysarthria affects these rules in a similar manner. In particular, statistical analysis reveals that outputs from both types of rules are similarly affected. This point will be discussed further in the following section.

1.3 Test of Hypothesis

This paper will test the hypothesis that dysarthria affects in a similar manner the output of (a) categorial phonological rules, (b) gradient language-particular phonetic rules, and (c) gradient universal phonetic rules. The following more specific findings are expected:

(a) covert contrast (the ability to produce contrasts, but in a deviant way)

(b) no deep impairment of language-specific phonemic or phonetic rules

(c) across-the-board superficial impairment in phonetic implementation rules (both language-specific and universal) i.e. no difference in impairment between these rules.

In other words, dysarthria should affect the output of all types of rules in a similar manner.

If dysarthria were a deeper disorder, serious impairment would be expected in a patient's phonology and the output of categorial phonological rules would be impaired. For example, the adult could display errors in the production of final codas reflecting a deviant underlying syllable structure, i.e. the adult could omit coda consonants if sh/e lacked a coda position in his/her syllable structure. This example is analogous to disordered child phonology in which coda omission indicates defective syllable structure. These children delete coda consonants because there is no coda position and floating or stray consonants are not allowed in outputs (Bernhardt & Stemberger 1998, p. 376).

With respect to the dysarthric subject in this study, it is expected that there will be no deep impairment of language specific phonemic or phonetic rules. For example, the subject may make minor voicing or durational errors but these errors will not indicate a deep impairment in the subject's phonology. Superficial impairment in phonetic implementation in both language-specific and universal rules are expected. To illustrate, the realization of prosodic feet results from gradient language-specific phonetic implementation rules, as discussed in section 1.2.2.1.2 Current View, p. 6. It is expected that any error made by the dysarthric patient with respect to implementation of prosodic units will be superficial. That is, the subject may, for example, be monotone or monoloud but will still implement the prosodic units correctly. As another example, the phonetic rule of nasalization of an oral vowel in the environment of a nasal segment is a gradient universal phonetic rule. It is expected that any error made by the dysarthric patient with respect to this rule will also be superficial. That is, the subject may apply deviant amounts of nasalization to vowels compared to that of a normal speaker but he will still implement the rule of nasalization.

Finally, the subject in this study may exhibit covert contrast (i.e. a superficial impairment in which contrasts appear to be neutralized but actually are not affected). That is, the subject will have phonological knowledge of a contrast, but there may be a discrepancy between the production of a contrast and the perception of that contrast by others. For example, listeners may not be able to perceive the difference between the subject's production of /k/ vs. /g/ even though the subject has phonological knowledge of that contrast and has attempted to articulate it (Scobbie et al. 1998, p. 147-148).

In order to test the hypothesis that dysarthria is an across-the-board, superficial motor implementation impairment, factors such as duration, frequency, intensity, consonant omissions and weakly articulated segments were examined in this study (Chapter 4: Results and Discussion, p. 37). Duration (4.1 Duration, p. 37) was measured to test if the subject produced greater, smaller or the same duration for statements, classes of sounds or particular segments. It was expected that the subject's duration would be deviant overall. Statistical tests were performed comparing the subject to the SLP for duration of statements (prosody) and duration of classes of sounds of particular segments. It was found that the subject's duration of statements was similar to the SLP's but the subject's production of segment duration was unlike the SLP's. It was concluded that the subject had an across-the-board impairment of segmental duration (but see section 5.5 Methodological Limitations, p. 61, re: comparing the subject to an SLP).

Intensity (4.2 Intensity, p.42) was examined to test if the subject made particular patterns of error with respect to intensity. Statistical tests were performed comparing the subject to the SLP and it was found that the subject is not experiencing an impairment with respect to intensity, one of the main correlates of rhythm and stress. (Also see section 5.5 Methodological Limitations, p. 61, re: comparing the subject to and SLP).

Frequency (4.3 Frequency, p. 44) was examined to test if the subject made particular patterns of error with respect to frequency. Statistical tests were performed comparing the subject to the SLP and it was found that the subject is experiencing an impairment with respect to frequency, but not a major one (but see section 5.5 Methodological Limitations, p. 61, re: comparing the subject to an SLP).

At the segmental level, the dysarthric subject omitted 20 consonants in the 25 test sentences (4.4 Consonant Omissions, p. 48). These omissions were examined to see where they occurred. Statistical tests were performed (when appropriate) to determine if the subject and SLP were significantly different. It was concluded that consonant omissions occurred in coda position significantly more than in onset position. Omissions also occurred in final position in the word more than in any other position (but see section 5.5 Methodological Limitations, p. 61, re: comparing the subject to an SLP).

The subject also produced 33 weakly articulated consonant (segments where the articulators weakly approximated voicing, place or manner of articulation) (4.5 Weakly Articulated Consonants, p. 50). Using statistical analysis (when appropriate), these segments were compared with the SLP's accurately produced segments using duration measurements. It was found that these consonants were likely to be voiced consonants more than 50% of the time, suggesting laryngeal involvement. The weakly articulated segments were not equally spread among different places of articulation or manners of articulation, but statistical tests were then inconclusive about which place of articulation or manner of articulation was more likely to be weakly articulated (see section 5.5 Methodological Limitations, p. 61, re: comparing the subject to an SLP).

1.4 Summary

As previewed above, this thesis will show that the dysarthric subject is experiencing an across-the-board impairment in production of prosodic units, evidenced by an impairment in frequency, and across-the-board impairment in production of segmental units, evidenced by durational impairment, weakly articulated segments and consonant omissions. (Furthermore, Discussion in Chapter 5 (p.55) will argue that consonant omissions are not the result of a deeper phonological impairment or deviant syllable structure representations).

CHAPTER 2
PREVIOUS RESEARCH

2.1 Major Findings of Previous Literature

This chapter will provide a definition of dysarthria. The research considers dysarthria to be a motor impairment disorder, i.e. one which should not affect a person's competence. Types of segmental errors (illustrating covert contrast) made by patients with dysarthria will be reviewed. Types of prosodic and suprasegmental errors will also be discussed.

This chapter will show that dysarthria is a motor impairment that can affect the linguistic intelligibility of patients afflicted with the disorder. The linguistic effects include covert contrast and prosodic and like errors.

2.1.1 Dysarthria

This following section will provide a definition of dysarthria, describe symptoms of dysarthria and describe the types of dysarthria.

2.1.1.1 Definition

Dysarthria can be defined via five parameters, listed in Table 2.1:

Table 2.1 Five parameters of dysarthria.

Pathophysiology	Deficits in the physiology involving the central or peripheral nervous system.
Impairment	A neurologic motor speech impairment indicated by slow, weak, imprecise, and/or uncoordinated movements in the speech musculature possibly involving respiration, phonation, resonance and/or oral articulation.

Functional Limitation	Reduction in speech intelligibility and rate as well as errors in prosody.
Disability	Decreased ability to use understandable, efficient and natural sounding speech.
Societal Limitation	Decreased ability to fulfill societal roles and limited access to services and opportunities.

(Yorkston 1996, p. S46-S47)

In general, dysarthria involves physiological deficiencies, neurologic motor speech impairment, reduced speech intelligibility, a competence disability, and a limitation of roles, opportunities and services in society.

Dysarthria can be congenital or acquired and can progress in several ways. It can be developmental (cerebral palsy), recovering (stroke), stable (stroke), degenerative (ALS), or exacerbating-remitting (multiple sclerosis or MS). The diseased physiology may result in a number of motor impairments, including: (1) spasticity, which involves an increase in muscle tone or stiffness where greatest resistance occurs at the beginning of passive movement, e.g. jaw-jerk. (2) flaccidity, which involves a weakness or reduction in muscle tone. (3) ataxia, which involves uncoordinated muscle movement. (4) tremor, which involves involuntary rhythmic movements usually occurring at rest or during voluntary movement. (5) rigidity, which involves an increase in muscle tone present throughout a movement. (6) dysmetria, which involves a break in control of movement speech and range (Yorkston 1996, p. S46-S47). Clinical characteristics will be discussed later in this section (Table 2.3, p. 16).

Speech production is a complicated process that involves the coordination of many muscle contractions as discussed below. Nerve impulses originating from the motor areas of the cerebral cortex which pass through the muscles via motor pathways control muscle contractions involved in speech production. There are different levels of functional activity in which the nervous system plays a role in controlling muscular activity. First, the neurons connecting the central nervous system to the skeletal muscle fibres provide the lowest level of motor control. These neurons are responsible for the contraction of the skeletal muscle fibres (Murdoch 1990, p. 205). Second, the highest level of motor control provides initiation of voluntary muscle activity and is controlled by motor areas in the cerebral cortex. Third, the cerebellum co-ordinates muscular contraction. Damage to any of these impulses, pathways or activities may result in the speech disorder of dysarthria (Murdoch 1990, p. 206).

Impairment of the neuromuscular system can cause several types of dysarthria depending on where damage to the system is located (Murdoch 1990, p. 206). Table 2.2 correlates the different types of dysarthria along with the corresponding lesion sites.

Table 2.2 Types of dysarthria and the corresponding lesion sites.

Dysarthria types	Lesion site
Flaccid dysarthria	Lower motor neurons
Spastic dysarthria	Upper motor neurons
Hypokinetic dysarthria	Basal ganglia and associated brainstem nuclei
Hyperkinetic dysarthria	Basal ganglia and associated brainstem nuclei
Ataxic dysarthria	Cerebellum and/or its connections
Mixed dysarthria	
Mixed flaccid - spastic dysarthria	Lower and upper motor neurons
Mixed ataxic - spastic - flaccid dysarthria	Cerebellum/cerebellar connections, upper motor neurons and lower motor neurons

(Murdoch 1990, p. 206)

Distinguishing among the different types of dysarthria listed above can be difficult (Caplan1992, p. 148): For example, different types of dysarthria can display similar clinical characteristics, such as hypernasality, imprecise vowel and consonant articulation, poor alternating speech mechanism movements, disturbed stress, pitch and loudness patterns, irregularities in respiration and phonation, etc. Table 2.3 overviews different types of dysarthria along with the characteristics that best distinguish each type. These types of movement may affect the speech apparatus as well as other parts of the body.

Table 2.3 Types of dysarthria and distinguishing characteristics.

Dysarthria types	Clinical characteristics
Flaccid	- loss of muscle tone - muscle weakness - loss or reduction of muscle reflexes - muscle atrophy (deterioration) - muscle fasciculations (spontaneous twitches) (Murdoch 1990, p. 207) - disruption of reflex arc causing reflexes to become absent or diminished - reflexes become absent or diminished (Murdoch 1990, p. 225)
Spastic	- spastic paralysis (increase in muscle tone or stiffness where peak resistance occurs at the beginning of passive movement) - little or no muscle atrophy except that associated with disuse - hyperactive muscle stretch reflexes (ex. jaw-jerk) - pathological reflexes (ex. sucking reflex) - reflex arc intact (Murdoch 1990, p. 225)
Hypokinetic	- slowness and poverty of spontaneous movement (Murdoch 1990, p. 234) - initiation of movement difficulties - muscular rigidity - loss of automatic aspects of movement - tremor at rest (Murdoch 1990, p. 238)

Hyperkinetic	- abnormal involuntary movements disrupting the rhythm and rate of motor activities (Murdoch 1990, p. 244) - myoclonic jerks (irregularly occurring abrupt, sudden, unsustained muscle contractions) - tics (brief, unsustained, recurrent, compulsive movements) - chorea (single, unsustained, isolated muscle action producing a short, rapid, uncoordinated jerk) - ballismus (wild flailing movement) - athetosis (continuous, arrhythmic, slow, writhing-type movements) - dyskinesia (voluntary movement impairment) - distonia (slow and sustained abnormal involuntary movement) (Murdoch 1990. p. 244-252)
Ataxic	- uncoordinated muscle movements (Murdoch 1990, p. 255)
Mixed Mixed flaccid - spastic Mixed ataxic - spastic - flaccid	- characteristics include a combination of the above mentioned types of dysarthria (Murdoch 1990, p. 274-281)

The subject in this study has flaccid dysarthria. The specific impairments displayed by the subject will be discussed in section 3.1.1 Subject, p. 29.

2.1.1.2 Evidence Supporting a Motor Impairment Description

In this section, evidence supporting a motor impairment description of dysarthria will be provided. The studies to be examined will provide evidence that dysarthria is a motor deficit.

Langmore & Lehman (1994, p. 28) studied the physiologic deficits in the orofacial musculature system underlying dysarthria in ALS patients in an attempt to relate physiological deficits to severity of dysarthria. The researchers measured maximum strength and maximum rate of repeated contractions in 14 ALS patients and 15 normal subjects. Diadochokinetic rates were measured for /pə/ and /tə/ repetitions. (Diadochokinesis is the ability to perform rapid repetitive movements of the vocal organs (Crystal 1997, p. 425)). Maximum strength or force was measured for the lower lip and tongue by having subjects press on a bar with the lower lip or tongue, using as much force as possible. Maximum rate of repeated contractions was determined by having subjects press repeatedly, with their lower lip, tongue or jaw, on a bar as fast as possible (Langmore & Lehman 1994, p. 31). The investigators found that all subjects with ALS were impaired in all tasks. They found that the tongue was more severely affected than the lip or jaw. Furthermore, measures of repeated contraction rate were more highly correlated with severity of dysarthria than strength measures to severity of dysarthria. This correlation indicates that until substantial muscle strength is lost, the severity of dysarthria is dependent on rate of repeated contractions. In contrast, a small decrease in muscle strength may not be perceived as an impairment because people do not tend to speak using maximum muscle strength of the orofacial musculature (Langmore & Lehman 1994, p. 35). Thus, this study shows that dysarthria is a motor impairment in which decreased movement of the orofacial musculature is related to the severity of dysarthria.

McNeil et al. (1990, p. 255) investigated nonspeech motor control of the oral structure in normal, dysarthric, aphasic and apraxic speakers. Both isometric force (compression) and static position control (displacement) of the lips, tongue, jaw and finger were measured using a two-channel oscilloscope, an electronic instrument that produces a visual display of motion. Isometric force was measured as follows: Subjects were required to match one display with a second display on the scope which represented an idealized target. In other words, subjects had to attempt to produce idealized articulatory targets, etc. Reaction time and target speed were not measured (McNeil et al. 1990, p. 259). However, static position was measured by having subjects move the lips, tongue, jaw and finger while observing a cursor until the lips, tongue, jaw and finger reached the target line on a screen. Subjects had to then hold the lips, tongue, jaw and finger steady in order to keep the cursor at the target position (McNeil et al. 1990, p. 261). The researchers found that the dysarthric subjects tended to have significantly greater instability of the force and position of the orofacial structures and of the finger than normal subjects (McNeil et al. 1990, p. 262). The study suggests that use of nonspeech motor control tasks (such as finger movement) could help in the understanding of deficits in neuromotor speech production (McNeil et al. 1990, p. 266). This study is relevant to this thesis as it shows that dysarthria is a motor deficit not only specific to speech, but also to nonspeech motor tasks such as finger movement. This thesis argues that dysarthria is an overall motor impairment that happens to affect the linguistic intelligibility of patients in a minor way.

Ackermann et al. (1995, p. 1252) performed a kinematic analysis of lower lip movements in four subjects with ataxic dysarthria in order to investigate the influence this cerebellar disorder has on articulatory performance. (Kinematics is the study of motion, with specific reference to the influence of mass and force.) Ackerman et al. (1995) examined both opening and closing gestures (production of [p]) in /pap/ and /pa:p/ sequences. Specifically, they examined speech motor control by measuring the peak velocity or speed of each type of gesture, as well as the range and vowel duration of each sequence. It was found that subjects with ataxic dysarthria increased the duration of both phonologically long and short vowels. However, short vowels were lengthened more than corresponding long vowels. Nevertheless, three out of the four subjects were able to discriminate between two short and long vowel targets, indicating patients with ataxic dysarthria had preserved the phonological distinction of vowel length (Ackermann et al. 1995, p. 1258). Similar results are found in the present study (see section 4.1 Duration, p.37).

The investigators reported a correlation between peak velocity and movement amplitude for the motor control of both upper limbs and speech. For both, patients with dysarthria can maintain a steady state during the middle of a movement. However, dysarthric subjects displayed less variation and reduced peak velocity than normal subjects for opening and closing movements and for duration. In conclusion, dysarthric patients have an impaired ability to increase peak velocity. In order to produce articulatory gestures that can be perceived as different, dysarthrics need to be able to increase muscular forces within short time periods. Dysarthric patients are not able to do this (Ackermann et al. 1995, p. 1258).

These three studies all provide evidence which supports a definition of dysarthria as a fairly superficial speech disorder resulting from an impairment in muscular control of motor processes that are not speech-specific. They report that patients with dysarthria have physiologic deficits in the orofacial musculature system, specifically an inability to produce maximum strength and maximum rate of repeated contractions (Langmore & Lehman 1994, p. 28). They also display significantly greater instability in the force and position of orofacial structures and the finger (McNeil et al. 1990, p. 262), and an inability to increase muscular forces within a short time period (Ackermann et al. 1995, p. 1258).

2.1.1.3 Errors Made by Patients with Dysarthria

The above vowel length studies provide some evidence to support the idea that the patients have unimpaired phonemic systems (although they cannot reliably produce contrasts). This phenomenon is comparable to the stage of covert contrast that children pass through during the acquisition of phonetics and phonology. In covert contrast, the child's production of contrasting sounds is acoustically or articulatorily distinct but is not perceived as different by adults. The child does not articulate the contrast in an adult-like way until later; consequently, there is a delay between the production of the contrast and the perception of that contrast by others (Scobbie et al.1998, p. 147). I propose that covert contrast occurs with dysarthrics: dysarthrics are able to discriminate phonemic contrasts, but are unable to reliably produce them. I review further evidence below.

2.1.1.3.1 Phonetic Contrast Errors in the Production of Segments

People with dysarthria often make phonetic contrast errors. For example, the first three studies discussed below describe vowel and consonant misarticulations. Phonetic contrast errors in the production of segments were examined in a study of phonetic intelligibility (Kent et al. 1989, p. 482). The researchers developed a word intelligibility test for patients with dysarthria that examined 19 acoustic-phonetic contrasts. The test was used to assess 13 male subjects with ALS. Subjects were instructed to read a set of words from the intelligibility test. Ten judges selected the response best representing the production of the subject from four choices, namely: a target item and three alternatives differing in one or two phonetic features (Kent et al. 1989, p.

493). The subjects were divided into three groups based on their scores. These groups are: highly intelligible (≥ 95%), moderately intelligible (60% - 95%) and < 60% intelligible. The researchers found that the highly intelligible group made almost no phonetic contrast error proportions (Kent et al. 1989, p. 493). The moderately intelligible group had small error proportions; however two of the contrast errors involved high error rates, namely, errors involving stop versus nasal (e.g. dot-knot) and initial glottal versus null (e.g. hate-ate). The <60% intelligible group had error proportions that were higher in all phonetic contrasts than for the two other groups. The phonetic contrasts with the highest proportion of errors were stop versus nasal and initial glottal versus null (the same as for the moderately intelligible group). In summary, the most severely affected phonetic features involved: (1) phonatory function (larynx, voicing for speech), (2) articulatory deficit (involving velopharyngeal function as indicated by a high error rate for the stop versus nasal contrast), (3) laryngeal function (as indicated by a high error rate for the glottal versus null contrast), (4) place of articulation for lingual fricatives and (5) tongue regulation for vowel height (Kent et al. 1989, p. 494). This study supports the covert contrast hypothesis in that although the phonetic intelligibility of the dysarthric patients was impaired, patients were able to maintain phonological contrasts.

Acoustic-phonetic contrasts and intelligibility in the type of dysarthria associated with mixed cerebral palsy were investigated by Ansel & Kent (1992, p. 296). Subjects were instructed to read monosyllabic consonant-vowel-consonant (CVC) real word minimal pairs. The researchers investigated seven phonetic contrasts: syllable-initial voicing, syllable-final voicing, stop versus nasal, fricative versus affricate, front versus back vowel, high versus low vowel and tense versus lax vowel. Acoustic differences between contrast pairs indicated that all of the contrasts were successfully made except for the tense-lax contrast; however production of the dysarthric subjects was different from that of normal subjects (Ansel & Kent 1992, p. 304). Specifically, dysarthric subjects received low intelligibility scores and high error scores with respect to contrast-opposite pairs (Ansel & Kent 1992, p. 296). This study indicates that the phonemic system is maintained but not accurately produced, consistent with the hypothesis that dysarthrics display covert contrast.

Riddel et al. (1995, p. 304) investigated intelligibility and phonetic contrast errors in 29 highly intelligible speakers with ALS. Subjects were instructed to read aloud randomly assigned word lists after which two listeners were required to choose the most intelligible word out of the four. Failure to pick a dysarthric's word was measured (Riddel et al. 1995, p. 306). When the data was analysed for individual subjects, errors were found across all phonetic contrasts (Riddel et al. 1995, p. 310). When group data was examined, four out of seven of the most common contrast errors involved voicing (suggesting laryngeal involvement, e.g. /p/ vs. /b/) or vowel errors (high versus low vowels, e.g. /ɪ/ vs. /æ/ and vowel duration) (Riddel et al. 1995, p. 310-311). Dysarthric subjects made significantly more errors than nondysarthric subjects for the fricative versus affricate contrast, e.g. /ʃ/ vs. /ʧ/ and the alveolar versus palatal fricative contrast e.g. /s/ vs. /ʃ/. Dysarthrics also produced errors involving: (1) stop versus affricate, (2) stop versus nasal, (3) failure to produce final consonants and (4) reduction of the size of initial consonant clusters (Riddel et al. 1995, p. 311). (3) was replicated in this study (see section 4.4 Consonant Omissions, p. 48).

Kent et al. (1992) examined consonant misarticulations. A quantitative description of dysarthria in ten women with ALS was performed with the goal of studying speech intelligibility and its phonetic and acoustic correlates (Kent et al. 1992, p. 723). Phonetic contrasts were obtained from a word-identification test. The methodology was similar to the previously described study (Kent et al. 1992, p. 724). The most affected phonetic contrasts (and their physiological or articulatory interpretations) were stop versus nasal consonant (velopharyngeal function), alveolar versus palatal consonant (lingual function for fricatives), presence or absence of syllable-final consonant (syllable structure), initial consonant versus initial cluster (syllable structure), and stop versus affricate articulation (manner of articulation for lingual consonants) (Kent et al. 1992, p. 726).

In the last study to be reviewed, Odell et al. (1991, p. 67) examined perceptual characteristics of vowel and prosody production in apraxic, aphasic and ataxic dysarthric speakers. Subjects were asked to repeat each word once from a 30 word list of mono-, di- and trisyllabic words. Two transcribers performed perceptual judgements and narrow phonetic transcriptions (Odell et al. 1991, p. 69). The researchers found that distortions were the most common type of vowel errors made by ataxic dysarthric subjects. These distortions seemed to involve abnormal tongue positioning and sound source aberrations but not increased durations (Odell et al. 1991, p. 75). A common error was that ataxic dysarthric patients replaced half of the monophthong vowels (such as [ɑ:]) with diphthongs (such as [aj]). The researchers found that: (1) error rates were greatest for low vowels (/æ/ and /a/); (2) there was no evidence of vowel errors with respect to tongue advancement/retractions (e.g. back vowels /ʊ/, /o/, /ɔ/, /a/ vs. front vowels /I/, /ɪ/, /ɛ/, /æ/); (3) more errors were made with tense vowels (/I/, /a/, /o/, and /ɔ/) than lax vowels; (4) the error rate was slightly higher for non-retroflexed vowels than schwa before /r/ (/ər/; (5) and there were more errors with respect to non-rounded vowels (/I/) than rounded vowels (/o/). There was also a high frequency of paired vowel-consonant errors, indicating the complexity of VC articulation in vowel errors (errors which were clearly caused by the articulation of the following consonant), and a lower frequency of vowel errors in the context of consonant misarticulation. Finally, inaccurate vowel productions occurred more often in initial rather than in noninitial word position (Odell et al. 1991, p. 76-77). Phonetic contrast errors such as vowel misarticulations, were also produced by the subject in the present study. In this study the subject produced longer lax and longer low vowels than the SLP.

2.1.1.3.2 Prosody of Suprasegmentals in English

As the next section (2.1.1.3.3 Prosodic Errors, p.24) reports on errors in prosody discussed in the literature, this section will introduce preliminary concepts and definitions with respect to prosody. As mentioned earlier, dysarthrics make errors in producing segments and also in producing suprasegmentals (i.e. prosody). Suprasegmentals include pitch (fundamental frequency), loudness (amplitude), tempo and rhythm (rate and temporal organization of segments), and other suprasegmentals (Crystal 1997, p. 435). Suprasegmentals indicate how a person is feeling, provide a framework for the segments in an utterance and help a listener to understand a message (Fletcher 1992, p. 110). Linguistically, suprasegmentals convey mood (e.g. declarative, interrogative, etc) and "contrastive stress" (exemplified by sentence pairs such as: *No, I went to the <u>store</u>* vs. *No, <u>I</u> went to the store*). I overview more specific uses of prosodic suprasegmentals below.

The linguistic use of pitch in English is for different intonational contours which indicate a broad array of intonational meanings. English, for example, uses a falling pitch intonation to indicate a statement and a rising pitch intonation to indicate a question.

The acoustic definition of loudness is intensity in decibels (dB). The paralinguistic use of loudness is for conveying different meanings: for example, increased loudness is usually associated with emotions (e.g. anger). The linguistic use of loudness on a syllable is for stress. The perceptual use of loudness is for determining the prominent syllable with respect to other syllables in the phrase (Fletcher 1992, p. 124; Crystal 1981, p. 60).

The linguistic use of duration of a vowel is for stress (e.g. in English, longer vowels are more likely to be perceived as stressed than shorter ones) (Hayes 1995, p. 6). Also, the linguistic use of vowel quality is for stress (e.g. in English, syllables containing the schwa vowel are not stressed) (Hayes 1995, p. 12).

Changes in the rate at which syllables, words and sentences are produced is called tempo. The paralinguistic use of variation in tempo conveys different meanings: for example, fast speech is used to indicate urgency and slower speech is used to indicate deliberation or emphasis.

Together, pitch, loudness and tempo also express rhythm. English rhythm is stress-timed; that is, English produces stressed syllables at regular intervals of time: stressed syllables can be separated by any number of unstressed syllables (Crystal 1997, p. 171).

To summarize, the concepts and definitions introduced in this section, specifically, pitch, loudness, duration, tempo and rhythm are important ones to understand when reviewing studies of prosodic impairment. The following section reviews studies of prosodic errors made by subjects with dysarthria.

2.1.1.3.3 Prosodic Errors

This section will examine several studies which conclude that patients with dysarthria make prosodic errors.

As previously mentioned in section 2.1.1.3.1 Phonetic Contrast Errors in the Production of Segments (p. 20), Odell et al. (1991, p. 67) performed a study which examined the perceptual characteristics of vowel and prosody production in apraxic, aphasic and dysarthric speakers. Subjects were asked to repeat words from a 30 mono-, di- and trisyllabic word list. Three types of prosodic errors were examined: abnormalities in word stress, deviations in intraword temporal parameters (defined below), and difficulties in repeated production of syllables. Abnormal stress qualified as a stress error. Lack of a continuous, sufficiently rapid transition between syllables and lack of smooth, appropriately rapid and unobtrusive transition from one consonant to the next qualified as an intraword temporal deviation. Initial struggle (effort to produce an initial sound, cluster, or syllable) , noninitial struggle (added erroneous sound) and repetition qualified as a repeated production difficulty. Finally, features of syllable prominence like perceived deviations in intensity, pitch, and vowel duration were used to judge syllabic stress patterns (Odell et al. 1991, p. 71).

In an initial analysis, the researchers combined word production with equal and abnormal stress while ignoring vowel production accuracy and they found that dysarthric subjects made 23% errors for two syllable words and 25% errors for three syllable words. The small difference in percentage errors between two and three syllable words indicates that stress production was not greatly affected by an increase in word length. When syllabic stress errors were analysed in words where patients made vowel misproductions, the authors found 56% errors for two syllable words and 50% errors for three syllable words i.e. no difference due to word length (Odell et al. 1991, p. 72). Dysarthric patients also displayed more difficulties when initiating speech productions than when completing a word (Odell et al. 1991, p. 78). To summarize, patients with dysarthria make errors: (1) in the production of stress, (2) in the production of vowels and (3) in initiating speech. In contrast, they make relatively fewer errors in completing an utterance.

Selected acoustic characteristics of contrastive stress production in control geriatrics versus apraxic and ataxic dysarthric speakers (see Table 2.2, p. 15 and Table 2.3, p. 16 for ataxic dysarthria) were examined by Liss & Weismer (1994, p. 45). The authors propose that local stress effects (defined below) improve articulation of segments in the stressed word and also prosodic performance at the sentence-level. Subjects in this study were tested using: (1) two utterances (each containing three content words that could be contrastively stressed) and (2) phonemic sequences with large and complex changes in articulation (Liss & Weismer 1994, p. 47). Subject performance was measured using ratings by judges and acoustic analysis of segment and utterance duration (Liss & Weismer 1994, p. 48). Liss & Weismer (1994, p. 56 & 63) found phrase-level temporal effects of contrastive stress production in dysarthric subjects: (1) there was an abnormal adjustment of vowel duration in non-stressed words that followed a stressed word in an utterance. For example, when the word '*buy*' was stressed in the utterance '*buy Bobby a poppy*,' dysarthric subjects produced an abnormal adjustment of vowel duration in the non-stressed words that followed. (2) there was also an abnormal adjustment in vowel duration in non-stressed words in a neutrally stressed utterance. For example, when the utterance '*buy Bobby a poppy*' was produced with the absence of stress on the word '*buy*', there was an abnormal adjustment of vowel duration in the non-stressed words that followed. To summarize, Liss & Weismer (1994) found that patients with dysarthria produced abnormal stress adjustments in contrastive stress (defined earlier in 2.1.1.3.2 Prosody of Suprasegmentals in English, p. 23) at the sentence level.

Hertrich & Ackermann (1993, p. 177) investigated syllable intensity and fundamental frequency in patients with dysarthria resulting from Friedreich's Ataxia. Acoustical analysis was used to examine articulation test sentences that subjects repeated after an examiner (Hertrich & Ackermann 1993, p. 179). Fundamental frequency (F_o) and sound intensity (dB) were used as acoustic correlates of perceived pitch and loudness (Hertrich & Ackermann 1993, p. 178). The researchers found that dysarthric patients had: (1) increased sound intensity values (loudness) of within-utterance variation; in contrast (2) between-utterance variation of fundamental frequency (pitch) was within normal range, indicating little difference from normal subjects (Hertrich & Ackermann 1993, p. 177). To conclude, Hertrich & Ackermann (1993) found that patients with dysarthria produced abnormal loudness and intonational patterns that are linguistically adequate yet different from normal subjects within an utterance. In the present study, the dysarthric subject did not have an impairment of intensity but did have a minor impairment with respect to frequency (i.e. he is somewhat monotone).

Gentil (1990, p. 438) also investigated dysarthria in Friedreich's ataxia using acoustic analysis. Fourteen dysarthric subjects were instructed to repeat several nonsense utterances seven times at two different rates (Gentil 1990, p. 439). Analysis of fundamental frequency and intensity was examined for the repeated production of the syllable /pa/ and the sustained vowel /I/ (Gentil 1990, p. 440 - 441). Subjects with dysarthria were found to have abnormal parameters of fundamental frequency and intensity, marked by sudden and distinct variations of fundamental frequency and intensity (Gentil 1990, p. 446).

To summarize, Odell et al. (1991) found that patients with dysarthria produced: (1) abnormalities in word stress, (2) deviations in intraword temporal parameters and (3) difficulties with repeated productions. Segmental complexity did not affect stress production. Liss & Weismer (1994) found abnormal stress adjustment in contrastive stress. Hertrich & Ackermann (1993) found that dysarthric patients produced abnormal loudness within an utterance and intonational patterns that are linguistically adequate yet different from normal subjects. Lastly, Gentil (1990) found that dysarthric subjects produced abnormal parameters of fundamental frequency and intensity. Generally, it can be concluded that a dysarthric subject's use of pitch and intensity is mildly impaired and not the same as that of normal speakers.

2.1.1.3.4 Timing Errors

Patients with dysarthria often make timing errors. The following studies reveal timing deficits resulting from the speech disorder of dysarthria.

The timing of speech segments in seven patients with dysarthria resulting from Friedreich's ataxia was examined by Ackermann & Hertrich (1993, p. 75). Subjects were instructed to repeat 12 test sentences which were presented to them orally by an examiner. The test was performed twice for each subject (Ackermann & Hertrich 1993, p. 78). Acoustic analysis was used to examine durational measurements of syllables and intrasyllabic segments. The researchers found that dysarthric subjects produced prolonged syllables, vowels, stop lengths, and fewer durational contrasts between stressed and unstressed syllables (Ackermann & Hertrich 1993, p. 75). Still, stressed syllables of a word or sentence generally were longer than corresponding unstressed syllables (Ackermann & Hertrich 1993, p. 81). However, dysarthric subjects did not have higher voice onset time values (used for aspiration and voicing) and variation coefficients, with respect to segments, compared to normal subjects. They also did not have a timing deficit with respect to coordination of articulators in the sentence utterances (that is, a lack of timing deficit in the coordination of alternating movements of various articulatory organs within sentence utterances) (Ackermann & Hertrich 1993, p. 75).

The study by Gentil (1990, p. 438) also commented on timing, specifically on diadochokinesis, which is the ability to perform rapid repetitive movements of the vocal organs (Crystal 1997, p. 425). Diadochokinetic rates were studied by instructing subjects to quickly repeat the syllable /ma/ and the sequence /epapap/. The fast repetitions required subjects to alternate the movements of various articulatory organs. The mean number of repetitions per second was measured for each item. It was found that dysarthric subjects always produced lower diadochokinetic rates than normal speakers. The rate was very low for some patients (Gentil 1990, p. 445-446). Gentil (1990, p. 447) suggests that dysarthric patients are clumsy in their performance of alternating movements of the oralfacial structures. This deficit creates a problem specific to English and other stress-timed languages where stressed syllables are typically produced at regular intervals of time.

2.2 Summary

The above studies indicate that dysarthria is a motor deficit not specific to speech. Its linguistic effects include segmental covert contrast errors and suprasegmental errors, both of which contribute to the unintelligibility of the dysarthric. These findings are consistent with the hypothesis that dysarthria is a relatively superficial disorder reflecting a motor impairment and not a deeper phonological/phonetic disorder where there is a problem in programming of articulation.

CHAPTER 3

Method and Analysis

3.1 Method

Data was gathered from one English speaking adult with dysarthria. The subject was assessed by a speech-language pathologist using the National Hospitals College of Speech Sciences Assessment of Dysarthria (Robertson 1976) (Appendix 3, p. 134) supplemented by additional tests (Appendix 2, p. 130), which I provided, similar to those on the main test. The tape recorded results of the assessment test served as the primary data base for the study.

3.1.1 Subject

The subject is a 57 year old male adult who suffered from a right Cerebrovascular Accident (CVA) or stroke, and presents with progressive flaccid dysarthria. The subject displays the following types of linguistic impairments: (1) hypernasality affecting all stops (to varying degrees depending on the level of plosion needed) as well as making vowels more nasal; (2) sound distortions; (3) sound omissions (for example: /k/ gets deleted because of weak tongue back and hypernasality); (4) consonant cluster deletion (for example: /sn/ becomes /n/); (5) syllable reduction/deletion (for example: a three syllable word gets reduced to two syllable word); (6) sound substitutions (for example: /b/ becomes /p/ possibly because of the subject's inability to coordinate voicing while focussing on oral breath pressure; the subject has difficulty controlling breath support). Note that the subject did not exhibit each type of linguistic impairment consistently but only intermittently.

The subject has a left facial droop with a left sided weakness in the upper and lower extremities. He also has some difficulty swallowing. This is the second stroke experienced by the patient, the first of which occurred approximately two years before. In the past year, the subject has experienced Transient Ischemic Attacks (TIA's) approximately every two to three weeks. TIA's are blood clots in the brain that dissolve very quickly and do not cause permanent damage.

The subject retired after his first stroke because he felt that although he had no difficulty expressing himself or understanding spoken language, he did experience some difficulty reading and writing. He describes his reading and writing impairment as "no big loss" and does not have any desire to be assessed with respect to these skills. The patient felt his speech was slightly different after the first stroke. The patient reported that after his second stroke, his speech has become slurred and he is experiencing swallowing difficulties.

Assessment by a speech-language pathologist for swallowing difficulties revealed the patient had a mild dysphagia (swallowing difficulty) accompanied by a slight delay in initiation of the swallowing reflex.

With respect to expressive language, the subject was able to provide correct orientation information in a conversational exchange. For instance, he was able to correctly answer questions like: how are you, what is your name, what did you do for a living, what is your address, and why are you here? These questions clearly showed that the subject was oriented cognitively in that he was lucid with respect to person (in this case, himself), place and time. In a confrontation picture naming task and a confrontation questioning task, the subject was accurate 100% of the time. In a listing task the subject performed moderately well with some minor difficulty (the subject was able to provide the names of three fruits, but had difficulty providing three words beginning with the letter "b"). In a picture description task, the patient began by listing but when cued used complete sentences (the subject got all the major concepts and used appropriate pronouns, nouns, and verbs). The patient displayed no paraphasia (an involuntary error in the production of words or phrases (Crystal 1997, p. 434)) and no word finding difficulty. The subject did, however, use a simple sentence format; his ideas were usually connected with the term "and" rather than using embedded and relative clauses. The subject made informative descriptions. With respect to problem solving, the patient had minimal difficulty, which the speech-language pathologist did not feel needed treatment. The subject's responses were generally accurate but he needed encouragement to expand responses and explanations. The speech-language pathologist feels the subject's difficulty with production of speech is a compensation technique. The patient's wife noted that the subject was not a talkative person before either stroke but he was less so again after both strokes.

With respect to receptive language, the subject answered all yes-no questions correctly and was able to follow five-step commands accurately. The subject's comprehension of complex syntactical structures was examined and the subject responded correctly on four out of five structures. The subject has no major grammatical competence problem. These observations indicate little impairment of linguistic competence.

The subject has had a hearing loss for the past eight to nine years and was diagnosed with the loss approximately two and a half years ago. He wears Binaural Hearing aids, one in each ear, but his Speech-Language Pathologist did not feel they affected his competence in any way. The subject's hearing loss was pre-existing and there is no indication of pre-stroke speech or language problems in childhood or later adulthood. According to the subject's spouse, the subject's speech problems coincided with his initial stroke and deteriorated with each successive stroke. This was also the area temporarily affected by his TIAs (C. E. Kearney, personal communication, October 14 & 27, November 2, 1999; January 19, February 1, 2000; April 5 & 7, 2000).

3.1.2 Assessment Test

The subject was assessed using The National Hospitals College of Speech Sciences Assessment of Dysarthria (Appendix 3, p. 134) supplemented by additional tests (listed and described in Appendix 2, p.130). The main test is an elicitation test for adults used to assess the speech disorder resulting from dysarthria. Divided into five major sections, it examines Respiration, Phonation, Articulation, Prosody and Speed, and Speech Musculature.

The Respiration section examines the pattern and capacity or control of respiration. The Phonation section examines the ability to initiate and sustain voice, volume, repeated voicing, pitch, intonation, tone of voice, volume and quality. The Articulation section examines initial consonant production at the single word level, consonant production in different word positions at the sentence level, consonant blends, polysyllabic words, vowels, and intelligibility. The Prosody and Speed section examines rate of speech and rhythm of speech. The Speech Musculature section examines facial expression at rest and smiling, lip and jaw movement, tongue and palate position at rest and at movement, teeth condition, chewing, swallowing, drooling and diadochokinetic rates.

I supplemented the main dysarthria test (Appendix 3, p.134) with additional tests (Appendix 2, p. 130) which probed for intonation, vowel production and nonword repetitions.

A speech-language pathologist conducted the test by instructing a subject to repeat productions after her and by physically examining the patient in the section on Speech Musculature. The assessment was tape-recorded.

3.1.3 Analysis of Data

Data was gathered by the speech-language pathologist. Then the author did the following: The tape-recorded results were phonetically transcribed (Appendix 1, p. 69) and analysed using a nonlinear phonological framework and phonetics/phonology interface model to investigate the possibility of phonological impairment. Phonetic analysis was performed using PRAAT (Appendix 1, p. 69). Specific areas of investigation included phonetic contrast errors in consonants and vowels, prosodic errors in stress and intonation, and timing errors. Comparisons were made between the subject and the SLP. There are methodological limitations to this type of comparison with the SLP and they will be discussed further in section 5.5 Methodological Limitations (p. 61).

Both the main test and additional test problems were phonetically transcribed (Appendix 1, p. 69) (conventions from Pullman & Ladusaw 1986 and Du Bois, Cumming, Schuetze-Coburn & Paolino 1992). After this point, the focus of analysis shifted to one part of the Articulation section in the main test. The goal of this part of the test was to examine consonant sounds in different positions in 25 sentences (Appendix 1, p.76 for 25 statements). Focus was narrowed down to this particular section of the tests because it was decided that the 25 statements would provide an accurate sample for examining the hypothesis of the current study. (Initially, it was intended that question intonation would be examined, but upon analysis of the tape, it was discovered that the SLP did not produce question intonation in the intended question utterances. Consequently, the subject, who was supposed to imitate the SLP, did not produce question intonation in those utterances).

The 25 statements (Appendix 1, p. 76), each produced by the subject and the SLP, were analysed using PRAAT acoustic software. Both the subject's and SLP's 25 statements were measured for duration, frequency and intensity.

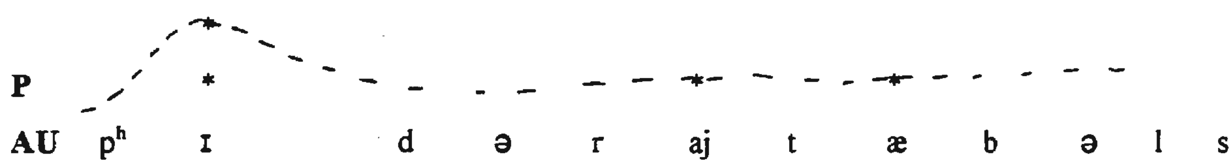
To test the subject's mastery of duration, two-tailed t-tests were performed (when appropriate) that compared the subject and the SLP. Durational comparisons between the subject and SLP were made of the following: statements, aspiration of voiceless stops, tense vowels ([aj] '*lie*', [ej] '*bay*', [uw] '*boot*', [ij] '*feet*', [ow] '*boat*', [aw] '*crowd*', [oj] '*boy*' and [ʌj] '*buy*'), lax vowels ([ɪ] '*bit*', [ʌ] '*shut*', [ɛ] '*bet*' and [ɔ] '*poor*'), low vowels ([ɑ] '*saw*', [æ] '*back*' and [a] '*guard*'), sonorants ([r], [m], [N], [l], [n], [w] and [j]), syllabic sonorants ([r], [n] and [l]), voiced fricatives ([v], [z], [ð] and [ʒ]), voiceless fricatives ([f], [s], [h], [θ] and [ʃ]) and [ə] vowels.

Intensity in decibels for both sets of statements was examined in several ways. Minimum and maximum intensity (range), and mean intensity and standard deviation from each mean were measured to test for monoloudness. Two-tailed t-tests of significance were performed to test for significant differences between the subject and the SLP. Relative ranges of intensity in the statements were measured for both the subject and the SLP and the means of theses ranges were compared to determine if the subject had a greater, smaller or same overall intensity range as the SLP. Mean intensity in the statements were measured for both the subject and the SLP and the overall mean of these statement mean intensities were measured to determine if the subject had a greater, lesser or same overall mean intensity as the SLP. Standard deviations from mean intensity in the statements were measured for both the subject and the SLP and the means of these deviations were compared to determine if the subject deviated from the mean more, less or the same as the SLP. (Caution must be taken when interpreting the results of the intensity analysis since the subject and SLP were not equidistant from the microphone. Intensity varies inversely with distance. In retrospect, more care should have been taken to ensure the subject and SLP were equally spaced from the microphone. However, they were approximately equidistant).

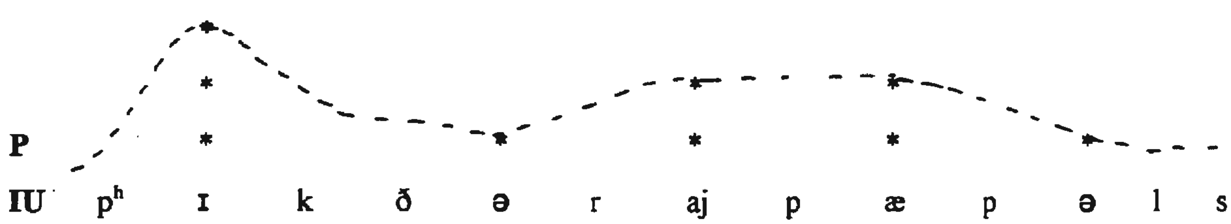
Frequency in Hertz for both sets of statements (subject and SLP) was examined in several ways. Minimum and maximum frequency (range) was measured, the number of frequency peaks were counted and the type of intonation (falling or rising) was determined. Mean frequency and standard deviation from each mean were also determined to test for monopitch. Two-tailed t-tests of significance were performed (when appropriate) to test for significant differences between the subject and the SLP. Relative ranges of frequency in the statements were measured for both the subject and the SLP and the means of these ranges were compared to determine if the subject had a greater, smaller or same overall frequency range as the SLP. Standard deviations from mean frequency in the statements were measured for both the subject and SLP and the means of these deviations were compared to determine if the subject deviated from the mean more, less or the same as the SLP. Stress placement was determined by examining vowel quality, frequency and intensity and was indicated using a grid pattern of asterisks (*) presented above each statement. There were four possible levels of stress that a syllable was assigned. The highest level of pitch assigned on a syllable is represented by three asterisks and the lowest level is represented by no asterisks. Intonation contours can be extrapolated by drawing a mental line of best fit over the asterisks. See example (6) in which the patient displays normal intensity but flattened pitch. The columns of asterisks in (6) represent the pitch patterns (P) produced by the SLP (intended utterance - IU) and the subject (actual utterance - AU). Pitch was determined by examining vowel quality, intensity and frequency.

(6) Repetition of "Pick the ripe apples."

(a) Subject's or actual utterance (AU):



(b) SLP's or intended utterance (IU):



The dysarthric subject omitted 20 consonants in the 25 sentences (4.4 Consonant

Omissions, p. 48). These omissions were examined to see where they occurred in the statements: before or after a lax vowel, or in a specific syllable position, word position and phrase position. Exact binomial tests were performed (when appropriate) to determine if the subject and SLP were significantly different.

The subject produced 33 weakly articulated consonants (segments where the articulators weakly approximated voicing, place of manner of articulation) (4.5 Weakly Articulated Consonants, p. 50). These segments were compared with the SLP's accurately produced segments using duration measurements. They were grouped by place of articulation, manner of articulation and voicing. Chi-squared (goodness of fit) tests and binomial tests were performed (when appropriate).

3.1.4 Types of Statistical Tests Employed

Two-tailed t-tests, chi-square tests and exact binomial tests were used in the analysis of data. To ensure the power and robustness of the statistical analysis, statistical testing was only employed if there were at least 15 observations in a group. Individual segment analysis was only performed when the subject produced significant differences from the SLP in the overall class of sounds and if there were at least 15 observations in a group.

Two-tailed t-tests were chosen because they are a useful tool to compare population means when the following assumptions are satisfied: (1) The relative frequency distributions are approximately normal in both sampled populations. (2) Both populations variances are equal. (3) Samples are independently and randomly selected from populations (McClare & Dietrich II 1992, p. 383 and 385).

Chi-square tests were chosen because they are a useful tool to compare two or more population proportions when the following assumptions are satisfied: (1) A multinomial experiment has been performed when a random sample has been taken from a population. (2) The sample size is large enough so that for every group, the expected number of observations in each cell should be at least five. The chi-squared is a goodness of fit test that tests if the same proportion of observations fall in each group (McClare & Dietrich II 1992, p. 450-454; G.

Sneddon, personal communication, April 20, 2000).

Exact binomial tests were chosen because they are a useful hypothesis test that can determine if a proportion of a population selects a particular response greater than 50% of the time. With the exact binomial test one does not have to make any assumptions that there be a certain number of observations (G. Sneddon, personal communication, April 20, 2000).

3.2 Summary

A subset of the transcribed data (namely, 25 statements, Appendix 1, p. 76) was subjected to statistical analysis to ascertain any significant differences between the speech of the SLP and the subject. The details are discussed and analysed in Chapter 4: Results and Discussion (p. 37) and methodological limitations are discussed in section 5.5 Methodological Limitations (p. 61).

CHAPTER 4

Results and Discussion

4.1 Duration

Duration was measured using PRAAT acoustic software (Appendix 1, p. 69) to test how the subject compared with the SLP for duration in statements, classes of sounds or particular segments. To test the subject's mastery of duration, two-tailed t-tests were performed (when appropriate) that compared the subject and the SLP.

Means (M), standard deviations (SD) and number of observations (N) were calculated with respect to duration for the subject and the SLP, and t-tests were performed where appropriate. Table 4.1 summarizes the statistical analysis of the subject's and the SLP's duration of statements, classes of sounds and particular segments.

Table 4.1 Duration of statements, classes of sounds and particular segments for SLP and subject (in seconds).

	SLP			Subject			
	M	SD	N	M	SD	N	t-statistic (where appropriate)
Statement	2.31	0.46	25	2.3	0.63	25	-------------------------
Tense vowels	0.2	0.1	37	0.2	0.1	37	-------------------------
Lax vowels	0.1	0	43	0.11	0	43	$t = -3.75$, $df = 84$; $p < 0.05$; Significant
[ɪ] lax vowel	0.1	0	20	0.11	0	20	$t = -2.68$, $df = 38$; $p < 0.05$; Significant
Low vowels	0.11	0.1	25	0.16	0.1	25	$t = -2.95$, $df = 48$; $p < 0.05$; Significant
Sonorants	0.11	0.1	67	0.11	0.1	67	-------------------------
Voiced fricatives	0.13	0.1	32	0.16	0.1	32	$t = -2.00$, $df = 62$; $p < 0.05$; Significant

	M	SD	N	M	SD	N	t-statistic (where appropriate)
Voiceless fricatives	0.14	0.1	19	0.13	0.1	19	--------------------------
Schwa	0.1	0	23	0.1	0	23	--------------------------

The overall mean for the 25 statements (Table 4.1) was calculated as 2.31 seconds for the SLP and 2.30 seconds for the subject. No t-test was performed as the means were the same. It can be concluded that there is no difference in overall length of statements between the subject and the SLP. So this aspect of the subject's production of prosodic units is unimpaired.

Tense vowels [aj], [ej], [uw], [ij], [ow], [aw] and [ʌj] were measured for duration. Mean duration for all tense vowels (Table 4.1) was calculated for the SLP and subject and both produced tense vowels that were on average 0.20 seconds long. No t-test was performed because the means were equal and it can be concluded that the SLP and subject do not produce tense vowels of different length. Tense vowels were not further analysed.

Lax vowels [ɪ], [ʌ], [ɛ], and [ɔ] were measured for duration[1]. (There were no examples of the lax vowel [ʊ]). Mean duration of lax vowels (Table 4.1) was calculated for the SLP and subject. The SLP had a mean of 0.08 seconds and the subject had a mean of 0.11 seconds. A two-tailed t-test was performed and it was found that the means were significantly different ($t = -3.75$, $df = 84$; $p < 0.05$). The subject produced lax vowels that were significantly longer than those produced by the SLP.

The lax vowel [ɪ] was further analysed to see if the subject and SLP produced length differences. Lax vowels [ʌ], [ɛ] and [ɔ] were not examined because there were not enough

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[1] Low vowels are not normally classified as either tense or lax. In English, however, low vowels [a] and [æ] are classified as lax. They pattern like lax vowels in that [a] and [æ] need to occur in words with a CVC structure rather than words consisting of a CV syllable (O'Grady & Dobrovolsky 1996, p. 35). For instance, [a] can only occur before /r/ in the relevant Newfoundland dialect of English, i.e. in a CVC syllable like 'car'. Likewise, [æ] can only occur in a CVC syllable like 'bat'. Note that in this study, although [a] and [æ] pattern like lax vowels in English, they will be grouped with the low vowels. Similarly, the low vowel [ɑ], acts like a tense vowel in English in that it can appear in CV structures like 'saw'. However, in this study [ɑ] is grouped with the low vowels rather than with the lax vowels.

observations for further analysis of these segments. Means were calculated for the lax vowel [ɪ] (Table 4.1) with the SLP producing the vowel for 0.08 seconds and the subject producing the vowel for 0.11 seconds. A two-tailed t-test was performed and it was found that the means were significantly different ($t = -2.68$, $df = 38$; $p < 0.05$). The subject produced significantly longer [ɪ] lax vowels than the SLP.

Low vowels [ɑ], [æ] and [a] were measured for duration. Mean duration of low vowels (Table 4.1) was calculated for the SLP and subject. The SLP had a mean of 0.11 seconds and the subject had a mean of 0.16 seconds. A two-tailed t-test was performed and it was found that the means were significantly different ($t = -2.95$, $df = 48$; $p < 0.05$). The subject produced low vowels that were significantly longer than those produced by the SLP. Individual low vowels [ɑ], [æ] and [a] were not further analysed because there were not enough observations for further analysis of these segments.

Sonorants [r], [m], [N] (the velar nasal), [n], [l], [w] and [j] were measured for duration. Mean sonorant length (Table 4.1) was calculated for the SLP and subject it was found that both produced sonorants that were on average 0.11 seconds long. No t-test was necessary to conclude there was no difference in length of sonorants between the subject and SLP. Individual sonorants [r], [m], [N], [n], [l], [w] and [j] were not further analysed.

Voiced Fricatives [v], [z], [ð] and [ʒ] were analysed for duration. Voiced fricative duration means (Table 4.1) were calculated with the SLP producing fricatives that were 0.13 seconds long and the subject producing fricatives that were 0.16 seconds long. A two-tail t-test was performed and it was found that the means were significantly different ($t = -2.00$, $df = 62$; $p < 0.05$). The subject produced voiced fricatives that were significantly longer than those of the SLP. Individual voiced fricatives [v], [z], [ð] and [ʒ] were not further analysed because there were not enough observations for further analysis of these segments.

Voiceless fricatives [s], [f], [h], [θ] and [ʃ] were analysed for duration. Means were calculated for voiceless fricative duration (Table 4.1). The SLP produced segments that were 0.14 seconds long and the subject produced segments that were 0.13 seconds long. No t-test was necessary to conclude there was no difference in length between the SLP's and subject's production of voiceless fricatives. Further analysis was not performed on individual voiceless fricatives [s], [f], [h], [θ] and [ʃ].

Duration of schwa production was calculated. Schwa duration means (Table 4.1) were: SLP = 0.07 seconds and subject = 0.07 seconds. No t-test was necessary to conclude there is no difference in length between the SLP's and subject's production of schwa.

4.1.1. Duration Summary

Table 4.2 presents a summary of differences in duration between the SLP and the subject.

Table 4.2 Summary of differences in duration of SLP and subject.

Not Significant (No t-test performed, means the same)	Significant (two-tailed t-test performed)
Statements	Lax Vowels
Tense Vowels	[ɪ] Vowels
Sonorants	Low Vowels
Voiceless Fricatives	Voiced Fricatives
[ə] Vowels	

The subject produced significantly longer lax vowels, low vowels, [ɪ] lax vowels and voiced fricatives than the SLP. However, even though the subject produces certain classes of sounds, lax vowels, low vowels and voiced fricatives and the segment, [ɪ], with longer durations than the SLP, the subject still matches the SLP in terms of statement duration. So it was hypothesized that perhaps the significant differences in segmental duration offered a way for the subject to compensate for other errors. For example, perhaps the subject lengthened lax vowels, low vowels, voiced fricatives and/or [ɪ] lax vowels when he omitted a consonant. Accordingly, consonant omissions were examined in section 4.4 Consonant Omissions (p. 48) to see if they occurred before or after lax or low vowels. However, there was no pattern with respect to consonant omissions in the environment of a lax vowel or low vowel.

It can also be noted that having lax vowels, having more than one low vowel, and having voiced fricatives in a phonemic inventory is typologically rare (Maddieson 1984). However, it has been argued that typological rarity is due to either articulatory complexity (Browman & Goldstein 1989, p. 201-251) or to phonological complexity (Avery & Rice 1989, p. 179-200). Therefore, typological rarity does not argue for or against the hypothesis of this thesis (that the disorder is not phonological).

Schwa duration was examined to discover if the subject had a different articulation rate than the SLP. Articulation rate can be defined as the tempo of articulating an utterance. The rate does not include silent pauses but does include filled pauses and syllable prolongations (Laver 1994, p. 539). Increases in articulation rate occur when unstressed syllables are shortened or when syllable structures are reorganized or both (Laver 1994, p. 544). It can be concluded that decreases in articulation rates occur when unstressed syllables are lengthened or when syllable structures are reorganized or both. Since the dysarthric patient in this study does not increase or decrease unstressed syllables (those containing schwa) and does not reorganize syllable structures, we can conclude that the subject's articulation rate is the same as that of the SLP. In conclusion, the subject's articulation rate is not impaired by dysarthria.

The results of the durational analysis can be related to findings of the literature reviewed in Chapter 2: Previous Research (p. 13). Ackermann et al. (1995, p.1258) found that ataxic dysarthric patients increased the duration of both phonologically long and short vowels. (In English, tense vowels are equal to long vowels while lax vowels are equal to short vowels). However, short vowels were lengthened more than corresponding long vowels. Nevertheless, the subjects' ability to discriminate between short and long vowel targets indicates they had preserved the phonological distinction of vowel length. Similar results were found in the present study in that the dysarthric patient produced significantly longer lax vowels than the SLP, but maintained phonological distinctions; long vowels were still longer that short vowels overall.

In this study, it was found that the dysarthric patient produced significantly longer low vowels than the SLP. Riddel (1995, p. 311) found that one of the most common contrast errors involved high vs. low vowels and vowel duration. Odell et al. (1991, p.76) found that sound distortion error rates for ataxic dysarthric patients were greatest for the low vowels /æ/ and /a/.

An overall conclusion from the duration analysis is that although the dysarthric subject produces some significant differences from the SLP (norm), the patient does not have a major impairment with respect to duration. Prosodic utterance length is unimpaired; articulation rate is unimpaired; and long/tense vowel duration is unimpaired. Some segmental duration is impaired, but not so much as to obscure phonological contrasts. The subject maintains vowel length distinctions, however his productions are less distinct than an unimpaired person. This phenomenon is analogous to covert contrast, but is not as obvious/advanced as covert contrast. The overall conclusion supports the claim that dysarthria is superficial motor implementation level disorder.

4.2 Intensity

Intensity (in decibels) was analysed in the 25 statements using PRAAT acoustic software (Appendix 1, p. 76). Intensity means for each statement were measured for the SLP and subject. Table 4.3 presents intensity, standard deviation means for the SLP and subject.

Table 4.3 Intensity means for statements of SLP and subject (in decibels).

	SLP	Subject
Mean	48.69	48.39
Standard Deviation	0.54	0.42
Number of Observations	25	25

Overall mean intensities for all 25 statements (Table 4.3) were calculated for both the SLP and subject. Overall, the SLP produced a mean intensity of 48.69 decibels and the subject produced a mean intensity of 48.39 decibels. No statistical test was necessary to conclude there was no difference in mean intensity between the SLP and subject.

Standard deviations from mean intensities were measured for all 25 statements to test for monoloudness. Table 4.4 presents standard deviation from mean intensity for both the SLP and subject.

Table 4.4 Standard deviation from mean intensity for statements of SLP and subject (in decibels).

	SLP	Subject
Mean	2.04	1.88
Standard Deviation	0.66	0.52
Number of Observations	25	25
t-statistic	t = -0.94; df = 48; p > 0.05; Not Significant	

Overall means for standard deviations from mean intensities (Table 4.4) were calculated for both the SLP and subject in order to measure whether the SLP or subject produced mean intensities that deviated differently from the mean. The SLP produced a mean standard deviation of 2.04 decibels and the subject produced a mean standard deviation of 1.88 decibels. A two-tailed t-test was performed and it was found that there was no significant difference in mean standard deviations from mean intensities between the SLP and subject ($t = 0.94$, $df = 48$; $p > 0.05$) which means that the SLP and subject produce mean intensities that do not deviate differently from the mean and that they use intensity to convey the stressed/unstressed contrast in a similar manner.

Relative ranges of intensity (in decibels) for each statement was measured for the SLP and subject in order to see whether the SLP or subject produced significantly different ranges in intensity. Table 4.5 presents the relative ranges of intensity for the SLP and subject.

Table 4.5 Relative ranges of intensity for statements of SLP and subject (in decibels).

	SLP	Subject
Mean	9.59	8.6
Standard Deviation	2.49	2.06
Number of Observations	25	25
t-statistic	t = 1.52; df = 48; p > 0.05; Not Significant	

Overall means of relative ranges of intensity (Table 4.5) were calculated for the 25 statements. The SLP produced a mean relative range of intensity of 9.59 decibels and the subject produced a mean relative range of intensity of 8.60 decibels. A two-tailed t-test was performed and it was found that there was no significant difference in relative range of intensity between the SLP and subject ($t = 1.52$, $df = 48$; $p > 0.05$) meaning that the SLP and subject produce the same ranges of intensity and use intensity to convey the stressed/unstressed contrast in a similar manner.

4.2.1 Intensity Summary

A summary of intensity findings are presented in Table 4.6.

Table 4.6 Summary of intensity findings for SLP and subject.

Not Significant (No t-test performed, means the same)	Not Significant (two-tailed t-tests performed)
Intensity Means	Standard Deviation from Mean Intensity
	Intensity Relative Ranges

The subject does not produce higher or lower intensity means than the SLP for the 25 statements. The subject does not produce significantly larger or smaller standard deviations from mean intensities than the SLP for the 25 statements. Lastly, the subject does not produce significantly larger or smaller intensity relative ranges than the SLP for the 25 statements. It can be concluded that the subject is not experiencing an impairment with respect to intensity. The dysarthric disorder has not affected production of intensity for this patient. The patient has no problems with intensity, one of the main correlates of prosodic units which are realized as rhythm and stress.

4.3 Frequency

Frequency (in Hertz) was analysed in the 25 statements using PRAAT acoustic software

(Appendix 1, p. 76). Standard deviations from mean frequency were measured for the statements to see if the SLP or subject produced mean frequencies that deviated differently from the mean to test for monopitch relative to the speaker's own mean. Table 4.7 presents standard deviations from mean frequency for the SLP and subject.

Table 4.7 Standard deviation from mean frequency for statements of SLP and subject (in Hertz).

	SLP	Subject
Mean	113.21	72.45
Standard Deviation	32.85	53.25
Number of Observations	25	25
t-statistic	$t = 3.26$; $df = 48$; $p > 0.05$; Significant	

Overall means for standard deviations from mean frequencies (Table 4.7) were calculated for all 25 statements for both the SLP and subject. The SLP produced a mean standard deviation of 113.21 Hertz and the subject produced a mean standard deviation of 72.45 Hertz. A two-tailed t-test was performed and it was found that there was a significant difference in standard deviations from mean frequencies between the SLP and the subject ($t = 3.26$, $df = 48$; $p > 0.05$). The subject produced lower standard deviations from the mean than the SLP which indicates that the subject was more monotone than the SLP.

Relative ranges of frequency (in Hertz) for each statement were measured for the SLP and subject to see whether the SLP or subject produced significantly different ranges in frequency[2]. Table 4.8 presents the relative ranges of frequency for the SLP and subject.

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[2] These tests are valid because they test relative, not absolute, ranges in frequency. Males and females have different absolute frequency ranges but can have the same relative ranges in frequency. See 5.5 Methodological Limitations, p. 61 for further discussion.

Table 4.8 Relative ranges of frequency for statements of SLP and subject (in Hertz).

	SLP	Subject
Mean	415.19	308.57
Standard Deviation	99.7	201.22
Number of Observations	25	25
t-statistic	t = 2.37; df = 48; p > 0.05; Significant	

Overall means of relative ranges of frequency (in Hertz) (Table 4.8) were calculated for the 25 statements. The SLP produced a mean relative range of frequency of 415.19 Hertz and the subject produced a mean relative range of frequency of 308.57 Hertz. A two-tailed t-test was performed and it was found that there was a significant difference in mean relative range of frequency between the SLP and the subject ($t = 2.37$, $df = 48$; $p > 0.05$). The subject produced a smaller mean relative range of frequency than that of the SLP, indicating that the subject was more monotone than the SLP.

4.3.1 Frequency Summary

A summary of frequency findings are presented in Table 4.9.

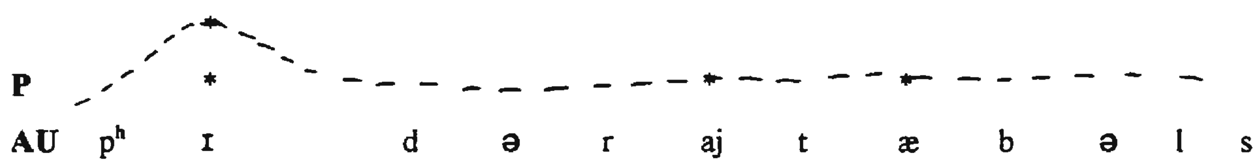
Table 4.9 Summary of frequency findings for SLP and subject.

Significant (two-tailed t-tests performed)
Standard Deviation from Mean Frequency
Frequency Relative Ranges

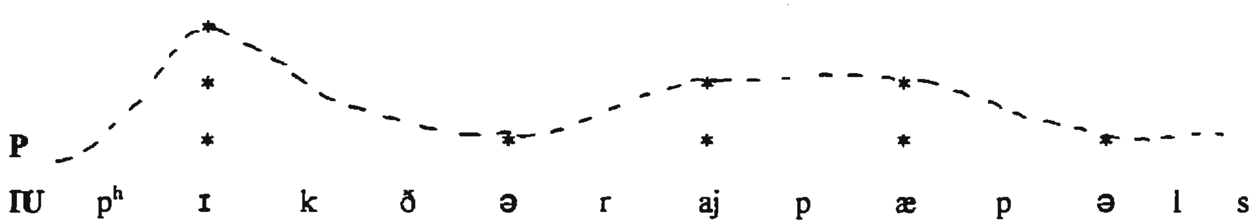
The subject produced a significantly smaller standard deviation from mean frequency than the SLP for the 25 statements. The subject did not deviate from the mean as much as the SLP. The subject produced significantly smaller frequency relative ranges than the SLP for the 25 statements. Although the relationship between frequency and pitch is not one to one, the smaller range of frequency can also be seen in the phonetic transcription of pitch (Appendix 1, p. 76). See also example (7). The subject often places appropriate stress on words in the statements but not with the same range of frequency as the SLP. The subject produces correct pitch patterns for statements but these patterns are flatter than those produced by the SLP. The subject uses the correct intonation pattern for statements (falling) but the pattern is smoother than the SLP's, as can be evidenced in example (7) (see Appendix 1, p. 76 for more examples). Pitch was determined by examining vowel quality, intensity and frequency. Intonational patterns can be seen by drawing a mental line of best fit using the asterisks as a guide. The patient displays normal intensity but flattened pitch.

(7) Repetition of "Pick the ripe apples."

(a) Subject's or actual utterance (AU):



(b) SLP's or intended utterance (IU):



It can be concluded that the subject has an impairment with respect to frequency and is somewhat, but not severely, monotone. His realization of prosodic units such as feet and the intonational phrase is somewhat impaired.

4.4 Consonant Omissions

Consonant omissions were analysed to see if they occurred before or after a lax or low vowel. It was hypothesized that perhaps there was compensatory lengthening of lax or low vowel duration in the environment of an omitted consonant. Consonant omissions were also examined to see if they occurred in onset or coda position in the syllable or in word initial, initial onset, medial, final or final coda position[3]. Consonant omission patterns by the subject are presented in Table 4.10.

Table 4.10 Consonant omissions by subject.

Statement Number	Segment	Before or After Lax Vowel	Before or After Low Vowel	Onset or Coda Position	Word Initial, Medial or Final
1	k	After	----	Coda	Final
4	ð	----	----	Onset	Initial
5	ð	----	----	Onset	Initial
5	k	Before	----	Onset	Medial
6	g	----	After	Coda	Final
7	d	----	----	Coda	Final
7	l	----	After	Coda	Final Coda
8	r	----	----	Onset	Initial Onset
9	θ	----	----	Coda	Final
9	θ	----	----	Coda	Medial
10	z	----	----	Coda	Final
11	r	----	----	Onset	Medial

[3]Consonant omissions in phrase positions were examined and it was found that most omissions occurred phrase medially. This was not examined further.

11	s	----	----	Coda	Final
12	z	----	----	Coda	Final
13	N	----	----	Coda	Final
14	d	----	Before	Coda	Final
14	z	----	----	Coda	Final
15	r	----	----	Coda	Final
16	p	----	----	Coda	Final Coda
20	t	After	----	Coda	Final
				Proportions:	Proportions:
				Onsets = 5/20	Initials = 2/20
				Codas = 15/20	Medials = 3/20
					Finals = 12/20
					Final Codas = 2/20
					Initial Onsets = 1/20

There was no pattern with respect to consonant omissions in the environment of a lax vowel or low vowel, i.e. vowels which were earlier found to be significantly longer. In other words, lax vowel lengthening was not a lengthening strategy to compensate for deleted consonants. Consonant omissions were examined with respect to syllable position (onset or coda) using an exact binomial test to see whether the proportion of consonant omissions in coda position (15/20) occurred more than 50% of the time. It was found that there is strong evidence that the subject deleted a consonant in coda position more than 50% of the time ($p = 0.02$). Word position could not be analysed using a statistical test, such as a chi-squared test because it was not possible to obtain at least five observations in each group (initial, initial onset, medial, final and final coda). This is a general rule that needs to be true if one is to perform a goodness of fit test like the chi-squared (this type of test procedure assumes fairly large sample sizes). It can be noted however that 12/20 times the consonant omission occurred in final position, 3/20 times in medial position, 2/20 times for both initial and final coda position and 1/20 times in initial onset position.

4.4.1 Consonant Omissions Summary

It can be concluded that consonant omissions occurred in coda position significantly more than in onset position. Kent et al. (1992, p. 726) examined consonant misarticulations in dysarthric patients and found that one of the most affected phonetic contrasts was presence or absence of a syllable-final consonant. Without the benefit of statistical testing we can note that the omissions also seemed to occur in final position in the word more than in any other position. Similarly, Riddel et al. (1995, p. 311) found that dysarthric patients failed to produce final consonants. Recall from section 1.3 Test of Hypothesis (p. 9) that errors in the production of final codas could reflect a deviant underlying syllable structure. (In other words, consonant omissions could indicate a deeper phonological impairment). In section 5.3.1.1 Deletion in Coda Position (p. 58), I will argue that consonant omissions made by dysarthric subjects are not necessarily the result of a phonological problem.

4.5 Weakly Articulated Consonants

Means were calculated for duration of weakly articulated consonants (segments where the articulators weakly approximated voicing, place or manner of articulation) to see if the subject produced the same duration of weakly articulated segments as the SLP's target segment[4]. Table 4.11 presents duration of weakly articulated consonants for the SLP and subject.

---

[4] Classes of weakly articulated consonants were not compared to classes of segments in an English sample in general. Thus the incidence of weakly articulated classes of consonants does not simply reflect the frequency of these classes of consonants in a general sample. (For further discussion of this non-problem see 5.5 Methodological Limitations, p. 61).

Table 4.11 Weakly articulated consonant duration of SLP and subject (in seconds).

	SLP Duration	Subject Duration
Mean	0.12	0.11
Standard Deviation	0.07	0.06
Number of Observations	33	33

The weakly articulated consonants duration means were: SLP = 0.12 and subject = 0.11. No t-test was necessary to conclude that there was no difference in length between the SLP's and subject's production of weakly articulated consonants. These consonants were further analysed by grouping the segments by place of articulation, manner of articulation and voicing to see if the weakly articulated consonants were of a particular place of articulation, manner of articulation or voicing. Table 4.12 presents weakly articulated consonants grouped by place of articulation, manner of articulation and voicing for the subject.

Table 4.12 Weakly articulated consonants grouped by place of articulation, manner of articulation and voicing by subject.

Place of Articulation	Manner of Articulation	Voicing
Bilabials - 1	Stops - 12	Voiced - 23
Labiodentals - 3	Fricatives - 9	Voiceless - 10
Velars - 11	Affricates - 5	
Alveolars - 8	Nasals - 3	
Alveopalatals - 7	Liquids - 4	
Glottals - 3		
Proportions:	Proportions:	Proportions:
Bilabials = 1/33	Stops = 12/33	Voiced = 23/33
Labiodentals = 3/33	Fricatives = 9/33	Voiceless = 10/33
Velars = 11/33	Affricates = 5/33	

Alveolars = 8/33	Nasals = 3/33	
Alveopalatals = 7/33	Liquids = 4/33	
Glottals = 3/33		

An exact binomial test was performed to see if weakly articulated segments happened to be voiced segments more than 50% of the time. It was found that there is strong evidence that the weakly articulated segments were voiced more than 50% of the time ($p = 0.02$) indicating the patient has some impairment of laryngeal functions. This result is congruous with the previous finding that the subject is experiencing difficulty producing voiced fricatives but not voiceless fricatives.

A chi-squared test was performed to test whether the probability of getting a weakly articulated segment in any place of articulation is equal. Noting that the rule for this goodness of fit test was barely met (this type of test procedure assumes fairly large sample sizes), it was found that there is strong evidence in favour of there not being an equal chance of the weakly articulated segments occurring in each group ($p = 0.02$). Indications are that the weakly articulated segments are not equally spread among different places of articulation; however, no conclusions can be drawn about which place of articulation tends to be weakly articulated. Errors with respect to weakly articulated segments could indicate a phonological problem (describable in terms of classes of sounds) or a motor implementation problem (describable in terms of which part of the vocal tract musculature is more impaired). So results are inconclusive for the hypothesis that the dysarthric impairment is not phonological. (Further study in this area would be relevant).

A chi-squared test was performed to test whether the probability of getting a weakly articulated segment in any manner of articulation is equal. Noting that the rule for this goodness of fit test was barely met, it was found that there is mild evidence in favour of there not being an equal chance of the weakly articulated segments occurring in each group ($p = 0.07$). Indications are that the weakly articulated segments are not equally spread among different manners of articulation; however, no conclusions can be drawn about which manner of articulation tends to be weakly articulated because of the small sample size.

4.5.1 Weakly Articulated Consonants Summary

Weakly articulated consonants are likely to be voiced consonants more than 50% of the time, suggesting some impairment of laryngeal functions. Riddel et al. (1995, p.310) found that one of the most common contrast errors involved voicing, suggesting laryngeal involvement. Weakly articulated consonants are also not likely to be equally distributed among different places of articulation or manners of articulation; i.e. indications are that the weakly articulated segments are not equally spread among different places of articulation or manners of articulation. Tests were inconclusive about which place of articulation or manner of articulation is more likely to be weakly articulated.

4.6 Realizations of Segmental and Suprasegmental Units

Recall the following prosodic hierarchy, repeated from 1.2.1.2 Prosodic Tiers, p.3.

```
(8)                    IP      (Intonational Phrase)
                       |
                       φ       (Prosodic Phrase)
                       |
                       ω       (Prosodic Word)
                       |
                       F       (Foot)
                     /   \
               σ strong   σ weak    (Syllables (strong and weak))
                  |        |
                  μ        μ        (Onset vs. rhyme (moras))
                  |        |
                  •        •        (Segmental/Melodic tier)
                  |        |
                 [F]      [F]       (Segmental Features) (not further shown)
```

The prosodic hierarchy consists of the following tiers: the intonational phrase, prosodic phrase, prosodic word, foot, syllables and moras. The segmental feature geometry consists of the segmental/melodic tier and feature tier (details are not shown).

The subject in this study is experiencing an impairment in the realization of units above the segmental tier. Specifically, there is a mild impairment with respect to the realization of the Intonational Phrase. The subject produces the correct intonational pattern for statements (falling) but the pattern is smoother or more monotone than the SLP's. The patient displays normal intensity but flattened pitch. There is an impairment with respect to feet in that the subject places appropriate stress on words but not with the same range of frequency as the SLP. Also, the subject may have an impaired syllable structure, as he omits consonants in coda position. However, this possibility is ruled out in section 5.3.1.1 Deletion in Coda Position (p. 58).

There is robust evidence that duration of some segments is mildly impaired, enough to cause a phenomenon reminiscent of but not as extreme as covert contrast. With regard to segments, there is weak evidence that voicing is impaired (this is analogous to covert contrast) and that certain place/manners of articulation are more likely to be impaired. However, neither finding addresses the issue of whether the impairment is phonological or phonetic, since the segmental impairments can be equally well described as a problem with a certain articulator, etc., or as a problem with a certain feature. Conclusions are presented in the following chapter.

CHAPTER 5

Conclusion

This chapter will overview the original thesis hypothesis, statistical analysis findings, literature supporting the hypothesis, predictions and findings of the phonetics/phonology interface model, possible methodological limitations and major conclusions.

5.1 Original Hypothesis

The hypothesis of this thesis is to investigate whether dysarthria affects the output of (a) categorial phonological rules, (b) gradient language-particular phonetic rules, and/or (c) gradient universal phonetic rules. The following findings are expected:

(a) covert contrast (the ability to produce phonemic contrasts, but in a deviant way)

(b) no deep impairment of language-specific phonemic or phonetic rules

(c) across-the-board superficial impairment in phonetic implementation rules (both language-specific and universal) i.e. no difference in impairment between these rules.

In other words, dysarthria should affect the output of all types of rules, at the level of phonetic implementation only.

5.2 Statistical Analysis Findings

With respect to duration (4.1 Duration, p. 37), the subject produced significantly longer lax vowels, low vowels, [ɪ] lax vowels and voiced fricatives than the SLP. Regardless of these errors (and other non-durational errors), the subject was able to match the SLP in terms of statement length. Schwa duration (and possible syllable reorganization) was examined in an effort to explore possible differences in articulation rate between the subject and the SLP and it was concluded that the patient did not have an impairment of articulation rate. The overall conclusion from the durational analysis was that the subject has a mild impairment with respect to duration which only shows up in the production of some short segments.

The intensity analysis (4.2 Intensity, p. 42) established that the subject and the SLP produce the same means of intensity, standard deviations from mean intensities and intensity relative ranges. Overall, it was concluded that the patient does not have an impairment of intensity, one of the main correlates of rhythm and stress.

With respect to frequency (4.3 Frequency, p. 44), the subject produced significantly smaller standard deviations from mean intensities and significantly smaller frequency relative ranges. The subject places appropriate stress on words in statements but not with the same range of frequency as the SLP. The subject produces the correct intonation patterns for statements (falling) but these patterns are flatter than those of the SLP. Overall, it was concluded that the subject is experiencing an impairment with respect to frequency (i.e. he is somewhat monotone).

Analysis of consonant omissions (4.4 Consonant Omissions, p. 48) uncovered that the subject omitted consonants in coda position more than in onset position. Consonant omissions also seemed more likely (not confirmed by statistical testing) to occur in word final position.

Analysis of weakly articulated consonants (4.5 Weakly Articulated Consonants, p. 50) proved that these consonants are likely to be voiced consonants more than 50% of the time, suggesting laryngeal involvement. Statistics indicate that the weakly articulated segments are not equally spread among different places of articulation or manners of articulation but statistical tests were then inconclusive about which place of articulation or manner of articulation is more likely to be weakly articulated.

5.3 Hypothesis Findings

This section will discuss how dysarthria affects (a) categorial phonological rules, (b) gradient language-particular phonetic rules, and (c) gradient universal phonetic rules, at the level of phonetic implementation only. The locus of the dysarthric disorder is at the level of motor implementation, into which the phonological/phonetic levels feed. The output of all types of rules are equally and superficially deviant.

5.3.1 Categorial, Phonological Rules/Representations

The output of categorial rules are mildly and superficially deviant. If dysarthria was a deeper disorder, serious impairment would be exhibited in the patient's phonology. The output of categorial phonological rules or representations would be severely impaired. For example, the adult could display errors in syllable production, reflecting defective syllable structure. This type of error was not expected or found in this study. The subject had a minor impairment with respect to consonant production in that the subject tended to omit consonants in coda position more than in onset position (these omissions also seemed more likely to occur in word final position). (See 5.3.1.1 Deletion in Coda Position, p. 58, for why consonant omissions in coda position reflect a phonetic error and a deviant syllable structure).

The subject with dysarthria produced minor voicing (e.g. weakly articulated consonants were more likely to be voiced) and durational errors (e.g. lengthening lax vowels, low vowels, [ɪ] lax vowels and voiced fricatives) but these did not indicate a deep impairment in his phonology. The subject does have covert contrast in that he is able to produce contrasts but sometimes in a deviant way. For instance, the subject produced several velar consonant segments which could not be classified as either a /k/ or a /g/ acoustically, but there was no evidence to indicate that the subject lacked phonological knowledge of the velar contrast /k/ vs. /g/. Likewise, the tense vowel /ij/ and the lax vowel /ɪ/ were measured for duration and statistically analysed. It was found that there was no difference in length between the subject's and SLP's production of /ij/, however, there was a significant difference between the subject's and SLP's production of /ɪ/. The subject produced significantly longer /ɪ/ vowels than the SLP. The subject did however maintain the phonological difference between the tense vowel /ij/ and the lax vowel /ɪ/. There was no impairment with respect to the categorial rule that distinguishes between /ij/ and /ɪ/ and the subject was able to correctly distinguish the two vowels; however, there was impairment (mild covert contrast) in the realization of this contrast. The subject lengthened the /ɪ/ but still produced phonemically different segments.

The subject had an unimpaired phonemic system, but he was unable to produce some contrasts completely accurately. Nevertheless, he generally produced sounds that were acoustically or articulatorily distinct.

5.3.1.1 Deletion in Coda Position

In this study, consonant omissions in coda position are considered to be a phonetic error. However, one could argue that the dysarthric patient's phonology is disordered because of the fact that the consonant omissions usually occur in coda position.

One could counter-argue, however, that errors in coda position are really errors in timing of the articulatory musculature. For example, in an analogous case, Crystal (1987, p. 25) argued that erroneous neutralization of voicing in coda position was not a phonological error but the result of a universal phonetic process. He argued that the sounds at the beginning and end of the word 'dad' represent the same phoneme; however, the initial sound is fully voiced whereas the final sound has less voicing. The sounds are in complementary distribution in that when the word is spoken in isolation, the fully voiced realization is not normally found word finally, whereas the less voiced realization is not normally found word initially. Thus if a speaker did use the full voiced realization word finally or the less voiced realization word initially, meaning would not be affected but neutralization would be apparent.

Similarly, the errors of the patient in question could be the result of articulatory mistiming such that a C is intended but not produced syllable finally. Thus consonant omissions in coda position could be considered a post-phonetic error where there is an impairment in the timing of the articulatory musculature.

There are two reasons why the subject's consonant deletions do not indicate defective syllable structure. First, the subject *can* produce codas, whereas children with codaless syllable representations cannot. Second, the subject never employs compensatory strategies like blending (e.g. realizing sn → n̥) whereas children with defective syllable structures do (Bernhardt & Stemberger 1998). So this adult's symptoms are not comparable to the symptoms of child subjects with disordered phonology.

The omission and weakening facts do not force us to conclude a phonological disorder. The subject can produce codas and complex CC's, and therefore has unimpaired syllable structure.

5.3.2 Gradient, Language-Particular Phonetic Rules

The output of gradient, language-particular rules are mildly and superficially deviant. Superficial impairment in phonetic implementation in language-specific rules was expected and found. To illustrate, the subject's realization of prosodic feet (which are realize in a language-specific manner) was mildly impaired. The subject had a minor impairment with respect to frequency in that he did not deviate from mean frequencies as much as the SLP and had smaller frequency relative ranges. The subject produced correct intonation patterns for statements (falling) but they were flatter than those of the SLP.

5.3.3 Gradient, Universal Phonetic Rules

The subject's output of gradient, universal rules are mildly and superficially deviant. The phonetic rule of nasalization of an oral vowel in the environment of a nasal segment is an example of a gradient universal phonetic rule. The subject experiences a superficial impairment with respect to this rule in that he applies more nasalization to vowels compared to that of the SLP, see example (8).

(8)

Normal Speaker (e.g. SLP):

Phonetic Interpolation

Phonological output: d ɛ n

[-nasal] [+nasal]

Phonetic implementation: fully nasal

(Target assignment

and interpolation) fully oral

Subject with Dysarthria:

Phonetic Interpolation

Phonological output: d ɛ n

(unimpaired phonemic

contrasts) [-nasal] [+nasal]

Impaired phonetic implementation: fully nasal

(Target assignment

and interpolation) fully oral

Example (8) illustrates that the normal speaker applies normal amounts of nasalization to the vowel [ɛ] in the word [dɛn], whereas the dysarthric subject applies deviant amounts of nasalization to the vowel [ɛ] in [dɛn]

5.4 Literature Review Support of Hypothesis

This section will briefly review the literature from Chapter 2: Previous Research (p. 13) in order to compare those findings with the results of this study.

Dysarthria is clinically described as a speech disorder that results from an impairment in muscular control of the motor processes involved in the production or execution of speech. Dysarthria does not involve a deeper disorder in programming of articulation.

The major conclusions of the literature are that in general, dysarthria is a motor impairment. The linguistic effects of dysarthria include segmental covert contrast errors and suprasegmental errors, both of which contribute to the unintelligibility of patients with dysarthria. These linguistics effects are consistent with the findings of this study, which found superficial impairment in some aspects of duration, frequency and consonant production.

5.5 Methodological Limitations

There are design limitations and methodological limitations with the type of analysis employed in this study, namely, the issue of comparison with one experimenter and the use of population statistics. I will first deal with the issue of comparison with one experimenter. In this study a 57 year old male adult was compared to a younger female Speech-Language Pathologist. There can be a great deal of variability within and between speakers in duration, intensity, pitch, dialect, gender, age, style, context, sociolinguistic factors, etc. Thus, some differences between the subject's and SLP's speech may be unrelated to the subject's impairment, but could be a result of variability with respect to some of the factors mentioned above.

However, duration of segments has not been previously shown to differ as a function of age, dialect, gender etc. so comparison of the subject to the SLP is not a problem in this instance.

Intensity has also not been shown to be a function of age, dialect, gender, etc. so comparison of the subject to the SLP with respect to intensity is not problematic. Further, the subject was asked to imitate the SLP, i.e. to match the SLP as closely as possible. As a result, any non-match can be taken for an error, assuming that normal subjects are capable of matching the SLP, at least quantitatively.

With respect to frequency, comparisons were made between the subject to his own norm and between the SLP to her own norm (standard deviation from mean frequency). In other words, the tests measured the qualitative differences between the SLP and the subject; methodology is not a problem here since the SLP and the subject were not compared quantitatively. (It is known that males and females differ very much quantitatively with respect to frequency).

With respect to the use of population statistics it is important to note that using t-tests or chi-squares to compare two individuals is a scientific risk because of lack of power, and because the parameters being compared are not sufficiently independent (i.e. they do not exist in one or the other person). When using these statistical tests, care was given to only analyse samples that were larger than 15.

Finally, recall that exact binomial tests were used to examine weakly articulated segments in order to determine whether errors were more likely to occur in one particular class of sounds than another. One might argue that the subject produced errors randomly, and that the error proportions found in the study simply reflected the normal proportions of the sounds in question in an average speech sample. To use a hypothetical example, suppose the subject produced random errors 1% of the time and that in a normal speech sample, velars occurred twice as frequently as alveolars. The result would be that the subject produced twice as many errors in velars than in alveolars. However, the subject was not compared to a normal speech sample; the subject was required to repeat specific statements made by the SLP. Thus, the null hypothesis is that no errors should be produced; however, 33 errors were produced. The distribution of these errors could reflect: (1) a typical distribution of speech sounds or (2) a deviant distribution of speech sounds. Given the nature of the sample, (2) might be more likely. Nevertheless, these findings are not robust.

For the purposes of this study, published data from groups of same-age/same-gender speakers were not used for comparison.

5.6 Conclusion

This thesis supports the hypothesis that dysarthria is a superficial disorder at the level of motor implementation that affects phonological and phonetic implementation rules alike. The output of categorial rules, language-specific phonemic and phonetic rules are equally (and mildly) deviant. Dysarthria appears to be a superficial level disorder affecting some aspects of duration, frequency and consonant production. Dysarthria does not reflect a deeper disorder where there is a problem in programming of articulation at the level of phonetic implementation. Dysarthria is a physical output level disorder.

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Appendix 1

Phonetic Transcription

Symbol Key:

Symbol	Key
... ( )	long pause (> 0.6 seconds) e.g. ... (0.7)
...	medium pause (0.3 to 0.6 seconds, inclusive) e.g. ...
..	short pause (< 0.3 seconds) e.g. ..
˞	retroflexion
__	creaky voice
N	velar nasal
˳	voiceless
D	flap
˜	nasalized
superscript symbols	weak or badly pronounced segments
<X>	uncertain hearing, indecipherable
( )	speech overlap, or no pause
@	laughter
K	indistinguishable velar
D	indistinguishable alveolar
ˊ	primary stress
ˋ	secondary stress

The 25 statements used for the analysis in this thesis are located on pages 110-132.

The following shows how the phonetic transcription is organized. **AU** represents actual utterance and is the SLP's production. **IU** represents intended utterance and is the subject's production. Any pauses between utterances will be transcribed within the utterance where it occurs and is measure in seconds. Pitch (**P**) is represented by a grid notation pattern of asterisks (*). There are four possible levels of pitch that a syllable can be assigned. The highest level of pitch assigned on a syllable is represented be three asterisks and the lowest level is represented by no asterisks.

Pitch (**P**)
Actual Utterance and Pause in seconds (**AU**)

Pitch (**P**)
Intended Utterance and Pause in seconds (**IU**)

The following chart was used to present acoustic information about the 25 statements produced by the SLP and subject:

- duration of statement
- frequency details such as range, number of peaks and type of intonation (rising - RI or falling - FI)
- frequency mean
- frequency standard deviation
- intensity range
- intensity mean
- intensity standard deviation

Any comments on the phonetic productions for either the SLP or the subject were placed in a comments (**C**) section under the chart.

	SLP		SUBJECT	
Duration				
	Frequency	Intensity	Frequency	Intensity
Range (Peaks; Intonation)				
Mean				
Standard Deviation				

Comments (**C**):

Although not marked in the phonetic transcription, the subject had a general nasal voice quality. Appropriate nasalization is marked in the Intended Utterance of the SLP. The following pages contain the phonetic transcription of the main test of dysarthria called "Robertson's Assessment of Dysarthria" (Appendix 3, p.168) as well as the additional tests (Appendix 2, p. 164) on consonants, intonation, vowels and non word repetition. The "Robertson's Assessment of Dysarthria" is divided into five main sections: Respiration, Phonation, Articulation, Prosody and Speed and Speech Musculature.

The Respiration section examines the pattern and capacity or control of respiration. The Phonation section examines the ability to initiate and sustain voice, volume, repeated voicing, pitch, intonation, tone of voice, volume and quality. The Articulation section examines initial consonant production at the single work level, consonant production in different work positions at the sentence level, consonant blends, polysyllabic words, vowels, and intelligibility. The Prosody and Speed section examines rate of speech and rhythm of speech. The Speech Musculature section examines facial expression at rest and smiling, lip and jaw movement, tongue and palate position at rest and at movement, condition of the teeth, chewing, swallowing, drooling and diadochokinetic rates.

The Robertson's test was supplemented with additional tests which probed for intonation in questions, vowel production and nonword repetitions.

The main test and additional tests are transcribed below, where appropriate (for instance, the Speech Musculature section required physical examination). The 25 sentences used for the analysis in this thesis are located on pages 110-132.

ROBERTSON'S ASSESSMENT OF DYSARTHRIA

RESPIRATION

Capacity/Control

Ability to Sustain /s/ on Exhalation

Actual Utterance and Pause in ms (**AU**)	s:	ʃ:
Intended Utterance (**IU**)	s:	

Ability to Crescendo on /s/

AU	s:	t ..	s:	ʃ:	tʃ
IU	s:				

Ability to Dimimuendo on /s/

AU	s:	ʃ:
IU	s:	

Ability to Repeat Series of /s/ sounds /s-s-s-s/

AU	ts: ...(0.74)	ts: ... (0.9)	ts: ... (0.83)	s: ... (0.86)	s: ... (0.74)	s: ... (0.81)	s:
IU	s:	s:	s:	s:	s:	s:	s:

Comments: The subject was supposed to take a breath in between each utterance. Subject paused between each utterance but failed to take a breath between the first three segments: [ts ts ts].

PHONATION

Initiating Voice

Ability to Initiate /a:/

AU h a:

IU ʔ a:

Sustaining Voice

Ability to Sustain /a:/

AU ʔ a:

IU ʔ a:

Note: Subject let air out on first attempt.

Volume

Ability to say /a:/ at:

a) Loud Volume

AU h a:

IU ʔ a:

b) Ability to Increase Volume on /a:/

AU h a:

IU ʔ a:

c) Ability to Decrease Volume on /a:/

AU h a: <u>a:</u>

IU ʔ a:

Repeated Voicing

Ability to initiate voice consistently on /a: a: a: a:/

AU	ʔ	a: ...(0.99)	ʔ	a: ...(1.53)	ʔ	a: ...(1.67)	ʔ	a: ...(2.44)	ʔ	a: ...
IU	ʔ	a:	ʔ	a:	ʔ	a:	ʔ	a:	ʔ	a:

AU	ʔ	a:
IU	ʔ	a:

ARTICULATION

Initial Consonants

pie

AU	^{p}	h	a
IU	p^h	aj	

boy

AU	^{p}	h	oj
IU	b	oj	

tea

AU	t^h	I
IU	t^h	ij

do

AU	d	u^w
IU	d	uw

car

AU	^{K}	ɑ	r
IU	k^h	ɑ	r

go

AU	^{g}	o^{w}	
IU	g	ow	

four

AU	f	ɔ	^{ə}
IU	f	ɔ	r

vie

AU	p^{h}	aj	
IU	v	aj	

thigh

AU	ð	aj	
IU	θ	aj	

though

AU	ð	o^{w}	
IU	ð	ow	

sea

AU	ts	z	ij
IU	s	ij	

zoo

AU	s	z	uw
IU	z	uw	

shy

AU	^{K}ʃ	aj	
IU	ʃ	aj	

beige

AU	b	ej	^{d}	ʒ
IU	b	ej	ʒ	

chair

AU	ʧ	e	r
IU	ʧ	e	r

joy

AU	ʤ	oj
IU	ʤ	oj

lie

AU	^{l}	aj
IU	l	aj

row

AU	rw	ow
IU	r	ow

way

AU	w	ɛ^{j}
IU	w	ej

why

AU	w	a^{j}
IU	ʍ	aj

Comments: Subject does not have [ʍ] in his dialect.

high

AU	ʔ	a^{j}
IU	h	aj

you

AU	j	u^w
IU	j	uw

my

AU	m	a^j
IU	m	aj

no

AU	n	ow
IU	n	ow

sing

AU	z	ɪ	N
IU	s	ɪ̃	N

Consonants

1. Pick the ripe apples.

		*										
P		*					*		*			
AU	p^h	ɪ		d	ə	r	aj	t	æ	b	ə	l
		*										
		*					*		*			
P		*			*		*		*		*	
IU	p^h	ɪ	k	ð	ə	r	aj	p	æ	p	ə	l

AU	s
IU	s

SLP			SUBJECT	
D	2.4		1.78	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	74.62 - 548.49 (2; FI)	46.67 - 53.77	75.05 - 580.87; (1, 1 very minor; FI)	46.61 - 55.20
M	135.2	47.95	99.52	48.17
SD	115.18	1.49	64.94	1.89

C: SLP: (1) exaggerates speech. Subject: (1) omits [k] in *pick*. (Deletion) (2) doesn't aspirate [p] in *pick*. (3) changes [ð] in *the* to [d]. (4) changes [p] in *ripe* to [t].

2. A tube of baby cream.

			*										
P	*		*	b	*			*			K	
AU	ej	tʰ	uw		ʌ	v	b	ej	p	ij		r
			*									
			*		*			*				
P	*		*		*			*		*		
IU	ə	tʰ	uw	b	ʌ	v	b	ej	b	ij	kʰ	ɾ̥

	*	
P	*	
AU	I	m
P	*	
IU	ĩj	m

SLP			SUBJECT	
D	2.09		2.27	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	77.12 - 505.29 (1, 2 minor; FI)	46.77 - 54.70	78.31 - 577.09 (1; FI)	46.69 - 56.92
M	177.35	47.92	116.41	48.57
SD	124.57	1.14	94.21	2.31

C: SLP: (1) exaggerates speech. Subject: (1) uses [ej] to say *a* whereas SLP uses [ə]. (2) weakly pronounced [^{b}] in *tube*. (2) [p] instead of [b] in second syllable of *baby* (Devoicing). (3) indistinguishable velar [^{K}] in *cream* instead of [k^h]. (4) voices [r] in *cream* instead of [r̥] (Voicing). (5) omits glide [j] in diphthong in *cream*.

3. Put out the butter for tea.

		*										
P		*		0					*			
AU	p^h	ʌ	d		d	ð	ə	b	ʌ	D	ə	r
		*										
		*		*					*			
P		*		*			*		*		*	
IU	p^h	ʌ	t	aw	t	ð	ə	b	ʌ	t	ə	r

P		*			*
AU	f	ɔ	r	d	ij
					*
P		*			*
IU	f	ə	r	t^h	ij

SLP			SUBJECT	
D	2.1		2.3	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	76.62 - 535.04 (1, 1 minor; FI)	46.69 - 57.39	74.93 - 581.56 (1, 2 very minor; FI)	46.61 - 51.22
M	160.93	48.38	99.35	47.69
SD	128.35	2.33	63.79	1.03

C: SLP: (1) exaggerates speech. Subject: (1) weird aspiration in *put*, [p^H] instead of [p^h]. (2) [d] instead of [t] in *put* (Voicing). (3) [d] instead of [t] in *out* (Voicing). (4) [d] instead of [t^h] in *tea* (Voicing).

4. The garden is hard to dig.

				*								
P			^{K}	*								*
AU				a	r	d	ə	n	ɪ	z		a

				*								
				*								*
P		*		*			*		*			*
IU	ð	ə	g	a	r	d	ə	n	ɪ	z	h	a

P						*	^{g}
AU	r	d	t^h	ə	d	ɪ	

						*	
P				*		*	
IU	r	d	t^h	uw	d	ɪ	g

	SLP		SUBJECT	
D	2.54		1.98	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	79.22 - 542.30 (3, 1 minor; FI)	46.68 - 56.93	78.90 - 548.91 (2, 2 very minor; FI)	46.75 - 56.78
M	205.69	48.57	156.69	48.83
SD	171.26	2.2	156.84	2.41

C: SLP: (1) exaggerating speech. Subject: (1) omits [ð ə] 'the' (Deletion). (2) omits [h] in *hard* (Deletion). (3) indistinguishable velar in *garden*, [^{K}] instead of [g]. (4) uses [ə] in *to* instead of [uw], not an error but would contribute to making statement shorter. (5) [^{g}] instead of [g] 'dig,' would contribute to making statement shorter.

5. The cat is drinking milk.

				*								
P			g	*								
AU		ə		a	r	d	ə	n	ɪ	z	d	r
				*								
				*								
P		*		*					*			
IU	ð	ə	kʰ	æ	tʰ				ɪ	z	d	r
P	*	N			N		*					
AU	ɪ			ɪ		m	ɪ	l	k			
	*						*					
P	*			*			*					
IU	ɪ̄	N	k	ɪ̄	N	m	ɪ	l	kʰ			

SLP			SUBJECT	
D	2.01		1.66	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	78.00 - 541.59 (1, 1 minor; FI)	46.97 - 53.95	75.43 - 126.87 (1 very minor; FI)	47.06 - 58.03
M	119.04	48.22	92.57	48.83
SD	99.51	1.39	15.25	2.74

C: SLP: (1) exaggerates speech. Subject: (1) The subject says *garden* instead of *cat*. (2) omits [ð] in *the*. (3) produces a weakly articulated [ᴺ] in the first syllable of *drinking* instead of [N]. (4) omits [k] in *drinking*. (5) produces a weakly articulated [ᴺ] in the second syllable of *drinking* instead of [N]. (6) does not aspirate the final [k] in *milk* as the SLP does. This is not an error but could contribute to the shorter statement duration.

6. The dog is in the garden again.

				*								
P				*								
AU	ð	ə	d	ɑ		ɪ	z	ɪ	n	n	ə	g
				*								
				*								
P		*		*		*		*			*	
IU	ð	ə	d	ɑ	g	ɪ	z	ɪ̃	n	ð	ə	g
P	*							*				
AU	a	r	d	ə	n	ə	g	ɛ	n			
	*							*				
P	*			*		*		*				
IU	a	r	d	ə	n	aj	g	ɛ̃	n			

	SLP		SUBJECT	
D	2.3		2.29	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	78.73 - 286.75 (2 minor; FI)	46.81 - 53.91	72.45 - 117.74 (4 very minor; FI)	46.97 - 53.12
M	124.23	48.13	96.44	48.44
SD	66.62	1.43	13.89	1.49

C: SLP: (1) exaggerates speech. Subject: (1) produces [n] instead of [ð] in *the*. (2) uses [ə] instead of [aj] in *again*. Not an error.

7. He telephoned for a game of golf.

				*								
P		*		*				*				
AU	h	ij	d	ɛ	l	ə	f	ow	n		f	ɔ
				*								
		*		*				*				
P		*		*		*		*				*
IU	h	ij	t^h	ɛ	l	ə	f	õw	n	d	f	ɔ
P			^{g}	*			^{g}	*				
AU	r	ə		ej	m	ʌ		ɑ		f		
				*				*				
P		*		*		*		*				
IU	r	ə	g	ẽj	m	ʌ	g	ɑ	l	f		

SLP			SUBJECT	
D	2.44		2.86	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	79.10 - 322.79 (1; FI)	47.01 - 51.62	75.23 - 556.63 (1; FI)	46.93 - 52.40
M	91.95	47.88	103.31	47.9
SD	34.62	0.73	84.09	1.07

C: SLP: (1) exaggerates speech. Subject: (1) uses [d] instead of [t^h] in *telephoned* (Voicing). (2) omits [d] in *telephoned*. (3) uses weakly articulated velar [^{g}] instead of [g] in *game*. (4) uses weakly articulated velar [^{g}] instead of [g] in *golf*.

8. Drive the van to the river.

P			**					*				*
AU	d	r	aj	v	ð	ə	v	æ	n	t^h		uw

P			***			*		**				**
IU	d	r	aj	v	ð	ə	v	ǣ	n	θ	r	uw

P				*			
AU	d	ə	r	u^w	b	ə	r

P		*		**		*	
IU	ð	ə	r	ɪ	v	ə	r

SLP			SUBJECT	
D	2.14		2.4	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	74.47 - 300.42 (3 minor; FI)	46.98 - 59.61	80.39 - 519.56 (1, 1 very minor; FI)	47.04 - 53.41
M	138.79	48.99	97.26	47.99
SD	78.06	2.16	50.06	1.25

C: SLP: (1) exaggerates speech. Subject: (1) says *through* instead of *to*. (2) uses [d] instead of [ð] in *the*. Could be dialect. (3) uses [u^w] instead of [ɪ] in *river*. (4) uses [b] instead of [v] in *river*.

9. Thanks for both birthday cards.

		*								
P		*							*	
AU	θ	a	N	s	f	ɔ	r ... (0.65)	p^h	ow ...(0.71)	
		*								
		*							*	
P		*				*			*	
IU	θ	ã	k	s	f	ɔ	r	b	ow	θ

P						*	^{g}	*		^{d}	
AU	b	ə	r		d	ej		a	r		z
						*		*			
P		*				*		*			
IU	b	ə	r	θ	d	ej	k^h	a	r	d	z

	SLP		SUBJECT	
D	2.71		3.94	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	79.97 - 540.43 (1, 2 minor; FI)	47.63 - 56.46	81.06 - 138.76 (4 very minor; FI)	46.90 - 57.24
M	163.5	48.43	91.78	48.36
SD	153.51	1.7	13.08	2.09

C: SLP: (1) exaggerates speech. Subject: (1) uses [p^h] instead of [b] in *both*. (2) omits [θ] in *both*. (3) omits [θ] in *birthday*. (4) uses weakly pronounced velar [^{g}] instead of [k^h] in *cards*. (5) uses weakly pronounced [^{d}] instead of [d] in *cards*.

10. Bathe the boy's brother.

		*										
P		*					*				*	
AU	b	ej	ð	ð	ə	b	oj		b	r	ʌ	ð
		*										
		*					*				*	
P		*			0		*				*	
IU	b	ej	ð	ð		b	oj	z	b	r	ʌ	ð
P												
AU	ə	h										
P	*											
IU	ə	r										

SLP			SUBJECT	
D	2		1.79	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	76.69 - 597.95 (2, 3 minor; FI)	47.06 - 55.24	80.42 - 125.02 (3 very minor; FI)	47.00 - 57.77
M	163.93	48.9	95.41	48.94
SD	130.11	1.82	13.5	2.49

C: SLP: (1) exaggerates speech. Subject: (1) omits [z] in *boys*. (2) says [h] instead of [r] in *brother*.

11. Sarah was missing from the house.

		*										
P		*							*			
AU	s	aw			w	ʌ	z	m	ɪ	z	ɪ	N
		*										
		*							*			
P		*		*		*			*		*	
IU	s	ɛ	r	ə	w	ʌ	z	m	ɪ	s	ɪ̃	N

P			*		^{d}	^{ə}	^{h}	*	
AU	f	^{r}	ʌ	m				aw	
			*					*	
P			*			*		*	
IU	f	r	ʌ̃	m	ð	ə	h	aw	s

	SLP		SUBJECT	
D	2.66		2.43	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	77.52 - 577.91 (3; FI)	47.14 - 55.93	75.73 - 127.38 (2 very minor; FI)	47.05 - 55.57
M	147.14	48.76	90.34	48.32
SD	132.63	1.99	12.55	1.68

C: SLP: (1) exaggerates speech. Subject: (1) says [aw] instead of [ɛ] in *Sarah*. (2) omits [r] in *Sarah*. (3) says [z] instead of [s] in *missing*. (4) says [^{d} ^{ə}] instead of [ð ə] for *the*. (5) omits [s] in *house*.

12. The zoo had a puzzling maze.

				*								
P	^{ð}			*		*		*		*		
AU		ɵ	z	uw		æ	d	ej	p^{h}	ʌ		l
				*								
				*		*				*		
P		*		*		*		*		*		
IU	ð	ə	z	uw	h	æ	d	ə	p^{h}	ʌ	z	l

P		^{p}				
AU	ɪ		h	m	ej	
					*	
P	*				*	
IU	ɪ̄		N	m	ej	z

	SLP		SUBJECT	
D	3.21		3.22	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	73.38 - 568.49 (3, 2 minor; FI)	46.92 - 54.85	78.46 - 129.84 (3 very minor; FI)	46.69 - 55.09
M	142.78	48.32	97.08	47.86
SD	103.27	1.53	13.26	1.41

C: SLP: (1) exaggerates speech. Subject: (1) uses [^{ð}] instead of [ð] in *the*. (2) omits [h] in *had*. Could be dialect. (3) uses [ej] instead of [ə] for *a*. Not an error but could contribute to lengthening of statement. (4) [p^{H}] instead of [p^{h}] in *puzzling*, weird aspiration. (5) [d] instead of [z] in *puzzling*. (6) inserts [^{P}] and [h] between *puzzling* and *maze*. (7) omits [N] in *puzzling*. (8) omits [z] in *maze*.

13. She was washing a brush.

		*										
P		*					*					
AU	ʃ	ij	w	ə	z	w	ɑ	ʒ	ə		ə	b

		*										
		*					*					
P		*		*			*		*		*	
IU	ʃ	ij	w	ʌ	z	w	ɑ	ʃ	ɪ̄	N	ə	b

P		*	
AU	r	ʌ	ʃ

		*	
P		*	
IU	r	ʌ	ʃ

SLP			SUBJECT	
D	2.48		1.93	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	78.81 - 586.15 (1, 2 minor; FI)	46.72 - 56.64	78.12 - 497.97 (1, 1 very minor; FI)	46.78 - 57.79
M	175.4	49.03	123.94	48.55
SD	134.11	2.04	98.93	2.22

C: SLP: (1) exaggerates speech. Subject: (1) [ə] instead of [ʌ] for was. (2) [ʒ] instead of [ʃ] in washing. (3) [ə] instead of [ɪ] instead of washing. (4) [^{N}] instead of [N] in washing.

14. Beige and azure are colours.

							*					
P		*					*				*	
AU	b	eʲ	³	æ	n		æ	³	ə	r	a	r

							*					
		*					*				*	
P		*		*			*		*		*	
IU	b	ej	ʒ	æ̃	n	d	æ	ʒ	ə	r	a	r

P		*			
AU	kʰ	ʌ	l	ə	r

		*				
P		*		*		
IU	kʰ	ʌ	l	ə	r	z

SLP			SUBJECT	
D	3.35		3.09	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	79.81 - 506.12 (2, 1 minor; FI)	46.73 - 57.68	74.69 - 543.79 (3; FI)	46.75 - 55.87
M	148.74	49.04	195.93	48.66
SD	93.23	2.6	183.4	1.76

C: SLP: (1) exaggerates speech. Subject: (1) [eʲ] instead of [ej] in *beige*. (2) [³] instead of [ʒ] in *beige*. (3) omits [d] in *and*. (4) [³] instead of [ʒ] in *azure*. (5) [k^H] instead of [kʰ] in *colors*, weird aspiration. (6) omits [z] in *colors*.

15. Your watch is on the kitchen chair.

P		*			**	ʃ	*		*			
AU	j	o^w		w	ɑ		ɪ	z	ɑ	n	n	ə
P		**			***		**		**			*
IU	j	ɔ	r	w	ɑ	ʧ	ɪ	z	ɑ̃	n	ð	ə

P	g	*	ʧ					r
AU		ɪ		ə	n	ʧ	ə	
P		**		*			**	
IU	k^h	ɪ	ʧ	ə	n	ʧ	ɛ	r

	SLP		SUBJECT	
D	2.71		3.75	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	76.67 - 589.66 (1, 1 minor, 1 very minor; FI)	46.58 - 53.87	75.59 - 521.29 (2, 3 very minor; FI)	46.69 - 56.06
M	152.46	48.19	112.43	47.9
SD	127.25	1.56	91.96	1.49

C: SLP: (1) exaggerates speech. Subject: (1) [o^w] instead of [ɔ] in *your*. (2) omits [ɹ] in *your*. (3) [^{ʃ}] instead of [ʧ] in *watch*. (4) [n] instead of [ð] in *the*. (5) [^{g}] instead of [k^h] in *kitchen*. (6) [^{ʧ}] instead of [ʧ] in *kitchen*. (7) [ə] instead of [ɛ] in *chair*. (8) [^{r}] instead of [r] in *chair*.

16. The badger jumped off the bridge.

				*								
P				*	ʤ		w	ʤ	*			
AU	ð	ə	b	æ		ə			ʌ	m		d

				*								
				*					*			
P		*		*		*			*			
IU	ð	ə	b	æ	ʤ	ə	r	ʤ	ʌ̃	m	p	t

P	*						*	
AU	ɑ	v	ð	o	b	r	ɪ	ʤ

	*						*	
P	*			*			*	
IU	ɑ	f	ð	ə	b	r	ɪ	ʤ

	SLP		SUBJECT	
D	2.9		2.49	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	80.06 - 579.72 (5, 1 minor; FI)	46.60 - 61.69	75.85 - 527.29 (2; FI)	46.70 - 58.16
M	240.94	49.29	172.81	48.24
SD	179	3.3	165.46	2.25

C: SLP: (1) exaggerates speech. Subject: (1) [^{ʤ}] instead of [ʤ] in *badger*. (2) [^{w}] instead of [r] in *badger*. (3) omits [p] in *jumped*. (4) [d] instead of [t] in *jumped*. (5) [v] instead of [f] in *off*. (6) [o] instead of [ə] in *the*.

17. All the leaves have fallen.

P	*					**		z		*		
AU	ɑ	l	l	ə	l	ij	v			æ	v	v
P	**			*		***				**		
IU	ɑ	l	ð	ə	l	ij	v	z	h	æ	v	f

P	*		ə	
AU	ɑ	l		n
P	**		*	
IU	ɑ	l	ə	n

SLP			SUBJECT	
D	1.95		1.86	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	78.74 - 432.91 (1, 2 minor; FI)	46.74 - 58.70	80.50 - 500.36 (1, 3 very minor; FI)	46.66 - 56.87
M	186.71	48.95	142.58	48.51
SD	104.5	2.29	115.27	2.15

C: SLP: (1) exaggerates speech. Subject: (1) [l] instead of [ð] in *the*. (2) [ᶻ] instead of [z] in *leaves*. (3) omits [h] in *have*. (4) [v] instead of [f] in *fallen*. (5) [ᵊ] instead of [ə] in *fallen*.

18. A red cherry.

P		*		**			*		
AU	h	ej	r	ɛ	d	ʧ	ɛ	r	ij
P		**		***			**		*
IU		ej	r	ɛ	d	ʧ	ɛ	r	ij

	SLP		SUBJECT	
D	1.36		1.51	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	79.56 - 486.78 (1, 2 minor; FI)	46.71 - 60.49	74.68 - 400.85 (1, 1 very minor; FI)	46.74 - 57.41
M	150.96	49.71	127.95	49.47
SD	87.07	3.12	90.51	3.03

C: SLP: (1) exaggerates speech. Subject: (1) inserts [h] in front of *a*.

19. Throw the water away.

							*					
P			*				*					
AU	t	r̥	ow	ð	ə	w	ɑ	D	ə	ʳ	ə	w
							*					
			*				*					
P			*		*		*		*		*	
IU	θ	r̥	ow	ð	ə	w	ɑ	D	ə	r	ə	w

P	*
AU	eʲ
	*
P	*
IU	ej

	SLP		SUBJECT	
D	1.79		1.73	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	80.15 - 507.80 (2, 3 minor; FI)	46.72 - 56.69	79.67 - 508.77 (1, 1 very minor; FI)	46.75 - 52.31
M	202.5	49.75	130.35	48.57
SD	125.7	2.65	92.65	1.63

C: SLP: (1) exaggerates speech. Subject: (1) [t] instead of [θ] in *throw*. (2) [ʳ] instead of [r] in *water*. (3) [e^{j}] instead of [ej] in *away*.

20. A while ago it was white.

			*									
P	*		*				*					
AU	ej	w	aj	l	ə	^{g}	ow	ɪ		w	ʌ	z
			*									
			*				*					
P	*		*		*		*	*			*	
IU	ə	ʍ	aj	l	ə	g	ow	ɪ	t	ʍ	ʌ	z
P		*										
AU	w	ʌj	ʔ									
		*										
P		*										
IU	ʍ	ʌj	t^h									

	SLP		SUBJECT	
D	2.55		2.22	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	76.95 - 538.42 (1, 2 minor; FI)	46.75 - 57.48	76.43 - 125.86 (3 very minor; FI)	46.72 - 56.87
M	129.5	48.58	102.48	48.98
SD	95	2.35	15.68	2.44

C: Subject uses [ʍ], not [w] in his dialect. The diphthong [ʌj] is centralized and raised. It is between [ʌ] and [ə]. SLP: (1) exaggerates speech. Subject: (1) [ej] instead of [ə] in *a*. (2) [^{g}] instead of [g] in *ago*. (3) omits [t] in *it*. (4) [ʔ] instead of [t^h] in *white*, dialect difference.

21. He was ahead of her.

		*										
P	^{h}	*						*	^{d}	*		^{h}
AU		ij	w	ə	z	ə	h	ɛ		ʌ	v	
		*										
		*		*				*		*		
P		*		*		*		*		*		
IU	h	ij	w	ʌ	z	ə	h	ɛ	d	ʌ	v	h

P		
AU	ə	r
P	*	
IU	ə	r

	SLP		SUBJECT	
D	1.95		1.9	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	80.90 - 515.20 (1, 2 minor; FI)	46.88 - 56.44	80.10 - 538.14 (2, 1 very minor; FI)	46.76 - 54.44
M	189.61	49.04	130.25	48.38
SD	127.67	2.04	106.71	1.53

C: SLP: (1) exaggerates speech. Subject: (1) [^{h}] instead of [h] in *he*. (2) [ə] instead of [ʌ] in *was*, not an error. (3) [^{d}] instead of [d] in *ahead.* (4) [^{h}] instead of [h] in *her*.

22. You fetch the layette.

				*							
P		*		*	^{ʧ}				*		^{D}
AU	j	u^{w}	f	ɛ		ð	ə	l	ej	ɛ	
				*							
		*		*					*		
P		*		*			*		*	*	
IU	j	uw	f	ɛ	ʧ	ð	ə	l	ej	ɛ	t^{h}

SLP			SUBJECT	
D	2.13		1.83	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	74.64 - 341.98 (1, 3 minor; FI)	46.68 - 53.55	77.49 - 548.90 (1, 2 very minor; FI)	46.52 - 51.93
M	141.53	48.17	122.33	48.06
SD	82.94	1.54	105.72	1.52

C: SLP: (1) exaggerates speech. Subject: (1) [u^w] instead of [uw] in *you*. (2) [^{ʧ}] instead of [ʧ] in *fetch*. (3) [^{D}] instead of [t^h] in *layette*.

23. The camera is in my room.

				*								
P				*							*	
AU	h	ə	t^h	æ	m	ə	r	ə	ɪ	z	ɪ	n
				*								
				*							*	
P		*		*				*	*		*	
IU	ð	ə	k^h	æ̃	m		r	ə	ɪ	z	ɪ̃	n

P		*		*	
AU	m	aj	r	u^w	m
		*		*	
P		*		*	
IU	m	aj	r	ũw	m

SLP			SUBJECT	
D	2.41		2.15	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	77.44 - 560.83 (3, 1 minor; FI)	46.76 - 57.62	79.55 - 119.53 (3 very minor; FI)	46.65 - 55.13
M	181.42	48.9	98.1	48.22
SD	146.53	2.38	12.96	1.88

C: SLP: (1) exaggerates speech. Subject: (1) [h] instead of [ð] in *the*. (2) [t^h] instead of [k^h] in *camera*. (3) uses [ə] as middle syllable in *camera*, not an error. (4) [u^w] instead of [uw] in *room*.

24. The man had no money.

P				* *			*			*		*
AU	ð	ə	m	æ	n		æ	d	n	o^w	m	ʌ
P		*		* * *			* *			* *		* *
IU	ð	ə	m	æ̃	n	h	æ	d	n	õw	m	ʌ̃

P		
AU	n	ɨ^j
P		*
IU	n	ij

SLP			SUBJECT	
D	1.94		2.19	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	77.84 - 306.13 (3 minor; FI)	46.66 - 59.82	79.33 - 554.00 (2, 1 very minor; FI)	46.29 - 53.38
M	190.3	49.53	132	48.1
SD	79.13	3.42	119.21	1.63

C: SLP: (1) exaggerates speech. Subject: (1) omits [h] in *had*. (2) [o^w] instead of [ow] in *no*. (3) [ɨ^j] instead of [ij] in *money*.

25. Bring the singer to me.

			*									
P			*		ð			*	N			
AU	b	ɾ	ɪ	N		ə	s	ɪ		ə	ɾ	d
			*									
			*					*				
P			*			*		*		*		
IU	b	ɾ	ɪ̄	N	ð	ə	s	ɪ̄	N	ə	ɾ	tʰ

P	*		*
AU	uʷ	m	iʲ
	*		*
P	*		*
IU	uw	m	ij

SLP			SUBJECT	
D	1.66		1.92	
	Frequency	Intensity	Frequency	Intensity
R (P; I)	77.89 - 505.62 (1, 1 minor; FI)	46.81 - 55.43	78.76 - 134.46 (2 very minor; FI)	46.73 - 54.99
M	177.65	48.5	98.65	48.14
SD	110.5	1.88	17.22	1.63

C: SLP: (1) exaggerates speech. Subject: (1) [ᶞ] instead of [ð] in *the*. (2) [ᴺ] instead of [N] in *singer*. (3) [d] instead of [tʰ] in *to*. (4) [iʲ] instead of [ij] in *me*.

Consonant Blends

plate

AU		ə	n	tʰ
IU	pʰ	l̥	ej	tʰ

pram

AU		ɾ̥	æ	m
IU	pʰ	ɾ̥	æ̃	m

blanket

AU	b	^{l}	æ	N	g	ə	^{d}
IU	b	l	æ̃	N	k	ɪ	t^{h}

bread

AU	p	r	ɛ	d
IU	b	r	ɛ	d

tree

AU	ʧ	ɾ̥	ij
IU	ʧ	ɾ̥	ij

dress

AU	d	r	ɛ	z
IU	d	r	ɛ	s

flag

AU	f		æ	^{g}
IU	f	l̥	æ	g

frog

AU	f	ɾ̥	ɑ	^{g}
IU	f	ɾ̥	ɑ	g

three

AU	θ	ɾ̥	ij
IU	θ	ɾ̥	ij

spoon

AU	ʃ	p	u^{w}	n
IU	s	p	ũw	n

smoke

AU	^{s}	m	ow	g	
IU	s	m	ow	k^k	

swim

AU	s:	w	ɪ	m	
IU	s	w	ɪ̄	m	

Comments: [s] is lengthened.

snake

AU	s	n	ej	g	
IU	s	n	ej	k^h	

star

AU		t	a	r	
IU	s	t	a	r	

slide

AU		θ	aj		
IU	s	l	aj	d	

skirt

AU		h	ə	^{r}	^{d}
IU	s	k	ə	r	t^h

crown

AU	^{g}		aw	n	
IU	k^h	r̥	āw	n	

clock

AU	^{K}		ɑ	k	
IU	k^h	l̥	ɑ	k^h	

queen

AU	^{K}	w	ij	^{n}
IU	k^h	w	ĩj	n

grape

AU	^{g}	^{r}	e^j	b
IU	g	r	ej	p

glove

AU	k^h	l̥	ə ...(0.95)	g	l	ʌ	v
IU				g	l	ʌ	v

splash

AU	θ		l	æ	ʃ
IU	s	p	l̥	æ	ʃ

straw

AU	s	t	r	ɑ
IU	s	t	r̥	ɑ

Comments: Subject coughed before saying word, consequently his voice sounded raspy during production.

scream

AU	s	^{K}	^{r}	i^j	m
IU	s	k	r̥	ĩj	m

Polysyllabic Words

encyclopaedia

AU	ɪ	n	z	aj	k	l̥	ə	p	i^j	d	i^j	ʌ
IU	ɪ̃	n	s	aj	k	l̥	ə	p	ij	d	ij	ʌ

autobiography

AU	ɑ	D	ow	b	aj	ɑ	^{g}	^{r}	ə	f	^{ij}
IU	ɑ	tʰ	ow	b	aj	ɑ	g	r	ɑ	f	ij

Comments: AU [ij] is hardly audible.

hypocritical

AU	h	ɪ	b	ə	g	r	ɪ	d	ə	ʔ		
IU	h	ɪ	pʰ	ə	kʰ	r̥	ɪ	tʰ	ə	k	ə	l

subtlety

AU	s	ʌ	D	ə	l	d	ij
IU	s	ʌ	tʰ	ə	l	tʰ	ij

kaleidoscope

AU	k		l	aj	D	ə	s	k	ow	^{b}
IU	kʰ	ə	l	aj	D	ə	s	k	ow	pʰ

secretiveness

AU	s	ij	g	r	ə	D	ɪ	v	n	ə	z
IU	s	ij	kʰ	r̥	ə	tʰ	ɪ	v	n	ə	s

permanency

AU	p	ə	r	m	ə	d	ɪ	n		
IU	pʰ	ə	r	m	ə̃	n	ə̃	n	s	ij

gentlemanly

AU	dʒ	ə	n		ə	l		^{ə}	^{n}	l	iʲ
IU	dʒ	ə̃	n	tʰ	ə	l	m	ə̃	n	l	ij

Intelligibility

General Conversation (Mr. Smith is a pseudonym)

Speech Language Pathologist (S-LP): Uhm, Mr. Smith why don't you, uhm, tell me a little bit about what happened, what brought you to the hospital? When was it, what was, where were you and what was going on?...(1.93)

Mr. Smith: Uh, (unintelligible speech) there was a stroke.

AU	ʌ ...(4.08)	<X>	^{d}	ə	r	w	ʌ	^{z}	ə	s	t
IU			ð	ə	r	w	ʌ	z	ə	s	t

AU	r	o^w	^{k} ...(0.93)
IU	r	ow	k

S-LP: Pardon? ...

Mr. Smith: stroke

AU	s	t	r	ow ...	
IU	s	t	r	ow	k

S-LP: Um...hmm ...(0.89)

Mr. Smith: (Unintelligible speech)

AU	<X> ...(0.73)
IU	

S-LP: Uh hmm, where were you? ...(0.86)

Mr. Smith: I was (unintelligible speech) happy birthday party.

AU	h	aj	w	ʌ	z ...(2.47)	<X> ...(2.32)	h	æ	b	ij
IU		aj	w	ʌ	z		h	æ	p	ij

AU	b	ə	r		d	e	p^h	a	r	D	I ...(1.01)
IU	b	ə	r	θ	d	ej	p^h	a	r	D	ij

S-LP: At a birthday party?

Mr. Smith: Eh.

AU	(ə)
IU	

S-LP: At your birthday party?

Mr. Smith: No, no.

AU	$(^{n}$	ʌ)	^{n}	ʌ ...
IU	n	ōw	n	ōw

S-LP: No, okay ...

Mr. Smith: Oh, an aunt.

AU	ow	ə	l	æ	n	^{d} ...(0.89)
IU		ə̄	n	ǣ	n	t

S-LP: An aunt?

Mr. Smith: Yeah.

AU	(j	ə) ...
IU	j	ə

S-LP: Okay. And where was that? ...(0.82)

Mr. Smith: In Mt. Pearl.

AU	ɪ	n	m	aw	p^{h}	ə	r	^{l} ...(0.72)
IU	ɪ̄	n	m	aw	p^{h}	ə	r	l

S-LP: Uh...hmm. What was her name? ...(1.02)

Mr. Smith: I... I forget now @.

AU	ə ...(2.91)	ə	f	ə	^{r}	^{g}	ɛ	t	n	aw ...
IU	aj	aj	f	ə	r	g	ɛ	t	n	aw

S-LP: Was it your aunt or Mary's aunt? ...

Mr. Smith: Mary's.

AU	m	ə	r	I	z ...(1.90)
IU	m	ə	r	ij	z

S-LP: Uh hmm, and ah, who, how many people were there? ...(1.34)

Mr. Smith: Uh, say about... hundred.

AU	ʌ ...	z	ej	ə	b	aw	ʔ ...(2.79)	h	ʌ	n	d	
IU		s	ej	ə	b	aw	ʔ	h	ʌ̃	n	d	r

AU	ə ...	
IU	ɛ	d

S-LP: Uh...hmm... wow. That's a lot...

Mr. Smith: One of them rented places, right.

AU	(w	ʌ	n)	ʌ		d	ɛ	m	r	ɛ	n	^{d}
IU	w	ʌ̃	n	ʌ	v	ð	ɛ̃	m	r	ɛ̃	n	t

AU	ə	d	p^h	l	ej	z	ə	z	r	ʌj	t ...
IU	ə	d	p^h	l̥	ej	s	ə	z	r	ʌj	t

Comments: The diphthong [ʌj] is centralized and raised, so it is between [ʌ] and [ə].

S-LP: Pardon? ..

Mr. Smith: One of them rented places in there.

AU	w	ʌ	n	ʌ		d	ɛ	m	r	ɛ	n	d
IU	w	ʌ̃	n	ʌ	v	ð	ɛ̃	m	r	ɛ̃	n	t

AU	ə	d	p^h	l	ej	z	ə	z	ɪ	n	^{d}	ə
IU	ə	d	p^h	l̥	ej	s	ə	z	ɪ	n	ð	ɚ

AU	r ...(1.46)
IU	r

S-LP: Oh in a rented place?

Mr. Smith: Yeah, yeah.

AU	(j	ə)	j	ə ..
IU	j	ə	j	ə

S-LP: Uh... hmm... so it wasn't in someone's home? ..

Mr. Smith: No, no.

AU	n	oʷ	n	oʷ ..
IU	n	õw	n	õw

S-LP: Okay. Yeah. And what were you doing at the time? How did you feel? What happened? ...(1.36)

Mr. Smith: I was sitting down. (Unintelligible speech) having a drink.

AU	ɑ	w	ʌ		z	ɪ	ʔ	ə	n	d	aw
IU	aj	w	ʌ	z	s	ɪ	D	ɪ	N	d	ãw

AU	n ...(1.57)	<X>		æ	v	ə	n		d	r	ɪ
IU	n		h	æ	v	ĩ	N	ə	d	r	ĩ

AU	N	ᴷ ...
IU	N	k

S-LP: Uh hmm ...(1.19)

Mr. Smith: And we were up and walking around. Ordered it in the bar (unintelligible speech) another one.

AU	æ	n	w	ɨʲ	w	ə	r	ʌ	p	æ	n
IU	æ̃	n	w	ij	w	ə	r	ʌ	p	æ̃	n

AU	w	ɑ	^{k}	$^{-}$		ə	r	aw			
IU	w	ɑ	k	ĩ	N	ə	r	ãw	n	d	æ̃

AU	n ...(1.87)	ɔ		D	ə				ɪ	ʔ	ɪ
IU	n	ɔ	r	D	ə	r	ə	d	ɪ	t	ɪ

AU	n	d	ə	b	a	r	<X>	ə	n	ʌ	D	ə
IU	n	ð	ə	b	a	r		ə̃	n	ʌ	ð	ə

AU		w	ʌ	n ..
IU	r	w	ʌ̃	n

S-LP: Uh hmm ...

Mr. Smith: And then

AU	ə	n	d	ə	^{n} ...(0.88)
IU	ə̃	n	ð	ə̃	n

S-LP: Uh hmm ..

Mr. Smith: So I was sat down and started drinking it...

AU	z	ow	^{z}				z	æ	^{d}	d	aw	^{n}
IU	s	ow	aj	w	ʌ	z	s	æ	t	d	ãw	n

AU	ə	n ...(1.11)	s	t	a	r	^{d}	ə	^{d}	d	r
IU	ə	n	s	t	a	r	ð	ə	d	d	r

AU	ɪ		ʔ	ə	n	ɪ	ʔ ...
IU	ĩ	N	k	ĩ	N	ɪ	t

S-LP: Uh hmm ...(0.82)

Mr. Smith: and I thought I was getting drunk.

AU	ə	n	ɑ	θ	aw	w	aw ...(1.10)				d
IU	ə̃	n	aj	θ	ɑ	t	aj	w	ʌ	z	

AU	r	ə	ʔ	ə	n	d	r	ow	N	k ...
IU	g	ɛ	D	ĩ	N	d	r	ʌ̃	N	k

S-LP: Hmm @ ah hm.

Mr. Smith: (@)

S-LP: Because of how you were feeling?

Mr. Smith: Yeah.

AU (ɑ)

IU

S-LP: Yeah ..

Mr. Smith: Unintelligible speech.

AU <X> ..

IU

S-LP: Uh hmm. Mmm ..

Mr. Smith: Eh.

AU ə ..

IU

S-LP: Uh hmm.

Mr. Smith: And then I got up and started to talk to somebody but they wouldn't understand.

AU	(ə	n)	^{d}	ə	^{n}	ɑ	g	ɑ	^{d}	ʌ	p	ə
IU	ə̃	n	ð	ə̃	n	aj	g	ɑ	D	ʌ	p	ə̃

AU	n ...(2.21)	^{s}	t	a	r	D	ə	^{ʔ}	d	ə	t
IU	n	s	t	a	r	D	ə	d	t^{h}	ə	t^{h}

AU	ɑ	^{k} ...	z	ʌ	m	b	ɑ	D	ij	b	ʌ	ʔ ..
IU	ɑ	k	s	ʌ̃	m	b	ɑ	D	ij	b	ʌ	t

AU	d	ə	r ...	w	ʊ	D	ə	n		ʌ	n	^{d}
IU	ð	ej		w	ʊ	D	ə̃	n	t	ʌ̃	n	d

AU	ə	r	s	t	æ	n ...	
IU	ə	r	s	t	æ̃	n	d

S-LP: (Uh hmm.)

Mr. Smith: And then bumping into people.

AU	ə	n	^{ð}	ə	n	b	ʌ	m	ʔ	ə	n	ɪ
IU	ə̃	n	ð	ə̃	n	b	ʌ̃	m	p	ɪ̃	N	ɪ̃

AU	n	n	ə	b	ij	b	ə	l ...
IU	n	t	uw	p^{h}	ij	p	ə	l

S-LP: Uh hmm ..

Mr. Smith: And I said Mary I can't see that from what I had two drink.

AU	ə	n	ɑ	s	ɑ ...		m	ə	r	ɪ	ɑ	k
IU	ə̃	n	aj	s	ɛ	d	m	ə	r	ij	aj	k

AU	æ	n		s	ij	ð	æ ...		f	r	ʌ	^{m}
IU	æ̃	n	t	s	ij	ð	æ	t	f	r	ʌ̃	m

AU	w	ə	D	ɑ	h	æ		t^h	uw	d	r	ɪ
IU	w	ɑ	D	aj	h	æ	d	t^h	uw	d	r	ɪ̃

AU	N	g ...	
IU	N	k	s

S-LP: Uh hmm ...

Mr. Smith: And then I sat down and then Mary helped and we went out to the car.

AU	ə	n	ð	ə	n	ɑ	s	æ		d	aw	n ...(1.53)
IU	ə̃	n	ð	ə̃	n	aj	s	æ	t	d	ãw	n

AU	ə	n	n	ɛ	n ..	m	ə	r	ij	h	ɛ	^{l}
IU	ə̃	n	ð	ɛ̃	n	m	ə	r	ij	h	ɛ	l

AU	p		ə	n	w	ɪ	w	ɛ	n		aw
IU	p	t	ə̃	n	w	ij	w	ɛ̃	n	t	aw

AU		t^h	ə	^{d}	ə	k^h	a	r ..
IU	t	t^h	uw	ð	ə	k^h	a	r

S-LP: Uh hmm ...(0.80)

Mr. Smith: Came home.

AU		ej		^{h}	ow	^{m} ...
IU	k^h	ẽj	m	h	õw	m

S-LP: Uh hmm ..

Mr. Smith: And (unintelligible speech) home.

AU	ə	n	<X>	h	ow	^{m} ...
IU	ə̃	n		h	õw	m

S-LP: Uh hmm ...

Mr. Smith: So I waited until Sunday.

AU	z	ow	ɑ	w	ej	D	ə	^{d}	t	ɪ	l	s ...
IU	s	ow	aj	w	ej	D	ə	d	t^{h}	ɪ	l	s

AU	ʌ	n		ej ...
IU	ʌ̃	n	d	ej

S-LP: Uh hmm. That was a Friday was it? ...

Mr. Smith: No, Saturday night.

AU		^{w}..	s	æ	D	ə		D	e^{j}	n	aj	^{ʔ}..
IU	n	ow	s	æ	D	ə	r	D	ej	n	aj	t

S-LP: (Oh, it) was Saturday night, okay.

Mr. Smith: Okay and then it was Sunday then.

AU	(ow	g	ej	ə	n)	n	ɛ	n	ɪ	ʔ	w	ʌ
IU	ow	k	ej	ə̃	n	ð	ɛ̃	n	ɪ	t	w	ʌ

AU		s	ʌ	n	^{d}	ɛ	ð	ə	^{n} ...
IU	z	s	ʌ̃	n	d	ej	ð	ə̃	n

S-LP: Uh hmm ...(0.72)

Mr. Smith: And that was it.

AU	æ	n		æ	ʔ	w	ʌ	z	ɪ	t ...
IU	æ̃	n	ð	æ	t	w	ʌ	z	ɪ	t

S-LP: Uh hmm.

Mr. Smith: Um.

AU	ʌ ...(1.03)
IU	ʌ

S-LP: You finally decided to go to the hospital that day.

Mr. Smith: Yeah

AU	(j	æ) ..
IU	j	æ

S-LP: Yeah, okay.

PROSODY AND SPEED

Diadochokinetic Rates

oo-ee

AU	ʔ	uw	ʔ	ɨʲ	ʔ	uw	ʔ	ɨʲ	ʔ	uw	ʔ	ɨʲ
IU	ʔ	uw	ʔ	ij	ʔ	uw	ʔ	ij	ʔ	uw	ʔ	ij

AU	ʔ	uw	ʔ	ɨʲ	ʔ	uw	ʔ	ɨʲ	pʰ ...	ʔ	uw	ʔ
IU	ʔ	uw	ʔ	ij	ʔ	uw	ʔ	ij		ʔ	uw	ʔ

AU	ɨʲ
IU	ij

Comments: Virtually no pause (< 0.05 seconds) between SLP's production of oo-ee. There is virtually no pause (< 0.05 seconds) between the subject's production of oo-ee except in one place.

pa-pa-pa

AU	b	ɑ	b	ɑ	b	ɑ ...	b	ɑ	b	ɑ	p^h	ɑ ...
IU	p^h	ɑ	p^h	ɑ	p^h	ɑ	p^h	ɑ	p^h	ɑ	p^h	ɑ
AU	p^h	c	p^h	ɑ	b	ɑ ...	p^h	ɑ	p^h	ɑ	p^h	ɑ ...
IU	p^h	ɑ	p^h	ɑ	p^h	ɑ	p^h	ɑ	p^h	ɑ	p^h	ɑ
AU	p^h	ɑ	p^h	ɑ	b	ɑ ...	p^h	ɑ	p^h	ɑ	b	ɑ
IU	p^h	ɑ	p^h	ɑ	p^h	ɑ	p^h	ɑ	p^h	ɑ	p^h	ɑ

Comments: Couldn't get reading for SLP's production of pa-pa-pa. Forgot to turn recorder back on.

ta-ta-ta

AU	t^h	ɑ	d	ɑ	ne	d	ɑ ...	t^h	ɑ	d	ɑ	
IU	t^h	ɑ	t^h	ɑ		t^h	ɑ	t^h	ɑ	t^h	ɑ	t^h
AU	ɑ	t^h	ɑ ...	t^h	ɑ	d	ɑ	d	ɑ	d	ɑ ...	t^h
IU	ɑ	t^h	ɑ	t^h	ɑ	t^h	ɑ	t^h	ɑ	t^h	ɑ	t^h
AU	ɑ	d	ɑ		ɑ	d	ɑ ...	t^h	ɑ	d	ɑ	
IU	ɑ	t^h	ɑ	t^h	ɑ	t^h	ɑ	t^h	ɑ	t^h	ɑ	t^h
AU	ɑ	d	ɑ									
IU	ɑ	t^h	ɑ									

Comments: There is virtually no pause (< 0.05 seconds) between the SLP's production of ta-ta-ta. Subject produced ta-ta-ta-ta sequences with a medium pause between each sequence.

ka-ka-ka

AU	^{K}	ɑ	^{K}	ɑ		ɑ	^{K}	ɑ ...	^{K}	ɑ	^{K}	ɑ
IU	k^h	ɑ	k^h	ɑ	k^h	ɑ ..	k^h	ɑ	k^h	ɑ	k^h	ɑ

AU		ɑ	^{K}	ɑ ...(1.07)	^{K}	ɑ		ɑ	^{K}	ɑ	^{K}
IU	k^h	ɑ	k^h	ɑ	k^h	ɑ	k^h	ɑ	k^h	ɑ	k^h

AU	ɑ ..	^{K}	ɑ		ɑ	^{K}	ɑ	^{K}	ɑ
IU	ɑ	k^h	ɑ	k^h	ɑ	k^h	ɑ	k^h	ɑ

Comments: Except between the SLP's first and second production of ka-ka-ka when there was a short pause, there were virtually no pauses (< 0.05 seconds) between sequences of ka-ka-ka. Subject produced sequences of ka-ka-ka-ka, with pauses between each.

ka-la-ka-la

AU	^{K}	ɑ	^{l}	ɑ	k^h	aw ...(0.73)			g	a^w	^{l}
IU	k^h	ɑ	l	ɑ	k^h	ɑ	l	ɑ ..	k^h	ɑ	l

AU	ə	^{g}	aw	^{l}	ə ...(0.62)	k	ɑ	^{l}	ə	^{g}
IU	ɑ	k^h	ɑ	l	ɑ ..	k^h	ɑ	l	ɑ	k^h

AU	aw	^{l}	ə ...(0.75)	^{g}	a^w	^{l}	ə	^{g}	a^w	^{l}	ə
IU	ɑ	l	ɑ ..	k^h	ɑ	l	ɑ	k^h	ɑ	l	ɑ

Comments: Subject produces ka-la-ka-la in 3 out of four sequences. In the first sequence the subject produces the sequence ka-la-ka.

pa-ta-ka

AU	p^h	ɑ	d	ə	^{K}	ɑ ...	p^h	ɑ	d	ɑ	^{k}	ɑ ...
IU	p^h	ɑ	t^h	ɑ	k^h	ɑ	p^h	ɑ	t^h	ɑ	k^h	ɑ

AU	p^h	ɑ	d	ɑ	^{K}	ɑ ...(0.88)	p^h	ɑ	d	ə	^{k}	ɑ
IU	p^h	ɑ	t^h	ɑ	k^h	ɑ	p^h	ɑ	t^h	ɑ	k^h	ɑ

Comments: There is virtually no pause (< 0.08 seconds) in between the SLP's production of pa-ta-ka sequences.

ADDITIONAL TESTS

Consonants and Intonation

1. Pick the ripe apples?

AU	p	ɪ		d	ə	r	a^{j}	t	æ	p	ə	l
IU	p^{h}	ɪ	k	ð	ə	r	aj	p	æ	p	ə	ɫ

AU	
IU	z

2. A tube of baby cream?

AU	ej	t^{h}	uw	^{b}	ʌ	v	b	ej	b	ij	g	ɾ̥
IU	ə	t^{h}	uw	b	ʌ	v	b	ej	b	ij	k^{h}	ɾ̥

AU	i^{j}	m
IU	ĩj	m

3. Put out the butter for tea?

AU	p^{h}	ʊ	D	aw	^{t}	ð	ə	b	ʌ	D	ə	r
IU	p^{h}	ʊ	t	aw	t	ð	ə	b	ʌ	D	ə	r

AU	f	ə	r	t^{h}	ij
IU	f	ə	r	t^{h}	ij

4. The garden is hard to dig?

AU	ð	ə	g	a	r	d	ə	n	ɪ	z		a
IU	ð	ə	g	a	r	d	ə̄	n	ɪ	z	h	a

AU	r	d	t^{h}	ə	d	ɪ	^{g}
IU	r	d	t^{h}	ə	d	ɪ	g

5. The cat is drinking milk?

AU	ð	ə	g	ɑ		ɪ	^{z}	d	^{r}	ɪ	N	k
IU	ð	ə	k^{h}	æ	t	ɪ	z	d	r	ɪ̃	N	k
AU	ɪ	N	ə	m	ɪ	l	^{g}					
IU	ɪ̃	N		m	ɪ	l	k					

6. The dog is in the garden again?

AU	h	ə	d	ɑ	r	ɪ	z	ɪ	^{n}	n	ə	^{g}
IU	ð	ə	d	ɑ	g	ɪ	z	ɪ	n	ð	ə	g
AU	a	r	d	ə	n	ə	g	ə	^{n}			
IU	a	r	d	ə̃	n	ə	g	ə̃	n			

7. He telephoned for a game of golf?

AU		ij	d	ɛ	l	ə	f	ow	n		f	ɔ
IU	h	ij	t^{h}	ɛ	l	ə	f	ōw	n	d	f	ɔ
AU	r	ə	g	ej	^{m}	ʌ		^{g}	ɑ			
IU	r	ə	g	ẽj	m	ʌ	v	g	ɑ	l	f	

8. Drive the van to the river?

AU	^{d}	^{r}	aj	v	ð	ə	v	æ	n	t^{h}	ə	d
IU	d	r	aj	v	ð	ə	v	æ̃	n	t^{h}	ə	ð
AU	ə	r	ɪ	v	ə	^{r}						
IU	ə	r	ɪ	v	ə	r						

9. Thanks for both birthday cards?

AU	θ	æ	N		s	f	ɔ	r	b	ow		b
IU	θ	æ̃	N	k	s	f	ə	r	b	ow	θ	b
AU	ə	r		d	ej	k^{h}	a	r	d	z		
IU	ə	r	θ	d	ej	k^{h}	a	r	d	z		

10. Bathe the boy's brother?

AU	b	ej	ð	ð	ə	b	oj	^{z}	b	r	ʌ	ð
IU	b	ej	ð	ð	ə	b	oj	z	b	r	ʌ	ð
AU	ə	^{r}										
IU	ə	r										

11. Sarah was missing from the house?

AU	s	ɛ	r	ə	w	ʌ	z	b	ɪ	z	ɪ	
IU	s	ɛ	r	ə	w	ʌ	z	m	ɪ	s	ɪ̃	N
AU		^{r}	ʌ	m	^{n}	ə	h	aw	^{z}			
IU	f	r	ʌ̃	m	ð	ə	h	aw	s			

12. The zoo had a puzzling maze?

AU		ə	z	uw	h	æ		ə	p^{h}	ʌ	d	l
IU	ð	ə	z	uw	h	æ	d	ə	p^{h}	ʌ	z	l
AU	ij		m	ej								
IU	ɪ̃	N	m	ej	z							

13. She was washing a brush?

AU	ʃ	ɨʲ	w	ʌ	z	w	ɑ	ʒ	ɪ		ə	b
IU	ʃ	ij	w	ʌ	z	w	ɑ	ʃ	ɪ̃	N	ə	b

AU	r	ʌ	ʒ
IU	r	ʌ	ʃ

14. Beige and azure are colors?

AU	b	ej	ʒ	æ	n	æ		ə	r	a	r	k^{h}
IU	b	ej	ʒ	æ̃	n	æ	ʒ	ə	r	a	r	k^{h}

AU	ʌ	l	ə		
IU	ʌ	l	ə	r	s

15. Your watch is on the kitchen chair?

AU	j	ɔ	r	w	ɑ	ʧ	ɪ	z	ɑ	n		ə
IU	j	ɔ	r	w	ɑ	ʧ	ɪ	z	ɑ̃	n	ð	ə

AU	g	ɪ	ʧ	ə	z	t	ə	r
IU	k^{h}	ɪ	ʧ	ə̃	n	ʧ	ə	r

16. The badger jumped off the bridge?

AU		ə	b	æ	ʤ	ə	r ...	d	ʌ	m	p	t
IU	ð	ə	b	æ	ʤ	ə	r	ʤ	ʌ̃	m	p	t

AU	o^{w}	v		ə	<X>	b	r	ɪ	ʧ
IU	ɑ	f	ð	ə		b	r	ɪ	ʤ

17. All the leaves have fallen?

AU	ɑ	l	l	ə	l	i^{j}	v	z		æ	v	v
IU	ɑ	l	ð	ə	l	ij	v	z	h	ə	v	f

AU	ɑ	l	ə	n
IU	ɑ	l	ə̃	n

18. A red cherry?

AU	ej	r	ɪ	t	ʧ	ɛ	r	ij
IU	ə	r	ɛ	d	ʧ	ɛ	r	ij

19. Throw the water away?

AU	θ	r	ow	ð	ə	w	ɑ	D	ə	r	ə	w
IU	θ	r	ow	ð	ə	w	ɑ	D	ə	r	ə	w

AU	ej
IU	ej

20. He was ahead of her?

AU	h	ij	w	ʌ	z	ə	h	ɛ	d		v	
IU	h	ij	w	ʌ	z	ə	h	ɛ	d	ʌ	v	h

AU	ə	r
IU	ə	r

21. You fetch the layette?

AU	j	u^{w}	t^{h}	ʌ	t	d	ʌ	l	ej	ɛ	d
IU	j	uw	f	ɛ	ʧ	ð	ə	l	ej	ɛ	t^{h}

22. The camera is in my room?

AU		ɑ	k^h	æ	m	r	ə		z	ɪ	n	j
IU	ð	ə	k^h	æ̃	m	r	ə	ɪ	z	ɪ̃	n	m

AU	ɔ	r	r	ə	m
IU	aj		r	ũw	m

23. The man had no money?

AU	^{ð}	ə	m	æ	n		æ	d	n	o^w	^{m}	ʌ
IU	ð	ə	m	æ̃	n	h	æ	d	n	õw	m	ʌ̃

AU	^{n}	ɪ
IU	n	ij

24. Bring the singer to me?

AU	^{b}	^{r}	^{ɪ}	ə	^{d}	ə ...(1.17)	^{s}	ɪ	^{N}	ə	^{r}
IU	b	r	ɪ̃	N	ð	ə	s	ɪ̃	N	ə	r

AU	d	ə	m	ɪ
IU	t^h	ə	m	ij

Vowels

feet

AU	f	$ɨ^j$	d
IU	f	ij	t^h

bit

AU	b	ɪ	t^h
IU	b	ɪ	t^h

mate

AU	m	ej		
IU	m	ej	t^h	

pet

AU	p	ɛ	^{ʔ}	
IU	p	ɛ	t^h	

bat

AU	b	æ		
IU	b	æ	t^h	

tide

AU	^{t}	aj		
IU	t^h	aj	d	

crowd

AU	k^h	r	aw	
IU	k^h	r	aw	d

shut

AU	ʃ	ʌ	^{t}	
IU	ʃ	ʌ	t^h	

book

AU	b	ʊ	k	
IU	b	ʊ	k^h	

boot

AU	b	uw	t	
IU	b	uw	t^h	

note

AU	n	ow	
IU	n	ow	t^h

boy

AU	b	oj
IU	b	oj

caught

AU	k^h	ɑ	
IU	k^h	ɑ	t^h

not

AU	n	ɑ	
IU	n	ɑ	t^h

She bought some cream.

AU	ʃ	ij	b	ɑ	d	s	ʌ	m	g	ɾ	ɾ^{ij}	m
IU	ʃ	ij	b	ɑ	t	s	ʌ	m	k^h	ɾ̥	ĩj	m

The shirt did not fit.

AU	d	ə	ʒ	ə	r	t ...(1.05)	d	ɪ	d	n	ɑ
IU	ð	ə	ʃ	ə	r	t	d	ɪ	d	n	ɑ

AU	t	f	ɪ	t
IU	t	f	ɪ	t^h

It was a great day.

AU	ɪ	d	w	ʌ	z	ə	g	r	ɛ	^{t}	d	ɛ
IU	ɪ	t	w	ʌ	z	ə	g	r	ej	t	d	ej

The bed was wet.

AU	b	ə	b	ɛ	d	w	ə	z	w	ɛ	d
IU	ð	ə	b	ɛ	d	w	ʌ	z	w	ɛ	t

Put the hat in the van.

AU	^{p}	ʊ	d	ð	ə	h	æ	d	ɪ	n	ð	ə
IU	p^h	ʊ	t	ð	ə	h	æ	t^h	ɪ̃	n	ð	ə

AU	v	æ	n
IU	v	æ̃	n

Buy the blue tie.

AU	b	aj		ə	b	l	u^w	t	aj
IU	b	aj	ð	ə	b	l	uw	t^h	aj

A crowd was in the house.

AU	e^j	@	k^h	r	aw	@	w	ʌ	z	ɪ	n	ð
IU	ɑ		k^h	r	aw	d	w	ʌ	z	ɪ̃	n	ð

AU	ə	h	aw	
IU	ə	h	aw	s

The window was shut.

AU	ð	ə	w	ɪ	n	d	ə	w	ə	z	ʒ	ʌ
IU	ð	ə	w	ɪ̃	n	d	ow	w	ʌ	z	ʃ	ʌ

AU	^{d}
IU	t^h

Put the book away.

AU	p^{h}	ʊ	d	ð	ə	b	ʊ	k	ə	w	ɛ
IU	p^{h}	ʊ	t	ð	ə	b	ʊ	k	ə	w	ej

He bought new boots.

AU		ij	b	ɑ	d	n	u^{w}	b	u^{w}	t	s
IU	h	ij	b	ɑ	t	n	uw	b	uw	t	s

The boat was slow.

AU	^{ð}	ə	b	ow		w	ʌ	z	s	l	ow
IU	ð	ə	b	ow	ʔ	w	ʌ	z	s	l	ow

The boy found the toy.

AU		ə	b	oj	f	aw	n		ð	ə	t^{h}	ə
IU	ð	ə	b	oj	f	ãw	n	d	ð	ə	t^{h}	oj̃

He saw the dog.

AU		ij	z	ɑ	^{ð}	ə	d	ɑ	
IU	h	ij	s	ɑ	ð	ə	d	ɑ	g

He did not see the cot.

AU		ij	d	ɪ	d	n	ɑ	ʔ	z	ij	ð	ə
IU	h	ij	d	ɪ	d	n	ɑ	ʔ	s	ij	ð	ə

AU	g	ɑ	
IU	k^{h}	ɑ	t^{h}

Nonword Repetition

bift

AU	b	ɪ	f	
IU	b	ɪ	f	t^{h}

prindle

AU	pʰ	r	ɪ	n	d	ə	l
IU	pʰ	r	ɪ̃	n	d	ə	l

bannifer

AU	b	æ	n	ə	t	ə	r
IU	b	æ̃	n	ə	f	ə	r

sep

AU	z	ɛ	p
IU	s	ɛ	pʰ

neke

AU	n	ɨʲ	
IU	n	ij	kʰ

tull

AU	tʰ	ow	
IU	tʰ	ʌ	l

thip

AU	z	ɪ	p
IU	θ	ɪ	pʰ

Comments: Subjects says *zip*.

hond

AU	h	ɑ	n	
IU	h	ɑ̃	n	d

grall

AU	g	r	ɑ	ˡ
IU	g	r	ɑ	l

smip

AU	s	m	ɪ	p			
IU	s	m	ɪ	p^h			

clird

AU	g	l	ə	r			
IU	k^h	l̥	ə	r	d		

pennel

AU	p^h	ɛ	n	ə	l		
IU	p^h	ɛ̃	n	ə	l		

rubid

AU	r	uw	b	ə	d		
IU	r	uw	b	ɪ	d		

diller

AU	d	ɪ	l	ə	^{r}		
IU	d	ɪ	l	ə	r		

bannow

AU	b	æ	n	aw			
IU	b	æ̃	n	ow			

hampent

AU	h	æ	m		ə	^{n}	
IU	h	æ̃	m	p	ə̃	n	t^h

glistow

AU		l	ɪ	z	g	^{l}	o^w
IU	g	l	ɪ	s	t		ow

sladding

AU		l	æ	d	ə	n
IU	s	l	æ	d	ɪ	N

tafflest

AU	t^h	æ	v	d	ə		
IU	t^h	æ	f	l	ɪ	s	t^h

commerine

AU	^{K}	ɑ	m	ə	ɾ	$ɾ̃^j$	n
IU	k^h	ɑ̃	m	ə	ɾ	ĩj	n

barrazon

AU	b	a	r	ə	z	aw	
IU	b	a	r	ə	z	ɑ̃	n

doppelate

AU	d	ɑ	b	ə	l	ej	t
IU	d	ɑ	p	ə	l	ej	t^h

thickery

AU	ð	ɪ	g	ə	ɾ	ɪ
IU	θ	ɪ	k	ə	ɾ	ij

klistow

AU	g	l	ɪ	z	g	l	o^w
IU	k^h	l̥	ɪ	s		t	ow

trumpetine

AU	d		ʌ	m	b	ə	d	ij	^{n}
IU	t^h	ɾ	ʌ̃	m	p	ə	t	ĩj	n

dafflest

AU	d	æ	v	l	ə	@	
IU	d	æ	f	l̥	ɪ	s	t^h

pannow

AU	p^h	æ	n	aw
IU	p^h	æ̃	n	ow

clirp

AU	g	l	ə	
IU	k^h	l̥	ə	p^h

bennel

AU	b	ɛ	n	ə	^{l}
IU	b	ɛ̃	n	ə	l

doppelade

AU	d	ɑ	p	ə	l	ej	^{d}
IU	d	ɑ	p	ə	l	ej	d

rubit

AU	r	uw	b	ɪ	^{d}
IU	r	uw	b	ɪ	t^h

smib

AU	s	m	ɪ	b
IU	s	m	ɪ	b

Comments: Can hear air coming through nose during subject's production of [s].

thib

AU	θ	ɪ	b
IU	θ	ɪ	b

nege

AU	n	ij	ʒ
IU	n	ij	ʒ

seb

AU	s	ε	d
IU	s	ε	b

Appendix 2

Additional Tests

Consonants & Intonation:

p	Pick the ripe apples?
b	A tube of baby cream?
t	Put out the butter for tea?
d	The garden is hard to dig?
k	The cat is drinking milk?
g	The dog is in the garden again?
f	He telephoned for a game of golf?
v	Drive the van to the river?
θ	Thanks for both birthday cards?
ð	Bathe the boy's brother?
s	Sarah was missing from the house?
z	The zoo had a puzzling maze?
ʃ	She was washing a brush?
ʒ	Beige and azure are colors?
ʧ	Your watch is on the kitchen chair?
ʤ	The badger jumped off the bridge?
l	All the leaves have fallen?
r	A red cherry?
w	Throw the water away?
h	He was ahead of her?
j	You fetch the layette?

m	The camera is in my room?
n	The man had no money?
N	Bring the singer to me?

Vowels: Ability to repeat accurately the following vowel sounds.

ij	feet
ɪ	bit
ej	mate
ɛ	pet
æ	bat
aj	tide
aw	crowd
ʌ	shut
ʊ	book
uw	boot
ow	note
oj	boy
ɑ	caught
a	not

Vowels: Ability to repeat accurately the following vowel sounds.

ɪ	The shirt did not fit	
ej	It was a great day.	
ɛ	The bed was wet.	
æ	Put the hat in the van.	
aj	Buy the blue tie.	

aw	A crowd was in the house.	
ʌ	The window was shut.	
ʊ	Put the book away.	
uw	He bought new boots.	
ow	The boat was slow.	
oj	The boy found the toy.	
ɑ	He saw the dog.	
a	He did not see the cot.	

Nonword Repetition:

Item Number	Item	Examiner's Pronunciation	Subject's Pronunciation
Practice 1.	bift		
Practice 2.	prindle		
Practice 3.	bannifer		
Practice 4.	perplisteronk		
1	sep		
2	neke		
3	tull		
4	thip		
5	hond		
6	grall		
7	smip		
8	clird		
9	pennel		
10	rubid		

11	diller		
12	bannow		
13	hampent		
14	glistow		
15	sladding		
16	tafflest		
17	commerine		
18	barrazon		
19	doppelate		
20	thickery		
21	klistow		
22	trumpetine		
23	dafflest		
24	pannow		
25	clirp		
26	bennel		
27	doppelade		
28	rubit		
29	smib		
30	thib		
31	nege		
32	seb		

Appendix 3

Dysarthria Assessment

A S S E S S M E N T O F D Y S A R T H R I A

Method of Scoring

1. Where there is a descriptive analysis - tick the appropriate boxes.

2. Where there are gradings, score as appropriate.

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RESPIRATION

1. PATTERN:

At Rest - Clavicular	[ ]	Rapid	[ ]
Diaphragmatic	[ ]	Slow	[ ]
Abdominal	[ ]	Stridor	[ ]

During Speech - Clavicular	[ ]	Rapid	[ ]
Diaphragmatic	[ ]	Slow	[ ]
Abdominal	[ ]	Stridor	[ ]

Speaks on Inhalation?	[ ]
Speaks on Residual Air?	[ ]
Synchronised with Phonation?	[ ]

2. CAPACITY/CONTROL

	Normal 15-20 secs. SCORE 4	Slight Diff/ 10-15 SCORE 3	Mod.Diff/ 5-10 secs. SCORE 2	Sev.Diff/ 1-5 secs. SCORE 1	Unable 0 secs SCORE
Ability to Sustain /S/ on Exhalation (time in secs).					
Ability to Crescendo on /S/ (normal - unable)					
Ability to Diminuendo on /S/ (normal-unable)					
Ability to Repeat Series of /S/ sounds /s-s-s-s/ (normal - unable					

TOTAL SCORE FOR CAPACITY AND CONTROL OF RESPIRATION
(Poss. Score 16)

PHONATION

(*s = secs)	Normal 15–20s. SCORE 4	Sl.Diff/ 10–15s. SCORE 3	Mod.Diff/ 5–10 s. SCORE 2	Sev.Diff/ 1–5 s. SCORE 1	Unable 0 secs. SCORE 0
1. INITIATING VOICE. Ability to Initiate /a:/ (Normal - unable)					
2. SUSTAINING VOICE Ability to Sustain /a:/ (Time in secs.)					
3. VOLUME Ability to say /a:/ at a) Loud Volume (Normal - unable					
b) Ability to Increase Volume on /a:/ (Normal - unable)					
c) Ability to Decrease Volume on /a:/ (Normal - unable)					
4. REPEATED VOICING Ability to initiate voice consistently on /a: a: a: a:/ (Normal - unable)					

TOTAL SCORE (Poss. Score 24)

5. PITCH Pitch of Voice: -

Normal	
Abnormally High	
Abnormally Low	
Occurence of Pitch Breaks	

6. INTONATION Intonation Pattern:-

Normal	
Monotonous	
Inappropriate	

7. TONE OF VOICE:

7. TONE OF VOICE:		Hypernasal	☐
		Hyponasal	☐
		Mixed	☐
8. VOLUME	Volume of Voice:-	Normal	☐
		Increased	☐
		Reduced	☐
		Variable	☐
9. QUALITY	Quality of Voice:-	Hoarse	☐
		Breathy	☐
		Weak	☐
		Strident	☐
		Intermittent	☐

ARTICULATION

1. INITIAL CONSONANTS Ability to repeat accurately the following initial consonant sounds. (Score 1 for each correct sound)

p	pie	
b	boy	
t	tea	
d	do	
k	car	
g	go	

f	four	
v	vie	
θ	thigh	
ð	though	
s	sea	
z	zoo	
ʃ	shy	
ʒ	beige	
tʃ	chair	
dʒ	joy	

l	lie	
r	row	
w	way	
ʍ	why	
h	high	
j	you	
m	my	
n	no	
ŋ	sing	

TOTAL SCORE (POSS. SCORE 25) = ________

2. CONSONANTS — *Ability to repeat consonant sounds in different positions in sentence (Score 1 for each correct sound).*

		I	M	F
p	*Pick the ripe apples*			
b	*A tube of baby cream*			
t	*Put out the butter for tea*			
d	*The garden is hard to dig*			
k	*The cat is drinking milk*			
g	*The dog is in the garden again*			
f	*He telephoned for a game of golf*			
v	*Drive the van to the river*			
θ	*Thanks for both birthday cards*			
ð	*Bathe the boy's brother*			
s	*Sarah was missing from the house*			
z	*The zoo had a puzzling maze*			
ʃ	*She was washing a brush*			
ʒ	*Beige and azure are colours*	-		
tʃ	*Your watch is on the kitchen chair*			
dʒ	*The badger jumped off the bridge*			
l	*All the leaves have fallen*			
r	*A red cherry*			-
w	*Throw the water away*			-
ʍ	*A while ago it was white*			-
h	*He was ahead of her*			-
j	*You fetch the layette*			-
m	*The camera is in my room*			
n	*The man had no money*			
ŋ	*Bring the singer to me*	-		

TOTAL SCORE (POSS. SCORE 68) = ____

ARTICULATION (CONT'D)

3. CONSONANT BLENDS

Ability to repeat accurately the following consonant blends (Score 1 for each correct blend).

plate		flag		snake		queen	
pram		frog		star		grape	
blanket		three		slide		glove	
bread		spoon		skirt		splash	
tree		smoke		crown		straw	
dress		swim		clock		scream	

TOTAL SCORE (POSS. SCORE 24) = ____

4. POLYSYLLABIC WORDS

Ability to repeat accurately the following polysyllabic words (Score 1 for each correct word).

encyclopaedia		kaleidoscope	
autobiography		secretiveness	
hypocritical		permanency	
subtlety		gentlemanly	

TOTAL SCORE (POSS. SCORE 8) = ____

TOTAL SCORE FOR ARTICULATION -
(POSS. SCORE 125)

5. VOWELS

Vowel Distortion Present ?	
Vowels Omitted ?	
Vowels Substituted ?	

6. INTELLIGIBILITY

Assess Intelligibility of Patient's Speech:

a) Reading Short Passage
b) General Conversation

	THERAPIST (a)	THERAPIST (b)	RELATIVE (a)	RELATIVE (b)	STRANGER (a)	STRANGER (b)
NO OBSERVABLE IMPAIRMENT						
SLIGHT DIFFICULTY BUT ALWAYS INTELLIGIBLE						
GENERALLY INTELLIGIBLE, BUT IF ROOM NOISY OR SUBJECT UNKNOWN THERE IS SOME DIFFICULTY						
SPEECH OFTEN UNINTELLIGIBLE, BUT WITH CAREFUL REPETITION CAN BE UNDERSTOOD						
ONLY OCCASIONAL WORDS UNDERSTOOD						
SPEECH UNINTELLIGIBLE						

PROSODY AND SPEED

1. RATE:

RATE OF SPEECH:

NORMAL	
TOO FAST	
TOO SLOW	
PROGRESSIVELY INCREASING RATE	
PROGRESSIVELY DECREASING RATE	

2. RHYTHM:

RHYTHM OF SPEECH:

NORMAL	
PROLONGATION OF SOUNDS OR WORDS	
STACCATO RHYTHM	
INSUFFICIENT STRESSING	

EXAMINATION OF SPEECH MUSCULATURE

1. FACIAL:

FACIAL EXPRESSION AT REST -

NORMAL	
ASSYMETRICAL	
DROOPS ON (R) SIDE	
DROOPS ON (L) SIDE	
INVOLUNTARY MOVEMENTS	

FACIAL EXPRESSION ON SMILING

NORMAL	
ASSYMETRICAL	
DROOPS ON (R) SIDE	
DROOPS ON (L) SIDE	
INVOLUNTARY MOVEMENTS	

2. LIPS: MOVEMENTS OF SPEECH MUSCULATURE

	NORMAL	Slight Diff.	Mod. Diff.	Sev. Diff.	UNABLE
Score:	4	3	3	1	0
PROTRUSION (PURSING)					
LATERALIZATION (STRETCHING)					
FIRM CLOSURE (AT REST)					
FIRM CLOSURE (DURING SPEECH)					

TOTAL SCORE FOR LIP MOVEMENTS -
(POSS. SCORE 16)

3. JAW

Score:	4	3	2	1	0
OPENING/CLOSING					
LATERAL TO (R)					
LATERAL TO (L)					

TOTAL SCORE FOR JAW MOVEMENTS -
(POSS. SCORE 12)

4. TONGUE:

APPEARANCE AT REST:	
NORMAL	
LARGE AND CLUMSY	
SMALL AND TENSE	
BUNCHED	
WASTING	
TREMOR	
FASCICULATION	
FURRED	
FOOD RESIDUE	
DEVIATES TO (R)	
DEVIATES TO (L)	

MOVEMENTS	Normal Score 4	Slight Diff. Score 3	Mod. Diff. Score 2	Sev. Diff. Score 1	Unable Score 0
Protrusion					
Retraction					
Lateral to (R)					
Lateral to (L)					
Passing over teeth					
Lateral (in mouth)to (R)					
Lateral (in mouth) to (L)					
Elevation of tip (in mouth)					
Elevation of tip (outside mouth)					
Curling tip up and back					

TOTAL SCORE FOR TONGUE MOVEMENTS -
(POSS. SCORE 40)

5. PALATE:

APPEARANCE AT REST:

Normal	
Deviates to (R)	
Deviates to (L)	

MOVEMENT:

	Normal Score 4	Sl.Diff. Score 3	Mod.Diff. Score 2	Sev.Diff. Score 1	Unable Score 0
Ability to Rise During Prolonged Phonation of /a:/					
Ability to Rise During Repeated Phonation of /a: a: a:/					

TOTAL SCORES FOR PALATE MOVEMENTS - (POSS. SCORE 8)

6. TEETH:

Teeth Present	
Dentures Present	
Dentures Needed	
Dentures Loose	

7. CHEWING

Movement Normal	
Movement Difficult	

8. SWALLOWING

Action Normal	
Action Difficult	
Choking	

9. DROOLING

At Rest	
During Speech	
Other Occasions	

DIADOCHOKINETIC RATES

WITHOUT PHONATION	Normal SCORE 4 5/5 secs	Sl.Diff. SCORE 3 4/5 secs.	Mod. Diff. SCORE 2 3/5 secs.	Sev. Diff. SCORE 1 1 or 2 5 secs.	Unable SCORE 0 0/5 se
Jaw: Open/Close					
Lips: Protrusion/Retraction					
Tongue: Protrusion/Retraction					
Elevation of Tip					
Lateral (Exterior)					

WITH PHONATION	15/5 secs.	10-14 /5 secs.	5-9 /5 secs.	1-4 /5 secs.	0/5 secs.
oo-ee					
pa-pa-pa					
ta-ta-ta					
ka-ka-ka					
ka-la-ka-la					
pa-ta-ka					

TOTAL SCORE FOR DIADOCHOKINETIC RATE -
(POSS. SCORE 48)