CHAPTER ONE
PROBLEM STATEMENT AND RATIONALE FOR THE STUDY

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1.1 INTRODUCTION AND PROBLEM STATEMENT

The study of neurogenic speech disorders "compliments the study of normal speech to reach an understanding of the normal regulation of spoken language" (Kent, 1990:365). Clarification of the nature of neurogenic speech disorders is thus vitally important, not only for the diagnosis and treatment of these disorders, but also for providing significant information about normal and pathological speech motor control (Itoh & Sasanuma, 1984).

Apraxia of speech (AOS) is one neurogenic speech disorder which, since its initial description in the late 1960s, has been surrounded by controversy regarding its underlying nature (Seddoh, Robin, Hageman, Sim, Moon & Folkins, 1996a). Even though it is now generally accepted that the underlying deficit in AOS is phonetic-motoric in nature (Ballard, Granier & Robin, 2000; McNeil, Robin & Schmidt, 1997), it frequently co-occurs with aphasia where the impairment is linguistic, specifically phonological in nature. In this regard, it was most recently stated that "After more than 30 years of research and hundreds of studies, however, the most incisive reviews are still asking for clarification of the nature of the disorder and for more reliable criteria for differentiating AOS from the dysarthrias and aphasic phonological errors" (Croot, 2002:267).

A factor which further complicates the understanding of normal and pathological speech production, and consequently the nature of AOS, in a country such as South Africa, is the fact that bilingualism, or even multilingualism, is extremely common. Consequently, in addition to the complexity of understanding speech motor control and its possible impairments, there is the poorly understood organization and control of two or more languages in the brain. It is against this backdrop that the study of speech production in bilingual speakers with either AOS or phonemic paraphasia (PP) is undertaken.

The aim of Chapter 1 is to motivate the relevance of the study of temporal parameters of speech production in bilingual speakers with AOS and persons with PP, by presenting the rationale for the study. Furthermore, the relevant terms used in the thesis are defined and an overview of the division and content of the chapters contained in the thesis is provided.

1.2 ORIENTATION TO AND RATIONALE FOR THE STUDY

In order to accurately characterize and describe the salient characteristics of AOS, various studies using different methods of analysis have been conducted. In this regard studies using acoustic (Freeman, Sands & Harris, 1978; Itoh, Sasanuma, Tatsumi, Murakami, Fukusako & Suzuki, 1982; Kent & McNeil, 1987; Kent & Rosenbek, 1983; McNeil, Liss, Tseng & Kent, 1990a; Tuller & Story, 1987; Ziegler & von Cramon, 1985, 1986), kinematic (Fromm, 1981; Hardcastle, Morgan Barry & Clark, 1985; Itoh, Sasanuma, Hirose, Yoshioka & Ushijima, 1980; McNeil & Adams, 1991; McNeil, Caliguiri & Rosenbek, 1989; Robin, Bean & Folkins, 1989; Tseng, McNeil, Adams & Weismer, 1990) and physiologic (electromyographic) (Forrest, Adams, McNeil & Southwood, 1991; Fromm, 1981; Fromm, Abbs, McNeil & Rosenbek, 1982; Shankweiler, Harris & Taylor, 1968) methods of analysis have been performed.

A common conclusion from the results of these studies has been that persons with AOS display a deficit regarding *temporal control*. The deficit regarding temporal control has been supported by findings of longer than normal vowel durations (Collins, Rosenbek & Wertz, 1983; Freeman *et al.*, 1978), overlapping ranges of voice onset time (VOT) for voiced and voiceless stop consonants (Freeman *et al.*, 1978; Itoh, Sasanuma, Tatsumi & Kobayashi, 1979a), longer than normal consonant durations (Kent & Rosenbek, 1983), longer than normal and more variable stop gap durations (Seddoh, Robin, Sim, Hageman, Moon & Folkins, 1996b), longer than normal between-word segment durations (Strand & McNeil, 1996) and greater than normal variability regarding most durational measures (Kent & McNeil, 1987; Seddoh *et al.*, 1996a, b; Strand & McNeil, 1996).

Complicating the characterization of AOS is the fact that considerable overlap of characteristics with persons exhibiting PP has been demonstrated (Kent & McNeil, 1987; McNeil *et al.*, 1997). This overlap of characteristics exists despite the fact that phonemic paraphasic errors are believed to be the result of a deficit at a distinct level of the speech production process compared to apraxic errors. Apraxic speech errors are generally described as phonetic-motoric in nature, whereas phonemic paraphasic errors, which are predominant in persons with conduction aphasia (CA), are generally described as phonological (Kent & McNeil, 1987). McNeil *et al.* (1997:312) state that in order to differentiate motor speech disorders (AOS and the dysarthrias), from phonological-level disorders (literal or PP in aphasia), it is "essential to contrast the phenomenology and the assumptions underlying the labels of these clinical neighbors". These authors emphasize the importance of "contrasting assumed mechanisms, signs and symptoms between AOS and phonemic paraphasia" in order "to eventually work out the significant characteristics of the groups and find constant differences between them".

The need to differentiate between AOS and PP is emphasized by the statement by Ballard *et al.* (2000:975), which highlights the fact that even though theoretical characterizations of AOS quite clearly identify specific behavioral manifestations of the disorder, "clinical descriptions have lacked diagnostic power", with resultant failure to differentiate clearly between AOS and some aphasic syndromes. The focus of the present study is on speech production of persons with AOS, although inclusion of subjects with PP renders the possibility of comparison and/or contrasting of findings in these two groups for better elucidation of the characteristics of AOS. For these reasons, both groups of speakers will be included in the present study.

In order to assist with differentiation of different speech and language disorders and explanation of the level of breakdown in the speech production process related to these disorders, various models and theories of speech production have been compiled. In this regard, Van der Merwe (1997:1) states that "the almost overwhelming corpus of ever increasing data on the intricate detail of the speech production process and the neurophysiology of motor control and also unresolved issues concerning the nature of neurogenic speech disorders underscore the necessity of a comprehensive explanatory framework". Van der Merwe (1997) proposed a four-

level framework of speech sensorimotor control which has appeal for understanding the level of breakdown in the speech production process following a neurologic insult, as well as for understanding normal speech motor control. It has been noted that this framework is perhaps the most detailed and comprehensive attempt to explain deficits in the speech production process in the extent literature, since many of its hypotheses are testable (Ballard *et al.*, 2000). In Van der Merwe's (1997) framework, the speech production process is depicted as consisting of four stages, namely linguistic-symbolic planning, motor planning, motor programming and execution. According to this framework, the deficits in AOS are ascribed to the level of the motor planning of speech, whereas phonemic paraphasic errors are ascribed to the level of linguistic-symbolic planning (Van der Merwe, 1997).

One of the testable hypotheses in Van der Merwe's (1997) framework relates to the depiction of speech production as being context-sensitive. The context-sensitivity of speech production is an important aspect to be recognized in the study of AOS since contextual factors have been found to cause variation in the symptoms of AOS (Kent & Rosenbek, 1983; Van der Merwe & Grimbeek, 1990; Van der Merwe, Uys, Loots & Grimbeek, 1987, 1988; Van der Merwe, Uys, Loots, Grimbeek & Jansen, 1989). Van der Merwe (1997:6) proposes that "contextual factors affect the dynamics of motor control by exerting an influence on the mode of coalition of neural structures involved during a particular phase and on the skill required for the planning, programming and execution mechanisms". It is hypothesized within this framework that certain variants of a specific contextual factor might necessitate more complex control strategies than others. From a motor learning and information processing perspective, this would imply that certain contextual factors might increase the speech and language processing demands causing speech production to be more complex in certain contexts. In these more demanding contexts, the demand for attentional resources also presumably increases (Magill, 2001; McNeil, Odell & Tseng, 1991a). Van der Merwe (1997) emphasizes the need for the determination of the role of the various contextual factors in the different phases of the speech act, since the influence of variation in contextual factors is important for both research and treatment.

On the basis of a review of the relevant literature, Van der Merwe (1986, 1997) identified various contextual factors that presumably influence the process of speech

sensorimotor control. According to Van der Merwe (1997), these factors include voluntary or involuntary (automatic) speech (Kelso & Tuller, 1981), phonological structure (MacNeilage, 1983), motor complexity of the utterance (Ladefoged, 1980), utterance length (Strand & McNeil, 1996), familiarity versus novelty of utterances (Sharkey & Folkins, 1985) and speech rate (Kelso, Tuller & Harris, 1983; MacNeilage, 1980). The influence of various contextual factors on different aspects of speech production in AOS and to a lesser degree PP has been investigated. These include studies investigating the influence of linguistic factors (Deal & Darley, 1972; Dunlop & Marquardt, 1977; Martin & Rigrodsky, 1974a, b; Martin, Wasserman, Gilden, Gerstman & West, 1975; Strand & McNeil, 1996), speech rate (Kent & McNeil, 1987; McNeil *et al.*, 1990a), word frequency (Varley, Whiteside & Luff, 1999), sound structure and articulatory characteristics (Van der Merwe, 1986) on speech production. The increased processing demands imposed by various contextual factors might cause persons with deficits regarding one or more of the stages of speech production to be more susceptible to breakdown. For accurate characterization of neurogenic speech and language disorders, it is important to determine which contextual factors lead to breakdown in persons with deficits at different levels of the speech production process. This has the potential to inform about the underlying nature of the disordered processes and will have important implications for the compilation of assessment and treatment procedures.

An aspect that has the potential to influence speech and language processing, and which has been greatly ignored in the study of AOS, is speech production in the first versus the second language (L1 versus L2) in bilingual speakers with AOS. Although bilingual aspects of aphasic speech have been studied quite extensively (Paradis, 1995a), bilingual speech production in persons with AOS has not been systematically investigated. Considering the large number of bilingual speakers that are encountered in the clinical setting (Wiener, Obler & Taylor Sarno, 1995), it is surprising that the effect of the language of production of a bilingual speaker, that is, L1 versus L2 in AOS, has not been investigated. Paradis (1995b:219) states that "Bilingualism is not just a rare, occasional occurrence in the language/speech pathology clinic…but a phenomenon every clinic must be prepared to cope with".

The relevance of studying L1 versus L2 speech production in AOS was first underscored by Van der Merwe and Tesner (2000), who postulated that speech production in L2 will probably differ from that in L1 in the late bilingual speaker, since L2 is not as familiar to the speaker. These researchers conducted the first perceptual study in bilingual AOS by examining the nature and severity of perceptual errors in L1 and L2 in a bilingual speaker with AOS. Van der Merwe and Tesner (2000) found that a greater number of perceptual errors and incorrect words were produced in L2 compared to L1 by the bilingual subject with AOS and proposed that the subject experienced speech production in L2 as motorically more complex, compared to L1. From the results of their study, these researchers concluded that speech production in L2 presumably requires more conscious control, which consequently also affects the motor dynamics of speech production. Furthermore, L2 has not become as automatized and consequently the speaker might experience speech production in L2 as more difficult. These researchers suggested that speech production in L2 requires the speaker to more consciously process on both the linguistic and the motor levels and that this impacts even further on the processing demands.

Regarding the more complex nature of speech production in L2 compared to L1, Klein, Zatorre, Milner, Meyer and Evans (1995) also concluded that L2 might be motorically more difficult to produce. These researchers studied the neural substrates of bilingual language processing using positron emission tomography and found that the left putamen was activated during L2 repetition tasks, but not during repetition tasks in L1. Klein *et al.* (1995) hypothesized from this finding that "activation of the left putamen is a function of the increased articulatory demands imposed by speaking a language learned later in life" (Klein *et al.*, 1995:31). In this regard, the possibility of differential processing patterns during speech production of L1 and L2 has also been proposed (Van der Merwe & Tesner, 2000).

If L2 is motorically more difficult to produce, it would presumably increase the processing demands imposed on the speech production system. The normal speech production mechanism might be able to adjust to these additional demands, but the increased processing demands might impact on the temporal parameters of speech production in persons with AOS who exhibit deficits regarding temporal control

(Kelso & Tuller, 1981; Kent & Rosenbek, 1983). The influence of the increased processing demands might also be evident in persons with PP, due to the proposed sharing of resources amongst language and motor processes (Strand & McNeil, 1996). The fact that language and speech motor processes presumably share processing resources has the implication that resources might be more easily exceeded in the presence of increased processing demands when certain processes involved in speech and language processing already require more than normal resources due to impairment at one or more of the levels of the speech production process.

From the above discussion, the importance of studying speech production in L1 and L2 in bilingual persons with neurogenic speech and language disorders becomes evident. The present study is the first to attempt a systematic investigation of the influence of speech production in L1 versus L2 on specific temporal parameters of speech production in persons with AOS and persons with PP. Speech rate alterations will also be employed to further increase the processing demands posed to the speech production mechanism, since this "additional" contextual factor might assist in demonstrating the effect of speech production in L2 on temporal control more clearly. Studying the influence of L1 and L2 in bilingual speakers with neurogenic speech disorders, renders novel opportunities to infer more about the nature of these speech disorders and the interaction of speech and language processes in the presence of neurologic lesion (Van der Merwe & Tesner, 2000). These data will contribute to further description and definition of temporal aspects of speech production in persons with AOS or PP, which in turn will shed light on normal and pathologic speech motor control. This is of special importance in a society "where bilingualism or even multilingualism is almost the rule" (Van der Merwe & Tesner, 2000:79). The reader is referred to Figure 1.1 for a schematic presentation of the purpose of the study.

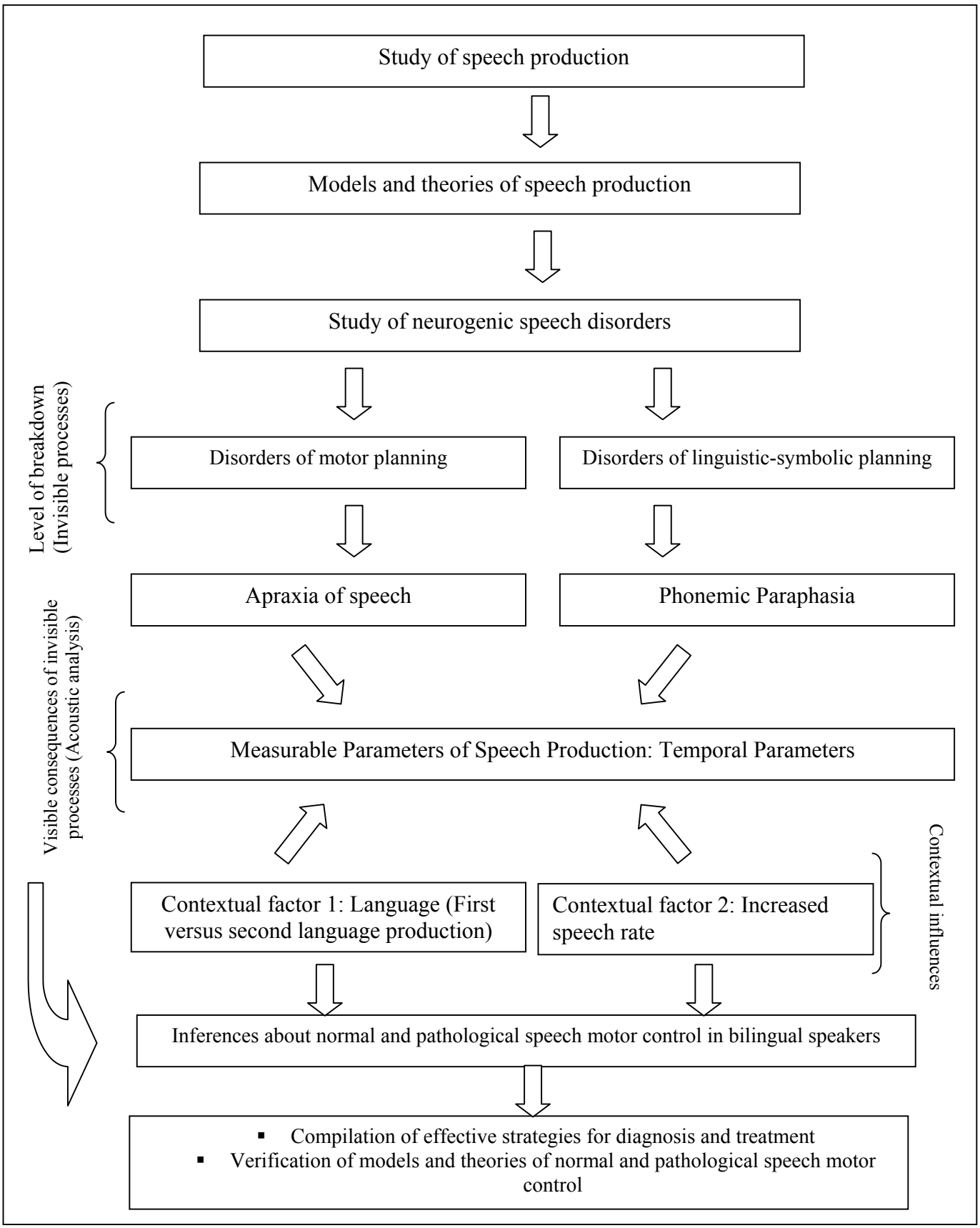

Figure 1.1 Schematic presentation of the purpose of the study of temporal parameters of speech production in bilingual speakers with neurogenic speech disorders

1.3 TERMINOLOGY

In order to obviate confusion, misinterpretation and misunderstanding of the terms used in this study, it is necessary to define and discuss these terms.

1.3.1 Temporal parameters

Articulation refers to the "movements of the vocal tract to produce speech sounds" (Borden & Harris, 1984:279). Van Riper and Emerick (1984:68) provide an even clearer definition by saying articulation involves "the production of speech sounds by incredibly swiftly impeding or valving the airstream and vocal tone by the tongue, lips and jaws". These movements of the articulators need to be *spatially* and *temporally* ordered. Articulation has an acoustic result. The acoustic output of the vocal tract can be depicted as a bridge between speech production and perception. By studying the acoustic output of the vocal tract more can be learned about the mechanism problems related to disordered speech, as well as the effect these problems have on speech intelligibility (Forrest & Weismer, 1997).

Forrest and Weismer (1997:63) state that “the acoustic output of the vocal tract contains the product of the entire speech system’s effort, rather than an isolated component of that effort”. From the acoustic signal information regarding a wide range of speech parameters can be obtained, including, “speaking rate, articulatory configuration for vowels and consonants, rates of change in the overall configuration of the vocal tract, flexibility of the articulatory behavior and aspects of phonatory behavior” (Forrest & Weismer, 1997:63). Temporal aspects of speech production “reflect the duration of selected events” (Forrest & Weismer, 1997:64). One temporal characteristic which has often been studied is segment durations since it is believed to reflect principles of speech timing (Forrest & Weismer, 1997).

The temporal parameters of the acoustic signal which will be investigated in the present study are vowel duration (VD), utterance duration (UD), utterance onset duration (UOD) and VOT.

1.3.2 Bilingual speakers

Paradis (1987:3) describes bilingual speakers as follows:

> Bilinguals have two languages at their command. They can speak one or the other and understand either at any time. They can switch between them, and they can mix them at any level of linguistic structure (phonetic, phonological, morphological, syntactic, lexical, semantic).

In the present study the level of bilingualism of the different subjects had to be the same. In other words, the age at which L2 was introduced, as well as the frequency with which it was used during their nursery, primary and high school years had to be similar. The person thus had to have been educated in Afrikaans, their home language or mother tongue, while English had been introduced as a second language at school. In the present study L1 refers to Afrikaans, while L2 refers to English.

In bilingual aphasic patients, some of their linguistic abilities are lost selectively. The two languages of a bilingual aphasic patient can be affected selectively (Paradis, 1995a). Little is known about the language status of the two languages in bilingual persons with AOS.

1.3.3 Speech

Borden and Harris (1984) state that speech is audible and can be described in terms of its loudness, pitch and duration. Speech "is meaningful sound strung out in time" (Borden & Harris, 1984:2), although speech is only one way in which to use language. Netsell (1982:247) describes "Speech is the motor-acoustic expression of language".

In this thesis "speech" refers to the realization of language through movements of the articulators. The movements involved in speech production are the result of muscle contractions due to nerve impulses, all of which are controlled in the nervous system (Borden & Harris, 1984). Speech results in an acoustic signal. The temporal parameters of speech production can be measured in the acoustic speech signal. In this thesis, speech is thus viewed as separate from language.

1.3.4 Language

Language is a "rule-governed communication system composed of meaningful elements, which can be combined in many ways to produce sentences" (Borden and Harris, 1984:2). Borden and Harris (1984:5) state that language "enables us to express ideas about people, places, or things which are not present".

Language refers to the language systems, also referred to as "the grammar, namely, phonology, morphology, syntax and the lexicon-in other words, what has come to be known as *implicit linguistic competence*" (Paradis, 1998:72).

1.3.5 Neurogenic speech disorders

It is important to define when speech can be classified as being disordered, in other words, when one can state that a person exhibits a speech disorder. It is thus necessary to compile a definition of deviancy. Van Riper and Emerick (1984:34) state "Speech is abnormal when it deviates so far from the speech of other people that it calls attention to itself, interferes with communication, or causes the speaker or his listeners to be distressed".

Neurogenic speech disorders are speech disorders caused by neuropathology and can be divided into two main groups namely, developmental disorders and acquired disorders (Thompson, 1989). Common neuropathologies include cerebrovascular accidents (CVA), head trauma and progressive, degenerative neuropathologies, for example, multiple sclerosis. Developmental neurogenic speech disorders are the result of an insult or lesion to the brain which occurs prior to or during the course of speech development. Acquired neurogenic speech disorders are the result of a lesion to the adult brain after speech development has been completed.

The present study is concerned with acquired neurogenic speech disorders, specifically persons with AOS and subsequently persons with aphasia exhibiting predominant PP. These two disorders will be defined briefly.

Apraxia of speech is defined by McNeil *et al.* (1997:329) as "a phonetic-motoric disorder of speech production caused by inefficiencies in the translation of a well-formed and filled phonological frame to previously learned kinematic parameters assembled for carrying our the intended movement…".

According to McNeil and Kent (1990:350) "Aphasia is, in the simplest sense, an impairment of the cognitive apparatus that performs language" as a result of "focal brain damage or disease".

Goodglass and Kaplan (1983:90) state "Literal (or phonemic) paraphasia refers to a paraphasia in which, in spite of "easy" articulation of individual sounds, the patient produces syllables in the wrong word order or embellishes his words with unintended sounds". McNeil *et al.* (1997:312) state that phonemic paraphasias "cross aphasic classifications", but frequently occur in persons with CA.

1.3.6 Context

Van der Merwe (1997, 2002) depicts speech production as being context-sensitive. This "implies that the context in which speech is produced will have an effect on the complexity of the motor task" in that it exerts an influence on the coalition of neural structures (Van der Merwe, 2002:5). More complex utterances might require more complex control strategies (Van der Merwe, 1997). Contexts identified by Van der Merwe (1997, 2002) include voluntary versus automatic production, motor complexity of the utterance, sound/syllable structure, utterance length, familiarity versus unfamiliarity of the utterance and rate of production.

In the present study, *context* refers to factors which influence the complexity of production at any level of the speech production process. The four specific contexts which will be investigated in the present study include speech production in L1 at a normal speaking rate (L1NR), speech production in L1 at a fast speaking rate (L1FR), speech production in L2 at a normal speaking rate (L2NR) and speech production in L2 at a fast speaking rate (L2FR).

1.3.7 Speech rate and speech rate alterations

Smith, Sugarman and Long (1983:748) refer to speech rate as "the timing of phrases and sentences". It can also be viewed as the number of syllables which are produced per second. Speech rate is a temporal variable of speech which can bring about great changes in the speech production process (Gay, 1981; Kelso *et al.*, 1983). Both temporal and spatial aspects of speech are influenced by changes in speaking rate.

Adams (1990:1) states that "Speaking rate is a dimension of speech production that can be controlled voluntarily over a relatively wide range and therefore its manipulation and subsequent investigation has offered the prospect of gaining insight into some of the mechanisms underlying speech motor control".

Speech rate alterations refer to an increase or decrease of rate of speech production. An increase in speaking rate can be achieved by various means, for example, reducing pauses between phrases, by increasing the rate of words within a phrase and by reducing word or syllable durations (Ludlow, Conner & Bassich, 1987). A decrease in speaking rate can be accomplished by the opposite means used to increase speech rate.

Requesting an alteration in speaking rate is one means of assessing a speaker's motor facility (Kent & McNeil, 1987; McNeil *et al.*, 1990a). A characteristic of motoric competence is the ability to make rate alterations when required. The normal speech production mechanism handles rate adjustments with ease, whereas the impaired motor system may be limited in its ability to vary rate of performance. Another reason for the employment of rate alterations in the study of speech and language disorders is because the linguistic properties of an utterance can be held constant, while the effect of higher demands, with an increase in rate, can be assessed (Kent & McNeil, 1987).

1.3.8 Speech and language processing

One of the many approaches which can be taken to study motor learning and control is an information processing approach. In this view, humans are regarded as active

processors of information rather than passive recipients (Shea, Shebilke & Worchel, 1993). The basic assumption is that a number of cognitive processes are required for correct execution of movement by an individual (Shea *et al.*, 1993; Stelmach, 1982).

Levelt (1989:1) views the speaker as a "highly complex information processor which can, in some still rather mysterious way, transform intentions, thoughts, feelings into fluently articulated speech". He further says that "A theory of speaking will involve various such processing components".

When referring to processing or speech and language processing in the present study, the operations or processing occurring during the various stages of the speech production process are implied. Various models of speech production have been proposed to depict the stages involved in speech and language processing. The stages depicted by Van der Merwe (1997) include linguistic-symbolic planning, motor planning, motor programming and execution. The term processing in the present study, includes both speech and language processing and implies the operations involved in the four stages of speech production proposed by Van der Merwe (1997). This also includes the cognitive processes involved in these stages, for example, attention and memory, necessary to drive these processing operations.

1.3.9 Automatic versus controlled processing

Most of the stages involved in speech and language processing are proposed to be automatic, implying that they do not require capacity in working memory (Kent, 1990; Levelt, 1989). In this regard, Kent (1990:374) states "Automatic, or capacity-free, processing contrasts with controlled, or capacity-demanding, processing". Kent (1990:374) further postulates that "speakers are flexible in the deployment of automatic and controlled processing. Under difficult situations, a speaker may rely more on controlled processing. It is likely that speakers with a neurological impairment of speech may be more reliant on controlled processing than are normal speakers".

Levelt (1989) proposes that the processing components which underlie speech work in a "highly automatic, reflex-like way" allowing them to work in parallel which is a

prerequisite for uninterrupted fluent speech. Levelt (1989) further proposes that processes involved in speech production can run in parallel and that each processor can work on different bits and pieces of an intended utterance. The fact that the latter can occur is based on the concept of automaticity, since only automatic processors can work without sharing access to attentional resources (Levelt, 1989).

In other words, automatic processing refers to processes which occur without conscious attention exerted by the speaker, whilst controlled processing occurs when demands which increase the processing load are placed on the speech production mechanism (Kent, 1990; McNeil *et al.* 1991a). It can consequently be deduced that the increased processing load presumably causes the speaker to concentrate more "consciously" on speech and language production.

1.3.10 Processing demands

McNeil *et al.* (1991a:35) state that "*Processing load* refers to the idea that the more complex or difficulty the task, the greater is the processing load and the outlay of effort. Tasks that require effort and attention are said to be under *controlled processing.* Conversely, when the task is more automatic, the processing load is smaller and fewer resources, less attention and less effort are required for its successful completion".

In the present study processing demands are synonym to processing load and refer to the influence exerted by a specific context to increase the complexity of production and consequently the cognitive effort involved in speech production.

1.3.11 Attentional resources

Shea *et al.* (1993:312) define attention as "The direction of mental energy or the allocation of resources to important stimuli and ignoring irrelevant ones; the process by which we notice important, meaningful, or relevant information and ignore unimportant stimuli".

Magill (2001:117) describes attention as follows: "in human performance the conscious or nonconscious engagement in perceptual, cognitive and/or motor activities before, during or after performing skills".

McNeil *et al.* (1991a:31) state that "Attention plays a role equivalent to the power supply in man-made mechanical devices. Attention can be conceived as effort per unit of time…It is both indispensable and non-specific for the completion of mental activity". The function of attention or resources "is to energize the machinery responsible for a particular task at hand" (McNeil *et al.*, 1991a:31).

Attention is also referred to as resources, capacity or effort (McNeil *et al.*, 1991a).

Limitations exist regarding the number of activities which can be attended to at one time (Kahneman, 1973; Magill, 2001; Stelmach, 1982). A person is able to perform several tasks simultaneously as long as the resource capacity limits of the system are not exceeded. If these limits are exceeded, performance of one or more of these tasks will deteriorate (Just & Carpenter, 1992; Magill, 2001; Stelmach, 1982).

In the present study, attention or attentional resources refers to available mental "drive" for the performance of speech and language processing operations. Attentional resources are used as synonym to resource capacity.

1.3.12 Resource allocation

Stelmach (1982:79) states that "attentional capacity is not restricted to any one stage of processing, nor is it modality specific, but rather that it can be flexibly allocated depending on the nature of the task".

McNeil *et al.* (1991a:33) state "Several factors, such as the nature of the task or the motivation of the performer, may also influence how attention is actually distributed".

In the present study, resource allocation, refers to the process which is performed either consciously or subconsciously of assigning resources or attention to performance of a specific processing operation.

1.4 DIVISION OF CHAPTERS

Chapter one is the introductory chapter that serves as an orientation to the field of study and presents the rationale and motivation for the study. The importance of accurately defining neurogenic speech disorders is emphasized as well as the study of such disorders within a framework of normal and pathologic speech motor control. The necessity of differentiating between AOS and PP is highlighted, since these two disorders exhibit overlapping speech characteristics despite deficits at distinct level of the speech production process. The importance of the study of the influence of various contextual factors on speech production in persons with AOS or PP is emphasized, since speech characteristics can vary depending on the context of production. The study of the influence of speech production in L1 versus L2 in AOS and PP is imperative because of its potential to inform about bilingual speech production in these speakers and the influence of increased processing demands thereon. A discussion of relevant terms and concepts is provided, as well as a brief review of the chapters of the study.

In *chapter two* prominent models and theories of speech production are reviewed in an attempt to delineate the processes and stages involved in the speech production process. Factors which influence information processing are reviewed with reference to specific contexts which might influence speech and language processing. From this discussion, L1 versus L2 speech production in bilingual speakers is proposed as a context for speech production and concepts relevant to bilingualism are discussed. The manifestation of language processing in the temporal and spatial parameters of speech production is discussed with reference to specific temporal parameters which can be measured acoustically. From this discussion, the relevance of studying the influence of L1 versus L2 production as a context for speech production on specific temporal parameters of speech in persons with neurogenic speech disorders is motivated.

In *chapter three*, AOS is defined and theories attempting to explain its underlying nature are discussed. The importance of the study of the speech of persons with

predominant PP is emphasized and PP is contrasted with AOS. The importance of studying the speech of persons with AOS or PP in various contexts, specifically L2 and increased speaking rate is motivated. Studies investigating specific temporal parameters of speech in AOS and CA are reviewed and results are interpreted with reference to Van der Merwe's four-level framework for the sensorimotor control of speech (Van der Merwe, 1997). The need for the study of the effect of specific speech contexts on the temporal parameters of speech production in AOS and PP, in order to determine qualitative differences between these two disorders and to learn more about normal and pathological speech motor control under circumstances of increased processing demand, is highlighted.

In *chapter four* the experimental methodology of the empirical research is described in terms of the research aims, subject selection criteria and procedures, research design, measurement instruments, speech material, data collection procedure and finally the data analysis and processing procedures employed in this study.

In *chapter five* the results of the study are presented according to the various sub-aims. Intra- and intersubject comparisons are made using descriptive statistics. This chapter serves as an introduction to Chapter 6 where the results are interpreted and discussed.

In *chapter six* the results presented in Chapter five are discussed with reference to each sub-aim. Where relevant, the results of the current study are compared to the results of other studies and discussed with reference to the underlying nature of AOS and PP and the influence of speech production in L2 on the speech of these persons. A general discussion is then undertaken for highlighting of the main theoretical issues which emerged from the results of the study.

In *chapter seven* general conclusions are provided as well as an evaluation of the research methodology. The theoretical and clinical implications of the study are discussed and recommendations for future research are made.

1.5 SUMMARY OF CHAPTER ONE

In this chapter the rationale and motivation for the study were presented. The importance of the study of the influence of L1 versus L2 on specific temporal parameters of speech production in AOS and PP was motivated in order to learn more about speech motor control in bilingual speakers with neurogenic speech and language disorders under circumstances of increased processing demands. Finally, the terminology was explained and the content of the chapters in the study were briefly outlined.