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2024

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FACTORS INFLUENCING LISTENER COMPREHENSION IN MULTICULTURAL DYSARTHRIA

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in the Faculty of Humanities, University of the Witwatersrand.

March 2024

DECLARATION

I, Dilys Margaret Jones, declare that this thesis is my own, unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.

Dilys Margaret Jones

9th day of March, 2024 in Yeoville

ABSTRACT

The dysarthrias are a group of motor speech disorders which may be congenital, or may be acquired due to neurological injury or disease. Dysarthria frequently affects the intelligibility of speech, that is, the ability of the listener to decode the signals produced by the speaker, as well as the ability of the listener to understand the meaning of the speaker's message. As such, it has a great impact on the ability of the speaker to function in daily life and on quality of life. Most research is focused on the speaker with the impairment, but the listener plays a key role in the chain of communication. This study examined listeners in an attempt to describe some of the variables which may affect their ability to comprehend dysarthric speech. Given the multilingual and multicultural environment of South Africa, a particular focus was on language mismatch between speaker and listener.

A mixed methods design was used in which the main aim was to identify barriers and facilitators of listener comprehension in dysarthria. Sub-aims were to compare the performance of listeners on tasks of intelligibility evaluation and comprehension; to identify the role of second language use in listener comprehension and intelligibility; to identify the role of experience in listener comprehension and intelligibility; to evaluate whether a training programme could be effective in improving listeners' comprehension and to describe the strategies used by a small group of successful listeners to decode dysarthric speech. The research comprised three sub-studies: The first quasi-experimental sub-study examined the variables of language use and experience in groups of listeners (n=93) on tasks evaluating the intelligibility and comprehensibility of the speech of four speakers with dysarthria; The second, qualitative sub-study focused on the listening strategies used by a small group of people (n=3) identified as being “successful” listeners; The third was an experimental study to investigate the effect of a training intervention, in which a group of 15 listeners were evaluated on intelligibility and comprehension tasks before and after receiving training.

The results indicated that neither speaking the same language as the speaker nor previous

experience with dysarthric speakers was a predictor of success in comprehending dysarthric speech. However, the combination of experience and matching language was a significant facilitator. The group who underwent the short training programme performed significantly better than the untrained control group, suggesting that training could be an important facilitator of comprehension.

These results provide a very preliminary understanding of how the comprehension of dysarthric speech may be affected in the multilingual environment, a completely neglected area of research, and thus have potential theoretical implications as well as raising several implications for future research in the area. They also have important clinical implications, especially for resource-limited populations who do not have access to intensive rehabilitation, and for those whose dysarthria is progressive and whose speech will thus deteriorate. For both of these groups, greater focus on the listener, rather than the speaker, is likely to be more effective in improving communication.

In memory of

CLAIRE PENN

1951-2018

ACKNOWLEDGEMENTS

I wish to acknowledge the following people, without whose help, guidance and support this research could not have been undertaken or completed:

Associate Professor Heila Jordaan, Department of Speech Pathology and Audiology, School of Human and Community Development, University of the Witwatersrand: For taking on the unenviable task of supervising someone else's project. Thank you for your unfailing patience and calmness and for helping to restore some of my shattered confidence; I would never have been able to finish without you. You were the first person to introduce me to motor speech disorders as an undergraduate so many years ago, and have been a role model to me and so many other speech therapists ever since. Your trailblazing research into, and advocacy for multilingualism have always been inspirational.

The late Professor Emeritus Claire Penn, Department of Speech Pathology and Audiology, School of Human and Community Development, University of the Witwatersrand, my supervisor, teacher, mentor, colleague and friend: Thank you for the extraordinary vision and critical thinking that you brought to every piece of work, clinical or research, for allowing me to follow my own path even when it differed from yours, and for your passionate endorsement of the notion of clinician-researcher. It was an enormous privilege to have been able to learn from you, to work with you, to share our interests, both in communication and in indigenous flora and the natural world, and our mutual dry and sometimes dark sense of humour. You are greatly missed.

The late Professor Peter Fridjhon, School of Statistics and Actuarial Science, University of the Witwatersrand: For your advice on statistical procedures and for many hours of fruitful discussion about research generally, and this project in particular, as well as your commitment to advancing the rigour of research in the Humanities.

The people with dysarthria who were participants: Thank you for your enthusiasm for this project and your willingness to share your experiences for viewing by strangers. I have listened to your stories hundreds of times and never fail to be moved by them.

The listener participants: Thank you for giving up your time to participate in what was, for many of you, a stressful and quite threatening task and for the respectful manner in which you viewed the speakers.

My husband, Bruce Armstrong, for all of your support, both practical and emotional, for so many years, and for your love of data and spreadsheets! For you, Aidan and Katherine for enduring a lifelong diet of vicarious speech pathology.

All of my patients with dysarthria: Thank you for the privilege of sharing in a small part of your journeys. I have gained so much more than I have given.

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LIST OF ABBREVIATIONS USED

ENT	Ear, Nose and Throat specialist (otolaryngologist)
MND	Motor Neuron Disease
AAC	Alternative/Augmentative Communication
ASHA	American Speech and Hearing Association
ALS	Amyotrophic Lateral Sclerosis
LSVT®	Lee Silverman Voice Therapy
ASSIDS	Assessment of Intelligibility of Dysarthric Speech
SIT	Sentence Intelligibility Test
FDA	Frenchay Dysarthria Assessment
ASR	Automatic Speech Recognition
EFL	English First Language
ESL	English Second Language
SMMSE	Standardised Mini-Mental State Examination
ANOVA	Analysis of variance
HD	Huntington's Disease
ANCOVA	Analysis of covariance
EFL+	English First Language with experience
EFL-	Naive First language
ESL+	English Second Language with experience
ESL-	Naive English Second Language
ICC	Intraclass Correlation Coefficient

CHAPTER 1

INTRODUCTION: A PERSONAL PERSPECTIVE, DESCRIPTION OF THE PROBLEM AND RATIONALE FOR THE STUDY

"In the beginning was the word
wedded to creation,
its sound the essence
of the world itself"
(Don Maclennan, *Finale*, in Wylie, 2013)

Two incidents, which exemplify for me my interest in listener comprehension in dysarthria, stand out. In the first, a young woman with dysarthria attended the multidisciplinary voice clinic to get an opinion as to whether she could benefit from a Botox injection into her vocal folds. As was customary, after the clinical examination, the team discussed her case together before giving her feedback. ENT A was called out of the room as the discussion began, but while he was out ENT B commented that he felt that everything possible should be done to improve her voice because, apart from the voice, her speech was so good. Indeed, he had conversed easily and naturally with her during the consultation. At that point, ENT A returned to the room and initiated the discussion by saying that the patient's speech was unfortunately so unintelligible that, even if her voice quality were to be improved, there would be no difference in the functional outcome. As both of the ENTs, both highly skilled and experienced, had interacted with her at the same time, the difference in their perceptions of her speech was clearly something within them, and not the speaker.

The second incident involved a conversation between myself and a neurosurgeon about a patient with dysarthria and hearing impairment resulting from neurofibromatosis. The neurosurgeon was at first surprised that I had been able to understand the patient at all, but then concluded quite dismissively that "of course, you people (speech therapists, presumably) have special skill at understanding this kind of thing". Certainly, I have quite often been called in by panic-stricken staff in the various settings I have worked, to "interpret" for patients that they find unintelligible, as if

speech therapists do possess the “special skills” to which the neurosurgeon alluded. If we, as a group, have these skills (which I am by no means convinced about), what are they, and how did we acquire them?

I have been privileged over the years to work with a large number of people with severe dysarthria, initially mostly people with traumatic brain injuries or stroke, subsequently people with motor neuron disease (MND) and, more recently, people with Parkinson's disease and other neurodegenerative conditions. While I have witnessed the devastating impact that even mild dysarthria can have on a person, and I do not in any way wish to negate this, it is the people whose speech is severely affected in whom I am most interested. Despite the magnificent advances in Alternative and Augmentative Communication (AAC) over the past few decades, it has been my experience that many people, even with the most profound dysarthria, remain motivated to use at least some speech to try to communicate. This may be slow, unimaginably frustrating and involve numerous false starts, misunderstandings and repetitions, and yet they persevere, frequently not to express basic needs, but to make a comment, an aside or a joke. One of my earliest patients, WC, had told me that he once interviewed Elizabeth Taylor. It then took half an hour for me to understand what he was determined to tell me – that she really did have violet eyes! I recall with awe JR, in the last time he was ever able to attend the MND support group, using literally almost his last breath to relate his favourite funny anecdote[1]. This, for me, is the essence of communication.

I have always been fascinated by language comprehension, the “hidden” part of the communication chain. It can only be inferred from the response or behaviour of the listener, not measured directly; it is impacted upon by so many factors within the speaker, the listener, the environment and the context; and if it does not work, then ultimately the whole interaction is unsuccessful. I am intrigued

---

1 When his diagnosis of MND was confirmed, the neurologist told him that he would probably die within 3 months. As JR was wheeled out of the office, the neurologist told him he should make another appointment in 6 months' time!

by the interplay of such a multitude of factors that help a person to understand – language, cultural, prosodic. Perhaps this is partly because I love and am fascinated by the tiny subtle ways in which a meaning can be changed by a single word, or a single change in tone, as well as ambiguity and humour. A source of constant delight to me is the way in which word meanings are determined culturally or even geographically ("a checkers" to refer to a plastic bag, "die Kaap" to refer to Cape Town, "a groovy", describing an empty colddrink can). Working as I do in my second language environment, I face daily challenges to my own comprehension, usually related to idiomatic or locally idiosyncratic use of language. Such intercultural differences in language use can also have disastrous consequences – for example, when the Premier of the Western Cape referred to economic migrants from the Eastern Cape as "refugees", this was interpreted by many communities as a pejorative and highly offensive term.

There are many desirable outcomes in therapy with people with the dysarthrias, and to some extent these will be determined by the goals of the patient, the theoretical philosophy of dysarthria, and the approach to treatment. Overarching all of these, however, and, indeed, any speech or language therapy, is one simple outcome: for the person to be able to communicate more effectively. Whether the therapy is aimed at improving the quality of the voice, the production of specific individual phonemes, or implementing a system of AAC, all therapists and all patients with dysarthria essentially wish to enable the person to be better understood. In this sense, the roles of the listener and the communication environment are implicit in all speech therapy approaches.

In addition to the communication challenges facing most people with dysarthria, South African people, even the minority who are monolingual themselves, function in a multilingual, multicultural environment. Daily, routine interactions offer the potential challenges of misunderstanding and miscommunication, even to speakers whose speech is not impaired. Due to the historical inequalities in South Africa, there is frequently a cultural and/or linguistic mismatch in healthcare interactions. There are insufficient speech therapists in the country, and, despite ongoing, concerted

efforts to address this issue, most of them are still speakers of English or Afrikaans. It is probably true to say that the vast majority of South Africans with dysarthria do not receive sufficient therapy, if any at all, to address their communication needs in a realistic, effective way. People with communication disorders are undoubtedly among the most marginalised people in a society already rife with inequality and injustice.

Broadly, 'intelligibility' is seen as the degree to which speech is understandable. The concept of intelligibility is one of the cornerstones of speech pathology: It is frequently used as an indicator of whether speech production is impaired or not; it is widely considered to be an index of the severity of a disorder; it is used, both formally and informally, as a key treatment outcome measure, and compromised intelligibility is frequently acknowledged as having major psychosocial consequences for the speaker. Kent (1992) has described intelligibility as ".. the behavioural standard of communication (p.1)….. the *sine qua non* of spoken language" (p.9) and points out that intelligibility is one of the first and most important criteria by which a communicative attempt is judged.

Traditionally, intelligibility has been viewed essentially as the problem of the speaker. The role of the listener, both in terms of the evaluation of intelligibility and its treatment, has received very limited attention. More contemporary approaches, however, acknowledge the dyadic nature of communication and stress that production (by the speaker) and perception (by the listener) play equally important roles in intelligibility (Hustad, 2006). Variability among listeners' ability to understand impaired speech has been well-documented for many years (eg. Yorkston, Beukelman and Bell, 1988), but to date the listener variables which may affect understanding are not clearly understood. Clearly, this has profound implications for the use of speech intelligibility measures in research and for determining treatment outcomes. The implications of listener variability, however, extend well beyond this and raise several important questions: How do listeners understand dysarthric speech? Why do some listeners find dysarthric speech easier to understand than others?

Can listeners be trained to understand dysarthric speech better? What is the impact of a language mismatch between speaker and listener?

This study aims to examine some of the listener variables which may impact on the ability to understand dysarthric speech within the multilingual, multicultural South African context, and to determine whether this information can be used to improve the listening ability of poorer listeners.

Chapter two provides a brief outline of the dysarthrias in South Africa. The notions of speech intelligibility and comprehensibility are discussed in chapter three while chapter four focuses on listener comprehension. The three sub-studies which comprised the research project are described in the methodology section in chapter five. The results, discussion and conclusions follow in chapters six to ten.

CHAPTER 2

THE DYSARTHRIAS IN SOUTH AFRICA

Brief overview of the dysarthrias

The dysarthrias are a group of motor speech disorders resulting from the weakness, paralysis or inco-ordination of the speech musculature. The various types of dysarthria were first described by Darley, Aronson and Brown (1969), and this definition and the classification system are still very widely used in speech pathology today (Duffy, 1995; Halpern and Goldfarb, 2013). Acquired dysarthria can result from many neurological conditions, including stroke, traumatic brain injury, and various neurodegenerative diseases such as Parkinson's Disease, Motor Neuron Disease, Multiple Sclerosis etc., while dysarthria may also be congenital due to cerebral palsy. For ease of writing and reading, the term 'dysarthria' will be used for the whole group of disorders.

A Mayo Clinic review of 3417 patients with acquired neurogenic communication disorders evaluated in their neurology department found that 46% of these patients had one of the dysarthrias as their primary pathology (cited by Duffy, 1995). Although this data was gathered in the late 1980s and early 1990s, there is little reason to suppose that these figures would have changed substantially. Dysarthria is thus a common speech disorder. There is very limited incidence and prevalence data for dysarthria in South Africa. However, a retrospective review of all patients receiving speech therapy services over a two year period at Chris Hani Baragwanath Hospital revealed that 23,62% presented with dysarthria (Stone, Hoosen, Hochfelden, Maposa and Singh, 2020). This public, academic hospital is the largest in South Africa, and the third largest in the world, with more than 3000 beds (Chris Hani Baragwanath Hospital, 2021), so this can be seen as a fairly representative sample of communication and swallowing disorders in South Africa. As both stroke and traumatic brain injury (from motor vehicle accidents and interpersonal violence) are among the top 10 causes of death in this country (Statistics, South Africa, 2017), it can be inferred that the dysarthrias occur with at least the same, or greater frequency as elsewhere in the world.

Despite its high prevalence, research into the dysarthrias in South Africa is limited. For example, the South African Journal of Communication Disorders has published only three articles on dysarthria in the past twenty years (one of which concerns speech assessment in Swahili, not a language spoken in South Africa). One of the reasons for this could be the perceived difficulty in researching or treating a speech disorder in the context of multilingualism and multiculturalism.

On one level, dysarthria can be seen as an “acoustic” problem, or an impairment at the signal level. That is, one or more aspects of the speech signal, comprising voice, fluency, resonance, articulation and prosody, are distorted as a result of the underlying motor impairment. These acoustic differences can be described perceptually and demonstrated objectively using increasingly sophisticated technologies and data continues to accumulate on how the speech signal is affected by the different types of dysarthria and by specific neurological disorders.

On another level, dysarthria is seen as a social or life participation problem in which the dysarthric speaker's ability to make him/herself understood is compromised by the distorted speech signal, the important notion of speech intelligibility. Great strides have been made in the past decades to link these two levels and to obtain a greater understanding of how different signal-level problems contribute to the intelligibility of the speaker.

Approaches to the treatment of dysarthria

Treatment of people with dysarthria falls broadly into two approaches, although these are not mutually exclusive (Duffy, 2013). Speaker-oriented approaches are mostly 'restorative' in nature, in that they aim to improve individual aspects of the person's speech. This would include, for example, direct work on breathing, or voicing or articulation. It also includes more general techniques such as rate modification or the use of prosthetic aids such as the palatal lift prosthesis for patients with hypernasality. Attempts to change the underlying physiological impairment via

non-speech oromotor exercises continue to be popular speaker-oriented treatments, despite the very limited evidence for their efficacy. In 1985, Rosenbek and La Pointe, stated that "...speech pathology has spent more of its energy and resources defining and describing the dysarthrias than on developing treatments for them" (p 101). Happily, this is no longer true, and the past few decades have seen significant strides in the development of evidence-based, effective speaker-oriented treatments. Unfortunately, most of these are highly resource and time intensive, which makes access to appropriate treatment limited in developing countries such as South Africa.

In contrast to the approaches which focus on the speaker and improving aspects of the speech signal, are the communication-oriented approaches to treatment. These are essentially compensatory in nature, where the primary goal is more successful communication, even if the speech signal itself remains unchanged (Duffy, 2013). The focus is on the interaction between speaker, listener and environment, recognising that all three play an important role in the ultimate success or failure of the communicative attempt. Examples of communication-oriented treatments include the use of AAC, speaker strategies such as alphabet supplementation (eg. Hustad, Jones and Dailey, 2003), environmental modifications and communication partner training. A communication-oriented approach to treatment may be more appropriate for people with very severe dysarthria, whose speech is unlikely to improve, those with degenerative conditions, whose speech will deteriorate, and, possibly, in situations where there is lack of access to resources and therapists who are not able to speak the speaker's language.

Bilingualism and dysarthria

Penn and Armstrong (2017) state that "indigenous health matters have largely been neglected in the speech-language pathology literature" (p.563) and this is certainly true in the case of the dysarthrias. According to Miller and Lowit (2014), the vast majority of data concerning the dysarthrias is based upon English speakers, particularly speakers of American English, and, to a lesser extent, on the related Indo-European languages. They state that while motor speech disorders in French, German,

Japanese and Chinese have been studied, there are many world languages in which dysarthria has not been described or investigated at all. Their (2014) book was the first attempt to provide a cross-language perspective on motor speech disorders, including Spanish, Cantonese, Mandarin, Dutch, French, German, Hindi, Kannada, Japanese, Portuguese and Swedish. In a chapter in the same book, van der Merwe and le Roux (2014) present the first published description of how dysarthria and apraxia of speech affect speech production in Tswana and Zulu. Recently, the burgeoning literature on Lee Silverman Voice Therapy (LSVT®) has begun to include research into languages other than English (eg. Whitehill, Kwan, Lee and Chow, 2011 (Cantonese), Nakayama et al., 2020 (Japanese); Moya-Gale et al., 2018 (Spanish)).

Historically, speech production was viewed as “universal” - that is, although different languages make use of different phonemes, the way in which individual phonemes is produced is the same, irrespective of the language being spoken. However, as Miller, Lowit and Kuschmann (2014) point out, how important a particular phoneme, or feature of speech is, is not universal across languages and thus features of dysarthria (such as, for example, hypernasality, or reduced loudness) potentially affect intelligibility differently depending on the language being spoken.

Despite the rapidly growing interest in speech production across languages and how dysarthria manifests in these, the area of multiculturalism and multilingualism in the dysarthrias remains largely unexplored (Ramos and Ardila, 2011). The American Speech and Hearing Association (ASHA) practice portal for adult dysarthria states that “Treatment..... is provided in the language(s) used by the person with dysarthria, either by a bilingual SLP or with the use of trained interpreters when necessary” (ASHA, 2021) but, interestingly, the 'evidence map' section does not include any evidence to support this. There is still almost no research into the phenomenon of bilingualism in the dysarthrias, including whether a bilingual dysarthric speaker may have different severity of speech symptoms across their languages or whether the speech production of bilinguals differs from that of monolinguals. The impact of a mismatch between the speaker and the listener's language on

intelligibility and listener comprehension is not known. Bilingualism and its possible effect on intelligibility specifically will be discussed in chapter 3.

South African speakers and listeners, even those who are monolingual themselves, do not function in a monolingual and monocultural world and the notion of intercultural communication is thus particularly important.

Intercultural communication

According to Scollon and Wong Scollon (1995), most breakdowns in intercultural communication occur on the discourse level, rather than at the level of understanding words and sentences. There are cultural, gender, generational and professional differences in the way in which discourse is organised which often contribute to difficulty in interpreting the main point of someone else's speech. Many of these differences have not yet been described. For example, the gender discourse characteristics described by Tannen (1996) and still widely used, refer primarily to speakers of American and British English. However, as Wong and Scollon (1995) point out, one can assume that there are discourse differences between groups of people even if the nature of the differences is not known. They highlight four important principles of intercultural communication, which appear to have equal relevance to communicative exchanges in dyads where one speaker is dysarthric:

1. Language, being jointly constructed between conversational partners, is fundamentally ambiguous at every level
2. Listeners must draw inferences about meaning
3. The inferences drawn tend to be fixed, rather than tentative (so that listeners require some kind of "mark" to indicate that the usual assumption is not true)
4. Inferences have to be made very quickly because of the rapid pace of normal conversational turn-taking.

One way to avoid communication breakdown is to recognise discourse differences and ambiguities

and expect problems of interpretation. This may help the listener to question his/her inferences. (Scollon and Wong-Scollon, 1995).

Jandt (2004) describes six barriers to intercultural communication, namely anxiety, assuming similarity instead of difference, ethnocentrism, stereotypes and prejudice, misinterpretations of non-verbal behaviours and language. While these barriers are not listed hierarchically, it is interesting that language differences or problems are listed last. These will clearly play a role for the listener in intercultural exchanges with dysarthric speakers. As Tannen (1994) points out, “Human interaction is a 'joint production' … everything that occurs results from the interaction of all participants” (p.27).

CHAPTER THREE

SPEECH INTELLIGIBILITY AND COMPREHENSIBILITY

Overview of the history of intelligibility measures

Despite its ubiquity in the management of communication disorders, the notion of intelligibility and its measurement did not originate in the field of speech pathology, and this probably accounts, at least in part, for the evolution of its measurement and even its definition. Speech intelligibility tests were first devised by sound engineers working in the field of telephony. Audiologists later began to use intelligibility measures to evaluate the speech recognition ability of hearing-impaired people, and to describe their speech. Speech pathologists rapidly adopted intelligibility measurement as a means of quantifying the severity of speech disorders. Speech intelligibility measures are also used by linguists in determining whether related speech samples can be considered as different languages or as different dialects of the same language (Schiavetti, 1992). The development of speech recognition technologies has been a major focus of recent research.

While the early research into intelligibility in telephony was obviously focussed on the transmission system, the traditional view of intelligibility in speech pathology was also that it lies firmly within the domain of the speaker. That is, there are components of speech (articulation having received the most attention) which contribute towards compromised intelligibility and intervention is focussed on these impaired components (Keintz, Hustad, Garcia and Klasner, 2006). However, more modern approaches (for example, Olmstead, Lee and Viswanathan, 2020) recognise the role of both speaker and listener. This is clear in any contemporary definition of intelligibility. For example, the match between what the speaker intends and how the listener responds to transmitted speech (Schiavetti, 1992) or the extent to which a listener is able to decipher the signal which a speaker has produced (Keintz et al., 2006). Lindblom's (1990) model of mutuality (although originally developed in the field of AAC) has been influential in stressing that successful communication is dependent on

speaker and listener understanding each other's perspective. As Yorkston, Beukelman, Strand and Bell (1999) point out "speech intelligibility is a complex and multifaceted construct" (p 268) in which production and perception play equally important roles.

Intelligibility in the dysarthrias

Tikofsky and Tikofsky (1964) conducted the first investigations into the intelligibility of speakers with dysarthria. They found that dysarthric speakers were more likely to make errors which affected intelligibility on spondees rather than on monosyllabic words. This suggested that there was the potential to examine the phonetic underpinnings of compromised intelligibility in more detail. (Weismer and Martin, 1992). The seminal work of Darley, Aronson and Brown (1969) included an evaluation of intelligibility in the rating scale for the dysarthrias, but this was a general perceptual rating made of the speaker's running speech. It was not until the late 1980s that Kent et al. began to look systematically at the aspects of dysarthric speech which contributed to unintelligibility. They found that impairment in certain phonetic contrasts contributed more to intelligibility than others, and, importantly, that even within the same diagnostic categories, the error profile varied from speaker to speaker (Weismer and Martin, 1992). In other words, there are many different ways in which dysarthric speakers can be unintelligible. However, they point out that there had been very few attempts to elucidate the acoustic and phonetic factors which contribute towards unintelligibility in the dysarthric population. Even today, there is still a lack of clarity regarding the relationship between intelligibility and phonetic features as well as the underlying physiological impairments (Rong, et al., 2021). This is in contrast to the literature in intelligibility in other speech disorders (e.g. In the hearing-impaired population), which provides strong evidence that segmental deficits are not a very accurate predictor of intelligibility, while the suprasegmental features of rhythm, stress, pause, intonation etc are significant contributors to intelligibility (Weismer and Martin, 1992).

Duffy (1995) points out that the dysarthrias do not always result in less intelligible speech, but Ansel and Kent (1992) state that impaired intelligibility is the aspect of dysarthria which has the greatest impact both socially and in the clinical setting. However, to date, it is still not clear what the relationship is between a dysarthric speaker's social interaction and intelligibility of speech (Bloch and Barnes, 2020). Indeed, it is only very recently that the communicative competence of people with dysarthria, and its relationship to compromised intelligibility, has begun to be examined at all by authors such as Borrie et al. (2022). There is the potential for intelligibility to be impaired in all of the dysarthrias, although the major contributor to unintelligibility will vary as a function of the specific dysarthria type. In both speaker- and communication -oriented approaches to treatment of dysarthria, changes in intelligibility would usually be seen as an overall goal, but in more recent times, there has been more focus on explicitly improving intelligibility itself.

Rate control and increasing the precision of speech production have been identified as effective methods of improving intelligibility in some cases (eg. Yorkston, Miller and Strand, 2004). In recent years, there has been an explosion of research into speech supplementation as a method of improving intelligibility (eg. Hustad, Jones and Dailey, 2003) and the technical report of the Academy of Neurologic Communication Disorders and Sciences (Yorkston, Hanson and Beukelman, 2009) has concluded that speech supplementation strategies may be useful for speakers with severe or profound dysarthria. Speech supplementation strategies involve the provision of additional information to supplement the distorted speech signal. The most commonly used strategies are semantic/topic cues, alphabet cues (indicating the first letter of the spoken word), simultaneous use of gestural cues and spoken words and syntactic supplementation (provision of information about the word class of each word as it is spoken). Yorkston et al.'s (2009) review examined 19 studies of speech supplementation and found that intelligibility improved for all speakers, irrespective of which cueing strategy was used and how intelligibility was measured, with

the greatest benefit being seen in the speakers with the most severe dysarthria. Nevertheless, there are methodological limitations which preclude broad generalisation to normal communication. These include the nature of the tasks (not spontaneous speech), speaker and listener attitudes to supplementation, the magnitude of change in intelligibility which is needed to be functionally important, and the role of the listener.

Changes in intelligibility over time, both as a function of treatment and as a measure of deterioration in degenerative conditions continue to be seen as important indicators of severity. Stipancic, Yunusova, Berry and Green (2018) also conclude, though, that the magnitude of change needed is still not known. Their study of people with Amyotrophic Lateral Sclerosis (ALS -usually called MND in South Africa) found, interestingly, that there was not a correlation between patients' own rating of the severity of their speech and their speech intelligibility or rate of speech. They concluded that "... there is some (other) important and meaningful aspect of speech that influences patient self-ratings that is not accounted for by speech intelligibility and speech rate" (p.2768) and highlight the rather neglected area of how people with compromised intelligibility perceive their own speech.

The measurement of intelligibility

Considering its centrality in speech pathology, it is rather surprising that there are so few formal measures available for the measurement of intelligibility. The fact that all of them are so old probably attests to the shifting perspectives on the nature of intelligibility and its role in communication. The Frenchay Dysarthria Assessment (FDA) (Enderby, 1983) includes a section in which intelligibility is assessed ostensibly in words, sentences and in running speech. However, the sentence level assessment makes use of the same carrier phrase for each stimulus and there is therefore very little difference between the word and sentence level tasks. Orthographic transcription is required for the word and sentence tasks, and running speech is evaluated on a five

point rating scale (where (a) is no abnormality and (e) is the patient is totally unintelligible. Another widely used assessment is the Assessment of Intelligibility of Dysarthric Speech (ASSIDS) (Yorkston and Beukelman, 1981), and its slightly newer version, the Sentence Intelligibility Test (SIT) (Yorkston, Beukelman and Tice, 1996). The ASSIDS examines the intelligibility of words and sentences and then provides an estimate of what the authors describe as "communication efficiency" by examining the rate of intelligible words per minute. Kent et al. (1989) also describe a word intelligibility test, but this has not been standardised. The SIT consists of sentence tasks only. As Yunusova, Weismer, Kent and Rusche (2005) point out, although measurement of intelligibility at the level of discourse is considered to be more ecologically valid, such studies are very rare, primarily because of the difficulty in quantifying intelligibility at this level. Xue, van Hout, Cucchiarini and Strik (2023) examined intelligibility ostensibly in sentences, but the sentences are actually presented in connected discourse.

Methods of measuring intelligibility can be grouped broadly into two categories, namely scaling procedures and orthographic transcription. The FDA makes use of both methods. In scaling procedures, the listener is required to make judgements about the speaker's intelligibility using direct magnitude estimation or an equal interval scaling procedure (Shiavetti, 1992; Yunusova et al., 2005). One early example of such a scale is provided by Duffy (1995) in his textbook of motor speech disorders. In this scale, the listener is required to consider the environment, the context and the efficiency of speech, and a rating is given from 1 (speech is not a viable means of communication in any environment, regardless of restrictions in context or attempts at repair) to 10 (intelligibility is normal in all environments without restrictions on context, without need for repairs). Unfortunately, inter-rater reliability for estimates of intelligibility is sometimes poor. This is perhaps well summed-up by Stipancic et al.'s (2021) article title "You say severe, I say mild" (p.4718) , although they themselves found good inter-rater reliability with severity judgements. Yorkston, Beukelman and Bell (1988) describe studies in which differences between naïve judge's estimates of intelligibility were as large as 90%. Also highly significant was the finding (using

speech pathologists as judges) that objective scores of intelligibility on transcription tasks were poorly correlated with estimates of intelligibility. Notwithstanding this evidence gathered more than 30 years ago, scaling procedures continue to be widely used.

Various paradigms of orthographic transcription are used. Some authors (eg. Hustad, Jones and Dailey, 2003) have required an exact phonemic match with the target word for a word to be counted as correct. Others (eg. Liss, Spitzer, Caviness and Adler, 2002) have accepted a word as matching the target even if there were small morphological errors (eg. Tense or number), provided that the syllabic structure was not changed. Hustad (2006) looked at the effects of 3 different transcription methods on intelligibility scores (total word phonemic match, informational word phonemic match and informational word semantic match) as well as whether linguistic class had any effect on transcription accuracy. The differences between the three transcription methods were small but significant and she concluded that the actual scoring method used is not particularly important, as long as procedures are used consistently.

As discussed previously, there is a difference in intelligibility scores depending on the type of words used (spondees versus monosyllabic words) in single word tasks. Yorkston, Beukelman and Bell (1988) also compared intelligibility scores on single word tasks and on sentence tasks and found that there was a significant severity effect in which scores for single words were higher than sentence scores for severely dysarthric speakers, but the opposite was true for less severely involved speakers.

The medium of transmission has also received attention. One of the practical limitations of most research projects is that live speech is not used. The effect of live versus recorded speech still requires investigation. Intelligibility scores have also found to be affected by whether recording is presented audio-visually, or auditorily alone. Studies of intelligibility in normal speakers, hearing-impaired speakers and speakers who have undergone laryngectomy have suggested that

performance is better with audiovisual presentation. For speakers with dysarthria, the results are mixed, seeming to vary as a function of severity (Keintz, 2006; Keintz, Bunton and Hoit, 2007). Keintz (2006) concludes that visual information enhances intelligibility for most speakers, but may hinder it in some disorders (eg. Hyperkinetic dysarthria). The COVID pandemic and its consequent wide-spread use of masks has added extra importance to the audiovisual versus auditory presentation of speech. Smiljanic, Keerstock, Meemann and Ransom (2021) compared word recognition and recall for normal speakers both with and without face masks and found that intelligibility could be retained at the same level with the mask, but only when listening conditions were optimal (ie. Quiet environment). Interestingly and quite unusually, they included both ESL and EFL listeners and found that the ESL listeners began to experience difficulty at lower background noise levels than the EFL listeners did.

Some more current researchers have attempted to bypass the perceptual component of intelligibility measurement because of its subjectivity and variability. Van Nuffelen, Middag, De Bodt and Martens (2009) describe the development of a speech technology intelligibility assessment using automatic speech alignment. They compared the perceptual scores of 60 dysarthric speakers with the "objective phoneme intelligibility" score obtained using the automatic technology and concluded that the objective scores were reliable. This finding has obvious utility in making technologies such as voice-recognition software more accessible to severely disabled people, but is unlikely to replace perceptual assessment tasks as it excludes a key component of the communication process.

Gutz, Stepancic, Yunusova and Berry (2022) highlight the growing interest in using technological intelligibility assessments. Their study compared experienced human listeners (speech pathologists) with a readily available automatic speech recognition (ASR) system using 72 speakers, all with ALS, producing sentences from the SIT, and concluded that the ASR system was

not able to determine speech intelligibility with sufficient accuracy in dysarthric speakers. Importantly, they also point out that ASR systems are unable to take into account the fact that not all speech distortions affect intelligibility equally.

Intelligibility, comprehensibility and listener comprehension

Hustad and Beukelman (2002) state that the various intelligibility measures provide useful information about the integrity of the speech signal, but that they do not provide sufficient insight into how well the intended meaning of the message is transmitted. Keintz et al. (2006) sum up the limitations of intelligibility measures:

- no information is gained about the underlying reasons for the problem (the nature of the production deficits and the nature of the listener's difficulties;
- intelligibility is influenced by many factors, and clinical intelligibility measures provide only a "snapshot" of performance in a specific context which is not typically a "real" communication situation.

They propose an alternative measure of the listener's ability to comprehend the message, or "contextual intelligibility", namely **comprehensibility** (Enderby (2000) uses the term "operational intelligibility" and Bloch and Barnes (2020) use "understandability"). Comprehensibility measures also make use of orthographic transcription and percentage correct scores, but deliberately include contextual information (for example, listeners are given a topic cue).

A third dimension is that of **listener comprehension**, the ability of the listener to understand the spoken message – described by Lagerberg et al. (2019) as "listener intelligibility". This requires the listener to decode the acoustic signal and to process its linguistic content, and Hustad and Beukelman (2002) propose that it is a "more ecologically valid way to characterise the adequacy of

dysarthric speech" (p.546) because it comes closer to replicating real-life communication. Listener comprehension is usually assessed by having the listeners answer "comprehension" questions about the speech sample. Orthographic transcription is not required, and the listener is required to reflect a global understanding of the sample, and not the individual words used (eg. Drager and Reichle, 2001; Keintz et al,. 2006). In the domains of the World Health Organisation's conceptual framework, the International Classification of Functioning, Disability and Health (ICF) (WHO, 2001), intelligibility can usually be seen to fall within the Activity Limitation level, while comprehensibility and listener comprehension can be seen as affecting Life Participation (Dykstra, Hakel and Adams, 2007).

To date, the relationship between intelligibility and listener comprehension is not clear. From the results obtained in their study, Hustad and Beukelman (2002) concluded that intelligibility and listener comprehension measures are not related and that "complete and accurate decoding as measured by intelligibility scores is not requisite for comprehension" (p.555). They further suggest that the two measures in fact tap into completely different areas of perception. This probably accounts for the differences in judges' ratings of intelligibility and the scores obtained on orthographic transcription tasks described by Yorkston, Beukelman and Bell (1988) discussed previously. A more detailed study performed by Hustad (2008) again concluded that there is no significant relationship between sentence transcription and narrative comprehension.

Listener comprehension and the role of the listener and listener variables which may affect comprehension are discussed in more detail in the following chapter.

CHAPTER FOUR

LISTENING COMPREHENSION

The role of the listener, both in the measurement of intelligibility/comprehension and in the treatment of intelligibility impairments, has received scant attention in the dysarthria literature for many years, although the importance of the listener has repeatedly been highlighted. In their 1988 textbook, Yorkston, Beukelman and Bell state that "… increasingly we are involving the frequent listeners in interaction training activities with our dysarthric clients" (p.176). Duffy's (1995) text stresses that communication- oriented approaches to therapy with dysarthric patients should include both speaker strategies and listener strategies. He describes the latter as decreasing noise, maximising listener hearing and visual acuity, establishing methods of feedback and learning active listening. Yorkston, Miller and Strand (2004) provide "tips for understanding severely dysarthric speech" (p.227) along the same lines – controlling the communication environment, setting the stage for interaction, prompting the speaker. However, specific strategies for improving listener comprehension still do not appear to be available. The area of listener training to improve intelligibility of dysarthric speakers has become a major focus of research in the past two decades (Borrie and Lansford, 2021) and is discussed in more detail below.

Listener variables are often perceived as methodological limitations in studies of intelligibility. The corollary is, however, also true: the rigorous selection criteria for listeners have made it difficult to interpret the effect of various listener variables. For example, most intelligibility studies have used university students as listeners, although this does not reflect the population of most frequent listeners for most dysarthric speakers. Similarly, the selection criteria of most studies exclude listeners who have a history of neurological illness, or hearing loss, as well as those who are not first language speakers of the speaker's language. As a result, the impact of variables such as age, gender, education, language etc on the perception of intelligibility is not clear.

Listener age and educational level

Clark (1985) investigated the role of age in the perception of intelligibility of alaryngeal speakers and found a significant age effect favouring younger adult listeners. Markham and Hazan (2004) investigated word intelligibility rates from groups of 7-8 year old children, 11-12 year old children and adults using a normal speaker with intelligibility manipulated by the signal to noise ratio. They found that younger listeners made significantly more errors than older children or adults. The variable of age has not been extensively investigated in the dysarthrias. In Pennington and Miller's (2007) study, age was not found to be a factor influencing intelligibility scores, with the obvious proviso of considering hearing acuity. However, they concluded that more research is still needed into the effects of age and gender of both speaker and listener on speech intelligibility. McHenry (2011) investigated both listener intelligibility and listener judgements of intelligibility and concluded that age did not have a significant effect.

Similarly, scant attention has been paid to level of education. McHenry's (2011) study is one of very few investigating so-called "everyday listeners" who have been recruited with a broad range of educational levels. Level of education was not found to have a significant relationship to either objective intelligibility scores or judgement of intelligibility. Her participants' educational level ranged from 10 to 21 years, so that there were, in fact, no listeners with very limited education. This may be an important factor in South Africa, where many dysarthric speakers may have frequent listeners who have received limited formal education.

Listener experience and training

Two broad methodological issues need to be considered in reviewing the literature in this area. The first is that the terms 'familiarisation' or 'experience' and 'training' are used somewhat interchangeably (eg. Smith et al.'s 2019 paper entitled "Rating the intelligibility of dysarthric speech amongst people with Parkison's Disease: a comparison of trained and untrained listeners" compares

speech therapy students and listeners from the general public). For the purpose of this study, 'familiarisation' or 'experience' is taken to mean prior exposure to dysarthric speakers, whereas 'trained' refers to an explicit training process. The second broad issue is whether the effect of training is speaker-dependent (listeners are trained to understand that particular speaker better) or speaker-independent (the benefit of training extends beyond the speaker in the training to other speakers), sometimes referred to as 'specific' and 'general' benefit.

According to Osberger (1992), there is strong evidence to suggest that listeners who are not experienced in listening to the speech of hearing-impaired people perform more poorly on intelligibility tasks than experienced listeners. Furthermore, the ability to understand the speech of hearing-impaired people seems to be generalised and not limited to speakers whom the listener knows. Monsen (1983) has also indicated that this experience-advantage is fairly rapidly acquired. McGarr (1983) concurred that experienced listeners consistently performed better under various conditions than inexperienced listeners when listening to the speech of hearing-impaired speakers. However, the reasons for this difference have not been explored.

As yet, there is a lack of consensus as to the role of experience in the perception of intelligibility in dysarthric speakers. Walshe, Miller, Leahy and Murray (2008) investigated the perceptions of dysarthric speakers about their own intelligibility, compared to naïve and experienced listeners. Dysarthric speakers tended to rate intelligibility differently to non-dysarthric listeners but there were no statistically significant differences in perceptions across the three listener groups. They also did not find statistically significant differences across gender and listener experience. Yorkston, Hanson and Beukelman (2009) cite studies which suggest that listeners who are familiar with the speaker perform better than people who have general experience with dysarthria (eg. Speech therapists) and naïve listeners. Keintz, Bunton and Hoit (2007) used a group of experienced and a group of inexperienced listeners to transcribe the speech of people with Parkinson’s Disease

and found no significant difference between the two groups. In a locally conducted pilot study, Sims (2006) found that the intelligibility scores obtained increased as a function of experience in groups of speech therapy students in the various years of study and a group of experienced clinicians. However, there was a very large range of scores within groups, with some first year students obtaining scores comparable to those of experienced clinicians. At least some of the apparent conflict in results can be attributed to basic methodological or terminological differences, such as whether "experience" refers to familiarity with one particular dysarthric speaker, or exposure to many people with dysarthria (ie. Speaker dependent, or speaker independent).

The most recent investigation into experience is that of Smith et al. (2019) which compared speech therapy students and naïve listeners on intelligibility tasks and found no significant differences between the two groups. However, their "trained" (experienced) group had received theoretical education about acoustics, phonetics and speech production but had not had exposure to patients with dysarthria or other speech disorders and so were essentially also naïve listeners. In contrast, Borrie, Lansford and Barrett (2021) found that speech therapists with more experience with dysarthric speakers performed better on intelligibility tasks than their colleagues with less experience.

A slightly different approach to experience which does not appear to have been researched is the role of other forms of auditory or perceptual training, for example in speech and drama or accent reduction coaching, or even formal learning of a second language, all of which might be assumed to confer at least greater awareness of phonetics. McHenry (2011) suggests that a musical background might provide a perceptual advantage to listeners to dysarthric speech, and that this is a potential listener variable which warrants investigation. Connaghan, Fisk and Patel (2021) compared word transcription intelligibility between listeners with and without musical training. Although there was no difference between the overall scores of the two groups, there were differences between the

types of errors transcribed, suggesting that listeners with musical training do use different listening strategies.

The question of whether listeners can be trained to improve their understanding of speech is embedded within the concept of 'perceptual learning'. As a listener becomes familiar with a distorted signal, perception becomes better because of the flexible and dynamic nature of the perceptual system. Perceptual learning of speech has focussed on the areas of foreign-accented speech, speech of the hearing impaired, synthetic speech (as in AAC devices), noise-vocoded speech (simulating the experience of cochlear implant users), and, more recently, dysarthric speech.

Francis, Nusbaum and Fenn (2007) investigated the effects of training on the recognition of synthetic speech. Listeners were trained under various conditions, either actively (with feedback on their performance) or passively (only receiving a written version of the speech) using a single word recognition task. They were then tested on their ability to identify synthetic consonants. All of the trained groups improved. The fact that listeners' ability to identify consonants when they had been trained on whole words suggested that at least some of their improvement had been due to changes in their ability to process phonemes. This was an important finding, as little is understood about the mechanisms which contribute to perceptual learning.

Bradlow and Bent's (2008) study examined perceptual learning of foreign-accented speech under two conditions, namely speaker-dependent and speaker-independent, in which listeners' ability to understand novel speakers with the same foreign-accents was evaluated. They concluded that listeners not only improved when trained with individual speakers (speaker dependent) but that listeners who had been exposed to multiple speakers of Chinese-accented English during training could also perform better with new speakers (speaker- independent). As might be expected, there was variation in the speed and amount of benefit acquired during training, and this appeared to be

dependent on the initial level of intelligibility of the speaker, with more exposure being required for less intelligible speakers. They suggest that their results support the notion that speech perception is a highly flexible process which is able to adapt rapidly even to speech which differs significantly from what is the norm for that listener. It is important, however, to realise that foreign-accented speech differs from the "norm" in a more predictable and systematic manner than dysarthric speech. Bradlow and Bent (2008) also raise the interesting question of the extent to which perceptual "flexibility" can be acquired (p.727) – that is, are listeners exposed to many variable foreign accents more adept at understanding foreign accents generally, or is their perceptual flexibility linked to specific features of one particular foreign accent. This is a question which has great relevance, both to the wide range of dysarthric speakers, and in South Africa, where most listeners have daily exposure to a wide range of accents, dialects and languages. Might this exposure enhance the perceptual flexibility of listeners functioning in a multicultural environment?

Davis, Johnsrude, Hervais-Adelman, Taylor and Gettigan (2005) describe a perceptual phenomenon they call "pop-out". Their studies involve training listeners to better understand noise-vocoded sentences (synthetic sentences in which some frequencies are replaced with noise, to create a distorted signal). Listeners typically perform very poorly on intelligibility tasks. However, if given a clear version of the same sentence (either a clear auditory repetition or a written transcription) while they are listening to the sentence, they are able to recognise the words in a noise-vocoded sentence much more easily. Their performance on intelligibility tasks improves rapidly, and the improvement is lasting. According to Davis et al. (2005), "it is as if the content of the sentence pops out from what would otherwise be heavy distortion" (p. 227). Importantly, pop-out occurs for novel material as well, and not only for previously trained words, suggesting that perceptual learning is a top-down and lexically driven process. A further study (Davis and Johnsrude, 2007) confirmed that pop-out does not occur if the clearer version of the sentence is only provided after the distorted speech.

The phenomenon of pop-out, in which the listener is given an auditory or visual representation of the speaker's utterance, a type of Rosetta stone for unintelligible speech, was utilised by Tjaden and Liss in their 1995 study. Naive listeners were exposed to a dysarthric speaker and required to perform a range of listening tasks. There was no learning effect from repeated exposure to the speaker – listener performance only improved once they had been given a "script" of what the speaker was saying. Familiarisation (training) was only effective when it was accompanied by the script. It is noteworthy that this study is one of very few which used a bilingual participant as the speaker, although bilingualism was not a particular focus of the study. Nevertheless, the authors comment that the training procedure also improved listeners' ability to perceive patterns of the speech which were related to second language use and not dysarthria. This study only considered a single speaker, so the results of training cannot be generalised beyond that speaker. However, Tjaden and Liss (1995) also suggest that more experienced listeners may be able to be less speaker-specific because they have learned to fine-tune the perceptual strategies that they use.

Similarly, D'Innocenzo, Tjaden and Greenman (2006) examined the effects of training on sentence intelligibility for a single dysarthric speaker. The familiarisation (training) procedures involved the listeners being given either paragraphs or single words prior to transcribing the speaker's sentences. No difference was found between the two types of training – this is of theoretical importance in that it suggests that the benefits conferred by training came from improvements at the level of word intelligibility rather than from contextual or suprasegmental (pitch, tone, etc) benefits. Importantly, however, trained listeners performed more successfully than non-trained ones.

Liss, Spitzer, Caviness and Adler's (2002) study considered the issue of speaker-independent response to training as part of their larger research into identifying the sources of training benefit. . Groups of trained listeners obtained higher intelligibility scores than untrained listeners. Importantly, these effects were greater when training had been with a speaker who had the same

type of dysarthria as the speaker in the task, but all trained groups were superior to untrained. The training (referred to by the authors as familiarisation) was very short, consisting of six dysarthric speakers each reading three novel phrases. Clearly, the suggestion that training can have a speaker-independent benefit has significant clinical implications. More than that, however, the authors also point out that this finding also has important theoretical implications. Models of speech perception need to take into account this aspect of perceptual learning.

Borrie, McAuliffe and Liss' (2012) paper and Borrie and Lansford (2021) review all of the current published studies into perceptual learning of dysarthric speech and highlight its clinical and theoretical significance. They postulate that training does not alter either the quality or the quantity of the acoustic information available to the listener, but enables the listener to direct cognitive resources to the aspects of the signal which are most relevant for its recognition. Review of all of the perceptual learning studies suggests that there are probably multiple sources for the learning that takes place, including segmental, suprasegmental and even indexical information (age, gender, dialect, etc) about the speaker.

Borrie et al. (2012) summarise the important characteristics of perceptual learning as follows:

1. Perceptual learning is influenced at the lexical level – syntax does not appear to be critical, and words are better than non-words at facilitating learning)
2. Both passive and explicit familiarisation appear to facilitate perceptual learning, although they hypothesised that more explicit learning is required for more degraded signals. Their follow up study (Borrie, McAuliffe, Liss, O'Beirne and Anderson, 2012), however, concluded that explicit familiarisation is required to improve the perception of dysarthric speech.
3. There is not yet evidence to suggest how much training or familiarisation is required for perceptual learning to take place, but it does appear that learning takes place very rapidly, and that once perceptual adaptation has taken place, there is a permanent change in perception (ie. Once learning has taken place, the effects are lasting).

4. Generalisation from trained to untrained words can take place, but the extent to which generalisation occurs across speakers is not yet known.

(Borrie, McAuliffe and Liss, 2012).

Borrie and Lansford (2021) conclude that "there is robust support for the development of an approach that shifts the weight of behavioural change from speaker to listener, exploiting perceptual learning to ease the intelligibility burden of dysarthria" (p.3060).

Listener effort

According to Weismer and Martin (1992), normal speech perception requires not only recording the sequence of sounds heard, but attending preferentially to some aspects of the signal in order to begin to make hypotheses about words before all of the acoustic information is available. This situation may change when listening to a dysarthric speaker, and they suggest that much of the effort involved in trying to understand dysarthric speech may be associated with the fact that typical listening strategies do not work. Klasner and Yorkston (2005) point out that research is needed into listener effort. They speculate that listener effort probably increases to a point with increasing severity, but that it may decline again once severity becomes such that the person is no longer able to gain sufficient information from the signal to process. They state further that other listener variables such as fatigue also require investigation since both fatigue and effort are likely to determine the cognitive resources available to the listener. Whitehill and Wong (2006) conducted a preliminary investigation into the factors which contribute to listener effort for dysarthric speech and found a predictably high correlation between poor intelligibility and high listener effort. Interestingly, however, they also had a small number of speakers whose speech was not judged to be significantly unintelligible, but which was still rated by listeners as being very effortful to listen to. Interestingly, Stipancic et al. (2021) found that visual analogue scale ratings of listening effort were more reliable predictors of overall severity of dysarthria than more objective measures such as speech rate and transcription intelligibility. This finding highlights, once again, the limits to our

understanding of the relationship between speaker and listener in jointly bringing meaning to what is said.

Listener attitudes

Some dysarthric speakers tend to attribute communication breakdowns to a negative attitude on the part of the listener, and indeed the study of Hustad and Gearhart (2004) suggests that there is a relationship between positive attitudes of the listener and intelligibility scores although the relationship is not necessarily cause and effect. Toy and Joubert (2008) found no difference in attitude ratings between a group of familiar and unfamiliar listeners in South Africa. Methodologically, accurate evaluation of listener attitude is difficult, and it seems unlikely that listeners who do have a negative attitude towards dysarthric speakers would disclose this.

Klasner and Yorkston (2005) have developed the Barriers to Intelligibility Scale as a tool to begin to understand the strategies and barriers to intelligibility across the domains of segmental, suprasegmental, linguistic and cognitive. This is the first systematic examination of the factors perceived by listeners to facilitate or impede their understanding of dysarthric speech. It has been used to compare the barriers and facilitators in speakers with Huntington's Disease and speakers with Amyotrophic Lateral Sclerosis (ALS) (Motor Neuron Disease). They found that listeners endorsed the same strategies across the two groups, but experienced more barriers in the ALS group. This highlights the need to examine intelligibility and listener comprehension with a range of types of dysarthria. For both speaker groups, more successful listeners made more use of cognitive and linguistic strategies to understand than the less successful speakers did.

Language and cultural background of the listener

Most studies of intelligibility and comprehension explicitly exclude second-language listeners and the impact of a second or third language on intelligibility or listener comprehension is not known. There seems to be a tacit acceptance that intelligibility measurement by second language users will

be poorer, but this is not necessarily the case. Sims (2006) found that ESL listeners obtained poorer intelligibility scores when listening to an English-speaking dysarthric person. However, bilingualism may well confer some cognitive advantages in the more top-down processing task of listener comprehension.

Pennington and Miller (2007) investigated the influence of familiarity with the speaker's accent on intelligibility and found that it was not significant. However, it is noteworthy that the speakers used different regional dialects of British English from those of the listeners, but all were first language speakers of English. They conclude that "it is possible that unfamiliarity with speaker accent adds an extra dimension to the processing of dysarthric speech" (p.393).

Tjaden and Liss' (1995) influential investigation of the role of familiarisation in understanding dysarthric speech used speech samples produced by a bilingual speaker (with the research being conducted in English, the speaker's second language). Although bilingualism was not a primary focus of the study, some pertinent observations were made about bilingualism in dysarthria. Most notably, the familiarisation process improved listeners' ability to understand consistent patterns of articulation which were attributed to second language use as well as the impairment to the signal contributed by the dysarthria. This seems to suggest that second language use is not necessarily an obstacle to learning to understand dysarthric speech better.

Burda and Hageman (2005) made use of the ASSIDS (Yorkston and Beukelman, 1981) to investigate the success of elderly listeners in transcribing the speech of (normal) second-language speakers of English. Performance was significantly poorer with the samples produced by the second-language speakers. An important finding was that performance was better on sentence transcription tasks than on single word tasks, highlighting once again that these tasks may have different perceptual requirements.

The Intelligibility in Context Scale (ICS) was developed for parents or carers to rate the speech of children with speech sound disorders. This is unique in the sense that it is the only tool whose validity and clinical usefulness have been specifically researched using listeners (parents) who speak a range of different languages, including all of the official South African languages (Pascoe and McLeod, 2016). In similar vein, Lagerberg, Lam, Olsson, Abelin and Strombergsson (2019) examined the role of second language use in listeners evaluating speech, but this was again in the area of paediatric speech sound disorders and not the dysarthrias.

McHenry (2011) aimed to have "ethnic diversity" (p.120) among listeners in her study (with dysarthric speakers), although culture is not specifically alluded to in the paper, nor is there any discussion of how the participants of different ethnic backgrounds performed. The listener tasks involved intelligibility judgement of a short spontaneous speech sample, single word recognition in a multiple-choice format, and sentence transcription, so that the tasks may well not have tapped into cultural differences as much as a more "real-life" interaction would have done (note that all of the listeners were also described as monolingual speakers of English).

Unfortunately, the lack of information about how language mismatch between speaker and listener impacts upon intelligibility and comprehension presents a major obstacle in the implementation of effective strategies to reduce what Borrie and Lansford (2021) describe as the "intelligibility burden" (p.3060) of severe dysarthria, exacerbating the disparity in treatment available to people with dysarthria in this country.

The preceding overview might create the impression that speech intelligibility and comprehension are discrete functions, easily distinguished from each other, and progressing in a linear fashion from decoding of the signal to understanding the message. Despite the limited evidence of how comprehension is affected by decreased intelligibility, it seems clear that this is not the case:

accurate decoding of the signal (even if not complete) is necessary, but not sufficient, for understanding the message, but comprehension of the message may, in turn, feed back to improve the accuracy of decoding. The “mutuality of communication” model proposed by Lindblom (1990) is valuable in understanding this, and represents the theoretical framework upon which this research project is based.

According to this model, the signal (speech) is the proverbial tip of the communication iceberg. While traditional models conceptualise the communication chain as being mostly about the signal, its encoding, transmission and decoding, Lindblom suggests that it is “mutuality” or shared knowledge which is the key to communicative success. That is, the listener brings as much meaning to the communication as the signal does, because “speech perception is not driven exclusively by the signal. Linguistic and other knowledge influences what we hear” (p.222). Further, Lindblom suggests that, because of this mutuality, understanding can be robust even when the signal is degraded, and that the variability of dysarthric speech (commonly viewed as a threat in research) is, in fact, an asset because it represents what he describes as “the enormous expressive power of spoken language” (p. 228).

In order to understand the effects of dysarthria, and to attempt to treat it, or minimise its effects, speech therapists must move beyond consideration of only the signal to consideration of the whole message and the listener's role in bringing meaning to it.

CHAPTER FIVE

METHODOLOGY

This chapter will present the research design and the aims of the study as a whole, and thereafter will describe the participants, research materials, procedures and methods of analysis for each sub-study. Reliability and validity, as well as ethical issues for all three studies are discussed at the end of the chapter. An outline of the whole study is also tabulated on the following page.

Research Design

A mixed method design was used, comprising three sub-studies, each of which examined a different aspect of the question of what factors influenced listener comprehension. According to Schiavetti, Metz and Orlikoff (2011), mixed methods designs allow for the study of a range of topics within a single project, and facilitate a broader perspective of the particular topic. The first arm of the study utilised a quasi-experimental, between groups design, in which the listener variables of experience and language use were examined in relation to intelligibility and comprehension. The second arm examined a small group of listeners who had been identified as being "successful" in order to describe the strategies that they used. This was a qualitative, descriptive study. The final arm investigated the possible effect of training on listener comprehension. As a "trained" group did not exist, this particular variable could not be studied with the other variables of language and experience. For this reason, the third arm comprised an experimental, within-group design in which comprehension was tested in a small group of listeners before and after undergoing a training programme. These three studies are identified as the Listeners study, the Successful Listeners study and the Training study respectively. Each of the three studies was discrete and independent. However, some of the data gathered in the Listeners and Successful Listeners studies was used to inform the training programme used in the Training study.

Table 1

Summary of Methodology

	Research design	Broad aim/s	Participants	Summary of procedure
Study 1 ("Listeners")	Quasi-experimental; Between groups	Identify role of second language use in intelligibility and comprehension; Identify role of previous experience in intelligibility and comprehension.	1. 20 first language speakers of English (EFL) with experience with dysarthria. 2. 20 second language speakers of English (ESL) with experience with dysarthria; 3. 20 EFL speakers with no experience with dysarthria; 4. 20 ESL speakers with no experience with dysarthria.	Participants watched video recordings of dysarthric speakers and then performed sentence intelligibility and comprehension tasks. Listeners also rated their perception of listening effort and had the option of giving subjective comments on what made a particular speaker easier or more difficult to understand.
Study 2 ("Successful Listeners")	Qualitative; Descriptive	Describe strategies used by successful listeners when listening to dysarthric speakers.	3 dyads, each comprising a speaker with dysarthria and his/her regular communication partner	Each dyad was recorded with the dysarthric person relating a narrative to his/her partner. Partners were asked to describe the strategies they used using a rating scale.
Study 3 ("Training")	Quasi-experimental; Within groups	Evaluate effect of training programme on listener comprehension of dysarthric speech.	25 Third year Speech Therapy students, randomised into a control and an experimental (training) group.	All participants underwent a pre-test procedure. The experimental group participated in a one-hour training programme. The control group received no further intervention. Both groups then underwent the post-test.

Main Aim

To identify barriers and facilitators of listener comprehension in dysarthria in a multicultural context.

Sub aims

1. To compare the performance of listeners on tasks of intelligibility evaluation and comprehension.
2. To identify the role of second/third language use in listener comprehension and intelligibility.
3. To identify the role of experience in listener comprehension.
4. To evaluate whether a training programme can be effective in improving listeners' comprehension of dysarthric speech.
5. To describe the strategies used by a small group of “successful” listeners to decode dysarthric speech.

STUDY 1: LISTENERS

Aims

1. To compare the performance of listeners on tasks of intelligibility evaluation and comprehension.
2. To identify the role of second/third language use in listener comprehension and intelligibility.
3. To identify the role of experience in listener comprehension and intelligibility.
4. To describe listeners' own perceptions of how much effort they used to understand, and the features of the speakers' speech that they felt made it easier or more difficult to understand.

Participants

1. Speakers

People with dysarthria were not research participants as such, but acted as research collaborators who provided the speech stimuli. It was attempted to have speakers with a range of types of dysarthria, since type of dysarthria has been found to influence comprehensibility (Klasner and Yorkston, 2005). Potential speakers were recruited from Headway Gauteng and from the pool of dysarthric speakers known to the researcher. No attempt was made to match the speakers in terms of age, type of dysarthria, severity or time since onset as comparisons would not be made of listener performance between speakers. As it was not known how second-language listeners would respond to dysarthric speakers, a deliberate attempt to include speakers with only mildly to moderately compromised intelligibility was made. With the important caveat that judgements of severity may differ from listener to listener, Yorkston et al.'s (1993) ALS Severity Scale was used to determine the severity of the speech disorder. Speakers were selected with scores of 5 and above.

It was initially intended to recruit one speaker without a communication disorder to provide a sample of "normal" speech[1]. This was felt to be important as listeners, particularly those who do

1 For ease of writing and reading the term "dysarthric speech" will be used to describe the speech of a person/people

not use the speaker's language as their first language, may not obtain 100% correct scores for intelligibility and comprehension (c. f. Burda and Hagemann, 2005). Ultimately, a normal speaker was not recruited, but a dysarthric speaker who was judged to have normal speech intelligibility (Score of 8 on the ALS Severity Scale - " Perceived Speech Changes: Speech changes are noted by others, especially during fatigue or stress. Rate of speech remains essentially normal") was selected instead. The reasons for this were two-fold: Firstly, she would act as a screen of listeners' English comprehension so that listeners who did not achieve scores of 80% or above on both intelligibility and comprehension tasks would be excluded from the study. Secondly, she is physically-disabled, seated in a wheelchair and with a visible tracheotomy scar. This was felt to be important to ensure that any differences in intelligibility or comprehension did not arise from listeners' reaction to or perception of physical and communication disability.

2. Listeners

Two broad groups of listener participants were selected:

a). Groups of people experienced in listening to the speech of people with dysarthria (speech-language therapists, other rehabilitation professionals, teachers in specialised education facilities). These were recruited from rehabilitation facilities, private practices and specialised schools. The group was split into an English first language (EFL) and English second language (ESL) sub-group.

b). Groups of naïve listeners. These were specifically not university students, as used in many listener studies, but were chosen to reflect more typical conversational partners for people with dysarthria. They were recruited from general nursing staff, teachers and church groups or similar organisations of people who were willing to participate. This group was also split into EFL and ESL subgroups.

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with dysarthria. It is in no way intended to refer to people with dysarthria by their diagnostic labels, nor to imply that the dysarthrias are a homogeneous disorder. Likewise, the term "normal speech" will be used to describe the speech of individuals without any communication disorder without pejorative connotations for people with disordered communication.

There were thus four subgroups of listeners: EFL experienced, EFL naïve, ESL experienced and ESL naïve, each group comprising a minimum of 20 people in order to ensure a sufficiently large sample for statistical comparison. Due to a problem with the data obtained from one of the experienced EFL participants, this group unfortunately only comprised 19 people.

Participant Selection Criteria

Dysarthric speakers were required to:

1. have decision-making capacity (determined by a treating therapist if applicable, or a social-worker/case manager/group facilitator of the agency) and be able to give informed consent for having themselves videotaped
2. have broadly intact cognition, as screened on the Standardised Mini-Mental State Examination (SSMSE) (Molloy et al., 1991) both in order to be able to give informed consent, and to be able to participate in the tasks. This criterion was subsequently felt to be unnecessary as three of the four speakers are functionally independent and employed, and the fourth was judged by her clinical psychologist to be able to give informed consent
3. be first language speakers of English
4. be able to read the intelligibility stimuli
5. be able to communicate effectively using Alternative/Augmentative Communication (AAC) if necessary, in order to validate the content of the speech samples
6. be able to follow and recall instructions
7. have broadly intact memory, so that memory impairment did not impede communication or the ability to generate a short narrative.

Listener participants were required to:

1. be between the ages of 18 and 65 in order to exclude developmental or ageing-related problems including presbycusis (Two listeners were included who did not fit this criterion, but whose hearing

was within normal limits.)

2. have normal hearing and corrected vision in order to be able to perform the listening tasks

3. have no history of language/learning disorder, neurological illness or substance abuse as these may potentially affect the person's ability to comprehend language

4. be able to understand conversational English and use it regularly either at home, at work or in community interactions, as the listening tasks involved spoken English

5. be able to understand spoken and written instructions in English in order to provide the demographic information required and complete the listening tasks

6. have completed secondary school education at least to the Grade 10 level in order to ensure language performance at an appropriate level to complete the listening tasks.

In addition to the above criteria, the experienced listener group were required to:

a. be healthcare or other (eg. Teachers) professionals who had had regular (weekly) experience working with people with dysarthria for a period of at least five years, or

b. be healthcare or other professionals who had daily experience working with people with dysarthria for a period of at least six months. There is limited guidance in the literature to suggest what constitutes “experienced listeners” and these criteria were thus selected somewhat arbitrarily to include health-care professionals who would have had at least 100 hours of one-to-one direct contact with dysarthric speakers.

A final category of experienced listeners were lay people who had personal experience with dysarthric speakers, as caregivers or close friends.

The naïve listener groups were required to have had no more than incidental exposure to people with dysarthria.

As far as possible, it was attempted to include both male and female listeners in all groups.

However far more female than male listeners participated, reflecting the preponderance of females in both healthcare and education for the experienced listeners.

Description of Participants

Dysarthric Speakers

The characteristics of the four dysarthric speakers are summarised in the table below.

Table 2

Description of Dysarthric Speakers

Speaker number	Gender	Age	Etiology	Type of dysarthria	Time since onset	ALS Severity Scale (Yorkston et al., 1993)
1 (DU)	F	37	Stroke	spastic	6 years	8
2 (AM)	M	49	Cerebral palsy	hyperkinetic	congenital	5
3 (BC)	M	53	Traumatic brain injury	ataxic	11 years	7
4 (TN)	F	33	Traumatic brain injury	flaccid	13 years	6

Listeners

Characteristics of each group of listeners are summarised in the tables which follow.

Table 3

Description of Experienced EFL Listeners

Number of participants	19
Mean age	40
Age range	18-67
Gender	18 female; 1 male
Mean years of education	15,7
Years of education range	14-20 years
Other languages spoken	14 monolingual English speakers 5 considered themselves to be bilingual (4 speaking Afrikaans and 1 Portuguese)
Experience	8 therapists with experience in treating patients with neurological conditions; 1 student whose mother had had MND and who had volunteered in a group with other patients; 4 teachers in specialised education; 4 nurses in neurological or rehabilitation units; 2 people who were volunteers working with people with dysarthria

Table 4

Description of Naive EFL Listeners

Number of participants	20
Mean age	42.25 years
Age range	25-69
Gender	10 male; 10 female
Mean years of education	15.1 years
Years of education range	12-18 years
Other languages spoken	18 monolingual English speakers 2 considered themselves to be bilingual (one speaking Cantonese, the other Afrikaans)
Experience	none

Table 5

Description of Experienced ESL Listeners

Number of participants	28
Mean age	44,6 years
Age range	24-63 years
Gender	32 female; 1 male
Mean years of education	14,8 years
Years of education range	10-17 years
First language	30 Afrikaans; 3 isiXhosa
Experience	20 teachers in specialised education; 5 nurses/carers in a neurological rehabilitation unit; 8 therapists with experience in treatment of patients with neurological conditions

Table 6

Description of Naive ESL Listeners

Number of participants	26
Mean age	41.7 years
Age range	20-61 years
Gender	20 females; 6 males
Mean years of education	14 years
Years of education range	10-16 years
First language	23 Afrikaans; 1 isiZulu; 1 siSwati; 1 Portuguese and Afrikaans (considers both to be equivalent)
Experience	none

Procedure

The dysarthric speakers were each videotaped performing two tasks:

a. Reading ten sentence stimuli from the Assessment of the Intelligibility of Dysarthric Speech (ASSIDS) (Yorkston and Beukelman, 1981). This comprised the sample for the intelligibility test.

b. Producing a sample of natural speech, in which they described a memorable event. This comprised the sample for the comprehension task.

The broad content of each proposition of the narrative was transcribed and the speakers were asked to verify that the transcription was correct. Ten comprehension questions were devised about the content of each sample. The narrative transcriptions and comprehension questions are presented in Appendix A. Some of the narratives lent themselves more easily to comprehension questions, and there is thus no equivalence between the comprehension tasks for each speaker.

Listeners completed a short biographical questionnaire (presented in Appendix B) which included the following information: gender, age, level of education, and occupation. Participants were asked to state their home language/mother tongue and other languages spoken, and to describe how they acquired these languages and their normal patterns of use of each language. People who considered themselves to be completely bilingual in English and another language were included in the EFL group, irrespective of whether the languages were acquired simultaneously or sequentially and without any test of proficiency. That is, participants essentially allocated themselves to either the EFL or the ESL group. Given the complex multilingual nature of the South African population, this was felt to be the most appropriate method of determining language use and preference as many of the participants could not give unambiguous "checklist" responses. (For example, two participants who were siblings entered into quite a heated discussion while completing the questionnaire and finally each gave a different language as their "home" language).

For each speaker, listeners watched the video recording of the intelligibility task, followed by the recording of the narrative. In order to achieve optimal listening conditions, listeners were able to select their own most comfortable distance from the screen and their own most comfortable loudness level. This was done prior to commencement of the first video, but listeners were also free to adjust the volume or distance at any time. The sequence of the speakers was not randomised - each speaker presented new material, and there was therefore no risk of a learning or familiarisation effect during the tasks. Listeners watched the videos individually, or in small groups in order to minimise the possibility of collaboration.

Intelligibility tasks – The normal administration procedures for the ASSIDS were followed, namely that each sentence was played twice, whereafter the video playback was paused. Listeners were then required to do a broad transcription (ie. Minor morphological differences from the stimulus, such as tense or number, were considered to be correct) of each word that they heard.

Narrative comprehension tasks – Listeners watched the video recording of the narrative once, and then answered the comprehension questions.

On completion of both tasks for each speaker, listeners were asked to rate the amount of effort that they thought they had used in listening to and understanding the speaker on a 10-point Likert scale, ranging from no effort at all, to maximum effort required (the procedure of Whitehill and Wong, 2006). If they wished to, they also offered qualitative opinions on what aspects of the speech made it more difficult to understand, and what made it easier.

The researcher administered the test to all listener participants, and was thus also able to record some qualitative observations when these stood out. These included verbal comments that the listeners might have made, whether or not they made obvious use of subvocal repetition and

whether or not they made use of visual and auditory information or auditory only.

No time limit was set for the duration of the testing. The whole battery took approximately one hour to complete, but there was individual variation because of the time taken to do the transcription, and variability in reading and writing speeds in answering the comprehension questions. One listener had a broken arm, and dictated her responses to the researcher. Other than the pausing for transcription and answering of questions, the tasks for each speaker were completed without interruption. However, listeners were able to take breaks between speakers if necessary. It is acknowledged that this weakens the study, but it was felt to be desirable for listeners to be able to listen under the most optimal conditions for themselves, and many listeners found it too taxing to listen and write for an hour without a break.

Sentence intelligibility tasks were scored according to the ASSIDS procedure, in which each correctly transcribed word (irrespective of spelling or minor morphological errors) was given one point. A maximum of 70 points could be achieved for the whole task, and the final score was converted into a percentage.

Responses to the narrative comprehension questions were rated as either correct or incorrect. Credit was given for responses which were essentially correct even if they differed slightly from the "model answer". For example, at the start of his story, speaker 3 said that he was "on top of the world". In response to the question "How was he feeling at the start of the story?", any response such as "excited", "pleased", "happy", "proud" was accepted as correct. The score out of 10 was converted to a percentage.

Perception of effort ratings on the Likert scale were measured in centimetres, where a rating of maximal effort corresponded to a score of 10. Perceptual observations about the speaker's speech or

the listener's behaviour were noted on the data capture sheet.

Research Materials

1. Materials for testing intelligibility

A core of sentences from the ASSIDS (Yorkston and Beukelman, 1981) battery was used as the stimuli for the intelligibility task. (As discussed previously, there is a newer, computerised version of the test, the Sentence Intelligibility Test (SIT)(Yorkston, Beukelman and Tice, 1996). However, the ASSIDS is more readily available for clinical use in South Africa, and as it is a valid measure of intelligibility, and intelligibility forms only a small component of the study, it was not felt to be necessary to use the newer version). The ASSIDS was devised specifically for the assessment of intelligibility and the measurement of speech rate for clinical and research purposes to (1) rank order different speakers with dysarthria, (2) compare the performance of a single dysarthric speaker to the performance of normal speakers and (3) monitor changing performance over time (Yorkston and Beukelman, 1981 p.2). It allows for repeated administration with reliable results and has been found to be sensitive to a range of levels of severity. Speech intelligibility in the ASSIDS is evaluated using two different message formats, namely single words and sentences. For both message formats, samples are randomly generated from the master pool of words or sentences. For some speakers, a comparison of intelligibility under the two message conditions may be useful (for example, much higher rate of intelligibility under the single word condition suggests that the speaker might benefit from rate reduction strategies). In other circumstances, intelligibility scores might differ as a function of severity, in which case, depending on the purpose of the assessment, one or the other message format may be used. The SIT only makes use of the sentence format, but it was initially felt to be desirable to evaluate how well ESL listeners would perform on both single words and sentences. Results of a brief pilot study, however, suggested that ESL listeners are not able to obtain scores close to 100% on either the multiple choice or the transcription procedures for the single word intelligibility test of the ASSIDS when listening to a “normal” speaker and the word

tasks were thus deemed inappropriate for the present study.

The sentence intelligibility task consists of sentences ranging from 5 to 15 words, with 100 sentences per set. Two sentences from each length set are randomly selected, resulting in a total of 22 sentences. For the purposes of this study only 10 sentences were used in order to reduce the time taken to complete the task. Furthermore, only sentences from the 5 to 9 word pool were used as it was felt that the longer sentences were likely to impose very high transcription demands on second-language speakers of English (e.g. The pool of 15 word sentences includes stimuli such as "If the barometer is correct, conditions should be good for the growing number of fishermen"). A range of sentence lengths is required, since the length and complexity of the message affects its intelligibility (see, for example, Yorkston, Beukelman and Bell, 1988), but it would have been counter-productive to the study to include sentences which were linguistically so complex that ESL listeners may have had difficulty understanding them even when spoken by a normal speaker. Sentences containing vocabulary items not commonly used in South African English (eg. "The closet was too full") were excluded from the pool. Each speaker read different sentences in order to avoid a familiarisation effect for the listeners. They all followed the same format, namely 2 each of the 5 word, 6 word, 7 word, 8 word and 9 word sentences, making a total of 10 sentences containing 70 words. The sentence materials read by each speaker are presented in Appendix C.

2. Materials for testing comprehension

Most studies which evaluate listener comprehension have relied on narratives generated in advance by the researchers, which are then read by the speaker (for example, Hustad and Beukelman, 2002 and Hustad, 2008). This has the advantage that both narrative stimuli and comprehension questions can be tightly controlled in terms of phonetic content as well as predictability. There are, however, various disadvantages associated with this procedure. These include the fact that the speaker is not necessarily producing language or content which is typical for him/her, and that the speech

produced during a reading task may well be different from that produced during more natural speech. For the purposes of this study, it was felt to be desirable for the speech samples to be as close to natural communication as possible. Stimuli for the comprehension tasks were thus generated by the speakers themselves. The narrative was broadly orthographically transcribed by the researcher. Speakers were asked to verify the transcription before the comprehension questions were devised, and to verify the answers to each question. Questions were excluded if the answer could be inferred from another question, or if there was a high probability of guessing the correct answer (similar to the procedure used by Hustad, 2008). Two raters were required to attempt to answer the questions without having had access to the content of the original narrative in order to confirm the suitability of the questions. Obviously self-generated narratives cannot be equivalent between speakers, but the need for a sample of natural speech, using language and a topic that was typical for the speaker, was felt to outweigh the need for equivalence.

Equipment

Speech stimuli were videorecorded by the researcher using an iPad video camera mounted on a stand. Audio recording was supplemented with an external Joseph MS-712 microphone. Speakers were seated at a distance of 2 metres from the camera, looking directly at it, with the external microphone 50cm from the speaker's mouth, mounted on a microphone stand. As speaker 4 was severely dysphonic with a very quiet voice, the external microphone was moved closer to her for recording. Recorded data was transferred onto a computer. Each sentence stimulus was digitally repeated once so that listeners would automatically hear the sentences twice, and a pause between each pair of sentences was digitally inserted. All stimuli were then stored on DVD.

Listeners were given an answer sheet booklet (Appendix B) comprising the biographical questionnaire, a 10 line answer sheet for each set of sentence stimuli and the questions for each narrative. At the end of the narrative sheet was the 10cm Likert scale on which participants were

asked to indicate the level of effort that they had needed to understand the speaker. The questions "what aspects of the person's speech made it easier to understand?" and "what aspects of the person's speech made it more difficult to understand?" were presented after the Effort rating. Speech stimuli were played to listeners on an Acer Intel laptop computer with external SBS A40 stereo speakers. Listeners adjusted the screen and the loudness for their own comfort.

Data Analysis

Separate analyses were performed for the sentence and narrative tasks. Data from the groups of listeners were compared using two-way analysis of variance (ANOVA) in which the dependent variable was the test score and the independent variables were language (IV1) and experience (IV2). Since the group variables (experienced or naïve, ESL or EFL) are categorical and the dependent variable (listening score) is on an interval scale, analysis of variance was the appropriate manner in which to examine the relationships (Devlin, 2006). Two-way ANOVA is a way of testing the differences between groups in which each group has different sub-groups (Mc Call, 1986). This study had a two factor design (level of experience and language) with two levels of each factor, as summarised in the table below.

Table 7

Summary of two-factor design

FACTOR A
experienced
naive

FACTOR B
ESL
EFL

The main effects were the differences between the levels (experienced and naïve) in factor A, the differences between the levels (ESL and EFL) in factor B and the interaction between factors A and B.

Results of the Likert scale rating perception of effort are summarised numerically. Participants' subjective descriptions of what made listening easier or more difficult are grouped into broad themes and analysed qualitatively only.

STUDY 2: SUCCESSFUL LISTENERS

Aim

To identify and describe the strategies used by a small group of "successful" listeners to decode dysarthric speech.

Participants

Research participants were three dyads consisting of a person with dysarthria with compromised intelligibility, and his/her spouse, primary caregiver or regular communication partner. As there is no scientific definition of what constitutes a "successful listener", participants were chosen after being described by speech therapists, or the speakers themselves, as having good ability to understand the speech of that speaker. There were no additional selection criteria apart from retained ability to participate in conversation. The participants are described in Table 8 on the following page.

Procedure

Each dyad was videotaped by the researcher in a semi-natural interaction. The speakers were asked to narrate a memorable event and the listener was asked to interact as naturally as possible, requesting clarification or repetition or whatever was required for successful listening. The whole interaction was broadly transcribed and strategies used by the listener were identified and described. A structured interview was then conducted with the listeners in order to complete a checklist of listener strategies used. Hustad, Dardis and Kramper's (2011) Listener Strategy Scale was modified for this purpose. Both of the participants in dyad 1 were Afrikaans-speaking, but indicated that they were comfortable using the rating scale in English. The conversation partner in dyad 3 preferred to be interviewed in Afrikaans, and the definitions on the rating scale were discussed with her in both English and Afrikaans. The verbal interview format was used in preference to only using the checklist so that interviewees could request clarification if necessary.

Table 8

Description of Participants in Successful Listeners Study

	Person with dysarthria (PWD) age and gender	Communication partner - age and gender	Relationship to PWD	Language	Etiology of dysarthria	Primary method of communication
Dyad 1	Mr PL; 76	Dr ML (f); 72*	Wife	Afrikaans	Spino-cerebellar degeneration, with Parkinsonian features	Speech only. Only able to communicate with familiar interlocutors
Dyad 2	Mrs MD; 80	Mrs PS; 62**	Friend	English	Essential Tremor affecting mainly jaw, tongue and voice.	Speech only, but avoids communication with unfamiliar interlocutors.
Dyad 3	Mrs LW; 77	Ms DX; 33	Carer	English (DX is a first language speaker of isiXhosa, speaks Afrikaans as her second language, and English as her third).	Progressive Supranuclear Palsy.	Mostly AAC, which she is reluctant to use. Prefers to use speech with familiar interlocutors

*Dr ML, the communication partner in dyad 1 has a hearing loss.
**Mrs PS, the communication partner chosen by the speaker in dyad 3, has mild aphasia

Materials

The Barriers to Intelligibility Scale was developed by Klasner and Yorkston (2005) to identify the strategies which listeners were aware of using when listening to speakers with amyotrophic lateral sclerosis (ALS) and Huntington's Disease (HD). This was modified by Hustad, Dardis and Kramper (2011) to form the Listener Strategy Scale, which they used in a study of 10 listeners and 8 dysarthric speakers with cerebral palsy. The Listener Strategy Scale comprises 24 statements describing a listening strategy, grouped into 4 broad categories, namely:

Segmental (eg. “ When sounds were missing I filled in what I thought should be there”

Suprasegmental (eg. “ A slow rate allowed me to listen for the meaning of the sentence”)

Linguistic (eg. “ I tried to understand the unclear words from the context”)

Cognitive (eg.”I had to be prepared to hear distorted speech”).

This scale was designed to be used by listeners performing a sentence transcription task and the strategies included thus reflect listener judgements about a single speech task rather than strategies that they habitually use. Because of this, slight modifications to the scale were needed to make the strategies applicable in a conversational context. These were mostly changes in the tense from past to present progressive (eg. “I pieced fragments of words together to understand what was said” was changed to “I piece fragments of words together to understand what is said”). The changes to the scale are detailed in Appendix D.

Data Analysis

Given the very small sample size, statistical treatment of the data is not possible. Listening strategies endorsed by each dyad are listed and discussed. Strategies and barriers are grouped into the four broad areas outlined by Klasner and Yorkston (2005), namely segmental, suprasegmental, linguistic and cognitive.

STUDY 3: TRAINING

Aims

1. To evaluate whether a training programme can be effective in improving listeners' performance on intelligibility tasks.

2. To evaluate whether a training programme can be effective in improving listeners' comprehension of dysarthric speech.

2. To evaluate whether a training programme effected any change in listeners' perceived effort when listening to dysarthric speech.

Participants

A convenience sample of third year Speech-language Pathology students was selected as the research participants. The main study, examining the influence of second language and prior experience with dysarthria deliberately did not use students as participants, since they would not reflect frequent conversational partners for people with dysarthria. However, the issue of whether or not training can be effective in improving performance on intelligibility and comprehension tasks remains unresolved. This study thus aimed to provide some data, albeit limited, in an attempt to answer this question, namely, is training a factor which might potentially influence listener comprehension?

Participant description

Speaker 2 from the Listening study was the main speaker participant. Four additional speakers who had volunteered to participate in the studies, but who were not found to be suitable for the main Listening study, were also included in the training programme and their details are summarised below.

Table 9

Description of Speakers for the Training Study

Speaker number	Gender	Age	Type of dysarthria	Time since onset	Severity (ALS severity scale, Yorkston et al., 1993)
5	male	32	flaccid	13 years	6 – Repeats messages on occasion; Rate is much slower; Repeats specific words in adverse listening situations; does not limit complexity or length of message.
6	male	24	spastic	10 years	3 – Limits speech to One-word responses: vocalises one-word response beyond yes/no; otherwise uses AAC; Initiates communication non-vocally.
7	male	36	mixed	15 years	6
8**	female	63	flaccid	5 years	2 – Vocalises for emotional expression; Uses vocal inflection to express emotion, affirmation and negation.

** Unable to read sentences, so generated sample of automatic speech.

Demographic details of all listeners in the training study are summarised in Table 10 on the following page.

Procedure

Participants were informed about the procedure, any potential risks and benefits and the maintenance of confidentiality.

2. Those who wished to participate signed the informed consent form and completed the biographical questionnaire.

3. All participants underwent the pretesting procedure which is described below.

4. Participants were randomised into a training group and a control group. The control group did not receive any further intervention at that stage. Members of the control group were subsequently offered the opportunity to receive the training after the research project had been completed if they wished to do so.

5. The training group participated in the training programme detailed below.

6. One week after the training, both groups underwent the post-testing procedure.

Table 10

Description of Listeners for the Training Study

Number	Age	Home language	Other languages spoken	Previous experience with dysarthria
1	21	English	-	-
2	21	Greek/English	Afrikaans	Volunteered at brain injury support group
3	21	English	Afrikaans	-
4	21	English	-	-
5	21	English	Afrikaans	-
6	22	Sesotho	English, Setswana, isiZulu	Treating patient who is AAC user
7	21	English	-	-
8	20	Mandarin	English, Cantonese, Afrikaans	Treating a patient with dysarthria
9	20	Hebrew	English	Treating a patient with dysarthria
10	24	English	Hebrew	-
11	21	English	Afrikaans	Treating a patient with dysarthria
12	22	French/English	Lingala/Tshiluba	-
13	21	English	-	-
14	20	English	-	-
15	20	English	Afrikaans, German	Treating a patient with dysarthria
16	21	English	Afrikaans	-
17	21	English	-	Treated patient with mild dysarthria
18	23	English/Shona	-	-
19	20	English	-	Treating patients with dysarthria
20	21	English	Hebrew, Afrikaans	Treating patients with dysarthria
21	24	English	-	-
22	21	English	Afrikaans	-
23	26	English	-	-
24	20	English	-	-
25	21	English	Afrikaans	Treating patients with dysarthria

Pre-and post-testing procedure

Pre- and post-testing comprised the same material and procedure. This was considered to be necessary given that there is such great variability in listener performance on intelligibility and comprehension tasks. That is, it was essential to avoid the possibility of material used in one test being "easier" than another. This is obviously a limitation, in that change in results could possibly have been attributable to prior exposure to the material. This was the primary reason for the control group, in order to determine the magnitude of change in test scores that could be attributed to learning, rather than to prior exposure.

There were two tasks in the tests.

1. Intelligibility -

Participants watched the video recording of speaker 2 (moderately severe dysarthria) reading six sentence stimuli from the Assessment of intelligibility of Dysarthric speech (ASSIDS) (Yorkston and Beukelman, 1981). Participants were presented with two 5 word sentences, two 6 word sentences and two 7 word sentences, thus comprising a total of 36 words. Using only half of the sentence stimuli for the testing procedure allowed for use of the other half during the training programme without exposing the listeners to the test stimuli. As per the test instructions, each sentence was presented twice, after which participants were required to transcribe it orthographically.

2. Comprehension -

Participants watched the video recording of the same dysarthric speaker (speaker 2) narrating the story of his personally memorable event once. They were then required to answer questions on the narrative.

A score for each task was calculated using the same procedure as was used in the Listeners study.

Participants were asked to indicate on a 10cm Likert scale the amount of effort that they were required to make in order to understand the speaker. They also had the option of making a qualitative comment on aspects of the speaker's speech that they found made it harder or easier to understand.

Materials

The pre-and post-testing utilised the same materials as the Listening Study, but only made use of the stimuli generated by one speaker in order to limit the time taken for the testing. Speaker 2 was selected for this because he was found to be the most unintelligible and the most difficult to understand in the Listening study.

The training programme

The training programme had two broad components, namely general listening guidelines and guided listening of samples of dysarthric speech. The general listening guidelines were compiled from the feedback of the successful listeners in the Successful Listeners study, the subjective observations of the more successful listeners in the Listening Study and their comments about what was more or less useful in understanding the dysarthric speakers. These may be summarised as follows:

- reassurance that variability among listeners is normal and that it is normal for clinicians to find the tasks anxiety-provoking;
- keep listening actively, since the universal feature of less-successful listeners is giving up after they have not understood the first few words;
- try to identify specific sound errors or patterns which might make decoding easier (eg. Prosodic variations, hypernasality), but thereafter do not try to diagnose or identify perceptual features;
- give as much attention to suprasegmental and extralinguistic cues as to purely segmental and

linguistic information.

The guided listening aspect involved listening to samples of moderate to severely dysarthric speech, accompanied by orthographic transcriptions of the utterances. This is the simple, explicit familiarisation procedure used by Tjaden and Liss (1995), in which listeners who had repeated exposure to the stimuli (utterances of dysarthric speech by a single speaker) showed no learning effect, while those who had a written script of the utterances showed benefit across a range of listening tasks. Participants watched four dysarthric speakers reading ten different sentences from the ASSIDS, while the transcriptions of the sentences were presented via overhead projector. One dysarthric speaker was unable to read, and counted aloud. Participants were told that she would be counting aloud in lieu of a written transcription. The participants also watched four new sentences (comprising 34 words) being read by the speaker in the test.

As all participants had already received theoretical training in motor speech disorders, they were not provided with any more theoretical input. Some indexical information about speakers was provided, since this has identified as having an effect on intelligibility and comprehension in prior research (eg. Borrie, McAuliffe and Liss, 2012) and a need for indexical information was also observed in clinicians in the main study.

Throughout the training, it was attempted to project a positive view of speakers with dysarthria, and to reinforce that the participants were being successful in decoding their speech. The training was completed in one hour.

Data Analysis

As in the listening study, data from the sentences and narrative in the pre- and post-testing was handled separately. Means, variances and ranges of both groups are presented. Pre- and post-test

performance between the two groups was compared by one way analysis of co-variance, in which the covariate was the pre-test result (co-variate because of the groups' non-equivalent starting point), the dependent variable was the post-test score, and the independent variable was the group (control or trained).

RELIABILITY AND VALIDITY FOR ALL THREE STUDIES

Reliability refers essentially to the accuracy of the assessment measures used and is an essential contributor to the final validity (integrity or truthfulness) of the research (Devlin, 2006; Schiavetti, Metz and Orlikoff, 2011). These are key issues, particularly in a project such as this one in which there was heavy reliance on non-standardised measures. In addition to the possibilities of error in measurement, the English proficiency of ESL speakers potentially impacted strongly on reliability in two ways:

1. There needed to be a high probability that failure to transcribe the sentences correctly and/or to answer the comprehension questions reflected poor decoding and understanding of dysarthric speech and not poor comprehension of the instructions and questions. It was attempted to address this by conducting a pilot study testing all of the written instructions on the scoring sheets and ensuring that these were easily understandable to second language speakers of English. Written instructions were also supplemented by verbal input, and participants were free to ask the researcher if they were uncertain about the instructions.

2. There needed to be a high probability that failure to transcribe the sentences and/or answer the questions reflected poor intelligibility and comprehension of dysarthric speech specifically and not poor comprehension of English speech generally. This was addressed by the inclusion of speaker 1 who was judged to have unimpaired intelligibility. Results of participants who performed poorly when listening to her were considered not to be reliable, and their data was thus not included for any of the listening tasks. A small pilot study of EFL listeners listening to the narrative of a normal speaker found that some listeners achieved scores of only 80% when answering comprehension questions, and 80% on the narrative task of speaker 1 was thus used as a cut-off score for inclusion in the study.

The ASSIDS has established and published reliability data, both test-retest and inter-rater, and was

chosen because it is considered a valid and reliable measure of intelligibility of dysarthric speech (eg. Duffy, 1995). It is acknowledged that this data was gathered using EFL listeners only. Scoring of listeners' responses on the sentence intelligibility tasks is open to minimal interpretation: each word is rated as either correct or incorrect within the parameters specified by the ASSIDS manual, namely that errors of tense or number are accepted as correct. However, issues of literacy and spelling may have impacted on this, in that it may not always have been clear whether a particular response represented an incorrectly heard word, or poor spelling of the word, although the contextual clues offered by the sentences minimised this problem. The sentence tasks of ten percent of the listeners were independently scored by two other raters in order to estimate the inter-rater reliability of the sentence measures and the Intraclass Correlation Coefficient (ICC) was calculated for the three raters using Excel (Appendix E). Ten percent of the sentence tasks were also rated a second time by the researcher to estimate test-retest reliability. ICCs of 0,99 were obtained for both inter-rater and test-retest reliability, suggesting excellent agreement (ICC of 0 reflects no agreement, and ICC of 1 reflects perfect agreement).

Language comprehension is a much more difficult construct to measure (or, more correctly, to infer). There is no single measure of comprehension which can be used across speakers and listeners, since comprehension must acknowledge the role of context, world knowledge and so on. As discussed previously (Research Materials), listener comprehension is often assessed using narratives which the researchers have generated and which are then read by the speakers. While this method is undoubtedly more reliable in terms of having greater control over the predictability of the answers as well as the phonetic content of the material, its validity as a measure of comprehensibility of natural speech is very questionable. It is acknowledged that monologic narration of a memorable incident is also far from natural conversation, but it was felt that it would come closer to natural speech and thus be more ecologically valid.

The answers to the comprehension questions contained factual information which could easily be

scored as either correct or incorrect with minimal interpretation required. Inter-rater reliability of scoring was calculated by having ten percent of the narrative tasks rated by two additional raters. The researcher also re-scored ten percent of the narratives as a simple measure of test-retest reliability, and reliability was calculated in the same manner as for the sentence tasks (Appendix F). Again, the ICC value was 0,9, suggesting a high level of agreement. However, the small numbers of responses for calculating inter-rater and test-retest reliability are acknowledged as a major threat to reliability and limitation of the study.

An additional limitation relates to the test-retest reliability for each **listener.** The issues described above concern the reliability of ratings of the performances of the listeners. However, no attempt was made to determine the extent to which listener performance itself might fluctuate from day to day. This was not done because of practical considerations of time and also because of the need to avoid a practice or repetition effect. This "intra-listener" reliability would raise interesting questions about environmental factors such as fatigue and the emotional status of the listener, and how these might affect listener performance. This is an area which clearly warrants additional research.
In all parts of the study, subject selection presents a threat to the validity. It is probable that by calling for volunteers, and indeed by giving them information about the study, bias was introduced. Ideally, it would have been desirable to have much larger sample sizes, with participants subsequently grouped according to language use and experience. In reality, however, the sample had to be selected for convenience, and in some cases (especially experience) specifically recruited. This implies that the results obtained need to be interpreted with caution, and cannot be generalised to other populations.

Although the Likert scale for rating the effortfulness of listening has been used in previous research (Whitehill and Wong, 2006), its reliability has not been established. Both reliability and the validity of the scale are felt to be questionable. There is obvious potential for bias in that participants may

have felt a need to perform well and therefore expended greater effort than they would normally when listening to a dysarthric speaker (one participant even reported that he is normally "very impatient and lacks empathy" which might suggest that he usually makes less of an effort). Conversely, watching videotaped material might entail much less effort than face-to-face interaction. Performing the "test" itself was often perceived as effortful by the participants, which might have affected their perception of effort involved with listening to each speaker. It was clear during the testing that participants often found it difficult to "calibrate" this scale, as many people were noted to go back and change their rating after they had rated another speaker. At best, it is felt that the scale is a very blunt instrument which may give some indication of perception of effortfulness.

With regard to the training study, participants were randomly assigned to the two groups (control and training) in an attempt to strengthen the internal validity of the study. Although the biographical background of both groups was similar, unfortunately the performance of the control group during pre-testing was superior. This potentially represents a threat to the validity of the comparison between the two groups, but the statistical comparison indicates that there was nevertheless a difference in outcome after training. A further threat to validity was the fact that the two groups could not be isolated from each other, so that group members could have discussed both the testing and the training procedures. Exposure to the testing, or the mere fact of participating, may have affected the results and/or attitudes of the groups, which reduces the external validity of the procedure. Similarly, the attitude of the researcher may have affected the training group, rather than the training itself. Some of these limitations could have been overcome by the use of a four-group design, but this was not practical within the confines of this study. For the purpose of obtaining preliminary information, the quasi-experimental two-group design was considered to be adequate. Clearly, generalisations beyond the population of third year speech pathology students cannot be made (Devlin, 2006; Shuttleworth, 2009; Schiavetti, Metz and Orlikoff, 2011).

Ethical Issues

Before starting the research, ethical clearance was obtained from the University of the Witwatersrand's Human Ethics Committee (Protocol number H120211). As data collection had not been completed during the approved time frame, renewed ethical clearance was unconditionally approved in protocol number H15/11/10. The ethical clearance certificates are included in Appendix G.

Speakers

Only speakers with the cognitive capacity to give informed consent were recruited as they were considered to be a potentially vulnerable population. Where there may have been any ambiguity regarding capacity to give consent, a professional staff member of the referring agency (in most cases a clinical psychologist) was asked to confirm the individual's ability to consent. The names of the speakers have been concealed. However, all speakers and a family member or carer were made aware that they would be videotaped and the videos used for both research and training purposes. The consent form for the speakers in included in the Appendix H. Speakers were required to consent explicitly to the use of videotaped material of themselves.

Listeners

Listeners provided demographic information as described above, but were not identified by name. Listener participants in all three studies signed written informed consent forms before participating.

All potential participants, whether speakers or listeners, were given information sheets detailing the purpose and procedures of the study/ies. These are included in Appendix H. No participants were offered payment for their participation, but all were offered snacks and a beverage during or after completion of the tasks. All participants were free to withdraw from the study at any stage and it was made clear that withdrawal would not prejudice their future treatment, employment or

education in any way.

It was felt that no harm was likely to result from the study, either to speakers or to listeners, nor was there any direct benefit. Listeners who might have found comprehension failure distressing in face-to-face interactions with a dysarthric speaker were thought to be less likely to be distressed by watching recorded material. It was noteworthy that many of the listeners who were therapists, especially speech and hearing therapists, appeared to feel that they should have been able to understand better and were distressed by their perceived "poor" performance. The researcher addressed this by spending a few minutes at the end of the testing reassuring them that a wide range of listener performance is normal and that performance on such a test does not reflect on clinical ability in any way.

One listener contacted me a short time after the testing and asked me to identify and make a note on her response sheet about her experience. She was currently receiving counselling because of a traumatic incident and had found the narrative of one of the speakers upsetting because either he/she or the story triggered memories of the incident. As a result, she had found it extremely difficult to follow and had, in fact, "switched off". After discussion with her therapist, she felt it to be appropriate to make this clear. This unfortunate incident could not have been foreseen or prevented. She did not wish to withdraw from the study. Her results for this speaker were excluded from the group calculations, but provide a useful reminder of the role of emotion in language comprehension.

CHAPTER SIX

RESULTS OF LISTENERS STUDY

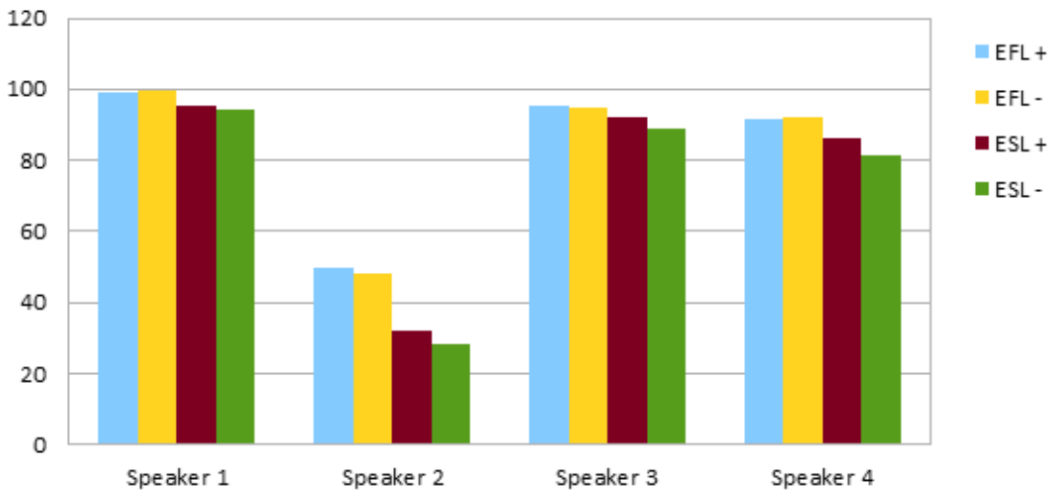
The results of all four groups for each speaker and each task are presented in the figures and tables which follow. Thereafter, the individual results for each speaker are presented. As the two tasks of intelligibility and comprehension represented two completely different processes, no attempt was made to compare them statistically. However, where the patterns are similar or different, these are discussed.

Results of the intelligibility (sentence) task

Figure 1 presents the results of the intelligibility task for each group, namely the experienced English first language group (EFL+), the naïve English first language group (EFL-), the experienced English second language group (ESL+) and the naïve English second language group (ESL-).

Figure 1

Results of the Four Groups for the Intelligibility Task



Performance was better for the first language speakers of English (blue and yellow bars), as one might have expected. However, the differences appeared to be small, apart from speaker 2. This suggests that increasing severity of dysarthria may increase the influence of the listener's language. Similarly, in comparing the experienced and naïve groups, although the experienced groups performed better, the differences were very small. Statistical comparison, using two-way ANOVA yielded the following results (calculations in Appendix I):

Table 11

ANOVA Results for Sentence Task

	Speaker 1	Speaker 2	Speaker 3	Speaker 4
Experience (Factor A)	75,26%	62,55%	10,16%	29,94%
Language (Factor B)	**0,01 %**	**0,01%**	**0,01%**	**0,01%**
Interaction between A and B	34,28%	33,76%	5,49%	9,91%

For the sentence intelligibility task, English first language use was significant across all speakers at p=0,01. Neither experience nor the interaction between language and experience were significant, although they came closer to being so for speakers 3 and 4 with a p value under 10%. In contrast, the other p values reject the null hypothesis.

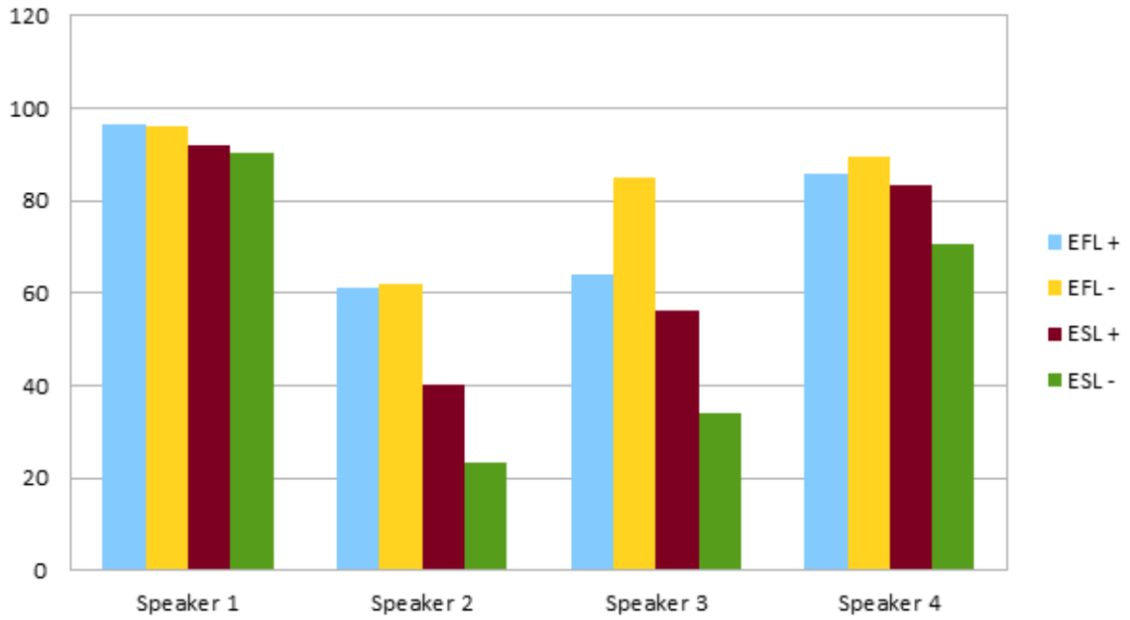
Results of the comprehension (narrative) task

Figure 2 on the next page shows the results for the comprehension task for each of the four groups. In contrast to the intelligibility task, there was a much greater spread of performance for the comprehension task, as well as different patterns across the different groups. For speaker two, the two first language groups performed similarly, and better than the second language groups. In the ESL groups, the experienced group were better than the naïve one. For speaker three, there is an unexpected pattern in which the naïve EFL listeners performed considerably better than any of the

other groups, while the ESL groups showed a similar pattern to that seen in speaker two, namely experienced being superior to naïve. For speaker four, performance was similar for the EFL+, EFL- and ESL+ groups, but again with the somewhat unexpected pattern of the naïve EFL listeners being superior.

Figure 2

Results of the Four Groups for the Narrative Comprehension Task



Statistical comparison using the two-way ANOVA yielded the following results:

Table 12

ANOVA Results for Comprehension Task

	Speaker 1	Speaker 2	Speaker 3	Speaker 4
Experience (Factor A)	67,24%	14,17%	55,57%	7,77%
Language (Factor B)	**2,15%**	**0,01%**	**0,01%**	**0,06%**
Interaction between A and B	59,16%	**3,30%**	**0,01%**	**0,54%**

Thus for the comprehension task, English first language use emerged as being significant, with p=0.01 for speakers 2 and 3 and p=0,06 for speaker 4. Experience was not significant, but the combination of language and experience was significant for speakers 3 and 4 (with p=0,01 and p=0,54 respectively) and approaching significance for speaker 2 with p being less than 10.%.

Individual results for each group

Table 13 on the following page presents the individual results for each listener and each speaker for the naïve
(EFL-) group.

Note that although participant 1 (marked with asterisk) scored only 50% on the comprehension task for speaker 1, the criterion of 80% or above (specified in the methodology) was not included for first language speakers of English and this data was thus included. It is difficult to account for this poor performance, but it does highlight that factors other than language play an important role in comprehension.

Table 13

Results of Naive EFL Group

	Speaker 1 (DU)		Speaker 2 (AM)		Speaker 3 (BC)		4 (TN)Speaker	
P	Sent	Narr	Sent	Narr	Sent	Narr	Sent	Narr
6	100	100	57	60	97	90	93	100
8	100	100	53	70	87	100	93	90
9	100	100	56	60	96	70	93	100
10	100	100	51	70	96	100	94	80
11	99	100	33	50	94	100	94	80
12	100	100	59	40	96	70	90	90
16	95,7	100	34,2	60	92,8	100	90	90
1 *	98,5	50	52,8	60	94,2	60	92,8	70
2	100	100	55,7	70	97	80	92,8	90
18	100	100	47	20	95,7	80	78,5	90
19	100	90	35,7	10	97,1	70	92,8	70
20	100	100	20	80	95,7	90	92,8	100
21	100	90	44,2	90	94,2	100	95,7	100
22	100	90	68,5	90	95,7	100	91,4	100
23	100	100	28,5	60	95,7	60	85,7	90
56	98,5	100	45,7	70	95,7	90	90	90
55	100	100	48,5	80	92,8	90	94,2	90
57	100	100	47,1	80	97,1	70	97,1	100
86	97,1	100	51,4	40	95,7	80	92,8	80
58	100	100	75,7	80	95,7	100	95,7	90

The average scores and ranges for each speaker are presented in table 14 below.

Table 14

Summary of Scores Obtained by Naïve EFL group (N=20)

	Speaker 1 (DU)		Speaker 2 (AM)		Speaker 3 (BC)		Speaker 4 (TN)	
	Sent	Narr	Sent	Narr	Sent	Narr	Sent	Narr
Mean Score Obtained	99,44	96	48,2	62	95,06	85	91,96	89,5
Range	95,7-100	50-100	20-75,7	10-90	87-97,1	60-100	78,5-97,1	70-100

While performance across both tasks was similar for speakers one and four, many listeners showed marked differences between intelligibility and comprehension for speakers two and three. Interestingly, this pattern was not the same: for speaker two, narrative comprehension was generally better than sentence intelligibility, while for speaker three, the reverse was true.

The results of the experienced EFL group are presented in table 15 on the next page.
As with the naïve EFL group, it can be seen that one participant did not obtain the baseline score of 80% for the narrative task for speaker one. These results are summarised in Table 16.

As was seen with the naïve EFL group, there was a very large range of performances for all speakers except speaker one. As these participants were all first language speakers of English, experienced in listening to speakers with dysarthria, one can only conclude that this must be a normal phenomenon.

Table 15

Results of the Experienced EFL group

	Speaker 1 (DU)		Speaker 2 (AM)		Speaker 3 (BC)		Speaker 4 (TN)	
P	Sent	Narr	Sent	Narr	Sent	Narr	Sent	Nar
3	98,5	100	40	80	97,1	80	97,1	100
4	100	100	50	80	94,2	90	87	80
17	100	100	67,1	90	95,7	100	94,2	90
27	100	100	52,8	70	97,1	90	95,7	100
45	98,5	100	44,2	80	94,2	70	97,1	90
53	100	100	81,4	90	97,1	50	95,7	100
54	100	100	31,4	60	97,1	40	91,4	80
77	94,2	80	14,3	0	78,6	40	64,2	40
87	100	100	68,57	90	97,14	80	95,71	90
88	100	100	44,28	40	97,14	70	94,28	90
89	100	100	78,6	70	95,7	100	94,2	90
91	100	90	54,3	70	97,1	60	92,8	90
90	100	90	37,14	20	97,1	20	90	70
92	100	90	54,2	80	97	80	95,7	90
93	97,1	100	55,7	70	97,1	100	94,2	90
94	100	90	82,9	70	97,1	100	95,7	90
95	97,1	100	68,57	70	97,1	70	95,7	90
68	100	90	61,4	70	95,7	60	94,2	90
82	98,5	100	24,3	10	95,7	10	88,6	90

Table 16

Summary of Scores Obtained by Experienced EFL Group (N=19)

	Speaker 1 (DU)		Speaker 2 (AM)		Speaker 3 (BC)		Speaker 4 (TN)	
	Sent	Narr	Sent	Narr	Sent	Narr	Sent	Narr
Mean Score Obtained	99,15	96,32	53,22	63,68	95,52	68,94	92,28	86,84
Range	94,2-100	80-100	14,3-81,4	0-90	78,6-97,1	10-100	64,2-97,1	40-100

The results of the naïve ESL group are presented in the tables which follow (p.75). Participant 71 (marked with asterisk) presented a methodological challenge. The score of 70 for the narrative tasks for speaker one was below the baseline for what was intended as a screening for English proficiency and the data should thus have been excluded. However, one of the first language speakers obtained an even lower score (50%) but was not excluded as English proficiency was obviously not a criterion for first language speakers. It thus seemed that excluding the data of ESL participants could potentially artificially increase the scores obtained for the whole group. The data for participant 71 was therefore included.

Table 17

Results of the Naïve ESL Group

	Speaker 1 (DU)		Speaker 2 (AM)		Speaker 3 (BC)		Speaker 4 (TN)	
P	Sent	Narr	Sent	Narr	Sent	Narr	Sent	Narr
3	100	80	31	40	96	70	93	80
7	96	90	36	6	96	90	80	80
9	84,2	80	31,4	30	80	30	95	60
11	89	90	21	30	89	50	86	100
12	88,5	100	25,7	20	90	40	88,5	40
15	91,4	100	25,7	50	87,1	70	71,4	80
25	100	100	47,1	40	91,4	20	91,4	90
4	100	100	66	80	89	40	96	90
24	100	100	35,7	70	88,5	70	90	90
59	97,1	100	54,3	50	95,7	50	95,7	100
63	100	100	31,4	0	95,7	40	84,3	80
62	92,8	80	15,7	20	97,1	30	78,6	70
61	100	100	21,4	10	98,5	10	85,7	70
66	95,7	80	35,7	10	92,8	10	87,1	80
73	82,9	90	8,6	0	75,7	20	61,4	50
71*	87,1	70	17,1	30	82,9	20	61,4	70
76	95,7	100	15,7	20	78,6	10	58,6	50
75	97,1	90	30	10	85,7	60	80	70
64	92,8	80	18,6	0	85,7	20	74,3	70
67	98,5	100	28,6	30	97,1	30	85,7	80
72	97,1	80	30	30	81,4	20	75,7	60
70	100	100	22,9	10	91,4	10	88,6	90
69	100	80	28,6	0	95,7	30	85,7	30
81	98,5	100	15,7	0	82,9	10	87,1	40
83	82,9	80	15,7	10	82,9	20	61,4	40
84	81,4	80	27,1	10	80	20	75,7	80

As seen in table 18, the very wide range of scores was also seen in this group. However, the pattern of narrative performance being superior to sentence intelligibility for speaker two was not seen.

Table 18

Summary of Scores Obtained by Naïve ESL Group (N=26)

	Speaker 1 (DU)		Speaker 2 (AM)		Speaker 3 (BC)		Speaker 4 (TN)	
	Sent	Narr	Sent	Narr	Sent	Narr	Sent	Narr
Mean Score Obtained	94,18	90,38	28,33	23,30	88,72	34,23	81,47	70,76
Range	81,4-100	70-100	8,6-66	0-80	75,7-98,5	10-90	58,6-96	30-100

The results of the experienced ESL group are shown in the table 19 on the following page. As with the other groups, two participants (40 and 8, marked with asterisk) did not meet the cutoff score of 80 for the narrative task for speaker 1. However, the data was included for the reason discussed previously. The results for the whole experienced ESL group are summarised in table 20.

Table 19

Results of the Experienced ESL Group (N=28)

	Speaker 1 (DU)		Speaker 2 (AM)		Speaker 3 (BC)		Speaker 4 (TN)	
P	Sent	Narr	Sent	Narr	Sent	Narr	Sent	Narr
1	100	100	41	50	97	60	94	90
2	100	100	47	90	91	90	97	90
5	96	100	41	20	94	80	84	100
5	90	90	40	40	85,7	60	85,7	90
6	97,1	90	12,8	30	88,5	40	84,2	70
7	87,1	100	20	60	85,7	30	90	70
8 *	85,7	70	11,4	30	77	0	60	80
13	90	100	27,1	40	95,7	50	85,7	80
26	100	100	32,8	40	97,1	80	92,8	90
28	98,5	100	41,4	55	87,1	60	90	80
51	98,5	100	44,2	60	95,7	70	95,7	100
50	92,8	90	42,8	60	94,2	60	94,2	90
48	92,8	100	24,2	0	81,4	60	85,7	80
46	88,5	100	34,2	50	97,1	40	84,2	80
44	91,4	80	34,2	40	95	40	88,5	70
43	98,5	100	42,8	10	97,1	50	71,4	90
42	100	90	41,4	50	95,7	60	88,8	80
41	97,1	90	14,28	70	94,2	60	77,14	80
40 *	90	70	27,14	10	94,2	20	78	70
39	92,8	100	35,7	50	94,2	90	85,7	90
38	97,1	100	34,28	20	94,2	60	88,57	80
37	100	100	52,8	70	92,85	90	91,4	80
36	87,1	80	4,2	10	88,5	40	81,4	80
34	100	100	25,7	20	91,4	50	80	90
33	100	90	25,7	10	91,4	50	78,5	80
35	100	80	50	80	92,8	50	85,7	100
31	100	80	17,1	30	97,1	100	92,8	80
30	100	80	37,14	30	98,5	40	97,1	70

Table 20

Summary of Scores Obtained by Experienced ESL Group (N=28)

	Speaker 1 (DU)		Speaker 2 (AM)		Speaker 3 (BC)		Speaker 4 (TN)	
	Sent	Narr	Sent	Narr	Sent	Narr	Sent	Narr
Mean Score Obtained	95,39	92,14	32,22	40,17	92,29	56,42	86,01	83,21
Range	85,7-100	70-100	4,2-52,8	0-90	77-98,5	0-100	60-97,1	70-100

Summary of results for each group of listeners with each speaker

The tables which follow summarise the results of each group of listeners for each individual speaker. As was expected, most listeners performed well on both tasks for speaker 1. The ESL speakers obtained slightly lower scores for both tasks, but prior experience with dysarthric speakers did not appear to affect performance. It is interesting to note, for example, that, despite the high scores obtained on the intelligibility task, one member of the EFL group obtained the lowest score of any of the groups on the comprehension task (50). This highlights the fact that intelligibility

Table 21

Summary of Scores Obtained by All Groups for Speaker 1

	Speaker 1	
Listener Group	Intelligibility Mean (range)	Comprehension Mean (range)
EFL (+ experience)	99.4 (94.2-100)	96.3 (80-100)
EFL (- experience)	99.4 (95.7-100)	96 (50-100)
ESL (+ experience)	95.4 (85.7-100)	92.1 (70-100)
ESL (- experience)	94.2 (81.4-100)	90.4 (70-100)

does not necessarily predict comprehensibility, and that language facility also does not automatically assist comprehension, even in an essentially normal speaker. This feature is addressed in more detail for speaker 3. It is also noteworthy that wider ranges of performance are seen for the comprehension task for most of the groups.

One of the most striking features of the summary for speaker 2 (Table 22), the most severely dysarthric of the speakers, is the very wide range of scores obtained (from 4,2 to 81,4 for the sentence task and from 0 to 90 for the narrative). While the first language English groups performed markedly better, experience did not appear to be a factor. It is interesting to note that all four groups had individuals who performed very poorly, and individuals who performed very well, irrespective of their language background or experience with dysarthria. For most of the groups, performance was better for the comprehension task than for intelligibility, but this was not the case for the naïve ESL group. In some ways, this was an intuitive finding as one could expect that the narrative gave more contextual information, which facilitated comprehension. It is hard to account for why the naïve ESL group did not appear to be able to use this information. However, the pattern of comprehension being generally superior to intelligibility is not seen in the data of speaker 3.

Table 22

Summary of Scores Obtained by All Groups for Speaker 2

	Speaker 2	
Listener Group	Intelligibility Mean (range)	Comprehension Mean (range)
EFL (+ experience)	50.2 (14.3-81.4)	62.5 (0-90)
EFL (- experience)	48.2 (20-75.7)	62 (10-90)
ESL (+ experience)	32.2 (4.2-52.8)	40.2 (0-90)
ESL (- experience)	28.3 (8.6-66)	23.3 (0-80)

As can be seen in Table 23, the data for speaker 3 highlights the non-relationship between intelligibility and comprehension. For every group, performance was poorer for the narrative task than for the sentence task. Despite generally high scores for intelligibility (the lowest score obtained being 75,7), there was a very large range of scores for comprehension (0 to 100). Thus, despite all participants being able to decode most of what he said accurately, a surprisingly large number across all groups had marked difficulty in understanding or recalling his story. This suggests that the factors influencing his comprehensibility were not related to language or experience of the listener, or even to the speech itself, but to something within the content of the narrative, or the context in which it was delivered. In this regard, the qualitative comments provided by the listeners provide some interesting insights, which are discussed later.

Table 23

Summary of Scores Obtained by All Groups for Speaker 3

	Speaker 3	
Listener Group	Intelligibility Mean (Range)	Comprehension Mean (Range)
EFL (+ experience)	95.2 (78.6-97.1)	65 (10-100)
EFL (- experience)	95.1 (87-97.1)	85 (60-100)
ESL (+ experience)	92.3 (77-98.5)	56.4 (0-100)
ESL (- experience)	88.7 (75.7-98.5)	34.2 (10-90)

Speaker 4 (Table 24) again shows the somewhat counter-intuitive pattern of intelligibility being better than comprehensibility. As with speakers 2 and 3, there was a very wide range of performance in all groups for the comprehensibility task. To some extent, this is a function of the

task, where the answer was either right or wrong, as opposed to the intelligibility task, in which credit was given for every correct word. However, many of the participants who performed poorly seemed to demonstrate an "all or nothing" approach in which they seemed to give up if they were battling to understand or decode. This was seen in the sentence intelligibility tasks as well, in which they might transcribe the first word and none thereafter, as opposed to more successful listeners who continued to attempt transcription throughout the sentence. These more subjective results, and the qualitative feedback given by the listeners, will be discussed in the following chapter.

Table 24

Summary of Scores Obtained by All Groups for Speaker 4

	Speaker 4	
Listener Group	Intelligibility	Comprehension
EFL (+ experience)	91.7 (64.2-97.1)	86.2 (40-100)
EFL (- experience)	92 (78.5-97.1)	89.5 (70-100)
ESL (+ experience)	86 (60-97.1)	83.2 (70-100)
ESL (- experience)	81.5 (58.6-95.7)	70.8 (30-100)

CHAPTER SEVEN

RESULTS: QUALITATIVE COMPONENTS OF LISTENERS STUDY

The qualitative component of the Listeners study comprised two broad sections, namely the listeners' perceptions of how much effort they used in order to understand the various speakers, and the features of each speaker's speech that they felt made it easier or more difficult to understand. In addition, if listeners offered any kind of comment about the stimuli, or if the researcher observed any particular feature during the listening task (most frequently listening with eyes closed, or subvocal repetition), these are discussed in this section.

Listener Effort

Perceived listening effort was rated on a 10 point Likert scale, where one represented no effort and 10 maximal effort. As with the objective measures, there was a wide range of ratings of perceived effort within each group. The average rating of effort for each speaker and each listener group is summarised in the table below, with the range indicated in brackets.

Table 25

Average Subjective Rating of Listening Effort for Each Group and Each Speaker

Listener group	Average effort rating - Speaker 1	Average effort rating - Speaker 2	Average effort rating – Speaker 3	Average effort rating -Speaker 4
ESL naive	3,05 (0-10)	8,38 (7-10)	7,5 (2,5-10)	6,3 (1-10)
ESL experienced	3,07 (0-10)	8,88 (5,5-10)	7,53 (1-10)	6,32 (0,5-10)
EFL naive	2,02 (0-6,5)	8,69 (7,5-10)	4,31 (0-8)	4,61 (1-9)
EFL experienced	0,95 (0-3)	8,27 (6,5-10)	4,55 (1-10)	3,78 (1-10)

The pattern of reported effort broadly mirrored the objective scores, with speaker one requiring minimal effort, speaker two requiring a high level and speakers three and four being quite variable. It is interesting to note that all four groups essentially reported the same listening effort for speaker

two. Experience with listening to dysarthric speakers did not appear to affect the amount of effort which was expended, with the naïve and experienced ESL groups being remarkably similar although the EFL groups were slightly less so. Overall, the ESL groups reported making greater effort than the EFL groups, which seems consistent with what one would expect, namely that harder work is required by ESL listeners to achieve similar objective results. It is difficult to account for the large difference in reported effort between the two EFL groups for speaker one, particularly as she was an essentially normal speaker.

The notion of "effort" is somewhat ambiguous. The instruction to listeners on the answer sheet was to rate "how hard you feel **you had to work** to understand..." but it seems possible that some listeners interpreted this as how hard the speaker was to understand. This subtle difference was apparent, for example, in listeners who scored speaker two with a 10 on the Likert scale (ie. Found him very difficult to understand), but abandoned the attempt to transcribe his utterances (and thus actually expended only minimal effort).

Given the remarkable consistency of effort ratings for speaker two across all listener groups, it is interesting to examine listener performance on the comprehension task in relation to the effort rating. Data for listeners who gave effort ratings of 10 (ie. Maximal effort required) are presented in the table below.

Table 26

Summary of Narrative Comprehension Scores for Speaker 2 for Listeners with Maximal Effort Ratings

Narrative comprehension score for speaker 2	**Number of listeners who rated effort as 10**
0-10%	13
20-30 %	12
40-50 %	4
60-70 %	8
80-90 %	3

While most listeners who had rated their effort as maximal performed poorly (50% and under), 27% scored above 60%, which suggests that the perception of listening effort (or perhaps listening difficulty) is not necessarily a good predictor of narrative comprehension.

Features of communication which made it more difficult to understand

Listeners were asked to describe any features of each speaker's speech that they felt had made it more difficult to understand. Similar features (eg. “she showed her emotion” and “facial expression”, or “slurred” and “poor pronunciation”) were grouped together. Features included by five or more listeners are tabulated below. The record sheets asked listeners to describe features of speech particularly, but as many of them included aspects which were not specifically speech-related, these will be listed as features of communication rather.

Table 27

Features of Communication which made Speaker 1 More Difficult to Understand

Feature of communication	**Frequency of reporting**
Talking when laughing	16
Articulation	28

A large number of listeners commented on her articulation as contributing to difficulty in understanding, although she was not, in fact, objectively difficult to understand. This seems to suggest a mismatch between listeners' perceptions of their performance and their actual performance, or merely a way of highlighting some kind of difference in her communication.

With regard to Speaker 2 (table 28 on the following page), most listeners who singled out prosody as a barrier to comprehension specified pitch, rhythm and intonation, but two of them included the slow rate of speech as being problematic (one listener stated that “my mind wandered” because of the rate). Interestingly, reduced rate of speech was often listed as a facilitator by other listeners.

Table 28

Features of Communication which made Speaker 2 More Difficult to Understand

Feature of communication	**Frequency of reporting**
Prosody	14
Articulation	33
Facial distortion /inability to lip read	7
“Everything”	7

Seven listeners succinctly stated that “everything” about his speech was a barrier (“the way he speaks”). Although this was a very small number, it was noteworthy that they were all people who performed poorly.

Table 29

Features of Communication which made Speaker 3 More Difficult to Understand

Feature of communication	**Frequency of reporting**
Prosody	19
Articulation	22
Rapid rate	28

Rapid speech rate for speaker 3 was listed as a barrier to comprehension so frequently that it was separated from other aspects of prosody. In contrast to the facilitators, described in the next section, one listener wrote “looking at him made it harder for me – I forgot what he said and couldn't follow the story”.

Table 30

Features of Communication which made Speaker 4 More Difficult to Understand

Feature of communication	**Frequency of reporting**
Articulation	27
Reduced volume	5
Prosody	5

In addition to the communication features above, four listeners wrote that they were “distracted by her eyes”. The speaker has heterochromia (this was not really visible on the video to an uninformed viewer, but it may be that listeners could see that there was something unusual about her eyes) in addition to the severe ptosis which was a result of her head injury. It was not clear whether the distraction mentioned was because of the heterochromia, the ptosis or both. Her communication is not overtly affected by her eyes – she maintains normal eye contact, for example, but as with the facial distortions described by some listeners with speaker two, it appeared that her unusual eyes may have impacted on the communication of the listeners. One of the listeners (an ophthalmology registrar) performed very poorly on the sentence task for this speaker until the point at which he remarked “Oh, it's heterochromia!”, whereafter he was able to attend to her speech and perform better.

Features of communication which made it easier to understand

As in the previous section, listeners were asked to comment on aspects of the person's speech which they thought had made it easier to understand. However, these are reported as features of communication rather, as numerous listeners included aspects which were not directly related to speech. Similar features were grouped together, and those which were reported by five or more listeners are summarised in the tables which follow.

Table 31

Features of Communication which made Speaker 1 Easier to Understand

Feature of communication	**Frequency of reporting**
Facial expression	14
Being able to see her face/watch her mouth	6
Reduced rate of speech	23

It was interesting to note that facial expression and the ability to see the speaker's mouth were listed so frequently despite her having essentially intact intelligibility. This highlights the importance of

expression for comprehension even between normal speakers and may have interesting implications for mask wearing and cultural face covering.

Table 32

Features of Communication which made Speaker 2 Easier to Understand

Feature of communication	**Frequency of reporting**
Looking at his face	8
Key words (shorter, emphasised, etc)	6
Reduced rate	13

Although Speaker 2 has a considerably slower rate of speech than speaker 1, reduced rate was less frequently reported for him as a facilitator of comprehension. This is probably a function of his more severe dysarthria. As mentioned previously, two listeners found his reduced rate to be a barrier. Another contradictory comment related to looking at the speaker, with one person commenting that "sometimes averting my eyes helped" and another that "I needed to look at him". The researcher's observations of this phenomenon are discussed later. One listener also described perceptual learning as being a facilitator: "It got better as I listened to him".

Table 33

Features of Communication which made Speaker 3 Easier to Understand

Feature of communication	**Frequency of reporting**
Clear articulation	8
Repetition/clarification	6
Engages with listener/eye contact	5
Context – similar experience	5

Although five listeners said that the speaker's eye contact had facilitated understanding, as seen in the table above, two others also said that he had poor eye contact. In contrast to the barriers, in which one listener described looking at the speaker as hindering comprehension, another listener commented that "I had to look at him and not just listen" when describing the comprehension

facilitators. It was noteworthy that five listeners said that the context of his narrative and the fact that they had had similar experiences made him much easier to understand. On the other hand, two listeners from different cultural groups expressed their bafflement about his narrative to the researcher afterwards. One said "I always thought white men **enjoyed** going to the army. His story didn't make sense".

Table 34

Features of Communication which made Speaker 4 Easier to Understand

Feature of communication	**Frequency of reporting**
Reduced rate of speech	27
Context – being able to identify with the story	5

As with most of the speakers, reduced rate of speech was commonly described as making her speech easier to understand. Only two listeners described good eye contact as having been a facilitator, but, interestingly, two also listed poor eye contact as having been a barrier.

Additional observations

The observations which follow were either made by the researcher while doing the listening tasks, or, in the case of "all or none" responders, while counting the scores for the sentence tasks. An "all or none" observation was made when listeners either transcribed the whole or almost the whole utterance in the sentence tasks, or were not able to transcribe more than the first word or two. One listener described this very well - "It's like morse code; Once you start getting lost, it's hopeless". This was in clear contrast to other listeners who were able to continue to attempt to transcribe words until the end of the sentence, even when there were many gaps. Many of these listeners subsequently attempted to fill in the gaps by guessing from the context of the whole sentence.

A total of 12 listeners across the four groups (by chance, six were EFL and six ESL) were described as "all or none" responders. In order to see whether there might have been any relationship between this listening behaviour and their actual scores, their performance for speaker two (the most difficult

to understand) is summarised in next table. Scores indicated in red were above the mean for the group, and those indicated in green were below.

Table 35

Performance of "All or none" Listeners for Speaker 2

	Performance for listening tasks (speaker 2)	
Listener	Sentences	Narrative
P3 (ESL-)	31	40
L5 (ESL +)	40	40
L6 (ESL+)	12.8	30
L8 (ESL +)	11.4	30
L43 (ESL+)	42.8	10
L30 (ESL+)	37.14	30
L20 (EFL-)	20	80
L3 (EFL+)	40	80
L45 (EFL+)	44.2	80
L91 (EFL+)	54.3	70
L90 (EFL+)	37.14	20
L68 (EFL+)	61.4	70

The small sample precludes any firm conclusions, but from these observations the "all or none" responses were not necessarily associated in any way with poorer results. This seems to suggest that it is a difference in listening style and not a less effective listening strategy.

The following additional observations were made by the researcher while the listeners were engaged in the tasks, or the comments were made by the listener to her while they were busy. It is important to clarify that only a limited number of these observations were made, either because they were very obvious, or because the listener spontaneously commented. This does not imply that more people did not experience the same feeling or utilise the same strategy, but only that it was not noted. This is a major shortcoming, but it was felt to be important to include those observations

which were made. This point will be addressed in more detail in the discussion of the results.

Subvocal repetition, in which the listener whispered or mouthed the stimuli after the speaker, was clearly observed in six listeners. The impression gained was that this strategy was probably much more common, but was not always visible or obvious. Further research in this area should ensure that the face of the listener is always visible to the rater or researcher and that listeners are explicitly asked about the use of subvocal repetition.

Six listeners demonstrated obvious active engagement with the speakers, nodding and smiling in response to their narratives. This tiny sample is too small to generalise at all, but it was interesting that all six obtained high scores on the objective tasks and all were healthcare professionals. One (an audiologist) commented “I get very involved in listening. I'm a very auditory person”. It may be that healthcare professionals (mostly therapists) are more accustomed to watching video recordings of patients as part of an assessment process and thus found the procedure more “interactive” than other listeners, or they felt subtly pressured to appear to be empathetic.

Six other listeners, also all healthcare professionals, became obviously anxious or panicky when they were battling to understand. One commented “I should be able to do this better. I'm a speech therapist”. Another said (about speaker two) “I'm struggling to find the thread to put it together”. Two of the healthcare therapists made clinical comments (“he's getting tired” and “he'd breathe better if he was positioned better”) and two requested indexical information (“how old is she?”, “What happened to him?”).

In addition to the comments about eye contact and looking at the speaker which were noted in the previous section, two listeners also added an additional general comment that they needed to be able to look at the speakers' faces in order to understand. Two listeners were specifically noted by the researcher to close their eyes when listening to Speaker two.

CHAPTER EIGHT

RESULTS: THE SUCCESSFUL LISTENERS STUDY

This chapter presents the results of the small Successful Listeners study. The results of the Listening Strategy Scale are described first, followed by a qualitative description of the videorecorded interactions of the three dyads.

Results of the Listening Strategy Scale (Hustad et al., 2011)

The Listening Strategy Scale was a useful framework for the structured interview and was easy to administer with the first two dyads, but much more difficult with the third. Several features may account for this. Dr ML (dyad 1) is a retired language teacher who has a keen interest in speech and language. PS (dyad 2) was an actress and a writer. Being a person living with aphasia who has received intensive language therapy, it seems possible that she also has a higher than usual level of metalinguistic awareness. DX (dyad 3) is a second-language speaker of Afrikaans (the language in which she was interviewed), has a lower level of education, and was not familiar with concepts such as 'syllable' and 'context'. These were exemplified for her. When initially asked the open-ended question of how she is able to understand LW, she responded with some surprise "*Ek luister, Mevrou*!" ("I listen"). On the face of it, this seemed like an over-simplistic answer, but it was an accurate reflection of what she felt that she actually did. She was clearly an active and successful listener, although she found it difficult to explain what she did and possibly had not previously thought about this a great deal. Klasner and Yorkston (2005) and Hustad et al. (2011) were the first authors to document that listeners were aware of their use of strategies, but it also seems important to stress that lack of awareness of listening strategies (as in the case of DX) need not necessarily equate to lack of skill in using them.

The strategies reported for each dyad are summarised in the table on the next page.

Table 36

Strategies Reported by Successful Listeners (Listening Strategy Scale)

Strategy category	No.	Strategy statement	Dyad 1	Dyad 2	Dyad 3
Segmental	-	-	-	-	-
Suprasegmental	7	Slower speaking allows me to listen for the meaning of the sentence	x	x	x
	11	I try to use the rhythm of the sentences to understand them.	x		
	12	I depend on breaks between words to help me understand the sentences.	x		
Linguistic	13	I try to understand the unclear words from the context.	x	x	
	16	I use context to help me understand what is being said.	x	x	x
	18	I try to predict what is being spoken about based on the words that I do understand.			x
Cognitive	19	I have to be prepared to hear unclear speech.			x
	20	I have to completely attend to the person in order to understand him/her.	x	x	x
	21	I use repetition of the sentences to help me remember what has been said.		x	
	22	I guess the meaning based on the words that I do understand.			x
	23	I have to concentrate on understanding what is being said.	x	x	x
	24	I have to remember words that I have understood in order to understand the rest of what is being said.			x

None of the listeners endorsed any of the segmental strategies. This is not unexpected, given that the participants in this study were participating in a conversation rather than listening to individual words or sentences. It is likely that they were not even aware of any segmental strategies that they may have been using as they were more focussed on top-down processing of discourse.

All dyads endorsed reduced speech rate as being important. Speaker MD (dyad 2) stated that she " *tr(ies) to speak slowly*". Listener Dr ML (dyad 1) commented that she frequently reminds her

husband before starting a conversation that he needs to speak loudly and slowly, and often does so again while he is speaking. When asked how he feels about this, Mr PL said that he sometimes does need reminding because his wife is hard of hearing (ie. He interprets the strategy as compensating for her difficulty, rather than his own or both of theirs).

Interestingly, Dr ML (dyad 1) was the only listener who endorsed other suprasegmental strategies (using rhythm to facilitate understanding, and relying on breaks between words). Speaker MD (dyad 2) said that she actively tries to use prosody when speaking: "*Pause, emphasis are important. I've got to, otherwise people don't understand what I say and then they just switch off*" (cf. Results of the Listeners sub-study in which some unsuccessful listeners were observed to give up or 'switch off'). To some extent, this strategy was not successful with her particular listener, as is discussed later on. There is inconsistency in the literature regarding endorsement of suprasegmental strategies, with Klasner and Yorkston (2005) finding higher endorsement for speakers with Huntington's disease than Hustad et al. (2011) found for speakers with cerebral palsy, suggesting that it is probable that strategy use may differ according to the type of dysarthria. This is plausible in relation to PL (dyad 1), for whom the most marked features of his speech are loudness and rate, so that one may expect that attention to suprasegmental aspects would be greater. For LW (dyad 3), in contrast, suprasegmental features of her speech were so profoundly impaired that a listener might well devote less attention to them because they would be unlikely to yield any useful cues.

All three listeners highlighted the linguistic strategy of making use of context to understand what was being said. PS (dyad 2) summarised it by saying "*we know each other well and have shared many experiences. When M talks about things we both know, it is very easy to understand. The shared context is important*". To some extent, both of the other listeners also helped to **create** a shared context by cueing the speakers to talk about things that they both knew. ML acknowledged that she actively prompts PL to talk about specific things or events when they are with other people because she wants to ensure that the context is shared between them so that she can understand him,

even if the other people don't, and thus demonstrate his communicative competence. PS (dyad 2) added that "*she has to use **real** words for me to understand – not Afrikaans, or French, or slang*", and while this undoubtedly reflected her own auditory comprehension difficulties, it also appeared to be embedded within context as she went on to explain that she finds it much harder to understand if MD is not using her 'own' words or speaking in her normal manner. This was demonstrated very clearly in the video observation described below.

The listeners also all endorsed the cognitive strategies of completely attending to the person, and of concentrating on understanding. This is consistent with Hustad et al.'s (2011) conclusion that there may be a "core set of strategies that are common across listeners and that listeners may fine tune their strategy use based on the characteristics of the speech signal with which they are presented" (p 12).

Description of videorecorded interactions

Analysis of the videorecorded interactions yielded less data, possibly because the listeners were so successful that they needed to make less use of repair strategies. However, this also represents a methodological flaw: listening to a narrative does not really lend itself to conversational turn-taking with natural opportunities for repair.[1] It may also be that allowing the dysarthric speaker to speak without interruption is a strategy that successful listeners use to enable the speaker to maintain the flow of his/her discourse.

One of the most striking features of all three interactions was how little the listeners spoke. ML (dyad 1) spoke the most, but her utterances all took the form of prompts or cues – either reminding her husband to speak more slowly or more loudly as described above, or in prompting him to give more information (" … *and what about...?"*). DX (dyad 3) did not speak at all, but responded non-

1 In recruiting dysarthric speakers for the studies, it was also noted how many prospective participants struggled significantly to generate a narrative. The influence of a motor speech disorder on discourse and the interconnectedness of speech, language and communication are obviously not the focus of this study, but this anecdotally observed difficulty with producing narrative discourse does raise interesting questions.

verbally with smiles and nods. This may have been in part due to reticence, but seemed to be a deliberate strategy. It was noteworthy during this interaction that LW's husband was present, and occasionally interjected but neither LW nor DX attended to him, but focussed entirely on each other. Anecdotally, a similar pattern was observed, but not recorded, during an informal conversation between the researcher, LW and her husband, in which LW appeared to exclude her husband completely, remarking twice that "*he's too deaf*".

PS (dyad 2) demonstrated the most use of repair strategies, occasionally asking for repetition of individual words, as exemplified below:

MD: *This one (*referring to a poem) *is called "New Phone"*
PS: *New ...? Say that one again. New...?*
MD: *Phone*
PS: *Ah, new phone! Oh dear (*laughs)

Mostly she listened intently, nodded and smiled and occasionally murmured assent. She was noted to repeat subvocally everything that MD said. MD told her about someone whom she knows who had recently published a book of poetry. At one point, she read one of the poems aloud. At the end of the poem, PS laughed, indicating that she had appreciated the humour of the poem, but then requested repetition:

PS: *That's a good one. I would need to hear it again because all your wonderful, um – what is the word I'm looking for? The way you always* (gestures to her face)
MD: *Expression?*
PS: *Expression, yes, and to certain of your expressions. I do lose the odd words because it takes me a little longer. I would love to hear it again. I understood what it's about.*
MD: *Shall I just read it ....*
PS: *No*
MD: *And not express?*
PS: *No, I don't think you should take out your expression. I love the expression. But slowly. I'd like to hear it again.*

Although PS used the gesture to indicate facial expression, she was alluding to the vocal expression used by MD, and MD understood it as such. In this episode, MD's particular focus on pause, emphasis and pitch change (which she used deliberately in an attempt to compensate for her impaired articulation and the visual distraction of her tremor) seemed to add to the processing demands experienced by PS. In the context of MD using words that were not her 'own' (reading the

poem), PS had insufficient resources to process both suprasegmental and cognitive aspects.

All three conversations were seen to be successful, and were also judged to be so by all of the participants. All three were also collaborative, highlighting the notion that meaning is brought to conversation by both conversational partners. PS and MD's conversation was the most obviously collaborative, with MD speaking slowly, for example, both to compensate for her dysarthria, and for PS's aphasia. PL viewed his wife's reminders to change his speech as a response to her hearing loss, which could in one sense be interpreted as a type of denial of his own unintelligibility. However, it did reflect the conversational reality of two people needing to work together to make the conversation work. Similarly, ML's prompting of what to say also reflected a desire to reveal PL's communicative competence, collaborating with him to generate a successful narrative. Even DX's silent response was a collaboration with LW to enable her to communicate successfully. LW's apparent rejection of her husband as a conversational partner (“*he's too deaf”)* suggests that the speaker also has to endorse the conversational partner as a successful listener.

CHAPTER NINE

RESULTS: TRAINING STUDY

This chapter presents the results of the Training study. Pre- and post-training test results for both tasks are given for all participants. Thereafter, the group results for the sentence intelligibility task are described, followed by the group results for the narrative comprehension task. Qualitative findings and listener effort ratings are then presented.

The pre- and post- test scores for both tasks for the training group are presented in Table 37.

Table 37

Pre- and Post- test Results for the Training Group on the Intelligibility and Comprehension Tasks

Participant No.	Intelligibility Pre	Intelligibility Post	Comprehension Pre	Comprehension Post
1	55,5	58,3	60	70
2	27,7	61,1	40	70
3	36,1	58,3	60	50
4	30,5	38,8	20	70
5	-	-	70	90
6	19,4	52,7	50	80
7	38,8	33,3	60	80
8	30,5	22,2	60	80
9	30,5	38,8	20	50
10	27,7	22	30	60
11	38,8	41,6	60	70
12	34,6	61,1	30	60
13	19,4	61	50	80
14	50	47,2	50	60
15	58,3	86	60	90

The pre- and post- test scores for both tasks for the control (untrained) group are presented in table 38 on the next page.

Table 38

Pre- and Post- Test Results for the Control Group on the Intelligibility and Comprehension Tasks

Participant No.	Intelligibility Pre	Intelligibility Post	Comprehension Pre	Comprehension Post
16	41,6	33	40	40
17	69,4	69,4	70	70
18	30,5	13,8	30	50
19	63,8	50	50	40
20	36,1	36,1	50	50
21	36,1	30,5	30	30
22	63,8	63,8	80	70
23	47,2	44	20	10
24	38,8	50	70	60
25	61	63,8	90	90

Response of listeners to sentence intelligibility task

The mean score of the control group was 48,83% (range 30,5 to 69,4) for the pretest and deteriorated slightly to 45,4% (range 13,8 to 69,4) for the post-test. The training group improved from a mean of 35,5% (range 19,4-58,3) to a mean of 48,7% (range of 22-86). The training group thus performed more poorly in the pre-test, but improved to approximate the control group after training. The average change in score from pre- to post-test for both groups in the sentence intelligibility task is depicted in Figure 3 on the next page.

The ANCOVA analysis (Lowry, Vassar Stats) (detailed in Appendix J) facilitates the adjustment of the group means so that the pre-existing differences between the groups are removed. As seen in the ANCOVA summary in Table 39 (also on the next page), the adjusted post-test means differ by p=0,046. As p>0,01, the difference in scores is thus not statistically significant.

Figure 3

Mean Change from Pre- to Post- Testing on Intelligibility Task

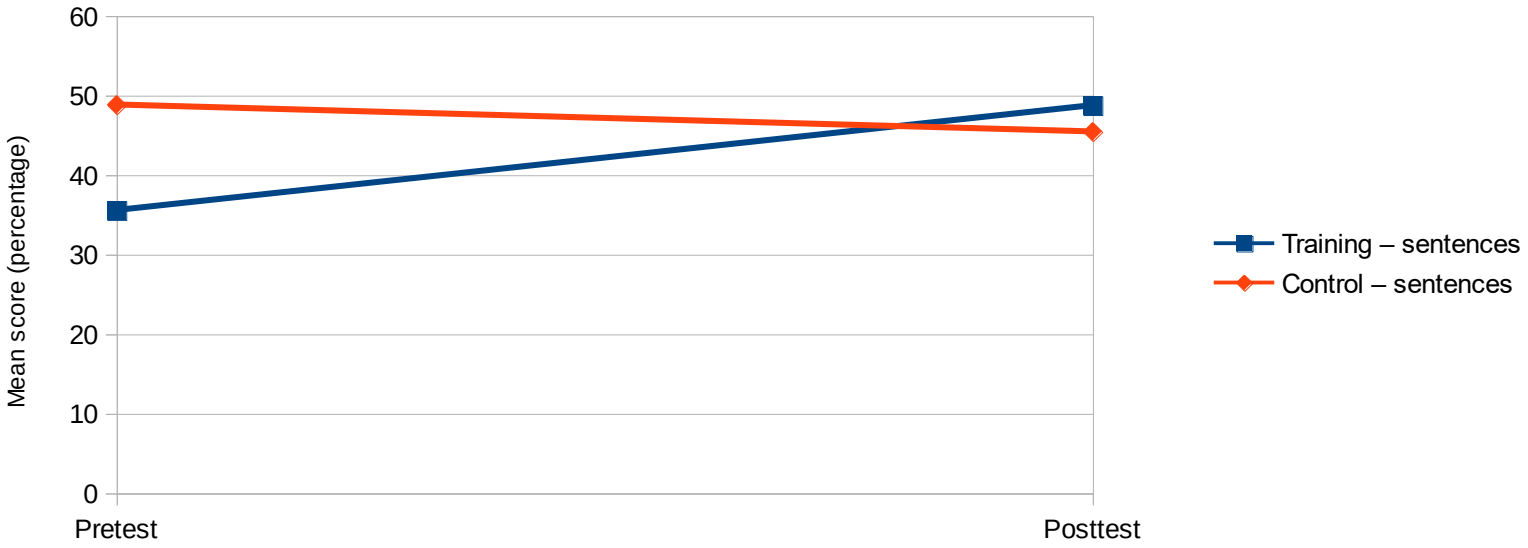


Table 39

Summary of ANCOVA Analysis for Intelligibility Task

Source	SS	df	MS	F	P
Adjusted means	909,74	1	909,74	4,49	0,046183
Adjusted error	4252,21	21	202,49		
Adjusted total	5161,95	22			

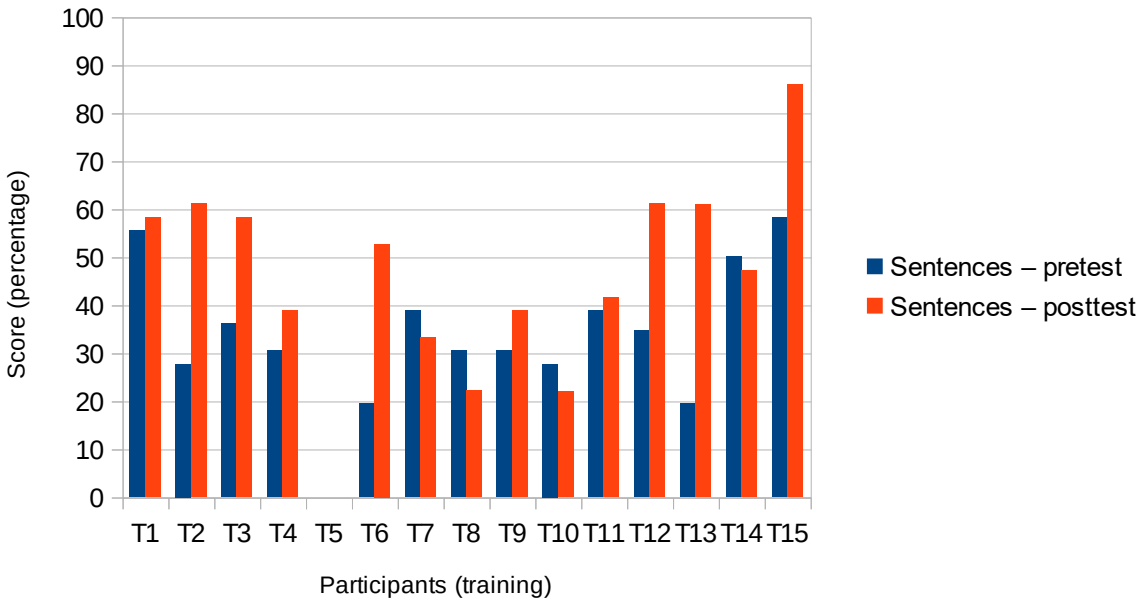
The lack of a statistically significant difference in pre- and post-training results is not consistent with recent studies (summarised in Borrie and Lansford, 2021), which have demonstrated that perceptual learning improved listener performance on sentence intelligibility transcription tasks. This can possibly be attributed to methodological differences and flaws in the training provided – this will be discussed in more detail later.

Despite the lack of statistical significance, examination of individual results remains interesting, and these are depicted in figures 4 and 5. Unfortunately, due to a technical error with the

videorecording, sentence data for participant five are not presented. The population size for this data was thus only 14. Ten participants improved after the training, while four deteriorated. In the control group (n=10), (figure 5), two participants improved, three remained the same, and the remaining five deteriorated between the two test conditions.

Figure 4

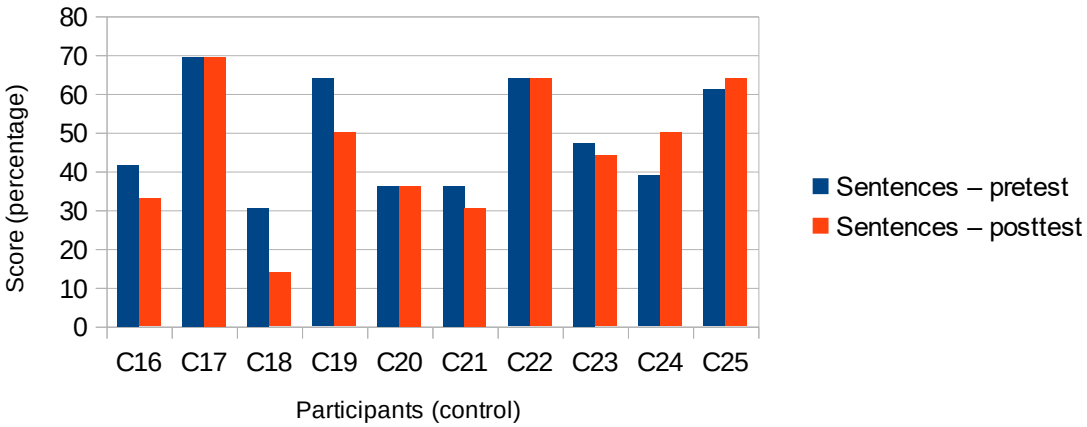
Pre- and Post- Test Results of Training Group on Intelligibility Task



It is interesting to note the wide range of performance on the sentence tasks, similar to that noted in the Listeners study. Although four people in the trained group did not consider themselves to be first language speakers of English, this did not appear to affect their performance.

Figure 5

Pre- and Post- Test Results of Control Group on Intelligibility Task



Response of listeners to narrative comprehension task

The average changes in scores from pre- to post-test for both groups in the comprehension task are summarised in Figure 6.

Figure 6

Mean Change from Pre-to Post-Testing in Comprehension Task



In the pre-test, the control group achieved a mean score of 53% (range 20 to 90), while at post-testing the mean was 51% (range 10-90). For the training group, the mean of 48% (range 20 to 70) improved to 70,6% (range 50 to 90). In this task, both groups started at a similar level. The training group appeared to improve while the control group deteriorated slightly. For the statistical analysis, the data of listener C25 (control group) was excluded. Her score of 90% during the pre-test was considered to be at ceiling, and further improvement was thus unlikely. The adjusted post-test means, calculated using ANCOVA, shown in the table below, differed by p=0,00054 and the difference between the two groups after training was thus statistically significant.

Table 40

Summary of ANCOVA Analysis for Comprehension Task

Source	SS	df	MS	F	P
Adjusted means	3171,03	1	3171,03	26,05	**0,000054**
Adjusted error	2434,79	20	121,74		
Adjusted total	5605,82	21			

Individual results are presented in Figures 7 and 8 on the next page. In the control group, the scores of five participants remained the same, while four deteriorated. One person showed an improvement. In the training group, one participant's (T11) score decreased, while the others all improved. Although T11's score on the narrative task decreased, she showed a large improvement on the sentence intelligibility task, which may suggest a cognitive style which is more focussed at the word level than at the gist of the meaning. The other individuals whose scores on the sentence task decreased with training all showed improvement in the narrative comprehension task. That is, even where training did not appear to change speech intelligibility, comprehension still improved.

Figure 7

Pre- and Post- Test Results of Training Group on Comprehension Task

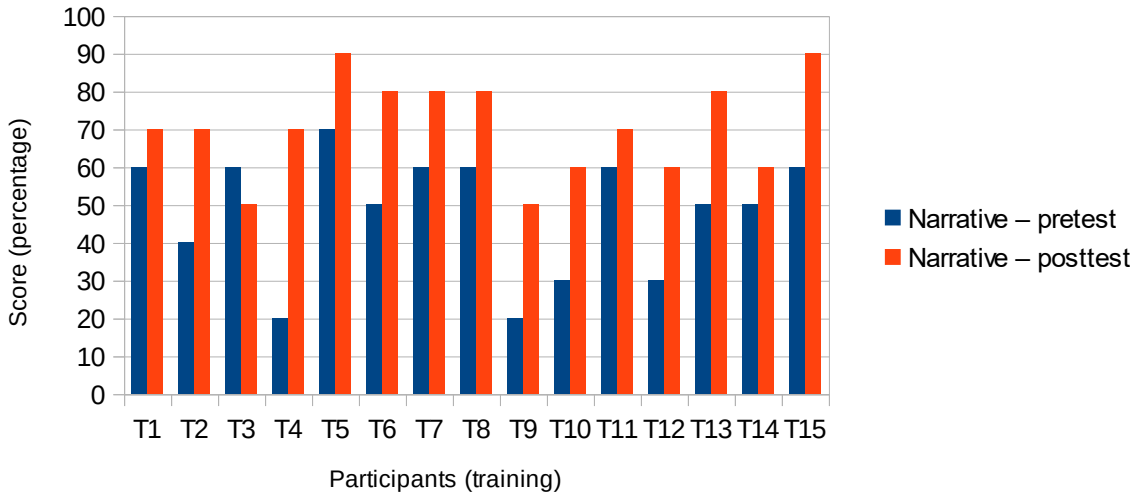
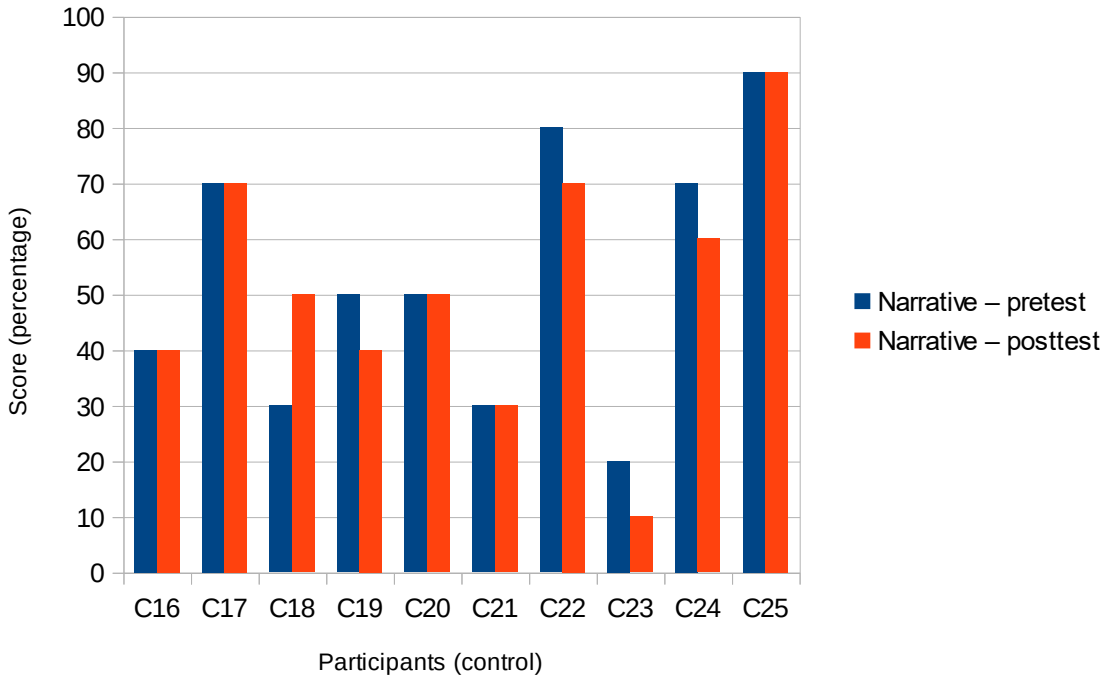


Figure 8

Pre- and Post- Test Results of Control Group on Comprehension Task



Qualitative findings and listener effort ratings

Only two of the training participants offered qualitative comments, one saying in the post-test that she “tried to focus more on the overall message to understand it” and the other that she actively listened for clearer words in order to understand the context of the message. Interestingly, when asked to comment qualitatively on aspects of the speaker's speech which made it easier or harder to understand, one control group participant said that listening for the second time was much easier, although her scores for both tasks in fact remained unchanged. Only one trained participant reported making more effort in the post-test, while six remained the same and eight felt that they had needed to make less effort. In the control group, five participants' effort ratings remained the same, and five decreased. The effort ratings are tabulated below.

Table 41

Listeners' Perception of their Effort Pre- and Post- Testing

	Training group	Control group
Less effort for post-test	8	5
Same effort for both	6	0
More effort for post-test	1	5

More listeners in both groups considered that they had made less effort while listening to the test stimuli for the second time. However, it is not clear whether this was because they wished to put in less effort (which is probably natural when being exposed to the same stimuli for the second time) or because less effort was actually required (ie. It became easier). It is difficult to account for those in the control group who made more effort.

As discussed in the main listeners study, the whole concept of 'effort' is problematic. In neither of the studies was there a relationship between the rating of effort and the level of success on the tasks. This is probably because of a difference in definition of effort. Some listeners may have equated

effort with the level of difficulty experienced, and so rated their effort as having been high because they did poorly on the transcription or comprehension tasks. Others may have rated their effort as having been high because they had worked hard to do well on the transcription or comprehension tasks. Similarly, when effort is rated as low, it is not clear whether that was because the listener only expended a little effort, or because the task was actually easy and did not require much effort. The Likert scale required listeners to rate their effort with both intelligibility and comprehension of each speaker. As this section followed immediately after the comprehension task for each speaker, it seems likely that they were commenting on their effort with narrative comprehension. However, as discussed at various points, intelligibility and comprehension are different and it is probable that the perception of effort for the two tasks could be different, at least for some speakers.

CHAPTER TEN

DISCUSSION OF RESULTS AND CONCLUSIONS

The Listeners Study

As expected, performance, both by individuals and by the groups, was different in the intelligibility (sentence) and comprehension (narrative) tasks, with some listeners performing better in one and some in the other. This confirms previous findings (eg. Hustad and Beukelman, 2002) that intelligibility and comprehension are different processes, tapping into different perceptual and cognitive skills. Furthermore, it suggests that some listeners are better able to focus on the bottom-up process of decoding individual words (intelligibility), while others make more use of top-down processing of meaning in context (comprehension), and still others perform equally in both tasks, suggesting both bottom-up and top-down processing. This variability occurred irrespective of language use or experience.

The comprehension task for Speaker three was an exception to the similar trends seen across groups for the other speakers, in that the naïve EFL group performed so much better than the other groups. One clue, which might suggest a way of accounting for this, lies in the qualitative results. Although only five of the listeners explicitly stated that their similar experience had made the narrative easier to understand, it is possible that this was the case for more listeners as well. These five listeners, although obviously only constituting a very small sample, were all male, highly educated, first language speakers of English. Speaker three's narrative was about his time as a military conscript in apartheid South Africa in the 1980s, and the challenges of being both English-speaking and a graduate in an environment where this was unusual. People who had first- hand experience of this themselves, or who had relatives or friends who had been conscripts, found his story easy to understand and relate to, and recognised the places named (eg. Voortrekkerhoogte) or the slang expressions used (eg. “genies”) automatically. Those who had not had this experience found it very difficult to follow. Ethnicity was not a selection criterion for listener participation, but the majority

of the EFL group were white. Many of the ESL group were not, and therefore could not have had any experience with conscription, as only white males were conscripted. One of these listeners even remarked after listening to the narrative: “But I thought white men **enjoyed** going to the army?”. Having had this preconceived idea, it was hardly surprising that she found the speaker's description of the traumatic experience of conscription baffling. This is consistent with Scollon and Wong Scollon's (1995) statement three decades ago that most breakdowns in intercultural communication occur at the level of discourse rather than at the level of understanding words or sentences.

This finding is very important as it highlights the role of the narrative itself in influencing comprehensibility. One method of reducing this influence might have been to have presented the speakers with a prepared narrative for them to relate but this would have had the disadvantage of a lack of personal salience. Despite the limitations of the memorable experience narrative as a tool for evaluating comprehension, it is still felt that it did present an ecologically valid assessment. A more neutral narrative would probably have been more easily understood by many of the listeners, but then the barriers (or in some cases, facilitators) to his comprehensibility posed by his choice of content, and to some extent, his style of narration, would not have been apparent. As postulated by Lindblom’s (1990) model, comprehension does not take place in a vacuum, but within a context which is just as important as the intelligibility of the speech and the content of the language.

Undoubtedly, assessing comprehension is methodologically very challenging, which probably accounts for why it remains under-researched in most areas of speech pathology, and in the dysarthrias particularly. However, the preliminary results of this study suggest that it is an important area to pursue. Future research could evaluate comprehension in a range of different tasks (eg. Giving instructions to complete a task, relating a prepared narrative, telling a joke) to examine the impact of the nature of the comprehension stimulus in more detail. Alternative methods

of scoring rather than the right/wrong binary used in this study would also allow for more nuanced assessment.

As discussed in the introductory sections, there is almost no research into intelligibility using listeners who do not speak the same language as the speaker, so the finding that first language use was significantly associated with better performance on the intelligibility tasks is an important one. The conventional practice of only investigating intelligibility where there is a language match is not valid in the multilingual environment of South Africa, or, indeed, anywhere else. There is a critical need to move both research and clinical practice away from a kind of utopia in which everyone speaks the same language to an acknowledgement that we all speak different languages and need to understand the impact that this potentially has on the intelligibility and comprehensibility of dysarthric speakers. A tacit assumption that second language listeners will automatically be poorer than first language ones is not sufficient, as seen by the performance of many of the individual listeners.

The statistical analysis demonstrated that the factors influencing comprehension were different from intelligibility. First language use was again significant across all speakers, and, although experience alone was not significant, the combination of being a first language speaker and having experience with dysarthric speech was significant for the more mildly impaired speakers. It is interesting that the combination was not significant for speaker two, who had the most severe dysarthria, although it was approaching significance. In contrast to what many of the experienced listeners believed, having prior experience with dysarthric speakers did not confer an advantage unless they also had a same-language advantage. Given the heterogeneity of the dysarthrias, it makes sense that even experience with many dysarthric speakers does not necessarily facilitate understanding of the speech of individuals. Prior experience with a specific individual, does, however, facilitate understanding, as seen in the training sub-study.

The qualitative component of the Listeners' study was originally viewed as a subjective adjunct to the objective data. As a result, the findings were somewhat limited and can only be interpreted very cautiously. However, they do suggest that the subjective opinions of listeners add a valuable layer to our understanding of intelligibility and comprehension. If we are to embrace Lindblom's (1990) model of mutuality, in which successful communication is dependent on speaker and listener understanding each other's perspective, then the perspectives of the listener about the speech are as important as the acoustic signal or the semantic content.

The general pattern of high levels of reported effort being associated with less intelligible speech was consistent with that described by Whitehill and Wong in 2006. Fletcher et al.'s (2022) finding that subjective effort did not always correlate with improved intelligibility is also shown to an extent in the effort ratings for speaker two, in which most listeners reported a high level of effort, but only some showed higher performance. This is a growing area of research, and the current study made only a superficial attempt to consider effort, and that mostly in relation to comprehension. Future research should examine this issue in much more detail. Fletcher et al. (2022) hypothesise that listener effort increases demand for working memory resources, so that the presence of dysarthria (and its associated increase in effort) impacts on the listener's ability to remember the speaker's content, even if intelligibility is not compromised. This is potentially a powerful explanation for the mismatch between intelligibility and comprehension for some listeners.

A few striking findings emerged from the section in which listeners commented on the features of communication which made the speaker more or less difficult to understand. The first is that while prosody and articulation were described as barriers for each speaker, different facilitators were identified for the different speakers. Some features (eg. Speech rate) which were identified as

facilitators for most listeners were barriers for others. This has important implications for therapy aimed at improving comprehensibility because it is clear that there is no "one size fits all". This is particularly true in languages other than English, in which the importance of various features of speech may well differ.

The second striking finding was that the frequency of reporting of barriers and facilitators was generally low. For example, the most reported feature (articulation for speaker two) occurred 33 times for a total of 93 listeners (<40%). It is difficult to account for this. Possibly listeners found it difficult to identify what was making the speaker easier or more difficult to understand because this is just not a normal listening activity for the average listener, or because they are unaware of the different components of speech production. It would be useful to be able to examine this in more detail to determine if there is any relationship between awareness of speech, and intelligibility and comprehension.

The "additional observations" during the listeners' study cannot be interpreted because they were too limited. As mentioned, there was no systematic attempt to gather this data, which is a shortcoming. The findings do suggest that such observations can yield important information, and it is therefore suggested that future research could incorporate an observational checklist. It would be valuable for a checklist to include obvious subvocal repetition, facial expression and gesture (such as head nodding) of the listener and whether the listener showed a preference for visual cues (looking at the speaker) or for audio only (looking away).

The Expert Listeners Study

This was a very preliminary study, with small numbers of participants which preclude the drawing of any conclusions. However, it did confirm both that this is a potentially valuable area of research and that the Listener Strategy Scale is a useful means to identify strategies that are being used, and,

potentially, to teach a listener to make use of different or additional strategies. Unfortunately, it does not seem to have been used again since the Hustad et al. (2011) study.

Despite the very limited conclusions that can be drawn, the results do suggest that this is potentially a very rich vein clinically. Unless one is able to observe how patients and their interlocutors actually communicate in real life, there is very little value in improving intelligibility and comprehensibility and there appears to be a great need for the development of easy-to-use clinical measures for observation. The work of Bloch (eg. Bloch and Barnes, 2020) and Wilkinson (Bloch and Wilkinson, 2004) focuses on the sources of conversational breakdown and the use of repair strategies for people with dysarthria, but to date, very limited attention has been paid to what **works** in dysarthric conversations. Hanson, Beukelman and Yorkston (2013) suggest that "future intervention practices (should) overtly include key communication partners in decision-making about strategies and intervention activities" (p.318) and, indeed, this is in line with current Evidence Based Practice guidelines (ASHA, 2022). The insights of people identified as being "successful listeners" are thus invaluable. Although methodologically challenging, it would also be valuable to have clearer insights into the strategies and practices of people identified as **unsuccessful** listeners.

Training study

The results of the Training study, although necessarily tentative due to the small sample size, suggest that training can be effective in improving listener comprehension of dysarthric speech. The fact that there was a training-related change in comprehension even in the face of non-significant changes in sentence intelligibility highlights once again that these are completely different processes. Clearly there is a relationship between the two processes, but the nature of that relationship is still not defined.

At the time of devising the training programme, very limited guidelines were available as to what training could or should comprise. As a result, the training was a type of hybrid of general

communication or listening strategies (for which there is still no evidence) and familiarisation (initially described by Tjaden and Liss, 1995), for which there is now strong evidence (but was not at the time) for sentence intelligibility improvements. This is a major methodological flaw, because it is not clear which of the two very different components of the training contributed to the apparent improvement in listener comprehension. However, the findings do lend support to the idea that listener training is an important variable which requires in-depth research. Future research should obviously examine both components (namely listening strategies and familiarisation) separately. Some of the qualitative findings of the Listeners' Study, and the input from the Expert Listeners suggest that there may still be room for general listening training and communication education in a formal programme to train listeners.

It is difficult to interpret why the current study did not show statistically significant improvement in intelligibility after training, as several other studies have now demonstrated this. It is probable that it is related to the small sample size, and to the heterogeneity of the listener participants (all final year speech therapy students). To date, no other study has examined the effect of familiarisation on the comprehension of dysarthric speech. Notwithstanding the limitations of the sample, as well as the very limited training provided, the trained group performed significantly better than the control group, suggesting that training is, indeed, an important factor in improving comprehension. More research is needed to replicate this in other groups and to demonstrate its potential utility clinically. This is felt to be a natural and necessary extension of the growing body of evidence supporting training to improve intelligibility – unless training also improves comprehension, the improvement which it can bring about in intelligibility is of limited real-life value to dysarthric speakers and their interlocutors.

Conclusions

This research considered three possible variables which may influence the comprehension of dysarthric speakers, namely language use, previous experience with dysarthria, and training. The combination of both first-language and experience was significantly associated with better performance on the comprehension task, while only language was significant for the intelligibility task. Training was effective in improving comprehension in a group of final year speech therapy students, irrespective of their language background.

Wide variability was seen in all tasks and this was corroborated by the qualitative measures. This suggests that different decoding and listening styles, as well as different degrees of success are a normal phenomenon and not necessarily a function of lack of interest or empathy. This is felt to be a very important finding in terms of the social participation of people with dysarthria. Many dysarthric speakers become angry or despondent when they battle to make themselves understood. Undoubtedly, this may sometimes be because of a negative attitude towards them, or a reluctance to listen, but it seems clear that it is normal for some listeners to understand with ease while others have much more difficulty. Different types of dysarthria and other characteristics of the speakers also impact differently on both intelligibility and comprehension and it is clear that every dyad is unique. Attempts to repair conversational breakdowns need to be based on these unique features and not only on general principles.

Numerous implications for future research have arisen from the findings of these sub-studies, most notably the need for much greater focus on comprehensibility at the discourse level for dysarthric speakers. Different methodologies for examining this need to be developed and explored, despite the difficulties. Failure to address comprehensibility will mean that even the strongest findings about speech intelligibility in the dysarthrias can never be translated into clinical practice and are thus not likely to have “real world” value for people with dysarthria.

The second notable implication for future research is multilingualism and multiculturalism in the dysarthrias. It is unfortunate that when language differences between speaker and listener are addressed at all, it is generally within an attitude of negativity, where difference is seen as an obstacle. It is a rather sad reflection on Speech Pathology that much of the (limited) research into intelligibility with other languages seems to be driven by the need to accommodate increasing numbers of migrants (as discussed, for example, by Lagerberg et al., 2019). While this is, of course, a vitally important area of research, and, as a profession we need to be able to react to the changing dynamics of the environment, it seems likely that this focus will continue to emphasise "other" languages and their speakers as minorities who need to be "accommodated'. We, in South Africa, are in the unique position of having natural diversity of language and culture and it behoves us to be proactive in using this rich resource to benefit multilingual speakers everywhere. Exploring the possibilities that diverse language use might bring to improving the comprehensibility of people with dysarthria also seems valuable.

The finding of this study that a short, simple training procedure could improve the comprehensibility of a speaker with dysarthria has implications which extend far beyond the dysarthrias, to all people with speech disorders and even to normal speakers with different dialects or accents.

The mixed-methods design used in this study, although very preliminary, appeared to have utility. Acknowledging that comprehension is a complex, multi-faceted phenomenon, it seems appropriate to try to view it through various different lenses. That is, it can only begin to be understood by considering speaker, listener and environment, both subjectively and objectively. However, there were, unfortunately, numerous methodological flaws and shortcomings. These have been highlighted as they arose, but can be broadly summarised as including very small sample sizes, the use of only English assessment tasks, the grossness of the comprehension task, in particular the

validity of videorecorded narrative. Finally, while there appeared to be value in the researcher gathering all of the data and being able to observe the participants while they completed the tasks, it must be acknowledged that this introduced a bias.

Jakobson, Fant and Halle (1963, cited by Pisoni 1993) stated that “We speak to be heard, in order to be understood”. This must surely be the ultimate goal for all who are concerned with communication and its disorders.

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APPENDIX A

NARRATIVE TRANSCRIPTIONS AND COMPREHENSION QUESTIONS

SPEAKER ONE

“I'm going to tell you a story about what happened last night. I've got a little boy of seven years old and he loves to frighten people. So I was in my room and I heard my maid shout – he gave her a fright with this little gecko. And he came to my room with his hand behind his back. I said to him 'What have you got in your hand?' and he said 'no, I just frightened Lucy with a snake'. But I knew there was something more. And he threw this gecko at me, and obviously I had a fright as well. And he left the room, and I got the gecko and I thought 'You little bugger, I'm going to frighten you!'.

He came back after a while. I took the gecko and I threw it at him and I said 'Waaa!' And the gecko's got sharp little, um, nails, and it touched him and he started crying. He started crying, running away. And I was just laughing. And, um, I said to him afterwards 'Don't do something to other people that you don't want to be done to yourself.' ”

1. What was the broad topic of the story? (What was it about?)
2. When did it happen?
3. Who else was in the story?
4. What does the little boy like to do?
5. Who did he frighten first?
6. Then what did he do?
7. What did the woman decide to do?
8. Why did he cry and run away?
9. How did she respond?
10. What did she say to him at the end?

SPEAKER TWO

“I think the most memorable occasion was when I surprised my parents: I knew there was a conference coming up in Austria, but I didn't know when. It was before you could take a credit card overseas, so I said to God 'If you want me to go, you must provide a way to take a credit card overseas!'

I heard about it on the news advert. It took me two days to get the courage to talk to my boss because I wasn't talking as clearly as I do now. Then he came back to me and said I need to be in Austria the end of the following week. It took all day, the credit card. I picked it up at 2:00 p.m. on the day I left.

I was able to make myself understood. At that stage I was talking a bit worse, but for some unknown reason, when I go into new situations I concentrate more. And I flew over to Switzerland and I caught another plane to Innsbruck, where the conference was. I was able to give my talk with people. Then I had to get back to Basel in Switzerland, and I heard that a few people were going to Karlsburg (?) in Germany. So I said 'Can I catch a train with you?' I had to walk two kays to buy a ticket because we were leaving at 4:00 a.m. The next morning. When I got off the train in Basel, I didn't know who to look for because it was a friend of my parents. The last time I saw them when I was eleven. They found me!”

1. What was the broad topic of the story? (What was it about?)
2. What was the problem, or obstacle, preventing him from going?

3. Who did he ask for help with this?
4. Why was he scared to talk to his boss about it?
5. Did he have a long time to get ready?
6. Where did he go?
7. What did he do there?
8. How did he get to the next place?
9. What time of the day did they leave?
10. Why didn't he know who to look for when he arrived?

SPEAKER THREE

"OK, this goes back to 1980. We had just graduated with chemical engineering degrees and were feeling on top of the world. This was the toughest degree at varsity at the time so we were feeling pretty good. Then I had to go to the army – in those days – two years of army service. That was a nightmare of note, a nightmare of note.
It was two years of hell. First of all, all of us went to... well, some of us went to a place called Voortrekkerhoogte, or "Tiffies" which was for maintenance people. But we were graduates, well, one or two of us were graduates there. The rest were all, well, the highest was standard eight, so we were ….. way above.

So we lasted there for two weeks until we were shipped off to Kroonstad for the "genies" - engineers – so we were very happy about that. Hundreds of graduates were with us there, so it was all very companionable. But it was tough as hell!"

1. What was the broad topic of the story? (What was it about?)
2. How was he feeling at the start of the story?
3. Why?
4. Then what happened?
5. Was this a good experience for him?
6. For how long did it last?
7. Where did he go first?
8. Where did he go after that?
9. Which place did he like better?
10. Why?

SPEAKER FOUR

"OK, it was, I think, the November or December two years ago when I met Pieter and we went shopping together with Mimi, at the time his girlfriend. And we just clicked straight away. And it was really nice. I thought we'd be lucky if we recognised each other when we got back after Christmas. But when we saw each other when we got back, it was like the first time we'd ever met. Really, really nice. And we just clicked. I fell in love with him by first looking at him.

We've gone through a bit of a rough patch over the last while. We've been together on and off over the last almost two years. But we're back together now and we're doing very OK. But we have a lot of people who don't like us being together. I don't know why. They just don't like us because he suffers from cerebral palsy and he's with me, brain injured. And people don't think he can handle me."

1. What was the broad topic of the story? (What was it about?)
2. How did they first meet?
3. What time of the year did they meet?

4. How did they get on at first?
5. How long have they been together?
6. How have things been between them lately?
7. What is the reaction of other people to them?
8. Why does she think other people react this way?
9. What does he suffer from?
10. What do people think about him?

APPENDIX B

LISTENERS' BIOGRAPHICAL QUESTIONNAIRE AND ANSWER BOOKLET

Please fill in the following information in as much detail as possible. Please ask me if you need any help in answering the questions.

Age:

Gender:

Home language/s/Mother tongue:

What other languages do you speak?

If you speak more than one language, where did you learn to speak it? (eg. Playing with friends/neighbours, or at school, or when you moved to a new community, etc)

If English is not your home language/mother tongue, where did you learn to speak it?

What is your highest educational achievement? (eg. Completed high school, or completed diploma)

In what language were you educated?

Please describe your pattern of language usage at the moment (eg. Speak isiXhosa and English at home with friends and family, and use mostly Afrikaans at work).

What work do you do at the moment?

For how long have you been doing this work?

Do you know anyone who has a speech problem? If so, please describe the problem or the cause in as much detail as possible.

Have you ever had musical training, speech and drama training or accent coaching? If so, please describe it.

Thank you very much for giving me this information.

Dilys Jones

SPEAKER 1

You may listen to each sentence twice. Pause the recording after each sentence, and write down what you have heard. Even if you can only make out occasional words, please write those words down. If you have not completely understood a word, you may try and guess its meaning.

1. _____

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2. _____

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10. _____

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Listen once to the story. Write down the answers to the following questions:

1. What was the broad topic of the story? (What was it about?) _____

_____

2. When did it happen? _____

3. Who else was in the story? _____

4. What does the little boy like to do? _____

5. Who did he frighten first? _____

6. Then what did he do? _____

7. What did the woman decide to do? _____

_____

8. Why did he cry and run away? _____

_____

9. How did she respond? _____

10. What did she say to him at the end? _____

_____

Please mark on the line below how hard you feel you had to work to understand the speaker.

No effort required Maximum effort required

_____

What aspects of her speech made it harder to understand?

What aspects of her speech made it easier to understand?

SPEAKER 2

You may listen to each sentence twice. Pause the recording after each sentence, and write down what you have heard. Even if you can only make out occasional words, please write those words down. If you have not completely understood a word, you may try and guess its meaning.

1. _____

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2. _____

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9. _____

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10. _____

_____

Listen once to the story. Write down the answers to the following questions:

1. What was the broad topic of the story? (What was it about?) _____

2. What was the problem, or obstacle, preventing him from going? _____

   _____

3. Who did he ask for help with this? _____

4. Why was he scared to talk to his boss about it? _____

   _____

5. Did he have a long time to get ready? _____

6. Where did he go? _____

7. What did he do there? _____

8. How did he get to the next place? _____

9. What time of the day did they leave? _____

10. Why didn't he know who to look for when he arrived? _____

_____

Please mark on the line below how hard you feel you had to work to understand the speaker.

No effort required Maximum effort required

_____

What aspects of his speech made it harder to understand?

What aspects of his speech made it easier to understand?

SPEAKER 3

You may listen to each sentence twice. Pause the recording after each sentence, and write down what you have heard. Even if you can only make out occasional words, please write those words down. If you have not completely understood a word, you may try and guess its meaning.

1. _____

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10. _____

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Listen once to the story. Write down the answers to the following questions:

1. What was the broad topic of the story? (What was it about?) _____

2. How did he say he was feeling at the start of the story? _____

3. Why? _____

4. Then what happened? _____

5. Did he enjoy this experience? _____

6. For how long did it last? _____

7. Where did he go first? _____

8. Where did he go after that? _____

9. Which place did he like better? _____

10. Why? _____

Please mark on the line below how hard you feel you had to work to understand the speaker.

No effort required Maximum effort required

_____

What aspects of his speech made it harder to understand?

What aspects of his speech made it easier to understand?

SPEAKER 4

You may listen to each sentence twice. Pause the recording after each sentence, and write down what you have heard. Even if you can only make out occasional words, please write those words down. If you have not completely understood a word, you may try and guess its meaning.

1. _____

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9. _____

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10. _____

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Listen once to the story. Write down the answers to the following questions:

1. What was the broad topic of the story? (What was it about?) _____

_____

2. How did they first meet? _____

3. What time of the year did they meet? _____

4. How did they get on at first? _____

5. How long have they been together? _____

6. How have things been between them lately? _____

7. What is the reaction of other people to them? _____

_____

8. Why does she think other people react this way? _____

_____

9. What does he suffer from? _____

10. What do people think about him? _____

_____

Please mark on the line below how hard you feel you had to work to understand the speaker.

No effort required Maximum effort required

_____

What aspects of her speech made it harder to understand?

What aspects of her speech made it easier to understand?

APPENDIX C

SENTENCE MATERIALS READ BY EACH SPEAKER

SPEAKER ONE
1. We have an excellent team.
2. Life is short and precious.
3. They bought six loaves of bread.
4. The book has a red cover.
5. I don't think it's a good idea.
6. The new highway is straight and empty.
7. I put on twenty kilograms in one month.
8. I don't know how to deal with it.
9. The mother bear reared up on her hind legs.
10. Our last evening was the most beautiful of all.

SPEAKER TWO
1. We bought a brown chair.
2. Please open the window quickly.
3. I loved every minute of it.
4. It fell out of his pocket.
5. It was a good win for us.
6. That's what life is really all about.
7. This will not be challenged in the court.
8. I can train any dog in five minutes.
9. You must try to do whatever you do best.
10. He laughed at the joke as much as anyone.

SPEAKER THREE
1. The books are very expensive.
2. The job provides many benefits.
3. Their house is grey and white.
4. He took me out one day.
5. They carried me off on the stretcher.
6. I just try to do my best.
7. It was a huge part of my life.
8. It grows faster than anything else on earth.
9. For further details, go on to the next page.
10. I put some bread in the oven to toast.

SPEAKER FOUR
1. It was a great meeting.
2. Try to work things out.
3. We hope to meet them again.
4. She filled the bag with tomatoes.
5. We had a picnic on the beach.
6. He told the patient to be careful.
7. I think we'll be lucky with this one.
8. You can't expect to make too much money.
9. There is nothing in this world he cannot do.
10. I just cannot sit here and worry any more.

APPENDIX D

CHANGES MADE TO THE LISTENING STRATEGY SCALE

(Adapted from Hustad, Dardis and Kramper, 2011)

Please circle any of the statements that you feel are true when you are trying to understand your partner's speech:

Category	No.	Strategy
Segmental	1	When sounds are missing, I fill in what I think should be there. *
	2	I piece fragments of words together to understand what is said.*
	3	I try to put the sounds together to make words.*
	4	I try to listen to the words without any regard to context Adapted from the original 'I wrote down what I heard without any regard to context'
	5	I use the sounds I hear clearly to understand words.*
	6	I put the syllables I hear together to make the words in the sentences.*
Suprasegmental	7	Slower speaking allows me to listen for the meaning of the sentence. Adapted from the original 'A slow rate allowed me to listen.....'
	8	Focusing on individual words helps me to understand the sentences.*
	9	I try to break up strings of sounds into words.*
	10	I break down the sentences into individual words to understand them.*
	11	I try to use the rhythm of the sentences to understand them.
	12	I depend on breaks between words to help me understand the sentences.*
Linguistic	13	I try to understand the unclear words from the context.*
	14	I add/delete words to make the sentences make sense. Strategy 15 omitted completely: 'I listened the first time and filled in the blanks the second time'
	16	I use context to help me understand what is being said.*
	17	I try to tell if the sentences are questions or statements. Adapted from the original 'I tried to tell if the sentence was a question or a statement.'
	18	I try to predict what is being spoken about based on the words that I do understand. Adapted from the original 'I tried to predict what the sentence would be based on the words I understood'
Cognitive	19	I have to be prepared to hear unclear adapted from the original 'distorted' speech.*

	20	I have to completely attend to the person in order to understand him/her. Adapted from the original 'I had to completely attend to the sentence to understand it'
	21	I use repetition of the sentences to help me remember what has been said. Adapted from the original 'I used repetition of the sentence to help me remember the whole sentence'
	22	I guess the meaning Deleted the original 'of the sentence' based on the words that I do understand.*
	23	I have to concentrate on understanding what is being said. Adapted from the original 'I had to concentrate on understanding the sentence'
	24	I have to remember words that I have understood in order to understand the rest of what is being said. Adapted from the original 'I had to remember the words that I had understood in order to understand the rest of the sentence.'

* indicates a change from the past tense

APPENDIX E

INTRA-CLASS CORRELATION COEFFICIENT CALCULATIONS – SENTENCE TASKS

Data Set

Participant Number	Rater 1	Rater 2	Rater 3	Sentence Task
l13	90	88.5	88.5	s1
l13	27.1	27.1	28.5	s2
l13	95.7	97.1	98.5	s3
l13	85.7	85.7	87.1	s4
l16	95.7	95.7	95.7	s1
l16	34.2	24.2	24.2	s2
l16	92.8	92.8	95.7	s3
l16	90	85.7	92.8	s4
l20	100	100	100	s1
l20	20	20	20	s2
l20	95.7	95.7	98.5	s3
l20	92.8	94.2	95.7	s4
l21	100	100	100	s1
l21	44.2	47.1	45.7	s2
l21	94.2	95.7	97.1	s3
l21	95.7	97.1	98.5	s4
l22	100	100	100	s1
l22	68.5	61.4	71.4	s2
l22	95.7	95.7	98.5	s3
l22	91.4	90	92.8	s4
l8	87.5	87.5	87.5	s1
l8	11.4	8.5	11.4	s2
l8	77	77	77	s3
l8	60	52.8	52.8	s4
lrr1	100	100	100	s1
lrr1	35.7	37.1	35.7	s2
lrr1	88.5	91.4	92.8	s3
lrr1	90	88.5	91.4	s4
lrr2	100	100	100	s1
lrr2	32.8	31.4	32.8	s2
lrr2	97.1	98.5	98.5	s3
lrr2	92.8	94.2	97.14	s4
lrr3	100	100	100	s1
lrr3	47.1	47.1	47.1	s2
lrr3	91.4	95.7	95.7	s3
lrr3	91.4	91.4	92.8	s4
lrr4	100	100	100	s1
lrr4	28.57	32.8	34.2	s2
lrr4	95.7	98.5	98.5	s3
lrr4	85.7	85.7	90	s4

ANOVA: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
l13	3	267	89	0.75
l13	3	82.7	27.56667	0.653333
l13	3	291.3	97.1	1.96
l13	3	258.5	86.16667	0.653333
l16	3	287.1	95.7	0
l16	3	82.6	27.53333	33.33333
l16	3	281.3	93.76667	2.803333
l16	3	268.5	89.5	12.79
l20	3	300	100	0
l20	3	60	20	0
l20	3	289.9	96.63333	2.613333
l20	3	282.7	94.23333	2.103333
l21	3	300	100	0
l21	3	137	45.66667	2.103333
l21	3	287	95.66667	2.103333
l21	3	291.3	97.1	1.96
l22	3	300	100	0
l22	3	201.3	67.1	26.47
l22	3	289.9	96.63333	2.613333
l22	3	274.2	91.4	1.96
l8	3	262.5	87.5	0
l8	3	31.3	10.43333	2.803333
l8	3	231	77	0
l8	3	165.6	55.2	17.28
lrr1	3	300	100	0
lrr1	3	108.5	36.16667	0.653333
lrr1	3	272.7	90.9	4.81
lrr1	3	269.9	89.96667	2.103333
lrr2	3	300	100	0
lrr2	3	97	32.33333	0.653333
lrr2	3	294.1	98.03333	0.653333
lrr2	3	284.14	94.71333	4.906533
lrr3	3	300	100	0
lrr3	3	141.3	47.1	0
lrr3	3	282.8	94.26667	6.163333
lrr3	3	275.6	91.86667	0.653333
lrr4	3	300	100	0
lrr4	3	95.57	31.85667	8.591633
lrr4	3	292.7	97.56667	2.613333
lrr4	3	261.4	87.13333	6.163333
T1	40	3122.07	78.05175	742.0187
T2	40	3111.8	77.795	785.8123
T3	40	3164.54	79.1135	792.3068

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Rows	90218.62	39	2313.298	676.4351	1.06E-84	1.553239
Columns	39.08901	2	19.54451	5.715039	0.004829	3.113792
Error	266.7473	78	3.419837			
Total	90524.46	119				

To calculate ICC

(MS{Rows}-MS{Error})/(MS{Rows}+df{Columns}*MS{Error}+(df{Columns}+1)*(MS{Columns}-MS{Error})/(df{Rows}+1))

ICC = (2313.298-3.419837)/(2313.298+2*3.419837+(2+1)*(19.54451-3.419837)/(39+1))

ICC = 0.995059

APPENDIX F

INTRA-CLASS CORRELATION COEFFICIENT CALCULATIONS – NARRATIVE TASKS

Data Set

Participant Number	Rater 1	Rater 2	Rater 3	Narrative Task
l13	100	100	100	n1
l13	40	40	40	n2
l13	50	50	50	n3
l13	80	80	60	n4
l16	100	100	100	n1
l16	60	80	70	n2
l16	100	100	100	n3
l16	90	100	100	n4
l20	100	100	100	n1
l20	80	80	90	n2
l20	90	100	100	n3
l20	100	100	100	n4
l21	90	90	90	n1
l21	90	90	90	n2
l21	100	100	100	n3
l21	100	100	100	n4
l22	90	90	90	n1
l22	90	90	90	n2
l22	100	100	100	n3
l22	100	100	100	n4
l8	70	60	70	n1
l8	30	20	30	n2
l8	0	0	0	n3
l8	80	70	80	n4
lrr1	100	90	100	n1
lrr1	70	70	70	n2
lrr1	70	60	70	n3
lrr1	90	90	100	n4
lrr2	100	100	100	n1
lrr2	40	40	50	n2
lrr2	80	80	80	n3
lrr2	90	80	90	n4
lrr3	100	100	100	n1
lrr3	40	40	40	n2
lrr3	20	20	20	n3
lrr3	90	90	90	n4
lrr4	100	100	100	n1
lrr4	60	75	70	n2
lrr4	60	60	60	n3
lrr4	90	80	90	n4

ANOVA: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
l13	3	300	100	0
l13	3	120	40	0
l13	3	150	50	0
l13	3	220	73.33333	133.3333
l16	3	300	100	0
l16	3	210	70	100
l16	3	300	100	0
l16	3	290	96.66667	33.33333
l20	3	300	100	0
l20	3	250	83.33333	33.33333
l20	3	290	96.66667	33.33333
l20	3	300	100	0
l21	3	270	90	0
l21	3	270	90	0
l21	3	300	100	0
l21	3	300	100	0
l22	3	270	90	0
l22	3	270	90	0
l22	3	300	100	0
l22	3	300	100	0
l8	3	200	66.66667	33.33333
l8	3	80	26.66667	33.33333
l8	3	0	0	0
l8	3	230	76.66667	33.33333
lrr1	3	290	96.66667	33.33333
lrr1	3	210	70	0
lrr1	3	200	66.66667	33.33333
lrr1	3	280	93.33333	33.33333
lrr2	3	300	100	0
lrr2	3	130	43.33333	33.33333
lrr2	3	240	80	0
lrr2	3	260	86.66667	33.33333
lrr3	3	300	100	0
lrr3	3	120	40	0
lrr3	3	60	20	0
lrr3	3	270	90	0
lrr4	3	300	100	0
lrr4	3	205	68.33333	58.33333
lrr4	3	180	60	0
lrr4	3	260	86.66667	33.33333
T1	40	3130	78.25	660.9615
T2	40	3115	77.875	688.3173
T3	40	3180	79.5	666.4103

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Rows	77286.46	39	1981.704	116.6221	2.82E-55	1.553239
Columns	57.91667	2	28.95833	1.704181	0.188624	3.113792
Error	1325.417	78	16.99252			
Total	78669.79	119				

To calculate ICC

(MS{Rows}-
MS{Error})/(MS{Rows}+df{Columns}*MS{Error}+(df{Columns}+1)*(MS{Columns}-
MS{Error})/(df{Rows}+1))

ICC = (1981.704-16.99252)/(1981.704+2*16.99252+(2+1)*(28.95833-16.99252)/(39+1))

ICC = 0.974275837

APPPENDIX G

ETHICAL CLEARANCE CERTIFICATES

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON MEDICAL)
H120211 Jones

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER H120211**
PROJECT TITLE	Factors influencing listener comprehension in multicultural dysarthria
INVESTIGATOR(S)	Ms D Jones
SCHOOL/DEPARTMENT	Health Community Research Unit
DATE CONSIDERED	10 February 2012
DECISION OF THE COMMITTEE	Approved Unconditionally
EXPIRY DATE	28 February 2014
DATE 13 February 2012	**CHAIRPERSON** (Professor R Thornton)

cc: Professor C Penn

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

Signature **Date** 7/3/2012.

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Jones

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H15/11/10**
PROJECT TITLE	Factors influencing listener comprehension in multicultural dysarthria
INVESTIGATOR(S)	Ms D Jones
SCHOOL/DEPARTMENT	Human & Community Development/
DATE CONSIDERED	23 October 2015
DECISION OF THE COMMITTEE	Approved unconditionally
EXPIRY DATE	19 January 2019

DATE 20 January 2016 **CHAIRPERSON** J. Knight
(Professor J Knight)

cc: Supervisor : Professor C Penn

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

D Jones
Signature

02, 01, 2016.
Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

OFFICE OF THE DEPUTY REGISTRAR

14 October 2015

Ms D Jones
Student number: **8402734**

TO WHOM IT MAY CONCERN

"Factors influencing listener comprehension in multicultural dysarthria."

This letter serves to confirm that the above project has received permission to be conducted on University premises, and/or involving staff and/or students of the University as research participants. In undertaking this research, you agree to abide by all University regulations for conducting research on campus and to respect participants' rights to withdraw from participation at any time.

This notice serves as proof that the University's internal mailing system may be used as the mechanism by which potential participants can be approached.

If you are conducting research on certain student cohorts, year groups or courses within specific Schools and within the teaching term, permission must be sought from Heads of School or individual academics.

Ethical clearance has been obtained.

Potgieter

Nicoleen Potgieter
DEPUTY REGISTRAR

Private Bag 3, Wits, 2050, South Africa | T +27 11 717 1204/8 | F +27 86 553 2271 | www.wits.ac.za

APPENDIX H

PARTICIPANT CONSENT AND INFORMATION FORMS

1. Information letter for speaker participants
   Consent form for speaker participants

2. Information letter for listener participants
   Consent form for listener participants

3. Information letter for successful listener dyads
   Consent form for successful listener dyads

4. Information letter for listener participants in training study
   Consent form for listener participants in training study

University of the Witwatersrand

The Health Communication Research Unit
School of Human and Community Development
University of the Witwatersrand, Johannesburg
Private Bag 3, Wits 2050

Good day.

I am a speech-language therapist involved in research towards a PhD degree at the University of the Witwatersrand. I am conducting a research project entitled "Factors Influencing Listener Comprehension in Multicultural Dysarthria". When a person has a speech disorder which makes his/her speech difficult to understand, the focus is often largely on the person with the problem. However, we know that speaker and listener actually play equal roles in a conversation. I am interested in the role of the listener, and specifically, why it is that some people seem to find it easier to understand people with speech disorders than other people do. I hope to be able to use this information to compile a training programme to help family members, caregivers and other people to become better listeners who are more successful at understanding impaired speech.

For my project, groups of listeners will watch videotapes of different people with speech disorders reading a list of sentences and telling a short story to evaluate how well they are able to understand.

I am looking for people with the speech disorder known as dysarthria to participate as the speakers for my study, and would like to invite you to do so. This will entail being videorecorded by me reading a list of ten English sentences, and then telling a short story of a memorable event. This should take no longer than five minutes to record. Thereafter, I will ask you to check that I have understood the story correctly in order to devise a set of comprehension questions for the listeners.

If you are willing to participate in the study, your name or personal details will not be revealed to anyone else. However, the listeners participating in the study will watch the videorecording of you. Videorecording will be done at a location convenient for you. Once competed, video recordings will be stored on digital discs for playing in the study and for possible teaching purposes by me. No copies of the discs will be made available to anyone else, nor will they be played or broadcast by anyone other than me or my supervisor for the purposes of the research or training.

Participating in the research project will not have any direct benefit for you. The only likely risk to you is fatigue as talking is often effortful and tiring for people with dysarthria. You will be able to take short breaks in the videorecording whenever you need to in order to reduce fatigue.

If you do not wish to participate in the study, this will not jeopardise your current or future Speech Therapy treatment in any way. If you are willing to participate, you will be free to withdraw at any stage and any recordings already made will be destroyed. Please contact me at 082 8241798, or my supervisor, Professor Claire Penn, at 011-7174577, if you need any further information.

Ethical clearance for this study has been given by the University of the Witwatersrand Human Research Ethics Committee (Protocol number H120211).

Thank you for giving this your consideration.

Yours sincerely

Dilys Jones

I, _____ am willing to participate in Dilys Jones' research study. I understand that there will be no direct benefit for me in participating in this study and that there are not likely to be any risks involved.

I understand that I am free to withdraw from the study at any time, and that withdrawing will not jeopardise my current or future speech therapy treatment in any way.

I agree to be videotaped by Dilys Jones. I understand that the video recordings of me will be played to listeners in the research study and may be used for training purposes. I understand that participants in the research study and training programme will be able to see and hear me on the video recordings, but will not know my name or any other personal details about me. Should I decide to withdraw from the study, any video recordings of me will be destroyed.

Signed: _____ Date: _____

University of the Witwatersrand

The Health Communication Research Unit
School of Human and Community Development
University of the Witwatersrand, Johannesburg
Private Bag 3, Wits 2050

Good day

I am a speech-language therapist involved in research towards a PhD degree at the University of the Witwatersrand. I am conducting a research project entitled "Factors Influencing Listener Comprehension in Multicultural Dysarthria". When a person has a speech disorder which makes his/her speech difficult to understand, the focus is often largely on the person with the problem. However, we know that speaker and listener actually play equal roles in a conversation. I am interested in the role of the listener, and specifically, why it is that some people seem to find it easier to understand people with speech disorders than other people do. I hope to be able to use this information to compile a training programme to help family members, caregivers and other people to become better listeners who are more successful at understanding impaired speech.

For my project, groups of listeners will watch videotapes of different people with speech disorders reading a list of sentences and telling a short story to evaluate how well they are able to understand.

I am looking for people to participate as the listeners for my study and would like to invite you to participate. This will entail watching five people with a speech disorder each read ten sentences, and tell a story. After each recording, listeners will be required to write down each sentence that they have heard, and answer ten questions about the content of the story. It will take about 40 minutes to complete the whole task.

If you are willing to participate in the study, your name will be kept confidential. You will be asked to provide information regarding your age, gender, languages spoken, occupation and educational level. This information will be important in understanding what may help you or make it more difficult for you to understand the speakers. The scores that you obtain will be used in the research, but will not be revealed to anyone else.

If you do not wish to participate in the study, this will not jeopardise your employment or training in any way. If you are willing to participate, you will be free to withdraw at any stage. Please contact me at 082 8241798 or dilys@icon.co.za, or my supervisor, Professor Claire Penn, at 011-7174577 or claire.penn@wits.ac.za , if you need any further information.

Ethical clearance for this study has been given by the University of the Witwatersrand Human Research Ethics Committee (Protocol number H120211).

Thank you for giving this your consideration.

Yours sincerely

Dilys Jones

LISTENER CONSENT FORM

I, _____ am willing to participate in Dilys Jones' research study. I understand that I am free to withdraw from the research at any stage without any risk to myself.

My name will not be recorded, and the information I provide will be kept strictly confidential.

Signed: _____ Date: _____

University of the Witwatersrand

The Health Communication Research Unit
School of Human and Community Development
University of the Witwatersrand, Johannesburg
Private Bag 3, Wits 2050

Good day

I am a speech-language therapist involved in research towards a PhD degree at the University of the Witwatersrand. I am conducting a research project entitled "Factors Influencing Listener Comprehension in Multicultural Dysarthria". When a person has a speech disorder which makes his/her speech difficult to understand, the focus is often largely on the person with the problem. However, we know that speaker and listener actually play equal roles in a conversation. I am interested in the role of the listener, and specifically, why it is that some people seem to find it easier to understand people with speech disorders than other people do. I hope to be able to use this information to compile a training programme to help family members, caregivers and other people to become better listeners who are more successful at understanding impaired speech.

I am looking for pairs of conversational partners who feel that they are generally successful in communicating with each other, and would like to invite you to participate. The research will entail me making a videorecording of a person with dysarthria telling a short story to his/her conversational partner, while the conversational partner interacts normally by asking questions or commenting on the story. I will then ask the listener to complete a short questionnaire about the strategies used to understand the speaker, and will interview both speaker and listener to find out what strategies seem to help and what barriers seem to impede the ability to understand. I hope to be able to use this information to gain a better understanding of how listeners understand dysarthric speech, and to develop a programme to train listeners to understand better.

If you are willing to participate in the study, your names or personal details will not be revealed to anyone else. Videorecording will be done at a location convenient for you. Once competed, video recordings will be stored on digital discs for analysis for the study and for possible training purposes by me. No copies of the discs will be made available to anyone else, nor will they be played or broadcast by anyone other than me or my supervisor for the purposes of the research or training.

Participating in the research project will not have any direct benefit for you. The only likely risk to you is fatigue as talking is often effortful and tiring for people with dysarthria. You will be able to take short breaks in the videorecording whenever you need to in order to reduce fatigue.

If you do not wish to participate in the study, this will not jeopardise your current or future Speech Therapy treatment in any way. If you are willing to participate, you will be free to withdraw at any stage and any recordings already made will be destroyed. Please contact me at 082 8241798 or dilys@icon.co.za, or my supervisor, Professor Claire Penn, at 011-7174577 or claire.penn@wits.ac.za, if you need any further information.

Thank you for giving this your consideration.

Yours sincerely

Dilys Jones

SUCCESSFUL LISTENERS CONSENT FORM

I, _____ am willing to participate in Dilys Jones' research study. I understand that there will be no direct benefit for me in participating in this study and that there are not likely to be any risks involved.

I understand that I am free to withdraw from the study at any time, and that withdrawing will not jeopardise my current or future speech therapy treatment in any way.

I agree to be videotaped by Dilys Jones. I understand that the video recordings of me will be viewed by Dilys Jones for analysis and may be used for training purposes. I understand that my name or any other personal details about me will not be revealed. Should I decide to withdraw from the study, any video recordings of me will be destroyed.

Signed: _____ Date: _____

University of the Witwatersrand

The Health Communication Research Unit
School of Human and Community Development
University of the Witwatersrand, Johannesburg
Private Bag 3, Wits 2050

Good day

I am a speech-language therapist involved in research towards a PhD degree at the University of the Witwatersrand. I am conducting a research project entitled "Factors Influencing Listener Comprehension in Multicultural Dysarthria". When a person has a speech disorder which makes his/her speech difficult to understand, the focus is often largely on the person with the problem. However, we know that speaker and listener actually play equal roles in a conversation. I am interested in the role of the listener, and specifically, why it is that some people seem to find it easier to understand people with speech disorders than other people do. For this part of the project, I am particularly interested in whether a short training programme can affect the way in which listeners understand dysarthric speech.

For this project, listeners will watch a videotape of a person with dysarthria reading a list of sentences and telling a short story, in order to evaluate how well they are able to understand. The listeners will then be randomly assigned into either a training group or a control group. The training group will undergo a short programme, aimed at facilitating comprehension of dysarthric speech. The control group will not receive any further input. Both groups will then repeat the task of watching the videotape and evaluating comprehension.

I am looking for people to participate as the listeners for my study and would like to invite you to participate. If you are willing to participate in the study, your name will be kept confidential. You will be asked to provide information regarding your age, gender, languages spoken, occupation and educational level. This information will be important in understanding what may help you or make it more difficult for you to understand the speaker.. The scores that you obtain will be used in the research, but will not be revealed to anyone else.

Participation is entirely voluntary. If you are willing to participate, you will be free to withdraw at any stage. Please contact me at 082 8241798 or dilys@icon.co.za, or my supervisor, Professor Claire Penn, at 011-7174577 or claire.penn@wits.ac.za , if you need any further information.

Ethical clearance for this study has been given by the University of the Witwatersrand Human Research Ethics Committee (Protocol number H120211).

Thank you for giving this your consideration.

Yours sincerely

Dilys Jones

I, _____ am willing to participate in Dilys Jones' research study. I understand that I am free to withdraw from the research at any stage without any risk to myself.

My name will not be recorded, and the information I provide will be kept strictly confidential.

Signed: _____ Date: _____

APPENDIX I

ANOVA CALCULATIONS FOR SENTENCE AND NARRATIVE TASKS

	Speaker 1		Seaker 2		Seaker 3		Speaker 4	
	sentence	narrative	sentence	narrative	sentence	narrative	sentence	narrative
Experience	75.26%	67.24%	62.55%	14.17%	10.16%	55.57%	29.94%	7.77%
Language	**0.01%**	**2.15%**	**0.01%**	**0.01%**	**0.01%**	**0.01%**	**0.01%**	**0.06%**
Combination	34.28%	59.16%	33.76%	**3.30%**	5.49%	**0.01%**	9.91%	**0.54%**

The p values were obtained using the steps below. The process for Speaker one sentences is detailed and the same method was used to calculate the other results.

The data was grouped into two factors, where Factor A was previous experience with dysarthria (experienced or naïve) and Factor B was language (EFL, and therefore matched with the speaker, or ESL, and therefore not matched with the speaker).

The two Way ANOVA was then performed:

1. The sum of squares of each factor was determined by obtaining:
Total average 96.61 (Sum of all 8598.2 / total participants 89)
Average of EFL 99.39 (Sum of all EFL 3478.5/ EFL 35)
Average of ESL 94.81 (Sum of all ESL 5119.7/ ESL 54)
Average of Experienced 96.76 (Sum of all Experienced 4160.7/ Experienced 43)
Average of Naive 96.47 (Sum of all Naive 4437.5/ Naive 46)

Sum of Squares difference for Experienced/Naive 1.91 (43*(96.61-96.76)^2+46*(96.61-96.47))
Sum of Squares difference for EFL/ESL 44.476 (35*(96.61-99.39)^2+54*(96.61-94.81))

2. The sum of squares within factors was calculated by adding together (the difference of each result and the average of each division) squared.

Average of group EFL experienced 99.32 (1489.7/15)

Experienced EFL 33.32 ((99.32-98.5)^2+(99.32-100)^2+....+(99.32-100)^2+(99.32-98.5)^2)
Similarly
Naive EFL 26.13
Experienced ESL 652.7
Naive ESL 979.98

Total 1692.13 (33.32+26.13+652.7+979.98)

3. The total sum of squares was obtained adding the (difference between each result and the overall average) squared

Total Sum of Squares 2156.83 ((96.61-98.5)^2+(96.61-100)^2+....+(96.61-82.9)^2+(96.61-81.4)^2)

4. The sum of squares interaction was calculated SS total-SS FactorA -SS Factor B -SS Within = 2156.83-1.91-444.76-1692.13=18.03

5. The table was completed below and the p value was obtained from the distribution calculator

Seaker 1 Sent	SS	df	MS	F	P
Factor A	1.91	1.00	1.91	0.10	0.75
Factor B	444.76	1.00	444.76	22.34	0.00
Interaction	18.03	1.00	18.03	0.91	0.34
Within	1,692.13	85.00	19.91		
Total	2,156.83	88.00			

df Factor A 2-1 = 1
df Factor B 2-1 = 1
df Interaction 1*1 = 1
df within 89-2*2 = 85
df total 89-1 = 88
MS = SS/df
F = SS/MS Within

APPENDIX J

ANCOVA ANALYSES FOR SENTENCE AND NARRATIVE TASKS (TRAINING STUDY)

Using http://vassarstats.net/ancova2L.html

Data from the Training group comprised Sample A, and from the Untrained control group comprised Sample B.

The 'calculate' function was used to obtain the following results: Used the Calculate function to get the following results:

VassarStats Printable Report
One-Way ANCOVA for 2 Independent Samples (sentences)

Dependent Variable			
Sample			
A	B	Total	
N			
14	10	24	
Observed Means			
48.7429	45.44	47.3667	
Adjusted Means			
53.2479	39.1329	47.3667	

Aggregate Correlation within Samples: CV vs DV	
r = 0.61	r^2 = 0.37

ANCOVA SUMMARY

Source	SS	df	MS	F	P
adjusted means	909.74	1	909.74	4.49	0.046183
adjusted error	4252.21	21	202.49		
adjusted total	5161.95	22			

Test for homogeneity of regressions:

Source	SS	df	MS	F	P
between regressions	270.22	1	270.22	1.36	0.257256
remainder	3981.99	20	199.1		
adjusted error	4252.21	21			

VassarStats Printable Report
One-Way ANCOVA for 2 Independent Samples (narrative)

Dependent Variable			
Sample			
A	B	Total	
N			
14	9	23	
Observed Means			
69.2857	46.6667	60.4348	
Adjusted Means			
69.8728	45.7534	60.4348	

Aggregate Correlation within Samples: CV vs DV	
r = 0.71	r^2 = 0.5

ANCOVA SUMMARY

Source	SS	df	MS	F	P
adjusted means	3171.03	1	3171.03	26.05	0.000054
adjusted error	2434.79	20	121.74		
adjusted total	5605.82	21			

Test for homogeneity of regressions:

Source	SS	df	MS	F	P
between regressions	331.63	1	331.63	3	0.099468
remainder	2103.17	19	110.69		
adjusted error	2434.79	20			