DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made. This thesis contains no material, which has been accepted for the award of any other degree or diploma in any university.

Jade Cartwright

Signature: ..............................................

19th December 2014
Date: .....................................................
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ABSTRACT

Background: Primary progressive aphasia (PPA) is a dementia syndrome, characterised by the gradual, insidious loss of language. The most widely adopted definition of PPA conceptualises the syndrome as a focal dementia, targeting the language networks of the brain. Focal definitions are driven by assumptions of modularity, which have greatly influenced the research and clinical approaches employed by the field to date. This thesis examines the need for contemporary conceptualisations of PPA that consider the nature and psychosocial impact of the syndrome holistically, moving beyond the level of focal impairment and offering new theoretical perspectives and methodological approaches to the field. A dynamic systems account of PPA is presented as a novel theoretical alternative, conceptualising disease expression as the emergent output of a complex, self-organising system.

Aims: The primary objectives of this thesis were to present, apply and test a dynamic systems framework of PPA through exploratory, proof of concept research. This aimed to provide a multi-layered account of PPA in order to uncover the dynamics of disease expression and its global consequences for behaviour and psychosocial wellbeing. These aims were addressed by: (1) quantifying and examining the system-wide expression of PPA across cognitive, linguistic, and social-emotional functions, and (2) exploring subjective-insights into the perceived nature of disease expression and associated psychosocial reactions to understand how individuals perceive, respond and adapt to language dissolution.

Predictions: Given the exploratory nature of this research specific hypotheses were not formulated. Drawing upon a dynamic systems account of PPA broad predictions were made. It was predicted that the system-profiles and subjective-insights would provide evidence for the dynamic, multi-layered nature of PPA, while differentiating the participants with PPA from healthy ageing controls. Unique patterns of emotional and psychosocial adjustment were expected, highlighting the individualised nature of adaptation and disease expression.

Methods and Procedures: Five individuals with a diagnosis of PPA and 14 healthy-ageing controls were recruited to the study. The data set for the entire thesis is based on this single
cohort of participants (PPA and controls) with an empirical focus on the individual cases with PPA. The small sample size was justified given the exploratory nature of the research and case-controls design that aimed to examine the five individual systems in detail.

All participants attended four evaluation sessions, completing a battery of objective and subjective measures of cognitive, linguistic, and social-emotional functions, including personal insights into disease expression and associated responses. This enabled comprehensive sampling of system performance and adaptation. The data collected were analysed across two levels providing different, yet complementary windows into the individual dynamic systems.

**Outcomes & Results:** The multivariate, systems-approach to sampling, profiling and analysis provided rich and novel insights into the nature and psychosocial impact of PPA.

The system-profiles revealed the multi-layered impact of PPA with performance decrements manifesting across cognitive, linguistic and social-emotional components of the system. This was further supported by the subjective-insights, with individuals with PPA perceiving significant linguistic impairment, as well as broader psychosocial and functional consequences of language dissolution.

The system-profiles and subjective-insights differentiated the participants with PPA from the control group, providing preliminary support for the clinical utility of a systems-approach to PPA. Measures of linguistic performance and self-efficacy for social communication were particularly sensitive to language dissolution.

Evidence for significant social-emotional impact of PPA, ranging from mild to profound, was a key finding of this research. Examples of maladaptive coping strategies were detected at an early disease stage, highlighting the need for timely diagnosis and proactive intervention.

While some commonalities were evident across the system-profiles, the subjective-insights revealed unique patterns of adaptation and coping. Internal and external factors were identified with potential to influence individual patterns of disease expression and impact.
Conclusion: The primary aims of the thesis were achieved, providing preliminary support for a dynamic systems account of PPA. The findings suggest that the expression of PPA is dynamic and multi-layered, with individuals experiencing and adapting to language dissolution in unique ways. An intimate understanding of an individual’s system and personal construction of disease is advocated for identifying therapeutic goals and developing management plans with potential to bolster adaptation. Future research should test the preliminary findings on a larger sample of individuals with PPA, refining the theoretical framework and methodological approaches employed.
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AEMSS</td>
<td>Age- and Education-corrected MOANS Scaled Score</td>
</tr>
<tr>
<td>AMSS</td>
<td>Age-corrected MOANS Scaled Score</td>
</tr>
<tr>
<td>BNT</td>
<td>Boston Naming Test</td>
</tr>
<tr>
<td>CIU</td>
<td>Correct Information Unit</td>
</tr>
<tr>
<td>CT</td>
<td>Computed Tomography</td>
</tr>
<tr>
<td>DRS</td>
<td>Dementia Rating Scale</td>
</tr>
<tr>
<td>DTI</td>
<td>Diffusion Tensor Imaging</td>
</tr>
<tr>
<td>GDS</td>
<td>Geriatric Depression Scale</td>
</tr>
<tr>
<td>ICF</td>
<td>International Classification of Functioning, Disability and Health</td>
</tr>
<tr>
<td>MRI</td>
<td>Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>MOANS</td>
<td>Mayo’s Older Americans Normative Studies</td>
</tr>
<tr>
<td>PET</td>
<td>Positron Emission Tomography</td>
</tr>
<tr>
<td>PPA</td>
<td>Primary Progressive Aphasia</td>
</tr>
<tr>
<td>PPA-G</td>
<td>Primary Progressive Aphasia – Grammatical</td>
</tr>
<tr>
<td>PPA-L</td>
<td>Primary Progressive Aphasia – Logopenic</td>
</tr>
<tr>
<td>PPA-M</td>
<td>Primary Progressive Aphasia – Mixed</td>
</tr>
<tr>
<td>PPA-S</td>
<td>Primary Progressive Aphasia – Semantic</td>
</tr>
<tr>
<td>PROMPT</td>
<td>Prompts for Restructuring Oral Muscular Phonetic Targets</td>
</tr>
<tr>
<td>QOL</td>
<td>Quality of Life</td>
</tr>
<tr>
<td>SD</td>
<td>Semantic Dementia</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WPM</td>
<td>Words per Minute</td>
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Chapter 1

BACKGROUND AND MOTIVATION

“Language tethers us to the world; without it we spin like atoms.” François de La Rochefoucauld

Introduction

Primary progressive aphasia (PPA) is a dementia syndrome that results in the isolated decline of language function for a period of at least two years (Mesulam, 1982, 2001). The underlying pathology results in the gradual dissolution of a defining human skill that is often taken for granted. The language disorders associated with PPA provide unique opportunities to study the networks of human communication (Orange & Kertesz, 2000; Rohrer, Knight, Fox, Rossor, & Warren, 2008). They allow insight into how the language system responds and adapts to progressive neurological change and consideration of the intrinsic relationship between language and cognition. PPA is considered a low prevalence disorder compared to other types of dementia (Mesulam, Wienke, Thompson, Rogalski, & Weintraub, 2012). While community-based estimates of the frequency of PPA are not available (Grossman, 2010), the syndrome accounts for 20-40% of cases of frontotemporal dementia (Matias-Guiu & Garcia-Ramos, 2013), which is a leading cause of early-onset dementia (Ratnavalli, Brayne, Dawson, & Hodges, 2002). The costs associated with PPA are significant with unique and devastating implications for the individual and their families given the ubiquitous nature of language to everyday life (Dickerson, 2011). Different rates of progression have been reported, with some individuals living with the profound consequences of language dissolution for 12 or more years (Hodges et al., 2010). This highlights the critical need for therapeutic support services.

As a speech-language pathologist working with people with dementia and progressive neurological disorders in the early stage of my career I was not satisfied with the body of knowledge available to direct my practice, particularly in regard to PPA. I sought applied evidence and theoretical frameworks that would enable me to understand the nature of my client’s progressive language difficulties and to hypothesise areas of care need that I should address and prioritise in my clinical management. Given that scientific enquiry into PPA
remains in its relative infancy, much of the literature and theoretical debate I was searching for was not yet available and significant gaps were evident in regard to the holistic conceptualisation and proactive clinical management of the syndrome.

**Definitions and Conceptualisation of PPA**

Current definitions and understanding of PPA are shaped by the field's focus on diagnosis, clinico-pathological profiling and the identification of biomarkers of disease. Research is driven to identify and profile dissociable clinico-anatomical features of PPA and its variants and is guided by assumptions of localization of function together with neurological specialisation. The current consensus classification system for PPA is based on impairment based definitions, enabling conceptualisation of the syndrome in terms of its discrete or selective impairment of language processing modules. In clinical practice these definitions guide diagnostic reasoning and classification of focal language difficulties. The clinical application of impairment based diagnostic categories is however limited in regard to ecological validity and potential to adequately describe the real-life nature or impact of the syndrome.

Limitations of focal definitions are further exacerbated by the complex and heterogeneous nature of PPA. This was evident in my own clinical experience as individual clients often failed to fit neatly into the diagnostic categories. This led me to question the theoretical assumptions driving current definitions of PPA and to identify the need for broader conceptualisations that move beyond the focal level to embrace the complexity and variability of the syndrome. Moving beyond the focal level would also enable the psychosocial impact and subjective experience of PPA to be explored, which is critical for informing the development of proactive, holistic interventions and care pathways for people living with the syndrome.

**Significance of the Current Research**

This thesis examined the critical need to reframe conceptualisations of PPA in light of neuroscientific evidence of how language is distributed and processed in the brain and the heterogeneous nature of disease expression. To move beyond conceptualisations of PPA as a focal dementia and to contribute new theoretical perspectives to the field a conscious shift in...
methodology is required. While previous research has adopted a bottom up focus, starting with
discrete clinico-pathological profiling via fractionated testing regimens such as word fluency,
picture naming and repetition tasks, this thesis is concerned with examination of PPA from a
broader perspective, including the individual’s own descriptions of their language dissolution
and ensuing adaptation to language change. Using a wide-lens of enquiry, the primary aims of
the thesis were (1) to examine the holistic system-wide impact of PPA, including the
consequences for language performance and social-emotional functions, and (2) to explore
individual patterns of adaptation and coping in response to language dissolution.

It was predicted that widening the lens of enquiry and deepening the level of analysis
would reveal new insights into the nature of PPA, while identifying novel targets for clinical
practice and future large-scale research. This represents exploratory, proof of concept research
seeking to inform the design of theoretically driven, proactive interventions that can sensitively
and flexibly manage individual care needs as the syndrome and associated symptomatology
unfold over time. Given the paucity of theoretical debate published to date and the implications
for the management and long-term outcomes of people living with PPA, this research
contribution is timely and significant.

**Thesis Structure**

The thesis consists of seven chapters. The content and aims of each subsequent chapter
are outlined below.

**Chapter one.** The first chapter provides the personal motivation and background to the
thesis as well as an overview of the thesis structure.

**Chapter two.** The second chapter provides a theoretical introduction to the field of
study. It examines definitions of PPA and underlying theoretical assumptions, while introducing
some of the controversy in the field concerning diagnosis, classification criteria, and assessment
techniques. Significant gaps in the current theoretical and empirical literature are presented,
highlighting the field’s focus on diagnosis and the focal or discrete aspects of the syndrome.
The need for new theoretical conceptualisations of PPA will be outlined drawing upon dynamic systems theory as a novel alternative.

**Chapter three.** The third chapter presents an integrated dynamic systems framework of PPA that informed the design, analysis and interpretation of the current research. Through presenting the framework, key components within the system are identified, addressing cognitive, linguistic, and social-emotional functions. Relevant literature is reviewed within each component to identify potential parameters of interest and gaps in the current evidence base regarding the holistic, system-wide impact of PPA. While the components of the system and parameters are discussed in isolation, the interactions and relationships between components are of primary interest, in keeping with a dynamic systems framework. It is assumed that the interactions across components ultimately determine the nature of disease expression for individuals living with PPA, influencing behavioural and psychosocial outcomes. This chapter concludes with an overview of the broad aims of the thesis, leading into the theoretical design and methodology of the thesis.

**Chapter four.** In the fourth chapter an overview of the general methodology of the study, including an overarching rationale for the statistical methods, sampling and analysis techniques is provided. The research design is driven by the dynamic systems framework of PPA presented in chapter three, enabling the nature of disease expression and the subjective-insights into PPA to be examined holistically for each individual case. Chapter four also includes a demographic description of the single participant cohort, including the individual participants with progressive language impairment and the characteristics of the healthy ageing control group. It outlines the procedures employed and what participation in the study involved. Ethical issues and considerations are discussed.

**Chapter five.** The fifth chapter presents the aims, methods, and results of the first level of analysis, which aimed to quantify and critically examine the holistic system-profiles of each

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1 Throughout this thesis the terms *dynamic* and *dynamic system* are used to refer to systems of components that are complex and that self-organise and evolve over time.

2 *Parameters* are defined as factors that a dynamic system is sensitive to or that affect the state of a system. Parameters can be internal or external to the system, including social and physical context, as well as motivational and attentional states.
participant with PPA as compared to the healthy ageing control group. The system-profiles are objective and quantitative in nature, providing insight into the relative severity of impact for each participant with PPA across the components of system function and selected parameters of interest. This quantification is statistically driven, utilising the range of control group performance for case-control comparison. The system-profiles are described and examined in detail, exploring the nature of disease expression and seeking evidence for variability and complexity across participants. The relative contribution of different intra- and inter-personal factors is considered to explain patterns of behavioural and psychosocial variance.

**Chapter six.** The sixth chapter presents the background, aims, methods, and results for the second level of analysis. This aimed to extend the system-profiles presented in chapter five, by examining the participants’ subjective-insights into the language changes experienced since the onset of PPA in comparison to healthy ageing. Furthermore, the individual’s reactions and responses to perceived changes were studied to explore patterns of adaptation and coping. Leximancer™ (2011) text analytics software was used to quantify the subjective-insights allowing examination of emergent concept maps. The concept map of the healthy control group is described and examined first to provide a platform for comparison. The concept maps and qualitative data for each participant with PPA are then described and examined on a case-by-case basis. Insights gained into the perceived nature of disease expression and patterns of adaptation and resilience are discussed providing direction for future research, while allowing identification of preliminary practice implications. The utility of Leximancer™ is examined, as the methodological approach has not been previously used to study PPA.

**Chapter seven.** The final chapter provides the general discussion and integration of findings, examined within the dynamic systems framework of PPA and in light of current research in the field. Theoretically, this chapter shows how the experience of PPA can be accounted for and understood using a dynamic systems account of brain functioning. The clinical implications for the diagnosis, assessment and proactive management of PPA are discussed. The limitations of the research are also considered, providing direction for future large-scale research.
Chapter 2

LITERATURE REVIEW

Introduction

Primary Progressive Aphasia (PPA) is a clinical syndrome that results in the gradual and isolated decline of language function (Mesulam, 2001). Considered a focal dementia, the progressive language impairment is the most salient neurobehavioural deficit, with relative preservation of episodic memory, executive function, visuospatial, and social skills for a period of at least two years and up to 10 to 14 years (Mesulam, 1982, 2001, 2003; Mesulam et al., 2012). To support diagnosis, imaging studies and neurological examination must exclude any cause other than neurodegeneration, such as stroke or vascular disease (Mesulam et al., 2012). PPA typically presents in the presenium (before age 65), when individuals may still be working and fulfilling active family, social and other community roles. Furthermore, given the nature of the disorder, individuals with PPA typically have preserved insight into their difficulties, particularly in the early stages of disease. As such, individuals are acutely aware of the profound communication difficulties experienced during their everyday interactions, with implications for quality of life (QOL), social engagement and general wellbeing.

While research and clinical interest in PPA has grown significantly, the field remains in its relative infancy. A recent Medline search using the key word primary progressive aphasia returned 588 results as compared to an identical search for Alzheimer’s disease that returned 87,974 results. While this search did not attempt to capture all of the respective papers, it reveals the comparative difference in research enquiry across the two diagnostic categories. Furthermore, within the PPA field, research efforts have been directed predominantly towards differential diagnosis and classification (Dickerson, 2011; Leyton et al., 2011; Mesulam et al., 2012; Rohrer, Rossor, & Warren, 2010; Savage, Hsieh, Leslie, Foxe, Piguet, & Hodges, 2013), identifying clinico-pathological and neuroimaging correlates of disease (Galantucci et al., 2011; Heim et al., 2014; Rohrer, Rossor et al., 2010; Sonty, Mesulam, Weintraub, Johnson, Parrish, & Gitelman, 2007), and characterising the defining linguistic features of the syndrome (Knibb, Woollams, Hodges, & Patterson, 2009; Sajjadi, Patterson, Tomek, & Nestor, 2012; Thompson,
Lukic, King, Mesulam, & Weintraub, 2012). Despite the devastating impact that the syndrome has on well-being and life participation, psychosocial research and rigorous treatment studies remain limited. A Medline search for primary progressive aphasia and treatment or therapeutics returned 38 results, with a small emerging body of research reporting the outcomes of pharmacological and behavioural treatments for individuals with PPA (Kertesz, Blair, McMonagle, & Munoz, 2007). No Cochrane reviews have been completed for the syndrome to date.

The natural history of PPA has not been well studied, which has implications for clinical intervention and prognostic counselling during the disease course (Dickerson, 2011; Le Rhun, Richard, & Pasquier, 2005). The longitudinal studies that have been conducted suggest that the disease evolves over a seven to 10 year period from reported onset of symptoms until death (Dickerson, 2011; Le Rhun et al., 2005). Preliminary findings suggest that some forms of PPA progress more slowly than others, with reports of survival up to 20 years following diagnosis (Hodges et al., 2010). This time frame is likely to be dependent on when symptoms are detected and how early a diagnosis is made (Dickerson, 2011). The length of time between onset of symptoms and total loss of language also appears variable, ranging between five and 10 years, at which time muteness can develop (Le Rhun et al., 2005). Given the predominance of language symptomatology, it has been documented that individuals with PPA maintain independence in activities of daily living into the late stages of disease, in some cases up until one to two years before death (Le Rhun et al., 2005). There is a critical need for more longitudinal studies to advance understanding of the evolution of the syndrome over time.

PPA is described as a low prevalence disorder compared to other types of dementia (Mesulam et al., 2012). Population-based surveys are notably difficult for rare conditions, as large sample sizes are needed to draw reliable and precise estimates of prevalence (WHO, 2012). Like other rare diseases, the available prevalence data for PPA has been collected predominantly from registry-based studies, which reflect the number of cases known to local services (WHO, 2012). This is problematic as not all individuals living with PPA are diagnosed accurately or present to local services seeking assessment or support, particularly in the early
stages of disease. As such, available figures are likely to underestimate the true prevalence of PPA and with the population ageing, diagnosed cases are expected to escalate in the future.

It is documented that individuals with PPA are presenting to speech-language pathology clinics with growing frequency (Fried-Oken, 2008; Taylor, Kingma, Croot, & Nickels, 2009) and there is a justified and growing need to advance the intervention and clinical services available. Historically, it was thought that behavioural treatment for dementia is futile and that meaningful change cannot be made or sustained given the degenerative nature of disease (Hopper, 2003). However, a growing body of evidence refutes this notion demonstrating that behavioural treatments can significantly enhance QOL and life participation in the face of progressive disease (Hopper, 2003). As such, the ethical responsibility for speech-language pathologists to treat and provide intervention services has been duly noted in the literature (Duffy & McNeil, 2008). With changing perspectives and new research findings, rehabilitation services for people living with PPA and dementia more broadly is an emerging area of practice with a pressing need to bridge the divide between scientific knowledge and routine clinical care.

**Presentation and Classification of PPA**

PPA is described as a heterogeneous syndrome (Mendez, Clark, Shapira, & Cummings, 2003; Mesulam, 2001) with “...no single type of language dysfunction that is pathognomonic for PPA” (Mesulam, 2001, p.426). Word finding difficulty or anomia represent the most common presenting complaint, providing a sensitive marker of degradation within the language system (Mendez et al., 2003; Mesulam, 2001). In the earlier literature there was debate about whether or not PPA should be seen as a distinct clinical entity or rather on a continuum with other types of dementia, most notably Alzheimer’s disease (Knibb, Xuereb, Patterson, & Hodges, 2006). With mounting evidence PPA now has a stronger place in the dementia field recognised as a diagnostic category in its own right (Gorno-Tempini et al., 2011; Knibb et al., 2006; Mesulam et al., 2012). PPA represents the root diagnosis with three subtypes or variants. The agrammatic and semantic variants were the first canonical subtypes to be described, with the more recent recognition of the logopenic variant (Mesulam et al., 2012; Gorno-Tempini, 2008).
In 2011, Gorno-Tempini and colleagues published revised consensus classification criteria to provide a systematic approach to subtyping and uniformity in research. These guidelines represent the culmination of a growing evidence base of clinicopathological research that has provided robust and detailed characterisation of presenting language symptomatology for each variant as outlined below (Gorno-Tempini et al., 2011; Mesulam et al., 2012). The criteria (see Table 2.1) include the root diagnosis of PPA, the three main subtypes (agrammatic, semantic and logopenic) and a mixed variant. Criteria represent descriptions of clinical observation that are supported by review of medical records, history from a reliable informant, and performance on a battery of standardised neuropsychological assessments. It is important to note that the current consensus criteria do not specify assessment procedures or cut-off scores that should be applied (Gorno-Tempini et al., 2011; Mesulam et al., 2012). Furthermore, they do not explicitly consider the stability of classification over time or how the clinical syndromes evolve with disease progression.

**Agrammatic variant.** The non-fluent phenotype or agrammatic variant (PPA-G) is characterised by effortful, halting, agrammatic speech in language production, with inconsistent speech sound errors or concomitant apraxia of speech (Ash et al., 2006; Gorno-Tempini et al., 2011). Two of three ancillary features must be present: difficulty comprehending complex grammatical sentences, spared single word comprehension, and spared knowledge of objects (Gorno-Tempini et al., 2011). Verbal output becomes progressively more effortful and hesitant over time. Judgements of effort and hesitancy are typically made using subjective, perceptual judgements while listening to a sample of spontaneous speech (Mesulam et al., 2012). Alternatively fluency scores can be calculated, reflecting the number of words produced per minute (Mesulam et al., 2012). Fluency rates are significantly reduced, with speech produced at about one-third the rate expected of healthy adults (Grossman et al., 2013). In a study by Sajiadi et al. (2012) participants with non-fluent PPA produced on average 60.4 words per minute, as compared to 140 words per minute produced by controls when describing a picture. While motoric difficulties are associated with PPA-G, the grammatical deficit is recognised as the
most prominent feature, indicating that it is a central disorder of language (Grossman et al., 2013).

**Semantic variant.** In clinical practice, the fluent variant of PPA is known as Semantic Dementia (SD), although use of this term has been widely debated (Adlam et al., 2006). In the most recent consensus criteria, this subtype has been labelled the ‘semantic variant’ (PPA-S; Gorno-Tempini et al., 2011). The core criteria for diagnosis require impaired object naming and impaired single-word comprehension. Both features must be present for a diagnosis to be made (Gorno-Tempini et al., 2011). Three of four ancillary features must also be present, including impaired knowledge of low frequency or low familiarity objects; surface dyslexia or dysgraphia; spared repetition; and/or spared grammaticality of speech without a speech-sound disorder (Gorno-Tempini et al., 2011). Descriptively, individuals with PPA-S present with fluent speech output that is circumlocutory, non-specific, and littered with semantic paraphasias or word meaning errors (Mesulam, 2001). Comprehension of spoken and written information is severely impaired with ‘lexical- semantic lacunae’ impeding word comprehension (e.g. “What are drugs?”; Cartwright & Elliott, 2009, p.280). Individuals with PPA-S are thought to develop a central semantic deficit, with spoken discourse characterised by impoverished meaning and progressively empty speech (Ash et al., 2006).

**Logopenic variant.** The logopenic variant (PPA-L) has not been studied as extensively as the two original subtypes (Rohrer et al., 2013). Logopenia refers to a reduction in the overall number of words produced (Rohrer, Ridgway et al., 2010); with PPA-L characterised by impaired word retrieval and impaired repetition of phrases and sentences (Gorno-Tempini et al., 2011; Henry & Gorno-Tempini, 2010). Three of four ancillary features must be present, including phonological errors in natural language and naming, spared comprehension of single words and object knowledge; preserved motor speech with no evidence of apraxia of speech; and absence of frank agrammatism. PPA-L has been described as a primary phonological loop deficit, which results in impaired verbal short-term memory and sentence repetition, sparse spontaneous speech, with frequent and severe word finding hesitations and pauses (Gorno-Tempini et al., 2011; Rohrer, Rossor et al., 2010).
PPA unclassifiable. Individuals with atypical or overlapping features may present with a mixed variant that is often characterised by agrammatism in language production in addition to word comprehension impairments (Alladi et al., 2007; Gorno-Tempini et al., 2011; Mesulam et al., 2012). Gorno-Tempini et al. (2011) recommend that mixed cases be coded as “PPA unclassifiable” (p. 1007) until empirical understanding of other variants of PPA or the clinical syndrome more broadly improves.

Table 2.1

Criteria for the Diagnosis of PPA and its Subtypes

A. Criteria for the root diagnosis of PPA
Diagnostic criteria for PPA (Mesulam, 2001, 2003)
The following three conditions must all be present.
1. A new and progressive language disorder (aphasia) as documented by neuropsychologically determined abnormalities in one or more of the following domains: grammaticality of sentence production, word retrieval in speech, object naming, word and sentence comprehension, spelling, reading, repetition, isolated impairments of articulation do not qualify.
2. Relative preservation of episodic memory, executive functions, visuospatial skills and comportment as documented by history, medical records and/or neuropsychological testing.
3. Imaging and other pertinent neurodiagnostic test results that rule out causes other than neurodegeneration.

B. Criteria for PPA subtypes
Non-fluent/agrammatic variant (PPA-G) (Gorno-Tempini et al., 2011)
A. One of the following core features must be present.
1. Agrammatism in language production.
2. Effortful, halting speech with inconsistent speech sound errors and distortions (apraxia of speech).
B. Two of the following three ancillary features must be present.
1. Impaired comprehension of syntactically complex (non-canonical) sentences.
2. Spared single-word comprehension.
3. Spared object knowledge.

Semantic variant (PPA-S) (Gorno-Tempini et al., 2011)
A. Both of the following core features must be present.
1. Impaired object naming.
2. Impaired single word comprehension.
B. Three of the following ancillary features must be present.
1. Surface dyslexia or dysgraphia.
2. Spared repetition.
3. Spared grammaticality and motor aspects of speech.

Logopenic variant (PPA-L) (Gorno-Tempini et al., 2011)
A. Both of the following core features must be present.
1. Impaired single-word retrieval in spontaneous speech and naming.
2. Impaired repetition of phrases and sentences.
B. Three of the following ancillary features must be present.
1. Phonological errors (phonemic paraphasias) in spontaneous speech or naming.
2. Spared motor speech.
3. Absence of frank agrammatism.

Mixed variant (PPA-M) (Mesulam et al., 2009)
A. Both of the following features must be present.
1. Agrammatism in language production.
2. Word comprehension impairments.

Template approach to classification. The above description of the variants of PPA highlights that the classification of the syndrome and its subtypes is predominantly based on the assessment and profiling of language abilities across core language domains (i.e. grammatical ability, word comprehension, object naming, repetition, and motor speech skills) (Mesulam et al., 2012). The consensus guidelines specify the core and ancillary criteria that must be met within each of the language domains (Mesulam et al., 2012). As such, each variant is defined according to the presence or absence of core and ancillary language features (Leyton et al., 2011).

This criterion driven approach to classification and diagnosis has led to the development of classification templates, which have specified assessment tasks and provided explicit cut-off scores in attempt to aid diagnostic rigour and accuracy. Mesulam et al. (2009) have tested the validity and reliability of one template approach, where quantitative performance is profiled across two orthogonal axes representing word comprehension and grammaticality. To study the clinical value of this approach in the early stages of PPA, Mesulam et al. (2012) set a cut-off score of 90% accuracy, with scores above cut-off interpreted as preserved or within normal limits. Scores of less than 80% were interpreted as definite impairment within that domain of language function. Using this template, test performance was first converted to a per cent correct score and then mapped to one of four quadrants, representing different subtypes of PPA. The condensed template was found to be as successful in subtyping individual cases as compared to profiling performance across a greater number of test scores and/or domains of language function (Mesulam et al., 2012). Readers are directed to Mesulam and colleagues (2009, 2012) for further information about this template approach to classification.

Despite attempts to refine classification criteria and develop templates and algorithms to aid diagnosis, individual profiles continue to fail to fit neatly into one of the established subtypes (Amici, Gorno-Tempini, Ogar, Dronkers, & Miller, 2006). This is in part due to the reliance on group studies, where the accuracy of classification methods is often tested at a group-level, rather than for individual cases (Leyton et al., 2011; Mesulam et al., 2012). Difficulty classifying at the level of the individual is inherently difficult given the complexity
and heterogeneity of PPA both within and across variants. It has been noted that it is easier to
differentiate the agrammatic variant from the semantic variant, than it is to differentiate the
logopenic variant from the other two, given varying degrees of overlap (Leyton et al., 2011;
Mesulam et al., 2012; Wilson et al., 2010). As such careful interpretation and analysis of
performance and presenting features is required, with use of a range of measures recommended
to increase discriminative accuracy (Wilson et al., 2010). The need for large, and often
sophisticated, batteries of assessment can be time consuming and restrictive in practice.
Furthermore, the value of the resultant assessment profiles has questionable value beyond the
level of diagnosis.

**Neuroimaging and classification.** In practice the clinical phenotype of PPA is
routinely combined with structural and functional imaging results to aid classification and
diagnostic subtyping (Gorno-Tempini et al., 2011). It is important to note that imaging data are
used to support, rather than confirm the working diagnosis, with radiographers looking for
specific atrophy sites that fit a particular syndrome or diagnostic category (Mesulam et al.,
2012; Rosen et al., 2002). In the majority of cases, PPA is characterised by distinctly
asymmetric atrophy, hypoperfusion, and hypometabolism involving the language networks of
the dominant hemisphere (Mesulam, Weintraub, Parrish, & Gitelman, 2005; Mesulam et al.,
2012). This asymmetry is evidenced most dramatically in the early to mild stages of disease
(Mesulam et al., 2012). It has been reported that in the early stages of PPA structural imaging
results (Brain CT or MRI) are negative without evidence of focal atrophy in a large proportion
of cases (Mesulam et al., 2012), despite reports of emerging word finding and language
difficulty. Functional imaging (e.g. PET) may demonstrate the characteristic asymmetric
hypometabolism in some of these cases where structural imaging failed to assist diagnostic
reasoning (Mesulam et al., 2012).

In the case of PPA-G and PPA-L, atrophy has a more perisylvian focus (Mesulam et al.,
2012). For PPA-G structural and functional imaging have demonstrated characteristic changes
in several regions of the brain, most notably the left inferior frontal lobe, the anterior insula, and
frontal operculum (Gorno-Tempini et al., 2011; Grossman et al., 2013; Nestor et al., 2003),
extending to the left anterior-superior temporal lobe (Grossman et al., 2013). This involves the
dorsal white matter tracts, which include the superior longitudinal fasciculus, involved in speech
production processes (Rohrer, Ridgway et al., 2010). For PPA-L the left posterior temporal and
parietal regions of the brain show the most atrophy (Gorno-Tempini et al., 2008; Rohrer,
Ridgway et al., 2010). This indicates that PPA-L has a more posterior cortical involvement, as
compared to the other PPA variants, involving long association tracts in the left hemisphere that
connect the dorsal language processing stream to inferior frontal areas (Rohrer, Ridgway et al.,
2010).

In comparison, the atrophy that underlies PPA-S has a more “temporopolar focus”
(Mesulam et al., 2012, p.1552). The semantic variant may be associated with hypometabolism
and reduced grey matter density in the temporal lobes bilaterally, however dysfunction is
typically more pronounced in the left anterior and inferior temporal lobe (Adlam et al., 2006;
Rabinovici et al., 2008). These regions comprise the white matter tracts that play an important
role in semantic processing consistent with presenting symptomatology (Rohrer, Ridgway et al.,
2010; Spitsyna et al., 2006).

Into the more advanced stages of PPA the underlying disease processes and ensuing
atrophy start to spread into other regions of the brain; however pathology retains its predilection
for the perisylvian and connected language areas, in an asymmetric fashion (Mesulam et al.,
2012; Rohrer et al., 2013). The rate of brain atrophy in the early stages of PPA has been
calculated to be 2.0% per year (Rohrer et al., 2012; 2013). More extensive loss or spread of
pathology within the intra-hemispheric networks is typically evident, at least in the early stages
of the disease (Rohrer et al., 2013). Language deficits remain the primary complaint and most
prominent clinical feature even as broader symptoms start to emerge and are the focus of
diagnostic assessment and clinical profiling across the disease trajectory.

The Diagnostic Challenge

The diagnosis of PPA and its variants draws upon a range of different information
sources including clinical assessment of speech, language and neuropsychological functions,
neurological examination and neuroimaging (Gorno-Tempini et al., 2011; Wilson et al., 2010).
Despite recognition of the variants of PPA and published classification guidelines, diagnosis remains a contentious and widely debated issue (Dickerson, 2011; Grossman, 2013; Knibb et al., 2006; Mahoney et al., 2013; Mendez et al., 2003; Rohrer et al., 2008). In fact, PPA has been described as “…one of the most difficult differential diagnostic challenges faced by the neurologist” (Cummings, 2008, p.361) with no one source of information sufficient to make a diagnosis alone (Wilson et al., 2010). The heterogeneous nature of presentation and symptomatology, sensitivity of clinico-pathological measures, use of inconsistent terminology, and changing classification criteria all contribute to the diagnostic challenge. Like many dementias, the diagnosis and underlying cause of PPA can only be confirmed on autopsy, with obvious implications for treatment and counselling during its clinical course.

Like the language profiles and neuroimaging findings, the pathological correlates of PPA are heterogeneous with wide probabilities and no direct one to one mapping or correspondence between the clinical phenotype and underlying pathology (Gorno-Tempini et al., 2011; Grossman et al., 2013; Mahoney et al., 2013). Still, the semantic and agrammatic variants of PPA have been linked to non-Alzheimer, tau-positive and ubiquitin/TDP43 positive frontotemporal lobar degeneration pathology respectively (Gorno-Tempini et al., 2011). In some cases Alzheimer’s pathology is discovered on autopsy for these clinical variants, representing a source of ongoing debate in the field (Ahmed, de Jager, Haigh, & Garrard, 2012; Grossman et al., 2013). The logopenic variant of PPA is most strongly associated with Alzheimer’s pathology and is thought by some to represent an atypical clinical presentation of Alzheimer’s disease (Ahmed et al., 2012; Harciarek & Kertesz, 2011; Leyton et al., 2011).

Recent research has demonstrated that the root diagnosis of PPA can be made in the very mild stages of disease, even though anecdotal evidence suggests high occurrence of misdiagnosis or dismissal of symptoms at the first medical encounter (Mesulam et al., 2012). It is not unusual for language symptoms to be attributed to stress or depression rather than emerging neurodegenerative disease (Mesulam et al., 2012), which may heighten distress and frustration for the individual and their family. The diagnosis or classification of the PPA variant or subtype is more difficult than the root diagnosis, given the noted heterogeneity and overlap
within and across variants (Mesulam et al., 2012). General principles of brain-behaviour relationships assert that similar patterns of clinical phenomenology can be expressed by different underlying pathology and conversely, the same disease process can manifest in different ways (Tien & Gallo, 1997). As an example, word finding difficulties or anomia is the leading symptom of PPA however represent hallmark features of many different disease states and distinct pathophysiological processes (Hird, Brown, & Kirsner, 2006; Rohrer et al., 2008). This means that the leading symptom of PPA fails to map directly to a causal disease process, posing a diagnostic conundrum when approached from a localization perspective (Rohrer et al., 2008).

Despite these challenges, the quest for enhanced diagnostic precision and identification of biomarkers of disease is of continued and growing importance. This urgency has been intensified by the emergence of disease modifying drugs and pharmacological treatments for dementia, whose development and efficacy rely on accurate diagnosis and understanding of underlying disease processes (Gorno-Tempini et al., 2011; Ralph, Patterson, Graham, Dawson, & Hodges, 2003). This explains why one of the most dominant research questions in the PPA field concerns the differential diagnosis of PPA from other types of dementia, in particular Alzheimer’s disease and the behavioural variant of frontotemporal dementia. Prospective diagnostic research will continue to burgeon rapidly in coming years (Gorno-Tempini et al., 2011) and it is important for clinicians to keep abreast of continuously evolving classification criteria (Knibb et al., 2006). As reliable and sensitive biomarkers of disease are found, the implications for diagnostic precision, counselling and development of medical treatments in the PPA field will be significant.

The need for continued diagnostic research is clearly evident however this should not remain the only dominant line of empirical enquiry in the field. While the search for a biomarker (and cure) continues, there is a pressing need to advance research investigating proactive intervention and support services. This is endorsed by current dementia policy, which has identified the need for timely diagnosis as a pathway to evidence-based dementia services, while ensuring that individuals have the opportunity to plan ahead for their future (WHO,
2012). Timely diagnosis and both the design and translation of efficacious interventions into practice require a strong conceptual understanding of the nature of PPA, including its psychosocial impact beyond the level of diagnosis. The need for richer theoretical debate and new conceptual frameworks to guide clinical management should be seen as a priority for the field.

**Theoretical Conceptualisation of PPA**

To inform the development of new conceptual frameworks of PPA, the next section of this thesis will contrast the more traditional *focal* account of PPA, to two alternative theoretical perspectives. The first is a *distributed networks* account of PPA that has recently emerged in the literature, followed by a novel conceptualisation of the syndrome driven by *dynamic systems theory*. The general assumption is that while the focal classification criteria and discrete clinical profiles that have been elucidated may provide markers or indicators of disease they should not be confused with definitions of the disease themselves (Tien & Gallo, 1997). Such accounts of PPA underestimate the complex nature of language processing and brain-behaviour relationships (Garrard, Maloney, Hodges, & Patterson, 2005). Advances in neuroscience have enabled researchers to visualise, assess and reconstruct large-scale neural networks at various temporal and spatial resolutions allowing well-established theories of language, mind-brain relationships, and patterns of disease to be tested biologically, stimulating the need for more contemporary views of language and related disease states (McIntosh, 2010; Pievani, de Haan, Wu, Seeley, & Frisoni, 2011; Sun, Tong, & Yang, 2012). This highlights the need for methodologies and approaches that capture and explore the integrity of the whole system or the nature of the syndrome and disease expression holistically (Sun et al., 2012). Furthermore, the need for alternative conceptualisations of PPA that consider the nature of impairment beyond the focal level and offer new theoretical frameworks and methodologies for thinking about the canonical syndrome complex are required. This has been acknowledged by the field, with researchers noting that the dynamics of changes in language and non-linguistic abilities in PPA are poorly understood (Etcheverry et al., 2012).
**PPA as a disorder of distributed networks.** In response to the limitations of traditional lesion-deficit approaches to studying language and supported by advances in neuroscience, a conceptualisation of PPA as a “disease of neural networks” (Rohrer et al., 2008, p.30) has emerged in the literature. This distributed account of PPA is concerned with how pathology disrupts connectivity within the language networks of the brain, rather than the integrity of “functionally segregated cortical areas” (Sonty et al., 2007, p.1334). The importance of key centres, such as Broca’s and Wernicke’s areas of language processing is still recognised; however the inter-regional connections that functionally bind the hubs together are of primary interest (Mahoney et al., 2013; Sonty et al., 2007). It has been suggested that disconnection accounts may provide a more accurate explanation for the patterns of language dysfunction associated with PPA and more direct correspondences between pathology, disease severity, and its functional expression (Rohrer et al., 2008; Sonty et al., 2007).

Language processing and expression depend on the recruitment and temporal coordination of multiple, widely distributed cortical and subcortical neuronal systems (Matsumoto et al., 2004; Stowe, Haerkort, & Zwarts, 2005). Regions within the left and right hemispheres and the cerebellum are active during language tasks, highlighting that language processes are complex dynamic behaviours during which diverse cognitive functions cooperate (Stowe et al., 2005). The hubs of the system are viewed as the key functional units (Sporns, 2010), constituting individual neurons, cell assemblies, or brain regions of interest. These specialised modules are known to have neurobiological importance; promoting speed, automaticity and efficiency of language processing (Sporns, 2010; Sun et al., 2012). However, strong connectivity and tight coupling of hubs within the frontal and temporal lobes of the circuitry means that these regions of interest are recruited almost simultaneously and in parallel during language tasks (Pulvermüller, 2005). This tight coupling is supported by both structural and functional connectivity⁹ (Sun et al., 2012), meaning that different parts of the system or

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⁹ Structural connectivity refers to physical connections between neural ensembles or brain regions via axonal fiber tracts (Sporns, 2010); while functional connectivity refers to patterns of dynamic interaction or to regions or nodes within a network that fire simultaneously and are thus functionally connected (Sporns, 2010). It is important to note that functional connectivity does not require a direct ‘structural connection’ between two regions. Distinct language
distributed language networks operate as a mutually inclusive whole. While the individual components of the system operate holistically, they are not bound structurally together, meaning that moment-to-moment changes in functional connectivity can occur. Furthermore, there is natural capacity for compensatory or reorganisation mechanisms to be activated within a distributed system if it is damaged or compromised.

The notion of rich connectivity within the language system provides an explanation for how focal lesions can disrupt a wide range of cognitive and functional abilities (McIntosh, 2010). This means that structurally undamaged areas may fail to operate normally due to the influence of highly connected or influential hubs within a network (Mummery et al., 1999; Sporns, 2010; Stern et al., 2000). This accounts for why performance on discrete language tasks often fails to predict the functional output of distributed brain systems (Mummery et al., 1999) and why whole language syndromes are often far more complex than the sum of damaged parts (Bookeimer, 2002). The critical assumption is that specialised centres or hubs within the network rarely operate alone and that integrated output is critical for natural language (Pievani et al., 2011). In practice, this means that both the regionally specific and distributed effects of PPA should be examined and understood (Mahoney et al., 2013). This cautions against the sole use of focal assessment tasks or methodologies that isolate parts of the system (Garrard et al., 2005). Such measures capture discrete functions at a single point in time, without the presence of competing demands or processing requirements that are typically present within context or during the performance of more complex, integrated tasks.

The complexity of brain connectivity also accounts for the degree of heterogeneity of disease expression that is characteristic across individuals with PPA. Neural network research has demonstrated significant variability between individuals in terms of both structural and functional connectivity (Sporns, 2010). This might reflect different cognitive and language processing styles (Sporns, 2010), as well as the availability of neurocognitive reserve and capacity for reorganisation within an individual’s language networks in response to emerging
pathology. As a result, when sampling language behaviour, the surface symptoms observed will reflect both the primary impact of pathology, as well as secondary responses or compensatory reorganisation mechanisms (Code, 2001; McIntosh, 2010). It is the combined result that determines network integrity and capacity for functional performance. Given the highly adaptive nature of the brain, damaged brain networks may continue to operate at reduced efficiency or alternatively, reorganisation may allow alternative pathways to take over and compensate for loss of normal function (Stern et al., 2000). This further explains why the nature and severity of impairment and functional impact can reach far beyond the “zone of tissue loss” (Rohrer et al., 2008, p.27) with clear implications for clinical assessment and research methodologies.

It has been noted that distributed definitions of PPA are yet to be translated into the clinical realm (Rohrer et al., 2008) with a continued reliance on more focal or discrete approaches to diagnosis and assessment. Sampling network function requires a conscious shift in methodology and measures employed, moving away from focal assessments (e.g. picture naming, repetition, and single-word comprehension) to more complex, natural language tasks that engage distributed language networks and require interaction between hubs of the system. The development and translation of tasks and measures that sample and index distributed network function would bring clinical assessment in line with advances in neuroscience (Hird & Kirsner, 2010), while potentially enhancing diagnostic precision and providing clinical insight into new phenotypes of PPA (Pievani et al., 2011).

While further research is required to translate distributed accounts into practice, it is important to appraise what they can offer holistic clinical management. It is evident that the research investigating PPA from a distributed networks perspective has retained an impairment and localization focus, seeking to identify “white matter tract signatures of PPA syndromes” (Mahoney et al., 2013, p.1687) that may aid the diagnosis of PPA and its variants (Mahoney et al., 2013; Warren, 2013). As a result, while such research is advancing understanding of the pathophysiology of PPA, the critique regarding ecological validity remains. It is not yet clear how well measures of distributed function reflect language abilities during everyday interactions.
or the broader impact of, and adaptation to, progressive language impairment. Furthermore, while notions of functional and causal connectively provide a better explanation for inter-individual variability they have not explicitly considered the intra-individual variability that is expected across moments in time. Research should explore how the distributed network adapts online and with disease progression, and how external and internal factors may influence connectivity and performance. Patterns of decline and adaptation in response to PPA are not expected to take a linear or predicable course, and as such, the severity of impairment is not predicted to reflect the degree of functional or real-life psychosocial impact alone. This requires additional theoretical frameworks or conceptual models to broaden understanding of PPA and its psychosocial impact beyond both the focal and distributed levels of impairment.

A novel approach: **PPA from a dynamic systems perspective.** Dynamic systems theory has been identified as a novel alternative for taking the theoretical conceptualisation of PPA one step further and extending definitions of PPA beyond its pathogenesis alone, to consider the holistic, system-wide consequences of disease. It is assumed that dynamic systems theory can account for the inherent complexity and heterogeneity that characterises PPA and to consider the many intra- and inter-personal factors that can influence both language performance and dissolution across time (De Bot, Lowie, & Verspoor, 2007). It has been stated that dynamic systems accounts of cognitive processes, or disorders such as PPA, can be more biologically plausible and better equipped to deal with advances in contemporary understanding of the brain and human nature more broadly (Lewis, 2005).

According to van Gelder and Port (1995) dynamic relationships exist between the brain, the body, and the environment, with cognitive and language processes spanning all three levels. As such, the language system is embedded or nested within a broader system, with the same dynamic principles operating at every level (De Bot et al., 2007). This is where the current conceptualisations of PPA fall short, retaining a strong focus on the brain and the distributed language networks in isolation, without moving from the ‘inner processes’ to the ‘outer world’. The brain, body, and environment interact and operate as a single unified system, with tight coupling between internal and external processes (van Gelder & Port, 1995). This means that
“cognitive processes and their context unfold continuously and simultaneously in real time” (van Gelder & Port, 1995, p.2). This results in constant evolution and self-reorganisation (De Bot et al., 2007) highlighting the need to consider both the ‘resting states’ of the system, as well as the parameters within context that influence performance over time.

Governed by a dynamic system, individuals rely on preferred behavioural patterns or resting states as a mechanism for maintaining equilibrium and stability within their system (Lewis, 2005). This balance is important for optimal performance across neural, cognitive and behavioural levels, while mediating the psychosocial outcomes or global resting states of the system (e.g. patterns of social engagement and general wellbeing). Preferred or stable behavioural patterns are referred to as attractor states, which the system looks for and depends upon. Significant perturbation within the system is required to alter or change its resting-state (Lewis, 2005) and the emergence of PPA symptomatology is expected to represent a significant source of perturbation. While operating in a turbulent or chaotic state, the system is known to have heightened sensitivity to critical parameters and local effects, which stimulate adaptation and reorganisation processes (De Bot et al., 2007; Lewis, 2005). Phase-shifts can then occur, which may disrupt or alter preferred behavioural patterns (e.g. social engagement) and stimulate the emergence of new resting-states or behaviours (e.g. avoidance or withdrawal). With mounting pathology it is expected that the range of states that the system can occupy will reduce over time, as will the individual’s flexibility to deal with rapid changes in context or task demands. Such patterns of behaviour and performance may provide more accurate markers of disease severity as well as insight into the functional nature of disease expression over time.

From a dynamic system perspective, the impact of PPA is expected to be complex and variable, mediated by a number of interactive, multi-dimensional factors. It is expected that individual systems will respond and adapt in unique ways across different time-scales, with dynamic shifts occurring online during natural language performance, as well as across longer time periods of months to years over the clinical course of PPA. Parameters affecting the trajectory of disease expression include the causal pathology spreading through the language networks of the brain and associated impairments, as well as factors as diverse as an
individual’s subjective response to their symptoms, the nature of the environment or contexts within which they live, and the availability of cognitive reserve or resources supporting performance. Examining patterns of coping and adaptation within natural language and during everyday interactions are of particular interest to the current research, aiming to determine factors and processes that influence functional abilities, patterns of behaviour, as well as the social-emotional outcomes associated with PPA. It is of interest whether positive and proactive phase-shifts and coping strategies are evident and drawn upon spontaneously in response to the emergence of language symptoms or whether therapeutic interventions are required to promote and optimise positive adaptation. A paucity of research has explored these questions in the context of progressive language impairment and there is very little understanding of system function and change beyond the focal and distributed network levels.

**Where to From Here?**

The primary aims of this thesis were to present, apply and evaluate a dynamic systems framework of PPA to advance understanding of the syndrome. It was predicted that widening the lens of enquiry would provide new insights into the nature and impact of language dissolution, while identifying novel targets for therapeutic intervention.

Driven by a dynamic systems account of PPA, the following research questions were under investigation:

1. Is PPA a multi-layered syndrome that manifests beyond focal-linguistic impairment and pervades multiple levels of an individual’s dynamic, self-organising system?
2. Do individuals living with PPA perceive and experience more significant language impairment as compared to healthy ageing controls?
3. Do individuals living with PPA perceive and experience more significant emotional and psychosocial consequences of language symptoms as compared to healthy ageing controls?
(4) Do individuals with PPA adapt to language dissolution in unique ways with a range of internal and external parameters mediating global behavioural and psychosocial outcomes?

If evidence for multi-layered nature and impact of PPA and unique patterns of adaptation and coping emerge from the findings, this would provide preliminary support for the dynamic systems conceptualisation and approach to PPA.

In order to address the research questions two levels of analysis were employed to:

1. Objectively profile and examine the system-wide expression of PPA from a dynamic systems perspective, and
2. Explore subjective-insights into PPA to understand how individuals perceive, respond and adapt to language symptoms.

While two levels of analysis are separated and presented sequentially in chapters five and six of this thesis, they are viewed as overlapping and inter-related, contributing different yet complementary windows into the individual dynamic systems and applied to the same cohort of participants. As such, the findings and patterns to emerge from the two levels of analysis will require integration to address the research questions under investigation.

It is important to emphasise that the aims of this thesis and component analyses are exploratory in nature, representing proof of concept research. A multivariate, case-controls research design is employed to allow the individual system-profiles and personal constructions of disease to be examined in-depth. Furthermore, this allowed commonalities and discrepancies to be explored across the case series. It was expected that rich insights into the research questions would be gained, providing direction for future large-scale research and preliminary practice recommendations. Before detailing the design and methodology of the research a dynamic systems framework of PPA will first be presented that provides the theoretical foundation for the thesis.
Chapter 3

PRESENTING A DYNAMIC SYSTEMS FRAMEWORK FOR PPA

Introduction

A theoretical framework is required to examine the holistic impact of PPA and to unpack the complexity of disease expression for individuals living with and adapting to language dissolution. To inform an integrated, dynamic account of PPA the components of the system of clinical and theoretical interest must first be identified. The selection of ecologically valid and reliable markers of system function is then required to sample the manifestation of disease and to reveal patterns of adjustment and coping across pertinent levels of language function and performance. This chapter presents the conceptual framework that forms the theoretical foundation of this thesis.

Identifying Levels of Impact

The World Health Organization’s *International Classification of Functioning, Disability, and Health* (ICF; WHO, 2001) has emerged as the leading conceptual framework for capturing the holistic impact of disease states on individual biopsychosocial system function. The assessment and treatment of PPA has been discussed in the context of the ICF (Croot, Nickels, Laurence, & Manning, 2009; Nickels, Taylor, & Croot, 2011) and expert opinion in the field has endorsed the pervasive impact of progressive language impairment across domains of life participation and function. Many studies make reference to the devastating nature and impact of PPA for the individual and their family (Dickerson, 2011; Mesulam et al., 2012) however the holistic impact of the syndrome has not been profiled or examined systematically. With the diagnostic focus, most research has concentrated on the *body structure and function* component of the ICF, with the nature of focal impairment well quantified across the variants of PPA (Hillis, Oh, & Ken, 2004; Mesulam et al., 2009; Hillis, Heidler-Gary, Newhart, Chang, Ken, & Bak, 2006; Hodges, Martinos, Woollams, Patterson, & Adlam, 2008; Tyler, Moss, Patterson, & Hodges, 1997; Wilson, Galantucci, Tartaglia, & Gorno-Tempini, 2012). Borrowing from related fields, such as post-stroke aphasia and stuttering, it has been demonstrated that the
severity and nature of discrete impairment fails to predict the life-consequences of language loss or how individuals will react and respond to their communication disorder (Cruice, Hill, Worrall, & Hickson, 2010; Mulcahy, Hennessey, Beilby, & Byrnes, 2008; Ross & Wertz, 2002). This highlights that the expression and global impact of disease is complex and multifactorial, requiring investigation across all levels of the system to examine unique patterns of loss, strength and adaptation.

Multi-dimensional, biopsychosocial frameworks have now been developed to understand the complexity of a range of disorders, from stuttering, to pain and cancer (Ezrati-Vinacour & Levin, 2004; McGuire, 1992; Wool & Mor, 2005; Yaruss & Quesal, 2004). Given that heterogeneity is a recognised feature of PPA it seems valid to assume that the syndrome will be best understood from a broad-based framework or multi-dimensional perspective. While the presenting symptoms may be language-based, their impact is likely to reach far beyond the linguistic impairment to other aspects of function and life participation. Furthermore, it is expected that non-disease factors will mediate and influence the broader experience and psychosocial impact of PPA, as well as an individual’s capacity to adapt and cope with emerging symptoms and consequent life changes.

A limitation of the ICF conceptual framework is that it remains a box-and-arrow model that facilitates static description and profiling of an individual’s biopsychosocial system. As such, it is not informed directly by dynamic systems theory. The connections between components of the ICF are bidirectional and non-linear; however a dynamic systems perspective would require a step further to examine and consider the complex interactions, and the mediating role of internal and external parameters and feedback loops more explicitly. A dynamic account would further consider the biological nature of the system and the ebbs and flow in performance and behavioural outcomes over time.

**Dynamic Systems Framework of PPA.** A dynamic systems framework has not yet been proposed for dementia or PPA. Adapting from the motor speech disorders field one established intervention, Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT, 2003; Hayden, 2006), aligns with the tenets of dynamic systems theory (Hayden, 2006; Ward,
2012) and has been chosen as a starting point for developing a new conceptual framework for PPA. The PROMPT model addresses communication holistically, “including how the physical-sensory, cognitive-linguistic and emotional-social domains develop and interact in normally developing humans” (Hayden, 2006, p.265). The components of system function are viewed as integrated and co-dependent, with interactions within and across components determining functional communication abilities. Due to this interactive nature, addressing or treating impairment within one component of the system requires dynamic re-integration and re-structuring, as opposed to treating single domains or parts of the system in isolation (Hayden, 2006). Furthermore, the model highlights that improvements in function can also be brought about through provision of environmental supports, embracing the embedded nature of intra-personal functions within the environment and social context (Hayden, 2006).

As a result, the PROMPT conceptual model provides a systematic framework for the clinician to examine different aspects of performance, while explicitly considering the dynamic interactions within and across components and the role of internal and external influences. Such a model moves beyond the static, descriptive nature of the ICF, to more critical examination of interactions within the system that influence and determine global behavioural and psychosocial outcomes. Within this framework, the ultimate goal of PROMPT therapy is to promote a state of equilibrium or balance within the system, at the highest level attainable for an individual client (Hayden, 2006). This is achieved through refining components of the system or targeting abnormal attractor states, enhancing interactions and efficient integration of function across components, while building in external or exogenous supports (Hayden, 2006).

The dynamic systems framework adapted for the current study, defines PPA as a complex, multi-layered and variable syndrome, with individual patterns of impairment and adaptation determined by the interplay between a range of intra-personal, inter-personal and environmental factors. Within the person, the impact of emerging pathology on cognitive, linguistic and social-emotional functions is of interest. While intra-personal components of the system are differentiated, the framework represents one integrated or interdependent system. Inter-personal and environmental factors of interest include context and task demands, available
supports and resources, and the nature of family systems. The global behavioural and psychosocial outcomes in response to progressive language impairment are of primary interest and are viewed as emergent, self-organising properties of system-wide interactions. Patterns of performance, subjective-insights, and interactions within and across components of the system will be examined and interpreted to reflect an individual’s functional abilities, resilience, and levels of coping in response to PPA. The framework assumes that multiple permutations and interactions are possible, predicting variability and heterogeneity of disease expression and individual reactions. The framework is presented in Figure 3.1 and described below.

Intra-personal domain. The framework profiles aspects of cognitive, linguistic, and social-emotional function and their interactions, underpinning behavioural and psychosocial outcomes. The measures selected for this research will provide insight into the functioning of focal hubs as well as distributed circuitry within the system, to examine patterns of performance and influencing personal factors within and across individuals.
Cognitive. The cognitive component will assess general cognitive functions, such as memory, attention, executive functions, and perceptual abilities that are known to interact closely with linguistic functions to support natural language and communication. The examination of cognitive abilities also considers an individual’s level of awareness or insight, and cognitive reserve or capacity available to support adaptation and compensatory adjustments within the system. Based upon focal definitions of PPA, the syndrome is characterised by relative strengths within the cognitive component for a period of at least two years (Mesulam, 2001). Unlike Alzheimer’s disease, episodic memory remains a reported strength well into the disease course, and insight and awareness of difficulties are characteristically preserved in the early stages of PPA (Banks & Weintraub, 2008a). Cognitive strengths are expected to interact positively with emerging language difficulties, promoting strategic competence and cognitive capacity, to solve problems and adapt to symptoms, at least in the early stages of PPA. Negative interactions however may also emerge, with acute awareness mediating heightened focus on impairments, as well as anxiety, reduced self-esteem and other negative social-emotional reactions (Medina, 2009). Hyper vigilant monitoring and a heightened focus on error have been demonstrated during natural language tasks in previous PPA research (Hird, Brown, & Kirsner, 2006) with implications for resource allocation, communicative efficiency and self-efficacy to achieve functional communication goals.

Cognitive reserve is important in the context of progressive neurological disease where compensatory shifts and reorganisation naturally occur in response to emerging pathology. Neuroimaging studies have found increased pre-frontal activation in individuals with early Alzheimer’s disease while performing cognitive tasks (Grady, McIntosh, Beig, Keightley, Burian, & Black, 2003). This circuitry is recruited to support more complex cognitive functioning (Cabeza, Anderson, Locantore, & McIntosh, 2002), and increased bilateral recruitment of the prefrontal circuitry has been correlated with enhanced performance on both semantic and episodic memory tasks (Grady et al., 2003). This suggests the presence of compensatory circuitry and recruitment of additional cognitive resources to bolster cognitive function in response to emerging cognitive decline (Grady et al., 2003). This natural adaptation...
appears to be a fluid, self-organising response within the system, demonstrating a window of heightened plasticity or reorganisation that could be harnessed and strengthened by targeted interventions. Higher levels of strategic competence at the cognitive level are expected to support behavioural and psychosocial outcomes.

In the later stages of PPA, pathology is known to spread beyond the distributed language circuitry to invade other areas of function (Mesulam et al., 2012; Rogalski & Mesulam, 2009). A large body of research has profiled the cognitive strengths and weaknesses across the disease trajectory, although systematic longitudinal studies are limited (Hsieh, Hodges, Leyton, & Mioshi, 2012). Within the conceptual framework, assessment tasks and measures will be identified that assess component cognitive functions (i.e. focal tasks and measures), while also sampling interactions between cognitive and linguistic functions (i.e. natural language or linguistic performance tasks). This will profile patterns of relative strength and weakness within and across individuals, while seeking evidence for strategic competence and adaptation.

**Linguistic.** The second intra-personal component of the model assesses the primary locus of breakdown associated with PPA, assessing and profiling an individual’s language abilities within a theoretically driven paradigm. The proposed framework is interested in (1) language competence, and more importantly for a dynamic conceptualisation of PPA, (2) language performance within context. Language competence involves a speaker’s internalised and tacit knowledge of language and their discrete linguistic abilities (Chomsky, 1965), while performance considers the actual ‘use’ of language in real time and physical space (Port & Leary, 2005). As such, competence based tasks and measures tap into the function of specialised nodes or hubs within the language system (discrete linguistic functions), while performance based tasks and measures may better reflect the integrity of distributed networks (functional integration) within the language system.

The linguistic competence of individuals with PPA has been extensively documented, particularly for the agrammatic and semantic variants. To test the integrity of linguistic processes, researchers have drawn upon a range of modular assessment tasks (e.g. Pyramids and
Palms Trees; Howard & Patterson, 1992); standardised language batteries (e.g. Western Aphasia Battery; Kertesz, 2006); and linguistic measures of connected speech or spoken discourse (e.g. grammatical complexity, lexical counts, speech sound errors). The dissociable linguistic characteristics have been quantified across variants of PPA in terms of word production (Croot, Patterson, & Hodges, 1998; Hillis et al., 2004; Mesulam et al., 2009) and comprehension (Hillis et al., 2006; Hodges et al., 2008), semantic processing (Tyler et al., 1997), phonological processes (Henry, Beeson, Alexander, & Rapcsak, 2012; Patterson, Graham, & Hodges, 1994; Southwood & Chatterjee, 1998), syntactic skills (Thompson et al., 2012; Tyler et al., 1997; Wilson et al., 2012), and other discrete processes. This enables the formulation of specific hypotheses or expected patterns of linguistic function across the PPA subtypes according to classification criteria. These hypotheses need to be tested in relation to individual clients, given that heterogeneity of disease expression is well documented and of primary interest to the current study.

Conversely, the language performance of individuals with PPA has not been as well documented or described, although the field has witnessed a growing interest in the connected speech of individuals with PPA (Gorno-Tempini et al., 2011; Rogers & Alarcon, 1998; Rohrer et al., 2008; Sajjadi et al., 2012; Wilson et al., 2010). In fact, Rohrer and colleagues (2008) have asserted that the “systematic analysis of an extended sample of the patient’s spontaneous speech is the single most valuable aspect of the examination” (Rohrer et al., 2008, p.14). However, much of the connected speech research has retained a diagnostic and discrete, localization focus. This research has further elucidated the dissociable patterns of linguistic competence that characterise PPA and its subtypes; however provides limited insight into natural language performance and capacity at different stages of disease. To move beyond the focal level, toward more performance based measures natural language sampling techniques must be combined with distributed measures that capture the interaction between cognitive, linguistic and pragmatic functions, and as a result, the integration of several brain networks (Hird & Kirsner, 2010; Sajjadi et al., 2012; Stern et al., 2000). Measures of communicative efficiency and effectiveness may provide more sensitive, ecologically valid and functional markers of system
function than discrete linguistic measures, such as lexical content or syntactic complexity (Hird et al., 2006). The efficiency of communication may predict success in a social setting or real-life scenario more reliably than one’s ability to find or repeat words alone. As such, further research is needed into the distributed language performance associated with PPA, moving beyond isolated or controlled sampling of language behaviour.

**Social-Emotional.** The social-emotional component considers the (1) direct, and (2) indirect impact of disease pathology on social-emotional functions, as well as the (3) personal factors unique to an individual and unrelated to the disease process itself that mediate disease expression. Given that language is ubiquitous to the interaction and socialisation that takes place during everyday life, individuals with PPA are expected to have profound and unique areas of care need within this component of the system. In the stroke literature, the relationship between language impairment and mood disturbance has been demonstrated, with the presence of aphasia associated with higher occurrence of depression (Astrom, Adolfson, & Asplund, 1993). Furthermore, the emotional impact of aphasia is known to negatively impact recovery, long term QOL outcomes and psychosocial adjustment following stroke (Code, Hemsley, & Herrmann, 1999; Code, 2001; King, 1996) and as such is worthy of further investigation in relation to PPA.

In regard to the direct impact of PPA on social-emotional functions, it is well documented that the syndrome is not associated with changes in comportment, personality or behaviour as presenting or early features of the disease, which differentiates the syndrome from the behavioural variant of frontotemporal dementia (Marczinski, Davidson, & Kertesz, 2004). With disease progression and spreading of pathology, frontal-executive signs and symptoms can emerge in the later stages. Furthermore, while preliminary research has demonstrated a high occurrence of depression symptoms associated with PPA, it is believed that the psychological distress develops as a reactionary response to emerging symptoms, rather than a direct consequence of the disease process itself (Medina, 2009). This has been linked to the high levels of awareness and insight that are characteristic of PPA, at least in the early stages of disease (Medina, 2009). This has been reported in other types of dementia, for example Alzheimer’s
disease, where the occurrence of depressed mood is more prevalent in the early stages while the person is more aware of the cognitive changes occurring (Arkin & Mahendra, 2001).

The indirect impact of PPA on social-emotional functions has received scant attention, even though the emergence of PPA affects all aspects of an individual’s life that are dependent on language. A retrospective study has provided preliminary evidence for the psychological impact of PPA comparing the prevalence of depression symptoms in 61 people with PPA to a healthy control sample (Medina & Weintraub, 2007). The Geriatric Depression Scale (GDS) was the screening instrument used to determine the presence of depression. Normative data are available for this tool with a score of 10 or greater indicating that a person is significantly depressed. The study found that more individuals with PPA ($n = 21$, 34.4%) had GDS scores within the depressed range as compared to the control group ($n = 1$, 1.8%). While the PPA group was not depressed overall, their GDS scores were significantly lower and the participants with PPA endorsed a greater number of depression symptoms. Further analysis indicated that items relating to lack of mental and physical energy and social withdrawal were endorsed most frequently, with 39% of the participants with PPA avoiding social gatherings and 32% preferring to stay at home. Conversely a smaller proportion of participants endorsed items relating to agitation and restlessness (25%), sad mood or pessimistic outlook (25%), or absence of positive mood or optimism (15%). Subsequent research by Medina (2009) indicated that PPA is also associated with increased feelings of worry and frustration in response to language difficulties, suggesting that a large proportion of people with PPA experience sub-clinical depression.

While the research of Medina and colleagues (2007, 2009) has provided valid and reliable insight into the prevalence of depression symptoms in a sample of individuals with PPA, the results do not allow in depth examination of this psychosocial impact. Severity of naming difficulties and previous history of depression were identified as factors influencing the presence of depression in PPA (Medina, 2007) however it is expected that other internal and external factors will play a role in mediating social-emotional outcomes. Further prospective research is required to substantiate and build on these findings. In particular, the subjective
experience and insights of individuals living with the syndrome should be examined, providing a rich source of information. A multi-faceted approach to studying the social-emotional impact of PPA has been recommended, while cautioning against the use of proxy or caregiver measures when assessing depression or mood state (Medina, 2009). Furthermore, this investigation should move beyond mood state and the presence of depression alone, to explore the impact of PPA on communicative confidence or self-efficacy, overall QOL and patterns of social engagement and life participation.

Drawing upon the ICF framework, personal factors of interest may include an individual’s personality traits, culture, background and life experiences, their educational level, and coping style (WHO, 2001). While personal factors are independent to the health condition, they are predicted to have a significant impact on an individual’s reaction and response to PPA and general-capacity to adapt effectively in response to challenging life situations. For example, in both the post-stroke aphasia and dementia literature, it has been documented that individuals with more optimistic outlooks react in more positive and proactive ways to their impairment and disability as compared to those individuals with more pessimistic or anxious personality styles (Clare, 2002; Fromm et al., 2011; Hemsley & Code, 1996). Similarly, in the case of stuttering, protective factors such as self-efficacy, social support and ‘hardy’ personalities can ameliorate the severity of stuttering impact and bolster psychosocial outcomes (Mulcahy et al., 2008). As a result, such intra-personal factors may have significant influence on disease expression, shaping behavioural and psychosocial outcomes.

**Inter-personal and environmental factors.** The notion of embodied functions is important within a dynamic systems framework, considering the embedded nature of cognitive and linguistic processes within a broader environmental, social and inter-personal context. The environmental domain of the framework enables consideration of the interactions between intra- and inter-personal factors. For example, this considers the influence of factors from outside the person, such as external feedback, task and contextual demands, and available supports on language performance and both behavioural and psychosocial outcomes across time.
Factors that affect the state of the system are known as *parameters* (van Gelder & Port, 1995), with potential to directly influence behavioural patterns, stimulate phase-shifts, and reorganisation within the system. While modularity argues that discrete processors or hubs within the language system operate in an encapsulated and mandatory fashion, protected from external influences, it is known that integrated and controlled functions that drive speech production processes, such as planning, conceptualisation and self-monitoring functions, are resource dependent and sensitive to internal and external factors (e.g. fatigue, cognitive load, contextual demands, motivational and attentional state; Levelt, 1989; Murray, 1999). In aphasia research it is known that external factors such as the familiarity of information, time pressure, familiarity of the conversational partner, and background noise or distraction are all factors that can influence language performance (McNeil, Odell, & Tseng, 1991; Murray, 1999). The factors that influence natural language performance of individuals with PPA have not been systematically explored, however it is predicted that similar parameters of interest will emerge. It is also expected that individuals with PPA will be aware of different task or environmental constraints that either facilitate or hinder their language performance and adaptive mechanisms, given the preserved insight that characterises the syndrome. This will be of interest for the design of therapeutic interventions and for considering the role of environmental and inter-personal supports to optimise behavioural and psychosocial outcomes.

**Global behavioural and psychosocial outcomes.** The intra- and inter-personal elements of the system discussed above were dissected and considered in isolation. The global behavioural and psychosocial outcomes are however of primary interest. This reflects the interactions between the cognitive, linguistic and social-emotional components, further influenced by inter-personal and environmental factors. This will be determined by interpreting patterns of performance on component measures in light of an individual’s subjective experience of living with PPA. This will examine functional disease expression and an individual’s capacity to maintain or re-establish stability in response to the onset of progressive language impairment. A well-functioning system must be able to move fluidly through space and time, making adjustments in response to changing internal and external circumstances
(Lewis, 2005). Some variability and perturbation is healthy within a functioning system that has capacity to deal with unexpected change. However, adaptive processes and coping strategies have not been studied systematically in the PPA field. Behavioural and psychosocial outcomes will reflect an embodied aggregate of the individual system components and mediating parameters, providing global insight into the nature of coping and adaptation in response to PPA.

Behavioural outcomes of interest will include consequences like social withdrawal or avoidance of language use, representing negative coping strategies that may emerge in response to PPA. Withdrawal from social interactions has been documented as a negative reaction following the diagnosis of Alzheimer’s disease or dementia and has highlighted the need for timely diagnosis and proactive interventions (Alzheimer’s Disease International, 2011; Leifer, 2003). Withdrawal may prevent opportunities for natural reorganisation and compensation to take place within the distributed language circuitry and may lead to the development of less appealing attractor states that may become difficult to shift the longer they are practised and relied upon. Patterns of withdrawal may also restrict opportunities for language use and stimulation, which may hasten the rate of language decline. It has been noted in the second language acquisition literature that lack of language use results in general deactivation of language circuitry, which may lead to ‘switching off’ of elements within the system if a certain critical threshold is reached (De Bot et al., 2007). It is not yet clear how patterns of avoidance could interact with PPA pathology, but is of theoretical and clinical interest. Within the dynamic framework such behavioural outcomes will be identified and examined to determine the underlying factors that may exacerbate or protect against such negative adaptation.

Studying the social emotional and global impact of PPA in terms of QOL and psychological wellbeing is also important for advancing understanding of the syndrome. QOL is a multi-domain concept that is broad enough to explore the different aspects of an individual’s experience of living with a disorder, such as stuttering, aphasia or PPA (Yaruss, 2010). According to Yaruss (2010) definitions of QOL typically encompass constructs that relate to an individual’s satisfaction with their life overall or their sense of general wellbeing. Typically,
QOL assessments are multi-dimensional, measuring different aspects of an individual’s life (e.g. physical health, emotional and mental wellbeing, social function and relationships, ability to fulfil vocational and other life roles, financial wellbeing, and living situation). There are no disorder-specific instruments for measuring the QOL of people with PPA; however tools do exist within the broader dementia and post-stroke aphasia fields that may be of relevance.

In summary, the global impact of neurological disease is not viewed as static or stable, but rather a dynamic, fluid and embodied phenomenon. Systematic research in the Alzheimer’s field has shown that individuals with early-stage dementia pass through a number of different phases following the onset of symptoms and that each individual journey is unique (Steeman, De Casterle, Godderis, & Grypdonck, 2006). Understanding the pressing life-needs of individuals living with progressive language impairment is critical for clinical management and the development of an integrated theory of PPA has been identified as a priority for the field. While complexity and heterogeneity are expected, emergent system-profiles driven by dynamic systems theory are predicted to capture the severity of disease and its holistic impact more accurately than the function of isolated system components.

**Applying and Testing the Dynamic Systems Framework of PPA**

In presenting the dynamic systems framework of PPA in this chapter a number of opportunities for extending the current knowledge base have been identified. It is clear that the holistic, system-wide expression of PPA has not been well studied to date and factors that mediate the functional consequences of the syndrome are poorly understood. Furthermore, while PPA is associated with symptoms of depression (Medina, 2009), the psychosocial impact of language dissolution and personal constructions of disease have not been examined in-depth. This strengthens the justification for the research questions posed in chapter two and the need to study PPA from a wide-lens perspective.

As such, this research will apply and test the dynamic systems framework of PPA on a small number of cases seeking preliminary support for its research and clinical value, while providing direction for future large-scale studies. Drawing upon the dynamic systems framework of PPA it is predicted that:
1. The expression of PPA will be multi-layered with significant performance decrements spanning the cognitive, linguistic, and social-emotional components of the system and differentiating the individuals with PPA from the healthy control group.

2. Adaptation to PPA will vary across individuals living with the syndrome, mediated by unique coping styles and a range of internal and external parameters that extend beyond the severity of impairment or the nature of language symptoms alone.

Support for these predictions would provide justification for a dynamic systems account of PPA. This would demonstrate that disease expression is mediated by a range of intra- and interpersonal factors that should be examined and unpacked on an individual basis in both research and clinical contexts. By revealing the system-wide phenomenology of PPA the need to broaden the lens of empirical enquiry will be supported. To test the above predictions a theoretically driven approach to research design and methodology is required, which will be outlined in the next chapter. The two levels of analysis will then be presented and discussed in chapters five and six. The final chapter will return to the dynamic systems framework of PPA, summarising the key findings of the research and integrating the results within the conceptual model. Preliminary recommendations for clinical practice and service pathways will also be identified and discussed.
Chapter 4

GENERAL METHODOLOGY

Overview

This chapter provides the general methodology of the thesis. The research design of the study is presented, the study participants and recruitment strategy outlined, and the details of the materials and procedures employed described. Further information about specific procedures and methods will be provided in subsequent chapters in relation to the two levels of analysis.

Research Design

The research adopts a theoretically driven case-controls design to apply and test the dynamic systems framework of PPA, while enabling rich, in-depth examination of the individual system-profiles and subjective-insights of a single participant cohort (PPA and controls). The case-controls design is justified and instrumental for achieving the exploratory aims of this thesis, testing the theoretical framework and methodological approach on a small number of cases to inform future large-scale research. The imperative for single subject research in the cognitive neuropsychology field is well established for complex, heterogeneous cases or problems (Caramazza, 1986; Caramazza & McCloskey, 1988) and where unique patterns of individual performance are of primary interest (Hemsley & Code, 1996). Furthermore, the value of multivariate case-series research has recently been demonstrated in the PPA field for understanding the dynamics or multi-causal basis of individual system-profiles and for planning tailored interventions (Etcheverry et al., 2012).

Research design: Analysis one. The first level of analysis aimed to objectively profile the holistic expression of disease, applying and evaluating a dynamic systems approach to clinical profiling. As such, assessment tools and measures were selected to align with components of the model and to allow sampling of system-wide function and performance (i.e. cognitive, linguistic, social-emotional). The statistical solutions of Crawford and Howell (1998) were used to test the null hypothesis that each participant with PPA represents an observation from a sample of healthy ageing controls. If an individual’s performance falls sufficiently
outside that of the control sample, then the null hypothesis of no difference can be rejected (Crawford, Garthwaite, & Howell, 2009). An advantage of the method is that the \( p \)-value provides an optimal point estimate score, representing the “level of abnormality of a patient’s score” (Crawford et al., 2009, p.2693) or the proportion of the control sample likely to obtain a lower score. An effect-size estimate (\( z_{cc} \)), equivalent to Cohen’s \( d \), provides “an estimate of the average difference, measured in standard deviation units so as to be scale independent, between a case’s score and the score of a randomly chosen member of the control population” (Crawford, Garthwaite, & Porter, 2010, p.246). The index is scale-independent and provides a more robust means of profiling the relative strengths and weaknesses of individual cases across a number of different measures, expressing performance on a common metric (Crawford et al., 2010). The effect size values were used to provide an overall index of severity of impact within and across components of the system for each individual with PPA.

**Research design: Analysis two.** In the second level of analysis the subjective-insights of the participants are sampled and examined to explore individual perceptions of and reactions to language dissolution, as well as the global functional and psychosocial consequences of PPA. The research approach is again quantitative and focused on the unique experiences or subjective-insights of the individual participants with PPA. The interview transcripts were analysed using Leximancer\textsuperscript{TM} (2011) text-analytics software, a text-mining system that performs sophisticated concept analysis. This analytical approach was used to quantify the most significant concepts and themes to emerge from the transcripts, providing an objective platform to compare the experiences of the participants with PPA to the healthy ageing control sample.

Across both levels of analysis, patterns of performance within and across participants were of interest, looking for commonalities and/or discrepancies. This aimed to identify unique interactions within the system and parameters of interest that mediate individual system-profiles and global outcomes. Identifying the nature and impact of disease expression from a functional perspective was of primary interest, investigating the individual participant’s potential for adaptation and proactive coping in response to PPA. The findings will support the generation of
hypotheses to direct future research and enable preliminary practice recommendations to be presented and discussed.

Participants

Eight individuals with PPA entered the first examination. Three of these individuals were subsequently excluded from the study as they did not meet the inclusion criteria for participation. One of these cases was in the late stages of PPA, living in a residential aged care facility and the severity of language impairment precluded participation in the study. The two other cases presented with a motoric-based speech disorder characteristic of progressive anarthria and/or apraxia of speech, without prominent or primary language symptoms. Thus, five participants with a clear history of progressive language impairment were enrolled in the study and included in this thesis.

The five participants with a history of progressive language impairment were recruited to the study from private neurologists and speech-language pathologists working in the Perth metropolitan area. Participants ranged in age from 75 to 82 years, with one female and four males. All participants were living in their own homes with their spouse in the community in private dwellings or within lifestyle villages. The demographic details of each case are summarised in Table 4.1. All cases have been given a participant code (i.e. T1 to T5) for ease of reference noting that all information provided has been de identified.

The five participants met the following inclusion criteria: (1) history of progressive language decline that could not be explained by stroke or other neurological or medical conditions, (2) working diagnosis of PPA, PPA variant (i.e. PPA-S, PPA-G, PPA-L, PPA-M), and/or dementia of Alzheimer’s type with primary language symptoms, (3) seen by a neurologist or physician for diagnostic evaluation prior to enrolment in the study, (4) within the early to moderate stages of dementia as determined by their treating specialist, and (5) deemed able to give informed consent as determined by the treating or referring specialist.

A sample of 14 healthy ageing controls was recruited to the study to act as a comparison group. Inclusion criteria for the control sample included: (1) no history of alcoholism or drug abuse, (2) no history of neurological illness (e.g. Parkinson’s disease, stroke, TIA), (3) no
history of major depression. Control participants were recruited on a voluntary basis circulating the study information sheet and flyer via local organisations, community groups and lifestyle villages. Control participants were required to contact the researcher directly to register their interest in taking part in the study.

Participation in the study was voluntary with ethics approval received from human research ethics committees at the University of Western Australia and Graylands Selby Lemnos and Special Care Services. All participants were able to give written informed consent as a requirement of the study inclusion criteria, prior to enrolment.

**Recruitment Strategy**

The recruitment strategy initially targeted the Neurosciences Unit (North Metropolitan Health Service) in Perth, Western Australia. This is a state-wide specialist service that provides diagnostic workup and multidisciplinary management for adults under the age of 65 with progressive neurological complaints. Research staff at the unit screened their database for potential candidates however only two patients met the study inclusion criteria and were invited to participate in the study. As a result, the recruitment strategy was broadened to private neurologists and speech language-pathologists working in the related field. An information flyer about the study was sent to a number of neurologists and information provided to speech-language pathologists via the researcher’s clinical networks.

Recruitment to the study was challenging, particularly finding participants in the early stages of PPA. This is a well-documented problem within the PPA literature. Given the low prevalence rate of PPA, large samples are hard to acquire (Etcheverry et al., 2012). In the context of the current study, this was further challenged by the diagnostic and care pathways for PPA in Western Australia that are fragmented and poorly coordinated. It is expected that a higher number of individuals would be living with PPA in the community that have not yet been diagnosed or picked up by a specialist health service. Despite the challenges to recruitment and the selection of participants this was not seen as a deterrent to the current thesis given that the value of systematic case-series research has been demonstrated in PPA and related fields.
(Etcheverry et al., 2012; Hemsley & Code, 1996). A flowchart showing the recruitment process and what participation involved is provided in Figure 4.1.

**Figure 4.1.** Flowchart illustration of participation procedures for the participants with PPA and the healthy-ageing control group.

**PPA Case Presentation**

Given the case-controls design of the current research and the focus on in-depth inquiry of individual cases, a clear demographic overview of each participant is provided below. This background information was collected during the semi-structured case-history interviews. Table 4.1 provides a summary of demographic information, followed by a descriptive introduction to each of the five participants with PPA.
**Table 4.1**

Demographic Details of Participants with Primary Progressive Aphasia

<table>
<thead>
<tr>
<th>Case</th>
<th>Participant</th>
<th>Age</th>
<th>Sex</th>
<th>Education</th>
<th>Diagnosis</th>
<th>Marital Status</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T1</td>
<td>75</td>
<td>M</td>
<td>22</td>
<td>PPA / non-fluent</td>
<td>Married</td>
<td>Medical practitioner</td>
</tr>
<tr>
<td>2</td>
<td>T2</td>
<td>77</td>
<td>F</td>
<td>8</td>
<td>PPA / non-fluent</td>
<td>Married</td>
<td>Office worker</td>
</tr>
<tr>
<td>3</td>
<td>T3</td>
<td>82</td>
<td>M</td>
<td>7</td>
<td>PPA / Semantic variant</td>
<td>Married</td>
<td>Foreman</td>
</tr>
<tr>
<td>4</td>
<td>T4</td>
<td>75</td>
<td>M</td>
<td>12</td>
<td>PPA / Semantic variant</td>
<td>Married</td>
<td>Accountant</td>
</tr>
<tr>
<td>5</td>
<td>T5</td>
<td>79</td>
<td>M</td>
<td>10</td>
<td>PPA</td>
<td>Married</td>
<td>Manager</td>
</tr>
</tbody>
</table>

**Note.** Age measured in years, age at initial interview & assessment. Ed. total number of years of education, including primary, secondary, and tertiary education.

**T1.** The first participant enrolled into the study was T1, a 75-year-old medical practitioner. He was right handed, married and lived at home independently with his wife. T1 had completed 22 years of education and described a successful professional career. He had noticed the onset of word finding difficulty and trouble "formulating words" approximately 12 to 18 months earlier. He met the diagnostic criteria for PPA with progressive language loss presenting as his primary complaint, remaining independent in activities of daily living with no reports of episodic memory problems. He continued to drive, complete domestic duties, and manage household finances. He presented with early stage PPA and his language complaints were predominantly expressive in nature with strong receptive language skills.

**T2.** T2 was a 77-year-old lady who was referred for neurological investigation following a two-year history of slowly evolving language difficulty, with reported inability to speak, type, or use the telephone. Her memory was reportedly unchanged and she continued to manage the household finances and weekly budget. She remained independent in all self-care tasks and lived at home with her supportive husband. She had ceased driving two years earlier when her symptoms emerged; however continued to complete domestic duties such as washing, gardening and ironing. Following comprehensive neurological investigation and imaging, she was diagnosed with frontotemporal dementia and progressive non-fluent aphasia. Following this neurological investigation T2 had been referred to a private speech-language pathologist, who invited her to join the study prior to commencing assessment or intervention. T2 reported seven
years of formal education and then attended Business College. She worked as a secretary for two to three years until marrying her husband and starting a family. T2 presented with a marked expressive aphasia, with strong receptive language skills. There were no reports or signs of behavioural or personality change.

**T3.** T3 was an 82-year-old gentleman with a working diagnosis of PPA (semantic variant). He first presented to his Physician following a 12-month history of worsening language decline. He was initially diagnosed with anxiety however T3 continued to pursue medical investigations, certain that something was wrong. He remained independent in all activities of daily living, continuing to drive, run errands, prepare breakfast, use the microwave, and self-care independently. His primary difficulties related to language rather than episodic memory. Gradual withdrawal from social events, including his golf club, was reported as a result of increasing difficulty telling stories and finding words. T3 indicated that he had received very limited formal education, leaving school when he was 13 years of age. He went on to work as a foreman on the docks until his retirement. He lived with his wife and had the additional support of two children and four grandchildren.

**T4.** T4 was 75 years old when he enrolled in the study. He had presented to his medical specialist with a reported history of expressive language difficulties, with preserved memory and ability to self-care. Following thorough investigation, a diagnosis of PPA or atypical Alzheimer’s disease was made with referral for further neuropsychological and speech and language assessment. At time of enrolment to the study, T4 had been experiencing progressive language difficulties for approximately five years. These were reported to be predominantly expressive in nature; however were progressing to a more global language disorder, with comprehension difficulties worsening over the preceding six months. He indicated awareness of his language difficulties, with significant associated distress and frustration, confirmed by his wife. He was described as a workaholic who had managed his own accountancy practice for many years. Difficulties managing numbers emerged with his expressive language difficulties, representing a dramatic change in his pre-morbid abilities. He had 12 years of education and was described by his wife as previously social and outgoing.
T5. T5 was a 79-year-old gentleman with a four-year history of progressive speech decline, characterised by constant word finding difficulties and trouble initiating speech. He frequently looked to his wife for language support, with reduced participation in conversation and social interactions. Similar difficulties were reported in the written modality, with decline in spelling and legibility of writing. He was still involved in managing the household finances and weekly budget and was independent with self-care. His wife indicated that his level of motivation and drive to complete chores around the house, walk to the shops, and maintain social contact with friends was declining. He reportedly still enjoyed reading the newspaper and checking his lotto numbers. He had become much more passive in conversation, despite previously holding the floor, with a more outgoing personality style. T5 had been referred to a Neurologist and following investigation a working diagnosis of PPA had been made.

Control Case Presentation

Five male and nine female healthy ageing control participants were recruited to the study, ranging in age from 69 to 87 years of age ($M = 76.57, SD = 6.03$). Years of education ranged from eight to 26 years ($M = 13.71, SD = 4.83$). All of the control participants lived in their own home or within a lifestyle village maintaining independence in activities of daily living. Five of the control participants were widowed and lived alone, with the other nine married and living at home with their spouse. The demographic details of the 14 control participants are summarised in Table 4.2.
Table 4.2

Demographic Details of Control Participants

<table>
<thead>
<tr>
<th>Case</th>
<th>Participant</th>
<th>Age\textsuperscript{a}</th>
<th>Sex</th>
<th>Ed.\textsuperscript{b}</th>
<th>Marital Status</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C1</td>
<td>87</td>
<td>F</td>
<td>8</td>
<td>Widowed</td>
<td>Shop assistant / Air force nurse</td>
</tr>
<tr>
<td>2</td>
<td>C2</td>
<td>77</td>
<td>F</td>
<td>13</td>
<td>Widowed</td>
<td>Teacher</td>
</tr>
<tr>
<td>3</td>
<td>C3</td>
<td>72</td>
<td>F</td>
<td>8</td>
<td>Married</td>
<td>Milliner</td>
</tr>
<tr>
<td>4</td>
<td>C4</td>
<td>73</td>
<td>M</td>
<td>8</td>
<td>Married</td>
<td>Butcher / Taxi driver</td>
</tr>
<tr>
<td>5</td>
<td>C5</td>
<td>70</td>
<td>F</td>
<td>26</td>
<td>Married</td>
<td>Nurse</td>
</tr>
<tr>
<td>6</td>
<td>C6</td>
<td>71</td>
<td>M</td>
<td>15</td>
<td>Married</td>
<td>Builder / Administration</td>
</tr>
<tr>
<td>7</td>
<td>C7</td>
<td>78</td>
<td>F</td>
<td>12</td>
<td>Widowed</td>
<td>Nurse</td>
</tr>
<tr>
<td>8</td>
<td>C8</td>
<td>81</td>
<td>F</td>
<td>17</td>
<td>Widowed</td>
<td>Teacher / Principal</td>
</tr>
<tr>
<td>9</td>
<td>C9</td>
<td>78</td>
<td>M</td>
<td>18</td>
<td>Married</td>
<td>Human Relations</td>
</tr>
<tr>
<td>10</td>
<td>C10</td>
<td>83</td>
<td>F</td>
<td>11</td>
<td>Widowed</td>
<td>Office work</td>
</tr>
<tr>
<td>11</td>
<td>C11</td>
<td>85</td>
<td>F</td>
<td>11</td>
<td>Married</td>
<td>Office work</td>
</tr>
<tr>
<td>12</td>
<td>C12</td>
<td>69</td>
<td>F</td>
<td>15</td>
<td>Married</td>
<td>Teacher</td>
</tr>
<tr>
<td>13</td>
<td>C13</td>
<td>69</td>
<td>M</td>
<td>15</td>
<td>Married</td>
<td>Research scientist / Sales manager</td>
</tr>
<tr>
<td>14</td>
<td>C14</td>
<td>79</td>
<td>M</td>
<td>15</td>
<td>Married</td>
<td>Business manager</td>
</tr>
</tbody>
</table>

Note. Age\textsuperscript{a} measured in years, age at initial interview & assessment. Ed.\textsuperscript{b} total number of years of education, including primary, secondary, and tertiary education.

Materials

Standardised assessment materials for the study included the Dementia Rating Scale-2\textsuperscript{TM} (DRS-2; Jurica, Leitten, & Mattis, 2001) and Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1983). Materials for questionnaires and quality of life scales included the Quality of Life-AD (QOL-AD; Logsdon, 1996), the WHO 5-item Wellbeing Index (WHO-5; 1998 Version), and a self-efficacy for social communication scale developed for this study. Stimuli for the natural language sampling included laminated black and white composite picture scenes. The pictures were the Cookie Theft scene from the Boston Diagnostic Aphasia Battery (Goodglass & Kaplan, 1983), the Picnic scene from the Western Aphasia Battery (Kertesz, 2006), and the Birthday scene from Nicholas and Brookshire’s (1993) elicitation procedure for their standardised Correct Information Unit (CIU) analysis. All natural speech samples were recorded using an Olympus DS-50 digital voice recorder and lapel condenser microphone.
Procedure

All participants were required to attend an initial assessment, followed by three natural language-sampling sessions. T1 and T2 conducted their evaluation and treatment sessions in a clinic room at a community-rehabilitation hospital site, while the remaining participants were seen at home on their request. All evaluation sessions were conducted in a quiet room with careful attempts to minimise distraction and promote focused attention. Rest breaks were offered as required, however all participants tolerated the testing and evaluation time. The assessments administered are outlined in Table 4.3 and detailed below.

Table 4.3

<table>
<thead>
<tr>
<th>System Component</th>
<th>Assessment Measure / Tool</th>
<th>Assessment Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td>Dementia Rating Scale-2 – valid and reliable assessment tool to provide an index of general cognitive ability.</td>
<td>Initial Assessment</td>
</tr>
<tr>
<td>Linguistic Competence Performance</td>
<td>Boston Naming Test – used to quantify severity of anomia or discrete language performance.</td>
<td>Initial Assessment</td>
</tr>
<tr>
<td></td>
<td>Natural Language Sampling – used to analyse the efficiency and informativeness of natural language performance.</td>
<td>Sampling Sessions (1-3)</td>
</tr>
<tr>
<td>Social-Emotional</td>
<td>Self-Efficacy for Social Communication Scale – measure of self-efficacy or confidence in social communication skills as a function of context / situation.</td>
<td>Initial Assessment</td>
</tr>
<tr>
<td></td>
<td>WHO 5-item Well-Being Index – composite measure of general wellbeing.</td>
<td>Sampling Sessions (1-3)</td>
</tr>
<tr>
<td></td>
<td>Quality of Life-AD – used to rate overall perceived quality of life.</td>
<td>Initial Assessment</td>
</tr>
<tr>
<td>Global Behavioural and Psychosocial Outcomes</td>
<td>Case History Interview – used to explore subjective-insights into PPA.</td>
<td>Initial Assessment</td>
</tr>
</tbody>
</table>

Initial assessment. The initial interview and assessment session was designed to gather information about the participants’ demographic details and relevant case history, while assessing their cognitive, linguistic and social-emotional functions. This initial session took on average two hours to complete with participants willing to engage in detailed discussion about their language abilities and changes experienced. All participants with PPA were given the opportunity to have their spouse or a family member with them during the interview. T1 was the
only participant to decline this offer, attending all sessions on his own. All control participants completed the initial assessment independently in their own homes.

**Sampling sessions.** Following the initial assessment, participants attended three evaluation sessions to record natural language samples across three time points to control for intra-individual variability and ensure a representative sample of linguistic performance. Sessions were held weekly, over a three-week period. The WHO-5 was also completed at each sampling session to control for intra-individual variability within the social-emotional component of the system.

**Assessment Tasks and Measures**

**Case history interview.** The case history interview designed for this study used a semi-structured interview format (see Appendix A). Questions covered demographic information, history of presenting complaint, and communication history, encompassing questions that are routinely asked at an initial speech-language pathology assessment. This explored when the participant first noticed a change in their language or communication skills, the first symptoms they experienced, and their response or reaction to these changes. This also enabled the typical activity patterns, social roles and relationships of the participants, and any skills or compensatory strategies they were using to support their communication or cognitive difficulties to be captured and examined. As stated above, all participants in the patient group other than T1 were interviewed with their spouse in attendance. Given the presence of expressive language difficulties, this allowed the opportunity for their spouse to clarify, confirm or elaborate on their responses as required. All questions were first directed to the participants with PPA, with time and verbal encouragement provided. All control participants were interviewed on their own in their own homes. The interviews were digitally recorded and transcribed verbatim by the researcher to allow later concept analysis.

**Subjective-insights into PPA.** Responses to two primary questions were extracted from the transcripts to obtain the subjective-insights into PPA that were systematically examined in analysis two. These questions explored: (1) perceptions and descriptions of language and/or memory changes and difficulties noticed as a result of PPA or ageing processes, and (2)
perceived responses to these difficulties to provide insight into the nature of coping and adaptation.

**Dementia Rating Scale-2.** The DRS-2 was administered at initial assessment to obtain a brief, valid and reliable index of general cognitive ability. The test was administered by the researcher with training in test administration and interpretation provided by an experienced Neuropsychologist. The DRS-2 is used widely to measure the mental status of older adults with cognitive impairment, as well as a wide range of neuropsychiatric illnesses (Schmidt, Lieto, Kiryankova, & Salvucci, 2006). Normative data are based on a sample of healthy adults between the ages of 56 and 105 years of age (Jurica et al., 2001) and studies have provided support for the validity and reliability of the assessment (Schmidt et al., 2006). The revised DRS-2 has enhanced normative data due to permission of the Mayo Clinic to reproduce data collected as part of Mayo’s Older Americans Normative Studies (MOANS). The DRS-2 Total Score is a composite score comprising the five DRS-2™ subscales (Attention, Initiation/Perseveration, Construction, Conceptualisation, and Memory). DRS-2 total scores out of a value of 144 are converted to an aged-corrected MOANS scaled score (AMSS) ranging from two to 18. An AMSS of eight or less indicates impaired performance (mildly impaired 6-8, moderately impaired 4-5, or severely impaired 2-3). Conversely, an AMSS of nine or above indicates intact performance (below average 9-10, average 11-13, or above average 11-18). The AMSS score was checked against the age- and education-corrected MOANS Scaled Score (AEMSS), which enabled the individuals’ performance to be interpreted relative to their years of education (Jurica et al., 2001). This did not change the severity index for any of the participants. The AMSS and AEMSS are believed to provide more sensitive markers of cognitive ability and change over time (Jurica et al., 2001). This assessment was not administered to diagnose the presence of dementia, but rather to obtain a reliable estimate of general cognitive ability to assist when profiling participants.

**Boston Naming Test.** The BNT (Kaplan et al., 1983) was administered at initial assessment to obtain a formal measure of component or focal linguistic performance. It is a 60-item test of black and white line drawings that the participant is required to name. It is described
as the most frequently administered confrontation-naming test in the western world (Barker-Collo, 2001) and is used routinely in PPA research and the diagnostic assessment of dementia as a sensitive measure of object naming ability (Mesulam et al., 2012; Rogalski, Cobia, Harrison, Wieneke, Weintraub, & Mesulam, 2011). The BNT has sound psychometric properties (Strauss, Sherman, & Spreen, 2006) with strong test-retest reliability (Flanagan & Jackson, 1997). Participants were given at least 20 seconds to name each item, with full credit awarded to self-corrections during that time. If an error was made or a significant delay or struggle was evident a stimulus cue was provided (e.g. “It is a musical instrument”). If the stimulus cue was unsuccessful in eliciting the target response a phonemic cue was provided (e.g. “It starts with har…”). All responses were scored according to the standard single-word scoring key provided in the BNT assessment form. Participant responses (e.g. circumlocution, off task commentary) were also recorded for descriptive analysis.

**Natural language sampling.** Picture description stimuli were used to collect the natural language samples, given their recommended use in the diagnostic and clinical assessment of connected speech in PPA (Sajjadi et al., 2012; Rohrer et al., 2008; Wilson et al., 2010). The presentation of stimuli was not randomised or counterbalanced across sessions. Verbal instructions only were provided, repeated for the participant if required. No feedback was provided regarding the accuracy or appropriateness of the participant’s response. Social continuants were permitted such as “uh-huh” and head nods to provide some encouragement during the picture description tasks (Nicholas & Brookshire, 1993).

**Picture stimuli.** The picture stimuli included the *Cookie Theft scene* from the Boston Diagnostic Aphasia Battery (Goodglass & Kaplan, 1983), the *Picnic scene* from the Western Aphasia Battery (Kertesz, 2006), and the *Birthday scene* from Nicholas and Brookshire’s (1993) elicitation procedure for their standardised CIU analysis. To elicit the picture description samples the picture stimuli were placed in front of the participant and kept in view until they had finished their description or story. A standard instruction was used, asking participants to “Tell me a story about what you can see happening in the picture providing as much detail as
possible”. If a limited response was provided the participant was prompted by asking, “Is there anything else you can tell me?”

**Quality of Life-AD.** The QOL-AD (Logsdon, 1996) was administered to obtain a global rating of the participants’ perceived quality of life. It is a brief, dementia specific, 13-item measure. Total scores range from 13 to 52, with higher scores reflecting higher levels of quality of life (Logsdon, Gibbons, McCurry, & Teri, 2002). The QOL-AD was administered following permission and guidelines provided by Logsdon (1996). Items measure the domains of “physical condition, mood, memory, functional abilities, inter-personal relationships, ability to participate in meaningful activities, financial situation, and global assessments of life and QOL as a whole” (Ready & Ott, 2003, p.5). The QOL-AD uses simple and straightforward language, requiring participants to respond using a structured and consistent four-choice format (i.e. rating current QOL on each item as *poor, fair, good, or excellent*). It is completed using a structured interview format using explicit questions. Participants are provided with a test form and can respond either verbally or by pointing to or circling their response. Following test administration instructions, the QOL interview is discontinued if a participant is unable to comprehend and/or respond to more than two items, the QOL interview. No participants met criteria for discontinuation. For item seven (marriage) if participants were unmarried or widowed they were asked to rate their ‘closest personal relationship’ (Logsdon et al., 2002). If this item (or any other item) was unable to be rated, it was scored as missing. Logsdon et al. (2002) recommend replacing up to two missing items with the mean score of the remaining items; and if more than two items are missing, the entire measure should be considered as missing. The QOL-AD takes on average 10 minutes to administer and can be completed reliably and validly by individuals with mild to severe dementia with an MMSE of greater than two (Hoe, Katona, Roch, & Livingston, 2005; Logsdon, et al., 2002). The QOL-AD has been found to have very good psychometric properties with demonstrated face validity (Ready & Ott, 2003), internal reliability and test-retest reliability (Logsdon et al., 2002; Thorgrimsen et al., 2003). The tool’s content and construct validity, inter-rater reliability, and internal consistency have also been demonstrated (Thorgrimsen et al., 2003).
If there were any signs or reports of major depression during the initial interview and/or completion of the QOL-AD, referral was made to the participant’s General Practitioner (GP) or to a Clinical Psychologist. This was also raised with the treating clinician or specialist that made the initial referral to the study. T2 was the only participant who reported depression; consistent with very low ratings of QOL and wellbeing. As a result, she was referred to and seen by a Clinical Psychologist during the study period.

**WHO 5-item Well-Being Index.** The WHO-5 (1998 Version) was used to obtain a measure of general wellbeing, which is considered to be an important dimension of health-related QOL. This is a short screening instrument for measuring subjective wellbeing. The tool’s internal and external validity has been demonstrated for an elderly population (Bonsignore, Barkow, Jessen, & Heun, 2001). An adaptation to the index was made for the current study asking participants to rate their perceived wellbeing over the past 48 hours, rather than the past week to reduce memory load. Participants rated their wellbeing across five statements (i.e. “I have felt cheerful and in good spirits”, “I have felt calm and relaxed”, “I have felt active and vigorous”, “I woke up feeling fresh and interested”, “My daily life has been filled with things that interest me”) selecting the closest descriptor of how they had been feeling using a 6-score scale (from *all the time* to *at no time*). A sum score is calculated, ranging from 0 to 25. A high sum score represents a status of optimal wellbeing. The sum scores were converted to a percentage by multiplying by four. If a low measure on the WHO-5 is obtained, further clinical investigations are recommended to determine the severity of depression and hopelessness (Sisask, Varnik, Kolves, Konstabel, & Wasserman, 2008).

**Self-efficacy for social communication scale.** Guidelines by Bandura (2006) were used to develop a self-efficacy for social communication scale. Thirteen items were generated that reflect different gradations of or challenges to social communication, involving varying levels of cognitive load or resource demand (e.g. talking with family and friends, vs. talking to strangers in the community; talking about old memories vs. holding a debate or discussion about a current issue or event). Sufficient gradations are recommended to prevent ceiling effects (Bandura, 2006). Following standard protocols for measuring self-efficacy beliefs, participants
were presented with the 13-item scale and asked to rate the strength of perceived ability to perform or complete each social communication task. This judgement of capability was made using a 100-point scale, ranging in 10-unit intervals from 0 (“cannot do at all”), through intermediate assurance, 50 (“moderately certain can do”), to complete assurance, 100 (“highly certain can do”). A standard instruction was given for each item, asking participants to: “Rate how confident you are that you can communicate in that situation as of now. Rate your confidence by recording a number from 0 to 100 using the scale given below.” Participants were asked to write the number on to a response form. The self-efficacy ratings across the 13 items were summed and an average calculated, ranging from 0 to 100. Higher scores represented higher levels of self-efficacy or perceived ability to communicate across a range of social contexts or situational demands.

To familiarize participants with this task and notion of self-efficacy, a practice rating was completed, adapted from Bandura (2006). This required participants to judge their capability to lift objects of varying weights (ranging from 5 to 200 kilograms) using the same 100-point scale. A standard instruction was provided: “If you were asked to lift objects of different weights right now, how certain are you that you can lift each of the weights described below?” (Bandura, 2006, p.320). This emphasised the need to judge their abilities as of now; not in terms of previous ability or future potential (Bandura, 2006). All participants were deemed able to follow the instructions and complete the practice self-efficacy ratings appropriately however future validation of the tool is required.

Transcription and Data Analysis

All of the picture description samples and case history interviews were digitally recorded and transcribed orthographically allowing subsequent analysis. The procedures for the CIU analysis and Leximancer automated content analysis are described below.

**CIU analysis.** Nicholas and Brookshire’s (1993) system for quantifying the informativeness and efficiency of the connected speech of adults with aphasia was used to obtain objective measures of language performance, namely communicative efficiency, effectiveness and informativeness. This is a standardised rule-based scoring system that has
gained clinical acceptance and use to reliably quantify speech across a variety of stimuli (Doyle et al., 2000; Nicholas & Brookshire, 1993). The total number of words produced for each stimulus was counted; including words that were intelligible in context but not necessarily relevant to the stimulus (Nicholas & Brookshire, 1993). To be counted as a CIU, words needed to be “accurate, relevant, and informative relative to the eliciting stimulus” (Nicholas & Brookshire, 1993, p.36); however did not have to be used in a grammatically correct sentence (Nicholas & Brookshire, 1993). After words and CIUs were counted, the duration of each natural language sample was timed. Any preceding comments and task instructions were excluded from the sample duration. The time, word, and CIU counts were used to calculate: (a) words per minute (WPM), (b) correct information units per minute (CIUs/min), and (c) percent of words that were correct information units (%CIUs). This provided measures of speaking rate, communicative efficiency, and overall communicative informativeness respectively.

**Analysis of qualitative interview data.** A quantitative approach to content analysis was employed, utilising Leximancer™ text analytics software to extract meaning from the subjective-insights into PPA.

**Leximancer™ text analytics software.** Leximancer™ uses word-association information (i.e. word frequency and co-occurrence data) to extract and quantify concepts within the text (Cretchley, Rooney, & Gallois, 2010; Smith & Humphreys, 2006). A tailored taxonomy or concept categorisation is produced for each data set (Cretchley et al., 2010; Smith & Humphreys, 2006). The reliability of Leximancer™ has been assessed and demonstrated in regard to stability and reproducibility of results (Smith & Humphreys, 2006). The output of the analysis is a two-dimensional concept map. This provides a visual representation of the conceptual structure of the transcript text (Cretchley et al., 2010). Frequently occurring words are concepts (Cretchley et al., 2010), with similar concepts clustered into themes (Cretchley et al., 2010). The strength of relationship or connectivity between concepts is also quantified, highlighting that the analytical approach extends beyond simple counts of word frequency, to capture the complex conceptual meanings within a text corpus (Cretchley et al., 2010). Rank-ordered concept lists are also provided enabling the most common concepts to be identified.
This was then used as a platform to examine and interpret the quotes or comments underlying each concept or theme. Further information about the Leximancer\textsuperscript{TM} procedure and approach will be provided in chapter six.

\textit{Leximancer\textsuperscript{TM} procedure.} The transcripts were uploaded and analysed automatically using Leximancer\textsuperscript{TM} (version 4; Leximancer\textsuperscript{TM}, 2011). Given the exploratory nature of this research, the default operating settings were utilised, enabling automated text analysis. Minor adjustments to the text processing settings were made manually following recommendations within the Leximancer\textsuperscript{TM} user-manual (Leximancer\textsuperscript{TM}, 2011). The \textit{prose text threshold} was set to 0, which is the recommended setting for transcribed speech. The \textit{apply dialog tags} option was selected to tag individual speakers within the interview transcripts. The \textit{apply file tag} was also selected for the control group analysis as the transcripts were uploaded as individual files for each control participant and then pooled in the automated text analysis. File tags were not required for the PPA participants given that the content analyses were run separately for each individual case. Other parameters, for example, the length of the text segments to be analysed, the maximum number of sentences contained within each segment, and segment boundaries were kept at the default operating settings (Smith & Humphreys, 2006). Function or stop words with low semantic meaning were automatically excluded from the analysis (e.g. \textit{and}, is, but).

Several forms of validity have been studied and demonstrated for the emergent Leximancer\textsuperscript{TM} thesauri and concept maps including face validity and the reproducibility of data. Readers are directed to Smith and Humphreys (2006) for an in-depth examination of the validity and stability of the tool. Inter- and intra-coder reliability is not an issue for Leximancer\textsuperscript{TM}, given the use of statistical algorithms. Following recommended practice, the learned thesauri were inspected to ensure that concepts were linked to other concepts and weighted in ways that appeared appropriate (Smith & Humphreys, 2006).

Once the data sets were loaded and the minor adjustments to the default settings were made, the \textit{run project} button was selected. This activated the automatic processes to \textit{generate concept seeds} and the text-grounded \textit{thesaurus}. Once completed, the \textit{concept map} was opened and inspected. When opening the concept map for the first time, the top 50\% of concepts are
visible, and the theme size is set at 33%. This captures the most frequent and connected concepts within the text sample. The report tabs were then used to check the thesaurus items and access the required statistical data. Statistical data include: (1) theme summary: hierarchical list of themes, connectivity scores, and concepts contained within each theme with counts, and (2) ranked concepts: hierarchical list of concepts of word-like concepts contained within the text, ranked by frequency of occurrence and relevance. By clicking on a concept label, the hierarchical list of connections to other concepts was examined. This relational information was recorded for the most important emergent concepts. Direct access to the text excerpts was used to establish the validity and reliability of the data as well as the objective inferences to come from it (Elo & Kyngas, 2008).

**Levels of Analysis**

The statistical approaches and methodology employed are summarised in Table 4.4 below in relation to the two levels of analysis conducted. The two stages of analysis map to the primary objectives of the thesis and enable testing of the dynamic systems framework of PPA. Further detail regarding analysis one and two are provided in chapters five and six respectively. It is important to emphasise that while the two levels of analysis are presented and discussed separately they provide complementary insight into the individual dynamic systems for a single participant cohort with related and inter-dependent aims. As such, the findings of the two stages of analysis are integrated in the final chapter of this thesis.
Table 4.4

Summary of Methods in relation to the Levels of Analysis Employed

<table>
<thead>
<tr>
<th>Stage of analysis</th>
<th>Objective</th>
<th>Tasks / measures</th>
<th>Analysis / data</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis one</td>
<td>Quantify and profile the holistic system-wide expression of PPA</td>
<td>Cognitive (DRS-2), linguistic competence (BNT) and performance (WPM, CIUs/min, %CIUs) and social-emotional (QOL-AD, WHO-5, Self-efficacy) component measures</td>
<td>Crawford and Howell p values, effect size indices, radar plots</td>
<td>System-profiles Relative severity of impact across system components Patterns of strength and weakness</td>
</tr>
<tr>
<td>Analysis two</td>
<td>Explore the subjective-insights into PPA and unique patterns of adaptation</td>
<td>Semi-structured interviews (1) Perceived language changes (2) Associated reactions and responses</td>
<td>Leximancer™ concept maps, concept hierarchies, verbatim quotes</td>
<td>Subjective-insights Perceived changes and emotional responses Adaptive profiles</td>
</tr>
</tbody>
</table>
Chapter 5

ANALYSIS ONE

*Individual system-profiles for individuals with progressive language impairment: Examining PPA within a dynamic systems framework.*

**Introduction**

A driving assumption of this thesis is that while PPA manifests as a primary disorder of language (Mesulam, 2001; Rogalski & Mesulam, 2009), the impact and consequences of pathology extend far beyond the focal symptoms or clinical markers of disease. Analysis one addresses the critical need to sample and analyse PPA from a holistic, systems perspective to explore the nature of disease expression and to identify priorities for therapeutic interventions. No previous studies have examined the manifestation of PPA in this way, with limited research considering the complex interplay between cognitive, linguistic and social-emotional functions. Through applying the dynamic systems framework of PPA it is expected that novel perspectives of the syndrome will emerge, providing preliminary practice recommendations and direction for future large-scale research.

**Aims and Predictions: Analysis One**

Analysis one addresses the first objective of this thesis: *To examine the holistic, system-wide impact of PPA, including the consequences for language performance and social-emotional functions.* The following research questions were under investigation:

1. Is PPA a multi-layered syndrome that manifests beyond focal-linguistic impairment and pervades multiple levels of an individual’s dynamic, self-organising system?
2. Do individuals living with PPA experience significant social-emotional consequences of language symptoms?

To address these questions, the dynamic systems framework of PPA was applied to quantify system integrity across three components of function (i.e. cognitive, linguistic, and social-emotional) on a case-by-case basis. This sought evidence for the multi-layered expression of
PPA and the value of a systems approach to assessment and clinical profiling. As limited research has explored the social-emotional impact of PPA, the pattern of results within this component of system function was of particular interest. Given the exploratory nature of the research, specific hypotheses were not formulated however it was expected that complexity and variability would be evident when comparing the system-profiles across cases, supporting the notion that the expression and functional consequences of PPA are dynamic and emergent constructs. Furthermore, it was predicted that the system-profiles would differentiate the participants with PPA from the healthy ageing control sample and provide an overall impression of the severity of impact within and across participants.

Methods

An overview of the participant cohort (PPA and controls) and general methods was provided in chapter four and is not repeated here. The summary of methods in relation to analysis one is provided in Table 5.1. This enabled quantitative system-profiles to be constructed for the five participants with PPA with reference to the pooled performance of the healthy ageing control group.

Table 5.1

<table>
<thead>
<tr>
<th>Stage of analysis</th>
<th>Objective</th>
<th>Tasks / measures</th>
<th>Analysis / data</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis one</td>
<td>Quantify and profile the holistic system-wide expression of PPA</td>
<td>Cognitive (DRS-2), linguistic competence (BNT) and performance (WPM, CIUs/min, %CIUs) and social-emotional (QOL-AD, WHO-5, Self-efficacy) component measures</td>
<td>Crawford and Howell p values, effect size indices, radar plots</td>
<td>System-profiles Relative severity of impact across system components Patterns of strength and weakness</td>
</tr>
</tbody>
</table>

Data Analysis

The dependent variables for analysis one include: the age-corrected scaled scores for the DRS-2 sub-tests and total score (cognitive); BNT total score (linguistic competence); the WPM, CIUs/min, and %CIU scores averaged across the three picture description samples (linguistic
primary progressive aphasia (PPA) performance); and the QOL-AD composite score, the average percentage rating for the self-efficacy scale, and the WHO-5 total, averaged across three sampling sessions (social-emotional). The grouped performance of the healthy ageing control participants was analysed first, calculating the means and standard deviations for each dependent variable. With reference to the control range of performance, Crawford and Howell (1998) procedures were used to calculate a $t$-value, point-estimate score, case-controls effect size index ($z_{cc}$), and confidence intervals for the true effect size for each participant with PPA across component measures. The statistical data are provided in tabular form for the participants with PPA to enable examination of the system-profiles on a task-by-task and case-by-case basis.

The effect size values were of particular importance, providing a standard marker of effect size or severity of impact for each measure across the components of system function. The effect size values are presented in graphical form for each participant with PPA using radar plots. These represent the objective system-profiles for each participant. On the radar plots, the vertical-axis represents the estimated effect size in $z_{cc}$ units. The $z_{cc}$ values are truncated at 2.0 and -14.0 to allow visual comparison of the nature and severity of impact across participants. Negative effect size values reflect PPA scores that were below the performance of the control group, with larger values indicating greater severity of impact. Scores that fell two $z_{cc}$ or more below the performance of the control group were interpreted as significant performance decrements, identifying areas of impairment or concern. These system-profiles were examined closely on a case-by-case basis, exploring patterns of function, interactions and sources of variance.

**Item analysis.** Item comparisons were conducted for measures within the social-emotional component (i.e. QOL-AD, WHO-5, self-efficacy). The dependent variables for these measures represent composite scores, which may mask underlying issues or areas of concern. It was of interest whether item analysis would reveal further insight into the psychosocial impact of PPA and areas of therapeutic need that were not captured by the composite scores.
Results

Order and Style of Presentation

The results of the healthy ageing control group and participants with PPA are detailed in the following sections. The grouped results for the healthy ageing control sample are presented first. The results for each participant with PPA are then presented sequentially on a case-by-case basis with reference to the means and standard deviations of the control sample. For each participant the results are described and summarised in tabular form across the intra-personal components of the system, cognitive, linguistic (competence and performance), and social-emotional. The results of the item analyses within the social-emotional domain are provided in the body of the text indicating how many items diverged significantly from the healthy control sample for each case. The raw data for the social-emotional measures are also provided in Appendices B to D, given that these scales have not been used previously in PPA research.

Finally, the system-profiles for the five cases are presented in graphical form (radar plots) providing an objective, visual representation of the individual system-profiles. This allowed direct comparison of the five system-profiles and examination of areas of relative strength and impairment within and across cases.

Performance of the Healthy Control Sample

The 14 participants in the healthy ageing control group completed the range of tasks across the three components of intra-personal system function. The means and standard deviations for the control group performance are presented in Table 5.2 and provide the platform for analysis and interpretation of the PPA case data. The distribution of control responses for the self-efficacy scale violated assumptions of normality. While the Crawford and Howell analyses are robust to violations (Crawford & Garthwaite, 2005) box plots were also examined to confirm whether the self-efficacy scores for the participants with PPA were likely to fall within the control distribution or not, with all cases representing extreme outliers. It is important to note that for $p$ values below .025, the researcher can be 95% confident that a
participant’s score is significantly different from the control population even when extreme skewness is present (Crawford & Garthwaite, 2005).

**Cognitive.** No control participants met criteria for dementia on the DRS-2, with a mean total scaled score of 12.86 (SD = 1.99, range: 10-16). The DRS-2 total scaled scores for three control participants fell within the below average range (C5, C6, C7). The means, standard deviations and range of performance for each sub-test scaled score are provided in Table 5. Three control participants presented with mild impairment on the memory sub-test (C3, C7, C14). Four control participants presented with mild impairment on the initiation and perseveration (I/P) sub-test (C5, C6, C7, C11), mainly reflecting a mild reduction in word fluency. Otherwise general cognitive performance was within normal limits with reference to the participants’ age and education level.

**Linguistic competence.** The overall mean BNT score for the control participants was 54.79 (SD = 3.70; range: 46-60). C13 was the only control participant to reach ceiling. The control participants made no unrelated or phonemic errors. Items such as pretzel, beaver, and protractor were commonly missed by controls, consistent with previous research on Australian normative samples (Worrall, Yiu, Hickson, & Barnett, 1995). C11 performed the most poorly on the BNT scoring 46/60. This falls within the range of performance of healthy elderly subjects in previous research where adults aged 80 years or over (n = 51) named on average 44.7 items correctly (Welch, Doineau, Johnson, & King, 1996).

**Linguistic performance.** The linguistic performance measures (WPM, CIUs/min, and %CIUs) were averaged across the three picture description tasks for each control participant. The mean, standard deviation and range for the control group were then calculated for WPM (M =142.51, SD = 21.65, range: 98.6-184.4), CIUs/min (M = 125.05, SD = 22.31, range: 83.8-164.0) and %CIUs (M = 87.50, SD = 5.71, range: 74.14-96.60). C2 presented with the slowest speech fluency averaging 98.55 WPM (SD = 16.17) across the three-picture description tasks. Her mean communicative efficiency was also the slowest of the controls at 83.80 CIUs/min (SD = 21.97). C3 presented with the lowest overall communicative informativeness (M = 74.14%,

Boxplots indicated that participants C2, C3, C10 and C12 all represented outliers for the CIU/min scores.

**Social-emotional.** In regard to overall QOL the majority of controls rated aspects of their life as good or excellent with a mean composite score of 41.36 (SD = 4.78, range: 33-48). C7 had the lowest QOL-AD score (33) of the control participants rating six aspects of her life as fair (physical health, energy, memory, ability to do chores, ability to do things for fun, money), but no aspects as poor. C14 was the only control participant to rate an aspect of his life as poor (memory), with the second lowest QOL-AD score for the controls (34). He rated three other aspects of his life as fair (energy, mood, self as a whole), which he related to recent medical problems. C6 rated three aspects of his life as fair (energy, friends, ability to do things for fun), C1 rated one aspect of her life as fair (memory) and C10 rated two aspects of her life as fair (ability to do chores, ability to do things for fun).

The average WHO-Wellbeing rating for the control participants was 80.62 (SD = 9.61, range: 66.7-100). C7, C12 and C14 presented with the lowest wellbeing ratings for the control group.

Given that the self-efficacy for social communication scale was developed for use in this study, Cronbach’s alpha was calculated for the control sample. The internal consistency of the tool was adequate with a Cronbach’s alpha of .89. The mean self-efficacy for social communication rating for the control sample was 87.7% with a standard deviation of 12.4 (range: 51.5-100). C7’s self-efficacy rating was the lowest for the control group (51.54%), representing an extreme outlier from the control range of performance (more than 3 box lengths below the boundary).
Table 5.2

Means, Standard Deviations and Range of Healthy Ageing Control Group Performance across Measures and Components of Intra-personal System Function

<table>
<thead>
<tr>
<th>Component / Measure</th>
<th>N</th>
<th>M&lt;sup&gt;^&lt;/sup&gt;</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>14</td>
<td>13.07</td>
<td>1.33</td>
<td>11-16</td>
</tr>
<tr>
<td>Initiation/perseveration</td>
<td>14</td>
<td>10.71</td>
<td>2.27</td>
<td>7-14</td>
</tr>
<tr>
<td>Construction</td>
<td>14</td>
<td>10</td>
<td>0</td>
<td>10-10</td>
</tr>
<tr>
<td>Conceptualisation</td>
<td>14</td>
<td>12.64</td>
<td>1.45</td>
<td>10-14</td>
</tr>
<tr>
<td>Memory</td>
<td>14</td>
<td>10.64</td>
<td>2.21</td>
<td>8-15</td>
</tr>
<tr>
<td>DRS-2 Total</td>
<td>14</td>
<td>12.86</td>
<td>1.99</td>
<td>10-16</td>
</tr>
<tr>
<td><strong>Linguistic Competence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BNT</td>
<td>14</td>
<td>54.79</td>
<td>3.70</td>
<td>46-60</td>
</tr>
<tr>
<td><strong>Linguistic Performance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WPM</td>
<td>14</td>
<td>142.51</td>
<td>21.65</td>
<td>98.6-184.4</td>
</tr>
<tr>
<td>CIUs/min</td>
<td>14</td>
<td>125.05</td>
<td>22.31</td>
<td>83.8-164.0</td>
</tr>
<tr>
<td>%CIUs</td>
<td>14</td>
<td>87.5</td>
<td>5.71</td>
<td>74.1-96.6</td>
</tr>
<tr>
<td><strong>Social Emotional</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QOL-AD</td>
<td>14</td>
<td>41.36</td>
<td>4.78</td>
<td>33-48</td>
</tr>
<tr>
<td>WHO-5</td>
<td>14</td>
<td>80.62</td>
<td>9.61</td>
<td>66.7-100</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>14</td>
<td>87.72</td>
<td>12.35</td>
<td>51.5-100</td>
</tr>
</tbody>
</table>

Note. ^Values provided represent DRS-2 AMSS values, where a scaled-score of 8 or below indicates impairment.

System-profiles of Participants with PPA

The five participants with PPA completed the range of tasks at initial assessment and across the three sampling sessions. The results for each participant with PPA are presented in series below with reference to the grouped performance of the healthy ageing control sample. This provides information about the cognitive, linguistic and social-emotional expression of PPA, capturing patterns of disease expression and psychosocial adjustment.

Participant T1

T1 completed the range of measures with a summary of his performance provided in Table 5.3 and detailed below.

Cognitive. T1 achieved the highest DRS-2 raw score (144/144) of the participants with PPA. His age-corrected DRS-2 total score was within the range of the healthy ageing controls $t = 1.52; p = .08$, falling 1.58 $z_{cc}$ scores above the control group mean. His performance was
consistent with his years of education and expected cognitive reserve. T1 did not meet criteria for dementia and demonstrated relative strengths within this component of system function.

**Linguistic competence.** T1 achieved a raw score of 56/60 on the BNT, falling within the range of the control group \( t = .32; p = .38 \). Effective circumlocution was evident for missed items with occasional close-semantic errors (e.g. Pretzel = “Knot. I can’t think of the word, is it a pastry, bread sort of thing”; Dominoes = “Ah, dice or ah, I can’t think of it, you match it up. I know what you do with them - checkers”).

**Linguistic performance.** T1’s linguistic performance diverged significantly to that of the healthy ageing control group and was an area of noted weakness within his system profile. T1’s rate of speech production was significantly slower than the healthy controls producing on average 67.63 WPM across the three picture stimuli \( t = -3.34; p = .01 \), characterised by non-fluency, formulatory effort and frequent filled pauses (i.e. um, ah). T1 produced on average 48.48 CIUs/min when describing pictures, which was significantly lower than the healthy ageing controls \( t = -3.32; p = .00 \). T1’s overall communicative informativeness diverged significantly from the control performance, producing on average 71.67% CIUs \( t = -2.68, p = .02 \).

**Social-emotional.** T1’s overall QOL rating as measured by the QOL-AD fell within the range of healthy controls \( t = -.13; p = .45 \). Item analysis indicated that T1’s ratings for none of the 13 QOL-AD items diverged significantly from the healthy controls. The only aspect of his life that was not rated as good, or excellent was his memory, which T1 rated as fair. He qualified this by stating that this was specifically “memory for words”. T1’s overall rating of general wellbeing also fell within the range of the healthy controls \( t = -1.00; p = .168 \). His ratings fell within the healthy control range across all five items of the WHO-5. This was consistent with his description of his mood and psychological function, explicitly stating that he was “not depressed”. T1’s overall communicative self-efficacy rating was significantly lower overall when compared to the healthy controls \( t = -3.24; p = .00 \), with an effect size of -3.35. Of the 13 social-communication contexts, seven diverged significantly from the healthy control range. See Appendices B to D for T1’s ratings across items of the social-emotional scales.
Summary T1. T1’s system-profile is representative of mild PPA. He did not meet criteria for dementia, with noted strengths within the cognitive component. His confrontation-naming was a relative strength, performing within the control range on the BNT. Disease expression was captured by linguistic performance measures, with T1’s WPM, CIUs/min, and %CIU scores diverging significantly from the healthy ageing controls. This reflects a notable reduction in speech fluency and communicative efficiency, with hesitant, effortful speech output and frequent filled pauses (i.e. um, ah). T1 presented with positive adjustment to his emerging language symptoms with composite scores and item ratings for the QOL-AD and WHO-5 falling within the healthy control range. This indicated an absence of somatic symptoms, maintaining positive levels of wellbeing and no signs of depression. The only social-emotional measure to diverge significantly from the control group was T1’s average self-efficacy rating. This suggested a relationship between T1’s reduced communicative efficiency and his confidence in his ability to speak, most notably during tasks or contexts that were more cognitively demanding. His self-efficacy for six of the 13 items fell within the healthy control range, with this presence of perceived-strength or ability perhaps bolstering his overall levels of wellbeing and QOL.

Table 5.3

T1 Performance Results across Intra-personal Components of Function

<table>
<thead>
<tr>
<th>Component / Measure</th>
<th>Score^</th>
<th>Estimated Effect Size</th>
<th>Estimated effect size CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>13</td>
<td>-.05</td>
<td>-.1 to .5</td>
</tr>
<tr>
<td>Initiation/Perseveration</td>
<td>12</td>
<td>.57</td>
<td>-.0 to 1.1</td>
</tr>
<tr>
<td>Construction</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Conceptualisation</td>
<td>13</td>
<td>.25</td>
<td>-.3 to .8</td>
</tr>
<tr>
<td>Memory</td>
<td>13</td>
<td>1.07</td>
<td>.4 to 1.7</td>
</tr>
<tr>
<td>DRS-2 Total</td>
<td>13</td>
<td>1.58</td>
<td>.8 to 2.4</td>
</tr>
<tr>
<td>Linguistic Competence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BNT</td>
<td>56</td>
<td>.33</td>
<td>-.2 to .9</td>
</tr>
<tr>
<td>Linguistic Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WPM</td>
<td>67.63</td>
<td>-3.46*</td>
<td>-4.9 to -2.0</td>
</tr>
<tr>
<td>CIUs/min</td>
<td>48.48</td>
<td>-3.43*</td>
<td>-4.8 to -2.0</td>
</tr>
<tr>
<td>%CIUs</td>
<td>71.67</td>
<td>-2.77*</td>
<td>-3.9 to -1.6</td>
</tr>
<tr>
<td>Social Emotional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QOL-AD</td>
<td>42</td>
<td>-.134</td>
<td>-.4 to .6</td>
</tr>
<tr>
<td>WHO-5</td>
<td>70.67</td>
<td>-1.04</td>
<td>-1.7 to -.3</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>46.15</td>
<td>-3.35*</td>
<td>-4.7 to -.20</td>
</tr>
</tbody>
</table>

Note. ^Scores represent DRS-2 AMSS values, where a scaled-score of 8 or below indicates impairment. *More than 2 $z_{cc}$ scores away from the healthy control group range of performance.
Participant T2

T2 completed the range of measures with a summary of her performance provided in Table 5.4 and detailed below.

**Cognitive.** T2 achieved a raw score of 120/144 on the DRS-2 with her age corrected DRS-2 total score falling within the moderately impaired range for her age and educational level. Her DRS-2 total score diverged significantly from the healthy ageing control group $t = -4.301; p = .00$, falling -4.45 $z_{cc}$ scores below the control group mean. T2 met criteria for dementia, with impaired performance on the **Attention** and **Initiation and Perseveration** sub-tests. The sub-tests and items that T2 experienced difficulty with were those that depended on a verbal response modality.

**Linguistic competence.** T2 achieved a raw score of 55/60 on the BNT, falling within the range of healthy controls $t = .06; p = .48$. She provided a close semantic response (e.g. Pretzel = “Knot”) or circumlocution (e.g. Muzzle = “One of those that um... mask a dog”; Tongs = “Something you use for sugar cubes”), for all missed items indicating semantic access and knowledge.

**Linguistic performance.** T2’s rate of speech production was significantly slower than the healthy controls producing on average 27.62 words per minute across the three picture stimuli $t = -5.13; p = .00$ with a large effect size ($z_{cc} = -5.31$). Her communicative efficiency rating was also significantly reduced, producing on average 24.17 CIUs/min across the three picture description tasks $t = -4.37; p = .00$ with a large effect size ($z_{cc} = -4.52$). T2’s picture descriptions were however informative, with her average %CIU rating falling within the range of healthy controls $t = .01; p = .50$.

**Social-emotional.** T2’s overall QOL-AD rating fell within the range of healthy controls $t = -1.49, p = .08$. Item analysis indicated that her ratings for 2/13 QOL-AD items were significantly lower than controls (i.e. mood, and friends). She rated her energy, *self as a whole*, *ability to do chores*, and *life as a whole* as fair. This indicated that while her composite score was within normal limits, there were a number of areas of concern within her QOL profile. T2’s average wellbeing total was significantly lower than the healthy controls, $t = -6.77; p = .00$, .
with a large effect size $z_{cc} = -7.00$. Her average ratings for all five items of the WHO-5 diverged significantly from the healthy control range, reflecting significantly reduced mood and energy levels, poor sleeping patterns, and dissatisfaction with the activities that filled her daily life. T2’s self-efficacy score was also significantly lower than the control group $t = -4.81; p = .00$. Item analysis indicated that her self-efficacy ratings diverged significantly from the controls for $11/13$ items. The only items to fall within the control range related to her perceived ability to talk when tired (50%) and in the presence of background noise (50%). She reported 0% self-efficacy for four items (i.e. talking to strangers, talking under stress or pressure, talking in front of group, and talking about current affairs). See Appendices B to D for T2’s ratings across items of the social-emotional scales.

**Summary T2.** T2’s system-profile is suggestive of mild to moderate PPA. Some aspects of general cognitive ability were at ceiling or within the preserved range for her age and education level, including construction, conceptualisation, and memory functions. Areas of weakness within the cognitive component were directly impacted by her expressive language difficulties. This was consistent with her case history interview, indicating preserved episodic memory and ability to manage household finances and appointments. Like T1, the linguistic performance measures provided a more sensitive marker of disease. She performed within the control range on the BNT however her WPM and CIUs/min scores diverged severely from the healthy ageing control group, revealing a significant reduction in fluency and communicative efficiency. While slow and extremely effortful, her picture descriptions were informative, with the %CIU index falling within the control range. T2 presented with the most profound difficulties with social-emotional adjustment across the five participants with PPA. Severe performance decrements were evident for the WHO-5 and self-efficacy ratings. This suggested a relationship between T2’s reduced communicative efficiency and her psychological wellbeing and self-efficacy. T2’s self-efficacy ratings indicated significant cognitive load effects. She rated a number of elements of her overall QOL positively, although ratings pertaining to mood and friends diverged significantly from the control group. Signs of depression were evident and T2 was referred to a clinical psychologist as a result of overt somatic symptoms.
Table 5.4

T2 Performance Results across Intra-personal Components of Function

<table>
<thead>
<tr>
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<th>Score^</th>
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<th>Estimated effect size CI</th>
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<td>BNT</td>
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<td>WPM</td>
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<td>-5.31*</td>
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<td>CIUs/min</td>
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<td>Self-Efficacy</td>
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<td>-4.98*</td>
<td>-6.9 to -3.0</td>
</tr>
</tbody>
</table>

Note. ^Scores represent DRS-2 AMSS values, where a scaled-score of 8 or below indicates impairment. *More than 2 $z_{cc}$ scores away from the healthy control group range of performance.

Participant T3

T3 completed the range of measures with a summary of his performance provided in Table 5.5 and detailed below.

**Cognitive.** T3 achieved a raw score of 83/144 on the DRS-2, with overall cognitive ability falling within the severely impaired range for his age and educational level. His age-corrected DRS-2 total score diverged significantly from the healthy ageing control group $t = -5.27; p = .00$, falling -5.46 $z_{cc}$ scores below the control group mean. He performed at ceiling on the construction sub-test. His performance on all other sub-tests fell within the impaired range.

**Linguistic competence.** T3 achieved a raw score of 6/60 on the BNT, indicating a severe naming impairment that fell significantly outside the range of healthy controls $t = -12.74; p = .00$ with a large effect size $z_{cc} = -13.19$. His performance was characterised by circumlocution and attempts to self-cue that were non-specific and perseverative in nature (e.g. Bench = “Me, not me post ah, me, me, I’m sitting on my, not my fence, me post”). Gesture was used effectively to convey the meaning of some missed items (e.g. comb, tennis, coat hanger). T3 was aware of his naming difficulties as demonstrated by off-task commentary and increasing
distress with time on task (e.g. “What’s the name, I just freeze. That’s a, damn. I’m going bad now, that’s incredible”; “I’ve got the shakes now, I can’t move”).

**Linguistic performance.** T3 produced on average 100.22 words per minute across the three picture stimuli, which fell within the range of the healthy control group $t = -1.89; p = .08$. His communicative efficiency rating was significantly reduced, producing on average 20.32 CIUs/min across the three picture description tasks $t = -4.54; p = .00$ with a large effect size $\eta^2 = -4.69$. T3’s overall communicative informativeness was also significantly impaired, producing on average 19.75% CIUs per picture $t = -11.46; p = .00$ with a large effect size $\eta^2 = -11.87$.

**Social-emotional.** T3’s overall QOL rating as measured by the QOL-AD fell within the range of healthy controls $t = .13; p = .90$. Furthermore, his ratings for all 13 QOL-AD items fell within the control range. He rated four aspects of his life as *fair* (i.e. mood, memory, *self as a whole*, and *ability to do things for fun*). T3’s average overall ratings of general wellbeing also fell within the range of the healthy controls $t = .21; p = .84$. No divergence from the control range was observed across the five WHO-5 items. This indicated that while T3 was experiencing significant language difficulties, this was not detracting from many aspects of his life and subjective wellbeing. T3’s communicative self-efficacy index was significantly lower than the control group $t = -3.67; p = .00$. T3’s self-efficacy ratings diverged significantly from the control range for 7/13 social-communication contexts. He was most confident in his ability to *talk when tired* (100%), to *talk about old memories* (70%), and to *discuss current affairs* (70%). He reported 0% self-efficacy for *talking in front of a group* and *retelling a story that he had recently heard*. See Appendices B to D for T3’s ratings across items of the social-emotional scales.

**Summary T3.** T3’s assessment profile is representative of moderate to severe PPA. He presented with significant impairment across the cognitive and linguistic domains however his primary deficits were linguistic in nature. He performed at ceiling on the construction sub-test of the DRS-2, indicating some retained abilities within the cognitive component. This was consistent with reports of preserved episodic memory and his ability to keep track of appointments and manage his financial affairs. Marked disease expression was captured across
linguistic competence and performance measures. His scores for the BNT and %CIUs showed profound divergence from the control sample, suggesting a semantic based impairment. T3’s natural language was fluent, yet circumlocutory and at times verbose. His natural language was also replete with off task commentary and sensitivity to language symptoms, suggestive of awareness and insight into his PPA. Despite this awareness and hypervigilance, T3 presented with positive signs of adjustment within the social-emotional domain. His QOL-AD and WHO-5 composite scores fell within the control range, suggesting positive wellbeing and he did not rate any aspect of his life as poor. T3’s overall self-efficacy for social communication was however reduced and it was evident that he worried about his language symptoms. Cognitive load effects were again evident, with reduced confidence reported for demanding speaking contexts.

Table 5.5

<table>
<thead>
<tr>
<th>Component / Measure</th>
<th>Score&lt;sup&gt;∧&lt;/sup&gt;</th>
<th>Estimated Effect Size &lt;sub&gt;z&lt;sub&gt;cc&lt;/sub&gt;&lt;/sub&gt;</th>
<th>Estimated effect size CI</th>
</tr>
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<tbody>
<tr>
<td><strong>Cognitive</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Attention</td>
<td>7</td>
<td>-4.56*</td>
<td>-6.4 to -2.8</td>
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<td>Initiation/Perseveration</td>
<td>2</td>
<td>-3.84*</td>
<td>-5.4 to -2.3</td>
</tr>
<tr>
<td>Construction</td>
<td>10</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Conceptualisation</td>
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<td>-6.42*</td>
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<td>DRS-2 Total</td>
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<td>-5.46*</td>
<td>-7.6 to -3.3</td>
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<td><strong>Linguistic Competence</strong></td>
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<td></td>
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<td>BNT</td>
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<td>-18.2 to -8.2</td>
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<td><strong>Linguistic Performance</strong></td>
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<td></td>
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<tr>
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<td>-1.95</td>
<td>-2.9 to -1.0</td>
</tr>
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<td>CIUs/min</td>
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<td>%CIUs</td>
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<td>WHO-5</td>
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<td>-.3 to -.7</td>
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<tr>
<td>Self-Efficacy</td>
<td>40.8</td>
<td>-3.80*</td>
<td>-5.3 to -2.3</td>
</tr>
</tbody>
</table>

Note. <sup>∧</sup>Scores represent DRS-2 AMSS values, where a scaled-score of 8 or below indicates impairment. *More than 2 <sub>z<sub>cc</sub></sub> scores away from the healthy control group range of performance.
Participant T4

T4 completed the range of measures with a summary of his performance provided in Table 5.6 and detailed below.

Cognitive. T4 achieved a raw score of 44/144 on the DRS-2, with overall cognitive ability falling within the severely impaired range for his age and educational level. His DRS-2 total score diverged significantly from the healthy ageing control group $t = -5.27; p = .00$, falling -5.46 $z_{cc}$ scores below the control group mean. His performance was within the severely impaired range across all sub-tests. This indicated that T4 met criteria for dementia, with the most severely compromised cognitive abilities of the five participants with PPA.

Linguistic competence. T4 achieved a raw score of 7/60 on the BNT, indicating a severe focal naming impairment. His performance fell significantly below the range of healthy controls $t = -12.48; p = .00$, with a large effect size $z_{cc} = -12.92$. A number of phonemic errors were observed, often taking multiple attempts to produce the target (e.g. Tree = “Tr- tray-tree”; Scissors = “That’s virtually chickens, to cut, clickers”). Some effective attempts at circumlocution were evident (e.g. Broom = “That’s virtually a, that is a, ah, to go in the garden, for the floor, to clean the ground”; Racquet = “Playing tennis”; Cactus = “They bite you!”). T4 also used gesture effectively at times to convey the target (e.g. harp, whistle, broom, mask, dart). He occasionally produced superordinate labels for missed items (e.g. Rhinocerus = “He’s an animal”; harmonica = “Musical music”). T4 demonstrated awareness of his word finding difficulties with some frustration and frequent off-task commentary (e.g. “Jesus, I know what they are again too”; “Think and just say”; “I know it”). He was not responsive to phonological or semantic cues during task performance and demonstrated some impulsivity and erratic response, with prompts to slow down and take his time required.

Linguistic performance. T4 produced on average 94.62 words per minute, which fell just outside the range of the healthy controls $t = -2.14; p = .05$. His communicative efficiency rating was reduced, producing on average 13.64 CIUs/min across the three picture description tasks. This was significantly lower than the healthy controls $t = -4.82; p = .00$. T4’s overall communicative informativeness was also reduced, producing on average 16.98% CIUs per
picture $t = -11.93; p = .00$, with a large effect size $z_{cc} = -12.35$. His picture descriptions were circumlocutory, non-specific with frequent word finding difficulties and off task commentary.

**Social-emotional.** T4’s QOL-AD composite score fell within the range of healthy controls $t = -.07; p = .94$. He rated one aspect of his life as poor (mood), which was the only item to diverge significantly from the control sample. T4 rated his energy and ability to do things for fun as fair. T4’s average rating of general wellbeing was significantly lower than the healthy control group $t = -2.61; p = .02$. Item analysis indicated that his average wellbeing rating for 1/5 items diverged significantly from the control sample (i.e. *My daily life has been filled with things that interest me*). His self-efficacy ratings were also significantly lower overall when compared to the healthy controls $t = -4.00; p = .00$. T4’s self-efficacy ratings diverged significantly from the control group for 11/13 contexts. His confidence to talk in a *noisy environment* was the only item to fall within the healthy control range. See Appendices B to D for T4’s ratings across items of the social-emotional scales.

**Summary T4.** T4’s system-profile demonstrated the most severe disease impact overall, with more global cognitive difficulties indicating a later stage of disease as compared to the other participants with PPA. Most notably, T4 was the only participant of the sample to perform poorly on the construction sub-test of the DRS-2. This may in part relate to performance anxiety, which was evident across assessment tasks with T4 requiring significant encouragement and reassurance during the evaluation sessions. All measures within the linguistic component diverged significantly from the control group. Similar to T3, the most severe impairment was evident for the BNT and %CIU scores, reflecting a semantic based impairment and profound anomia. His WPM score fell just outside the control range however his speech was notably more fluent than T1, T2 and T5, yet comparatively circumlocutory, verbose and devoid of informational content. As such, his communicative efficiency and informativeness were profoundly impaired. Despite the severity of cognitive-linguistic impairment T4 was able to complete the range of assessment tasks and presented with awareness of his language symptoms, which was associated with a significant reduction in general wellbeing and communicative self-efficacy. Hypervigilance, distress and off-task
commentary were evident in response to error and language symptoms. Item analysis revealed that T4’s reduced wellbeing score mainly reflected reduced satisfaction with the activities that filled his everyday life. T4 also rated his mood as poor on the QOL-AD and both somatic symptoms and signs of depression were evident. T4 was under the care of a Psychiatrist who was monitoring his emotional state. He related his wellbeing to his language difficulties, which was directly observable during language tasks through off-task commentary and visible signs of distress and anxiety when pressure was placed on his language system. T4’s overall psychosocial adjustment was not as profound as T2 however notably more severe than the other three participants with PPA and in comparison to the healthy ageing controls.

Table 5.6

<table>
<thead>
<tr>
<th>Component / Measure</th>
<th>Score^</th>
<th>Estimated Effect Size zcc</th>
<th>Estimated effect size CI</th>
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<td><strong>Cognitive</strong></td>
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<td>Attention</td>
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<td>-8.32*</td>
<td>-11.5 to -5.1</td>
</tr>
<tr>
<td>Initiation/Perseveration</td>
<td>2</td>
<td>-3.84*</td>
<td>-5.4 to -2.3</td>
</tr>
<tr>
<td>Construction</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Conceptualisation</td>
<td>2</td>
<td>-7.34*</td>
<td>-10.2 to -4.5</td>
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<tr>
<td>Memory</td>
<td>2</td>
<td>-3.91*</td>
<td>-5.5 to -2.3</td>
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<td>DRS-2 Total</td>
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<td>-5.46*</td>
<td>-7.6 to -3.3</td>
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<td><strong>Linguistic Competence</strong></td>
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<td>BNT</td>
<td>7</td>
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<td>-3.2 to -1.2</td>
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<tr>
<td>Self-Efficacy</td>
<td>36.54</td>
<td>-4.14*</td>
<td>-5.8 to -2.5</td>
</tr>
</tbody>
</table>

Note. *Scores represent DRS-2 AMSS values, where a scaled-score of 8 or below indicates impairment. *More than 2 zcc scores away from the healthy control group range of performance.

Participant T5

T5 completed the range of measures with a summary of his performance provided in Table 5.7 and detailed below.

**Cognitive.** T5 achieved a raw score of 86/144 on the DRS-2, with overall cognitive ability falling within the severely impaired range for his age and educational level. His DRS-2 total score diverged significantly from the healthy ageing control group $t = -5.27; p = .00,$
falling -5.46 $z_{cc}$ below the control group mean. His performance was within the severely impaired range for three sub-tests (i.e. initiation and perseveration, conceptual, and memory). His attention was mildly impaired and his construction abilities fell within the below average (intact) range.

**Linguistic competence.** T5 achieved a raw score of 40/60 on the BNT, which fell significantly lower than the healthy control mean $t = -3.86; p = .00$. He made occasional close semantic errors (e.g. octopus = “a ah it’s a, it’s a squid”; globe = “atlas”; beaver = “mongoose”) and demonstrated some effective use of circumlocution for missed items (e.g. asparagus = “It’s like a radish”; cactus = “Prickles all over it”; compass = “You can draw a circle with it”; escalator = “Moving stairways”). Examples of perseveration of earlier items were evident without awareness (e.g. “Pyramid” was produced again for tripod and sphinx; “compass” was produced again for protractor; and “Flower tripod” produced for trellis).

**Linguistic performance.** T5 produced on average 59.97 words per minute across the three picture stimuli, which was significantly slower than the healthy controls $t = -3.68; p = .00$. His communicative efficiency rating was also significantly lower than controls, producing on average 31.47 CIUs/min across the three picture description tasks $t = -4.05; p = .00$ with a large effect size $z_{cc} = -4.20$. T5’s overall communicative informativeness was also significantly reduced, producing on average 53.2% CIUs per picture $t = -5.80; p = .00$, with a large effect size $z_{cc} = -6.01$.

**Social-emotional.** T5’s overall QOL rating as measured by the QOL-AD fell within the range of healthy controls $t = -1.08; p = .30$. His energy was the only aspect of his life rated as poor. T5 rated his physical health and friends as fair, which were both significantly lower than the healthy control ratings. T5’s overall ratings of perceived wellbeing were significantly lower than the healthy control group $t = -3.41; p = .00$. This related mainly to his reduced energy levels and reports that he rarely wakes feeling fresh and interested. T5’s communicative average self-efficacy rating was significantly lower overall when compared to the healthy controls $t = -2.95; p = .01$. His confidence was lowest for talking under stress or pressure (10%) and talking in front of a group (30%). His confidence talking to strangers, talking when feeling low in mood
or depressed, and in a social group were rated as 40% and significantly lower than controls. He was most confident when talking about old memories (100%). See Appendices B to D for T5’s ratings across items of the social-emotional scales.

Summary T5. T5’s system-profile is representative of moderate to severe impact, with a consistent reduction in performance across components and measures. His profile was different to the other four participants, reflecting an overall reduction in energy levels or a more apathetic profile. All measures within the cognitive and linguistic components diverged significantly from the healthy ageing control group, with the exception of the construction sub-test. He met criteria for dementia with severe overall reduction in general cognitive abilities. He presented with insight into his language difficulties however presented with indifference towards them, which was in stark comparison to the other four participants with PPA. During focal and natural language tasks T5’s performance was slow, with reduced elaboration of intent. Performance within the social-emotional component was consistent with this profile, rating his energy levels and physical health and activity as poor. These somatic symptoms did not appear to be an indirect response to language symptoms associated with PPA, but rather as a direct result of disease pathology, signifying a change in T5’s pre-morbid personality and conversation style. This may be indicative of a more frontal or behavioural variant of dementia or more advanced PPA, with spreading pathology. The biological basis could not be determined in the context of this research however provides support for the potential diagnostic value of the system-profiles. T5 rated his overall QOL and mood as good, conveying a sense of contentment with his life overall. It is not clear whether this is reflective of positive psychosocial adjustment to his language symptoms, or indifference and reduced awareness as a result of the underlying disease process. T5’s self-efficacy ratings provided evidence for insight, with a significant reduction in confidence evident for six items, which reflected higher levels of cognitive load and speaking demand, similar to the other participants with PPA.
Table 5.7

*T5 Performance Results across Intra-personal Components of Function*

<table>
<thead>
<tr>
<th>Component / Measure</th>
<th>Score</th>
<th>Score*</th>
<th>Estimated Effect Size $z_{cc}$</th>
<th>Estimated effect size CI</th>
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<tbody>
<tr>
<td>Cognitive</td>
<td></td>
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<td>Attention</td>
<td>7</td>
<td>-4.56*</td>
<td>-6.4 to -2.8</td>
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<td>Initiation/perseveration</td>
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<td>Construction</td>
<td>10</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Conceptualisation</td>
<td>3</td>
<td>-6.65*</td>
<td>-9.2 to -4.1</td>
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<td>Memory</td>
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<td>-3.91*</td>
<td>-5.5 to -2.3</td>
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<tr>
<td>DRS-2 Total</td>
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<td>-5.46*</td>
<td>-7.6 to -3.3</td>
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<tr>
<td>Linguistic Competence</td>
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<td>-4.00*</td>
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<td>WHO-5</td>
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<td>-5.0 to -2.1</td>
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<td>Self-Efficacy</td>
<td>50</td>
<td>-3.05*</td>
<td>-4.3 to -1.8</td>
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</tbody>
</table>

Note. ^Scores represent DRS-2 AMSS values, where a scaled-score of 8 or below indicates impairment.

*More than 2 $z_{cc}$ scores away from the healthy control group range of performance.

**Summary of Measures Differentiating PPA from Healthy Ageing**

Table 5.8 below summarises the performance of the five participants with PPA with reference to the healthy ageing control sample. This identifies the measures that successfully differentiated the participants with PPA from the healthy ageing control sample, which constituted 41/60 (68.3%) measures overall.

This summary table provides some information regarding the severity of impact across participants, with T1 showing the least divergence from the healthy ageing controls, while T4 and T5 presented with the most consistent divergence across measures and components of the system. This provides evidence for the multi-layered impact of PPA with performance decrements manifesting across all levels of the system, with the exception of T1, who showed preserved performance within the cognitive component consistent with early stage PPA.

Comparing the sensitivity of measures across the participants with PPA it is evident that the CIUs/min and average self-efficacy rating differentiated the participants with PPA from the healthy ageing control sample most consistently. Conversely, the QOL-AD was the least sensitive marker of PPA failing to differentiate any of the five participants from the healthy
ageing control group. These findings have clinical and diagnostic relevance and should be investigated by further large-scale research.

Table 5.8

*Summary of Measures that Differentiated the Participants with PPA from the Healthy Ageing Control Group*

<table>
<thead>
<tr>
<th>Component / Measure</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Initiation/perseveration</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Conceptualisation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Memory</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>DRS-2 Total</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Linguistic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BNT</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>WPM</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>CIUs/min</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>%CIU</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Social-emotional</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QOL-AD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHO-5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Total</td>
<td>4/12</td>
<td>6/12</td>
<td>9/12</td>
<td>11/12</td>
<td>11/12</td>
</tr>
</tbody>
</table>

*System-profiles*

The system-profiles for the five participants with PPA are presented graphically in Figure 5.1 below in the form of radar plots. The effect size ($z_{cc}$) values are plotted across the range of measures, excluding the construction sub-test of the DRS-2, as an effect size could not be calculated. The amount of white reflects the degree of impact, with more white signifying greater level of impairment. Radar points below the -2.00 $z_{cc}$ cut-off indicate significant divergence from the performance of the healthy ageing control group.

Visual examination of the profiles indicates that T1, T2 and T5 all show a more consistent reduction of performance across measures, most significant for T5. T1 presented with the smallest degree of system impact overall. T1, T2 and T5 all presented with non-fluent profiles, as reflected by greater divergence of WPM values from the control sample. In contrast, a striking similarity is evident between the profiles of T3 and T4, with both participants presenting with a fluent, semantic variant of PPA. For T3 and T4 the prominent divergence from the control group for the BNT and %CIU measures represent the most significant areas of
impairment, while WPM and CIUs/min values represent relative strengths. T4’s system profile revealed more profound impact overall as compared to T3, representing the most significant performance decrements overall.

T3, T4 and T5 presented with the most significant impairment within the cognitive component. Their cognitive performance should be interpreted with caution given the known interference of language impairment on standardised cognitive assessment. Strengths within this component will be considered further when exploring each participant’s degree of insight and awareness of language dissolution in the second phase of analysis. While less severely impaired, T2’s performance within the cognitive component also met criteria for dementia, whereas T1 presented with clear strengths across the DRS-2 subtests, consistent with early stage PPA and high levels of expected cognitive reserve given his years of education.

Visually examining the five system-profiles, T2’s presented with the second lowest degree of impact overall. However, she presented with the most profound impact within the social-emotional component of the system. Her low WHO-5 rating was of particular concern and a strong marker of depression. In comparison, T1 and T3’s profiles showed the lowest degree of impact within the social-emotional component, with only the self-efficacy measure diverging significantly from the healthy ageing controls.

This comparative examination of the five system-profiles strengthens evidence for the unique and multi-layered impact of PPA. Although emergent patterns were evident, each system-profile was unique, particularly in regard to item analyses across the social-emotional rating scales. While all participants showed some degree of social-emotional impact this was variable, ranging from mild to profound. This suggests that the emotional consequences of PPA are dynamic and do not appear related to the degree of cognitive-linguistic impairment alone.
Figure 5.1: System profiles for the five participants with PPA showing the relative severity of impact across parameters of interest.
Discussion

Analysis one addressed the first objective of this thesis: *To objectively profile and examine the system-wide expression of PPA from a dynamic systems perspective.* This aimed to apply and test the dynamic systems framework of PPA and to determine whether the system-profiles would show clinical and diagnostic potential for differentiating the participants with PPA from the healthy ageing control sample. The methodology was successful in achieving this aim with the system-profiles quantifying the system-wide expression of PPA for each individual case, while providing an index of overall severity of impact. This provided a rich and robust platform for examining and unpacking the individual systems, identifying patterns of relative strength and weakness, while exploring commonalities and discrepancies across the five cases.

The research questions under investigation were addressed, with two key findings emerging from the analysis:

1. The expression of PPA is dynamic and multi-layered with performance decrements spanning cognitive, linguistic and social-emotional components of the system.
2. PPA is associated with significant social-emotional impact, which for some individuals is profound.

Given the exploratory, wide-lens approach to sampling and analysis it was expected that other findings of interest would emerge from the examination of the system-profiles. This was the case and additional findings of theoretical and clinical significance emerged from the analysis. The additional findings of interest are listed below:

3. Linguistic performance measures (i.e. communicative efficiency) provided a sensitive and ecologically valid marker of pathology within the distributed language circuitry, aligning with contemporary views of the brain.
4. Self-efficacy for social communication ratings provided a sensitive marker of social-emotional impact, with the onset of PPA associated with reduced confidence in language use that varied according to contextual and situational demands.
5. Global QOL ratings failed to provide a sensitive marker of social-emotional impact of PPA.
6. The system-profiles may have diagnostic and biological relevance given that two distinct profiles emerged from the analysis aligning with fluent and non-fluent presentations of PPA.

7. Outliers within the healthy control sample were identified, suggesting that the systems approach to clinical profiling may differentiate sub-groups or different profiles within a healthy ageing cohort.

Taken together, these findings provide preliminary support for the systems-approach to clinical profiling providing rich and holistic insight into the nature of disease expression for the individual participants. Furthermore, the system-profiles successfully differentiated the participants with PPA from the healthy ageing control sample, detecting a range of performance decrements. The findings are discussed in greater detail below, acknowledging that they are exploratory and preliminary in nature.

**Profiling the System-Wide Impact of PPA**

The findings of analysis one have provided support for the theoretically driven and quantitative approach to assessment and profiling, with the system-profiles and radar plots permitting direct insight into the relative severity of impact across measures and the system-wide expression of disease. This provided an objective platform to examine each participant’s relative strengths and weaknesses, allowing the nature of disease expression to be examined holistically. This has direct clinical importance given the recommendation that clinicians must provide individuals with PPA and their families with clear information pertaining to the person’s communication strengths and weaknesses, in order to make treatment recommendations (Dickerson, 2011). The participants with PPA presented with a range of performance decrements when compared to the control group, with their performance diverging significantly from the healthy ageing controls on 41/60 (68.3%) measures. This indicated that the system-profiles were successful in detecting pathology within the system, providing diagnostic support for the root diagnosis of PPA. The system-profiles were sensitive to early stage disease as illustrated by T1’s profile, who presented with the mildest severity of impact.
overall, with an 18-month history of progressive language difficulties. This finding is consistent with recent research indicating that the early diagnosis of PPA is possible and should be considered in patients who present with an isolated complaint of intermittent word finding difficulties, in the presence of preserved functionality, global cognitive abilities and negative imaging results (Mesulam et al., 2012). The diagnostic value of the system-profiles should be examined by further large-scale research. This could compare the sensitivity of the system-profiles to more comprehensive standardised language testing, for example the Western Aphasia Battery-Aphasia Quotient (Kertesz, 2006), to determine whether the profiles afford heightened sensitivity to early stage disease. This may reduce the likelihood of misdiagnosis at initial medical encounter and the incorrect attribution of language symptoms to stress or depression, which have been reported in the PPA literature (Mesulam et al., 2012).

**Using system-profiles to quantify overall severity of impact.** Examining the individual system-profiles has demonstrated their clinical value, with potential use for quantifying and tracking the severity of impact across the disease course, while identifying components of the system of significant concern. In a clinical setting, the clinician must be able to clearly indicate where changes have occurred since previous assessment, as well as the magnitude and nature of change (Dickerson, 2011). The system-profiles have extended the template approaches adopted by the field to date, moving beyond focal competence within the linguistic domain (Mesulam et al., 2012; Savage et al., 2013) to profiling holistic system performance and interactions between cognitive, linguistic and social-emotional functions. This has clinical relevance for tracking progression and evolution of disease expression over time with heightened ecological validity.

**The Multi-layered Expression of PPA**

A primary research question under investigation concerned whether PPA is characterised by multi-layered impact to support a dynamic systems account of PPA. As predicted, the system-profiles revealed the multi-layered expression of PPA, demonstrating disease expression beyond the level of focal impairment. Performance decrements were detected across components of the system, with the exception of T1, who showed preserved function within the cognitive component and the mildest severity of impact overall. For all participants
symptomatology extended beyond the level of focal linguistic impairment and for three of the five participants the marker of linguistic competence was not of most significant concern. Furthermore, the severity of focal impairment did not appear to be directly related to the severity of impact within the social-emotional component of the system. While this association could not be tested given the small sample size, drawing comparisons across cases provides initial support for this hypothesis. For example, T2 who performed within the range of the healthy ageing control group on the BNT yet presented with the most profound impact across social-emotional measures. This is in contrast to T3, who presented with the most severe performance decrement on the BNT, yet presented with minimal impact within the social-emotional component. This suggests that the behavioural and psychosocial consequences of PPA are likely to be mediated by factors other than the severity of focal linguistic impairment alone. The factors driving disease expression are not captured by the static, impairment nature of the system-profiles and will be explored further in the second level of analysis. Still, the system-profiles provide preliminary support for the dynamic, multi-layered expression of PPA.

The Social Emotional Impact of PPA

The social-emotional impact of PPA was of particular interest for this thesis, aiming to extend understanding of the holistic nature of PPA and its psychosocial consequences. Limited research has examined the social-emotional impact of the syndrome and the second research question under investigation in this thesis sought explore whether individuals with PPA experience significant emotional consequences of PPA. It was predicted that the social-emotional impact would be significant based on previous research by Medina and colleagues (2007, 2009) revealing the high endorsement of symptoms of depression in PPA, the presence of retained insight into evolving symptoms, and the ubiquitous nature of language use during everyday life. This prediction was supported, with the system-profiles revealing variable and significant impact within the social-emotional component of system function. In some cases this impact was profound.

For each of the five participants with PPA at least one of their social-emotional measures was significantly lower than the healthy ageing controls. Significant variability
emerged from item analyses within the social-emotional component, further supporting the
dynamic nature of disease expression. The findings pertaining to each of the social-emotional
parameters will be discussed below.

**Global QOL and PPA.** To the researchers’ knowledge, this study was the first to test
use of the QOL-AD in the context of PPA. The QOL-AD provides a global measure of overall
QOL and while validated for individuals with Alzheimer’s disease, the domains of QOL rated
are very broad and general (e.g. satisfaction with family, friends, life as a whole). Furthermore,
given that it has been used reliably with individuals with severe Alzheimer’s disease (Hoe et al.,
2005; Logsdon et al., 2002), it was expected to be suitable for people with progressive language
impairment. The overall QOL-AD score was not sensitive enough to discriminate any of the
two participants with PPA from the healthy ageing control group. This is positive, indicating
that while the participants’ language and communication skills were significantly impaired,
there were still aspects of their lives that were perceived as good or excellent. In particular, all
two participants with PPA rated their marriage and living situation positively, and for two of
the five PPA cases their physical health was rated significantly better than controls. This may
suggest that following the onset of PPA individuals grow to appreciate some aspects of their
lives more, acknowledging the importance of family and support, as well as general health. This
is consistent with findings of Medina (2009) who found that 64% of participants with PPA
endorsed that their diagnosis had given them a new appreciation of life. This is positive and it is
important to help individuals to identify and focus on such strengths and resources within their
lives when counselling, educating and supporting clients and their families during the clinical
course of the disease.

While the composite score was not sensitive to the unique impact of PPA, looking at the
distribution and profile of individual item ratings there were areas of concern for participants.
For example, while T2’s overall QOL-AD score fell within the control range her ratings of
mood and friends were significantly lower and linked directly to her progressive language
difficulties. As another example, T5’s ratings of his physical health, energy, and friends fell
significantly outside the control distribution. Both T2 and T5 rated their mood as poor, which
was significantly divergent to the healthy controls. This is similar to the work of Medina and Weintraub (2007), where 34% of the participants with PPA reported more symptoms of depression than the healthy controls. This further indicates that for some individuals the psychological impact of PPA can be profound, highlighting the critical need for interprofessional support and intervention services. These findings highlight the importance of looking carefully at individual items for global or generic QOL scales and using this as a platform for further discussion and assessment of individual issues and life-concerns, cautioning against reliance on composite scores alone. Interpreting composite QOL scores is recognised to be inherently challenging (Cummins, 2010) given that they reflect separate underlying processes and life domains. Ultimately QOL should be viewed as a dynamic construct, with different profiles of impact for different groups of people or individuals in clinical practice (Cruice, Worrall, & Hickson, 2003). This highlights the importance of assessing and studying notions of QOL within a dynamic systems framework to identify and examine unique, complex patterns of impact and care need, ideally coupled with subjective-insights into disease expression.

A limitation of the QOL-AD is that it does not require participants to rate the degree of importance of each life domain to them, so it is not clear the relative weighting of positive or negative aspects of their life, which may ultimately contribute to overall QOL. Focus groups have shown that all items of the QOL-AD have relevance for people with dementia (Thorgrimsen et al., 2003) however people with PPA were not explicitly identified within this sample. As such, it is not yet clear whether additional or alternative items may have more relevance for individuals living with PPA to increase the sensitivity and content validity of the tool. This could be an area for future research and a question that has been explored in the post-stroke aphasia literature (Cruice et al., 2003, 2010). Cruice et al. (2003, 2010) found that activities were a fundamental component of QOL and also psychological wellbeing for people living with aphasia post stroke, viewed as a vehicle for contributing to society. A defining characteristic of PPA is that individuals retain their independence in many activities of daily living that do not rely heavily on language ability (Mesulam, 2003). This was clearly evident in
the current sample with all participants with PPA describing retained abilities such as continuing to manage household finances and appointments, continuing to drive, complete domestic duties and self-care tasks. This retained independence in many aspects of life may contribute to a more positive QOL overall. Furthermore, the five cases that participated in this study all had strong family support and very committed spouses. The QOL outcomes are expected to be very different for individuals with PPA without this degree of support.

**General wellbeing.** Subjective wellbeing is an important component and determiner of QOL and should be viewed as a mood-state rather than an emotion (Cummins, 2003; Kolanowski, Litaker, & Catalano, 2002). Emotions are the most dynamic state, representing reactive and fleeting feelings, lasting minutes to hours, while mood states can last hours to days (Cummins, 2003). Emotions and moods are further differentiated from personality traits, which are more stable, extending over an individual’s lifetime (Kolanowski et al., 2002). The degree of subjective wellbeing reflects a person’s feelings of positivity, which interact with self-evaluations and even motivation for living (Cummins, 2003). It is believed that people’s feelings of positivity are normally remarkably stable and genetically determined, providing an individual with a “set-point for levels of happiness” (Cummins, 2003, p.162). During the ups and downs of everyday life active homeostatic processes are believed to adjust internal standards to accommodate for a changing external environment and to ensure that a steady state is maintained (Allison et al., 1997; Cummins, 2003). In a resilient system, even quite marked and sudden changes in the internal and external environment may be associated with very little fluctuation in subjective wellbeing (Cummins, 2010), with a stable and robust level of positive mood critical for QOL and emotional wellbeing. Top down views of wellbeing predict that an individual’s perceived wellbeing will affect the way they feel about different aspects of their life, influencing overall QOL ratings (Allison et al., 1997). As such, higher levels of wellbeing are often associated with higher overall QOL, which requires further investigation in relation to PPA.

Given that the stability and level of subjective wellbeing contributes to overall QOL, it is critical to consider how well an individual’s homeostatic and adaptive mechanisms are
functioning in response to challenging internal or external threats, such as the onset of PPA symptoms. Cummins (2010) asserted that a “sufficiently adverse environment can defeat homeostasis” (p.162) and destabilise wellbeing if adequate defensive buffers or coping resources are not available. In a resilient system a fall in the wellbeing ‘set-point’ will activate ‘cognitive restructuring’ and adaptive processes to restore equilibrium, a natural property dynamic, biological system. In this study, the WHO-5 discriminated three of the five PPA cases from the healthy control sample, indicating a significant reduction in positive mood state for T2, T4 and T5. A sustained fall in subjective wellbeing is a significant risk factor for depression (Cummins, 2010), which was most clearly evident for T2. This may be suggestive of homeostatic defeat, with the system unable to restore balance, causing wellbeing to remain below its set-point range (Cummins, 2010). This suggests that T2, despite having a number of cognitive and linguistic strengths to draw upon, was not able to marshal sufficient adaptive or control strategies to moderate her own affective responses to language dissolution. For T5, while his subjective wellbeing was significantly lower than the controls, this was related to his energy levels and sleeping patterns, while he still rated his mood (or spirits) positively overall. For T1 and T3 their wellbeing ratings fell within the control distribution, which may suggest that adaptation had occurred in order to maintain positive mood in the face of progressive language decline.

The different patterns of adjustment or impact are interesting, as all five cases had strong family support, with close relationships identified as the most powerful external buffer (Cummins, 2010). Both T2 and T4 rated their marriage and living situation positively, so the disruption in wellbeing may be more related to more intrinsic factors or the internal buffers available to them. This suggests that for some individuals with PPA wellbeing and positive mood may be more robustly defended, but for others, critical support will be required to bolster adaptation and resilience. Pre-morbid personality traits are one factor believed to influence psychological resilience (Kolanowski et al., 2002) and as such, an individual’s ability to adapt to the challenges of progressive language impairment. The underlying adaptive mechanisms and influencing factors at play within each of the individual systems requires further investigation,
highlighting the limitations of the WHO-5 in exploring why wellbeing is reduced. Deepening understanding of the causal mechanisms is critical for identifying areas of therapeutic need and the supports or strategies required for bolstering resilience, robustness and positive self-regulation within the system, which will be explored in the second level of analysis.

**Self-Efficacy.** Of measures within the social-emotional component, the self-efficacy for social communication scale developed for this study was the most sensitive and consistent, discriminating all five participants with PPA from the healthy controls. Item analysis further indicated that ratings for 44/65 items (68%) diverged significantly from the control group ratings. This suggests that the onset of PPA and changes within the language system disrupt communicative self-efficacy and confidence to communicate irrespective of the stage of PPA or disease severity. T1 illustrates this point, as he presented with the highest level of functioning overall and was in the earliest stages of disease, yet still rated his self-efficacy as significantly lower than the control group for eight of the 13 items (61.5%). In particular his confidence talking in a social group and holding debates or discussions about current events and more complex topics had significantly reduced since the onset of his speech difficulties. Looking at patterns across the PPA participants as a whole, confidence talking with family and friends, talking to strangers, talking when under stress or pressure, in a social group, and retelling a story were significantly lower for all five cases. This reflects perceptions of personal capacity and sense of control (Au et al., 2009) to meet communication demands and goals, particularly under increased cognitive demand or more challenging social situations. Self-efficacy in social relations has been noted as a critical factor protecting against the consequences of loneliness and depression in older age, and can contribute to patterns of learned helplessness or excess disability (Blazer, 2002). Furthermore, it has been found that lonely people become more self-focused (Blazer, 2002), which may intensify the self-doubt and hyper vigilant monitoring that has been associated with PPA (Hird et al., 2006). This provides insight into the types of contexts for life participation and social engagement that may require targeted support strategies and proactive interventions to foster confidence and help maintain sense of self.
The need to bolster self-efficacy is particularly important given the known association between low levels of self-efficacy and avoidance of related activities (Bandura, 1997). Self-efficacy measures reflect an individual’s perceptions about their ability to perform a given task and to mobilise the required motivation, cognitive resources and strategies of action to meet contextual demands (Bandura, 1997). This relates particularly to difficult or challenging situations (Au et al., 2009), with self-efficacy known to influence patterns of future behaviour or interaction (Amtmann et al., 2012). It has been reported that when an individual perceives an outcome or performance goal to be unattainable disengagement or withdrawal from that pursuit is a natural reaction (Allison, Locker, & Feine, 1997). This is particularly concerning in the case of dementia and neurodegenerative disease given that continued engagement and cognitive stimulation is critical for maintaining and bolstering level of function for as long as possible (Crooks, Lubben, Petitti, Little, & Chiu, 2008; Woods, Aguirre, Spector, & Orrell, 2012). As a result, self-efficacy may be a particularly important target of intervention in the clinical management of PPA and for tracking meaningful treatment outcomes. While validation of the self-efficacy tool is required in future research, the findings have demonstrated its early promise for measuring the social-emotional impact of PPA. Future research should consider the fact that self-efficacy is not a global entity and can vary considerably across different activities, tasks or contexts (Au et al., 2009). This requires targeted self-efficacy measures specific to language use within activities, contexts and life roles that are pertinent to an individual client. Ultimately, further research into the impact of PPA on communicative self-efficacy is required to build upon the current findings. Furthermore, the functional consequences of reduced communicative self-efficacy require further information, building on the static system-profiles, to determine whether this is associated with patterns of withdrawal, avoidance or the nature of coping strategies employed.

Identifying Sensitive Markers of PPA: Efficiency Based Measures

While exploring the diagnostic value of the systems-profiles was not a primary aim of this thesis an interesting finding emerged from analysis one that is worthy of further discussion. It was evident that of measures used to assess cognitive and linguistic functions, the linguistic
performance measures, namely the CIUs/min measure, was the most consistent and sensitive marker of pathology. This measure differentiated all five cases from the healthy ageing controls.

This was predicted when presenting the dynamic systems framework of PPA based on previous research and an understanding of the distributed nature of language processing. It suggests that the emergence of PPA disrupts connectivity within the language circuitry irrespective of the stage of disease or the biological nature of underlying pathology. Furthermore, this indicates that communicative efficiency measures may be particularly sensitive to early manifestation of PPA. This is illustrated by T1’s system-profile. T1 showed the least severe impact or disease expression overall, representing the earliest stage of disease. While he performed within the range of the healthy ageing controls across measures of general cognitive ability and linguistic competence his linguistic performance measures diverged significantly. His WPM and CIUs/min values represented the most significant performance decrements within his system.

This is consistent with previous research by Hird et al. (2006) where reduced communicative efficiency differentiated five of six participants with PPA from a healthy control sample using similar assessment tasks and methodologies. Rogers and Alarcon (1998) have also concluded that measures of natural language provide the most sensitive markers of language dissolution, reflecting integrative processing of the entire language system. Furthermore, efficiency based measures provide a more ecologically valid marker of language performance, with the efficiency of information exchange having greater functional significance than focal symptoms or the diagnostic label alone. This should be examined further by future research and considered for inclusion in diagnostic templates or assessment batteries for detecting the early emergence of disease.

It is also hypothesised that a stronger association between efficiency measures (CIUs/min) and social-emotional markers, in particular self-efficacy ratings, may be evident, given the ecological validity and sensitivity of these measures. This hypothesis is supported by T2’s system-profile with severe performance decrements for WPM, CIUs/min, self-efficacy and wellbeing ratings, with dissociation of linguistic competence. This may be an interesting
question for a future study exploring the correlations between communicative efficiency and social-emotional measures for a larger sample of individuals with PPA. This could directly compare relationships between measures of linguistic competence, performance, and social-emotional ratings, as well as differences in relationships across variants or subtypes of PPA.

**Emergent patterns: Biological and Diagnostic Relevance of the System-profiles**

Two distinct profiles emerged when comparing the radar plots of the five participants with PPA. While it was predicted that complexity and heterogeneity would characterise the system-profiles both within and across cases, it was interesting that these two distinct patterns of performance emerged from the data. This provides preliminary support for the potential diagnostic and biological relevance of the system-profiles and dynamic systems approach to clinical assessment, which will require replication and extension by future research.

Most notably, the emergent patterns reflect the striking similarity between the system-profiles of T3 and T4, who both presented with a fluent, semantic variant of PPA. The profiles of T1, T2 and T5 also showed commonalities, with a more consistent reduction in performance across parameters. Non-fluency was a characteristic feature of these three profiles, most notably for T1 and T2 who presented with hesitant, effortful speech as their primary symptoms. As such, the two emergent patterns aligned broadly with fluent and non-fluent presentations respectively. Interestingly, the classical fluent/non-fluent dichotomy has failed to clearly demarcate or sub-type individuals with PPA, when relying on speech fluency or phrase length alone (Weintraub, Rubin, & Mesulam, 1990). As a result, fluency is no longer listed as a criterion for the classification of PPA (Mesulam et al., 2012). This may relate to how fluency has been assessed or measured in previous research, with the current findings supporting the potential diagnostic value of fluency profiling, particularly when combined with communicative efficiency measures. Whether the two profiles reflect different patterns or types of underlying pathology is not clear and requires further investigation. Examining the profiles across a larger number of participants may reveal other system-profiles of interest aligning with the subtypes of PPA currently recognised or potentially uncovering new variants or ways of classifying the canonical syndrome complex.
Fluent system-profile: Profound impairment of linguistic competence. Looking more closely at the emergent patterns it was evident that for T3 and T4 their BNT and %CIU scores were profoundly impaired, relative to other performance measures, including WPM and the index of communicative efficiency (CIUs/min). This is indicative of severe impairment within the distributed language circuitry supporting semantic processing and associated word retrieval processes, which comprise white matter tracts within the left anterior and inferior temporal lobe (Adlam et al., 2006; Amici et al., 2007; Rabinovici et al., 2008). Previous research has shown significant correlations between atrophy in a widespread region of the temporal lobes and confrontation naming scores in people with PPA-S, indicating that profound naming deficits are associated with temporal dysfunction (Amici et al., 2007). The striking similarity between T3 and T4’s profiles is consistent with previous research that has shown PPA-S to be the most homogenous in terms of clinical, imaging and pathological profiling and classification (Leyton et al., 2011).

Non-fluent system-profile: Linguistic competence versus performance. In comparison, examining the profiles of T1 and T2, the focal BNT score was a noted strength relative to the reduction in WPM and CIUs/min. This performance discrepancy was most evident for T2 whose speech rate was the slowest of all participants, yet her BNT and %CIU scores fell well within the range of performance of the healthy ageing controls. This indicated that despite proficient word retrieval abilities on the focal task, her overall efficiency of communication exchange was severely reduced. This was also evident for T1 who showed more apparent dysfunction during the picture description task that required distributed processing and integration of information within a temporal context. This is important clinically, as the BNT as a measure of linguistic competence alone, would have failed to detect pathology for T1 and T2, while the presence of disease was clearly demonstrated on the more distributed tasks. This is similar to findings of Rogers and Alarcon (1998) who also cautioned that single word production tasks might fail to tax spoken language processing to the degree that natural language does, particularly in the early stages of disease. As such, these quantitative differences between markers of linguistic competence versus linguistic performance are of theoretical and
diagnostic interest, with potential to reveal distinct patterns of impairment, which may have biological relevance. Previous PPA research has correlated reduction in fluency of speech production with atrophy in the left ventral middle and inferior frontal gyri (Amici et al., 2007). Amici et al. (2007) used subjective measures of speech fluency and did not consider information content, which highlights opportunities for future research.

**Other system-profiles.** While T5’s system-profile showed similarities to T1 and T2, his profile is worthy of further examination. His system appeared to capture an overall reduction in energy, effort or drive that was consistently reflected by his performance across components of the system. For example, T5’s rating of his energy levels on the QOL-AD was more than two standard deviations away from the control mean, and was consistent with significantly lower ratings on the WHO-5 for related items (i.e. feeling active and vigorous, waking feeling fresh and interested). This reduction in energy or effort was also captured subjectively by T5’s linguistic performance and reduced communicative efficiency, with his natural language characterised by slow and flat expression, with a noted reduction in drive, initiation and elaboration. This was characteristic of a more apathetic profile overall that was quite distinct from the other four participants, who presented with more linguistic-based disorders. This further highlights the potential clinical value of the system-profiles in understanding an individual’s system and identifying the nature of difficulties and areas of therapeutic concern. Further research is of course needed to substantiate these hypotheses and interpretations.

**Direction for future research.** Given the small sample size and other limitations of the current research, it is not yet clear whether the emergent patterns represent different categories of disease (i.e. subtypes of PPA) or not. As an alternative, the patterns may reflect different stages or severity of progressive language impairment, which is plausible given that T1 and T2 were in an earlier disease stage as compared to T3 and T4. However given the non-fluent nature of T1 and T2’s presentation it seems unlikely that their system-profiles would evolve into that depicted by T3 and T4 in the later stages of disease. It is of interest whether or not the emergent patterns would remain clearly differentiated into the more advanced stage of disease, which would support their biological relevance. As another possibility, the emergent patterns may
represent other dynamic factors, such as cognitive reserve or capacity for positive adaptation, which would be associated with different patterns of evolution over time. For example, T5’s profile signified a more general dampening of performance across parameters, suggesting reduced effort or arousal processes as a key function of disease expression, rather than the severity of linguistic impairment. This suggests that the system-profiles may provide a window into the inner workings of an individual’s system, allowing underlying causal processes to be hypothesised. This would be further strengthened by coupling the profiles with imaging results and other clinical data, including subjective-insights into disease expression. The benefit of exploring the system-profiles on a case by case basis is supported, particularly when considering the unique, multi-layered impact of disease. This is further supported by the nature of clinical practice where the classification of PPA is carried out one patient at a time (Mesulam et al., 2012).

**System-profiles of the Healthy Ageing Control Group**

As a final point for discussion, there was some evidence that the system-profiles may have potential to differentiate sub-groups or different profiles within a healthy ageing cohort. While the primary objectives of the thesis as well as the focus of this discussion were concerned with the participants with PPA, there were cases within the healthy ageing control group identified as possible outliers (i.e. C7, C11). These profiles may be reflective of a worried well profile, subjective cognitive impairment or prodromal dementia (Clarnette, Almeida, Forstl, Paton, & Martins, 2009), worthy of further large-scale investigation. It is widely recognised in the context of growing public awareness of dementia and a focus on early diagnosis, that many adults are developing “Alzheimer-phobia” (Draper, Peisah, Snowdon, & Brodaty, 2010, p.76), particularly in western countries. This also reflects the stigma attached to dementia and the critical importance of one’s faculties to sense of self and QOL. Research suggests that fear is stronger in individuals that have had a personal experience with or family history of dementia (Suhr & Kinkela, 2007), which was the case for C7. Similarly, this is likely to interact with or be influenced by personality style. Individuals falling within such sub-groups may benefit from
monitoring and provision of education and support to address worries and concerns early, in case more significant functional consequences develop over time.

**Conclusion**

A primary aim of analysis one was to test the dynamic systems framework of PPA on a case-by-case basis, to inform new conceptualisations of the syndrome. The findings have provided support for the dynamic, multi-layered impact of PPA and the utility of the dynamic systems framework for guiding assessment and clinical profiling. It was clear that the systems-approach provided rich insight into the expression of PPA and the theoretical and clinical value of moving beyond the level of focal linguistic impairment for understanding the nature of disease and the extent of impact. Given the small sample size the findings are preliminary in nature and the diagnostic and clinical value of the system-profiles will require further investigation. In particular, future research should consider whether other components of intra-personal system function or other measures should be included in the system-profiles to capture the disease expression more sensitively or with greater ecological validity. These limitations will be discussed further in the general discussion.

Overall, the results of analysis one clearly demonstrate that the nature and impact of PPA extends beyond focal impairment, with significant social-emotional consequences for individuals living with the syndrome and their families. To examine the system-profiles further, the next stage of analysis will systematically explore the subjective-insights of people living with PPA to identify the adaptive mechanisms and coping strategies that are active within the individual systems. It is assumed that notions of adaptation, self-regulation and styles of coping greatly influence the global behavioural and psychosocial consequences of PPA. Contextualising the system-profiles in light of subjective-insights may strengthen diagnostic accuracy, while providing clearer direction for proactive therapies with potential to bolster resilience and reduce the overall severity of impact within the system. In particular, this would involve the design of therapeutic interventions with potential to improve self-efficacy, wellbeing and overall QOL (Kolanowski, Litaker, & Catalano, 2002; Zank & Leipold, 2001), promoting positive life with PPA, while the search for a cure continues.
Chapter 6

ANALYSIS TWO

Subjective-insights: Examining individual experiences and adaptive mechanisms.

Introduction

In analysis one, the system-profiles of the five participants with PPA were constructed and examined. This provided evidence for the multi-layered impact of PPA, with performance decrements spanning the cognitive, linguistic, and social-emotional components of the system. The system-profiles were static in nature, impairment focused and researcher driven, revealing the severity of impact across the measures of interest. The adaptive mechanisms and factors influencing disease expression were not directly captured by the system-profiles. That is, it is still not clear how individuals with PPA perceive and experience language dissolution or whether they adapt to language symptoms in unique and variable ways. As such, the system-profiles need to be contextualised and interpreted in light of further evidence, in this case, the subjective-insights of the participants in relation to language dissolution and associated reactions and adaptive responses.

Adaptation, Coping and Psychosocial Outcomes

Notions of adaptation and coping are central to the dynamic systems framework of PPA. Furthermore, an individual’s ability to adapt effectively to life with a chronic illness or disability is recognised as an important indicator of QOL, wellbeing and disease outcomes (Ettema et al., 2005). That is, positive adaptation ensures that adequate levels of emotional, physical, and social functioning are maintained in the face of emerging disease. This requires conceptualisation of QOL as a dynamic construct, governed by an individual’s capacity to self-regulate and adjust flexibly when faced with significant threat or challenge (Allison et al., 1997), such as the onset of dementia or symptoms of PPA (Seiffer, Clare, & Harvey, 2005). As a result, the internal and external environment begins to change and in order to maintain equilibrium and control the individual must start adjusting their internal standards and reference points to accommodate the change (Allison et al., 1997). As dementia symptoms emerge the
individual faces a number of adaptive tasks, including learning to cope with emerging disabilities, maintaining an emotional balance and positive self-image, while at the same time preparing for an uncertain future (Droes, van der Meirlo, & Meiland, 2011). Individuals respond to and experience these challenges in varied ways, which is reflected by the heterogeneity of QOL and psychosocial outcomes for people living with dementia (Bunn et al., 2012). This heterogeneity in social-emotional outcomes was evident in the system-profiles associated with PPA that were examined in analysis one of this thesis. Composite scores and item analyses within this component of the system highlighted that for some participants with PPA the psychosocial impact was profound, yet for others it was less significant. This variance did not appear directly related to the severity or stage of emergent disease alone. Interpreting the system-profiles in light of the broader dementia literature the social-emotional impact is expected to have significant consequences for global patterns of life participation, social engagement and fulfilment of family, vocational and other important life roles (Bunn et al., 2012; Droes et al., 2011).

A key determinant of adaptational outcomes and, as a result, the unique, personal-experience of disease, is the notion of coping, or how effectively individuals deal with stressors as they emerge (Allison et al., 1997; Coyne & Gottlieb, 1996). Coping is a complex phenomenon, involving both overt and covert behaviours that are employed to manage stress within contexts where the internal and/or external demands placed on the system exceed the resources available (Lazarus & Folkman, 1984). The ultimate aim of coping is to maintain balance and control, which can be resource demanding and at times emotionally draining (Droes et al., 2011). Two broad categories of coping are recognised, namely problem-focused and emotion-focused coping (Lazarus & Folkman, 1984). Problem-focused coping is recognised as more positive, directing energy at proactively managing or altering the problem causing distress (Allison et al., 1997). Conversely, emotion-focused coping strategies are more negative or maladaptive in nature, with energy directed at regulating the emotional response to the problem (Allison et al., 1997). Emotion-focused ways of coping are mediated through processes like denial, detachment, avoidance, or regression (Droes et al., 2011; Allison et al., 1997). These
strategies are often effective in preventing or minimising the occurrence of symptoms and emotional distress however are restrictive in nature and associated with the emergence of excess disability and patterns of learned helplessness (Clare, 2002; Droes et al., 2011). The coping strategies employed by an individual are mediated by a number of different factors including cognitive and emotional appraisal, the availability of coping resources and strategic competence, self-control, and a host of other personal factors such as personality, prior experiences, cultural values and beliefs (Allison et al., 1997).

Evaluative processes play an important role in determining styles of coping and the nature of adaptation, concerned with how individuals think about or perceive a particular life challenge, as well as their appraisals of the resources and options available to them (Pearce, Clare, & Pistrang, 2002). This includes both cognitive and emotional perceptions, with the affective component known to fluctuate more noticeably over time (Allison et al., 1997). Evaluative processes are dynamically related to parameters like an individual’s self-efficacy, self-concept and sense of control over their current situation (Allison et al., 1997). For example, more negative appraisals, low-levels of self-efficacy, and lack of perceived control are likely to result in more avoidant styles of coping. Individuals may learn to anticipate a given stressor and as such, avoid the symptoms or unwanted consequences. For example, an individual with PPA may learn to avoid using the telephone or attending social events as a way of preventing word finding difficulties or conversation breakdown, preventing the experience of embarrassment or distress that may result. While this strategy would be effective, enabling the individual to regain a sense of control in the long term it would be restrictive for life-participation and psychosocial outcomes. This alludes to the fact that while styles of coping are deeply rooted in an individual’s personality and psychological makeup, people with dementia should be viewed as active agents in adjusting to and maintaining balance when facing the threat of dementia (Pearce et al., 2002). Through therapeutic interventions and support it may be possible to guide people towards more positive mechanisms of adaptation and coping (Bunn et al., 2012; Pearce et al., 2002).
Preliminary research has identified social withdrawal as a symptom of reactionary depression associated with PPA (Medina, 2009); highlighting that maladaptive and emotion-focused coping strategies may be drawn upon in response to emerging language symptoms. This is not surprising given the ubiquitous and intimate nature of language use to everyday interactions. It is predicted that over time, individuals with PPA, will continuously refine and habituate certain coping strategies, which in some cases, may allow negative attractor states or maladaptive strategies to become hardwired. It is important to note that engrained or habituated coping styles are more impervious to change (Coyne & Gottlieb, 1996), which is a concern if therapeutic interventions are left too far beyond their emergence. Notions of adaptation and coping have not been explored adequately in the context of PPA to date. It is of particular interest whether and under what circumstances negative styles of coping emerge and which adaptive mechanisms are spontaneously employed. It is evident from the dementia literature that understanding coping processes assists the development of care pathways and therapy services that are sensitive to changing and evolving needs (Pearce et al., 2002).

**Aims and Predictions: Analysis Two**

Analysis two addressed the second primary objective of this thesis: *To explore subjective-insights into the perceived nature of disease expression and associated psychosocial reactions to understand how individuals respond and adapt to language dissolution.*

This aimed to contextualise the individual system-profiles and explore patterns of adaptation. This addressed the following research questions:

1. How do individuals living with PPA perceive their language symptoms and the emergence of language impairment?
2. Do individuals living with PPA perceive significant emotional and psychosocial consequences as result of preserved insight and awareness into language symptoms?
3. Do individuals with PPA adapt to language dissolution in unique ways with a range of internal and external parameters mediating global behavioural and psychosocial outcomes?
It was predicted that individual participants with PPA would experience and react to language dissolution in different ways, with unique patterns of adaptation and ways of coping emerging. This would further provide further preliminary support for a dynamic systems account of PPA, indicating that a range of internal and external factors mediate disease expression. It was expected that parameters of interest would emerge from the concept maps, providing direction for future large-scale research. Furthermore, the subjective-insights were expected to provide further support for the significant social-emotional impact of PPA with subjective-insights revealing strong insight and awareness of language symptoms. The nature of emotional responses was expected to interact in both positive and negative ways with the adaptive mechanisms and coping strategies employed, influencing global behavioural and psychosocial outcomes.

A secondary aim of analysis two was to test the research and clinical utility of Leximancer™. It was predicted that the subjective-insights and emergent concept maps of the participants with PPA would be quantitatively and qualitatively different from that of the healthy ageing control group, providing preliminary support for the clinical value of Leximancer™ and the subjective-insights.

Previous research has not studied the expression of PPA from the perspective of individuals living with the syndrome and factors influencing adaptation are poorly understood. As such, this analysis makes a significant contribution to the current knowledge base with significant implications for the conceptualisation and understanding of PPA as well as its clinical management across the unfolding stages of disease.

Methods

An overview of the participant cohort (PPA and controls) and general methods was provided in chapter four and is not repeated here. The summary of methods in relation to analysis two is provided in Table 6.1. This enabled the subjective-insights of the five participants with PPA and the healthy ageing control group to be analysed quantitatively through the automated extraction of Leximancer™ concept maps and hierarchies. The
subjective-insights were gathered from the participant’s responses to questions within the semi-structured interview exploring: (1) perceptions and descriptions of changes and difficulties noticed, particularly in relation to language and memory, and (2) perceived responses to these difficulties to provide insight into the nature of coping and adaptation.

Table 6.1

<table>
<thead>
<tr>
<th>Stage of analysis</th>
<th>Objective</th>
<th>Tasks / measures</th>
<th>Analysis / data</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis two</td>
<td>Explore the subjective-insights into PPA and unique patterns of adaptation</td>
<td>Semi-structured interviews</td>
<td>Leximancer™ concept maps, concept hierarchies, verbatim quotes</td>
<td>Subjective-insights Perceived changes and emotional responses Adaptive profiles</td>
</tr>
</tbody>
</table>

| | (1) Perceived language changes (2) Associated reactions and responses |

Data Analysis

A quantitative approach to content analysis was employed, utilising Leximancer™ text analytics software to extract meaning from the interview transcripts. The procedure used to run this automated analysis was described in chapter four. The Leximancer™ concept maps are interpreted and contextualised with reference to the emergent concepts and relational data (Kondracki et al., 2002; Morgan, 1993). Objective inferences are drawn from the data to develop preliminary hypotheses about why and how the patterns in the data came to exist (Morgan, 1993). Statistical data extracted and examined included: (1) theme summary: hierarchical list of themes, connectivity scores, and concepts contained within each theme with counts, and (2) ranked concepts: hierarchical list of concepts of word-like concepts contained within the text, ranked by frequency of occurrence and relevance. Verbatim responses attached to the emergent themes and concepts were examined and described in depth, forming the basis of the results and discussion.
Results

Order and Style of Presentation

The Leximancer™ results are presented and described first for the healthy ageing control group, followed by the participants with PPA on a case-by-case basis. The key findings and prominent concepts and themes to emerge from the transcripts are displayed visually through the Leximancer™ generated concept maps. Statistical data are provided for prominent concepts in tabular form, including frequency data and connectivity scores. Some objective inferences are presented here and then explored further in the discussion.

Content Analysis for the Healthy Ageing Controls

Healthy control concept maps. To address the primary research questions the analysis first focused on the emergent concept map for the control group to examine the perceived changes in memory, thinking or language associated with healthy ageing. This provided an objective platform for comparison to later examine the emergent concepts for each participant with PPA. The control concept map is presented in Figure 6.1, visually displaying the concepts and themes to emerge from the pooled interview transcripts. The speaker tags are shown, indicating the proximity of concepts and themes to the individual control participants (i.e. C1 to C14). The results are presented thematically, according to the most prominent themes to emerge from the transcripts, which in hierarchical order according to connectivity were: remember (100%), name (27%), talking (10%), probably (9%), friends (4%), doing (3%), language (2%), and mind (1%). Table 6.2 provides the 10 most important concepts to emerge from the data in tabular form, with concepts ranked in accordance to count and relevance within the interview text. The most important concepts clustered within the top two themes remember and name, which are examined and described in greatest detail. Excerpts from the data are provided as evidence for objective inferences drawn within each theme.
Table 6.2

Healthy Ageing Control Group Leximancer™ Identified Word-like Concepts and Relative Frequencies

<table>
<thead>
<tr>
<th>Concept</th>
<th>Count</th>
<th>Relevance (%)</th>
<th>Top five related concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>remember</td>
<td>30</td>
<td>50</td>
<td>happening, language, trying, used, names</td>
</tr>
<tr>
<td>things</td>
<td>30</td>
<td>50</td>
<td>changes, describe, language, older, write</td>
</tr>
<tr>
<td>name</td>
<td>18</td>
<td>30</td>
<td>feel, names, remember, trying, forget</td>
</tr>
<tr>
<td>time</td>
<td>17</td>
<td>28</td>
<td>language, used, write, words, remember</td>
</tr>
<tr>
<td>forget</td>
<td>15</td>
<td>25</td>
<td>feel, names, write, words, things, name</td>
</tr>
<tr>
<td>word</td>
<td>11</td>
<td>18</td>
<td>happening, doing, words, happen, trying</td>
</tr>
<tr>
<td>names</td>
<td>10</td>
<td>17</td>
<td>changes, words, noticed, name, thinking</td>
</tr>
<tr>
<td>write</td>
<td>10</td>
<td>17</td>
<td>use, used, noticed, probably, talking</td>
</tr>
<tr>
<td>worry</td>
<td>10</td>
<td>17</td>
<td>feel, thinking, name, look, remember</td>
</tr>
<tr>
<td>trying</td>
<td>9</td>
<td>15</td>
<td>describe, happening, happened, mind, word</td>
</tr>
</tbody>
</table>

a. The relevance score provides a measure of the relative importance of a concept. The most frequently occurring concept(s) within the corpus equate to a value of 100%. The relevance of each consecutively ranked concept then represents its importance relative to the highest ranked concept(s) (Rooney et al., 2010).

**Remember.** The most prominent theme to emerge from the control transcripts was, remember, comprising the semantically connected concepts: remember, things, time, forget, word, trying, used, write, memory, words, people. This theme provided rich insight into the perceived changes in memory and recall that were experienced and described by the healthy ageing controls. The nature of reactions and responses to these changes as well as the proactive strategies drawn upon also emerged from this semantic cluster.

**Remember.** The most prominent concept within the memory and recall theme was remember, receiving 30 counts within the control transcripts and connected to the concepts: happening (50%), language (50%), trying (44%), used (44%), names (40%), name (39%), thinking (33%), describe (33%), feel (33%), and worry (30%). Eleven of the 14 control participants described changes in their ability to remember, excluding C2, C4 and C13 only. This indicated that as a group, the control participants were experiencing changes in memory and recall as part of ageing processes. In particular, this related to perceived changes in ability to remember names and think of words. Changes in ability to remember appointments, phone numbers, songs, recipes, and where they had put an item were also described, yet memory of the past was noted as a comparative strength. It was evident that the memory lapses fluctuated, occurring occasionally, yet unexpectedly. For example, C10 commented “Now see, I remember his name today, yesterday I could not think of his name”, indicating the variability of recall.
was also evident that the perceived difficulty was one of recall and access, rather than absolute loss of words or knowledge as illustrated by the following comments: “I find I sometimes forget names and then about 10 minutes later I remember them. They’re not gone forever” C10, and “You forget a name and then you, okay, you let it go and then a little while later – it might be half an hour, it might be half a day – you think, “Oh that’s it!” You remember the word!” C6. This was inferred to represent retained trust in their system and an expectation that the word would be recalled successfully with time. A number of control participants described their ability to remember or the changes experienced as ‘normal’ or a natural part of ageing, rather than a marker of pathology or impairment. For example, C9 commented “It’s just you know, you’re trying to think about – and it happens to younger people too. I remember it happening when I was in my 30s or 40s; you’d be trying to think of a word... and all of a sudden it’s like, ‘Now, what did I want to say?’” and C14 stated “My mother was the same” conveying a notion of acceptance or that the changes weren’t perceived to be out of the ordinary.

The control participants described a range of proactive strategies that they used to support their ability to remember and recall information, including writing lists, keeping a diary, using a calendar, and drawing upon word finding strategies. These strategies were perceived as effective, bolstering sense of control and functional ability as illustrated by the following excerpts: “For instance, I still belong to a choir and where I used to be able to learn the songs and remember them, I’m dependent on knowing, having the music and having things like that now” C1, and “Usually it’s, you want a word but you can’t remember the exact word so you go and get another word” C9. A number of control participants also noted that they were making a conscious attempt to stimulate their memory and to employ more conscious effort and strategies to memorise and rehearse important information. For example, C7 stated, “So you can have a practice and think, now I’m going to tell so and so something about this, so I must remember”.

Another meaning to emerge from the content analysis concerned the impact of cognitive load and fluctuating internal and external demands placed on the system. For example, C11 described factors that impacted her ability to remember and noted that her reaction or response to memory lapses in the moment were dependent on her mood. She commented “I’ve come to
the conclusion that I’m a fairly nervous person and when things go wrong for me I flounder a bit”. She was aware that her recall of words was much better when “fairly calm” and stated “and of course I suppose the more harassed I get, the less I can remember”. The impact of cognitive and emotional load was inferred, as well as the potential role of certain personality traits in determining how well individuals react to and cope with the language and cognitive changes associated with healthy ageing.

In regard to the emotional responses described by the healthy ageing controls the concepts remember and worry were connected. This relationship was mostly positive, indicating a ‘lack of worry’ or concern. For example, C10 stated, “It doesn’t worry me one bit because I know I’m going to remember it”, and C14 noted, “I don’t have to worry about it because the computer and the iPad all give me reminders!” This strengthens the inference that as a group, the healthy ageing controls had a retained sense of control over their perceived changes and functional abilities. Of the 30 text excerpts linked to the concept remember, 4 conveyed a more negative emotional response. This was most strongly connected to C7, who had cared for her husband with Alzheimer’s disease for many years and presented with heightened sensitivity to the word finding difficulties and memory lapses that she was experiencing. In response to these changes C7 stated, “I feel very insecure and I think I’m getting the same way as my husband; so that is a worry”. She also noted that she gets “frustrated and cross” when she experiences difficulty remembering names or words. Despite the negative reaction, this was not associated with functional disability, with no reports of withdrawal or avoidance emerging from her interview transcript and she was drawing upon proactive strategies to bolster her memory.

**Things.** The concept things was also prominent within the remember theme and the second most frequent concept to emerge from the transcripts overall. Things was related strongly to the concepts: changes (100%), describe (67%), language (50%), older (50%), and write (40%). Examining the relevant text excerpts it was evident that the control participants often referred to their age related changes non-specifically, referring generally to the types of information that they experienced difficulty recalling (e.g. “It’s hard to describe, it’s just things you think you remembered and you don’t and you’ve got to think about them” C2; “You know, I
This may suggest that the words, names or items difficult to recall were varied or unpredictable, and as such hard to describe or explain precisely.

**Time.** The concept time received 17 counts and was another prominent concept within the remember theme. It was counted in the transcripts of 7 of the 14 control participants, related to the concepts: language, used, write, words, remember, talking, things, names, and forget. The meaning within this concept was less cohesive, capturing diverse notions of time or frequency, including how often language difficulties were experienced and how often particular strategies were used. Time was most strongly linked to language with C11 stating that her language difficulties were now more evident, which had not been the case in the past (i.e. “This is when I can’t remember words. A lot of the time I notice I’m hesitant with my language these days, which I never used to be”). Time was also related to the concept used, which for one control participant related to a word recall strategy that she had used in the past, but no longer did so due to the additional time and effort taken (e.g. “Well I used to go through the alphabet and that took a bit, rather a long time, when you’re having a conversation” C7). Time was also referred to in a proactive sense, relating to strategy use and improving recall in the future. For example, C1 commented that she must actively use and recall important information “all the time” to support her memory and recall. Similarly, C7 noted the need to “write everything down” and makes lists “the whole time” to aid memory. These comments highlight the importance of repetitive and consistent use of strategies to support memory and recall over time.

**Forget.** Another prominent concept within the first theme was forget, representing the 5th most important concept overall and embodying similar meaning to remember. Ten of the 14 control participants described that they ‘forget things’, including people’s names, tasks that they were about to do, dates, and recipes. Forget was connected most strongly to the concept feel. This was a positive connection, indicating that while a number of the control participants experienced forgetfulness, they did not express related worry, concern or functional impact. C7 was the only control participant to convey a negative emotional response, further compounding her memory and recall difficulties, as illustrated by the following statement: “When I forget, I
feel anger with myself, which makes it worse. I get frustrated”. Forget was also related to the concept write, indicating that keeping lists and writing everything down was the most frequently reported strategy drawn upon by the control participants to minimise the experience of forgetting.

**Names.** The second most prominent theme to emerge from the control interviews was name, encompassing the concepts: name, names, and worry. Name was the most prominent concept within this cluster and the third most significant concept to emerge from the control transcripts. Name received 18 counts, linking to 9 of the 14 healthy control participants. A further 10 hits were counted for the directly related and connected concept names. Together they indicated that while participants spoke more generally about difficulty remembering words with age, a number highlighted a more specific and prominent change in their ability to retrieve names, including names of people, places, movies, books, and objects (e.g. “It can be a name of a friend that I’m, you know, just something that becomes automatically and sometimes it doesn’t” C7; “Oh, I can look at something, I know what it is and then I, “What the hell’s it called?” You know, I know what it is but I can’t think of the name of it” C4; “Well, you, people’s names escape me I find. I recognise people but I don’t always remember their name” C5). Consistent with their more general word finding difficulties, the control participants indicated that the name typically comes to them with time. For example C6 stated, “It’s like yesterday, not yesterday, the weekend. I was trying to remember somebody’s name in the morning and in the afternoon it just suddenly came to me!” C7, “Sometimes I forget a person’s name or one of the grandkids names, but it soon comes to me you know”, and C10 “It’s not bad but I find I sometimes forget names and about ten minutes later I remember them. They’re not gone forever”.

The theme name also encompassed the concept worry. This captured the control participants response and reaction to their difficulty retrieving names. For some control participants, they felt their difficulty thinking of names was normal for them (e.g. “Occasionally I lose a person’s name. But I’ve done it all my life!” C14), or alternatively, a natural and expected part of getting older (e.g. “Oh, I get annoyed with myself because I think,
“Oh I should know where that is” or “I should know her name”… then you think, “Oh well, another senior’s moment!”’ (C5). This indicated that fleeting negative emotions were experienced however pervasive worry was not described, and often the immediate response was reportedly softened by the reaction of their conversation partner. This presence of social support was noted for C7, who despite reporting the strongest emotional response stated “I just get frustrated and cross and say ‘oh damn it, I can’t remember the name’ and they just say ‘don’t worry, I can’t remember it’”. This conveyed a sense of camaraderie within the healthy ageing participants. Furthermore, it was apparent that when a word finding difficulty or memory lapse occurred the control participants were able to adjust to this or simply ‘move on’, dealing with the breakdown effectively without it causing undue distress or worry.

Other themes. The other themes to emerge from the text in order of relevance were talking, probably, friends, doing, language, and mind. The concept and text excerpts encompassed by these themes were examined however few prominent meanings were evident, representing concepts with low counts and/or connectivity. Of these other themes, the one of particular interest to the research questions under investigation was friends. The concept friends received 6 hits within the interview transcripts and strengthened the inference that social support assisted acceptance of age related changes in memory and recall. Through their friendships the participants were able to ‘compare notes’ and reassure each other drawing upon normalisation processes. This was examined in light of C7, who demonstrated the most negative emotional reaction to her perceived changes. C7 indicated that she had “lots of lovely friends” with significant social support and while her friends shared stories about their memory and word finding difficulties it was apparent that she perceived her difficulties to be more pronounced. She also described herself as ‘independent’, with a more introverted personality style noting, “I still love having friends and that and going to friends, but I’m just happy on my own”. It was inferred that the combination of her personality traits and prior experience of caring for husband with dementia represent risk factors for a worried-well profile or hyper-vigilance concerning age-related changes in memory and recall, which may fight against the protective buffering of social support.
Summary controls. The Leximancer™ concept map and hierarchy for the control participants revealed a number of interesting findings. Firstly, the near universal experience of word finding, memory and recall difficulties is important, with remember, name and forget constituting related concepts of importance. This suggested that language changes are perceived and experienced as part of healthy ageing processes. Despite the presence of language changes, as a group, the control participants maintained a healthy psychological perspective, with little concern or apprehension regarding their perceived language and memory changes. The concepts conveyed the ability to normalise these changes with a sense of camaraderie and shared experience with friends. As such, the control participants retained a sense of control over their system and did not see the language changes as markers of disease or pathology. This was also captured by the concept time, with many of the control participants retaining trust in the fact that words or names would come to them with time. Furthermore, proactive responses and coping strategies were evident, with the concepts write and trying indicating that by writing lists and actively trying to remember information, their performance was bolstered. As such, no functional consequences were described in relation to the memory or language changes, having relatively little impact on their everyday lives. Two control participants were identified as outliers within the control group (C7, C11) who described greater frustration and worry in relation to their language and memory changes. These participants felt that their difficulties were more pronounced than their friends however did not describe functional consequences or participation limitations as a result.
Figure 6.1. Leximancer concept map for the healthy ageing control group.
Concept Maps for the Participants with PPA

The Leximancer™ results and concept maps for the participants with PPA will be presented and examined below on a case-by-case basis identifying the most pertinent issues to emerge from the semi-structured interviews. The top 10 concepts are provided in tabular form with the count and relevance index and a list of the top five related concepts. Direct comparisons to the concept map of the healthy ageing controls are made as appropriate.

T1 concept map. T1 was the only participant with PPA to complete the semi-structured interview on his own, providing a detailed description of his language changes and associated responses. T1’s concept map is provided in Figure 6.2 with the top 50% of concepts shown. A ranked list of the 10 most prominent concepts and their respective counts and relevance ratings is also provided in Table 6.3. The most prominent themes to emerge from the text were: difficulties (100%), hesitate (62%), embarrassing (48%), used (37%), certain (30%), talked (7%), time (4%), thinking (3%), names (3%), and trouble (1%). The top 10 concepts were encompassed by the three most prominent and connected themes, which will be examined and discussed in most detail.

Table 6.3

<table>
<thead>
<tr>
<th>Concept</th>
<th>Count</th>
<th>Relevance (%)</th>
<th>Top five related concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>difficulties</td>
<td>7</td>
<td>16</td>
<td>months, things, noticed, words, legal</td>
</tr>
<tr>
<td>noticed</td>
<td>5</td>
<td>11</td>
<td>conversation, months, writing, talked, legal</td>
</tr>
<tr>
<td>certain</td>
<td>5</td>
<td>11</td>
<td>amount, anxiety, legal, notes, thinking</td>
</tr>
<tr>
<td>embarrassing</td>
<td>5</td>
<td>11</td>
<td>conscious, talked, time, anxiety, things</td>
</tr>
<tr>
<td>questions</td>
<td>5</td>
<td>11</td>
<td>hesitate, legal, conversation, remember, night</td>
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<tr>
<td>hesitate</td>
<td>4</td>
<td>9</td>
<td>night, words, legal, questions, conversation</td>
</tr>
<tr>
<td>anxiety</td>
<td>4</td>
<td>9</td>
<td>notes, amount, time, certain, embarrassing</td>
</tr>
<tr>
<td>words</td>
<td>4</td>
<td>9</td>
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</tr>
<tr>
<td>months</td>
<td>3</td>
<td>7</td>
<td>writing, legal, doing, noticed, night</td>
</tr>
<tr>
<td>things</td>
<td>3</td>
<td>7</td>
<td>doing, used, writing, legal, months</td>
</tr>
</tbody>
</table>

a. The relevance score provides a measure of the relative importance of a concept. The most frequently occurring concept within the corpus receives the highest value. The relevance of each consecutively ranked concept then represents its importance relative to the highest ranked concept (Rooney et al., 2010).

Difficulties. The most prominent theme captured T1’s descriptions of his language difficulties revealing strong insight and awareness into the nature and emergence of his language
symptoms. The concepts to cluster within this theme were: *difficulties, noticed, months, things,* and *legal.*

The most prominent concept *difficulties* was counted 7 times within the data set, most strongly related to the concept *months,* indicating that his language difficulties emerged “*roughly 18 months ago.*” T1’s descriptions captured the nature of his language difficulties, which were predominantly expressive and formulatory in nature. He described “*difficulty in formulating words*” and “*difficulty with explaining fluently what I want to say*”. It was evident that his difficulties were most pronounced when he was required to talk ‘spontaneously’ or when responding to questions. He also described difficulty remembering names, but associated this with “*progressive age difficulties*” similar to the healthy control group. One excerpt linked to this concept referred to a relative strength, with T1 stating that he had “*not noticed any difficulties with writing*”. This indicated that T1 was aware of both strengths and weaknesses within his language system and was able to differentiate between symptoms that were related to his PPA versus those more typical of natural ageing processes. His descriptions were semantically and qualitatively different to the control participants, with a more notable sense of ‘impairment’ and more prominent language difficulties that extended beyond trouble remembering words or names alone.

The 2nd most prominent concept within this theme was *noticed,* relating to concepts *conversation* and *months.* For 4 out of 5 times that this concept appeared in the transcript, T1 was describing changes that he had ‘noticed’ within his language symptoms and his associated reactions, further supporting preserved insight into and reflection on his emerging symptoms (e.g. “*I’ve noticed ah difficulty in I know what I want to say, I often have difficulty in formulating the words*”). He had also noticed some reluctance to become involved in “*discussing matters in detail*”, with an emerging tendency to hold back more in conversations. One count referred to other people noticing his language impairment. He had chosen not to talk to his family yet about the changes he was experiencing, but was sure “*they must notice in conversation*”. This was related to a conscious decision to keep his conversation “*to a minimum*”, which was inferred to represent a strategy to control his symptoms or mask the
formulatory difficulties and breakdown. He planned to talk to his family and colleagues at some point in the future, but hadn’t made a decision about when that time would be.

**Hesitate.** The 2nd most prominent theme to emerge from T1’s transcript encompassed the connected concepts *hesitate, questions* and *words*. Taken together, this captured T1’s perceptions of hesitancy when formulating words and also his hesitancy to get involved in conversation. Overall, *hesitate* was the 6th ranked concept to emerge, receiving 4 counts. One count referred to an ‘initial delay’ or hesitation when formulating words, and the other 3 counts referred to T1’s hesitation to ask questions and get involved in conversation. T1 identified this as a clear change in his functional ability and participation, stating that in the past he “*wouldn’t hesitate to ask a question and formulate it reasonably precisely***”. *Questions* represented the 5th most prominent concept to emerge from the transcript, receiving 5 counts. As well as his hesitation to ask questions, T1 also noted some difficulty in responding to them. He noted that while at professional meetings in the past he could “*ask questions and carry on at length***” this was no longer so. He described an “*embarrassing gap***” when people ask him questions during meetings and also during conversations with his son. Despite these perceived changes and reactions, T1 was still actively attending professional meetings and social gatherings.

*Words* was the 3rd concept to cluster within the *hesitate* theme, relating to T1’s primary difficulty “*formulating words***” and his speech non-fluency. He noted that he often had to “*pause***” to find a word or use a circumlocutory strategy, suggesting that this was a frequent occurrence during conversation. T1 stated that when he couldn’t find a word he would try and “*go around it and choose an appropriate word***”, which represented an effective and proactive strategy that he was drawing upon consciously to compensate for his language difficulties. This was similar to the types of word finding strategies employed by members of the healthy control group.

**Embarrassing.** The 3rd emergent theme captured T1’s most prominent emotional reactions in response to his language symptoms. This encompassed the related concepts: *embarrassing, anxiety, and amount.* *Embarrassing* was the most prominent concept within this theme, counted 5 times. On 2 occasions T1 referred to “*embarrassing gaps***” that occur during
conversation or when asking questions at professional meetings. He later qualified this as “mildly embarrassing” not wanting to overstate this feeling or response. Anxiety was another prominent concept within this theme also receiving 4 counts within the transcript. T1 described “a certain amount of performance anxiety” and “anticipatory anxiety” related to language use in professional meetings, conversation and other related tasks like giving a speech at his daughter’s wedding. Anxiety was strongly connected to notes and amount, which indicated that T1 used note-taking and pre-planning to help manage this anxiety. He further qualified that he didn’t want to “emphasise” his feelings of anxiety, or associated frustration, as this wasn’t a “big issue”. Integrating the meanings within this theme it was inferred that T1’s language difficulties were having some degree of emotional impact, qualified to be mild in nature. As such, pervasive worry or significant withdrawal from life roles or activities was not evident.

Other themes. The most prominent concepts were encompassed by the above themes, conveying the most important meanings within T1’s transcript. The other themes, used, certain, talked, time, thinking, names and trouble were still examined, with multiple reading of the relevant transcript excerpts however only a few points of interest were identified. In regards to talked this further highlighted T1’s decision not to talk to his children or committee members about his difficulties yet, with disclosure a very personal decision. Trouble was linked to difficulties with reading however T1 noted that this was due to vision impairment not comprehension or language difficulties.

Summary T1. T1’s subjective-insights and concept map demonstrate his strong awareness and understanding of his PPA, which were consistent with his mild stage of disease, identified cognitive strengths, and medical background. The most important theme and concept, difficulties, captured T1’s early, acute awareness of language symptoms, which he perceived to be ‘expressive’ and ‘formulatory’ in nature. T1 described a reduction in speech fluency, with a ‘hesitation’ when trying to formulate words and speak spontaneously. This was consistent with the significant reduction in fluency and communicative efficiency captured by his system-profile. Interestingly, T1 was able to differentiate aspects of language performance that were related to his PPA as opposed to ageing processes and he clearly perceived symptoms of ‘loss’.
This differentiated his concept map from the healthy ageing controls who as a group did not perceive language symptoms to be ‘difficulties’ per se or markers of disease or pathology. Furthermore, while T1’s concept map was suggestive of positive psychosocial adjustment overall, his emotional reactions were notably stronger than those that emerged from the control transcript. The concepts embarrassing, hesitate and anxiety conveyed more significant emotional impact than that associated with healthy ageing. T1 did not want to overemphasise these feelings, which suggested effective emotional-regulation and control, consistent with his positive ratings of mood, wellbeing and QOL that were captured by his system-profile. It would be of interest to track how his emotional responses evolve over time, particularly as language symptoms become more pronounced.

In regard to patterns of adaptation, the concepts to emerge from T1’s transcript provided evidence for both adaptive and maladaptive processes. Overall, similar to the healthy ageing controls, T1 appeared to be drawing upon problem-focused and proactive coping strategies, consistent with preserved cognitive strengths or strategic competence. He had actively sought diagnosis and was seeking information, strategies and ideas to support his language symptoms in the post-diagnostic phase. Still, evidence for maladaptation was evident, consistent with his negative emotional reactions and reduced self-efficacy for certain speaking contexts (analysis one). As such, his perceived formulatory difficulties were associated with subtle maladaptive responses, captured by concepts like hesitate and questions. While overt withdrawal was not evident, T1 was aware of a hesitation to ask questions at meetings and to get as involved in conversations as he would have previously. This was identified as a functional consequence of his perceived language changes that were not captured by the healthy ageing control maps, where avoidance and withdrawal mechanisms were not evident. Overall however it appeared that T1 was maintaining self-regulatory control, which set his profile apart from the other participants with PPA.
Figure 6.2. Leximancer concept map for T1. The top 50% of concepts are shown.
**T2 concept map.** Given the severity of T2’s expressive language impairment her husband contributed actively to the interview and his responses were included in the LeximancerTM analysis. The shared concept map is provided in Figure 6.3 with 100% of concepts shown to capture the contribution of both T2 and her husband. The proximity of concepts and themes to T2’s husband’s speaker tag shows that he contributed most actively to the transcript, which was taken into account when examining and interpreting the results. The 10 most frequent concepts to emerge are shown in Table 6.4 with the associated counts and relevance scores. The most prominent themes were: T2 (100%), happy (58%), feel (3%), avoid (2%), and books (1%). The top 50% of concepts were encompassed by the first two themes, which will be examined in most detail below. Avoid and feel were also examined under other themes given their close proximity to T2’s speaker tag.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Count</th>
<th>Relevance (%)</th>
<th>Top five related concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happy</td>
<td>5</td>
<td>14</td>
<td>feel, wanted, home, told, time</td>
</tr>
<tr>
<td>home</td>
<td>5</td>
<td>14</td>
<td>feel, daughter, husband, wrong, wanted</td>
</tr>
<tr>
<td>comes</td>
<td>5</td>
<td>14</td>
<td>daughter, words, phone, trying, time</td>
</tr>
<tr>
<td>trying</td>
<td>4</td>
<td>11</td>
<td>noticed, changes, computer, trying, understand</td>
</tr>
<tr>
<td>time</td>
<td>4</td>
<td>11</td>
<td>words, wrong, wanted, happy, home</td>
</tr>
<tr>
<td>wrong</td>
<td>3</td>
<td>8</td>
<td>noticed, changes, computer, understand, words</td>
</tr>
<tr>
<td>wanted*</td>
<td>3</td>
<td>8</td>
<td>happy, time, home</td>
</tr>
<tr>
<td>told*</td>
<td>3</td>
<td>8</td>
<td>trying, happy</td>
</tr>
<tr>
<td>doing*</td>
<td>3</td>
<td>8</td>
<td>typing, sense, trying</td>
</tr>
<tr>
<td>phone*</td>
<td>3</td>
<td>8</td>
<td>comes</td>
</tr>
</tbody>
</table>

a. The relevance score provides a measure of the relative importance of a concept. The most frequently occurring concept within the corpus receives the highest value. The relevance of each consecutively ranked concept then represents its importance relative to the highest ranked concept (Rooney et al., 2010). *Connected to less than five other concepts.

**T2.** T2 emerged as the strongest theme from the data given that her husband used her name throughout the interview when describing her difficulties and their psychosocial impact. This theme contained a number of prominent concepts that captured the nature of her difficulties and their onset. In order of prominence these concepts were: T2, trying, wrong, understand, words, sense, change, computer, told, noticed, doing, typing, sure, and memory.

**Trying** received 4 counts in the transcript and was the 4th most prominent concept overall. Firstly, this indicated that T2 often placed significant pressure on herself when trying to
recall words and access her language system, which T2’s husband felt was a key contributor to her difficulties. This is illustrated by his following comment: “Trying too hard, she’s trying to hard, that’s what it is. I told her to relax I said to her relax”. While a cognitive load effect emerged from the healthy control concept map, for T2 it was more prominent and having a more significant impact on her language performance and functional ability. Trying also captured the onset of T2’s language difficulties, which were first noticed when she was working as a volunteer tutor. Her husband described “she was trying to communicate something to one of the students and ah she would just hang for words and be embarrassed so she pulled out of that and ah and was much easier after that you know but didn’t know what it was and first of all I couldn’t understand that there was something wrong”. This indicated that despite conscious effort she wasn’t satisfied with her ability to communicate with her students successfully, which resulted in immediate withdrawal from this position. This was inferred to provide insight into T2’s emotional reactions, coping style and adaptive mechanisms. Furthermore, this suggested that the withdrawal was successful in enabling T2 to regain control and prevent the distressing symptoms from occurring.

Wrong was also an important and prominent concept within this theme further relating to the onset of T2’s language difficulties and the acute sensitivity she had to the early signs of PPA. This was despite her husband not being able to detect the emerging changes or to understand why she was finding them so distressing. Her husband described: “There’s something wrong with me she’d say!” and I’d say, “Darling there’s not”. Wasn’t as hesitant you know, “What’s wrong with you?” you know”. This concept also captured his efforts to support T2’s language difficulties, which was challenging at times. He noted that this could cause frustration for T2, “especially if she gets too much help like prompting and its wrong prompting”. It was evident that they had a strong partnership and her husband worked very hard to support her language and protect her emotional wellbeing, while attempting to understand the nature of the problems that she was experiencing.

The T2 theme also captured the challenges that she had faced during the diagnostic process and the uncertainty regarding her early symptoms. This was illustrated by the concepts
understand and told further highlighting the initial difficulty T2 had experienced understanding her early symptoms. Unlike the control participants, these changes could not be ‘normalised’ by T2 and were clearly perceived as distinct from natural ageing processes. Her husband reinforced: “we didn’t know what it was and first of all I couldn’t understand that there was anything wrong other than that sometimes she wouldn’t answer me”. They saw two specialists who were unable to provide a clear diagnostic explanation of her symptoms. They visited a third specialist who made the diagnosis of PPA and helped them to understand the changes that were taking place. This was met with a mix of relief and concern, given the progressive nature of the syndrome, without a cure.

Happy. Happy was the 2nd most prominent theme to emerge from the transcript encompassing the connected concepts: happy, doctor, home, and comes. Happy received 5 counts within the transcript, strongly indicating that T2 felt ‘happiest’ at home (i.e. “I don’t feel happy away from home. I don’t feel happy”). This was further reinforced by her husband stating: “We’re now retired with each other and just very happy together at home it’s more comfortable isn’t it”. This emphasised the strength of their relationship, while suggesting that T2 attempted to control the impact of her language difficulties by staying at home and avoiding situations that challenged her system or caused distress. On one occasion happy was related to T2’s diagnosis, also captured by the concept doctor. Her husband stated, “The Doctor... did all the tests and told us flat out between the eyeballs exactly what it was and that seemed rational and reasonable and right. We weren’t happy to hear it, but we know where we are exactly, yes”. This suggested that receiving a diagnosis or answer for T2’s symptoms was met with a sense of relief and adequately explained the symptoms she was experiencing. Even though the diagnosis was distressing for them both they appreciated being told directly. In response, T2’s husband noted that they had made a conscious effort to manage “the best we can” and described a range of strategies that they were employing to ‘handle’ the difficulties and minimise the distress and worry for T2 that will be described further below.

Home also emerged as a prominent concept receiving 5 counts within the transcript. This further reinforced that T2 felt most comfortable at home. It was evident that most social
occasions and contact with family was now taking place at their home. T2’s husband also noted that her speech was better when speaking to him at home stating, “I think there is a general self-consciousness that overlays all of this so that (she) is less hesitant when talking to me at home then she is in answering your questions – it could be less that you’re seeing today”. This further highlighted the impact of cognitive load and both internal and external parameters on T2’s language competence and performance. This was positive in a sense, indicating T2’s potential for improved language performance within a context or environment that she felt comfortable and supported within. In response to the cognitive load effects, T2’s husband noted that they planned to ask family to visit individually or in small groups, given that large groups were overwhelming and confusing for T2. Other strategies like these were described, again focussing on providing a supportive environment, while bolstering and protecting T2’s emotional wellbeing.

**Other themes.** The other themes to emerge from the transcript were *feel, avoid,* and *books.* *Feel* and *avoid* were the concepts in closest proximity to T2’s speaker tags, encompassing her most prominent concerns. *Feel* contained the concepts *feel* and *talk*. This captured T2’s feelings of distress away from home and her description of her primary difficulties, “I can’t talk and I can’t type and um reading I have trouble reading”. She also stated, “I can’t get on the phone”, which together highlighted the perceived severity and functional impact of her language difficulties. It was clear that T2 perceived profound loss of language function with no ability to talk and was very focused on her impairments, unable to see any residual strength within her system. When describing her difficulties during the interview visible signs of distress were evident through her body language and facial expressions, which her husband was very responsive to. The theme *avoid* was also of significance to T2, encompassing the concepts *avoid* and *use*. When asked about social interactions with friends she responded, “I tend to avoid it”. When asked if there were any social situations where she felt more comfortable she repeated again “I try and avoid it”. When asked directly, T2 endorsed that she did miss social contact with friends, however it was apparent that the stress provoked was a significant barrier to social participation. *Use* referred to
a brain training computer program that T2 was currently using, completing daily brain stimulation and cognitive practice, as well as daily physical exercise. She reported that this training was going well with steady improvement in her scores for trained functions. It appeared that this kept her engaged at home with a sense that she was actively doing something in response to her PPA.

**Summary T2.** T2’s concept map provided evidence for strong insight and awareness of language symptoms, perceiving profound speech difficulties. It was clear that T2 was experiencing severe loss or impairment associated with her PPA with a perceived inability to talk or use the phone. While her system-profile in analysis one revealed a severe reduction in communicative efficiency, it was apparent that she perceived ‘excess impairment’, unable to identify any relative strengths within her language system. This was associated with profound psychosocial impact and poor adjustment to her PPA that emerged from her concept map, consistent with her low ratings of wellbeing, mood and self-efficacy (analysis one). Similar to T1, it was clear that T2 had been acutely aware of emerging symptoms at a very early disease stage, before they were obvious to her husband or detectable by early screens for dementia. This was associated with immediate negative emotional responses with reactive worry, distress and anxiety reported. As a result, clear differences were evident when comparing T2’s perceived language changes and associated emotional reactions to the concept map of the healthy ageing control group. Furthermore, her concept map revealed the most profound psychosocial impact of the participants with PPA, despite her relative strengths in terms of communicative informativeness and linguistic competence (analysis one). This indicated that impairments within the social-emotional domain were more sensitive markers of disease expression and impact for T2 as compared to measures of cognitive-linguistic function, which is of clinical and theoretical importance.

In regard to adaptation, T2’s concept map was also notably divergent to that of the healthy ageing control group. The severity of overall disease impact was intensified by the presence of maladaptive, emotion-focused coping strategies with patterns of withdrawal and avoidance emerging strongly from her concept map. As a result of the severity of perceived
speech difficulties and her low levels of self-efficacy and control, T2 no longer felt comfortable outside the safety of her own home. Her concept map indicated a strong emotion-focused coping style with strong evidence for avoidance and withdrawal from speaking-related contexts. This had profound implications for her engagement and participation in everyday life, with excess disability evident. The impact of cognitive load and external, environmental parameters was evident, with her husband describing a degree of self-consciousness that overlayed her difficulties. This suggested potential for improved communicative performance when she felt comfortable and her emotional responses were better controlled. T2’s concept map strongly supports the need for timely diagnosis and provision of early, holistic and interprofessional intervention services.

![Figure 6.3: Leximancer concept map for T2. 100% of concepts are shown to capture the contribution of T2 and her husband (SPEAKER_husband) to the semi-structured interview.](image)

**T3 concept map.** T3’s wife was present during the semi-structured interview to clarify points or facts that T3 was unable to recall or explain however T3 made the most significant contribution to the interview. Given that his personal insights were of primary interest to the research questions only T3’s responses were included in the Leximancer™ analysis. Table 6.5 provides a list of the 10 most prominent concepts to emerge from the transcript with the associated counts and relevance scores. As shown by the concept map in Figure 6.4, the themes to emerge from T3’s description of perceived changes in his language system and response were: *tell* (100%), *people* (59%), *things* (31%), *doing* (23%), *happened* (18%), *listen* (7%), and *main* (1%). The top 10 concepts were captured by the first 4 themes. The top 3 themes will be examined and described in most detail.
Table 6.5

*T3 Leximancer*TM Identified Word-like Concepts and Relative Frequencies

<table>
<thead>
<tr>
<th>Concept</th>
<th>Count</th>
<th>Relevance (%)a</th>
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</thead>
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<td>saying, time, life, telling, working</td>
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<tr>
<td>talk</td>
<td>5</td>
<td>10</td>
<td>hearing, holding, name, working, feel</td>
</tr>
<tr>
<td>sudden</td>
<td>4</td>
<td>8</td>
<td>time, saying, telling, started, life</td>
</tr>
<tr>
<td>remember</td>
<td>4</td>
<td>8</td>
<td>time, word, saying, sudden, doing</td>
</tr>
<tr>
<td>doing</td>
<td>4</td>
<td>8</td>
<td>hearing, feel, name, tell, remember</td>
</tr>
</tbody>
</table>

a. The relevance score provides a measure of the relative importance of a concept. The most frequently occurring concept within the corpus receives the highest value. The relevance of each consecutively ranked concept then represents its importance relative to the highest ranked concept (Rooney et al., 2010).

Tell. The most prominent theme to emerge was tell, encompassing the concepts: tell, telling, sudden, used, talk, remember, saying, and time. This theme captured the most significant difficulties that T3 was experiencing and conveyed marked changes within his language system. The related concepts tell, telling, talk and saying received 10, 6, 5, and 2 counts within the transcript respectively. They conveyed similar meaning highlighting that T3’s perceived language changes were predominantly expressive in nature. For example, T3 stated, “Oh that’s how it starts off, I start to try and tell this story and then boom, I can’t tell any of this story” and “I can’t tell people. I go and talk to people, I go in I say “How you doing” you know and then I I can’t, I can’t tell them”. This indicated that the perceived changes were significant and characterised by loss of function, contrasting to the more momentary and mild lapses in memory or recall described by the healthy ageing controls. It was evident that the changes were more prominent than word finding difficulties alone and that they occurred suddenly with significant impact. He had a strong sense that his difficulties were a divergence from normal stating, “but this is what happened to me in the last three months, three years. I never had that trouble and all of a sudden I started, started ah coming down, falling down”. It was evident that T3 was still trying to understand the nature of his evolving difficulties (e.g. “I couldn’t tell what this one was or that one, it was strange”) and as a result, he was seeking information and support (e.g. “The only things that I like to talk about and find out about is learning how to talk to things, see
I, that’s what’s holding me up when I think about it. I’m being held up because I can’t say them extra things.”). T3 often referred to his difficulties as trouble ‘remembering’ however the text excerpts linked to the remember concept referred more to language and talking difficulties, as opposed to memory problems. Furthermore, T3 clearly indicated that his ability to “talk about things” was the main issue “holding him up”, signifying that his language difficulties were his primary complaint, consistent with his diagnosis of PPA.

In response to his ‘talking’ and ‘telling’ difficulties T3 described a number of avoidant coping strategies or withdrawal responses, for example he stated “I’ve got to shut up” and that he “got to the stage where (he) didn’t want to know anyone”. This loss of control was intensified by a sense that there was not anything he could do to help the problem stating, “I can’t I can’t do anything about it” and “Oh I felt, I I felt terrible, because I I just felt as though I would never be able to get over that. I still do really. I still do”. T3 indicated that he found it easier to talk to his wife and daughter, experiencing greater difficulty with other people, including his ‘good friends’. For example, he commented, “Oh, like sometimes I I I would walk up with my wife here I’d talk to her about it with no worry at all, but ah like my friend, we were here just recently and I couldn’t tell him a thing and we’re good friends.” This suggested that cognitive load and both internal and external parameters impacted on his language performance, as well as his related self-efficacy or beliefs about his current functional abilities.

People. The 2nd most important theme to emerge from T3’s transcript was people. The most prominent concepts within this theme were: people, knew, and name. People and name were strongly related, indicating that T3 was often unable to recall people’s names: “See yesterday, twice I went there, speak to these people, they knew me, they sung out to me but I couldn’t think of their names”. T3 noted that names often came to him at a later time, for example he stated, “But often when they go I can tell the name”. This was similar to the healthy control participants. The people theme also emphasised that one of T3’s most prominent issues related to talking “to people”, with clear implications for his social interaction and interpersonal relationships. In response to his speech difficulties, T3 expressed a desire to avoid people and social occasions illustrated by the following excerpt: “I find that I try to hide away
from people”. He also conveyed a sense of unease or discomfort around people, noting, “I’m a bit weary of them, I’m a bit unsure of them”. While this was interpreted as an avoidant coping strategy in response to his difficulties, it was also related to T3’s personality traits. When asked to expand on his tendency to avoid social interactions T3 noted, “I was always a bit frightened. My wife always had more nerve then I ever did”. However, he was aware that his social anxieties had been intensified by his emerging language difficulties, with a marked change in his social participation since the onset of his PPA.

The people theme also encompassed the concept knew, which received 10 hits in the transcript. This captured T3’s awareness of very early changes within his language system as they were occurring and a perception that the changes were divergent from normal ageing processes. For example, T3 stated, “No it was four or five years I’d say ah, yeah you know a little bit at a time and then it went on and on and on and I knew that I was gradually ah”. T3 was sure that other people had noticed his emerging difficulties stating, “You know and they knew, they knew that I was ah ah not repeating properly, but I couldn’t, I couldn’t, I couldn’t remember it”. This indicated that he was unable to mask or hide his language breakdown when it occurred, which was associated with self-consciousness in relation to his difficulties.

Things. The 3rd theme to emerge from the transcript was things, encompassing the concepts things, working and life. Things was the most prominent concept to emerge from the transcript overall, receiving 12 counts and strongly connected to the concepts trouble, working, and listen. Like the healthy controls, T3 often used ‘things’ when describing his difficulties, indicating that he was unable to identify specific words or topics of conversation that were more problematic (e.g. “I can’t say them extra things”, “We’d be telling things and I’d stop – I’d stop and I couldn’t do it”). T3 also used things when experiencing a word finding difficulty during the interview, which also resulted in non-specific attempts to circumlocute. The following excerpt illustrates this along with his response, “No no the things that they, when you get, when you get a kid, when you get ah picked up and ah you start ah, oh God, this is what happens”. This demonstrated the semantic nature of T3’s language difficulties, as well as his acute awareness of breakdown as it occurred online. His off-task commentary was suggestive of
hypervigilance and sensitivity to his word finding difficulties and language breakdown, which was at times disruptive to his ongoing language performance diverting his attentional resources and placing increased demand on his system.

**T3 other themes.** The other themes to emerge included *doing, happened, listen,* and *main.* Examining the excerpts within these themes did not reveal many additional insights into T3’s perceived difficulties or responses. The text excerpts further supported the finding that T3’s difficulties related to verbal expression and that his trouble started about four or five years earlier. Of significance, an excerpt linked to *happened,* indicated that T3 had been convinced that he had been living with dementia for some time (i.e. “Right up until this day as far as I was concerned I was convinced that that was what was happening”).

**Summary T3.** Despite T3’s reduced communicative efficiency and informativeness (analysis one), his subjective-insights and concept map were a rich source of information, providing evidence of retained insight and awareness of evolving symptoms. Like T2, he described awareness of emerging language symptoms and a sense of something being ‘wrong’ long before his wife had been able to detect the changes. His personal constructions of disease were captured by difficulties ‘telling stories’ and ‘talking about things’, with difficulties perceived as ‘sudden’ and unexpected during conversation. These perceptions of loss, impairment and reduced control differentiated T3’s concept map from that of the healthy ageing control group. Furthermore, strong evidence for reactive worry and distress was evident, with T3 unable to explain, understand, or normalise his language changes in the way that the healthy ageing controls were able to. This was further reflected by his off-task commentary and hyper vigilant monitoring.

In response to his perceived language difficulties and associated emotional distress it was not surprising that evidence for emotion-focused coping strategies emerged from T3’s concept map, further differentiating his profile from the control group. He admitted that he tried to hide away and was more reluctant to talk to people, despite encouragement from his wife to attend social events and gatherings. This was consistent with his reduced self-efficacy ratings (analysis one). Furthermore, T3 was aware that he did not have any strategies or ways of
supporting his language difficulties, which appeared to intensify his distress and worry. This was again discrepant to the proactive strategies and trust in their system that was conveyed by the healthy ageing controls. It was evident that T3’s emotional responses and symptoms related directly to his language symptoms and speaking-contexts. This may explain why his QOL-AD and WHO-5 ratings (analysis one) remained within the healthy control range, maintaining satisfaction in aspects of his life that were not dependent on language. This highlights the critical need for social-emotional scales specific to PPA and also the value of subjective-insights for exploring the true nature and impact of disease.

*Figure 6.4. Leximancer concept map for T3. The top 50% of concepts are shown.*
**T4 concept map.** T4 and his wife attended the initial interview. Given the severity of T4’s expressive language difficulties his transcript was the most difficult to analyse qualitatively and as such, his wife’s comments were included in the Leximancer™ analysis reported. The shared concept map is shown in Figure 6.5 and the 10 most frequent concepts to emerge from the transcript are listed in Table 6.6 with the associated counts and relevance scores. The most prominent themes to emerge from the transcript were: *feel* (100%), *time* (17%), *probably* (5%), *months* (4%) and *words* (1%). Less connectivity was evident within T4’s concept map, which reflected the disordered nature of his responses that were fluent, yet non-specific. While his perceptions of his language changes and reactions were less evident, the Leximancer™ analysis revealed some interesting aspects of his experience living with PPA and the nature of his language disorder, which will be examined and described thematically below.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Count</th>
<th>Relevance (%)</th>
<th>Top five related concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>feel</td>
<td>26</td>
<td>59</td>
<td>virtually, things, papers, met, started</td>
</tr>
<tr>
<td>virtually</td>
<td>26</td>
<td>59</td>
<td>feel, things, papers, met, started</td>
</tr>
<tr>
<td>time</td>
<td>11</td>
<td>25</td>
<td>tell, things, started, lovely, hours</td>
</tr>
<tr>
<td>involved</td>
<td>8</td>
<td>18</td>
<td>what-have-you, words, things, reckon, started</td>
</tr>
<tr>
<td>talk</td>
<td>7</td>
<td>16</td>
<td>what-have-you, lovely, involved, papers, kept</td>
</tr>
<tr>
<td>reckon</td>
<td>6</td>
<td>14</td>
<td>involved, problem, kept, things, started</td>
</tr>
<tr>
<td>things</td>
<td>4</td>
<td>9</td>
<td>started, papers, lovely, doing, involved</td>
</tr>
<tr>
<td>started</td>
<td>4</td>
<td>9</td>
<td>things, paper, lovely, doing, involved</td>
</tr>
<tr>
<td>people</td>
<td>4</td>
<td>9</td>
<td>kept, reckon, talk, feel, virtually</td>
</tr>
<tr>
<td>months*</td>
<td>4</td>
<td>9</td>
<td>tell, probably, time</td>
</tr>
</tbody>
</table>

* The relevance score provides a measure of the relative importance of a concept. The most frequently occurring concept within the corpus receives the highest value. The relevance of each consecutively ranked concept then represents its importance relative to the highest ranked concept (Rooney et al., 2010). *Connected to less than five other concepts.

**Feel.** The most prominent theme was *feel*, encompassing the concepts: *feel*, *virtually*, *involved*, *talk*, *things*, *reckon*, and *started*. *Feel* and *virtually* were strongly related concepts reflecting the language used by T4 when attempting to describe his difficulties and respond to the interview questions. *Virtually* received 26 counts within the transcript and represented a stereotypical word that T4 used repeatedly as a filler, rather than to convey meaning (e.g. “I’ve got virtually, pretty nice things to do, I can do, like virtually. Like and I feel virtually good virtually the fact, as far as the body, my body is concerned”). His natural language and
conversational speech was littered with this term, signifying the value of a tool like Leximancer™ in detecting and quantifying the prevalence and function of stereotypical words or phrases like these. “Reckon”, “lovely”, and “what-have-you” emerged as other stereotypical words used by T4, although not to the same degree as virtually.

The theme feel also encompassed the steady decline in language that T4 had experienced indicating that ‘talking’ was his primary difficulty. He stated, “Yes, oh my, you know, we always go some, we’d go to the dance, I couldn’t talk to them properly” and “I just sort of, I couldn’t talk and what-have-you is involved. I don’t know what it was”. This indicated that T4 was aware of his language difficulties and that they remained his primary concern or problem. Furthermore, it was the progressive and significant nature of his speech difficulties that prompted him to seek medical opinion, stated that his speech “kept on going down, down, down”. T4 noted that his difficulties had become more pronounced approximately two years earlier. His wife described: “It was more like a loss of ability, well getting older perhaps... it was almost as if, ‘Oh I’m getting older’ but it was much quicker, much worse”. This suggested that his early changes were more prominent than would be expected as a result of ageing processes alone, indicating that they were both aware of the significance of these early changes.

Examination of text excerpts linked to the concept started indicated that T4 had perceived improvements in his talking after receiving his diagnosis and follow up services. T4 was the only participant who had been seen by a speech-language pathologist prior to enrolling in the study, which had included assessment, education, and provision of speech exercises to practice at home. After this input he noted that his talking ‘started to improve’ and as a result he had continued to practice the exercises every day. His wife confirmed the positive outcomes of these strategies stating, “the improvement is amazing”. It was inferred that the information and support provided might have reduced some of the anxiety, frustration and worry that was evident pre-diagnosis, facilitating some improvement in language function. Furthermore, one of the key strategies T4 had been taught was to ‘stop, think and take his time’ when speaking, which was also assisting his control and language performance. Both of these strategies have
merit within a dynamic systems and resource allocation account of language performance however require further research and investigation.

**Time.** The second most prominent theme to emerge was *time* which encompassed the concepts *time* and *people*. The most relevant excerpts relating to *time* related to his medical history and diagnostic search, with his wife describing when he saw different specialists and the periods of time that had been more difficult or distressing for T4 since the onset of his PPA symptoms. This was essentially the period leading up to receiving his diagnosis, which had been a distressing and uncertain time. In regard to his diagnosis his wife noted that they had accepted his symptoms some time ago and that “*putting a label on it really didn’t make a difference*” other than allowing them to access needed services. His wife did however note that “*it was a relief rather than anything*”, signifying the importance of having an explanation for the changes and symptoms experienced.

In regard to the connection between *time* and *people* it was evident that T4 was still able to engage in basic social-exchange with family and friends. The following excerpts illustrate this finding: “*in a social sense, he’s almost at, well, he is at the stage, people don’t know*” and “*in a group of people, you really wouldn’t pick it up*”. This was positive, indicating that T4 had preserved social communication skills that enabled him to maintain his inter-personal relationships and to participate at social events to some degree that he continued to attend with his wife. As such, themes of avoidance or withdrawal did not emerge from T4’s transcript however the emotional impact of his difficulties was evident.

**T4 other themes.** The other themes, *probably, months* and *words* were less prominent and examination of the text excerpts did not provide further insights into the research questions.

**Summary T4.** While T3 and T4 presented with similar system-profiles, the severity and more advanced nature of T4’s PPA was evident during the semi-structured interview. He was unable to contribute as much meaningful insight into his perceived language difficulties and associated responses as compared to T3; however evidence of preserved insight was still evident. Although non-specific, T4 described difficulties ‘talking’, despite his ‘body’ being ok. Like the other participants with PPA he perceived his language symptoms to be expressive in
nature and comprehension difficulties were not described by T4 or his wife. T4 was unable to describe his emotional reactions, responses or coping strategies; however overt signs of distress and anxiety were visibly observable during the interview when speech difficulties were experienced. It was clear that like T2 and T3, T4 had experienced difficulty understanding or making sense of his difficulties prior to receiving a diagnosis. His wife supported this notion by stating that his mood and frustration levels had improved since receiving the diagnosis and receiving some initial support from a speech-language pathologist. This highlights the risks of a protracted diagnostic search in regard to psychosocial outcomes. Of clinical importance, the concept *virtually* emerged as an important concept from T4’s transcript, which was used by T4 as a filler or stereotypical phrase. This demonstrates the potential use of Leximancer\textsuperscript{TM} for detecting the emergence of divergent speech characteristics associated with PPA that may have diagnostic value.

![T5 concept map.](image)

**T5 concept map.** Given the severity of T5’s expressive language impairment his wife’s contributions to the interview were included in the Leximancer\textsuperscript{TM} analysis. The shared concept map is provided in Figure 6.7. The map reveals that T4 did not contribute actively to the interview. The most frequent concepts to emerge from the analysis are show in Table 6.8. The most prominent themes to emerge from the transcript were: *used* (100%), *sits* (44%), *things* (23%), and *yeah* (14%). The four most prominent themes are examined and presented below.
Table 6.8

T5 Leximancer™ Identified Word-like Concepts and Relative Frequencies

<table>
<thead>
<tr>
<th>Concept</th>
<th>Count</th>
<th>Relevance (%)</th>
<th>Top five related concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>things</td>
<td>5</td>
<td>13</td>
<td>conversation, night, noticed, used, talk</td>
</tr>
<tr>
<td>used</td>
<td>3</td>
<td>8</td>
<td>conversation, tend, sit, sits, talk</td>
</tr>
<tr>
<td>sits*</td>
<td>3</td>
<td>8</td>
<td>tend, conversation, sit, used</td>
</tr>
<tr>
<td>talk*</td>
<td>3</td>
<td>8</td>
<td>night, understand, used, things</td>
</tr>
<tr>
<td>speech*</td>
<td>3</td>
<td>8</td>
<td>feel, worried, night</td>
</tr>
<tr>
<td>finding*</td>
<td>3</td>
<td>8</td>
<td>word</td>
</tr>
<tr>
<td>word*</td>
<td>3</td>
<td>8</td>
<td>finding</td>
</tr>
<tr>
<td>noticed*</td>
<td>3</td>
<td>8</td>
<td>love, things</td>
</tr>
<tr>
<td>understand*</td>
<td>3</td>
<td>8</td>
<td>talk</td>
</tr>
<tr>
<td>love*</td>
<td>3</td>
<td>8</td>
<td>noticed</td>
</tr>
</tbody>
</table>

a. The relevance score provides a measure of the relative importance of a concept. The most frequently occurring concept within the corpus receives the highest value. The relevance of each consecutively ranked concept then represents its importance relative to the highest ranked concept (Rooney et al., 2010). *Connected to less than five other concepts.

**Used.** The most prominent theme to emerge from T5’s transcript was *used*, encompassing the concepts: *used, things, T5, conversation, talk, sit,* and *night.* This theme captured the most significant changes experienced and some of the functional implications of his difficulties. *Used* received 3 counts in the transcript, referring to the shifts in T5’s previous communication style and functional abilities. For example, T5 stated, “Well, I used to talk a lot and where I don’t talk much now”. His wife concurred that “whereas once (he) used to hold the floor, and I would sit back and be the one that was, his partner I’d be listening. Now I tend to have the conversation and he sits back because otherwise, he just sort of sits back and listens”. This conveyed a general reduction in T5’s participation and engagement in social interactions and conversation. Similarly, his wife reported that “he stopped using the phone and things like that, obviously because it’s too difficult to carry on a conversation with him”. This highlighted the functional consequences of his speech difficulties, but also indicated a lack of drive or motivation to connect with friends. His wife noted that he doesn’t seem to “miss” talking to friends despite her continued encouragement to “give them a call”, that they would “understand” his difficulties, and be “pleased to hear from (him)”. T5 reacted to this encouragement with a smile and “yeah” indicating that it was not of great concern or worry to him. *Things* was the most prominent concept within the transcript, receiving 5 counts. His wife noted that “his reactions to things aren’t as quick” signifying difficulties beyond his language
system, however still indicated that his difficulty finding words was “one of the first things (he) would have noticed”.

Sits. Sits was the 2nd most prominent theme to emerge from the transcript, with the underlying concept receiving 3 counts. This theme captured T5’s tendency to talk about topics or issues that weren’t relevant to the interview questions or topics of discussion. Sits refers to explanations of where he sits at the table, where his wife sits, and also the length of their table, which he talked about during the interview, unrelated to the questions asked. This may reflect the severity of his language impairment and receptive language difficulties. Alternatively, this may reflect his attention to and engagement with the interview process and/or his depth of insight as overall he appeared largely unconcerned about his difficulties.

The theme sits, contained the concept speech. For 2 of 3 counts this concept related to the act of ‘giving a speech’. While T5 was confident and able to give speeches in the past, this was no longer the case. T5 also commented that he was “a bit worried about (his) speech coming out”, which indicated some awareness of his language difficulties and functional concern however this was in response to a direct question and not expanded on or repeated elsewhere in the transcript.

Finding. Finding was the third most prominent theme to emerge from the transcript with the underlying concept receiving 3 hits and strongly connected to words. This indicated that word finding difficulties had been his primary presenting complaint and reason for seeking medical attention. His wife acknowledged that while word finding difficulties were common and a natural part of speaking (i.e. “You know how we all lose a word sometimes. Even young people”), she perceived T5’s difficulties to be more pronounced than ‘normal’ (i.e. “But with (T5) it was more frequently”).

Yeah. The final theme to emerge was yeah, with the underlying concept receiving 6 hits. The fact that this emerged as a prominent theme and concept highlighted T5’s reliance on this response. He did not elaborate on his responses and as such more closed questions were utilised during the interview to gain his perspectives and endorsement of the changes and reactions described by his wife. This style of communication was consistent of the overall
reports of reduced engagement and a tendency to sit back and take a more passive role in conversational exchange. His apathy and disregard of the severity of his difficulties was also part of this response style. This indicated the potential use of Leximancer™ in measuring the degree of active participation within conversation, detecting signs of apathy.

Other themes. Love and worried were the concepts in closest proximity to T5’s speaker tag on the concept map, revealing the most prominent contributions that he made to the text. He mentioned on two occasions that he ‘loved’ his wife, conveying their close relationship. On one occasion he mentioned ‘worry’ about his language difficulties however given the closed nature of his responses (relying heavily on “yeah”) limited insight into his perceptions or the extent of this emotional response were gained. Overall, T5 appeared content with his current situation.

Summary T5. T5’s concept map and contribution to the semi-structured interview was consistent with his system-profile in analysis one, further supporting a passive, apathetic profile. Visual examination of T5’s concept map shows that he contributed little meaning to the interview, drawing upon closed responses that were often tangential and off-topic. This finding suggests that Leximancer™ could be used to identify and track changes in conversation style and interaction overtime, while simultaneously providing personal constructions of disease. His response pattern and contribution to the interview and concept map was quantitatively and qualitatively different to the subjective-insights of the healthy ageing control group and the other participants with PPA.

T5’s subjective-insights conveyed indifference to his symptoms, despite acknowledging their presence. This indicated some degree of insight and awareness, in the presence of overall satisfaction and contentment with his life. He stated on two occasions that he loved his wife, was happy with his living situation, and enjoyed contact with his family, even though he did not engage actively with them or initiate this contact. His wife’s descriptions of his early symptoms focused on language difficulties, consistent with PPA, however also conveyed his reduced motivation, drive and energy levels. His indifference to his symptoms and lack of concern was consistent with his QOL and WHO-5 ratings (analysis one). As a result, the psychosocial impact of disease was much less notable for T5 as compared to the other participants with PPA with no
spontaneous or active attempts to adapt to his symptoms or employ any compensatory strategies. This was divergent to the healthy ageing control map, which demonstrated greater evidence of proactive coping and compensation. As such, a different profile of disease expression, adaptation and therapeutic need was evident.

Discussion

The second level of analysis addressed the second objective of this thesis: To explore subjective-insights into the perceived nature of disease expression and associated psychosocial reactions to understand how individuals respond and adapt to language dissolution. This aimed to contextualise the system-profiles in light of personal constructions of disease to further advance understanding of the nature and impact of PPA. The findings provided rich insight into the research questions under investigation. The key findings to emerge from analysis two are summarised below:

1. Individuals with PPA perceive profound language symptoms and have acute sensitivity to early signs of language dissolution.
2. Individuals with PPA perceive and experience emotional and psychosocial consequences of language symptoms, which can be intensified by a protracted diagnostic-search phase.
3. Negative appraisals and emotional reactions in response to PPA symptoms can result in maladaptive or emotion-focused coping strategies with functional and psychosocial consequences.
4. Adaptation in response to PPA is a dynamic, emergent construct, mediated by a range of internal and external parameters (e.g. personality, prior experience, environmental support, self-efficacy, coping style, awareness and cognitive appraisal).

5. Personal constructions of disease and use of Leximancer™ have diagnostic and clinical utility, with potential to differentiate the subjective experience of PPA from that of healthy ageing, while identifying areas of individual therapeutic need.

Taken together, the findings provide further support for the significant social-emotional impact of PPA, associated with acute insight and awareness of language symptoms. As predicted, unique patterns of adaptation were evident for the five participants with PPA and the nature of their perceived language changes and emotional reactions were quantitatively and qualitatively different to the healthy ageing controls. The findings provide further support for a dynamic systems account of PPA and the clinical utility of the methodological approach employed. The key findings will be discussed in more detail below with reference to the research questions under investigation and the dynamic systems framework of PPA. Preliminary practice implications are outlined briefly however explored in more detail in the general discussion of this thesis.

**How do Individuals with PPA Perceive Language Symptoms?**

To address the first research question, the perceived language changes described by the participants with PPA and the healthy ageing control participants were systematically analysed and compared. As predicted, participants with PPA had strong insight into their language difficulties consistent with previous research (Banks & Weintraub, 2008a; Banks & Weintraub, 2008b; Medina, 2009; Rogalski & Mesulam, 2009). This indicated that individuals with PPA have a meta-cognitive ability to reflect on the integrity of their own language system across the early to mid-stages of disease providing rich and valuable insights into the nature of disease expression. More importantly, the individuals with PPA perceived language changes that were distinct to healthy ageing, supporting the utility of subjective-insights for aiding early diagnosis and detection of pathology (Rogalski & Mesulam, 2009). The nature of perceived difficulties
experienced as part of PPA and key differences to the healthy ageing control group are discussed in more detail below.

**Capturing the root diagnosis of PPA.** Firstly, it was evident that the perceived changes or symptoms were consistent with the root diagnosis of PPA (Mesulam, 2001), with the five cases describing primary difficulties with language. The perceived language changes or most prominent symptoms experienced were predominantly expressive in nature with very few concepts relating to comprehension or receptive language emerging from the PPA concept maps. Furthermore, the individuals with PPA perceived strengths in other areas of cognition and memory, as well as independence and preserved function in aspects of their lives that were not dependent on language. For example, all of the cases remained independent in their own personal care and continued to assist with domestic duties and household budgets. T2 kept track of all appointments with her husband joking that her memory was much better than his own, and both T1 and T3 continued to drive and access the community independently. T1 was the only participant who was still working or maintaining professional roles and responsibilities. T5’s subjective-insights were the most atypical, with evidence of personality change emerging from his concept map. Speech difficulties were still identified by T5 and his wife as the most salient symptoms and the earliest manifestation of suspected pathology or disease.

**PPA associated with more profound language difficulties than healthy ageing.** Interestingly, the concept map of the control group demonstrated near universal experience of word finding difficulties and trouble recalling names as part of healthy ageing. *Remember* and *name* emerged as important themes from the control interview transcripts, highlighting that trouble remembering words and names of people were prominent and common experiences for this sample. The control participants often referred to difficulties with words as ‘memory’ or ‘recall’ problems. Previous research has suggested that language processes are resistant to age-related changes and that word finding abnormalities are not a part of normal ageing (Clarnette et al., 2001; Rogalski & Mesulam, 2009). A study by Clarnette et al. (2001) found that memory-complainers were more likely to report word-finding difficulties than non-complainers and when coupled with lower cognitive-test scores may be a sign of prodromal dementia. For the
current sample, none of the control participants met criteria for dementia however the high occurrence of perceived word finding difficulties is worthy of further investigation. This is particularly important in the context of the current research given that the emergence of a new language disorder (including anomia) is assumed to be abnormal and attributed to PPA if a focal, neurodegenerative and non-vascular disease process is evident (Rogalski & Mesulam, 2009).

While the control participants described language changes, the concepts to emerge from the PPA concept maps revealed the experience of more profound language difficulties that extended beyond focal word finding difficulties alone. Comparing the PPA concept maps to that of the control group identified that themes pertaining to difficulties and trouble were more evident for the participants with PPA, signifying a stronger sense of pathology, loss and progressive decline that were not perceived as normal or part of healthy ageing as was the case for the controls. Furthermore, the language changes were more pervasive and ever present for the individuals with PPA as opposed to fleeting or benign as described in relation to healthy ageing processes.

It was evident that the language symptoms perceived by the participants with PPA aligned more with notions of communicative efficiency or changes in linguistic performance, as opposed to linguistic competence. That is, the language changes extended beyond trouble with words, to trouble telling stories, formulating language, talking to people and in the most severe case perceived inability to talk at all. Furthermore, greater cognitive load effects were evident, with fluctuations in performance over time and across contexts.

**Subjective-insights into PPA reveal acute sensitivity to early stage disease.** A final key finding in relation to the perceived language changes concerned the participants’ acute sensitivity to the emergence of PPA symptoms at a very early disease stage. Four of the cases (excluding T5) had actively initiated the search for diagnosis, indicating that they were more aware of emerging symptoms than their family, friends and/or medical specialists that were consulted at the time of onset. T2, T3 and T4 all spoke of a diagnostic struggle and a period of worry, uncertainty and frustration during the pre-diagnostic phase, due to their acute insight into
emerging and evolving difficulties that were not always recognised or understood by others. This supports previous PPA literature, which suggests that the individual patient with PPA has the greatest awareness of the language problems at the initial manifestation of disease and that these complaints should be taken seriously and not dismissed as psychosomatic or functional disorders (Rogalski & Mesulam, 2009). This self-initiated search for diagnosis is in contrast to Alzheimer’s disease where a carer or family member typically initiates medical advice and where there is continued debate regarding the disclosure of the diagnosis to the individual with dementia (Bunn et al., 2012).

**Subjective-insights and perceived language changes.** In summary, the individuals with PPA had strong insight and awareness, perceiving more profound language difficulties than the controls. Furthermore, each participant with PPA described and experienced their symptoms in different ways, with the concept maps capturing their most salient concerns. This highlights the value of conceptualising PPA in terms of a person’s own construction of disease, enabling personally relevant therapeutic targets to be identified. It is known that preserved insight and awareness are associated with enhanced therapeutic outcomes and as such should be capitalised upon via early intervention and support services for individuals with PPA (Clare, Wilson, Carter, Roth, & Hodges, 2004; Clarnette et al., 2001). Care pathways must recognise and validate the individual’s acute insight, seeking to understand personal constructions of disease.

**How do Individuals respond Emotionally to PPA?**

The second research question under investigation in analysis two sought to examine how individuals with PPA react emotionally to language symptoms and the emergence of PPA. As expected, given strong awareness and the profound nature of perceived language symptoms, the subjective-insights into PPA revealed significant emotional responses that were again different to the emotional experience of healthy ageing. Furthermore, the emotional responses appeared to be intensified by delayed diagnosis, during which time individuals with PPA can struggle to understand or make sense of language dissolution. T1 was the only participant with PPA who did not describe a protracted diagnostic search phase, which appeared due to his medical background and ability to navigate the health system and direct the diagnostic process.
In contrast, the other participants had been living with their PPA without support for up to five years prior to diagnosis. This came at a significant emotional cost, with the concept maps indicating that negative emotional responses can develop at a very early disease stage, consistent with the acute sensitivity to emergent disease. This highlights the critical need for timely diagnosis and provision of early support services. The emotional reactions will be explored below, drawing comparisons to the healthy ageing control group.

**The emotional experience of PPA versus healthy ageing.** Analysis of the concept maps indicated that the individuals with PPA were experiencing more pronounced emotional reactions and responses to their language changes as compared to the healthy ageing controls. This was consistent with the system-profiles to emerge from analysis one and results within the social-emotional component. The emotional experiences were unique to each individual with PPA, further highlighting the need to explore and understand personal constructions of disease.

**Healthy ageing.** The concept map for the healthy ageing control group indicated that fleeting feelings of frustration or annoyance were experienced in response word finding and recall difficulties however the control participants were not inclined to worry about the perceived changes. This was with the exception of C7 and C11 who presented with the most prominent emotional reactions within the control group. The negative emotions were most evident for C7, with concepts pertaining to *anger*, *worry* and *frustration* emerging from her transcript. This appeared to be strongly associated with her prior experience of caring for husband with Alzheimer’s disease, with heightened sensitivity to memory changes and acute awareness of symptoms of dementia. It has been reported in the ageing literature that an individual’s fear of dementia is socially constructed and deeply embedded in previous life experiences (Corner & Bond, 2004). Despite the more pronounced worry, no functional consequences emerged from C7’s subjective-insights, indicating that she was maintaining an engaged and socially active lifestyle, which appeared to differentiate her profile from the participants with PPA.

**Protective factors for emotional adjustment to age-related language changes.** With the exception of C7 and C11, the control participants were well adjusted to their perceived language
changes, with a number of protective factors evident. Firstly, the concepts to emerge from the control transcripts conveyed a retained sense of control or trust in their language system, with a belief that the words, names or other pieces of information would come with time. Secondly, a strong sense of camaraderie emerged from the concept map, indicating that the perceived changes were a shared experience and could be explained or understood through normalisation processes. This is consistent with previous research where reports of forgetfulness or memory lapses are not always sinister findings or of functional or psychosocial concern (Mitchell, 2008). For example, while C7 perceived her word finding and memory difficulties to be more pronounced than her friends, she still described a sense of shared experience and understanding from her friends, who were experiencing similar memory lapses or word finding difficulties. For other control participants this camaraderie was even stronger, for example C5 was able to laugh off her word finding difficulties as “another senior’s moment”, which indicated positive adjustment to her perceived age-related changes. These protective factors were not evident for the participants with PPA, perhaps explaining their more negative emotional responses.

The emotional experience of PPA. For the individuals with PPA the emotional reactions were more prominent. Concepts and themes relating to embarrassment, self-consciousness, worry, frustration, and anxiety emerged from the PPA transcripts, ranging from mild to profound. This is consistent with the findings of Medina (2009) who found that 93% of participants with PPA reported that they felt frustrated by word finding difficulties, 83% worried about their language problems, while 39% reported feeling sad or depressed; highlighting that negative emotions are experienced following the emergence of PPA symptoms. It was inferred that the negative emotions were associated with the participants’ strong insight and the uncertainty that they had regarding the changes taking place within their system. Given the subjective reports of uncertainty and worry, the low levels of self-efficacy reported in analysis one are not surprising, with potential implications for sense of self, perceived functional ability and self-worth. In comparison to the control group, the themes or concepts suggesting normalisation processes or camaraderie were not evident. This means that the emerging changes were not a shared experience with their spouse or friends of a similar age,
which could explain the feelings of uncertainty, worry and distress that were evident. This indicated that the symptoms were more perceived to be more sinister or markers of disease, which distinguished them from the healthy ageing controls.

In comparison to the healthy ageing controls, the participants with PPA did not have the same sense of trust in their language system and their language symptoms were perceived as more difficult to mask or control. T3’s concept map illustrates this, highlighting the unpredictable and prominent nature of his language difficulties that occurred ‘suddenly’ with a ‘boom’. He also described a sense of ‘falling down’ and a feeling that he would ‘never be able to get over’ his evolving problems. This was interpreted as a loss of control, which was also evident through his off-task commentary and hyper vigilant monitoring. His statements like “oh God, this is what happens” showed the emotional nature of his response. He also noted that his ‘nerves start going’ when breakdown occurred or when increased pressure was placed on his language system, which resulted in signs of heightened anxiety and worry during conversation.

Similarly, while T2 had significant difficulty explaining the nature of her difficulties and reactions, she also presented with a loss of control. Through statements like “I can’t talk” it was clear that she perceived significant loss resulting in anxiety and distress that were overwhelmingly strong features of her disease expression. The presence of anxiety is concerning in the context of dementia. It has been linked to nighttime awakening (McCurry, Gibbons, Logsdon, & Teri, 2004), which was a primary complaint for T2, as well as limitations in activities of daily living, poorer QOL outcomes, and behavioural disturbances (Seignourel, Kunik, Snow, Wilson, & Stanley, 2008). Furthermore, anxiety is known to contribute significantly to caregiver burden and early transition into residential aged care (Gibbons, Teri, & Logsdon, 2002).

Subjective-insights and the emotional experience of PPA. In summary, the subjective-insights indicated that PPA is associated with negative emotional responses that can range from subtle or mild, to profound. Furthermore, the analysis indicated that individuals with PPA have insight into their emotional responses and are able to describe their reactions to symptoms and their resultant impact. The patterns of emotional response were unique and variable across the
five cases, highlighting that language dissolution is experienced and appraised in different ways. This further supports the use of subjective-insights for conceptualising PPA from the perspective of the individual to identify unique therapeutic needs. The emotional reactions show the risks associated with delayed diagnosis, which will be explored further below in relation to capacity for positive adaptation.

**How do Individuals with PPA Adapt to Language Symptoms?**

The final research question explored by analysis two concerned the patterns of adaptation or compensation in response to PPA. The notion of adaptation is central to the dynamic systems framework of PPA, mediating an individual’s potential to live positively or proactively with emergent disease (Ettema et al., 2005). Given the profound symptoms and negative emotional responses, it was not surprising that evidence for maladaptation emerged from the analysis. Furthermore, consistent with a dynamic systems account of PPA, the adaptive profiles were variable. The subjective-insights and concept maps provided a window into the unique coping strategies that were being drawn upon to accommodate emerging language symptoms, which enabled the system-profiles to be interpreted in terms of the functional or real-world consequences of disease. Examples of both problem-focused and emotion-focused strategies emerged from the transcripts, with some participants showing more proactive or positive self-regulation than others. For all participants it was clear that a range of parameters were influencing styles of coping, and that adaptation is a fluid, continuous and evolving process (Allison et al., 1997). Importantly, the patterns of adaptation further differentiated the participants with PPA from the healthy ageing control group.

**Adaptation and proactive coping in response to age-related language changes.** It was evident, that as a group, the healthy ageing controls were using more proactive strategies in response to their age related changes in language and memory, consistent with their retained sense of control, higher levels of self-efficacy and a belief that through use of various techniques their functional capacity could be maintained. Similar strategies were described across the control participants and were perceived to be effective, including note taking, shopping lists, and relying more on calendars and diaries. The availability of effective strategies
appeared to bolster emotional resilience in response to age-related changes, averting the need for significant worry or concern. It is important to note that the control participants talked more about general memory strategies rather than specific techniques drawn upon to help recall of words or names, other than ‘waiting’ for the word to appear or finding a close alternative. This may suggest that memory strategies are more commonplace, while targeted education and instruction may be required to introduce more sophisticated language techniques and word finding strategies.

**Adaptation and unique styles of coping in response to PPA.** The PPA concept maps revealed unique patterns of adaptation. Examples of proactive control emerged however overall stronger evidence for maladaptation and emotion-focused coping strategies were evident.

**Examples of proactive, problem-focused coping.** Of the participants with PPA, T1 presented with the most positive adaptation to his emerging symptoms, with the strongest profile of self-regulation and proactive coping. It is not clear whether this related to his early disease stage and/or preserved cognitive strengths, or other factors, such as certain personality traits or his medical background and understanding of dementia and language processes. Most likely a dynamic interplay between such factors underpinned his strategic competence and ability to look more constructively at the obstacles he was facing. T1 appeared to have accepted his diagnosis with a degree of pragmatism and he was consciously accommodating his PPA into his sense of self and everyday activities. He had actively sought diagnostic assessment and subsequent support services to gather information, which he had combined with his own research into the syndrome and his presenting symptoms. T1 described some of the strategies that he was using to support his language symptoms, for example, he noted that he ‘goes around and chooses another word’ when he experiences a word finding hesitation; however he did not have effective strategies for the more pronounced formulatory difficulties. Despite examples of problem-focused coping, some functional consequences and more emotion-focused coping strategies were still evident. For example, given his perceived difficulties with ‘spontaneity’, T1 noted that he was now more hesitant to ask questions during meetings or to actively participate in conversation, openly reflecting on his adaptive mechanisms. On the whole he appeared in
control and was making a conscious effort to avoid avoidance. He understood the need for strategies to support continued engagement from the perspective of slowing progression or maintaining his current level of function for as long as possible.

**Examples of maladaptive, emotion-focused coping.** T1’s profile of strategic competence and proactive control was in contrast to T2’s profile. T2 was also maintaining control, with cognitive strengths and abilities to draw upon. However her subjective-insights revealed a maladaptive and more emotion-focused self-regulation and coping style. As already discussed, T2 was experiencing a more profound sense of loss and anxiety in relation to her language dissolution as compared to the other participants with PPA. A stronger sense of helplessness was evident and as a result, there was evidence of excess disability through avoidance and withdrawal from speaking contexts. T2 had a strong, inter-dependent relationship with her husband and a supportive home environment, which was protecting her overall QOL; however at the same time appeared to reinforce avoidance strategies. While experiencing symptoms of depression and reduced wellbeing, there were aspects of her life that she continued to enjoy. T2 was comfortable and content at home with her husband and they regularly went to movies and watched television together. T2 also listened to audio books and completed daily physical and brain training exercises, which gave her reassurance that she was doing something actively to ‘treat’ or manage the disease. It was clear that she was happiest during tasks or roles that did not challenge or place demands on her language system. Interestingly, T2’s husband noted that her language and talking was better with him at home, perceiving a “general self-consciousness that overlays” her difficulties. This suggested potential for improved function or performance in certain situations, which has positive implications for intervention. Extending her degree of comfort, confidence or self-efficacy within other contexts or situations could be a goal for therapy through direct and indirect strategies. This would also aim to address the patterns of withdrawal and avoidance that T2 had been consolidating since the onset of her symptoms three years earlier as her primary strategy for maintaining equilibrium and control. While withdrawal had enabled her to regain control the underlying emotional impact was still
evident and T2 acknowledged that she missed her social interaction and relationships, while continuing to worry about the future.

T3 and T4 also presented with more emotion-focused coping styles that were strongly associated with hypervigilance and a more heightened state of worry and anxiety, reflected by off-task commentary and sensitivity to language symptoms. For example, T4 would often make comments like “What did I say that for?”, “I can’t sort of get what I mean”, and “come on, come on, think, think!” with visual signs of rising anxiety and sighing. He would often respond by changing the topic or using stereotypical fillers such as “That’s right” and “What-have-you” to move the conversation on. It was as if T4 was functioning just beneath a critical threshold, which was easily exceeded when language breakdown occurred. While all participants required reassurance and prompts to take their time during the interview and natural language tasks, in the case of T1, T2 and T5 it was more to encourage and extend their responses, rather than to calm them down, which was more the case for T3 and T4. Hypervigilance has negative implications for adaptation from the perspectives of resource allocation and emotional adjustment. The focus on error reduces potential to identify strengths and draw upon strategic resources to optimise language performance. This identifies a different target for therapeutic intervention. It is expected that providing individuals like T3 and T4 with strategies to help them regulate arousal, stay calm in the moment, and reduce their heightened attention to error or breakdown might increase the availability of resources to bolster language performance.

Significant cognitive load effects were evident, which were associated with functional limitations. For example, T3 described withdrawal or avoidance strategies and reactions through comments like “I’ve got to shut up” and “I got to the stage where I didn’t want to know anyone”, revealing a more emotion-focused coping style. He wasn’t aware of any strategies that he was using or that he could draw upon to help his language in the moment or to overcome his difficulties.

An example of passive coping. T5’s adaptive profile was different again, in this instance illustrating a paucity of adaptation, with limited active attempts to control or adjust to his difficulties. This reflected a more passive, apathetic response to the emergence of his
symptoms, consistent with his lack of concern or associated anxiety. This was consistent with the reduced arousal levels that characterised his system profile and consistent with behavioural outcomes such as his tendency to ‘sit back more in conversations’. T5 was not concerned about these behavioural changes, despite being aware of them, noting that he was very content and happy with his life, that he loved his wife and enjoyed spending time with his family, despite not actively initiating contact or engagement. This was suggestive of a more significant personality and behavioural change than what was evident for the other participants with PPA, indicating that his syndrome had evolved, or that perhaps he presented with a more frontal or behavioural variant of dementia. Irrespective of the accuracy of his diagnosis his profile provided evidence for the value and use of the semi-structured interview and content analysis for detecting different styles of adaptation and the nature of disease expression. Clearly, for T5 his syndrome was expressed by more apathetic mechanisms, in contrast to the heightened arousal of T3 and T4. This was in contrast also to T1 and T2, who showed more stable systems and self-regulation, even though some maladaptive strategies were selected, they were employed with evidence of conscious control. This suggests that self-regulation and control were mediated by different factors, which may or may not have biological relevance in terms of the underlying disease processes at play. This will require further investigation.

**Avoidance and withdrawal: Priorities for intervention.** The emotion-focused coping strategies and signs of withdrawal and avoidance to emerge from this study were important findings. Consistent with the findings of Medina (2009) it is evident that the onset of PPA can change the level of socialisation with family and friends and that maladaptive strategies can start developing in the very early disease stage, which can be functionally restrictive and of psychosocial concern. Avoidant and escape strategies, such as social withdrawal and passivity within conversation, have been conceptualised within psychoanalytic theory as a conscious behavioural response to manage stressful situations or contexts (Seiffer et al., 2005). In the context of dementia, they have also been described as an “intrinsic part of the disease biology” (Draper et al., 2010, p.77) serving important protective properties (Rabins, 2007). However through a grief and loss cycle reaching a point of acceptance, resilience and capacity for
proactive coping is important (Bleek, Reuter, Yaruss, Cook, Faber, & Montag, 2012), requiring a realisation that ‘life with PPA is possible’ and a shift towards more task orientated, positive adaptation (Draper et al., 2010). This is important for supporting continued cognitive stimulation, social interaction, and engagement, which in the face of progressive neurological disease may help strengthen cognitive reserves and promote maintenance of function for as long as possible (Robertson, 2013). Of interest, it has been proposed that the quality of social engagement is more important than the quantity in protecting against dementia and bolstering cognitive function (Amieva et al., 2010). This strengthens the rationale for timely diagnosis, early intervention and education for communication partners.

While emotion-focused coping styles were evident, for none of the participants in this study were the initial reactions to symptoms or eventual diagnosis catastrophic, which is similar to the findings of broader dementia research (Bunn et al., 2012; Carpenter et al., 2008). Many of the participants described a sense of relief that they had an explanation for the difficulties, even though the progressive nature of the syndrome was of course distressing to hear. This reaction to diagnosis opens up many opportunities for therapeutic intervention and support services to optimise and support positive adaptation. All of the participants, including T5, were eager to receive ideas, strategies, and supports although their individual needs were unique. The fact that very few proactive strategies had been implemented spontaneously may be due to the amount of energy that had been devoted to the diagnostic search and worry about emerging symptoms that could not be normalised or explained. This may divert energy away from looking proactively at residual strengths or identifying strategies that could assist or aid function. These preliminary findings further emphasise the need for timely diagnosis and intervention to allow practical strategies to be introduced, which can help bolster both function and self-confidence, while preventing patterns of avoidance and withdrawal from becoming hard-wired or engrained (Clare, 2002).

Subjective-insights and adaptive profiles. In summary, the subjective-insights provided a clear window into the individual patterns of adaptation and coping strategies that were employed. This allowed the system-profiles presented in chapter five, to be contextualised and
understood in terms of the underlying self-regulation and control mechanisms at play. Examples of both emotion- and problem- focused coping strategies emerged from the concept maps, highlighting that individuals with PPA respond to language dissolution in unique and variable ways. The diagnostic relevance of this analysis was also evident, with the patterns of emotional reactions, responses and coping strategies described by the participants with PPA diverging quantitatively and qualitatively from those of the healthy ageing controls. These differences were also of interest from a theoretical perspective, informing more holistic and dynamic conceptualisations of the syndrome that embrace the complexity of disease expression. Dynamic conceptualisations of PPA highlight the need to define the nature and impact of progressive language impairment on an individual basis in terms of adaptation and self-regulation to direct clinical management and care pathways.

Research and Clinical Use of Leximancer™

A secondary aim of analysis two was to explore the utility of Leximancer™ for future PPA research and clinical practice. While this will require further investigation with a larger sample size and additional controls, the findings provide preliminary support for the tool and the significant contribution that subjective-insights can play in diagnostic and clinical profiling. It is evident that Leximancer™ afforded a rich and objective platform to explore the personal insights of participants in regard to both their perceived language difficulties and their emotional and adaptive responses. This provided a unique opportunity to examine the nature of PPA and brain-mind relationships quantitatively, from the individuals’ own perspectives. The concept maps provided direct insight into the individuals’ perceptions and concerns while providing further clinical insights into the integrity of cognitive, linguistic and social-emotional functions. As such, the Leximancer™ concept maps contextualised and extended the static system-profiles, enabling deeper insights into the nature of disease expression and unique areas of need. The use of Leximancer™ for longitudinal tracking, diagnosis and therapeutic intervention is discussed below.

Diagnostic use of Leximancer™. The findings of this research provide preliminary evidence for the use of Leximancer™ and subjective-insights for the timely diagnosis of PPA.
The identification of early and valid clinical markers of disease is seen as an immediate priority for the field (Dickerson, 2011; Mesulam et al., 2012). There is a notion that self-reported memory or language changes may represent one of the earliest markers of dementia or neurodegenerative disease (Clarnette et al., 2009; Rogalski & Mesulam, 2001). From a diagnostic perspective this has proven problematic for individuals with mild cognitive impairment and prodromal Alzheimer’s disease as not all individuals experience subjective memory impairment or endorse memory problems on specific questioning (Mitchell, 2009). Given that preserved insight is a characteristic feature of early-stage PPA (Banks, & Weintraub, 2008b) a much larger proportion of individuals are expected to endorse language difficulties, strengthening diagnostic potential (Mitchell, 2009; Rogalski & Mesulam, 2009). The findings to emerge from the concept maps have demonstrated that the early subjective changes associated with PPA are differentiable from healthy ageing and that a pre-clinical stage of PPA may be detectable. This is promising given that individuals with PPA may perform well on tests of language and cognition at an early disease stage before more prominent or observable signs of aphasia develop (Dickerson, 2011; Rogalski & Mesulam, 2009). This calls for increased research and clinical attention to be directed to prodromal or pre-clinical PPA.

To extend the diagnostic use of Leximancer™, future research should systematically compare the concept maps of people across different stages of PPA, as well as across different variants and types of dementia. Another important line of diagnostic inquiry would be examining the concept maps for individuals with depression and mood disturbance given that this represents another important differential diagnosis for PPA (Mahgoub & Avari, 2012). It has been highlighted in the literature that there is substantial overlap between symptoms of dementia and PPA, including patterns of social withdrawal and avoidance (Mahgoub & Avari, 2012). Differentiating the cause of maladaptive strategies is of critical importance for determining the course of behavioural versus pharmacological therapies. As such, use of Leximancer™ may help to further refine and develop diagnostic features and clinical criteria for diagnosis. The added benefit of using Leximancer™ in this way is its ability to provide both objective markers for tracking performance over time, in addition to ecologically valid insight.
into critical areas of care need for individual clients and to hypothesise possible causal mechanisms grounded in the individual’s own subjective experiences and areas of pressing concern.

**Detecting pre-clinical PPA.** The identification of pre-clinical PPA would provide opportunities for proactive therapeutic interventions, counselling and education services that could potentially prevent maladaptive coping strategies and negative emotional reactions from having more significant and detrimental impact. Even if a proportion of these individuals do not go on to develop PPA, they are still worthy candidates for intervention. In individuals with subjective and mild cognitive impairment increased levels of cortisol have been found (Gauthier et al., 2006). This indicates that a stress response is present, which from a dynamic systems perspective would have implications for the functioning and integrity of the system that should be considered as part of public health policy and initiatives. This was evident for participants C7 and C11 in this study, whose profiles may be distinguishable from a larger healthy ageing cohort and who may benefit from monitoring, education and support (Clarnette et al., 2001).

While individuals with PPA are excellent historians in the early stages of the syndrome, evolving language difficulties will progressively disrupt their disease narrative. As such, there will come a point where Leximancer™ will no longer be a possible tool for use with the individuals themselves. As such, it would also be of both diagnostic and clinical interest for future research to examine the concept maps of the subjective reports and descriptions of partners and family members regarding the patterns of symptoms, emotional responses and behaviours associated with different stages of the disease and across different types of dementia or differential diagnoses. Similarly, in the early stages of PPA it would be of interest to compare the concept maps of the individuals with PPA and their significant others to determine whether similar themes, concepts, and areas of concern emerge. The difficulties relying on proxy reports have been documented in the PPA field (Medina, 2009). It is of interest whether similar findings emerge from use of Leximancer™ or whether new insights into the nature of differences or patterns of proxy-responses emerge and evolve over time. It would also be of interest to see how the proxy descriptions change following carer-education or communication skills training to
determine whether the language used to describe the changes and challenges shifts or whether more knowledge about PPA and the nature of the disorder and the individuals needs increases.

**Using Leximancer™ concept maps to track changes over time.** It would be of theoretical and clinical interest to see how the emergent concept maps evolve over time and whether they can be used to track longitudinal shifts within the system, which is seen as a particular strength of Leximancer™ and quantitative concept analyses (Kondracki, Wellman, & Amundson, 2002). This could provide critical insight into the nature of PPA, as well as how therapeutic needs and priorities change over time in a way that is easy for the person with PPA and their family to understand. The concept lists and hierarchies will change as different issues become more prominent or new symptoms emerge. Furthermore, Leximancer™ could be used to detect and track changes in conversational style, interaction and patterns of language use over time. Examining the concept maps of T2 and T5, more passive styles of conversation were evident, visually mapping both the quantity and quality of their contribution to the interview. This could be examined over the disease trajectory, as well as across different conversational topics, partners, and/or contexts. Furthermore, with reference to T4’s concept map, Leximancer™ could be used to detect the emergence of stereotypical phrases or filler words as they start to invade a person’s language use or compensate for loss of expressive vocabulary. The lexical item “virtually” emerged as a highly prominent concept within T4’s transcript, which was a distinct marker of pathology. Smith and Humphrey (2006) note that in the English language, speakers will tend to avoid using the same word in close proximity or an adjacent sentence, electing instead for a replacement term. As such, Leximancer™ has sensitivity for detecting repeated use of stereotypical words within natural language, revealing shifts in semantics and word usage over time. This is adds to a small body of previous research that has utilised automated techniques including concordance software (Garrard et al., 2005) and latent semantic analysis (Landauer & Dumais, 1997) to quantify subtle changes taking place within the language system over time. This enables interesting features to be identified, tracked and targeted therapeutically over the trajectory of disease.
Using Leximancer™ concept maps to identify therapeutic needs and priorities. Potential therapeutic use of Leximancer™ was also identified, guiding selection of goals for intervention, education and/or counselling for individuals with PPA and their families. For this exploratory research, the concept maps provided a robust and objective platform for identifying the prominent issues for the individual participants, grounded in the individual’s own descriptions of their evolving difficulties, emotional reactions, and consequences for their everyday lives. It has been noted in the PPA literature that outside of a research setting, standardised assessments and language batteries have limited clinical value, particularly for identifying personally relevant and meaningful management goals for individuals living with the syndrome (Khayum, Wienieke, Rogalski, Robinson, & O’Hara, 2012). The use of semi-structured interviews and Leximancer™ may address this limitation, helping clinicians to identify perceived language challenges and areas of significant concern to establish proactive therapy goals with potential to maximise communication abilities and address functional challenges and psychosocial concerns.

The automated nature of Leximancer™ and its focus on relationships between concepts provides opportunities for identifying indirect or latent meaning within the transcripts (Smith & Humphreys, 2006). This allows points of difference to be identified between an individual’s stated concerns and signs of maladaptive behaviour or emotional responses that may be more subconscious or hidden from view. T1 illustrates this point, given that while negative emotional responses like embarrassing and anxiety emerged as prominent concepts within his transcript T1 downplayed the significance of these symptoms using qualifiers like “certain amount”. He explicitly stated that he didn’t want to overemphasise the worry or frustration; however, these negative emotions and psychosocial reactions were clearly present and may represent a red flag for maladaptive strategies emerging or worsening over time as symptoms progress. Such red flags should be addressed and confronted proactively as part of a holistic, interprofessional approach to intervention and management. Furthermore, this opens the door for therapeutic counselling to addresses covert issues that may be masked by the individual through denial or protective adaptive mechanisms.
Conclusion

The findings of analysis two highlight the importance of understanding an individual’s own construction of their disease expression and associated coping strategies to strengthen diagnosis and direct proactive, tailored clinical management (Pearce et al., 2002). The subjective-insights and concept maps provided critical information for understanding the nature and severity of disease impact as a function of self-regulation and adaptive mechanisms that were found to influence behavioural and psychosocial outcomes.

The findings provided evidence for the profound nature of perceived language changes and the risk of maladaptive strategies emerging early in response to symptom onset. The results highlight the critical need for timely diagnosis and early, holistic and person-centred therapeutic services for individuals living with progressive language impairment. This would ensure timely access to information and the opportunity to bolster and enhance ways of coping and positive adjustment to life with PPA.

It was evident that the adaptive mechanisms drawn upon by the participants with PPA were heterogeneous and dynamic in nature, influenced by a range of intra- and inter- personal factors. For the purposes of this research, Leximancer™ was found to have powerful and valuable use for longitudinal tracking, diagnostic evaluation and the design of therapeutic interventions. The concept maps provided a rich and objective platform for analysing the subjective experience of PPA, mapping perceptions of language change and associated reactions and responses. In the final chapter of this thesis analyses one and two will be integrated and discussed further to draw the final conclusions and provide recommendations for future research and clinical practice.
Chapter 7

GENERAL DISCUSSION

Overview

This thesis examined the need for new theoretical perspectives of PPA to advance understanding of the syndrome and to provide direction for clinical profiling, therapeutic management and care pathways. The primary aims of the thesis were achieved:

(1) Examining the holistic system-wide impact of PPA, including the consequences for language performance and social-emotional functions, and

(2) Exploring subjective-insights to examine individual patterns of adaptation and coping in response to language dissolution.

The systematic and objective approach to sampling and analysis provided rich, personal insight into the nature and psychosocial impact of PPA. The findings extend the current evidence base, providing support for the complex, multi-layered impact of progressive language impairment and the critical need for timely diagnosis and proactive intervention. While the biological or pathological basis of PPA is acknowledged, the case profiles illustrate that disease expression is a complex, emergent property of a dynamic system with a range of internal and external parameters mediating behavioural and psychosocial outcomes. From a functional perspective, the severity of impact is influenced by an individual’s system-profile (i.e. relative strengths vs. impairment), tightly coupled with underlying adaptive mechanisms, coping style and ability to self-regulate effectively in the face of language dissolution. Examining PPA within the dynamic systems framework allowed the individual systems to be unpacked and understood holistically, making a novel contribution to the field.

Key Findings

This discussion chapter returns to the dynamic systems framework of PPA presented in chapter three of this thesis, integrating the findings of analysis one and two in relation to this theoretical account of PPA. The key findings to emerge from the two analyses are listed in Table 7.1.
Table 7.1
Summary of Key Findings to Emerge from the Research

1. The expression of PPA is dynamic and multi-layered with performance decrements spanning cognitive, linguistic and social-emotional components of the system.
2. PPA is associated with significant social-emotional impact, which for some individuals is profound.
3. Linguistic performance measures (i.e. communicative efficiency) may provide a sensitive and ecologically valid marker of pathology within the distributed language circuitry, aligning with contemporary views of the brain.
4. Self-efficacy ratings may provide a sensitive marker of social-emotional impact, with early language symptoms disrupting confidence for social communication.
5. Global QOL ratings may not provide sensitive markers of the social-emotional impact of PPA given preserved performance across activities of daily living that are not dependent on language use.
6. The system-profiles may have diagnostic and biological relevance with two distinct profiles emerging from the data aligning with fluent and non-fluent presentations of PPA.
7. The systems approach to clinical profiling may have relevance for differentiating sub-groups or different profiles within a healthy ageing cohort.
8. Individuals with PPA perceive profound language symptoms and have acute sensitivity to early signs of language dissolution, which can be difficult for the individual to explain or normalise.
9. Individuals with PPA perceive significant emotional and psychosocial consequences language symptoms, which can be intensified by a protracted diagnostic-search phase.
10. Negative emotional reactions and reduced self-efficacy can result in maladaptive or emotion-focused coping strategies with functional and psychosocial consequences.
11. Adaptation in response to PPA is a personal, dynamic and emergent construct, mediated by a range of internal and external factors (e.g. personality, prior experience, environmental support, self-efficacy, coping style, awareness and cognitive appraisal).
12. Personal constructions of disease and use of Leximancer™ may have diagnostic and clinical utility, with potential to differentiate the subjective experience of PPA from that of healthy ageing, while identifying areas of unique, individual therapeutic need.
The breadth of findings and novel insights to emerge from this research support the theoretical, research and clinical value of the multivariate, dynamic systems approach to PPA. Furthermore, the value of fine-grain, case-based research is demonstrated, enabling deep understanding of the individual system-profiles and adaptive responses. Taken together the key findings highlight that:

1. PPA can be conceptualised as a complex, dynamic disorder with multi-layered impact extending across levels of the system and characterised by unique patterns of social-emotional response and adaptation.
2. Timely diagnosis and early proactive intervention are important for promoting positive adaptation and optimising functional and psychosocial outcomes for people living with PPA.

The findings will be discussed below in regard to the dynamic systems framework of PPA. The clinical and professional implications to arise from the analyses are highlighted and discussed, identifying preliminary practice recommendations in regard to clinical profiling, diagnosis, and therapeutic management of PPA. Limitations of the study are then highlighted, acknowledging the preliminary, proof of concept nature of this thesis. The exploratory nature of the research has meant that more questions than answers have emerged from the two-levels of analysis with many opportunities to replicate and extend the findings on a larger scale identified.

**Conceptualising PPA within a Dynamic Systems Framework**

This thesis was based on the assumption that novel conceptual frameworks of PPA are required to advance understanding of the syndrome and to inform the design of clinical assessment and therapeutic approaches that move beyond focal aspects of disease. The research applied and tested use of a novel dynamic systems framework of PPA that considered the distributed nature of language processing and the complexity of brain-behaviour relationships. This conceptualisation of PPA aligns with contemporary views of cognitive neuroscience (Lewis, 2005) viewing the brain, body and environment as a single, unified system (van Gelder & Port, 1995). Through employing wide-lens sampling and two levels of analysis, the dynamic
systems of five individuals with PPA were studied from different view-points to construct a holistic impression of system integrity and functional disease expression. The system-profiles successfully differentiated PPA from healthy ageing, while revealing the multi-layered nature and consequences of the syndrome. Analysis of the subjective-insights further illustrated that the focal symptoms of PPA are just the tip of the iceberg, with impact spreading across levels of the system via unique patterns of adaptation in response to disease emergence.

The findings provide preliminary support for conceptualising and approaching PPA as a dynamic, multi-dimensional disorder. Disease expression reflects complex interactions between an individual’s system profile (i.e. intra-personal strengths and weaknesses) and factors mediating functional disease expression (e.g. personal factors, coping styles, contextual supports). This is consistent with dynamic systems theory, highlighting the need to sample both the resting states of the system, as well as the variables and parameters within context that influence performance and psychosocial outcomes over time (De Bot et al., 2005). Notions of self-organisation and adaptation were identified as central to the dynamic systems framework of PPA and were of primary interest to the current research. It was evident that different adaptive mechanisms were drawn upon by the five individuals with PPA, with examples of proactive and maladaptive coping strategies emerging, which as predicted, did not relate solely to the severity of focal impairment. This assumes that disease expression is emergent, reflecting interactions across levels of the system and principles of self-organisation and regulation over time (Lewis, 2005). The key findings of the research will be integrated within the components of the dynamic systems framework of PPA more explicitly below, refining the conceptual model and providing direction for future research.

**PPA as a source of perturbation to the system.** Firstly, through the subjective-insights into PPA it was apparent that the emergence of language symptoms was a significant source of perturbation to an individual’s system even at an early disease stage. The participants described acute sensitivity to early symptoms, highlighting that they were aware of subtle changes taking place within their language system. This is of critical importance within a dynamic systems framework given that perturbation causes phase-shifts to occur, which disrupts
behavioural patterns and stimulates the emergence of new resting-states and behaviours (De Bot et al., 2007; Lewis, 2005). This was also evident within the concept maps with the individuals with PPA describing immediate emotional and behavioural consequences of their language symptoms. This suggests that processes of self-organisation begin spontaneously as soon as the individual becomes aware of emerging disease. This self-organisation and adaptation is expected to take place across levels of the system, including reorganisation within the distributed language circuitry, shifts in emotional states and thought patterns, and more global changes in behaviour and social interaction. Through phase-shifts and self-organisation the system attempts to regain order and control (De Bot et al., 2007; Lewis, 2005; van Gelder & Port, 1995).

The current findings suggest that proactive and positive shifts in response to PPA may be challenged by the nature of emergent difficulties, which for the individuals involved in this research were difficult to explain and normalise. This was in stark contrast to the healthy ageing control group, who described word finding and memory changes as a result of ageing processes however this was accommodated into their self-concept, given the camaraderie and shared experience with their spouse and friends of a similar age. For the participants with PPA, feelings of uncertainty, distress and worry in relation to emerging symptoms appeared to interact with coping strategies and adaptive processes, which highlighted the need for timely diagnosis and intervention. Within a dynamic systems framework, it is known that in a state of chaos the system has heightened sensitivity to internal and external feedback and situational events (De Bot et al., 2007), which explains why dramatic shifts in behaviour occurred following symptom onset. This was illustrated by T2, who withdrew from a voluntary tutoring position and ceased driving as soon as she became aware of her symptoms. Similarly, while less dramatic, phase-shifts were also evident for T1, who was now adopting more hesitant, passive style within conversation that also represented a change in his preferred or usual behavioural patterns. Both participants were aware of these alterations in behaviour indicating that they had a conscious or meta-cognitive element. In both cases, these phase-shifts had been successful in restoring balance and order within the system however had notable implications for global behavioural
and psychosocial outcomes, which will be explored in more detail later when looking at the global behavioural and social-emotional consequences of disease.

**Intra-personal system function: Unique multi-layered impact of PPA.** The two levels of analysis employed revealed the significant, multi-layered consequences of PPA for an individual’s intra-personal system function. Analysis one measured performance within and across the selected components of the system, revealing patterns of strengths and impairments, while providing an index of overall system integrity. The system-profiles were static and impairment-focused, sampling performance at a single time point, using a narrow range of tasks. From a dynamic systems perspective, this is a limitation of the first level of analysis given that evolution of the system is expected across different time-scales. This should be considered in future research, tracking the stability of the system-profiles across short- and long-time scales. Each of the components of the system will be explored below, keeping in mind that the integrated function of the system as a whole is of primary importance. Interactions and reciprocal relationships between component functions were evident and will be considered through the discussion below.

**Cognitive component.** Interesting patterns emerged within the cognitive component of the system. Firstly, it was evident that the individuals with PPA presented with awareness and insight into their language symptoms, suggesting relative cognitive strength that is characteristic of PPA (Banks & Weintraub, 2008a; Mesulam, 2001). With the exception of T1, the participants with PPA showed impairments of general cognitive ability that reflected different stages of disease. Given the presence of PPA it is difficult to tease apart the influence of aphasia on cognitive test performance, which is a noted challenge for the diagnosis of PPA. However, irrespective of this linguistic influence, the extent of cognitive impairment relative to the healthy ageing controls was interpreted to reflect greater overall severity of disease. As such, T4 was identified to present with the most severe system impact overall and was the only participant with PPA to show impaired performance on the construction sub-test of the DRS-2. This provided a marker of non-verbal cognitive ability, less impacted by the language influence of PPA. Despite the degree of cognitive impairment, T4 was still aware of his language symptoms
and able to complete the range of social-emotional measures with consistent ratings evident across rating scales, with clinical implications consistent with previous PPA research (Medina, 2009).

*Retained insight and meta-cognitive abilities.* When presenting the dynamic systems framework of PPA in chapter three of this thesis it was predicted that while the presence of retained insight and metacognitive abilities would afford individuals with strategic competence to solve problems and adapt to PPA; that it could also have negative implications for system function if associated with worry, anxiety or hypervigilance. This concern was validated by the current research, with preliminary evidence for a dynamic relationship between meta-cognitive and emotional processes. The role of emotion-appraisal feedback cycles will be discussed further below in relation to social-emotional functions, indicating that the presence of acute insight can be detrimental to adaptation in some cases.

*Cognitive strengths and strategic competence.* The positive aspects of awareness and cognitive strengths were also evident, most notably for T1 who was in the earliest stages of PPA. Furthermore, with 22 years of education, and continued engagement in high-level vocational roles his cognitive reserve appeared significant. Through T1’s subjective-insights it was evident that he was drawing upon his strategic competence and actively seeking strategies and ideas to support his language difficulties. As such, he presented as an excellent candidate for therapeutic services and was highly receptive to strategies presented during evaluation and feedback sessions as part of the study.

*Linguistic component.* As predicted, the system-profiles and subjective-insights into PPA revealed most significant and profound impact within the linguistic component of system function. Performance across the linguistic measures, coupled with the personal descriptions of language change differentiated the individuals with PPA from the healthy ageing controls, indicating that the methodology employed was successful in identifying the root diagnosis of PPA (Mesulam, 2001; Mesulam et al., 2012). This was reflective of the biological changes taking place within the distributed language circuitry, with different patterns of impact emerging. It was evident that the linguistic symptoms directly impacted the social-emotional
domain, with the limitations in activities of daily living reported having direct associations with language dissolution, also consistent with the root diagnosis of PPA (Mesulam, 2001).

*Sensitivity of efficiency-based measures.* The dynamic systems framework of PPA and the methodology employed by analysis one differentiated between measures of linguistic competence and linguistic performance. The performance measures, most notably CIUs/min, were found to be particularly sensitive to pathology within the language system, differentiating all five participants with PPA from the healthy ageing control sample. Furthermore, for some participants, namely T1 and T2, while their CIUs/min scores were significantly lower than the healthy controls, their BNT scores were not, revealing dissociation between linguistic performance and competence. It is known that specialist hubs within the language circuitry rarely operate alone (Mummery et al., 1999) cautioning against the sole use of discrete language tasks (Garrard et al., 2005). In contrast, the CIUs/min measure reflects connectivity within the language system, dependent on the temporal coordination of multiple, widely distributed cortical and sub cortical neuronal systems (Hird & Kirsner, 2010). As such, it provides a valuable index of overall system integrity, requiring dynamic interactions between the cognitive and linguistic components of the system, while reflecting the availability of attention and other cognitive resources to support conceptualisation and distributed language processes.

*Cognitive load effects on linguistic performance.* When examining the participants’ self-efficacy for social communication ratings it was evident that cognitive load impacted their perceived language abilities with participants consistently rating their confidence lower for more demanding contexts like talking to strangers or talking under pressure as compared to relatively less demanding contexts, such as talking to family and close friends. This may explain why the efficiency and self-efficacy measures were more sensitive markers of dysfunction for this sample, capturing the distributed, resource-based nature of disease. These measures may be particularly sensitive to early stage disease when increased demands are placed on the system (e.g. time pressure, topic complexity) and should be investigated by further research. Furthermore, such measures are expected to provide a more ecologically valid index of one’s potential to use natural language during everyday life. This was illustrated by T2 whose patterns
of withdrawal and profound distress were best reflected by her severely divergent CIUs/min scores with significant cognitive load effects reported and observed.

**Emergent patterns: Profound anomia and PPA-S.** Another interesting pattern of linguistic performance was observed when examining the system-profiles of T3 and T4. For these participants, their language performance and overall communicative efficiency were severely compromised by profound word retrieval difficulties, reflected by the severe divergence of their BNT and %CIU scores from the healthy ageing control group. The severity of their anomia was consistent with PPA-S, which is associated with consistent and profound naming deficits and characterised by asymmetric atrophy within the anterior temporal lobe (Mesulam, Grossman, Hillis, Kertesz, & Weintraub, 2003; Mesulam et al., 2009). The profound anomia that characterises PPA-S is evident for even highly familiar objects (Mesulam et al., 2009). As the syndrome becomes more severe the individual may also lose the ability to recognise or comprehend many of the words they are unable to name (Mesulam et al., 2009). A discrete measure of single-word comprehension was not included in the system-profiles and should be considered by future research. While the system-profiles of T3 and T4 may align with focal conceptualisations of PPA, dynamic and resource-based factors were still evident. T3 and T4 also reported differential levels of self-efficacy across different contexts, suggesting the influence of cognitive load effects. Furthermore, thinking about the profound anomia from a dynamic perspective, focal naming tasks require the speaker to disengage their language network and retrieve single lexical items without contextual support. This was incredibly effortful for these participants, which resulted in overt distress, circumlocutory attempts and off-task commentary, indicating acute awareness of error and hypervigilance. Future research could compare the semantic and lexical performance of individuals with PPA-S in supported versus unsupported contexts to determine whether or not this bolsters communicative efficiency and functionality of language performance. Furthermore, if hypervigilance and sensitivity to error can be reduced, this may have a positive effect on linguistic competence and performance from a resource allocation perspective.
Social-emotional. Given that limited empirical research has considered the social-emotional impact of PPA, the pattern of results within this component of the system was of primary interest. Both the direct and indirect impacts of disease on social-emotional functions were considered when proposing the dynamic systems framework of PPA. T5 was the only participant to present with changes in personality in combination with progressive language impairment, which appeared to have a direct biological cause. His system profile and Leximancer™ analysis revealed patterns of apathy and reduced effort, which was associated with a consistent overall reduction in performance across measures. His natural language was slow and effortful, with reduced initiation, elaboration and turn taking during conversation, which were identified as marked changes in his previous conversational style. This questions whether or not T5’s diagnosis of PPA was correct however this was not of primary concern to this thesis. Given that he still presented with significant language complaints his profile was still of interest.

Evidence for indirect social-emotional responses. For the other four participants the social-emotional consequences of PPA appeared reactionary in nature, rather than as a direct consequence of disease, consistent with the findings of Medina and colleagues (2007, 2009). Furthermore, consistent with previous research social-emotional symptoms were evident however for no cases were they catastrophic or completely paralysing (Medina, 2009; Mesulam et al., 2012). As a result, while this thesis has drawn attention to the social-emotional component it is important for individuals with PPA and their families to understand that depression is not a “given” and that for some individuals positive adjustment can unfold naturally. The reactionary nature of the social-emotional impact of PPA is related to the presence of acute awareness and insight into evolving language difficulties, intensified in some cases by a protracted diagnostic search phase. This highlights that a range of non-biological factors can influence the experience of language dissolution and each individual’s capacity to adjust to or cope with it. Future research will need to profile and model factors that mediate disease expression, such as personality, coping style and previous history of anxiety or depressive disorders (Medina, 2009). Taken together these findings support the need to
examine an individual’s system-profile and subjective experiences in detail, to understand their unique needs and nature of disease expression and recommend treatment services or care pathways accordingly.

**PPA associated with consistent reduction in self-efficacy for social communication.**

Within the system-profiles, the self-efficacy for social communication scale was the most sensitive, with all five participants with PPA presenting with reduced confidence and self-perceptions of their language abilities. This was associated with patterns of withdrawal and avoidance of social interactions and active participation in social conversation, demonstrating that the onset of PPA can be socially isolating. Three of the five participants showed a significant reduction in wellbeing and some aspects of QOL were rated as lower than the healthy ageing control range. Furthermore, the subjective-insights into language dissolution and associated reactions revealed a range of social-emotional impacts from mild frustration and worry, to profound anxiety and distress. Taken together, the results strongly suggest that for some individuals with PPA the social-emotional consequences are significant, advocating the critical need for timely diagnosis and holistic, interprofessional support services.

**Cognitive-emotion interactions and feedback cycles.** Examining the participants’ subjective-insights into PPA a dynamic relationship between cognitive and emotional processes was evident, worthy of further discussion. All five participants with PPA presented with insight and awareness of their language symptoms and their descriptions of language change indicated sensitivity to the emergence of pathology at an early disease stage. For T2, T3 and T4 it was evident that the onset of language symptoms had triggered feelings of worry, uncertainty and distress, particularly given that their symptoms could not be explained or normalised. Through emotion-appraisal feedback cycles (Granic & Patterson, 2006; Lewis, 2005) the early emotional response to PPA appeared to influence cognitive appraisals and attempts to make sense of the symptoms as they were unfolding. In turn, the nature of cognitive appraisals influences an individual’s emotional state, which is fed back into the system through repeated iterations (Granic & Patterson, 2006). Examples of negative cognitive appraisals were evident when examining the concept maps, associated with heightened sensitivity to error and reduced self-
efficacy, with significant implications for resource allocation, language performance, behavioural responses, and overall coping potential (Lewis, 2005). Furthermore, it is known that as emotion-appraisal amalgams or response patterns stabilise, they bias the individual to process information and engage with the world in particular ways (Granic, Dishion, & Hollenstein, 2006; Lewis, 2005). This prompts clinicians to actively consider the downstream effects of an individual’s earliest reactions to disease onset within a dynamic system framework, further supporting the need for timely diagnosis and early intervention to prevent negative emotion-appraisal amalgams from developing.

**Unique social-emotional consequences and mediating factors.** The dynamic systems framework of PPA also postulated the role of unique personal factors in shaping the social-emotional impact of language dissolution. The variable system-profiles and concept maps to emerge provided support for this assumption. Furthermore, personality traits such as optimism, pessimism and anxiety are also known to shape the likelihood, strength and endurance of certain cognitive appraisals from developing (Frijda, 1993; Lewis, 2005). T1 presented with the most positive cognitive appraisals and attempts to make sense of his symptoms. While this was supported by his medical background and past experience, he also presented with a more self-directed, problem-focused coping style. Furthermore, his emotional reactions were not as extreme and appeared better regulated, not wanting to over-emphasise his feelings of frustration or performance anxiety. This self-regulatory control would support and bolster positive cognitive appraisals and ability to keep things in perspective, while ensuring that cognitive and attentional resources are available for language processing. This may be a function of T1’s early disease stage and cognitive reserve; however appeared to be further strengthened by other personal factors. For other participants the positive cognitive adjustments were not made, representing tension within the system and associated with more maladaptive, emotion-focused coping responses in attempt to restore balance and control. Furthermore, this was associated with less capacity to deal with error or language breakdown on line, evidenced through off-task commentary and hyper vigilant monitoring, which is an interesting area for future research.
Inter-personal and environmental factors. This research has focused most attention on the intra-personal system-profiles and subjective-insights; however the role of context and inter-personal factors are central to the dynamic systems framework of PPA. The pathology underpinning PPA emerges within the distributed language circuitry, which are nested within a brain, within a body, and context (van Gelder & Port, 1995). Notions of embodied function highlight that disease expression cannot be fully understood without moving from analysis of inner processes to the outer world (van Gelder & Port, 1995). The self-efficacy measure and subjective-insights provided greatest insight into the role of contextual factors for the participants with PPA however further research will need to examine this aspect of the conceptual framework in more detail. Evidence for cognitive load effects on language performance and social engagement emerged strongly from the data, with participants describing fluctuations in language processing across contexts and moments in time. For example T3 noted that language breakdown occurs suddenly with a ‘boom’ and that while he often can talk with his wife, he struggles with close friends. Similar reports were evident in relation to T2, with her husband describing a ‘self-consciousness’ that overlayed her language difficulties, with her performance improving when she felt comfortable and relaxed in her home environment. This is of critical importance for the therapeutic management of PPA and future research could systematically examine the cognitive load and resource allocation effects on language performance in PPA.

Global behavioural and psychosocial outcomes. While individual components of the dynamic system were identified, measured and examined, integrated or unified function of the system was of primary interest, reflected by global behavioural and psychosocial outcomes. This was expected to capture functional disease expression or the consequences of PPA for the individual’s everyday lives. Global outcomes or overall capacity of the system are again dynamic constructs, dependent on interactions within and across components of the system, coupled with a range of internal and external factors that mediate functional performance and outcomes within context, across moments in time. Central to this are notions of adaptation and self-organisation, determining whether an individual’s system has the capacity to adapt flexibly
in response to PPA, to accommodate as errors or language breakdown occur online, and to re-negotiate sense of self or adjust to a new life with PPA. This was a major question driving the current research, concerning whether individuals with PPA would demonstrate spontaneous, proactive coping or whether therapeutic interventions are required to promote and optimise positive adaptation. Examining the case profiles and subjective-insights provided evidence of maladaptation for some participants with PPA. This suggests that positive phase-shifts do not always emerge intuitively and that early intervention is of critical importance to optimise behavioural and psychosocial outcomes.

**Self-organisation and patterns of adaptation.** Self-organisation is defined as “the spontaneous emergence of order from nonlinear interactions among the components of a complex dynamic system” (Lewis, 2005, p.173). This supports the emergence and stabilisation of novel forms and attractor states that are mediated by feedback mechanisms (Granic & Patterson, 2006). Over time, as particular patterns of behaviour or emotional responses stabilise, they become increasingly predictable, representing stable states that the system is attracted to (Granic & Patterson, 2006). This explains how maladaptive strategies can become engrained following the onset of PPA, when they are reinforced and practised for an extended time. For T2, it was evident that early symptoms of PPA had heightened her system’s sensitivity to minor and local effects, with dramatic implications. For example, by withdrawing from her voluntary tutoring position, avoiding answering the telephone and confining social interactions to within her home, she had managed to successfully restore balance through patterns of avoidance and emotion-focused coping. As a result, significant excess disability was evident, which in dynamic terms, is associated with a reduction in the number of attractor states active within a system. Furthermore, this is expected to diminish the system’s flexibility to deal with changing environments over time (De Bot et al., 2007; Lewis, 2005). This was also evident for T2 who was no longer comfortable outside of her home and a range of strategies were in place to minimise demands placed on her system and to control associated stress. Given that maladaptive strategies can become engrained and resistant to change if practised and habituated, there is a need for early intervention to support adaptation, bolster resilience and to help the
system to ‘settle’ appropriately. While it is not clear whether timely diagnosis and support would have altered T2’s psychosocial outcomes, this is certainly worthy of further investigation.

*Preventing maladaptive strategies from hardwiring.* The future states of the system are experience-dependent, governed by the system’s current state and modified by ongoing activity and adaptive responses during real-time interactions (Granic & Patterson, 2006; Lewis, 2005). Through such processes learning and behavioural shifts take place, with new habits, skills, intentions, and thought patterns emerging, stabilising and consolidating over time (Port & van Gelder, 1995; Thelen & Smith, 1994). This habituation is believed to be reflected biologically through structural neural changes and mechanisms of Hebbian learning or synaptic strengthening (Lewis, 2005). As a result, for positive adaptation and self-organisation to occur, the system needs to be challenged in order to maintain functionality and movement through phase-transitions and perturbation, which are characteristic of everyday life (Lewis, 2005). This was positive for T1 who was still actively engaging in a range of professional and social roles, despite his language symptoms and reduction in self-efficacy. He was consciously aware that he needed to keep challenging his system and cognisant that if he were to withdraw completely, his difficulties would be quickly compounded which is supported by dynamic systems theory and should be encouraged through therapeutic intervention (Woods et al., 2012).

**Clinical and Professional Implications**

This research has provided proof of concept support for the theoretical and clinical value of the dynamic systems framework of PPA. A number of preliminary practice recommendations have been identified throughout this thesis that will be discussed in more detail here. Most significantly, examining PPA within a dynamic systems framework has highlighted the critical need for timely diagnosis and early intervention, given that negative emotional responses and maladaptive compensatory strategies can emerge immediately following symptom onset. Furthermore, the dynamic systems approach has shown promise for understanding the robustness or resilience of an individual’s system, quantifying the severity and nature of impairment to track change over time, while enabling the identification of ecologically valid and person-centred areas of therapeutic need. This is consistent with notions
that conceptualisations of language, cognition and disease states informed by dynamic systems theory “may be more biologically plausible and better able to integrate neural findings” (Lewis, 2005, p.169).

**The critical need for timely diagnosis.** One of the most important practice implications of this research concerns the critical need for timely diagnosis and provision of early intervention and support services for people with PPA, given the dynamic interactions between awareness of early symptoms, the emergence of maladaptive coping strategies, and the multi-layered functional and psychosocial consequences of disease that were evident for the participants of this research. This is consistent with priorities for the dementia field more broadly where it has been emphasised that research should be focusing on the earliest stages of disease possible (Dickerson, 2011; Mesulam et al., 2012; Selkoe, 2002). As a result, there is a critical need to identify clinical measures that provide sensitive, early markers of disease emergence. Furthermore, the need for explicit and quantitative guidelines for classification and diagnosis that can be validated at the individual patient level have been called for (Mesulam et al., 2012). The systems approach and methodology utilised in this research provide new opportunities for this endeavour, with potential to enhance both the accuracy and ecological validity of early diagnosis, through a holistic, quantitative case-controls approach, such as that evaluated through the current research. The choice of tests and measures utilised chosen to construct the system-profiles were theoretically driven, yet exploratory, and it is not yet clear whether they represent the most sensitive or clinically useful set of measures. This should be explored by further research. For example, the addition of markers of word comprehension and grammatical competence which are known to differentiate the variants of PPA (Mesulam et al., 2012) may reveal different patterns of results and assist classification beyond the root diagnosis of PPA, which was not a primary aim of the current research. Furthermore, use of more ecologically valid tasks other than picture descriptions, with richer sampling of natural language is recommended in future studies. Future research will also need to examine use of the system-profiles with patients who speak English as a second language or are from different cultural backgrounds (Mesulam et al., 2012).
**Acute sensitivity to emerging PPA.** In regard to timely diagnosis, it is important to consider the nature of early changes taking place within the brain that result in the incipient symptoms of PPA and other types of dementia. For example, in the earliest clinical phase of Alzheimer’s disease, subtle aberrations of synaptic function are believed to underpin early changes in memory and new learning as opposed to frank neuronal degeneration or loss of whole neurons (Selkoe, 2002). This contributes to functional disconnection between distant regions of the brain, compromising cognitive function (Stam, Jones, Nolte, Breakspear, & Scheltens, 2007). As a result, symptoms are more dynamic in early disease stages, characterised by subtlety and variability, due to synaptic failure occurring discretely and perhaps intermittently (Selkoe, 2002). Imaging technology is now able to reconstruct the distributed tracts and circuitry of the brain (McIntosh, 2010; Pievani et al., 2011; Sun et al., 2012). Finding clinical measures that reflect the integrity of the distributed language networks has been problematic, highlighting the limitations of the focal or discrete measures that the field has relied upon (Lewis, 2005). Given the dynamic, subtle and intermittent nature of pathology and early symptoms, it is assumed that more dynamic clinical measures will have greater sensitivity or potential to detect synaptic dysfunction.

**Identifying sensitive markers of emergent disease.** The findings of the current research have supported the use of natural language and communicative efficiency measures for this purpose, with potential to capture the integrity of distributed language processing or ‘whole brain systems’ rather than the isolated function of constituent parts or sub-systems. The CIUs/min metric used in this research differentiated all five cases from the healthy ageing control, including T1 who was in the earliest stages of disease. It is hypothesised that the temporal and integrative nature of this measure may index the extent of neuronal or synaptic dysfunction and selective neuronal loss within the language networks, also capturing underlying neurotransmitter deficits. For a case like T1, pathology may not be detected on focal linguistic tasks like the BNT until more profound synaptic alteration or subsequent neuronal death occurs. This hypothesis could be investigated by future research determining whether correlations are found between CIUs/min and neural correlates of functional connectivity, such as EEG data.
(Stam et al., 2007) or diffusion tensor imaging (Matsuo et al., 2008). If an association was to be found, efficiency measures would provide a reliable and objective means of tracking the severity of pathology over time. It is also of interest how early disruptions in communicative efficiency emerge, which would need to be tested via large prospective, longitudinal ageing studies across a trajectory of healthy ageing into emergent disease states. The value of such research has been demonstrated in relation to Alzheimer’s disease where subtle changes in spontaneous spoken and written language (e.g. vocabulary and lexical selection) have been found prior to subjective awareness of symptoms or compromised performance on standardised cognitive or language assessments (Forbes-McKay & Venneri, 2005; Garrard et al., 2005; Snowdon et al., 1996). Furthermore, previous research has demonstrated that picture description tasks have satisfactory power for this diagnostic purpose, differentiating individuals with early Alzheimer’s disease from healthy ageing participants (Forbes-McKay & Venneri, 2005). Measures of semantic processing (e.g. informational content, word retrieval delays) have been found to have strongest discriminatory potential (Forbes-McKay & Venneri, 2005), consistent with the sensitivity of the CIUs/min measure in the current study.

**Pre-clinical PPA and the diagnostic value of subjective-insights.** In regard to timely diagnosis of PPA, the current research findings highlight the critical importance of using subjective-insights and tools like Leximancer™ to detect emergent disease. The acute awareness and insight of people with PPA in the very early or emergent stages of disease differentiated their subjective-insights from healthy ageing. It is known that people with PPA often perform within healthy limits on standardised language tasks or generic dementia screens in the early stages of disease, which is why diagnosis is so problematic (Dickerson, 2011; Mesulam et al., 2012). Significant diagnostic weight should be given to the presence of subjective-linguistic impairment as a reliable and valid marker of emerging disease (Dickerson, 2011; Rogalski & Mesulam, 2009), particularly when the language complaints extend beyond occasional word finding or recall difficulties and are associated with negative emotional reactions and reduced self-efficacy for social communication. Even in the case of a worried well profile or cases that do not go on to progress further, reports of language dissolution should be
taken seriously given that maladaptive strategies can start forming early and have significant implications for social engagement and psychosocial wellbeing. Through further research exploring subjective-insights into PPA and personal constructions of disease on a larger scale, language symptoms that are particularly worrisome or more overt markers of disease are likely to emerge. This has significant potential to identify people in a prodromal or pre-clinical stage that may be months or years away from overt clinical symptoms or decrements on standardised assessments or general dementia screening tools (Garrard et al., 2005; Rogalski & Mesulam, 2009) and opening up new opportunities for preventative, early intervention.

Clinical value of the dynamic systems framework of PPA. The potential value of the dynamic systems framework of PPA and associated methodological approaches has been demonstrated, consistent with previous research showing that multi-dimensional perspectives of disease expression provide clinicians with a “sharper diagnostic lens” (Wool & Mor, 2005, p.732). This can enable the detection of subtle signs or unreported symptoms more readily (Wool & Mor, 2005), in particular pertaining to the social-emotional consequences of disease that the individual may not be consciously aware of, most notably when maladaptive strategies have become engrained. Using tools like LeximancerTM has significant potential for identifying these latent or indirect consequences that may be masked or hidden from view.

Advocating for early proactive intervention services for PPA. The policy and research pressure for timely diagnosis is not for the sake of labeling symptoms, but rather to direct the provision of personalised therapeutic and support strategies (Alzheimer’s International, 2011). Through education, information and support, an individual then has the opportunity to make informed decisions and plans for their future, with the possibility of support to make their current and future situation better (Alzheimer’s International, 2011). It is recognised that speech-language pathologists are well qualified to provide proactive management to people with PPA and their families (Khayum et al., 2012; Taylor et al., 2009). Furthermore, their ethical responsibility to do so is widely recognised (Duffy & McNeil, 2008). A dynamic conceptualisation of PPA requires an integrated, holistic and proactive approach to management that is interprofessional and initiated at the earliest possible disease stage to
prevent maladaptive strategies or psychosocial consequences from emerging. Treatment should focus on optimising system function, while supporting individuals to adjust positively to their emerging symptoms and diagnosis.

Targeting maladaptive or emotion-focused coping strategies. The findings of this research highlight that individuals do not always respond positively or proactively to the emergence of PPA and that given the foreign nature of language pathology, therapeutic guidance is required. The need for proactive management has been discussed previously in the PPA literature, focusing on the identification of treatment goals to support current needs, while in anticipation of future declines (Rogers & Alarcon, 1998). It is clear that management must be tailored to an individual’s system profile, while understanding their adaptive mechanisms or ways of coping. For example, the therapeutic recommendations for T1 and T2 would be quite different based on the understanding of the nature and psychosocial impact of their respective profiles. It is critical that management is holistic, addressing the global behavioural and psychosocial outcomes, not focusing solely on emerging linguistic impairments (Rogers & Alarcon, 1998). The value of using the dynamic systems framework of PPA to guide clinical management is supported by the findings. It is clear that disease expression is dynamic, complex and multi-dimensional, influenced by a range of internal and external factors. The system is continuously evolving and adapting and as such the therapeutic process should also be flexible, fluid and evolving. This requires a dynamic relationship between the interprofessional team working with the individual with PPA and their family.

Focusing on QOL and positive psychosocial outcomes. It has been stated that clinicians should not shy away from providing therapeutic services to people with PPA (Khayum et al., 2012), with many treatment options to consider. Given that a cure or effective pharmacological treatments for PPA are not yet available, it is important that clinicians have the skills and resources available to instil hope and foster proactive coping strategies as a key component of therapeutic management. This highlights the need to manage PPA within an interprofessional context with access to psychological support services. Byng, Cairns and Duchan (2002) presented a values-based practice framework, which guides clinicians to take a
considered approach during each stage of therapeutic intervention. This encourages clinicians to reflect on and think about the values and philosophy of care (or helping) that underpin their service or the profession more broadly and refer to these values when determining goals and the clinical strategies or processes for attainment (Byng et al., 2002). It is important that the values driving each decision made about therapy and how a clinician engages their client is made explicit for all parties, including the clinician, the client, and their family (Byng et al., 2002). This mutual agreement and understanding is important and helps ensure that stakeholders are working towards a common goal (Byng et al., 2002). It is critical that clinicians move beyond diagnosis, to help the individual navigate the disease trajectory and challenges faced. Byng and colleagues (2002) identify potential foci of therapy such as “supporting clients to achieve a healthy psychological state”, “supporting clients in their development of new or revised identities”, “enhancing communication”, and “identifying barriers to social participation” (Byng et al., 2002, p.99), which all have relevance for the management of PPA based on the findings of the current research.

Adopting a flexible, dynamic systems approach to intervention for PPA. Given the chronic, progressive nature of PPA it has been documented that “it is not appropriate to “graduate” an individual with PPA” (Khayum et al., 2012, p.41) and management plans need to adapt over time in response to changing needs and priorities. This requires the clinician to take a flexible approach to therapy, matching the complex, dynamic and evolving nature of disease expression. Meeting the dynamic, multi-dimensional needs of people living with PPA will require clinicians to feel confident in their counseling skills and holistic therapy techniques to help clients cope with symptoms and address the emotional and QOL impact (Khayum et al., 2012; Phillips & Mendel, 2008). Counseling services are recognized to be within the scope of practice of speech-language pathologists (Phillips & Mendel, 2008). However clear guidelines do not exist regarding this role, where professional boundaries lie, the types of counseling services that should be provided, or the clinician’s level of confidence or comfort in doing so (Phillips & Mendell, 2008). It has been highlighted in the literature that student speech-language pathologists require sufficient theoretical instruction and clinical experience in counseling to
enable them to effectively address the emotional issues that are associated with communication disorders to optimize treatment outcomes.

*Treating PPA within context and addressing external, inter-personal factors.* Within the dynamic systems framework of PPA, treatment must consider the environment, external and inter-personal factors, as well as broader contextual and societal issues that influence behavioural and psychosocial outcomes. This should be explored by further research, although the need for caregiver education and psychosocial interventions is well recognised (Khayum et al., 2012). The spouse’s involvement in the semi-structured interviews in this research provided insight into the impact of PPA on family members and a sense of the challenges face. This was illustrated by T2’s husband who was working incredibly hard to support and protect his wife from the emotional consequences of PPA by helping to proactively minimise the demands and challenges placed on her language system. He was seeking strategies and ideas to support her language difficulties and they presented with a very strong partnership that could be strengthened further through proactive therapeutic interventions. Taking a more holistic focus is expected to assist the clinician to help the individual with PPA find meaning and to find practical ways of helping the person to stay connected and engaged within their community (Khayum et al., 2012), which was a critical need for the participants involved in this research.

*Targeting multi-layered, interprofessional care needs.* It is important for interprofessional care teams to understand the complexity of PPA and its multi-layered nature, incorporating these dynamic properties into conceptualisations and definitions of the syndrome. This helps individuals to understand the challenges they are facing, particularly in relation to fluctuations and variability of performance over time, the impact of cognitive load, and the danger of maladaptive strategies. Helping the individual understand the dynamic and complex nature of their emerging difficulties may help acceptance and coping processes, rather than fighting against or trying to control their symptoms. In the stuttering field, integrated treatments are well established teaching the client strategies to speak more fluently (i.e. targeting the surface symptoms and impairment), while also addressing negative emotions and appraisals and reducing avoidance behaviours (Beilby, Byrnes, & Yaruss, 2012).
Proposing Acceptance and Commitment Therapy as a possible approach. Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 1999) is one treatment philosophy showing promise in the stuttering field (Beilby et al., 2012) that may have merit for PPA. ACT is a psychological therapy that targets psychological inflexibility, emotional instability and experiential avoidance through acceptance and a focus on value-based living (Beilby et al., 2012; Hayes, Luoma, Bond, Masuda, & Lillis, 2006). ACT targets the core mechanisms that drive psychological inflexibility including self-concept, defusion, acceptance, mindfulness, values and committed action (Beilby et al., 2012; Hayes et al., 2006). These processes have direct relevance to the individual profiles that have emerged through this research, whereby bolstering self-concept, supporting acceptance and teaching mindfulness techniques have potential to enhance resilience, while promoting positive patterns of self-regulation and adjustment for the participants with PPA. This could be explored through future research to determine whether early ACT therapy for people with PPA is associated with improved self-efficacy and wellbeing outcomes, while shifting some of the negative reactions and adaptive strategies that emerged from the subjective-insights. Leximancer™ could be used to track changes in cognitive appraisals and psychological processes following intervention.

The importance of tracking clinical progression and therapeutic gains over time. Finally, consistent with the need for timely diagnosis and early intervention, robust methods are required to monitor and track the progression of PPA over time (Dickerson, 2011). The findings of this research provide preliminary support for the use of the theoretically driven approach to profiling and analysis employed by this research for this purpose. Both the system-profiles and Leximancer™ concept maps demonstrated sensitivity to the early stages of PPA. Furthermore, given their quantitative nature, they provide a valid and objective baseline for future comparison. Dickerson (2011) highlighted the need for the clinician to determine the overall level of impairment following the diagnosis of PPA, which was captured by the radar plots and mediated by the adaptive mechanisms identified. The use of structured clinical interviews for the initial diagnosis of PPA has been identified (Dickerson, 2011) and Leximancer™ provides a viable option for quantifying and analysing the subjective-insights gathered. The findings of this
research stress the critical need for this baseline to be holistic, calling for clinicians to take a wide-lens, systems approach to clinical assessment and profiling, quantifying and examining disease expression beyond the level of focal impairment. This should consider the dynamic interplay between cognitive, linguistic and social-emotional functions, as well as the impact of external and environmental parameters on performance. This is expected to provide a more meaningful and ecologically valid platform for monitoring progression of disease over time.

Limitations and Future Directions

Given the exploratory nature of this research, the findings will need to be replicated and extended by future studies. A number of limitations are identified, providing recommendations for future research.

Sample size, sampling methods and generalisability of findings. The main limitation of this study relates to the small sample size, which reflects the fragmented diagnostic and management pathways for PPA in Western Australia that were particularly evident in the early stages of the project. This was a significant challenge for participant recruitment; however the small sample size promoted the rich, in-depth analysis of the five cases. The small sample size, convenience sampling, and the nature of the geographic location (i.e. fragmented diagnostic and care pathways, limited coordination of care services) does limit the generalisability of the findings to other geographical locations where PPA services may be better established or coordinated. Still, the findings provide indirect support for the continuation of these services, highlighting the negative behavioural and psychosocial consequences that may be associated with delayed diagnosis, treatment and support. The exploratory, proof of concept nature of the research has also enabled a number of hypotheses and research questions to be identified that have provided useful direction for future research.

Refining and extending the dynamic systems framework of PPA. The dynamic systems framework of PPA presented and applied in this thesis is in an early stage of development and should be refined and extended by future research. This should consider whether additional or alternative components, measures and parameters should be included. For example, given that PPA-G is associated with apraxia of speech, the addition of a motoric
component could be considered to aid diagnostic profiling. Furthermore, this thesis has focused very much on the individual, the intra-personal system and subjective-insights. While caregiver perceptions were incorporated into analysis two they were not the focus. Future research should examine self-organisation and adaptive processes within context and as a function of relationships (Granic et al., 2006; Granic & Patterson, 2006). Ecological frameworks have been presented in the literature that would allow the interactions between intra- and inter-personal processes to be examined in greater depth (Granic et al., 2006), which would have theoretical and clinical benefits for the field.

Another limitation is that a comprehensive battery of neuropsychological assessments was not conducted as part of the research protocol or system-profiles. Participants had undergone comprehensive testing during diagnostic workup, precluding repeated administration of a number of assessments. Furthermore, consensus classification criteria and assessment guidelines had not been well established in the early planning stages of this project. Embedding the Addenbrooke’s Cognitive Exam (ACE) into the system-profiles may have diagnostic and clinical merit given that previous research has demonstrated its use for monitoring longitudinal changes over time in people with PPA (Leyton, Homberger, Mioshi, & Hodges, 2010). Alternative measures of linguistic competence should also be considered, given that the BNT only provides a standardised measure of object naming and does not adequately examine both production and comprehension of nouns and verbs (Thompson et al., 2012). It is known that noun and verb comprehension and production fractionate in different ways across the variants of PPA, highlighting the diagnostic utility of accurate profiles of naming deficit patterns across word classes. As such, assessments like the Northwestern Naming Battery (Thompson et al., 2012) should be considered in future research, designed to provide comprehensive assessment of noun and verb production and comprehension. This would address a related limitation of the current study. The assessment protocol focused on speech production given that this represents the primary complaint associated with PPA (Rohrer et al., 2008). The inclusion of receptive markers is not only important diagnostically, but also practically, given that strong positive correlations between insight and level of comprehension have been reported in the PPA.
literature (Medina, 2009). Within the social-emotional component alternative QOL measures should also be considered. The QOL-AD did not differentiate the participants with PPA from the healthy ageing control sample and it would be interesting to compare this to other published and validated scales such as the Quality of Communication Life Scale (ASHA QCL; Paul, Frattali, Holland, Thompson, Caperton, & Slater, 2004). The ASHA QCL measures the impact of a communication disorder on relationships, communication interactions, participation in social, leisure, work and education roles, as well as overall QOL and as such, may capture the QOL impact of progressive aphasia more sensitively. The methodological approach and use of the radar plots provides a strong platform for integrating or embedding alternative and/or additional measures in the future.

Exploring interactions, correlations and critical factors of relevance. This research employed two levels of analysis to gain different windows into the dynamic system of individuals with PPA. Given the small sample size it was not possible to conduct correlational analyses across the two levels of analysis to determine the relationships between the system-profiles and subjective-insights. Furthermore, it is not possible to ascertain whether the two emergent system-profiles have biological or diagnostic relevance or whether they reflect other factors, such as the severity or stage of PPA, or other personal or environmental factors. As such, further large-scale research is required with greater control and a larger sample size, combined with more comprehensive characterisation of the participants. Ideally, this should include imaging data to help examine the biological relevance of the data and emergent profiles. Future research should also recruit a larger control group that is more closely age, gender and education matched to replicate and extend the current findings. The need to contextualise system-profiles in relation to subjective-insights is strongly supported by the current research, highlighting that test performance alone is a poor indicator of the global functional and psychosocial consequences of PPA. This supports the recommendations of Dickerson (2011) who states that the structured clinical interview should be used to understand the client’s potential to communicate and participate in everyday life. Adaptive mechanisms and ways of coping have been identified as critical mechanisms in mediating functional outcomes.
**Increasing focus on environmental, external and inter-personal factors.** Future research should explore the inter-personal, external and environmental factors that mediate disease expression, resilience and self-organisation in response to PPA. Multiple regression analyses could be used to determine predictive factors or contributors to resilience in the context of PPA using methodology similar to Craig, Blumgart and Tran (2011). Structural equation modeling could be applied to identify factors that explain large portions of variance in PPA expression and impact to identify key issues, providing further direction for dynamic conceptualisations of PPA, and assessment and management approaches. The findings of this research have shown that factors like communicative self-efficacy, certain personality characteristics and coping styles, prior history of depression, and presence of anxiety are predicted to be important factors for examination, supporting and building on the findings of Medina (2009). Evidence supporting resource allocation and cognitive load effects emerged from the system-profiles and subjective-insights, resulting in fluctuating symptoms that were often a source of frustration and uncertainty. Understanding how external factors impact language performance and disease expression over time would provide critical information for education and caregiver interventions, while allowing tailored strategies and recommendations to be made. Furthermore, this could help the individual understand the factors that influence their own individual system performance and capacity to help retain a sense of control and self-efficacy to participate in a wide range of contexts.

**Examining the psychosocial and therapeutic needs of younger people with PPA.** Interestingly the current sample constituted participants with PPA diagnosed during the seventh and eighth decades of their lives, even though PPA is recognized as an early-onset dementia. Future research could explore whether the holistic system-profiles, psychosocial impact, and subjective-insights are different for a younger cohort. Differences would be predicted if the onset of PPA occurs in the fifth or sixth decade of an individual’s life, during the prime of vocational careers and while prominent family and social roles are evident.

**Developing new therapeutic approaches and care pathways for PPA.** Finally, the preliminary findings have provided useful direction for future treatment research, highlighting
the need for holistic, integrated and interprofessional therapies. The potential value of ACT as a psychological intervention for people with PPA and their families was identified, which to the researcher’s knowledge has not been previously trialled with early stage dementia or PPA. Ultimately, future research should consider and address the wide ranging consequences of the syndrome, aiming to move beyond diagnosis, to improve behavioural and psychosocial outcomes at every stage of the disease journey. Proactive interventions and care pathways require development to support individuals with PPA and their families to adjust to and live well in the face of language dissolution.

**Conclusion**

It is known that the conceptual framework adopted to study disorders of cognition and language has profound implications for the phenomena studied, the questions asked, the methodologies drawn upon, and ultimately the advancement of a field (Beer, 2000). This thesis has investigated the new perspectives that can come from studying PPA within a dynamic systems framework, widening the empirical lens and conceptualising disease expression in terms of holistic system function and adaptation. The findings have provided preliminary evidence for the multi-layered nature of PPA and the complex interactions between internal and external influences whose interplay shape disease evolution and expression over time. The nature of language dissolution and its global behavioural and psychosocial consequences should be conceptualised as dynamic, distributed and emergent properties that manifest and evolve over time. The notion of self-organisation or adaptation is central to dynamical perspectives of PPA, mediating how the disease is expressed and experienced functionally on an individual basis. The research supports the value of single-case research for studying complex problems, with rich insights and perspectives gained from a small number of participants. Furthermore, the critical need for in-depth understanding of an individual’s system, disease expression and coping style is emphasised for identifying unique therapeutic needs and developing holistic management plans. This is essential for optimising system function and promoting the successful accommodation of PPA into an individual’s everyday life and natural contexts.
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APPENDIX A

Case History Interview Questions

How many years of education have you received?
Can you tell me about your employment history?
Can you tell me about your family? Are you married? How many children/ grandchildren do you have?
Have you experienced any changes in your thinking, memory, or communication skills? Can you describe these to me?*
What were the first signs, symptoms or changes you noticed?*
How would you describe your reaction or response to these difficulties?*
When were your vision and hearing last tested? What was the outcome?
Can you please describe what a typical day is like for?
What physical exercise do you get each day?
What social activities do you participate in?
Do you make a conscious effort to stimulate, use or strengthen your communication and/or memory skills on a daily basis?
What strategies or assistive devices do you feel help to facilitate your memory or communication?

Note. *Responses analysed in chapter 6, Leximancer™ analysis. The other responses provided more general background and case history information.
APPENDIX B

Item analysis for the QOL-AD. Means and standard deviations provided for the healthy control participants, with the raw scores and significance for the participants with PPA.

<table>
<thead>
<tr>
<th>Item</th>
<th>Control M (SD)</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical health</td>
<td>3.00 (.39)</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Energy</td>
<td>2.79 (.43)</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1*</td>
</tr>
<tr>
<td>Mood</td>
<td>3.14 (.66)</td>
<td>4</td>
<td>1*</td>
<td>2</td>
<td>1*</td>
<td>3</td>
</tr>
<tr>
<td>Living situation</td>
<td>3.57 (.51)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Memory</td>
<td>2.71 (.61)</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Family</td>
<td>3.71 (.47)</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Marriage</td>
<td>3.50 (.52)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Friends</td>
<td>3.36 (.63)</td>
<td>3</td>
<td>1*</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Self as a whole</td>
<td>3.14 (.53)</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ability to do chores</td>
<td>2.93 (.47)</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Ability to do things for fun</td>
<td>3.14 (.77)</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Money</td>
<td>3.00 (.55)</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Life as a whole</td>
<td>3.36 (.50)</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Number of items significantly different to the healthy control group: 0/13, 2/13, 0/13, 1/13, 1/13

Note: Self-efficacy is expressed as percentage confidence to talk in that context (0 = not confident at all, 100 = 100% confident). *More than 2 z-score away from the healthy control group range of performance.
APPENDIX C

Item analysis for the WHO-5 averaged across the three sampling sessions. Means and standard deviations provided for the healthy control participants, with the raw scores and significance for the participants with PPA.

<table>
<thead>
<tr>
<th>Item</th>
<th>Control M (SD)</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have felt cheerful and in good spirits.</td>
<td>4.22 (0.63)</td>
<td>4.00</td>
<td>1.67*</td>
<td>4.00</td>
<td>3.33</td>
<td>3.67</td>
</tr>
<tr>
<td>I have felt calm and relaxed.</td>
<td>4.10 (0.75)</td>
<td>4.00</td>
<td>.33*</td>
<td>4.00</td>
<td>2.67</td>
<td>3.67</td>
</tr>
<tr>
<td>I have felt active and vigorous.</td>
<td>3.55 (0.75)</td>
<td>3.33</td>
<td>.67*</td>
<td>4.33</td>
<td>2.33</td>
<td>1.67*</td>
</tr>
<tr>
<td>I woke up feeling fresh and interested.</td>
<td>4.12 (0.94)</td>
<td>2.67</td>
<td>.00*</td>
<td>4.33</td>
<td>3.00</td>
<td>.67*</td>
</tr>
<tr>
<td>My daily life has been filled with things that interest me.</td>
<td>4.17 (0.71)</td>
<td>3.67</td>
<td>.67*</td>
<td>4.00</td>
<td>2.33*</td>
<td>2.00*</td>
</tr>
</tbody>
</table>

Number of items significantly different to the healthy control group

<table>
<thead>
<tr>
<th></th>
<th>0/5</th>
<th>5/5</th>
<th>0/5</th>
<th>1/5</th>
<th>3/5</th>
</tr>
</thead>
</table>

Note. Self-efficacy is expressed as percentage confidence to talk in that context (0 = not confident at all, 100 = 100% confident). *More than 2 $z$ away from the healthy control group range of performance.
APPENDIX D

Item analysis for the self-efficacy for social communication scale. Means and standard deviations provided for the healthy control participants, with the raw scores and significance for the participants with PPA.

<table>
<thead>
<tr>
<th>Item</th>
<th>Control M (SD)</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talking when tired</td>
<td>85.00 (18.29)</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Talking with family or close friends.</td>
<td>97.14 (8.25)</td>
<td>80</td>
<td>50*</td>
<td>50*</td>
<td>50*</td>
<td>60*</td>
</tr>
<tr>
<td>Talking when doing another task at the same time.</td>
<td>89.29 (16.39)</td>
<td>70</td>
<td>40*</td>
<td>60</td>
<td>40*</td>
<td>70</td>
</tr>
<tr>
<td>Talking to strangers in the community.</td>
<td>91.43 (14.06)</td>
<td>40*</td>
<td>0*</td>
<td>10*</td>
<td>0*</td>
<td>40*</td>
</tr>
<tr>
<td>Talking when feeling stressed or under pressure.</td>
<td>81.07 (17.99)</td>
<td>40*</td>
<td>0*</td>
<td>20*</td>
<td>0*</td>
<td>10*</td>
</tr>
<tr>
<td>Talking in a noisy room or environment.</td>
<td>80.00 (24.49)</td>
<td>40</td>
<td>50</td>
<td>20*</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Talking when feeling depressed or low in mood.</td>
<td>83.57 (18.65)</td>
<td>80</td>
<td>30*</td>
<td>50</td>
<td>30*</td>
<td>40*</td>
</tr>
<tr>
<td>Talking in a group setting (e.g. at a dinner party or social gathering).</td>
<td>95.00 (13.45)</td>
<td>30*</td>
<td>50*</td>
<td>10*</td>
<td>50*</td>
<td>40*</td>
</tr>
<tr>
<td>Talking in front of a large group of people (e.g. formal meeting or speech).</td>
<td>80.71 (30.75)</td>
<td>40</td>
<td>0*</td>
<td>0*</td>
<td>0*</td>
<td>30</td>
</tr>
<tr>
<td>Talking about complex or detailed information.</td>
<td>85.71 (21.74)</td>
<td>20*</td>
<td>10*</td>
<td>60</td>
<td>10*</td>
<td>60</td>
</tr>
<tr>
<td>Talking about old memories or the past.</td>
<td>92.14 (15.28)</td>
<td>50*</td>
<td>40*</td>
<td>70</td>
<td>40*</td>
<td>100</td>
</tr>
<tr>
<td>Talking about or retelling a story that you have recently heard.</td>
<td>88.57 (16.57)</td>
<td>40*</td>
<td>20*</td>
<td>0*</td>
<td>20*</td>
<td>50*</td>
</tr>
<tr>
<td>Talking about a current issue or world event.</td>
<td>90.71 (15.92)</td>
<td>20*</td>
<td>0*</td>
<td>70</td>
<td>0*</td>
<td>60</td>
</tr>
</tbody>
</table>

Number of items significantly different to the healthy control group: 7/13 11/13 7/13 11/13 6/13

Note. Self-efficacy is expressed as percentage confidence to talk in that context (0 = not confident at all, 100 = 100% confident). *More than 2 z away from the healthy control group range of performance.