EVALUATING A TECHNOLOGY-BASED REMINISCENCE PROGRAM ON ENGAGEMENT AND AFFECT IN RESPITE AGED CARE: TIME TRAVELLING WITH TECHNOLOGY

Madeleine Jessica Radnan

BAdvSci(Hons)

19246097

A thesis submitted for the partial fulfilment for the degree of

Doctor of Philosophy

The MARCS Institute for Brain, Behaviour and Development

Western Sydney University

2021

Acknowledgements

I would like to give my utmost gratitude to all the remarkable people that have assisted me in completing this thesis. To my supervisors Professor Kate Stevens and Professor Caroline Jones, I have learnt so much from you both and am beyond grateful for the opportunity you gave me in being a part of this wonderful project. You have helped me to develop my research, cognitive psychology, linguistic, writing and professional skills (to name a few) to what they are now and assisted in paving a pathway to succeed in academia. I leave these three years in awe and continual inspiration of who you are, the work you do and the impact you have on MARCS and the greater community. I could not ask for better mentors on this journey, to provide encouragement, support, wisdom and guidance that has been invaluable to the success of this thesis.

My sincere gratitude is extended to Dr. Clair Hill, who joined my supervisor panel quite late, but who's help, support and expertise was vital to getting me across that finish line. Another big thank you to one of the busiest and talented people who gave me their undivided attention and support for the duration of the experiment, the manager of the Social Club at Baptist Care Kellyville, Maryla Berezowski. Thank you for pouring your enthusiasm and time into the TTT program and helping with the coordination of the participants.

Thank you to Andrew Leahy for helping me with the TTT interface, set-up and equipment. For helping me to provide an exciting and enchanting experience for older adults. I would also like to acknowledge and give my great appreciation to Weicong Li. Without your brilliant mastermind in coding I wouldn't have been able construct such a novel linguistic methodology and analysis. I thank you for the time you spent assisting me with analysis and your patience when software doesn't quite work the way it is expected to. My thanks is further extended to the MARCS Teach Team who helped me extensively with OpenFace and equipment for the delivery of the research.

I would also like to acknowledge and give special thanks to the MARCS Institute, Western Sydney University, and the Australian Department of Education and Training for supporting my research financially.

When it comes to my family and friends, words cannot capture the gratitude I have for all of your support. With deepest appreciation to my family members, Shana my mum, my sisters Gabby, Steffi and Genna, my grandma Jenny and aunty Julia, and my aunty Debbie and uncle Warwick. And for my closest friends Lilly, Anna, Lara, Mark and Nikki. I am whole-heartedly appreciative for all of your love, support and encouragement throughout the last three years and in light of all the unexpected situations that have arisen. To everyone else that has been a significant presence throughout this milestone, I thank you deeply. There are too many of you to list specifically and that in itself brings a warmth and understanding of how lucky I am to have you all in my life.

Last but not least, I would like to extend special thanks to the participants and their families. You shared your stories with me and were generous with your time. This thesis would not have been possible without you.

Statement of Authentication

The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in full or in part, for a degree at this or any other institution.

[redacted]

Madeleine Jessica Radnan

Table of Contents

List of Tables

List of Figures

Abstract

With an aging population, there is greater focus in ensuring that aged care facilities are delivering high quality care. This is particularly important with the increase in aged related diseases, such as those that result in dementia. Previous research makes clear the value of meaningful activity, socialisation and engagement for wellbeing and quality of life for older adults. The Comprehensive Process Model of Group Engagement (CPMGE) is a framework to conceptualise the theory of engagement. The CPMGE outlines how the interaction between person, environment and stimuli factors guide behavioural outcomes, which can be measured to characterise engagement. Reminiscence therapy (RT), is as well-established a non-pharmacological intervention, used to increase engagement in older adults. It actively involves stimulating conversation through discussion of past events and experiences. The theory behind RT is founded in person-centered care and meaningful activity. Person-centered care focuses on the needs of an individual and has an emphasis on interpersonal relationships. Through personal life events, autobiographical memories are recalled, which assist in creating a meaningful experience and connecting a person to their identity. Additionally, technological developments (such as sharing video/images) offer possible new methods for increased engagement in the RT approach. However, there is controversy in existing research as to the benefits of RT and there is limited understanding of the effect of RT when driven by digital technology.

The aim of this thesis is to build on and refine previous research by conceptualizing and quantifying older adult engagement. It explores this through investigating the impact of an experimental framework Time Travelling with Technology (TTT) on the engagement of older adults in respite aged care. TTT is a dynamic, interactive and immersive, technology driven RT program, that enables older adults to travel to locations of their past and novel places of interest. To determine the impact of technology on engagement outcomes in the TTT experiment, there were two levels of the within subject digital technology independent variable – Low-Tech and High-Tech. In the Low-Tech condition (LT), TTT was operationalized as static images of locations. In the High-Tech condition (HT), TTT was operationalized with dynamic and immersive features. This included the ability to pan around the environment, have a 360-degree view of locations, move up and down streets, and explore the inside of buildings. To determine the impact of personalised stimuli and the RT component of TTT on engagement outcomes, there were two levels of the within subject location specificity independent variable – Person-Specific locations condition and Non-Specific locations condition. The Person-Specific locations condition presented locations that were acquired from the past history of an individual. For example, where a participant went to school, a home they used to live in, where they used to work, a favourite holiday location, or a place of religious importance. The Non-Specific locations condition presented locations that were not known to have an association with the participants' past. These Non-Specific locations where either novel to all participants, or they were Person-Specific to another participant in the group. The older adults participated in a baseline dyadic RT interview and acted as their own control. The dyadic RT interview involved a conversation between the facilitator and a participant, with prompting questions addressing the participants' life story. Therefore, there would be an absence of technology and an absence of a group environment.

Engagement of older adults was investigated through a multi-dimensional approach. The dimensions recorded and analysed as measures of engagement included facial movement, lexical use and

prosodic patterns of speech. Facial movement was analysed through the dependent variables of facial action units, which are markers of facial movement. A greater affect-driven behavioural outcome of engagement, as measured through facial movement, would be seen with a higher presence and intensity of facial action units. Analysing lexical use, as a measure of engagement, included the dependent variables of the percentage of pronoun use and affective word use within speech, as well as analysing the emotional tone of speech. In interpreting lexical use as a measure of engagement, a more personalised experience would be seen with a greater number of pronouns used in speech. As a marker of affect-driven behaviour, a greater outcome of engagement would be seen with more affective words used within speech. The emotional tone of speech then indicates the affective valence of speech, being either negative or positive on a continuous scale. A more affect-driven behavioural response to the stimuli, as a measure of engagement, would be seen with a greater valence on the emotional tone continuous scale. Analysing prosodic patterns of speech included measuring the dependent variables of the duration of utterances, words per utterance, articulation rate and the variability of the fundamental frequency (F0). In interpreting prosodic patters of speech, a greater engagement outcome would be seen with longer duration of utterances, more words per utterance and a faster articulation rate. Articulation rate is also a measure of energy expenditure during speech. A greater F0 variability would indicate greater affect-driven behaviour, as an outcome of engagement. Based on previous research on group RT, engagement and technology, is was hypothesised that 1) the TTT experiment would elicit greater engagement outcomes compared to the baseline dyadic RT interview, 2) the Person-Specific locations condition would elicit a more personalised experience, with greater engagement outcomes compared to the Non-Specific locations condition, and 3) the HT condition would elicit greater engagement outcomes compared to the LT condition.

A 12-week intervention, carried out at a day respite facility in Sydney, delivered the TTT experiment to nine older adults. The LT condition and HT condition ran for 6-weeks each, with a 3-week break in the middle. Order of condition was counterbalanced to distribute serial order effects. The weekly sessions consisted of groups of 2-4 clients for approximately 30 minutes. Each session was facilitated by the researcher and audiovisually recorded. Locations acquired from the history of participants where shown (Person-Specific locations condition) as well as novel locations (Non-Specific locations condition). Participants were their own baseline which was measured through dyadic RT interviews conducted pre-experiment, mid-experiment and post-experiment. Behaviour and cognition were appraised alongside the baseline interview using the MMSE, NPI-NH and a discourse component of the interviews, which measured narrative, procedural and abstract discourse. Audio and video channels from recordings were processed to analyse facial movement, lexical use and prosodic patterns, as measures of engagement. Facial movement was processed using OpenFace to measure the presence and activity of facial movement using facial action unit markers. Lexical use, as a measure of engagement, was processed using the Linguistic Enquiry and Word Count to measure personal pronoun use, affective word use, and emotional tone of words in speech. Prosodic patterns of speech, as a measure of engagement, were processed using the Montreal Forced Aligner, Praat and Python, to measure the mean duration of utterances, mean words per utterance, articulation rate and variability of F0.

The results partially supported the first hypothesis. The TTT experiment had greater presence and intensity of facial movements, as measures of affect-driven behaviour, compared to the baseline dyadic RT interview. However, the baseline dyadic RT interview had a greater use of pronouns in speech, longer duration of utterances, and more words per utterance, as measures of engagement, compared to the TTT experiment. There were no differences in the articulation rate across all conditions. These findings show great variation in the behavioural outcomes of engagement in different intervention settings. It further shows how older adults socialise appropriately in different contexts. Within the group TTT environment, participants will have shorter utterances and more breaks in speech to allow other people to join in on the conversation, compared to a dyadic RT interview. Within the group TTT environment older adults also have split attention between the technology, other participants, and the facilitator, and therefore do not spend as much time speaking. Within a dyadic RT interview, older adults speak with longer duration of utterances and more words per utterance, as they respond to direct questions and do not have to consider other group members when responding.

The results support the second hypothesis. As expected, the Person-Specific locations condition had greater intensity of facial movement, greater amount of pronoun use in speech, longer duration of utterance and more words per utterance, as measures of engagement, compared to the Non-Specific locations condition. These results are supported by the theory of meaningful activity and personalising stimuli to promote behavioural outcomes of engagement. When viewing Person-Specific locations, older adults convey a more personalised experience with greater pronouns use as they recall autobiographical memories.

The results do not support the third hypothesis. The level of technology appeared to be mostly inconsequential, as seen through non-significant differences when comparing the LT and HT condition. Only one facial movement action unit marker had reduced presence in the LT condition compared to the HT condition. The findings suggest a simpler version of digital technology maybe more accessible and comfortable for older adults to interact with, compared to a more advanced interactive experience. The findings further suggest that it is the incorporation of digital technology that promotes affect-driven behavioural engagement, as seen through greater presence and intensity of facial movements, rather than the level of digital technology.

With the impact of Covid-19 on the ability to conduct research with older adults, there was a less than ideal sample for the current research. Due to this small sample size, it is with caution that these results are interpreted. The current study represents the first in-depth evaluation of the TTT experiment on facial movement, lexical use and prosodic patterns of speech, as measures of older adult engagement. The results show the complexity in the interactions between person, environment and stimuli factors that influence engagement outcomes. These findings highlight the importance of a multi-dimensional approach to characterise older adult engagement in varying contexts, which warrants further investigation.

Chapter 1: Overview

1.1 The Research Problem

The number of older adults in Australia is increasing as baby boomers are coming into their silver age, and with many expected to live longer. This is seen with increasing mortality over the last 60 years, with the life expectancy at birth for women rising from 74.2 to 84.9 years old, and for men, from 67.9 to 80.7 years old (Australian Institute of Health and Welfare, 2020). In 2017, greater than 1 in 7 people living in Australia were aged 65 years and older (AIHW, 2018). Residential care, including permanent and respite care, has been of particular interest in Australia, evidenced with the introduction of The Royal Commission into Aged Care Quality and Safety, in late 2018. With more reports of the conditions in aged care facilities arising, there is a greater focus on health and well-being, and ensuring there are optimal care practices being enforced. Current key concerns for older adults residing in the community and in aged care include loneliness, depression and social isolation (World Health Organization, 2017).

With the number of older adults increasing, there is an increase in the demand for residential care. In 2017 there were a total of 184,077 older adults in residential care (Department of Health, 2017). Whereas, in 2020 there were 189,954 older adults in residential care (Department of Health, 2020). A further contributing factor for the increase in demand for residential care is the rising number of people with dementia. Dementia is currently the single leading cause of disability for older adults in Australia (Dementia Australia, 2021). In 2021 there are an estimated 250 people diagnosed with dementia per day. This is predicted to increase to 318 per day in 2025 (Dementia Australia, 2021).

Dementia is a syndrome caused from disease of the brain, which results in the impairment of daily function (Coope & Richards, 2014). Dementia is progressive and is characterised by impairment of cognition (language, memory, perception, personality, cognition) and behaviour (social communication, movement, ability to perform everyday living activities). It is important to ensure the type of care and nonpharmacological programs offered to older adults are evidence-based and support the behavioural and psychological associates of dementia (Scales et al., 2018). With 1 in 3 older people in Australia born overseas (AIHW, 2018), there is also a need to ensure that the way older adults are cared for accounts for different cultures and backgrounds.

The syndrome of dementia is typically associated with an increase in apathy, depression, and anti-social behaviour, resulting in a lack of engagement and reduced quality of relationships (AIHW, 2012). As dementia progresses, communication becomes more difficult, activities become harder to participate in and there is greater fluctuation in mood. These contribute to the difficulties in creating and maintaining relationships (Harris, 2012). The difficulties in encouraging participation in activities and creating and maintaining relationships is further heightened once people are relocated into residential care. Within residential care, older adults spend the majority of their time unoccupied and not engaged in meaningful activity (Burgio et al., 1994). Providing stimulating and meaningful activity in residential care to promote engagement is important. This is due to a lack of stimulation having negative effects and being associated with increased apathy, boredom, depression and loneliness (Buettner et al., 1996; Engelman, 1999).

The current research will focus on characterising engagement of older adults participating in meaningful activity. "Engagement refers to the act of being occupied or involved with an external stimulus, which includes concrete objects, activities, and other persons" (Cohen-Mansfield et al., 2011). The Comprehensive Process Model of Group Engagement (CPMGE: Cohen-Mansfield et al., 2011) is a framework that outlines person, environment and stimulus attributes that contribute to engagement outcomes. The current research will investigate this framework by recording and analysing markers of engagement. Meaningful activity involves participating in activities that evoke feelings of pleasure, enjoyment, a sense of connection and belonging, while also retaining a sense of autonomy and personal identity (Phinney et al., 2007). Participating in meaningful activity is important as barriers arise for older adults to communicate and engage. For example, moving to or attending residential care, presents a contextually novel environment amongst carestaff and other residents. These carestaff and peers are usually unfamiliar with past personal histories and identities (Xiao, 2017). Group involvement in activities that are meaningful to individuals can reduce this barrier and promote positive social relationships within this residential care environment.

A contributing factor that influences the ability of older adults with dementia to create and maintain relationships, is the reduction in the ability to communicate effectively as dementia progresses; that is to perceive and/or produce language. Such impairments are seen with lexical mechanisms, which are responsible for the processing and construction of specific words (Elalouoi Faris, 2015). As it becomes increasingly more difficult to formulate words and sentences, older adults start to rely on non-verbal behaviour to communicate (Strandroos & Antelius, 2017). This is seen with the use of facial expressions, such as when communicating pain when verbally unable to (Lautenbacher et al., 2016). There is considerable interest and need in understanding how interventions could stem this loss of language and communication skills. In research to date on non-pharmacological interventions there has been a limitation. It has generally focused on one channel of communication, whether it be facial, verbal or behavioural. Understanding how older adults communicate in a complex multi-dimensional way in different contextual settings is unknown. The research presented in this thesis addresses this gap in understanding. This is achieved through exploring how non-pharmacological interventions affect engagement, measured though verbal and non-verbal communication in people with dementia.

The current research characterises engagement of older adults through a multi-dimensional approach. This involved measuring facial movement, lexical use and prosodic patterns, as dependent variables to characterise engagement. The first dimension analysed is facial movement as a measure of engagement. Different combinations of facial movements represent different facial expressions. Facial expressions are an important medium for affective communication and are commonly used to measure affect-driven behavioural engagement (Ekman, 1978; Grafsgaard et al., 2013; Mohamad Nexami et al., 2020). The facial movements that form facial expressions are represented through action units (AUs; Ekman, 1978). Whereby, AUs represent different muscles in the face (Ekman, 1978). In the current research, facial movements will be measured through the dependent variables of AU presence and AU intensity. The second dimension analysed is lexical use as a measure of engagement. Lexical use is concerned with the meaning of words. The lexical use dependent variables measured in the current research include personal pronouns, affective word use and emotional tone of language. Through analysing the use of personal pronouns (I, we, and they), the degree of personalisation of the participant speech is measured (Mühlhäusler & Harré, 1990). By analysing affective words (good, bad) as well as the emotional tone of the language (how positive or negative the general dialogue is) the affective valence of the participant speech is measured. The third dimension analysed is prosodic patterns of speech as a measure of engagement. Prosodic patterns are concerned with the acoustic parameters of speech. The prosodic dependent variables that are measured in the current study include the duration of utterance, the number of words per utterance, the articulation rate and variance of pitch, as measured through the fundamental frequency (F0). By measuring the duration of utterance and number of words per utterance, the articulation rate (words per utterance/duration of utterance) is calculated. This gives an understanding of the fluidity of speech and is a marker for the amount of energy exerted when speaking (Maeda, 2003). Variance in pitch corresponds with the affective state of an individual (Levelt, 1999) and is another measure of an affect-driven behavioural change, measured to characterise engagement. By using these measures, the current study provides insight into the complexity in interpreting engagement of older adults, with consideration to the interaction of personal, stimuli and environmental factors.

To address the need for engagement, the social needs of older adults, and the behavioural and psychological symptoms of dementia, RT has been a widely adopted intervention. RT draws on the strength of the retention of long-term memory in older adults and those with dementia. It promotes conversations of past experiences and memories with supporting material, such as personal objects, music and photos (Woods et al., 2018). What underlies reminiscence activities is the psychological theory of meaningfulness, evoking a sense of connection with personal identity and others, autonomy, pleasure and enjoyment (Havighurst, 1961: Phinney et al., 2007, Leone et al., 2012). There is a large body of research that has explored RT as an intervention for people with dementia. For example, experiments have concluded that RT can assist in the improvement of quality of life alongside improving behavioural and psychological symptoms of dementia, as seen with the reduction of agitation (Cohen-Mansfield et al, 2007; Werner et al., 2000). RT has also been seen to be effective in improving quality of life and improving depression symptoms, when it is delivered through digital technology, compared to not using any digital technology (Astell et al., 2010; Davison et al., 2016; Samuelsson & Ekström, 2019; Subramaniam and Woods, 2016). However, as deduced from Woods et al, (20018) there are inconsistencies in the impact of RT as a successful intervention. It is further unknown how the outcomes of RT are influenced when RT stimuli are delivered through varying levels of digital technology. This is a gap in the understanding of the effectiveness of RT and a motivating factor in the current research.

Within the current research, different locations around the world are displayed through digital technology, using Google Street View and Google Maps, in an experiment called Time Travelling with Technology (TTT). This thesis is further development from a pilot feasibility study that was carried out in 2016, which first introduced TTT (Watson et al., 2018). TTT allows participants to travel to locations of their past and stimulate long-term memory trails to encourage discussion of past memories. Such styles of person-centred activity that is meaningful has been shown to promote engagement (Leone, Deudon, Piano, Robert, & Dechamps, 2012). To evaluate the impact of technology on the characterisation of engagement, there are two levels of the technology independent variable – Low-Tech condition (LT) and High-Tech condition (HT). The LT condition displays the locations as static images on a television screen. The HT condition is a more dynamic and immersive experience than the LT condition. In the HT condition, older adults virtually pan around the location and have a 360-degree view of the environment, move back and forth and explore inside buildings. The comparison between the LT and the HT condition gives insight into the impact of technology on the behavioural outcomes of older adult engagement. To evaluate the effectiveness of RT, there are two levels of the location specificity independent variable – Person-Specific locations condition and Non-Specific locations condition. The Person-Specific locations condition includes locations derived from the history of participants and encourages RT through personalisation of the stimuli. This is compared to a

Non-Specific locations condition, which includes locations that are not known to have an association with a participant's past. The comparison between the Person-Specific locations condition and the Non-Specific locations condition gives insight into the effectiveness of RT on the behavioural outcomes of older adult engagement.

The current research was developed in response to the need to address engagement in aged care facilities and promote positive relationships between older adults. This research investigates whether the effectiveness of RT is enhanced when RT stimuli is delivered through digital technology. It further considers the psychological and communication mechanisms that drive the outcomes of the program with reference to the CPMGE (Cohen-Mansfield et al., 2011). The current research includes expanded research questions from the pilot feasibility study (Watson et al., 2018), the application of the CPMGE theoretical framework to explain communication mechanisms, and expanded methods and analyses. The experiment within this thesis outlines TTT as an individualised, exciting, dynamic and immersive interactive activity that gives older adults the opportunity to explore their past, as well as novel locations. Within the TTT setting, the interaction between older adults, the facilitator and the technology create an environment to foster intersubjectivity and relationship between older adults. Through sharing stories, relationships are encouraged as the older adults become engaged through recalled and shared identities.

1.2 Thesis aims and research questions

The research objective of this thesis is to investigate the effect of technology driven group RT on older adult engagement. More specifically, the focus is primarily on characterising engagement of older adults in residential care. This will be achieved through a multi-dimensional approach to measuring behavioural markers as proxies of the concept of engagement. The dependent variables include facial movement, lexical use and prosodic patterns of speech. Potential covarying factors, such as cognitive capacity, will additionally be considered to further explain such relationships.

The central research question addressed in this thesis is:

> To what extent does technology delivered through TTT impact the engagement of older adults in respite aged care?

1.3 Thesis Structure

The thesis is organised as follows. Chapter 2 Background will review the background theory and empirical findings that motivate the research question. The chapter begins with an insight into the current state of dementia in Australia and will explore the complexity of maintaining identity, socialisation and relationship in aged care. This is followed with a discussion of the importance of engagement and participation in meaningful activity, and reviews current models and behavioural measures of engagement. It then addresses language and communication amongst people with dementia and gives an oversight of current psychosocial and behavioural interventions for managing dementia, particularly with reference to meaningful and person-centred activity in the form of RT. This chapter concludes with describing the conceptual approach in the current study, and outlining the overarching research question and hypothesis.

Chapter 3 Method describes the methods for the investigation of the effect of TTT on older adult engagement, whereby RT stimuli are delivered through digital technology. The chapter begins by outlining the psychological, cognitive and behavioural baseline measures. It then presents a description of participants and the experimental design where independent and dependent variables are defined. Apparatus and procedure for the delivery of the TTT experiment are then outlined followed by ethical considerations. The facial movement markers, lexical use markers and prosodic patterns of speech as dependent variables are then introduced as behavioural measures of engagement. The chapter concludes by outlining the common data preparation method used to prepare the audio-visual recordings of the sessions for further analysis.

Chapter 4 Baseline Measures describes the psychological, cognitive, behavioural and discourse baseline profiles of participants. This includes the Mini-Mental State Examination, the Neuropsychiatric Inventory – Nursing Home Version and the discourse interview schedule. This chapter provides a baseline of the participants across the experiment to understand the way in which they are able to communicate and to what extent. It provides information on neuropsychological profiles of participants, their cognitive capacity, how their behaviour is perceived by carers and their narrative, procedural and abstract discourse ability.

Chapter 5 Facial movement as an indicator of engagement investigates the presence and intensity of five facial AUs, as dependent variables, used to evaluate affect-driven behavioural outcomes of engagement. It describes the process of analysing audio-visual data with OpenFace, describes the statistics model for analysis, and provides results and a discussion of the findings. Facial movement as an indicator of engagement is discussed in relation to a) a dyadic RT and a technology driven group RT environment, b) level of technology, being either LT or HT and c) type of location, being either Non-Specific or Person-Specific.

Chapter 6 Lexical use as a measure of engagement is the first linguistic analysis chapter. This chapter focusing on the lexical properties of personal pronouns use, use of affective words and emotional tone of speech, which are dependent variables measured as behavioural outcomes of engagement. It describes the process of analysing transcripts from the interviews and group sessions using the Linguistic Inquiry and Word Count, describes the statistics model for analysis, and provides results and a discussion of the findings. Similar to chapter 5, the lexical use is discussed in relation to engagement outcomes in the different session environments, levels of technology and type of location.

Chapter 7 Prosodic patterns of speech as indicators of engagement is the second linguistic analysis chapter. This chapter focuses on prosodic patterns as dependent variables to measure behavioural outcomes of engagement. These dependent variables include the duration of utterances, words per utterance, articulation rate and pitch, as measured through the fundamental frequency. It describes the process of analysing audio-visual recordings alongside transcripts using the Montreal Forced Aligner, Praat and Python. It further describes the statistics model for analysis, and provides results and a discussion of the findings. Similar to chapters 5 and 6, the verbal prosodic patterns are discussed in relation to engagement outcome in the different session environments, levels of technology and type of location.

Chapter 8 Discussion integrates and summarises the dependent variables results from the facial movement, lexical use and prosodic patterns chapters 5, 6 and 7, to address the key research questions. It provides a general discussion of how the different findings give insight into the impact of how contextual environments, technology and RT influence the engagement characteristics of older adults. It further discusses the potential of TTT in aged care facilities. The chapter reviews the contribution of this thesis to research and practice, discusses limitations and outlines future directions.

Chapter 2: Background

The key considerations of this thesis include aged care in Australia, dementia, older adult relationships in residential care, engagement, technology, and verbal and non-verbal communication. This chapter will review research relating to these topics to give an insight into the current aged-care environment and the necessity of addressing engagement and socialisation within this setting. This review will be explicitly related to research issues, and discuss theories of the psychological and communication mechanisms, that motivate the current research.

2.1 Aged care and dementia in Australia

With an increase in older adults, there is an increase in aged related diseases within the Australian population, such as those that result in dementia. Dementia is the second leading cause of death in Australia with twice the fatalities for females (7,277) compared to males (3,656) in 2013 (AIHW, 2016). The Australian Institute of Health and Welfare (AIHW, 2017) estimated that 365, 000 Australians had dementia in 2016. 99% were aged 60 and greater, and a projected 900, 000 will be affected by 2050. Within residential care, those with dementia need greater support, particularly in the execution of daily living tasks and behavioural assistance (AIHW, 2017). Residential care facilities are seeing a more diverse group of older adults within their client base and have a greater need to provide care for people with various cognitive impairment. With an increasing older adult population, there is a great focus on assisting older adults to live at home for longer. This is resulting in greater home care and support, and increasing accessibility to day respite centres.

The specific causes of dementia are still largely unknown; therefore, treatment is targeted at the behavioural and psychological symptoms of dementia (BPSD). The cognitive symptoms typically relate to attention, executive functions (e.g. multi-tasking, planning, organising etc.), learning and memory, language, perceptual-motor and visuospatial function, and social cognition (Hugo & Ganguli, 2014). The behavioural symptoms may include agitation, aberrant motor behaviour, anxiety, elation, irritability, depression, apathy, disinhibition, delusions, hallucinations, and sleep or appetite changes (Cerejeira et al., 2012). Dementia itself causes emotional distress of the individual which has been attributed to threats to the universal human needs for identity, belonging, hope, and predictability (Petty et al., 2018). These have traditionally been treated with pharmacological interventions such as cholinesterase inhibitors, memantine, antipsychotics, antidepressants and a range of other pharmaceuticals (van de Glind et al., 2013). Unfortunately, there are adverse effects that have been correlated with such treatments including increased adverse cerebrovascular events (stroke) and mortality, as seen with the use of antipsychotics (Douglas & Smeeth, 2008).

Non-pharmacological treatments include, but are not limited to, sensory practices (aromatherapy, massage, multi-sensory stimulation, bright light therapy), psychosocial practices (validation therapy, reminiscence therapy, music therapy, pet therapy, meaningful activities), and structured care protocols (bathing, mouth care; Scales et al., 2018). Non-pharmacological treatments have been shown to be effective across cultures, have minimal side-effects and require minimal to moderate investment (Couch et al., 2020; Scales et al., 2018; Spector et al., 2001). For example, Cognitive Stimulation Therapy, which involves at least 14 themed activities has been culturally adapted using standardised guidelines (Spector et al., 2003, Aguirre et al., 2014). A cognitive rehabilitation intervention has also shown to be effective across both native English and Spanish speakers (Loewenstein & Acevedo, 2006). There are also culturally appropriate care strategies which included collaborative approaches. For example, the Partners in Culturally Appropriate Care (PICAC) project. PICAC supports partnerships between residential care services and ethnic community groups to establish best care practices for older adults from culturally and linguistically diverse backgrounds (Australian Healthcare Associates, 2018).

Dyer et al. (2018) summarised available systematic reviews on pharmacological and non-pharmacological interventions and suggests non-pharmacological treatments as a first-line therapy. It was further suggested pharmacological treatment should only be administered if non-pharmacological interventions are not successful or are not feasible. Importantly, the aged population is more commonly prescribed multiple medication to treat varying health situations. There is not enough research surrounding poly-use medication to determine the interaction of medication. Since pharmacological treatments of dementia have such severe adverse consequences and non-pharmacological treatments have been shown to have minimal to nil adverse effects, the current research has value in further understanding non-pharmacological intervention to target the BPSD.

A key factor for non-pharmacological therapies is person-centred care, which emphasises respect for people as individuals. It is a practice that ensures the preferences, values and needs of the person under care is taken into consideration in care decisions (American Geriatrics Society Expert Panel on Person-Centred Care, 2016; Yasuda & Sakakibara, 2017). With respect to a person-centered approach, an individual with dementia should be supported in their preference for both pharmacological and/or non-pharmacological treatments. Barriers to person-centred care have been identified as time restrictions and symptoms of dementia limiting the ability to engage in the practice, as well as carestaff having an incomplete understanding of what person-centred care entails. Though, it has been shown that teamwork and education around person-centered care is able to assist the practice by increasing instrumental and relationship resources (Oppert et al., 2018).

It is becoming more important to understand person-centred care and what it means as Australia is becoming increasingly more diverse in culture and has a large culturally and linguistically diverse (CALD) older population. As of 2016, one in three older Australians were born overseas with the majority from non-English speaking countries (AIHW, 2018). Whereas a decade earlier, in 2006, 21.3% of older adults where born overseas (AIHW, 2007). It has been estimated, by 2021, greater than 30% of residents in aged care facilities over 65 will have been born overseas (Commonwealth of Australia (Department of Social Services) [DSS], 2015). There is also a greater cultural diversity in employed health care workers with 32.3% of the direct care workforce born overseas (Commonwealth of Australia (Department of Health), 2017). Therefore, the success and approach to interventions should be applicable and respectable to CALD populations. It is important to take into consideration cross-cultural issues that may arise within the facility in both day to day interactions and when implementing interventions to manage the symptoms of dementia. For example, culture influenced perception and behaviour, and the individual belief systems, have been shown to affect the interpretation of dementia symptoms in terms of reason and care strategies (Cox, 2007). Further, expectations of carestaff responsibilities influences the approach a person with dementia has towards their caregiver and the activities involved (Cox, 2007). There is currently a gap in the understanding of how the culture of healthcare workers and varying perceptions of illness, disease, older adults, and dementia, impacts quality and style of dementia care (Joanne et al., 2018).

Cultural perceptions and learnt behaviours of interaction also shape the communication between people of the same culture and people of diverse cultures (Cox, 2007). People of similar culture feel a sense of belonging and relate through a shared identity and mutual understanding. This sense of identity that often holds firm within the culture of a family home, can be threatened as older adults move into residential care. Cultural cues and associations may no longer be part of everyday life with the exposure to culturally diverse carestaff and peers, who have a diverse range of perceptions, customs and communication styles. Cultural considerations are essential when addressing the quality of an aged care facility, and in strategies used for transitioning into a nursing home (Yeboah et al., 2013). Understanding and acceptance of cultural diversity is an important aspect of ensuring positive relationships within the facility. It is also necessary for promoting positive care experiences and providing enhanced quality of care (Xiao et al., 2017). Further, older adult satisfaction and a sense of belonging have been shown to be protective against loneliness (Prieto-Flores et al., 2011). Currently there is a gap in understanding on how different non-pharmacological interventions are received across cultures. There is a further lack in understanding how cultural backgrounds and reduced connection to self-identity influences communication between older adults and carestaff.

The current research involves delivering a person-centered non-pharmacological intervention at a day respite facility, called Time Travelling with Technology (TTT). TTT operates by using digital technology to display reminiscence therapy (RT) stimuli. RT involves using items of familiarity to cue autobiographical memories and promote socialisation, connection and identity through the storytelling of life events (Woods et al, 2018). Previous research relating to person-centered care will be discussed in section 2.5.1. Previous research on RT will be discussed in section 2.5.2 as an overview and section 2.5.3 in relation to language use. Previous research relating to older adults and technology will be discussed in section 2.5.4.

2.2 RELATIONSHIPS IN AGED CARE FACILITIES

When referring to groups of older adults living in residential care, the older adults are generally referred to as residents. However, when older adults attend respite centres, they are typically referred to as clients. For the purpose of this thesis, the term clients will be used when referring to both older adults that live in residential facilities and those that attend respite centres.

The creation and maintenance of positive relationships between clients and with carestaff and peers, impact the quality of life of clients (Cooney et al., 2009). Clients create relationships with carestaff and peers through visiting or living in the facility. The relationships between carestaff and client develops through the care routine with the approach of the carestaff having great influence on the type of relationship that evolves (Wilson & Davies, 2009). Wilson et al., (2009) have identified three types of relationships that exist between residents, staff and family members. The ‘pragmatic relationship’ which has a focus on the occupational aspect of direct care, the 'personal and responsive relationships' which is more person-centered and is involved with understanding the resident as an individual through communicating with the resident and their family; and the 'reciprocal relationships' which is built through trust and focuses on creating a sense of community within the home, recognising and respects the roles of residents, staff and family members.

These social relationships have been shown to be a determinant of care outcomes (Heliker, 2009) and contribute to positive life experiences for both clients and carestaff (Davies & Wilson, 2007). This is partially due to social engagement reducing the risk of depression, loneliness and mortality (Drageset, 2004; Kiely & Flacker, 2003; van Beek et a., 2011). The social interactions within residential care are further shown to promote higher interest and pleasure, and increase positive affect (Jao et al., 2018). Therefore, the promotion of positive social relationships is important for the wellbeing of both clients and carestaff.

Previous research focuses on client-carestaff relationships as they are a primary source of socialisation for older adults (Baker et al., 2015; Custers et al., 2012; Jao et al., 2018; Jones & Moyle, 2016; Moyle et al., 2011; Roberts, 2018; Ward et al., 2008). The relationships within residential care can also become the only source of social connection for clients who no longer have family or friends visiting. However, often these relationships do not fulfil the emotional needs the residents require or desire (Moyle et al., 2011). van Manen (2021) suggests the factors that influence positive and effective communication between carestaff and client include; respect for needs, identity and privacy of people with dementia, a flexible and adapted communication approach and similar communicative styles.

A benefit of social relationships, particularly for people with dementia, is that they attain a sense of attachment and belonging. This is important as the symptoms of dementia often cause feelings of being in a strange place and disconnection (Fazio et al., 2018). The symptoms of dementia can contribute to difficulties that arise in creating and maintaining relationships in residential care. For example, with the progression of dementia and an enhancement in disruptive behaviours such as agitation, aggression and irritability (Cohen-Mansfield et al., 2007; Frederiksen & Waldemar, 2017), it becomes increasingly difficult to establish and foster healthy and positive relationship. This is particularly seen between carestaff-client relationships. With the progression of BPSD there is increasing impact on how carers perceive the BPSD affect themselves as the carer (Migliaccio et al. 2020).

Moyle et al., (2011) examined 32 dementia residents' perspective on their quality of life and several factors were perceived to impact the ability to establish relationships. First, the lack of social interaction was attributed to other 'people' not initiating conversation. Second, there was a recognition that other residents did not provide companionship and seeing other residents in more critical health situations hindered communication and was deemed confronting, making residents feel more depressed. Third, residents also felt that the nursing carestaff 'can't talk that much' due to being too busy with work tasks. The conclusion of the study determined that residents perceive their reduced quality of life as being caused by their inability to control their environment and the limited exposure to opportunities of social connectedness. As described in Mok & Müller (2013) restrictive factors that may limit relationship building also come down to carestaff attitudes, work duties and time restrictions (Ball et al., 2009; Ward et al., 2008). From the client's perspective, factors influencing the positive relationship with carestaff include whether clients have the opportunity to engage with the carestaff outside of immediate carestaff duties and whether the carestaff show acknowledgement for the client's individuality and uniqueness (Roberts, 2018).

Increasing social interaction opportunities between clients as peers is a solution to help foster positive relationships and address social isolation. Positive peer relationships are also associated with a better sense of wellbeing for residents with dementia (Clare et al.,2008) and reduced agitation (Kutner et al., 2000). Research shows that people with dementia are capable and willing to engage in casual conversations and put in the effort to socialise (Ward et al., 2008). The current research is designed to take into consideration the need to create an environment that fosters social connectedness amongst peers. This is achieved within the TTT experimental environment, as the session are run by a facilitator that asks questions to all clients. These questions are intended to prompt discussions and to give clients equal opportunity to communicate and interact. For the design and method in delivering the experiment, see Chapter 3.

2.3 Engagement

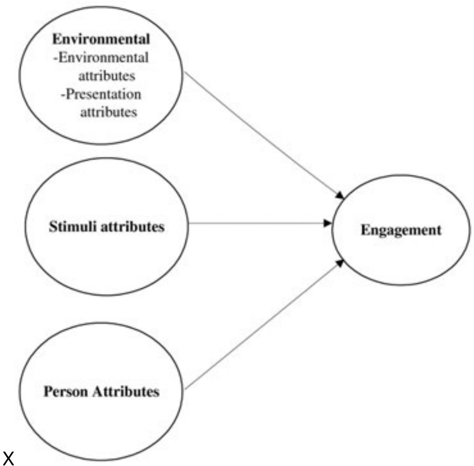
As defined earlier, "Engagement refers to the act of being occupied or involved with an external stimulus, which includes concrete objects, activities, and other persons" (Cohen-Mansfield et al., 2011). A common behavioural consequence throughout the progression of dementia is a reduction in the engagement in activities and life (Cohen-Mansfield et al, 2009). Engagement may be further defined as the manifestation of motivation in occupying and involving one-self in an external stimulus, derived from behavioural, emotional, and cognitive factors (Cohen-Mansfield et al., 2009; Skinner et al., 2009). An increase in negative dementia symptoms has been correlated with institutionalised care and an increased sedentary lifestyle with prolonged periods without stimulation, in particular a lack of meaningful stimulation (Burgio et al., 1994; Cohen-Mansfield et al., 2009). Social engagement is reduced significantly as cognitive function and vision are impaired. Social engagement is further reduced as depression, agitation, functional decline and mortality increase (Kang, 2012). As a result, many residents with dementia in aged care facilities spend a majority of their time unoccupied with activity (Burgio et al., 1994).

It is of benefit to people with dementia to be occupied in activities as it has been shown to increase positive emotions, positive self-reported mood, and improve activities of daily life (Engelman et al., 1999; Kolanowski et al., 2012). Further, general participation in recreational interventions has been shown to reduce agitation (Aronstein et al., 1996). Whereas, lack of participation in activity may promote, or be associated with, boredom, aggression, violence and negative affect (Janner & Delaney, 2012). Further, alterations in a change of affect, due to these factors, is presented with altered behavioural and communicative responses. As stages of dementia progress, the ability to maintain sustained engagement and attention reduces, most likely due to increased cognitive impairment (Cohen-Mansfield et al., 2011).

For people with dementia, a driving force of reduced engagement is the strong adverse effect of the two most prominent motivational disorders; apathy and depression (Perugia et al., 2018). Apathy, which is the lack of interest, enthusiasm and concern (Perugia et al., 2018), results in emotional blunting (Robert et al., 2010), and is a detriment for engaging (Leone et al., 2012). Apathy is the most prominent abnormality present in all stages of dementia (Robert et al., 2005). Apathetic people with dementia are less likely to engage in activities and interventions, particularly if they are not meaningful to the individual (Leone et al., 2012). Unfortunately, apathy is a self-propagating neuropsychiatric condition. This is seen with the reduction in engagement promoting higher apathetic feelings, and therefore an increased resistance to participate in activities and interventions (Cohen-Mansfield et al., 2011; Leone et al., 2012). Depression, characterised by the Diagnostic and Statistics Manual-5 (DSM-5; American Psychiatric Association, 2013) is the presentation for at least a two-week period of sad mood and a loss of interest and pleasure in the majority of life areas. It is accompanied with a multitude of dysphoric symptoms, such as feeling of shame, guilt, hopelessness, helplessness, inability to perform daily tasks, and may be accompanied with appetite and sleep disorders, and fatigue (DSM-5, 2013). The co-diagnosis of these motivational disorders with dementia may impact the ability for the person with dementia to engage in activities of life. Further, with the reduction in the capability of expressing behavioural and emotional interest, the capacity to measure resident engagement is impaired (Perugia et al., 2018).

2.3.1 The Comprehensive Process Model of Group Engagement

Cohen-Mansfield et al., (2011) constructed the Comprehensive Process Model of Engagement (CPME) framework which outlines three major factors that impact engagement levels of people with dementia. These include environment, stimuli and person attributes, as seen in Figure 2.1. Environmental attributes include contextual setting features such as background lighting and noise, novelty, enrichment of the environment and the number of people in close proximity to the person with dementia. Stimuli attribute examples include whether the stimulus is personalised, significant or novel. Personal attributes focus more on individual factors of functioning such as the cognitive abilities, demographic and culture, medical and functional status, or personality of the person with dementia. Across all factors, depression and cognitive functioning, within personal attributes, are the biggest predictive elements to determine whether a person with dementia will engage in a social situation (Cohen-Mansfield et al., 2009; Kang, 2012). Additionally, factors such as the mood of the person with dementia before commencement of the activity may also influence engagement with the activity. For example, positive self-reported mood was reported to be correlated with greater observed behaviours of attention, greater time spent engaged and less disengagement with activities. Positive mood can also elicit greater sustained attention in activities (Kolanowski et al., 2012).



x

Figure 2.1: Comprehensive Process Model of Engagement. Reprinted from Cohen-Mansfield, J., Marx, M. S., Freedman, L. S., Murad, H., Regier, N. G., Thein, K., & Dakheel-Ali, M. (2011). The comprehensive process model of engagement. Am J Geriatr Psychiatry, 19(10), 859-870.

Cohen-Mansfield, Hai, & Comishen, (2017) further developed the above framework in an adaptation for group interventions, known as the Comprehensive Process Model of Group Engagement (CPMGE; as seen in Figure. 2.2). It encompasses the three main predictive factors consistent with the previous model: person (e.g. cognitive functioning), environment (e.g. sound scape, context), and stimulus (e.g. group activity content) and outlines the interaction between these factors. Within the CPMGE, the group dynamic and attributes, such as group size, cognitive abilities and behaviour of others fall within environmental factors.

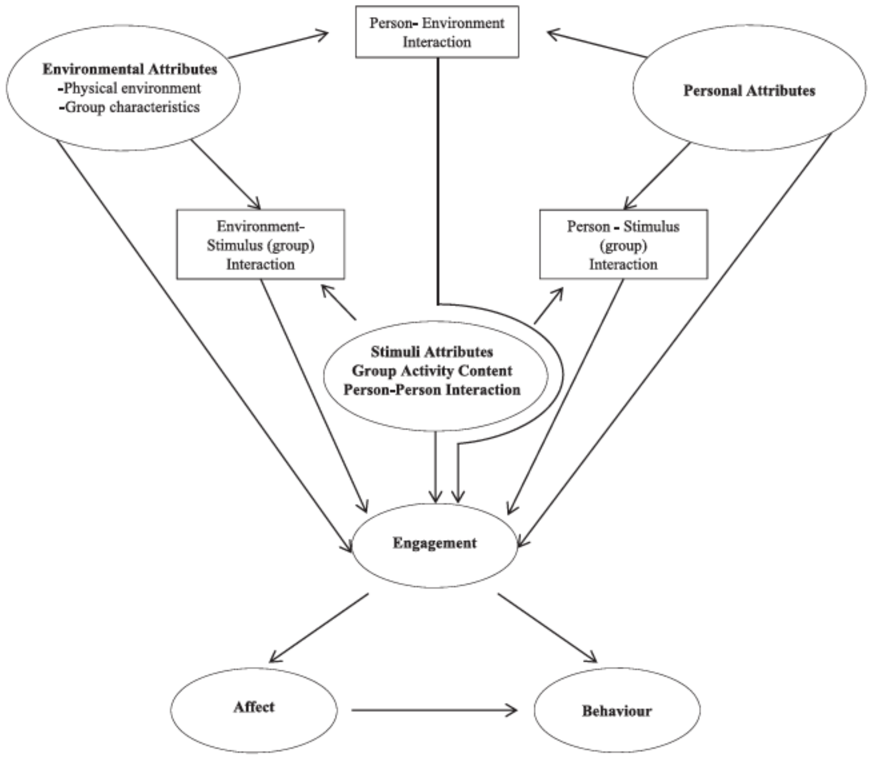


Figure 2.2: Comprehensive Process Model of Group Engagement. Reprinted from Cohen-Mansfield, J., Hai, T., & Comishen, M. (2017). Group engagement in persons with dementia: The concept and its measurement. Psychiatry Res, 251, 237-243.

The CPMGE furthers the preliminary model with the introduction of interactions between the factors which influence the engagement of the individual. There are person-environment interactions, environment-stimulus (group) interactions and person-stimulus (group) interactions. Person-environment interactions refer to factors of an individual person that are influenced by the environment. For example, this includes sensitivity to noise in the environment and attitudes to other people in the group. Person-stimulus (group activity content) interactions refer to an individual's attitudes towards the specific stimulus type and their cognition and sensory abilities. A person with good eye sight may engage in a visual show more readily than another with poor eye sight. Environment-stimulus (group activity content) interaction refers to the environmental attributes that will affect the delivery of the stimulus. For example, if someone is trying to watch a movie and there is noise from someone mowing the lawn outside.

The complex relationship between these factors influence the engagement of the older adult. In response, engagement influences affect (positive, negative) and behaviour (talking, agitation, restlessness, smiling, movement etc.) of the individual. Behaviour is used as a measurable outcome of engagement, whether it be a direct outcome of engagement or an affect-driven behavioural outcome of engagement. Therefore, measuring behaviour may give insight into the affective states that caused the behaviour. As an example, a response of talking would be a direct behavioural outcome. Whereas, smiling would be classified as an affect-driven behaviour. It is difficult to tease apart behaviour from an affect-driven behaviour. For example, if a person is asked to smile then it is interpreted as not being driven by affect, or a person may speak faster when excited, which talking is then driven by an affective state. For an overview of the measures of engagement within the current study, see section 3.8.

The current research will use the CPMGE framework as a guiding tool in establishing an intervention aimed at understanding engagement of people with dementia in aged care facilities. The research will focus on manipulating the stimulus factor, taking into consideration person-stimulus interactions, whilst trying to control for environmental factors. For the design and description of the stimulus factors, see section 3.3. For a description of the apparatus and environmental set up of the experiment, see section 3.4.

2.3.2 Measurements of engagement

Engagement outcomes of people with dementia are measured through observable motor and verbal activity in response to a specific stimulus (Cohen-Mansfield et al., 2009). Signs of engagement may be skewed with reduced cognitive function, as measuring engagement increasingly becomes more difficult. As dementia progresses, external means of measuring engagement in people with dementia becomes more appropriate and reliable. However, it is not clear from previous research whether available measuring tools of engagement are sensitive enough to measure the impact of activities with people with advanced stages of dementia (Cohen-Mansfield, 2017).

Within previous research, engagement for people with dementia has been measured through observed behavioural changes as a direct response to a stimulus. The Observational Measurement of Engagement (OME; Cohen-Mansfield et al., 2009), outlines five dimensions of engagement: 1) the degree to which the resident refuses the stimulus; 2) extent of time the resident is occupied or actively involved with a stimulus 3) level of attention to the stimulus; 4) attitude toward the stimulus, and 5) the direct behavioural change towards the stimulus, such as reaching out to the stimuli or conversing towards, about or around the stimuli.

The current research will focus on the fifth dimension; the direct behavioural change towards the stimulus. In a novel approach to measuring engagement, the current research will take a multi-dimensional methodology that is considerate to varying cognitive and behavioural abilities. The individualised methods, results and discussion, of the different dependent variables as measures of engagement, will be delivered in separate chapters. For facial movement as a measure of engagement, see Chapter 5. For lexical use as a measure of engagement, see Chapter 6. For prosodic patterns of speech as a measure of engagement, see Chapter 7. The discussion in Chapter 8 will discuss the results from these chapters to give a comprehensive understanding of older adult engagement.

2.4 LANGUAGE AND COMMUNICATION AS MEASURES OF ENGAGEMENT AND INTERVENTION OUTCOMES

2.4.1 Language and culture in a multicultural environment

The scientific study of language is linguistics. The definition of language is complex and it is interpreted variously between disciplines and sub-disciplines. For the purpose of the current research, language will be referred to in relation to its social ontology. In doing so, language is defined as a system of interactions that encompasses spoken, written and behavioural modes of linguistic communication (Wardhaugh, 2015). Communication, by definition is, ‘the imparting or exchanging of information by speaking, writing, or using some other medium' ("Communication", n.d.). Other mediums refer to such forms of communication such as body language and facial expressions. The relationship between language and communication is complex and variously interpreted depending on the language and language situation in question. The different variables that are addressed in the current research straddle this boundary. For example, pronouns are related to the constructs of language. Whereas, tone of voice and facial movement is more closely related to communication, though in some languages facial expressions is part of the para-linguistic system.

Language, communication and culture are inexplicably intertwined and are closely correlated as a significant part of a person's identity (Kramsch, 2014). Language has been argued to shaped by culture, and culture to be shaped by language (Levinson, 1998). Language transforms over time alongside cultural evolutions (Dunn et al., 2011). It is further transformed within the lifespan of an individual, whereby, language is fashioned by rules and patterns learnt through cultural influences and life experiences. For example, in terms of cultural influences, children have different language learning experiences in China, compared to children in the U.S. (Hoff & Tian, 2005). Another example, in terms of life experiences, is that a higher education of a mother is positively correlated with the language development of a child (Hoff & Tian, 2005). The way in which a person communicates is also adaptive over time and is dependent on the language resources that they know, life experiences, social norms and rules. This suggests that individuals will have different communicative styles. Ideally, when communicating with another person an obvious goal would be able to use communicative norms (and a shared language) that can be interpreted in the way it is intended.

Non-verbal body language is a vital communicative element in conversation and is thought to comprise 70% of all communication (Mehraby, 2005). There are many similarities in the messages conveyed with body language, however, there are unique elements to each language system and culture, e.g. greetings, appropriate distance and personal space, eye contact and general gestures (Mehraby, 2005).When entering a novel place that may present with a new environment, a person is presented with a challenge to adapt to the setting and assess how to communicate with, what may be, new people with different cultural backgrounds, new social practices and different ways of going about daily activity. As time progresses, a person learns more efficiently and effectively how to communicate within environments they have repeat exposure to, whilst their relationships, knowledge and understanding develop (Kim, 1977). This type of adaptation to the environment is a common barrier for immigrants entering into a new country with a significantly different culture (Kim, 1977). However, this may also be associated with older adults moving into residential care, which presents a new cultural environment. For example, when moving into residential care, older adults will face adaptation to new people, new ways of going about daily activities and new customs, such as food services they may not be familiar with (Wang & Villarose, 2017).

People with dementia will maintain the ability to form complete sentences until the later stages of the syndrome (Kempler et al., 1987). If a person loses their ability to communicate or has reduced capacity to communicate, such as verbally, they will utilise other means of language, such as pointing, to interact with their environment. This is often observed when a person is placed in a foreign environment. For example, when a person with dementia is relocated into an aged-care facility, the progression of the impairment to verbal language often requires the resident to rely on other forms of communication. Additionally, other residents may be from different cultural backgrounds and may not speak the same language, further encouraging the resident to utilise multiple communicative tools to successfully interact. Unfortunately, learnt behaviours and values may conflict with those from culturally different backgrounds, and may be maladaptive in the ability to positively communicate (Kim, 1977; Nelunova et al., 2016).

Identity through language and culture provides the groundwork for people of similar heritage to communicate and co-create a relationship with greater ease (Aikhenvald, 2013; Ting-Toomey & Dorjee, 2018). Most research on communication and social relationships focus on people from the same culture, or focus on relationships built between shared verbal languages. However, with increasing globalism it is becoming more important to focus on cross-cultural communication and overcoming language barriers (Ting-Toomey & Dorjee, 2018). In a multicultural environment, verbal and non-verbal communication may be misunderstood and misconstrued (Ting-Toomey & Dorjee, 2018; Villagran et al., 2012). When a person is placed into an environment that does not reflect their culture, difficulties arise in their ability to communicate effectively through their language. In response, new ways of communication need to be formed that can increase effectiveness of individual languages and reduce the chance of misinterpretation (Ting-Toomey & Dorjee, 2018). Aside from the deterioration in language abilities that is observed with monolingual speakers, bilingual speakers with dementia are faced with a greater adversity. Bilingual speakers may also lose the ability to distinguish between languages and may combine the languages in a given sentence. Progression of dementia diseases may cause a bilingual speaker to further resort to their mother tongue and loose the capacity to communicate with languages learnt later in life (Strandroos & Antelius, 2016).

Language and communication come together to form what is known as discourse. Discourse, is a verbal or written communication system comprising symbolic elements (words), rules defining the arrangement of these elements to form grammatical sentences (syntax), and systems for constructing conversations, stories and the exchange of ideas (Kemper & Zeinski, 1994). Effective communication relies upon the ability for a person to interpret and communicate verbally relevant information through their discourse. In the current study, a baseline discourse profile of participants will be measured to capture their ability to communicate through discourse, which is important in socialising and creating a social identity. The baseline discourse profile of participants will characterise three elements of effective discourse. These include narrative discourse, which is the ability to convey meaning within storytelling, procedural discourse, which is the ability to coordinate and arrange information in a sequential order, and abstract discourse, which conveys the ability to interpret and make abstract inferences (Chapman et al., 2004), see section 3.1.4.

2.4.2 Dementia and the production and understanding of language

At the level of neural processing, language processing has been correlated with Wernicke's area and Broca's area. Wernicke's area is located in the posterior section of the superior temporal gyrus, also known as the posterior portion of Brodmann's area 22, of the dominant cerebral hemisphere (97% the left hemisphere) and is responsible for the majority of language comprehension (Binder, 2015). Broca's area is located in the lateral frontal lobe of the dominant hemisphere and is responsible for the production and articulation of language (Keller et al., 2009). Frontotemporal dementia, being the progressive damage to the frontal and temporal lobe of the brain, particular affects these areas of language processing. Whereby, frontotemporal dementia is associated with gradual aphasia, which is the inability to understand and produce speech (Kirshner, 2014).

Disruption to the connection between the left and right hemispheres of the brain impairs the capability to communicate. As a result, people with dementia experience an increase in language deficiency in comprehension and production (Wray, 2014). In response, a person with dementia will utilise other forms of communication, such as body language or acting out and performing, to communicate their needs (Kindell et al., 2013; Strandroos & Antelius, 2016). Over time there is an overall decline in the ability to effectively and efficiently communicate. Increased difficulties in the ability to communicate thoughts and needs impacts on the ease of functioning and the capacity to sustain social relationships with family, friends and caregivers (Strandroos & Antelius, 2016; Woodward, 2013). As such there is a significant need to better understand the different ways in which people with dementia communicate to sustain relationships for as long as possible.

Language disorders in dementia are typically characterised by lexical impairment relating to the processing and construction of specific words, rather than relating to disorders in syntax, phonology, morphology or grammar (Elalouoi Faris, 2015; Taler & Phillips, 2008). In early stages of dementia, lexical processing begins to depreciate, marked by difficulties accessing specific words in conversation and semantic paraphasia. As the ability to identify specific words and convey precise information degrades, (e.g. shops, hammer), it is common to start replacing these terms with broader terms, (e.g. place, thing) (Hoffman et al., 2014). Verbal fluency markedly declines, the complexity of speech depreciates and minor grammatical errors occur (Verma & Howard, 2012). As the condition progresses circumlocutions and repetition are prominent (Dijkstra et al., 2004). Speech becomes incoherent, abrupt changes in conversation topics occur and fluidity in conversational exchange is reduced (Aline Nunes Da Cruzet al., 2017; Dijkstra et al., 2004). In late stages of dementia, awareness of incomprehensibility and mistakes may no longer be present and a person with dementia may be subjected to complete mutism (Aline Nunes Da Cruz et al., 2017; Verma & Howard, 2012).

2.4.3 Communication and dementia

Kindell et al., (2017) conducted a systematic review identifying the current understanding and knowledge of everyday communication of people with dementia. The review discusses how different cues of interaction are necessary to identify conversational transactions and conversational interactions. Conversation transactions are used to convey a specific meaning. For example, when a person is hungry they may want to convey this and so enquire 'Do you have anything to eat?'. Whereas, conversation interactions aim to create a social relationship and a person may instead say 'What do you think about breakfast?'. Kindell et al., (2017) describes that the engagement and intent to communicate goes beyond the ability of the speaker to vocalise information and exchange ideas. Other forms of communication are commonly used, such as eye gaze, imitating the speaker, and non-verbal behaviours. All forms of verbal and non-verbal communication should be considered when identifying a person with dementia's communicative strategies. Understanding the different modes of communication improves the potential to support the well-being and identity of the person with dementia. Furthermore, with an increase ability to interpret the conversation there may be an increase in attentiveness and interest when conversing with a person with dementia.

Facial expressions are a main non-verbal form of communication that communicate the affective state of a person (Ekman, 1965). Previous research has investigated how people with dementia perceive facial emotions in others. A symptom of dementia is impaired facial emotion recognition, particularly when the facial expressions are subtle (Dourado et al., 2019; Torres et al., 2015). Positive emotions, however, are more easily recognised than negative emotions. Further, despite impaired recognition, people with severe dementia retain their reactivity to facial expressions (Guaita et al., 2009). In regards to the expression of facial emotion, previous research centres around the facial expressions of pain and apathy (Kunz et al., 2007; Lautenbacher et al., 2016; Lautenbacher & Kunz, 2016; Oosterman et al., 2016; Seidl et al., 2012). This is valuable research especially in aged care facilities, when the ability to verbally communicate pain may be reduced. Apathy has been shown to mediate the expressiveness of facial expressions. Whereby, when apathy is controlled for, cognitive decline is related to increased facial expressiveness. However, when apathy is not controlled there was decreased facial expression (Seidl et al., 2012).

A study by Ellis and Astell, (2017) evaluated the Adaptive Interaction intervention for non-verbal individuals living with dementia. Adaptive Interaction is based around the non-verbal aspects of communication including, movements, such as nodding, shaking head or shrugging shoulders, and facial expressions. The outcome of the intervention was greater imitation behaviour, smiling and direct gaze from the people with dementia. Such a program empowered participants to retain their ability to communicate through aa small repertoire non-verbal components.

Aline Nunes Da Cruz et al., (2017) conducted a systematic review aimed at investigating language and communication interventions with people with Alzheimer's disease. Such interventions include: cognitive skills, language activities integrated with physical activities, lexical therapy, face-name association intervention, instrumental communicative activity of daily living, communicative training of caregivers, intervention based exclusively on conversational interaction, and use of memory cards during conversation. The majority of experimental designs for research regarding language were shown to have medium to low scientific backing, evidenced by small sample sizes (average n=13), lack of control group comparison and the non-randomisation of participants. Through analyses of the interventions in six studies, the most viable intervention technique, for reliability and efficacy purposes, were lexical approaches. Such interventions focused on semantic relationships, naming of figures, and the interpretation behind the meaning of words within sentences, stories, or in isolation. Such interventions showed improvements in post-intervention tasks of naming skills, and phonemic, verbal and semantic fluency. However, there was controversial findings between the six studies of whether long-term improvements were maintained.

Previous research has traditionally focused on lexical impairment, however there has recently been a focus shift to the prosodic patterns of speech (Misiewicz, 2018). Prosodic features of speech represent the acoustic features of speech, such as intonation, tone, stress and rhythm. A study by Gonzalez-Moreira et al., (2015) used automatic prosodic analysis to distinguish between people with mild dementia and healthy controls. The most noteworthy prosodic patterns to distinguish between dementia and healthy controls, where found to be mean syllable duration, standard deviation of fundamental frequency (F0), which is a measure of pitch variation, and mean of F0.

Understanding the multitude of ways that people communicate, particularly in relation to socialisation and engagement will further the ability to know the effect of situations and experiences on people with dementia. There are currently no standardised research methods to determine how interventions, designed for people with dementia, impact verbal and non-verbal communication. Furthermore, there has been a lack of interventions incorporating structured analytical frameworks targeting conversational abilities of people with dementia (Johnstone Young et al., 2011; Kindell et al., 2017). The current research will analyse both verbal and non-verbal dimensions of communication, as indicators of engagement. This will involve characterising and measuring the dependent variable of facial movements markers, lexical use markers and prosodic patterns, as measures of engagement. For an overview of these dependent variables as measures of engagement, see section 3.8. A greater description of the measures will be discussed in the corresponding chapters. For facial movement as a measure of engagement, see Chapter 5. For lexical use as a measure of engagement, see Chapter 6. For prosodic patterns of speech as a measure of engagement, see Chapter 7.

2.5 Current psychosocial and behavioural interventions for managing dementia

2.5.1 Person-centered care and the importance of meaningful activity

Person-centered care is a philosophy of practice and theory that has fundamental roots in the needs of an individual. It is reliant on understanding and knowing an individual through interpersonal relationships (Fazio et al., 2018). The origins of person-centered therapy come from Carl Rogers in 1940, (Rogerian Therapy). This evoked a new wave of research into a hypothesis that a self-directed growth process would be founded off relationships characterised by genuineness, non-judgemental caring and empathy (Raskin & Rogers, 2005). Kitwood (1998) adopted this philosophy and proposed that dementia is best understood through the interactions between neurological impairment and psychosocial factors. The most prominent being health, individual psychology and the environment with an emphasis on social context (Fazio et al., 2018).

Kitwood (1997) emphasises the need for personal identity for people in general, and the need for the support from carers and personal relationships to maintain a sense of identity in people with dementia. Identity is grounded in knowing oneself in cognition and feelings. In the ability to have a sense of continuity in life events and personal history that creates a narrative of oneself to communicate to others. Kitwood (1997) further developed the person-centered care approach. It outlined principles that encouraged the reconstruction of care practices, programs and communication to align with supporting personhood and well-being through the course of dementia. Whereby, personhood is the relational aspect of social identity in an inclusive psychosocial environment, which recognises individualist and personal life history (Røsvik et al., 2011). Brooker (2015) has drawn on the theory of Kitwood to create the ‘VIPS’ framework. This framework is an acronym that encompasses the four major elements of person-centered care for people with dementia. These are: 1. The value of the individuals, 2. having an individualised approach for each person, 3. considerations to the perspectives of people living with dementia and, 4. the importance of social environment.

Cohen-Mansfield’s et al., (2017) CPMGE framework aligns with Kitwood’s model of person-centered care (Kitwood, 1997), with both acknowledging the importance of the individual. Within the CPMGE, there are personal, environmental and stimulus attributes that influence engagement outcomes. The value of the person-stimulus attribute interaction on engagement outcomes draws from Kitwood’s emphasis on person-centered care and the importance of understanding and celebrating personal identity. In essence, Kitwood’s person-centered care can map onto the CPMGE framework to identify the person, stimulus and environmental attributes within a care setting to support personhood and well-being.

Activity theory claims that continuous engagement in enjoyable and meaningful activities benefit older adults (Havighurst, 1961), as it establishes heightened psychological and physical wellbeing (Havighurst & Albrecht, 1953; Phinney, 2006). There is also a need to involve older adults and people with dementia in the management of their life, to be involved in past and current interests and involved in activities of fulfilment and satisfaction (Fazio et al., 2018). Participation in familiar contextual and social environments further increases engagement of people with dementia (Phinney et al., 2007). This notion has been widely integrated into care interventions for dementia. However, there has been criticism of ambiguity in defining what constitutes 'meaningful activity' (Lazar et al., 2016; Mansbach et al., 2017; Phinney, 2006; Phinney et al., 2007). From the perspective of people with dementia, a meaningful activity induces feelings of pleasure and enjoyment, evokes a sense of connection and belonging, and retains a sense of autonomy and personal identity (Phinney et al., 2007).

Common meaningful activities, that have been included in clinical experimentation, and may be referred to as therapies, include reminiscence and listening to music (Lazar et al., 2016). Stimuli that is meaningful and tailored to the individual is thought to promote engagement (Leone et al., 2012) particularly if it focuses on areas of self-identity (Cohen-Mansfield, 2006). Such personalisation has been shown to enhance interest and positive affect (Cohen-Mansfield et al., 2007). The current research adopts a person-centered care philosophy, with respect to personal and social identity, to promote engagement in older adults. Within the intervention, a person-centered approach will be drawn from personalising the individual stimuli to the participants. The stimuli will be drawn from the life experiences of the older adults which is expected to increase the interest and positive affect of participants. Participants will be in a small group setting with other older adults. Discussion of the stimuli in the group setting is predicted to encourage personal and social identity. The stimuli chosen is drawn from a RT approach, which will be discussed in the next section.

2.5.2 Reminiscence therapy

Personal storytelling is common in everyday interaction, and is essential in establishing and maintaining a personal and social identity (Schrauf & Müller, 2014). RT actively involves stimulating conversation through discussion of past events and experiences, often evoked through mediums of photography and music (Woods et al, 2018). RT promotes the recall of autobiographical memories that comprise specific, personal events (Holland & Kensinger, 2010). RT draws on the strengths of autobiographical memory which creates interactions in the ways in which people make meaning of their lives, environment and social world. In doing so, participants develop a coherent sense of themselves and their relationships with other, their emotions and their intentions for the future (Harris et al., 2013).

Promoting autobiographical memory has been a focus of RT and dementia interventions as people with dementia typically have graded retrograde amnesia. That is, they preserve earlier life events in memory for a longer period, compared to more recent events (Westmacott et al., 2004). The memories that are retained the longest are also those that have been recalled and shared frequently (De Simone et al., 2016). RT is a person-centred approach and model to create an environment that encourages personal storytelling. In doing so, it allows people to assert identities, exercise agency, which adds meaning to life, facilitates social engagement, connect with others, and gives pleasure in the act itself (Fels & Astell, 2011; Schrauf & Müller, 2014). There are numerous methods and techniques that have been used to conduct RT for people with dementia in varying settings (home, aged-care facility) and modalities (individual, group). Most clinical research has measured the impact of RT on quality of life, functional capacity in daily activities, cognition, communication, relationship quality, behaviour, mood and carestaff outcomes.

RT has been suggested to improve cognitive function, anxiety, depressive symptoms, self-esteem, life satisfaction, communication and personal interaction (Azcurra, 2012; Cotelli et al., 2012; Forstmeier, 2012; Hsin-Yen & Li-Jung, 2018; Lopes et al., 2016; Nakamae et al., 2014; Pinquart & Huang et al., 2015; Redulla, 2019). For example, personalised video and audio recordings of family members were shown to reduce agitation in people with dementia (Cohen-Mansfield et al., 2007; Werner et al., 2000; Woods & Ashley, 1995), compared to generic videos (Cohen-Mansfield et al., 2007). Garland et al., (2007) investigated efficacy of RT on adverse agitated behaviours in the form of audiotapes that either presented family members speaking of earlier life memories or contained pre-recorded music based on music preferred in earlier life. Interestingly, both treatments showed reductions in agitated physical behaviours, however, only listening to audio recordings that stimulated the feeling of having family present, reduced agitated verbal behaviours. This was not present in the condition where participants listened to music based on musical preference. Despite overall improvements within the study, it is necessary to note presentation of treatments showed great variation in agitated behaviours in the participants. Whilst most people had reductions in agitated physical behaviours, a minority of others had increased agitated behaviours. This provides questions as to whether RT as an intervention should be used for all people with dementia.

The great inconsistency of the impact of RT on people with dementia is further seen in Woods et al., (2018) systematic review, inclusive of 1749 people with mild to moderate dementia across 16 studies. Results concluded that there appeared to be no great evidence that RT has a substantial impact on quality of life immediately post treatment in residential care, and a negligible benefit for home-care environments. Within the review, there appeared to be a high-quality improvement in cognitive measures immediately post treatment and low-quality improvement long-term. Cognitive capacity was obtained through the Mini-Mental State Examination (MMSE; Folstein et al., 1975). Within Woods et al., (2018), the outcome of RT for communication measures was inconsequential for individual RT interventions. However, there is supportive evidence of improvements immediately post treatment and at follow up for group interventions. The outcome of RT on mood, relationship quality and certain behavioural functioning, such as execution of daily activities, agitation and irritability, had no clear impact. The symptom of depression was shown to improve, with unknown clinical importance, for individual RT intervention conditions. In terms of adverse risk of RT for people with dementia, there is minimal evidence that RT is harmful. Although, as mentioned above, there are reported instances that RT has increased agitated behaviour in a minority of people.

RT has had a controversial effect on family carers at long-term follow up. Woods et al., (2012), assessed the effectiveness of joint RT on people with dementia and their carers. Of the 350 carers, 71% of carers were a spouse. At the 10-month follow up, carers that attended RT reported a significant increase in anxiety compared to carers that did not attend. Further, with attending more sessions of RT, there was an increase in caregiving stress. In another study by Charlesworth et al., (2016) at the 12-month follow up after joint RT, carers reported an improved perceived relationship with the person with dementia. It is unknown how the response from family carers translates to clinical and residential carestaff.

Overall, the systematic review of Wood et al., (2018), demonstrates that there is considerable inconsistency in outcomes of RT interventions both across settings and modality. Many of the effects that came from high quality research were measured at the conclusion of the intervention, whereby post-intervention outcomes were not maintained when measures were taken at long-term follow up.

This suggests implementation of RT interventions would best be delivered as a reoccurring activity to promote beneficial outcome. It is currently unknown what timeframe of such a schedule would best benefit a person with dementia.

In terms of effectiveness and contextual setting, RT has been shown to be more effective in residential care, compared to the home environment (Woods et al., 2018). In a home environment, older adults are surrounded by personal items that trigger reminiscence. Within residential care, there is not the same naturally triggering context to partake in activities and roles that characterise one's identity. Family and social contact may also be reduced which causes greater loneliness and a reduction in self-identity (Brownie & Horstmanshof, 2011). For people with dementia, it is thought that there are four categories of self-identity; family, work, hobbies, and attributes (Cohen-Mansfield, 2000; Cohen-Mansfield et al., 2006). All these areas may be compromised when relocated to an aged-care facility. Cultural differences within the aged care environment further contributes to this impediment on identity. The current experiment will be delivered at a respite aged care facility and will be designed to evaluate the effectiveness of RT to promote a personalisation of interactions. To measure the personalisation of the participant experience, the lexical use dependent variable of person pronouns use as a percentage of overall speech will be measured. For the findings of person pronouns use as a measure of engagement, see Chapter 6.

Considering the lack of quality studies and the inconsistencies across previous research, the current research aims to provide high quality research investigating how RT impacts engagement of people at an aged care facility. It is hypothesised that reminiscence through visiting Person-Specific locations will enhance the engagement of residents, seen through increased facial movement, lexical use and prosodic patterns of speech. It is thought that reminiscence would have a greater effect as it is a meaningful task that links the resident to their self-identity and fostered memories, which can be used as a source of communicative information. In other words, it is expected that by personalising the stimulus, the person-stimulus interaction will be affected and will enhance interest and the level of engagement. How the measures of engagement outcomes change across Person-Specific and Non-Specific locations will be discussed in the relevant chapters. For facial movement as a measure of engagement, see Chapter 5. For lexical use as a measure of engagement, see Chapter 6. For prosodic patterns of speech as a measure of engagement, see Chapter 7. The discussion in Chapter 8 will give an overview of the impact of RT and Person-Specific locations on the measures of engagement.

2.5.3 Reminiscence therapy and effects on language use

Understanding language of autobiographical memories and shared stories between older adults and other people, leads to understanding the impact of RT on communication. RT has been shown to be positively correlated with the increase in communication (Haight et al., 2006; Kruper & Smith, 1994). Okumura et al., (2008) compared a five session RT group with an everyday conversation group. Within the RT group, there was a significantly improved amount of dialogue spoken in the last session compared to the first. There was also a significantly greater amount of dialogue, higher verbal fluency and amount of non-verbal communication at the end of the experiment in the RT group compared to the everyday conversation group.

There is, however, inconsistency in previous research as to the effect of RT on language. Rose et al., (2020) investigated the effect of RT on the language of four older adults with MCI. The discourse genres that were included were everyday recounts, procedural and expository discourse. The evaluation focused on the macrostructure elements, including orientation (beginning), body (middle), and conclusion (end), as well as the richness, quantity rate, efficiency and informativeness of the language. There was considerable inconsistency across the four participants. Two participants showed improvements in the amount and richness of dialogue spoken. Whereas, the other two participants showed weaker performances with reduced amount of words. Further, one of these showed reduce richness and the other reduced efficiency. This was greatly attributed to the variance in the etiology of the older adults and their baseline discourse profiles. With the great diversity of cognition and etiology of older adults in aged care facilities, it is important to understand how interventions affect the population.

The current research will measure the discourse of participants across the intervention to measure communication stability, see section 4.8. Chapman et al., (2004) created a discourse battery to measure narrative, procedural and abstract discourse. This battery will be used within the current research and described in greater detail in Chapter 3.

2.5.4 Technological interventions for people with dementia

Electronic devices that can be modified to meet the requirements of the individual, and technology to use in interventions for dementia, are being adopted in aged care facilities, as technology becomes accessible and affordable (Alkhaldi et al., 2015). Assistive Technology (AT), also known as information and communication technologies (ICT), are currently available and are implemented to support and aid people with dementia, carers and dementia carestaff. AT are designed to assist in ease of functioning, particularly in terms of fulfilling daily activities, and to enhance safety through reducing risks and hazards (Van der Roest et al., 2017). As the accessibility, affordability and functions of technologies enhance, so too may the effects currently seen with digital technology-based interventions, particularly those which facilitate communication. For example, (Van der Ploeg et al., 2016) showed a trend of reduced agitation when communication with family members was through live video calls compared to landline telephone calls. However, the differences were non-statistically significant due to a low retention rate of participants and insufficient statistical power. If such an experiment was to be validly executed and significant results emerged, it may be due to a more dynamic and encompassing experience of communicating through an audio-visual medium, rather than audio alone. There is, however, evidence that even the most basic forms of technology used in an intervention benefits people with dementia (Garland et al., 2007). Further, technologies have been shown to provide an enjoyable activity that positively impacts on wellbeing and reduces neuropsychiatric symptoms of people with dementia, such as agitation and distress (Neal et al., 2020). The relationship between levels of technology and their beneficial outcomes in such interventions is currently unknown.

There are considerations in creating technology that is accessible to older adults. Current barriers to using technology by older adults include a lack of knowledge, negative attitudes, and age-related changes such as vision, hearing loss and fine motor difficulties (Gitlow, 2014). Negative attitudes toward the adoption of technology have been identified including frustrations with complexity, feelings of inadequacy and limitations, usability concerns, comparisons with younger generations, and lack of social interaction and communication (Heinz et al., 2013; Vaportzis et al., 2017). The creation of technology should take these into account and be sensitive to the needs, attitudes and requirements of older adults and people with dementia.

With the great potential that technology presents, there is currently a lack of technology facilitating meaningful activities (Lazar et al., 2016), in particular person-centred interventions tailored around the individual (Wey, 2005). The majority of AT is concentrated on memory impairment, with fewer devices aimed to address other progressive BPSD, such as aphasia, agnosia, apraxia, visuospatial, or executive dysfunction (Bharucha et al., 2009). Mass produced AT aimed towards assisting memory are generally focussed as a reactive aid treatment, designed to prompt activities when required or designed to enhance anterograde memories, which is the ability to create new memories. For example, Microsoft's SenseCam (Dourish & Friday, 2006) utilises a fish-eye wide angle camera that captures systematic images over time in an attempt to record an event. It has been suggested upon observing these images, people with mild Alzheimer's disease have a greater ability to recall autobiographical details compared to groups that utilised a basic memory training program (MEMO+) or wrote in a diary (Silva, Pinho, Macedo, Moulin, Caldeira et al., 2017). Use of SenseCam, compared to a diary writing group, further presented with enhanced episodic and semantic memory, and improved elements of executive function, that was maintained long-term (Silva, Pinho, Macedo, Moulin, Caldeira et al., 2017; Silva, Pinho, Macedo & Moulin, 2017). Older adults who were in the SenseCam condition also had reduced depression, which did not maintain at 6-months follow up (Silva, Pinho, Macedo, Moulin, Caldeira et al., 2017). The SenseCam utilises still images of contextual situations that have recently been experienced with the ability for the user to review these recent experiences to encourage the consolidation of new memories.

With most technology aimed at either prompting daily behavioural actions or attempting to create new memories, there is limited technology focused towards retrieval of past memories and experiences, to assist in reminiscence. In an evaluation of an interactive touch-screen system called CIRCA (Computer Interactive Reminiscence and Conversation Aid), it was confirmed that people with dementia are able to use touch screen devices. Furthermore, the use of photographs, music and video clips as explorable media promoted reminiscence and provided an engaging, enjoyable and positive experience for people with dementia and their carers (Astell et al., 2010; Samuelsson & Ekström, 2019). Davison et al., (2016) found that the use of a "Memory Box", a computer program containing personalised music, messages from relatives, movies and photographs, significantly reduced depression and anxiety compared to a control group that spent equivalent time with researchers. Subramaniam and Woods (2016) investigated the impact of a digital life storybook compared to a conventional life storybook. They found an improvement in quality of life, stability or improvement in depression symptoms, and self-reported improvements in positive emotions.

Technology focused towards autobiographical memory for people with dementia is valuable as the nature of dementia encompasses graded retrograde amnesia. That is, older memories of events in the life of people with dementia is retained longer than memories of recent events. This is seen with the loss of memory of life events from more recent years first, which then progresses to the loss of the memory of events in earlier years of life. Therefore, by focusing on autobiographical memories across the lifespan of an individual, life stories and the connection to identity are more accessible for people with varying degrees of dementia.

There is a gap in the understanding of how technology-based interventions may accompany RT and aid in the communication of these earlier memory traces. This gap is addressed in the current research and will investigate how the TTT experimental intervention, utilising an advanced technological interface to deliver RT stimuli, impacts the engagement outcomes of people with dementia. The current experiment includes two levels of technology as a dependent variable – a Low-Tech condition (LT) and a High-Tech condition (HT). The LT condition stimulus will involve static images of a location presented on a television screen, and the HT condition stimulus, will allow participants to explore the environment of the locations, move back and forth around the location and go into buildings, if it is available to do so. The control condition is a structured dyadic interview which asks questions about the older adult's history to encourage reminiscence. If the use of technology promotes participation, then outcomes of engagement in the HT condition, which is more immersive and interactive, is predicted to be greater compared to the LT condition, which is not as immersive and interactive. The comparison of the LT condition and the HT condition will determine the impact of different levels of digital technology on the engagement of older adults. For a description of the LT and HT dependent variable conditions, see section 3.3.

2.5.5 Guided interventions

Interventions that are non-guided or are not facilitator-led are more accessible and affordable than interventions that are guided. The outcome of mass-producing resources utilised in interventions, is that everyone is exposed to generic material. However, as previously mentioned, there are greater beneficial outcomes with interventions when the stimulus is meaningful and tailored to the individual. Ideally, generic material that is mass produced can be adapted to the individual. This may be provided through guided and facilitator-led interventions which can provide human input and adapt the intervention to the individual as the session progresses. Guided interventions have been shown to increase the engagement of older adults with dementia and reduce apathy (Leone et al., 2012). This is due to prompting of questions and socialisation encouraged by a facilitator.

There is a gap in the previous research outlining how guidance of programs may assist in the effectiveness of an intervention. Most of previous research that mentions guidance as an intervention does not have an appropriate control to determine the impact facilitation has on the observed outcome. Furthermore, it is unknown the degree of guidance that is used within interventions. In relation to RT, most research on reminiscence interventions mention the use of pictures, music or personal objects as prompts for conversation. However, it is unknown how the active involvement of a facilitator, using such devices to prompt and initiate conversation, may affect the engagement and communication of the resident. For example, Moos & Björn (2006) conducted a systematic review on the benefits of using the life story of an older adult within care strategies. Within eight interventions that aimed to improve either self-integration into the facility or aimed to improve self-esteem, there was no mention of whether the facilitator prompted the resident to mention unrecalled memories. Experiments that appropriately control for guidance by conducting a baseline observation (Engelman et al., 1999; Leone et al., 2012), showed that people with dementia increase their engagement with guidance, prompts and associated praise. Within Engelman et al., (1999) contact with each resident was conducted within every 15 minutes. It was not mentioned how the researchers decided on the 15-minute intervals as an ideal amount of prompting, and currently the appropriate amount of guidance throughout an intervention is unknown. However, it is suggested the time length of interventions targeted at people with advanced stages of dementia, should be shorter with higher frequency rates (Kolanowski et al., 2012). Considering the variations in cognition across people with dementia, the amount necessary to enhance engagement would most likely be varied and dependent on cognitive abilities. The current research will be facilitator-led with the facilitator using prompting questions to encourage socialisation and reminiscence. For a description of the questions used in the dyadic RT discourse interview, see section 3.1.3. For a description of the type of questions used to prompt conversation during the LT and HT conditions, see section 3.6.

2.5.6 Group interventions

Group activities to enhance the effects of dementia interventions are of particular interest due to their direct potential for engagement and social interaction. Group activities help to fulfil the need for social contact and enhance engagement to alleviate boredom (Cohen-Mansfield et al., 2017) and promote positive client relationships and assimilation. Group activities in small to moderate group sizes of four to nine people, provide a social platform to encourage engagement with others, and have a more profound effect on social connection than dyadic interventions (Cohen-Mansfield, Thein et al., 2010). They also have the ability to reduce the negative behavioural symptoms of dementia. For example, a music group activity with older adults in an aged care facility showed reduce agitated behaviour in individuals, and enhanced emotional relaxation and social interactions, compared to a control group who did not engage in the activity (Lin et al., 2011). Unfortunately, there was no control involving individual music sessions to determine if and to what extent the group setting contributed to the observed effect.

In support of group settings as a desirable intervention context, it has been shown that group activities, involving people with severe and very-severe dementia, held in enriched, stimulating and novel environments, enhanced active engagement and positive affect (Materne et al., 2014). Social interaction has further been shown to reduce physical agitation and improve engagement in persons with dementia more so than other forms of stimulation, such as music, artificial social stimulus, and individualised stimuli based on the person's self-identity (Ballard et al., 2009; Cohen-Mansfield, Marx et al., 2010). In a review of 10 papers, group RT had significant impact in providing short-term depression relief in older adults with depression. It further improved self-esteem, life satisfaction (Song et al., 2014), promoted balance in affective state and promoted positive mental health (Zhou et al., 2012).

The current research will incorporate groups of two to four older adults participating in RT on a weekly basis for three months. The group sizes and length of experiment were chosen for consistency with the pilot feasibility study that was carried out in 2016, which first introduced TTT (Watson et al., 2018). The group settings will include the presence of the other older adults in the group and the facilitator. Family and carestaff will be invited to join. Within the group setting, a communicative exchange will be constructed that is organised with the transfer of information between the group participants, the facilitator, and the stimulus. Each element provides an essential role in the communication and the relations that are established. Investigation in this group dynamic will give insight into the interaction between person, environment and stimuli attributes. It is predicted that with the prompting and guidance in an intervention, a person may be triggered to maintain a level of focus and engagement. This is due to a refocusing of the client's attention towards the stimuli and enhancing the interactiveness of the experience.

2.6 Summary of evidence

From previous research reviewed, there is an understanding that socialisation, communication and engagement is important for the wellbeing and quality of life of older adults in aged care facilities. As outlined within the CPMGE framework, the three main factors that interact and explain influences towards the behavioural outcomes of engagement are environmental attributes, personal attributes and stimuli attributes, with dyadic interactions between them. Within the framework, there are two measurable factors of engagement, affect and behaviour, whereby affect further influences behaviour outcomes. RT is a common approach used in facilities to promote storytelling, socialisation and connection to identity. However, previous research poses contradictory results as to the impact and benefit of RT. Technology is accessible and feasible, and is promising in being a medium in which to deliver RT stimuli and promote the beneficial outcomes of RT. RT has also been shown to be effective in group environments, as it is beneficial in encouraging socialisation and connection. There is currently limited understanding of how technologically enhanced group RT impacts older adult engagement.

Most of the research in this field has focused on single communicative channels as proxies for participant engagement. There is limited understanding of different behavioural measures to characterise older adult engagement. This thesis seeks to provide data to help to address this research gap developing more sophisticated techniques for recording and interpreting participant engagement. More specifically the dependent variables of facial movement, lexical use and prosodic patterns of speech will be investigated as measures of engagement.

2.7 THE PRESENT STUDY

This study is concerned with understanding how digital technology driven group RT impacts engagement of older adults. This study evaluates the TTT experiment on promoting engagement and socialisation of older adults in respite aged care. TTT as an experiment involves guided group RT. The group TTT sessions include a facilitator to assist in driving the session and asking open-ended questions about locations to promote conversation. Family members may also be present for the sessions. In the current research the TTT digital environment is used as a context to characterise engagement, and promote relationship building and maintain a sense of identity in residential care.

TTT uses Google Street View and Google Maps, to take people in residential care to revisit places of their past, as well as novel destinations they have not visited before. Whilst participating in the experiment, if the participants display increased measures of engagement, it would be unknown whether the results are due to sensory exposure with the technological interface, or due to the effects of reminiscing. To address this, older adults will be exposed to two levels of the location specificity dependent level. Person-Specific locations and Non-Specific locations. Within the Person-Specific locations condition, a participant will be viewing relevant locations to their personal history. Within the Non-Specific locations condition, participants will view novel locations. These novel locations are either novel to the entire group or may be a person-specific location to another group member. If the RT feature of TTT promotes engagement of older adults, it is hypothesised that the Person-Specific locations condition will have greater engagement outcomes compared to Non-Specific locations condition.

To understand the influence of digital technology within the TTT environment there will be two levels of technology independent variable – LT condition and HT condition. The baseline condition will be a structured dyadic RT interview with a facilitator that asks questions relating to the participants history. The LT TTT condition will present static images of both Person-Specific and Non-Specific locations in a group environment. The HT TTT condition will also be in a group environment and provide the participants with the ability to move around the Person-Specific and Non-Specific locations. Participants will be able to move down streets, go into buildings and have 360-degree views of locations where available, increasing the dynamic and immersive nature of the TTT environment. It is hypothesised that a dynamic and immersive technology-driven RT will provide a greater sensory experience and enable greater engagement of older adults compared to a dyadic RT interview. If the dynamic and immersive environment of TTT promotes engagement of older adults, it is hypothesised that there will be a positive association between the level of technology and the engagement outcomes of older adults.

The current research will record and analyse markers of engagement and apply the CPMGE framework (Cohen-Mansfield, 2017) to understand engagement outcomes. As reviewed earlier, there are limitations in using a singular approach to measure engagement of older adults as seen throughout previous research. The experimental design of this study takes a unique multifaceted approach. Measurements will focus on how RT, with stimuli delivered through digital technology, impacts the ability for a person with dementia to engage, communicate and socially interact. The study will combine both verbal and non-verbal measurements of engagement to characterise older adult engagement. More specifically, the dependent variables will include the presence and intensity of facial movement, lexical parameter inclusive of personal pronouns, affective word use and the tone of speech, and linguistic prosodic patterns inclusive of the duration of utterances, number of words per utterance and the pitch variation of speech. With this unique approach this study will contribute to the characterisation of older adult engagement within different contexts of a dyadic RT interview setting and a technology driven group RT setting. It will further give endowment for the use of TTT as an intervention to promote engagement of older adults in aged care facilities.

2.8 AIMS, HYPOTHESES AND RESEARCH QUESTIONS

The overall aim of this thesis is to evaluate the effect of the TTT group RT experiment on older adult engagement in a respite aged care facility. This thesis presents an analysis of a longitudinal dataset created as part of the thesis. Nine older adults from varying cultural backgrounds were recruited from Baptist Care Day Respite Facility, Kellyville. Cognitive capacity was measured pre-experiment and post-experiment using the Mini-Mental State Examination (Folstein et al., 1975). The Neuro psychological Inventory – Nursing Home Version (NPI-NH; Wood et al., 2000) and a discourse interview (Chapman et al, 2004) were administered pre-experiment, mid-experiment and post-experiment to understand the psychological, behavioural and communication profiles of the participants across the experiment. The RT interview and TTT sessions where audiovisually recorded. Facial movement was measured using OpenFace 2.0 Facial Analysis Toolkit (OpenFace; Baltrušaitis et al., 2018). Lexical use was measured using the Linguistic Enquire and Word Count (LIWC; Pennebaker & Francis, 1999). Verbal prosodic patterns were measured using the Montreal Forced Aligner (McAuliffee et al., 2017), Praat (Boersma & Weenink, 2020), and the programming language of Python 2.7 (van Rossum & Python Development Team, 2015).

As stated in Chapter 1, the central research question that this thesis aims to address is:

1. To what extent does technology delivered through TTT impact the engagement of older adults in respite aged care?

The overall hypotheses are as follows:

H1: If reminiscence therapy, technology and group environments promote engagement of older adults, it is hypothesised that the TTT intervention has greater engagement outcomes compared to the dyadic reminiscence therapy interview.
H2: If dynamic, interactive and immersive digital technology promotes engagement of older adults, it is hypothesised that there is a positive association between the level of technology and the engagement outcomes of older adults.

H3: If personalised stimuli within reminiscence therapy promote engagement, it is hypothesis that the Person-Specific locations condition will elicit greater engagement outcomes compared to the Non-Specific locations condition.

In order to address the overall research questions and hypotheses, a number of sub-questions are posed. Those sub-questions are outlined here, and will be addressed in turn in the chapters that follow. Specific hypotheses pertaining to each of the sub-questions are defined in the relevant chapters.

Chapter 4 Baseline Measures is a descriptive characterisation of the participants as baseline measures. It focuses on the cognitive, psychological, behavioural and discourse profiling of the participants. The MMSE is used for the characterisation of cognition and to assign participants to experimental conditions. This is to ensure comparable cognitive profiles across experimental conditions. It will further be used as a covariate in analysis. The NPI-NH is used to characterise the behavioural and psychological profiles of participants, and the discourse interview is conducted to characterise the baseline narrative, procedural and abstract discourse profiles of participants. Chapter 4 address the following questions:

1. Are the behavioural and psychological symptoms of dementia maintained or improved across the TTT experiment?
2. Are the narrative, procedural and abstract discourse characteristics of older adults maintained or improved across the TTT experiment?

These questions address the maintenance of performance across the experimental groups through detecting variations in cognitive, psychological, behavioural and discourse profiles across the experiment. The measures will be conducted pre-experiment, mid-experiment and post-experiment, as comparable baseline profiles of a participant across the experiment is an important variable in interpreting engagement outcomes.

Chapter 5, 6 and 7 each explore different dependent measures of engagement. These chapters respectively focus on facial movement, lexical use and prosodic patterns of speech as measures of engagement.

Chapter 5 Facial movement as an indicator of engagement motivates the following questions concerning affective facial movement with an interest in action unit presence and intensity as dependent variables:

1. What are the facial movement characteristics of older adults during the TTT experiment and how does this differ to a structured dyadic RT interview?
2. To what extent does the dynamic and immersive nature of technology mediate facial movement differences when participating in a LT version compared to a HT version of TTT?

3. To what extent does the reminiscence and personal familiarity of a location mediate facial movement differences when viewing Non-Specific compared to Person-Specific locations?

Chapter 6 Lexical use as a measure of engagement motivates the following questions concerning lexical use in dialogue with an interest in proper pronouns, affective word use and tone of speech as dependent variables:

1. What is the proper pronoun use, affective word use and tone of speech characteristics of older adults during the TTT experiment and how does this differ to a structured dyadic RT interview?
2. To what extent does the dynamic and immersive nature of technology mediate proper pronoun use, affective word use and tone of speech differences when participating in a LT version compared to a HT version of TTT?
3. To what extent does the reminiscence and personal familiarity of a location mediate proper pronoun use, affective word use and tone of speech differences when viewing Non-Specific compared to Person-Specific locations?

Chapter 7 Prosodic patterns of speech as indicators of engagement motivates the following questions concerning verbal prosodic patterns with an interest in duration of utterance, words per utterance and variation in F0 as dependent variables:

1. What is the duration of utterance, words per utterance and variation in F0 during the TTT experiment and how does this differ to a structured dyadic RT interview?
2. To what extent does the dynamic and immersive nature of technology mediate duration of utterance, words per utterance and variation in F0 differences when participating in a LT version compared to a HT version of TTT?
3. To what extent does the reminiscence and personal familiarity of a location mediate duration of utterance, words per utterance and variation in F0 differences when viewing Non-Specific compared to Person-Specific locations?

Chapter 3: Method

This chapter presents the method for delivering and evaluating the Time Travelling with Technology (TTT) experiment for older adults who attend an aged care day respite centre. From previous research reviewed in Chapter 2, the importance of engagement in meaningful activity, for older adults, has been emphasized to help promote positive relationships and connection to identity. The current impact of technology to assist with everyday living skills has been outlined. The TTT experiment will now be described and has been designed to consider location specificity and technology independent variables. This chapter will begin with an outline of the baseline measures that were used to characterise the cognitive and behavioural profiles of the participants. It will then follow with a description of the participants, design and apparatus. The procedure in deploying the experiment will be outlined with an overview of the ethical considerations and a summary of the outcome measures and analysis protocol.

3.1 COGNITIVE AND BEHAVIOURAL BASELINE MEASURES

Baseline measures were recorded to determine pre-experiment cognitive, verbal and behavioural characteristics of participants independent of the TTT environment. Participants were administered the Mini-Metal State Examination (MMSE; Folstein et al., 1975) to determine their cognitive capacity at the beginning and end of the experiment. The Neuropsychiatric Inventory – Nursing Home Version (NPI-NH; Wood et al., 2000) was completed by carestaff and family members to record the participant's cognitive and behavioural symptoms over a two-week period prior to completing the measure. The discourse interview schedule was used to assess relevant verbalisation and communication ability. The NPI-NH and discourse interview schedule were conducted at three time points, before the beginning of the experiment, during the mid-experiment break and at the end of the experiment.

3.1.1 Mini Mental State Examination

The Mini Mental State Examination (MMSE) is designed to screen for cognitive impairment and functioning and consists of 11 questions that takes approximately 10 – 15 minutes to complete. The MMSE has been shown to have good internal consistency (.96 from a mixed group of medical patients and .68 and .77 from two community samples) and test-retest reliability (between .80 and .95). The MMSE further has good validity with other generally accepted criteria for determining cognitive impairment, such as the Diagnostic Statistics Manual (Baek et al., 2016; Tombaugh & Mcintyre, 1992).

The MMSE is split into two sections. The first section requires verbal responses and asks questions relating to orientation, memory recall, and attention. The second part of the test examines greater cognitive function and ability. The participant is asked to identify by name, follow verbal and written instructions, write a spontaneous sentence, and copy a complex shape, thereby testing for arithmetic and language function. The maximum score of the two tests is 30. As a guiding indicator of severity of cognitive impairment, the MMSE is interpreted with a score of less than 10 as severe impairment, 10 to 20 as moderate impairment and 20 to 25 as mild impairment (Folstein, 1975). However, these categories should be interpreted cautiously (Woods et al., 2018).

The MMSE was administered prior to commencement of the current research experiment. Participants were assigned to each group using stratified randomization (Suresh, 2011), taking the MMSE into consideration as a covariate. This was to ensure that the mean cognitive capacity scores of each group were, in descriptive statistics terms, of similar standard deviation and range, see Appendix E. The MMSE was also administered at the end of the experiment to determine the extent of changes in participant's cognitive capacity over the course of the experiment. The MMSE was used as a covariate within the analysis of each dependent variable.

3.1.2 Neuropsychiatric Inventory – Nursing Home Version

The Neuropsychiatric Inventory – Nursing Home Version (NPI-NH) characterises neuropsychiatric symptoms and psychopathology, and measures the impact of antidementia and psychotropic drugs on behaviour of people with dementia in a nursing home setting. The inventory also includes an occupational disruptiveness scale to determine the influence behavioural symptoms of people with dementia have on facility carestaff and their work. The NPI-NH has been shown to have a test-retest reliability coefficient from r=0.55 to r=0.88 (Iverson et al., 2002; Lange et al., 2004). It further has a good validity for the subscales (Wood et al., 2000).

There are ten behavioural areas assessed (delusions, hallucinations, agitation/aggression, depression/dysphoria, anxiety, elation/euphoria, apathy/indifference, disinhibition, irritability/liability, aberrant motor behaviour) and two forms of neurovegetative changes (sleep and night-time behaviour disorders, appetite and eating disorders). Ratings of these areas include frequency (rarely, sometimes, often, very often), severity (mild, moderate, severe) and disruption (0-5, from not at all to very severely or extremely). The NPI-NH was completed by a family member or carestaff which informed about the participant's behaviours over the past two weeks. Since clients attended the day respite facility once a week, there was a preference for family members to complete the NPI-NH as family would have greater knowledge of the client's behaviour over the two-week period. However, if family were unable to complete the NPI-NH, carestaff were asked to complete it. It was important that the same person filled out the NPI-NH at all three time points to accurately capture perceived changed in behaviour.

3.1.3 Discourse interview schedule

The participant's baseline ability to interpret and communicate verbally relevant information is important in the communication within group interactions and for social engagement. The discourse interview consisted of three tasks including a narrative discourse task, a procedural discourse task and a proverb interpretation task, see Appendix C.

Three versions of the discourse interview schedule were created for the experiment. The first schedule was most similar to that used by Chapman et. al, (2004) with the only change being the picture scene used for the narrative discourse section was changed to a new image:

The narrative discourse task assesses the ability to integrate visual information and process emotions that are relevant to life events through the medium of storytelling. It further assesses whether the individual will communicate the generated stories at a gist-level or detailed-level of processing. For example, the narrative discourse image used in the first interview is of a parent speaking to their child in a school uniform, Figure 3.1. The participants would be handed the image and given the following instruction, *'Look at this picture. Can you tell me a story about what's happening in the picture?'*.

Scores between 0 – 5 points (incorrect – interpretive) were assigned for the 'main idea' of the participant's response in their interpretation of the picture scene. Scores between 1 - 10 points (incorrect – global) were also given for interpretive detail relating to the comprehensiveness of the semantic description. For example, describing a lesson involved in the scenario would reflect a more global response as it reflects on human behaviour and experience. Thus, a participant's response could be assigned a maximum of 15 points for their narration of the picture scene.

Figure 3.1: The image used in the narrative task section of the first discourse interview. Participants where requested to share a story about what is happening in the image. Note. From Sorapop Udomsri (n.d.). Retrieved from https://www.shutterstock.com/image-photo/family-happy-mother-mom-send-children-1124699387.

A 'gist-level' response example from a participant that received a score of 5/15 points was, *'The mother is talking to her daughter... I think that's a bus... And it must be somewhere around her house... Because she's going to school on the bus.'* Whereas, a more detailed-level response from a participant that received a score of 8/15 points was, '*I think that's the mother talking to her daughter, I'd say. They look alike and so now you be a good girl and do as you're told otherwise I'll stand you in the corner. Now that's pretty that... You'd almost think it was in a carpark, wouldn't you?... And some sort of a shopping centre... And, yes. Or it could even be outside a school... She's dropping the daughter off at school and said now you be a good girl and do as the teacher tells you.'* The other two images used for the second and third discourse interview included a scene in which a woman was saying goodbye to her partner as he left on a train, and a scene in which a family were enjoying a picnic.

The procedural discourse tasks assess the ability to coordinate and arrange in a sequential order. For example, in the first discourse interview the participants were asked, *'Now, can you tell me how you make scrambled eggs? What do you do?'* Scores between 0 - 4 points for assigned for the recall of 'gist' procedural steps and 0-7 points for the recall of 'core' steps. Thus, a participant's response could be assigned a maximum of 11 points for their description of the procedure. An example of a participant's response in which they received 3/11 points was, 'Okay. You beat, depends how many eggs you want to break... You mix it up.... And put it in a frying pan. And that's how you...' An example of a participant's response in which they received 8/11 points was, '*Well, you go to the fridge and you get two eggs, and you get some milk and some salt and pepper and a little bit of milk and you beat the eggs and the milk and then you put it in a frying pan on the stove, and you just leave it and then you stir it just a bit, then you dish it up and put it on a plate and you - you put a piece of toast with it.'* The other two interviews involved asking the participant how they make chicken schnitzel, and how do they make a salad.

The proverb test assesses the ability to make abstract inferences and appropriate choices. The task involved asking the participant to interpret the meaning behind three different proverbs. Proverbs did not repeat across interviews with new ones being presented at the different interview time-points. The participant's interpretations of the proverbs were scored on a scale of 0 – 10 from an incorrect interpretation to a correct and abstract interpretation. The participant's responses on the three proverbs could be assigned a combined maximum of 30 points.

Participants were instructed*, 'What does this saying mean? (If you haven't heard it, what do you think it means?)'* An example of a proverb in the second discourse interview was, *'It's no use crying over spilt milk.'* An example of a participant's response that received 3/10 points was, *'Spilt some milk, best thing to do is to wipe it up. So, there's a ah, kind ah, Wetex the sink over there Ill wipe it up and ah, paper towel, and ah just wipe it up and buy another bottle of milk.'* An example of a participant's response that received 7/10 points was, *'Um, that one's a bit more difficult. I think it's that you don't cry over something simple or something that's easy to correct, I think.'*

The sum of all tasks came to a total of 56 points for the discourse interview schedule. The analysis of the discourse interview and associated outcomes will be discussed in Chapter 4. For the marking matrices of the interviews, see Appendix D.

3.1.4 Discourse interview autobiographical recall

Once participants had completed the discourse interview schedule, they were asked autobiographical questions. The audio-visual recording of these questions would provide baseline data for the comparison of dyadic interviews to the group TTT sessions. Table 3.1 shows the autobiographical questions that were ask to promote storytelling and reminiscence. These questions remained consistent for each discourse interview at time points pre-experiment, mid-experiment and post-experiment.

Table 3.1: Baseline autobiographical recall discourse topics.

1.	Tell me about where you grew up?
2.	Where did you go to school? Did you like it?
3.	Where did you work, when you were younger?
4.	Did you get married and have a family?
5.	Where did you used to go on holidays?

3.2 Participants

The participants were nine older adults (8 female, mean age: 79 years, range: 72-90 years, standard deviation (SD): 6.89) with different stages of dementia or cognitive impairment recruited from an aged care day respite program run by Baptist Care, Sydney, Australia. Throughout this dissertation older adults will be referred to as 'clients' when discussing them as attendees of the day respite centre and I will refer to the older adults as 'participants' when discussing them in relation to the research. Participants had varying cultural backgrounds inclusive of; Polish, English, Scottish, Sri Lankan, Australian, Croatian and Samoan. Five participants spoke English as a first language and four spoke English as a second language. Demographic details of participants are represented in Table 3.2.

Participants or the person responsible were asked to sign a consent form prior to commencement of the experiment. To be able to participate, the older adults were required to have normal or corrected visual sight and hearing, and be able to complete the MMSE. Participants were randomly assigned to each experimental condition. Exclusion criteria included inability to complete the MMSE, a diagnosis of bipolar, schizophrenia or Parkinson's disease, a condition requiring confinement to bed, or clients who were deemed terminally ill with an expected prognosis of less than 3 months.

For inclusion in the final analysis, 9 of the 18 clients recruited satisfied the minimum attendance of three sessions in both technology conditions. Of the 9 clients excluded from the experiment, 7 clients attended the facility on a weekday that the experiment was not run, 1 client signed the consent forms after the commencement of the experiment, which did not give enough weeks to satisfy attendance rate, and 1 client was unable to complete the pre-requisite measurements.

MMSE scores at the beginning of the experiment were used to match participant profiles across the Low -Tech-> High-Tech (L->H, n = 4, M = 18.25, SD = 7.37) and High-Tech -> Low-Tech groups (H->L, n = 5, M = 16.75, SD = 6.46). Pre-experiment MMSE scores (n = 9, M = 16.8, SD = 6.55) compared to post-experiment MMSE scores (M = 16.44, SD = 7.585) did not differ significantly (p = 0.679). The averaged MMSE score for each participant was used for analysis. Using Pearson's r, there was a very strong interrater reliability (r(7) = 0.952, p = 0.000076) for the scoring of the discourse interview.

Table 3.2: Demographic details of participants.

Participant	Age (years)	Gender	Mean MMSE	Country of Birth	Native Language
Angela	79	F	29.5	Scotland	English
Colette	90	F	24.5	Australia	English
Barbara	85	F	11	Croatia	Croatian
Charlie	87	M	17.5	England	English
Colette	74	F	7	Sri Lanka	Sinhala
Diana	72	F	13.5	Poland	Polish
Jana	79	F	14.5	England	English
Julia	72	F	19	Australia	English
Nora	73	F	13.5	Samoa	Samoan

3.3 Design

The cognitive and behavioural symptoms of dementia are inconsistent in their presentation across time and across individuals. Due to this variability, it was important to have designed this study as a within-subjects repeated measures design. Older adults participated in each technology condition a minimum of three and a maximum of six times. Participants further acted as their own control, which was the baseline reminiscence therapy (RT) dyadic interview sessions.

The research experiment had technology and location specificity as the independent variables, see Figure 3.2. The levels of technology consisted of a LT condition and a HT condition. Both the LT and HT conditions were a group session with the TTT interface as digital technology to drive RT. TTT displayed locations sourced from Google Street View and Google Maps. In the LT condition, participants were presented with static images of locations. Different angles and viewpoints were presented for each location. In the HT condition, locations were presented in a dynamic and immersive format which allowed greater viewing flexibility as the facilitator was able to pan and move about the displayed environment, and zoom into and out of locations. For a visual of the LT and HT conditions visit the following link for a video demonstration https://youtu.be/Ga59Bymse3Q.

The location specificity independent variable consisted of a Person-Specific locations condition and a Non-Specific locations condition. The Person-Specific locations condition presented locations that were acquired from the past history of an individual. For example, where a participant went to school, a home they used to live in, where they used to work, a favourite holiday location, or a place of religious importance. The Non-Specific locations condition presented locations that were not known to have an association with the participants' past. These Non-Specific locations where either novel to all participants, or they were Person-Specific to another participant in the group.

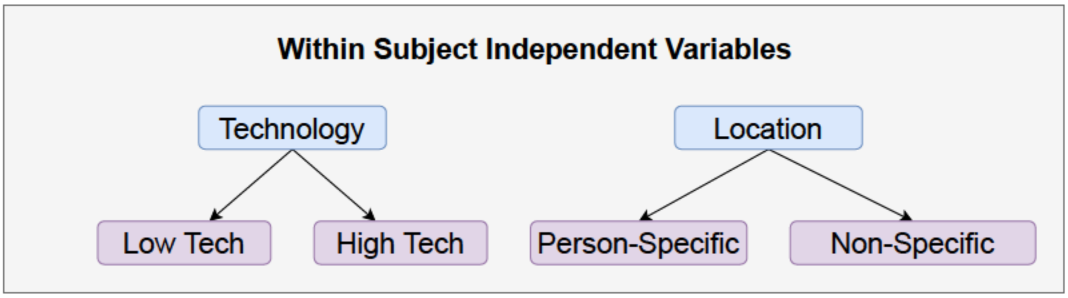


Figure 3.2: Levels of technology as an independent within subject variable of the experiment included a Low-Tech condition and a High-Tech condition. Levels of location specificity as an independent within subject variable of the experiment included a Person-Specific locations condition and a Non-Specific locations condition.

The LT and HT independent variable conditions each ran for 6 weeks, with a three week break in the middle. The order of condition of the technology independent variable was counterbalanced to distribute serial order effects, which accounts for the differences that may result in presenting or being exposed to experimental conditions in a specific order. Person-Specific locations and Non-Specific locations, as an independent variable, were presented randomly in each of the LT and HT sessions across the program. The timeline of the experiment is outlined in Table 3.3.

Table 3.3: The within subject repeated measures design of the experiment. Participants participated in RT within a LT and a HT condition. Each condition ran for 6 weeks. was administered before and after the experiment. The NPI-NH and discourse interview schedule was administered before and after the experiment and during the mid experiment break. The order of presentation of the conditions were counterbalanced across two groups, Low-Tech to High Tech (LT->HT) and High-Tech to Low-Tech (HT-> LT).

Group	Week 1-2	Week 3-8	Week 9-11	Weeks 12-17	Weeks 17-18
L->H	MMSE, NPI-NH, discourse interview	Low tech	Experiment break, NPI-NH, discourse interview	High tech	MMSE, NPI-NH, discourse interview
H->L	MMSE, NPI-NH, discourse interview	High tech	Experiment break, NPI-NH, discourse interview	Low tech	MMSE, NPI-NH, discourse interview

The weekly sessions consisted of small groups of 2 - 4 participants which ran for approximately 20 - 40 minutes, depending on the number of attendees. Each session was broken down into roughly 10-minute blocks presenting locations relevant to each of the participants. Each session was audiovisually recorded and displayed locations of significance to the participants on a television screen. Presentation of locations were randomised across the participants within the group. Therefore, there was no specific order to which participants' location would be viewed first.

The Comprehensive Process Model of Group Engagement (CPMGE; Cohen-Mansfield et al., 2017), as described in Chapter 2, outlines the two outcomes of engagement as affect and behaviour. Further, affect influences behavioural outcomes. The dependent variables, as measures of behavioural engagement, included the intensity and frequency of facial movements, lexical use of personal pronoun, affective words and emotional tone, and prosodic patterns including utterance duration, words per utterance, articulation rate and fundamental frequency, see Figure 3.3. How these dependent variables were measured and analysed will be discussed in section 3.8.

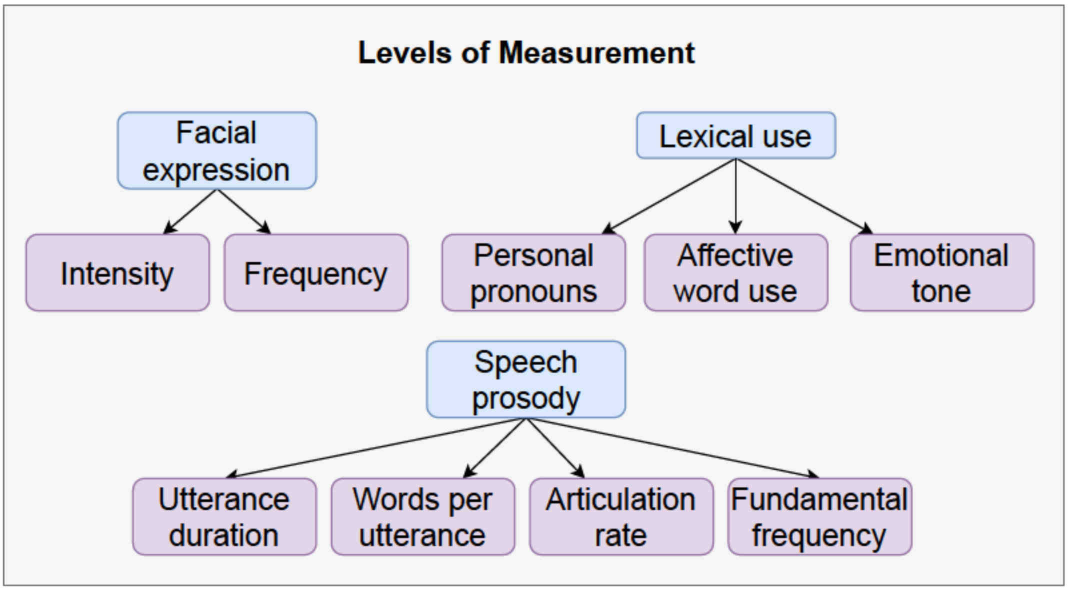


Figure 3.3: The dependent variables of the experiment that relate to affect and behaviour as measurable outcomes of engagement.

3.4 Apparatus

3.4.1 Discourse Interview

The discourse interviews required participants to sit on a chair that was next to where the interviewer sat. In front of the interviewer and the participant was a coffee table. A JVC GZ-EX555B Camcorder video camera was facing the participant, see Figure 3.4. If a family member joined the session, they were asked to sit out of the viewing of the video camera either on the couch next to the interviewer or behind the camera.

3.4.2 TTT Session

For both the LT and HT condition, locations were displayed on a 75" 4K LCD Samsung television screen powered by an Intel PC NUC minicomputer in an isolated room at the aged-care facility. The progression of locations and movement around the location environment was driven by a 10.5" Samsung Galaxy Tab S4 and controlled by the facilitator. Participants were seated centrally 1.5 metres in front of the TV and were audio-visually recorded using two JVC GZ-EX555B Camcorder video cameras. Participants were arranged in an arc to allow for easier communication between each other. The first camera was positioned to the left of the television, facing the participants to capture facial expressions and movement. The second camera was placed behind the participants facing the television to capture responses to specific locations. If a family member or visitor joined in on a session, they were asked to sit behind the couch and were placed out of view of the first and second camera as much as possible as not to obscure recording of participants. The layout of the room is presented in Figure 3.5.

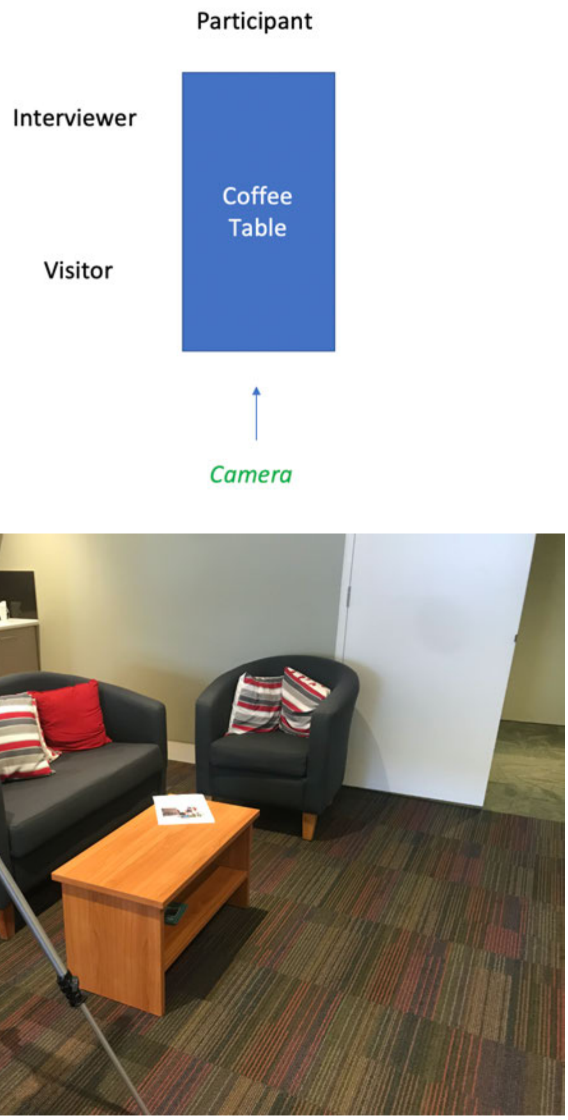


Figure 3.4: Arrangement of participant, interviewer guests and apparatus during a discourse interview session. Image of the room set up.

In response to differences in the audibility of participant speech, each participant wore a Lavalier lapel microphone attached at a distance of approximately 15 cm from the speaker's mouth, inclined at 45° in order to reduce breath artefacts. The lapel microphone was connected to either an Olympus LS-14 Audio Recorder or a Zoom H4n Pro Handy Recorder, to amplify individual audio recordings. The video cameras and audio recorders saved the recorded data to individual San Disk UI 16GB SD card.

The sound files were recorded through a stereo audio channel with a sample rate of 44.1kHz, 16 bits quantisation, and saved as an uncompressed CPM mono waveform audio file format (WAV).

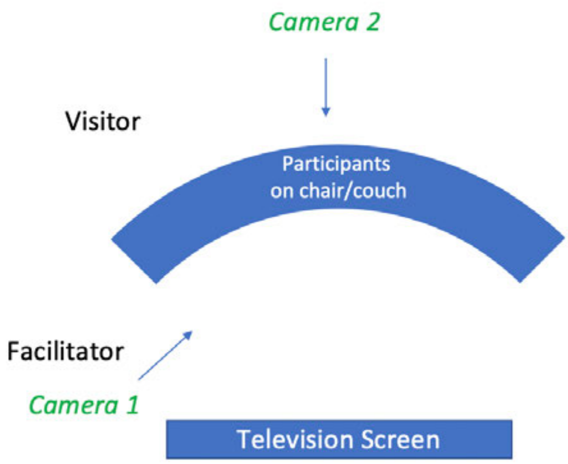


Figure 3.5: Arrangement of participants in relation to the television screen, facilitator, any visitors that joined the session and recording equipment during a TTT session. Image of the room set up.

3.5 Reminiscence therapy stimuli

Person-Specific locations of individual participants were informed by family members, carers, and the participant themselves during the initial interview. Non-Specific locations were locations that were either completely novel to all participant, or they were the Person-Specific locations of another participant. For example, when a participant was viewing a Person-Specific location, that location was deemed Non-Specific to all other participants in the group. At the end of each session, participants were asked if there were any locations that they would like to visit in the following sessions. These may have been either past or contemporary locations of importance. Locations of interest typically included previous residential homes, schools, vacation destinations, places of religious significance and places of work. Where possible locations were screened by myself before presenting them to the participants to ensure the visibility and alignment of the image was accurate. Each participant was shown at least three Person-Specific locations and three Non-Specific locations per session. At times, novel locations were loaded during a session in which case the image was screened for appropriateness as much as possible on the tablet, before mirroring the image to the television screen. The screening of locations will be discussed in section 3.7.

3.6 Procedure

After ethics approval had been obtained from Western Sydney University (HREC #13117; ethical considerations are outlined in section 3.7), a presentation was delivered at the BaptistCare Carers Meeting to inform the carers of clients about the proposed experiment. The manager of the Baptist Care Day Respite Centre assisted with the distribution of participant information forms, consent forms and pre-measure questionnaires to clients and their carers.

After the collection of signed consent forms, the first discourse interview was conducted for each participant. A carer or family member was invited to join the interview if it was appropriate, to ensure a comfortable environment for the participant. In this first session, the discourse interview schedule was conducted which was then followed by the administration of the MMSE. The completion of the first interviews and the first NPIs were conducted over two weeks before the commencement of the experiment. The Neuropsychiatric Inventory – Nursing Home Version (NPI-NH; Wood et al., 2000) was completed by either a carer, family member or the manager of the Day Respite Centre within the two weeks prior to the beginning of the first session.

With the results of the MMSE, participants were allocated to one of three sessions either beginning with the LT or the HT condition. Session times ran at approximately 10:15am, 11:15am and after lunch at 1:00pm. The 10:15am session began with the LT condition and was inclusive of four participants. The 11.15am and 1:00pm sessions began with HT condition and were inclusive of two and three participants, respectively.

At the beginning of the day I would set up the room which would involve packing away any equipment, desks and chairs left out. I would then arrange the couch, chairs, television and recording equipment for the first session. All technology was tested to ensure it had enough battery for the session and recorded properly. The seating arrangement was adjusted before each session depending on the number of attending participants. It was important to minimise the clutter in the room and keep a consistent layout between sessions for two main reasons. Firstly, it is better for the participants not to have clutter to distract them throughout the sessions. Second, the video recordings were analysed using facial processing software (which will be described later on in the analysis protocol). When using such software, a crowded and complicated environment makes it harder for software to identify the specific facial features.

After setting up the room, I would go to the main area of the day care centre and greet the clients and workers. I would speak to the manager whom would inform me of any updates in relation to participants and the different activities on during the day. The manager would inform me of who is already here, who will be coming late and who has informed of their absence for the day. With this information I would determine any adjustments to the sessions and participants. The exact time of the session varied slightly week to week depending on when participants had finished their morning tea and where able to be assisted into the session room. Participants were, however, encouraged to keep to their allocated session time each week. Due to some participants being unavailable to attend a specific session, the day’s schedule was adjusted to ensure that the session had at least two participants present to maintain a group environment.

Once organised, I would greet the individual participants and ask if they wanted to join the session. If, for any reason, they decided not to, they were excused from the session without question. I then escorted them to the experiment room. For participants that needed extra support, they were assisted by either a family member or a carestaff worker. Once all participants were in the room, I would brief the session with an introduction and overview, as they may not have remembered previously attending a session due to memory impairment. I pointed out the video recording equipment and asked permission to help attach the vocal recording equipment. Once the lapel recorders were attached, the cameras were switched on and the session began.

As the facilitator, I sat to the side of the television and in front of the participants. When a location was presented I would use prompting questions; ‘Where are we?’, ‘Does this place look familiar to anyone?’ and ‘What would we do in a location like this?’, to encourage story telling amongst the group. Questions asked were open ended to allow for a flow of conversation. At times, prompting questions were adjusted for different participants. Some participants needed more direct questions and other participants did not need any prompting in response to a location and would initiate storytelling themselves.

After several locations were presented that related to each participant, the session was ended. At the end of the sessions, participants were debriefed on the experience using questions such as, ‘How did you find that session?’ and ‘How did it feel going back to places you grew up in?’. Participants were also asked if there were any particular locations that they wanted to visit next week. Any mention of new locations during the active session or during the debriefing were recorded and utilised for a later session. The recording equipment was then turned off and the lapel recorders were retrieved from each participant. Participants were then escorted back to the main room in the day respite centre, where activities with other clients were being conducted.

The first group of sessions ran for 6 weeks. There was then a pause in the experiment for three weeks to reduce flow over effect when switching group conditions. During this break, participants completed a second session of baseline measures, inclusive of the discourse interview and NPI-NH. The second group of sessions ran for another 6 weeks in which the level of technology was switched between the groups. Therefore, the 10.15am session delivered the HT condition and the 11.15am and 1:00pm session delivered the LT condition. At the end of the second group of sessions, a final discourse interview schedule with a second MMSE, and a final NPI was completed.

At the conclusion of the experiment, I had joined the respite centre in their Christmas lunch celebrations. During this farewell, I had thanked the participants for being a part of the experiment and thanked Baptist Care for welcoming me into their centre.

3.7 Ethical Considerations

There is a multitude of ethical considerations involved when conducting research with older adults and particularly those with dementia. To ensure the best research practices were being upheld, these considerations were outlined and protocols were constructed to minimise risks and adverse events. These were then refined and approved through the Western Sydney University’s Human Research Ethics Committee before commencement of the research. This section specifies the ethical consideration and practices that were identified and outlined.

3.7.1 Consent

Within ethical practices, when conducting research with humans, participants are to be given a participant information form that outlines the research and what is to be expected of them, see appendix A. Participants are then to give consent for their participation in the research, see appendix B. A consideration when working with older adults and people with dementia is cognitive impairment and the inability to give informed consent. When participants were unable to give consent on their own behalf, the manager of the day care facility or I, discussed the research with guardians and family members. Consent was then given by the guardian or family member if they approved for the client to participate in the experiment.

Participant information sheets were required to be read before consent forms signed. Four different participant information sheets were created to inform clients, guardians, family members and carers of the research project. The sheet included an outline of what the project is about, what the participant is to expect and the requirements for participation. Participants and guardians were informed that clients were able to withdraw at any time without consequence. Four different consent forms were also created to receive consent from the clients, guardians, family members and carers if they wished to participate and join the sessions, or if they were to assist with the baseline measures.

3.7.2 Participant confidentiality

It is important to maintain anonymity when conducting research with people. The personal and demographic information collected from residents and their families were entered into a spreadsheet and a code deidentifying participants was generated.

Paper copies of any identifiable material (e.g. surveys and questionnaires) were scanned and stored on a password-protected computer. The paper originals were stored in a lock protected filing cabinet at the university. The scanned surveys were typed up without names or identifying information, and the participant codes were added. All other data e.g. digital audio, video or written material was stored in a password protected computer and a password protected external hard drive and password protected cloud storage as a backup.

Specific consent was sought from residents and/or guardian for permission to present any images or play any video clips in public, for example, at a conference.

3.7.3 Adverse risk of distress

Reminiscing about past events may cause distress for individuals if they recall memories that are upsetting, cause psychological pain or are displeasing. Before approving a client to join the experiment, I spoke to families and carestaff about the likelihood that residents would successfully and enjoyably complete the sessions, and that the activities were within their current level of functioning and personal interests. Any location that the residents nominated in advance was checked with the family members and carers in an effort to prevent unnecessary distress from choice of a location that is associated with painful memories.

There was also a risk of showing location on Google Street View that would show an adverse image, such as a Hurst in front of a church. Locations that were given in advance of the session were screened and bookmarked to ensure the loaded image was acceptable to view by participants. In the situation where participants asked for locations to be shown during the session, I would screen the image on my tablet before projecting it on the screen.

I monitored participants throughout the session to determine if they were enjoying the session and were not responding adversely. The following was decided in the instance of an adverse reaction: If there was any sign of discomfort or distress during the session then the session would be ended immediately. I would attempt to settle and reassure the participant. I would then seek assistance from carestaff to follow the protocol of the day respite centre, and the family were to be informed. It would then be my responsibility to follow up the next day with the carestaff to debrief the situation and ensure the participant was okay, with further assistance from management taken if necessary.

During one of the TTT sessions I needed to act on these procedures. Julia displayed some discomfort and entered into a verbal loop. The session was ended immediately and Julia was escorted back to the main client group with the assistance from a care worker. The coordinator of the day respite facility was available and informed. The coordinator informed that patterns of disruptive behaviour in the facility is not uncommon. It was noted that over the past few weeks, this has been a repeating behavioural occurrence independently for Julia. I was in contact with my supervisors on the day of the occurrence and followed up with them the next day. I followed up with the day respite facility and the family the following day and no further actions were required. The participant, on her own accord, returned for all subsequent sessions.

3.8 Dependent Variables

To characterise the properties of engagement in older adults and construct indexes of engagement, analysis focused on three dimensions including facial movement markers, lexical use markers and prosodic patterns of speech. This section will outline the various dependent variables of these components used for analysis.

3.8.1 Facial movement as a measure of engagement

Visual recordings of the participant during the experiment were used to analyse affective movements associated with facial expression. The Facial Action Coding System (FACS; Ekman & Friesen, 1978) is an anatomically based system that measures and taxonomises different expressive facial movements. Facial expressions are broken down into combinations of Action units (AUs) whereby a singular AU may represent the movement of an individual muscle or a group of muscles.

Facial expression AUs, as independent variables, were assessed using the OpenFace 2.0 Facial Analysis Toolkit (OpenFace; Baltrušaitis et al., 2018). OpenFace is a Python and Torch based face recognition software which uses deep neural networks. It has the capability of facial landmark detection, head pose estimation, AU recognition and eye-gaze estimation. Common facial recognition software is designed to assess a singular face detected by a camera, that is face on, has minimal head position movement, and takes up the majority of the recording screen. The benefit of using OpenFace is that it has the capability of detecting faces that are very small on the screen and uses real-time pose estimation to track an individual face across frames. Therefore, this software allowed a singular camera to record all the participants in the session face on. The approach to analysis using the OpenFace software will be further discussed in Chapter 5.

OpenFace recognises a subset of 18 AUs. The following five AUs were used during analysis.

Action Unit 04 – Brow lowerer

AU04 is the brow lowerer and contributes to the emotions of sadness, fear, anger and to confusion. The muscles involved in this action include the depressor glabellae, depressor supercilii, corrugator supercilia. See Figure 3.6.

Figure 3.6: Action Unit 04 (AU04) displaying the muscles involved in lowering the brow as activated.

Action Unit 06 – Cheek raiser

AU06 is the cheek raiser and contributes to the emotions of happiness. The muscle involved in this action is the orbicularis oculi (pars orbitalis). See Figure 3.7.

Figure 3.7: Action Unit 06 (AU06) displaying the muscles involved in raising the cheeks as activated.

Action Unit 12 – Lip corner puller

AU12 is the lip corner puller and contributes to the emotions of happiness and contempt. The muscle involved in this action is the zygomaticus major. See Figure 3.8.

Figure 3.8: Action Unit 12 (AU12) displaying the muscles involved in raising the corners of the lips as activated.

Action Unit 15 – Lip corner depressor

AU15 is the lip corner depressor contributes to the emotions of sadness, disgust and to confusion. The muscle involved in this action is the depressor anguli oris (also known as triangularis). See Figure 3.9.

Figure 3.9: Action Unit 15 (AU15) displaying the muscles involved in lowering the corners of the lips as activated.

Action Unit 17 – chain raiser

AU17 is the chin raiser and contributes to the affective attitudes of interest and confusion. The muscle involved in this action is the mentalis. See Figure 3.10.

Figure 3.10: Action Unit 17 (AU17) displaying the muscles involved in raising the chin as activated.

These five AUs were chosen for analysis as they are generally associated with specific emotions that are of similar direction in hedonic tone, being either pleasant (e.g. happy) or unpleasant (e.g. sad) emotions (Goldstein, 2002).

The two properties that describe the AUs include presence and intensity. Presence of an AU is characterised as either 0 (absent) or 1 (present). The intensity of the AU was attributed to a continuous five-point scale from 1 (minimal intensity) to 5 (maximal intensity). Each of the five AUs were analysed considering the percentage of time the AU was activated (presence) during a session and the intensity of the AU when activated.

3.8.2 Lexical use markers

Various lexical markers were used, as independent variables, to index a participant's sense of self and other awareness (Davis & Brock, 1975; Small et al., 1998) and valence of affective speech within a session. As a marker of focus on self in the interaction, the first person singular and plural pronouns 'I' and 'we' were investigated. As a marker of focus on others within the interaction, the second- and third-person pronouns 'you', 'he/she', and 'they' were investigated. The pronouns were pooled together to measure expression of identities and focus on self and others in interaction. Emotional valence, as the valence of affective speech included positive emotion words and negative emotion words. The emotional tone of speech was measured as an emotional valence of speech, as indicated on a scale of 0 – most negative, to 100- most positive.

The Linguistic Inquiry and Word Count (LIWC; Pennebaker & Francis, 1999) was used to investigate the percentage of total speech that were occupied with these parameters . LIWC computationally analyses dialogue into five broad word domains (linguistic dimensions, psychological processes, relativity, personal concerns, spoken categories), which further divides into 68 subcategories. The approach to analysis using the LIWC will be further discussed in Chapter 6.

3.8.3 Prosodic patterns of speech

Prosodic linguistic features analysed for engagement included mean duration of utterance (seconds), words per utterance, articulation rate (words/minute), and pitch as measured through the fundamental frequency (F0). The articulation rate was calculated (number of words per utterance/duration of utterance), to characterise the fluidity of speech as a behavioural marker of engagement. Articulation rate is also a measure of energy expenditure when speaking. F0 variability was investigated as an acoustic parameter that can contribute to the understanding of the affect-driven behavioural engagement of a participant. The F0 standard deviation was used to characterise the variance of pitch across conditions.

3.9 Common Data Preparation Procedure

This section will describe the procedure involved to transform the audio-visual recordings into a workable format for analysis. Chapter 5 – 8 will expand on this procedure and outline the individual method used specifically for the analysis of the particular dependent variables within that chapter.

The audio-visual recordings saved onto the SD card were imported onto a MacBook Pro using iMovie in the format of an Apple QuickTime Movie file (.mov). Once imported, the files were converted using Adobe Premier to 48 kHz, 16-bit Waveform audio file (.wav) and to a 1920 x 1080 MPEG-2 movie file (.mpg). The .wav audio recordings were sent to an external transcription company for transcribing. The returned transcription files were a Microsoft Word document and were used for linguistic analysis.

To prepare for audio-visual analysis, the individual .mpg files had to be transformed to represent a Person-Specific locations .mpg file and a Non-Specific locations .mpg file. Using Adobe Premiere, a .mpg file for a singular session was split using the 'cut' function into individual movie clip segments that represented the different locations being presented to the participants. The movie files acquired by camera 2, which was facing the television screen during the sessions, was used as a reference point to ensure the movie file that was capturing the participant faces was being split accurately. Each individual movie clip segment was labelled according to the location it represented and was colour coded to the individual participants. Some of the locations were Person-Specific to more than one participant, and this was considered within the colour coding system.

To create a Person-Specific locations .mpg file for a particular participant in a session, all clips that were Non-Specific were deleted and the remaining Person-Specific locations clips were aligned to create a continuous movie file. The movie file was then exported as a .mpg file with an appropriate name. To create a Non-Specific locations .mpg file for a particular participant in a session, all clips that were Person-Specific were deleted. The remaining Non-Specific locations clips were aligned to create a continuous movie file. The movie file was then exported as a .mpg file with an appropriate name. It should be noted that these .mpg files will be used for facial movement analysis in Chapter 5.

There were occurrences were a specific location had unexpected relevance to another participant. If this location was not a primary Person-Specific location to a participant, yet the participant was familiar with the location, it was not included in the Non-Specific locations video file. For example, Charlie grew up in England and enjoyed visiting Blackpool Towers when they were younger. This was one of the primary locations shown for Charlie and facilitator questions were directed mostly to Charlie when this location was presented on the screen. It became apparent that Jana had visited Blackpool Towers when they were younger, however it was not a primary Person-Specific location. Therefore, Blackpool Towers was not included in either of the Person-Specific or Non-Specific .mpg movie files for Jana.

Additionally, locations that may have been Person-Specific for a participant vicariously through their relationship with another participant was also excluded from analysis. For example, Angela and Charlie are married and some of the Person-Specific locations for Charlie were excluded from the locations included in Angela's Non-Specific locations video file, despite Angela never having visited the location themselves.

These Adobe Premiere files were then used alongside the raw transcripts to identify the correct dialogue spoken in the transcript for analysis. The beginning and end of each segment clip was listened to and marked in the raw transcript. The identified segments were highlighted and all other text that was not highlighted was deleted. The file was saved with an appropriate name relating to either baseline, Person-Specific or Non-Specific locations. Please take note that this transcript files will also be used in Chapters 6 and 7, for lexical use and prosodic patterns language analysis.

Chapter 4: Baseline Measures

4.1 Introduction

Older adults vary in their cognitive, psychological and behavioural capacity, and presentation (Aline Nunes Da Cruz et al., 2007; Harada et al, 2013; Noftle & Fleeson, 2010). Therefore, there is great diversity within residential care, with many older adults presenting with varying levels of cognitive and behavioural profiles. For this reason, participants acted as their own baseline for analysis within the current research.

The two questions relating to the baseline measures and discourse interview, which will be addressed in this chapter are:

1. Are the behavioural and psychological symptoms of dementia maintained or improved across the Time Travelling with Technology (TTT) experiment?
2. Are the narrative, procedural and abstract discourse characteristics of older adults maintained or improved across the TTT experiment?

In attempting to address these questions, the cognitive, psychological, behavioural and discourse profiles of participants were measured pre-experiment, mid-experiment and post-experiment. By measuring the profiles of the participants, a greater understanding of the person attribute within the Comprehensive Process Model of Group Engagement (Cohen-Mansfield et al., 2017) was gained in this study. It was important to capture any changes over the course of the experiment as this would act as a confounding variable and may be seen to impact engagement outcomes.

Chapter 3 introduced the three main components of the baseline data. First, the Mini-Mental State Examination (MMSE; Folstein et al., 1975) as a schedule to determine the cognitive capacity of participants. Second, the Neuropsychiatric Inventory – Nursing Home Version (NPI-NH; Wood et al., 2000) as a schedule to determine the behavioural and psychological symptoms of dementia (BPSD). Third, the Discourse Interview (Chapman et al., 2004), which focuses on understanding the discourse ability of each participant in relation to narrative, procedural and abstract discourse.

Within Wood et al., (2000) systematic review on reminiscence therapy (RT), the MMSE was the most common tool to assess the effect of RT on cognition of people with dementia. For the six studies of group reminiscence, with 281 participants, there was a probable improvement in favour of RT compared to a control group. Further there was little to no difference at long-term follow up. In the current research, the MMSE is used to characterise cognition of the participants for the assignment to the experimental conditions and will be used as a covariate in analysis, see section 4.2.

Francis et al. (2019) evaluated individual RT and Li et al., (2020) investigated the effect of group RT on the behavioural and psychological symptoms of people with dementia (BPSD). They found significant improvements in neuropsychiatric symptoms as measured by the Neuropsychiatric Inventory (NPI; Cumming et al., 1994). Further, RT has been shown to improve short-term symptoms of depression (Song et al., 2014). The first hypothesis of this chapter is: If group RT improves the neuropsychiatric symptoms of people with dementia, then there will be a significant reduction in neuropsychiatric symptoms of participants post-experiment compared to pre-experiment. This improvement is expected to be particularly relevant for the measure of the sub-domain depression within the NPI-NH.

As mentioned in Chapter 2, there is inconsistency in the effect of RT on discourse production (Rose et al., 2020). There was however, an interaction between cognitive capacity and effect of RT on discourse. When undertaking RT, participants with mild cognitive disorder showed improvements in discourse. Whereas, participants with more advanced stages of Alzheimer's disease showed a reduction on discourse measures. The second hypothesis of this chapter is: If RT is beneficial for people with early stages of cognitive decline, then participants who have MMSE scores of 20 or above will have significant improvements in discourse measures post-experiment compared to pre-experiment. This effect will not be seen with participants with greater cognitive decline, classified with an MMSE score of 20 and below.

This chapter provides results and analysis of the MMSE, NPI-NH and Baseline Interview. The chapter will give an in depth understanding of the participants and their individual differences in cognitive, psychological, behavioural and language presentation across the experiment.

4.2 Mini-Mental State Examination

The Mini-Mental State Examination (MMSE) measures cognitive capacity through verbal responses and written responses. Verbal responses focus on orientation, memory recall, and attention. Written responses focus on arithmetic and language functions (Folstein et al., 1975). The MMSE was administered to participants twice. Once, before the commencement of the experiment (pre-experiment), and another time at the completion of the experiment (post-experiment). This was to determine if there were cognitive changes over the course of the experiment, that may influence the engagement profiles of the participants. As mentioned in Chapter 3, the initial MMSE scores were used to organise participants into two groups and match participant profiles across the Low->High Tech group (L->H) and High->Low Tech (H->L) group.

As outlined in section 2.5, RT has been shown to improve cognition of people with dementia at the end of an intervention compared to the beginning. These improvements have not been seen at long term follow up (Wood et al., 2000). Therefore, it was to be expected that post-experiment MMSE scores would be maintained or higher in comparison to the pre-experiment MMSE scores. Table 4.1 shows the descriptive statistics for participant scores on MMSE pre-experiment and post-experiment, as well as their group allocation. As can be seen in Table 4.1 variation in participant scores both increased and decreased. Figure 4.1 shows the distribution and visualisation of participant MMSE scores when measured pre-experiment and post-experiment. For MMSE statistical output, see Appendix E.

4.3 Wilcoxon Signed-Rank test and results for MMSE

It was decided to use the non-parametric Wilcoxon Signed-Rank test (WSRT; Wilcoxon, 1945) to compare the pre-experiment and post-experiment MMSE scores for two reasons. First, the WSRT compares two paired samples. Second, due to the small number of data points for each participant, normality in the data cannot be assumed. WSRT analysis was carried out using the wilcox.test function within R software (RStudio version 1.2.5042; RStudio Team, 2020).

Using the WSRT, there were no significant difference found between pre-experiment MMSE scores and post-experiment MMSE scores (p = 0.7194). For this reason, when analysing the measures of engagement, the average MMSE score for each participant was used as a covariate. Figure 4.1 shows the interquartile ranges and paired MMSE responses of participants pre-experiment and post-experiment.

Table 4.1: Descriptive statistics for participant MMSE scores. Group allocations, pre- and post-experiment MMSE scores, the change in MMSE score across the experiment and the mean MMSE score for each participant is shown.

Participant	Group	Pre-MMSE	Post-MMSE	Change	MMSE-Mean
Angela	L->H	29	30	+1	29.5
Colette	L->H	26	23	-3	24.5
Barbara	H->L	13	9	-4	11
Charlie	L->H	17	18	+1	17.5
Colette	H->L	9	5	-4	7
Diana	H->L	15	12	-3	13.5
Jana	L->H	14	15	+1	14.5
Julia	H->L	17	21	+4	19
Nora	H->L	12	15	+3	13.5

The MMSE was conducted to assign and ensure a comparable distribution of cognitive capacity across experimental groups. Four participants showed a decline and five participants showed an incline in cognition. Within the systematic review of Wood et al. (2000) an improvement in MMSE scores post group RT was deemed probable with variations in previous research outcomes. These results do not support the findings within the systematic review, that there would be an improvement in cognition immediately post intervention. In addressing the first research question of this chapter, the cognitive symptoms of dementia were maintained across the TTT experiment.

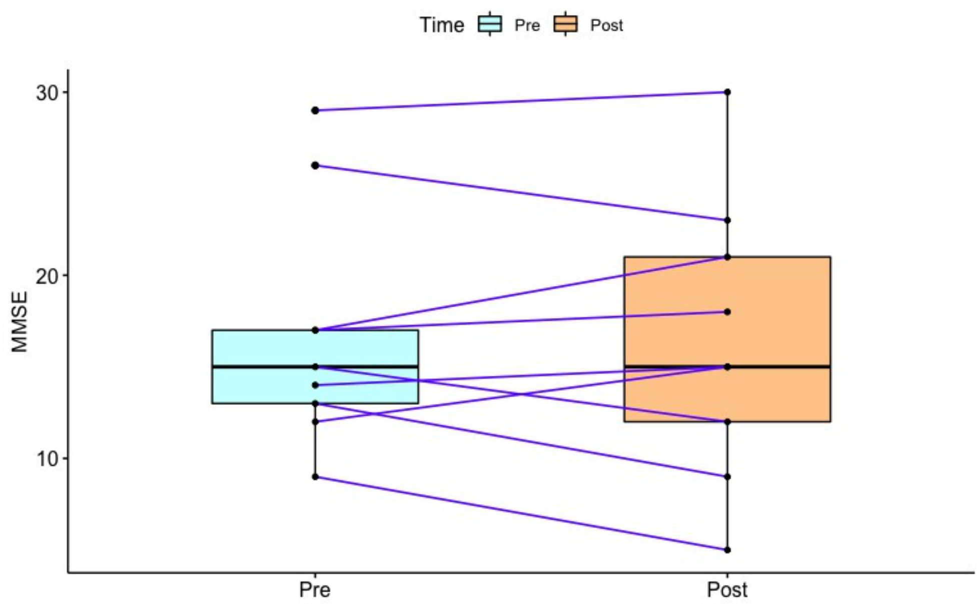


Figure 4.1: Paired-data plot of participant pre-experiment and post-experiment MMSE scores.

There may be several reasons for the unexpected variation across participants when comparing pre- and post-experiment MMSE scores. The MMSE was only conducted once before the beginning of the experiment and once at the end. It should be noted that fluctuating cognition, even on a day to day basis, is common amongst the major dementias. It has been shown that fluctuating cognition occurs in 20% of people with Alzheimer's Disease, 35-50% of people with Vascular dementia, and up to 90% of people with Dementia with Lewy Bodies (Walker et al., 2000). By only conducting the MMSE once at the beginning and once at the end of the experiment, there is a limitation in knowing whether a participant was having a 'good' cognitive day or a 'bad' cognitive day. For reliability purposes, it may have been better to have been able to repeat the MMSE at least three times before the experiment began and at commencement of the experiment. As the MMSE measures cognitive capacity, it may be confronting and uncomfortable when an older adult completes the examination. This is particularly seen when there is a reduced performance and the older adult is aware that their responses are incorrect. When weighing potential reliability issues with participant distress it was decided that the MMSE was to be administered once at the beginning and once at the end of the experiment. It is quite an intrusive measure and would raise ethical concern if it was to be repeated several times in close proximity.

Variation across participants when comparing pre- and post-experiment MMSE scores may also be due to environmental factors. The MMSE was not conducted in the same room for all participants both pre- and post-experiment. Some participants completed the pre-experiment MMSE separate to the discourse interview, in a small room, before being allocated the room in which the interviews and experiment would be delivered in. The size of the room can have an impact on the comfortability of the older adult. Whereby, discussing sensitive topics, such as topics of self-disclosure, are positively correlated with architectural space (Okken, 2012). Therefore, older adults may have felt less comfortable completing the MMSE in the smaller room, compared to the larger room, which may have affected their performance. Once decided, the remaining pre-experiment MMSE schedules and all post-experiment MMSE schedules were administered in the larger room during the same session as the discourse interview. Additionally, I had conducted the MMSE at both time points. Participants may have felt more socially anxious or under pressure at the pre-experiment time point when they did not know who I was. Over the course of the experiment and whilst facilitating the TTT sessions, participants became more familiar with myself. This familiarity may have impacted the performance on the MMSE when administered post-experiment.

4.4 Neuropsychiatric Inventory – Nursing Home Version

In addressing the first research question of this chapter, the Neuropsychiatric Inventory – Nursing Home Version (NPI-NH; Wood et al., 2000) was used to measure the BPSD. The NPI-NH is a version of the Neuropsychiatric Inventory (Cummings et al., 1994) that is adapted for the use in aged care facilities. The NPI-NH was administered at three-time point. During a two-week period before the beginning of the TTT experiment (pre-experiment), during the three-week break in the middle of the experiment (mid-experiment), and at the commencement of the experiment (post-experiment). The NPI-NH was administered by the same person at each time point. This was either by the manager of the aged care facility, a family member or a carer of the older adult.

As mentioned in Chapter 3, the NPI-NH measures twelve behavioural domains. These include ten behavioural areas (delusions, hallucinations, agitation/aggression, depression/dysphoria, anxiety, elation/euphoria, apathy/indifference, disinhibition, irritability/liability, aberrant motor behaviour) and two forms of neurovegetative changes (sleep and night-time behaviour disorders, appetite and eating disorders). These are scored in relation to three factors including frequency (rarely, sometimes, often, very often), severity (mild, moderate, severe) and an occupational disruptiveness score (0-5, from not at all to very severely or extremely). It must be noted that the occupational disruptiveness score is known as the carer distress scale on the original NPI and has been adapted to assess the impact of behavioural disturbances of professional caregivers. This occupational disruptiveness score is from the perception of the person who is completing the NPI-NH and how they perceive the BPSD of the participant impacts themselves as the carer.

In scoring the NPI-NH, each behavioural area has four scores including the *frequency*, *severity*, *Domain Total Score* (frequency x severity), and *caregiver distress*. The total NPI-NH score is calculated by summing the Domain Total Scores of the ten behavioural areas. The two neurovegetative changes domains (sleep and appetite disorders) are not included in the total NPI-NH score. The occupational disruptiveness scores are also not included in the total NPI-NH score and are calculated separately as a total occupational disruptiveness score by summing the occupational disruptiveness scores across the 10 domains. In special circumstances, where sleep and appetite disorders are of particular importance, they are able to be added into the total NPI-NH score and the total occupational disruptiveness score. However, traditionally they are not included in the calculations.

It was hypothesised that if RT improves short-term BPSD, then the total NPI-NH scores and would be reduced post-experiment compared to pre-experiment, with particular relevance to the depression sub-domain total score measures. Table 4.2 shows the total NPI-NH score for participants at the different time points of pre-experiment, mid-experiment and post-experiment. As can be seen in Table 4.2 there were two time points in which the NPI was not administered to a participant. NPI-NH forms were given to the carer of Nora before the commencement of the experiment and to the carer of Amy during the mid-experiment break. Unfortunately, these were never returned and the neuropsychiatric profile of the participants at those time points were not recorded.

Table 4.2: Descriptive statistics for participant total NPI-NH scores at time point pre-experiment, mid-experiment and post-experiment. Group allocation and change in total NPI-NH total from pre-experiment to post-experiment is shown.

Participant	Group	Pre-NPI-NH	Mid-NPI-NH	Post-NPI-NH	Change
Angela	L->H	1	0	2	1
Colette	L->H	8		7	-1
Barbara	H->L	10	35	56	46
Charlie	L->H	0	6	0	0
Colette	H->L	17	15	29	12
Diana	H->L	25	50	10	-15
Jana	L->H	8	18	59	51
Julia	H->L	19	20	20	1
Nora	H->L		38	11	-27

Table 4.2 also shows great variance in the total NPI-NH score across time points. The variance in NPI-NH across the time points may be caused by multiple factors. First, the indication of behaviour domains was completed by carer observations. How the carer scored each domain may be dependent on how they were feeling on the day. For example, if a carer was having a particularly difficult morning dealing with certain negative behaviours, or if the older adult was showing particularly bad

behaviours that day, then the scoring of the domains may be biased to a higher scoring. This would impact the validity of the scores as the behaviours are meant to be a general presentation of the domains over the last two weeks. It is unknown if this effect was occurring, however it is necessary to take this into consideration.

The same carer/person completed the NPI-NH across the time-points for an older adult which assists with increasing the reliability of the results. However, it should be noted the bias that may come from the relationships between the reporter and the older adult. For example, if a loved one, for example a wife or husband, where to complete the NPI-NH, they may have bias in their responses. It was observed that for Charlie's NPI-NH scores, their spouse indicated 0 for the aberrant behaviour domain across all time points. However, with greater time spent with Charlie during sessions and in the discourse interviews, it was noticed that there was a great expression of aberrant behaviours. For example, Charlie would make what would be classified as socially inappropriate noises. The relationship between the spouse and Charlie may impact the validity of the reporting.

4.5 MIXED METHODS ANALYSIS OF NPI-NH

For the total NPI-NH score and the occupational disruptiveness, a linear mixed model was used to analyse the data using R software (RStudio version 1.2.5042; RStudio Team, 2020). A linear mixed model takes into consideration fixed effects and random effects. Fixed effects are the independent variables of the study which are controlled by the experimenter. Within the analyses of the NPI-NH, the fixed effects were the experiment time points (Pre, Mid, Post) and group allocation (L->H, H->L, i.e. counterbalancing) categories. Random effects are those which are unable to be controlled. They vary across the sample naturally and are unrelated to the independent variables. Because the baseline measures were administered at multiple times across the course of the experiment, the individual participants were included as a random effect.

The linear mixed model included the following effects:

> Fixed effects: Time (Pre, Mid, Post), Group (L->H, H->L), MMSE (0-30).
> Random effects: ID (Participants)

The equation used for the linear mixed model was:

```
res2 = lmer(FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)
```

Within this model 'res 2' is the name of the linear mixed model, 'lmer' is identifying the linear mixed model package R software package "lme4" (Bates et al., 2015), 'FxS' is the value of the total NPI-NH score, 'Group', 'Time', and 'MMSE_Mean' represent the fixed effects of the time points, groups and MMSE, '(1|ID)' indicates the participant ID as a random effect and 'data=BC_data' identifies the data set. When analysing the occupational disruptiveness, and the individual sub-scores, the only difference in the model was changing the 'FxS' factor to 'OD' or the individual sub-score code.

To compare the individual conditions within the model, the 'emmeans' r package was used (Lenth et al., 2020). This is the estimated marginal means package, otherwise known as least-square means. Estimated marginal means are more appropriate to use in a linear model as they account for factors within a model and adjust the means accordingly. Using the 'contrast' function, pairwise comparisons between the groups provided a detailed output including, but not limited to, the coefficient, 95% confidence limits, the *t* ratio, and *p* value for the two factors being compared.

For further information on linear mixed model effects, please refer to Thomas and Monin (2016) and Winter (2013). For further information on the 'emmeans' r package please refer to Lenth et al., (2020). For all NPI-NH statistical output, see Appendix F.

4.6 NPI-NH Results

4.6.1 Total NPI-NH scores (frequency x severity)

As mentioned earlier, the total NPI-NH score is the summation of the ten behavioural domain total scores. There was no significant difference in the total NPI-NH (frequency x severity) when comparing time points Pre vs Mid (p = 0.3149), Pre vs Post (p = 0.8600) and Mid vs Post (p = 0.3823).

There were also no significant differences found in the comparison of groups L->H and H->L (p = 0.6224). MMSE scores did not significantly impact the total NPI-NH scores (p = 0.0521).

4.6.2 NPI-NH domain total scores (frequency x severity)

Table 4.3 shows the mean and standard deviation descriptive statistics for the domain total score (frequency x severity of the domain) for the NPI domains at each time point. As can be seen in Table 4.3 the domain total scores do not consistently either increase or decrease across the time points. This highlights the fluctuation in neuropsychiatric profiles over time.

Table 4.3: Mean and standard deviation [mean(sd)] for the domain total scores of each NPI domain at the pre-experiment (Pre), mid-experiment (Mid), and post-experiment (Post) time points.

	Time Point		
NPI-NH Domain	Pre	Mid	Post
Delusion	0.38 (0.74)	1.13 (2.23)	1.29 (2.89)
Hallucination	0.25 (0.71)	1.88 (2.85)	2.29 (3.35)
Agitation	0.63 (1.41)	1.25 (1.04)	1.00 (1.73)
Depression	0.38 (0.52)	1.88 (2.64)	1.43 (2.3)
Anxiety	1.88 (2.23)	0.88 (1.46)	2.43 (1.81)
Elation	0.75 (2.12)	0.38 (1.06)	0.00 (0.00)
Apathy	1.75 (2.92)	4.75 (4.13)	3.00 (3.21)
Disinhibition	0.63 (1.41)	2.13 (4.09)	1.14 (1.57)
Irritability	2.13 (2.53)	3.00 (3.21)	1.43 (2.23)
AMB	2.25 (3.28)	5.38 (5.42)	4.57 (4.72)
Sleep	0.75 (1.49)	5.25 (5.01)	2.57 (3.41)
Appetite	2.29 (3.90)	5.57 (4.61)	3.43 (4.86)

Table 4.4 shows *p* values for the 12 individual NPI-NH domain total score (frequency x severity) comparisons across time points (Pre, Mid and Post) and group allocations (L->H, H->T), using mixed method analysis.

Table 4.4: Statistical p-values for the total NPI-NH domain scores. Comparisons are between individual time points (Pre, Mid, Post) and group allocations (L->H, H->L). Statistically significant values are in bold and indicated with an asterisk (*). AMB = aberrant motor behaviour.

	Time Point Comparisons			Group Comparison
NPI-NH Domain	Pre vs Mid	Pre vs Post	Mid vs Post	L->H vs H->L
Delusion	0.2590	0.2248	0.8754	0.4039
Hallucination	0.1458	0.0862	0.6997	0.4413
Agitation	0.4711	0.7041	0.7483	0.7723
Depression	0.1956	0.3917	0.6761	0.9719
Anxiety	0.2445	0.6755	0.1297	0.3771
Elation	0.5797	0.3182	0.6273	0.8589
Apathy	0.0884	0.5782	0.2490	0.0856
Disinhibition	0.1510	0.7096	0.2844	0.3314
Irritability	0.6478	0.4572	0.2047	0.5294
AMB	0.1430	0.2636	0.7477	0.3653
Sleep	**0.0099***	0.2748	0.0930	0.6195
Appetite	0.0668	0.8719	**0.0494***	0.4542

As can be seen in Table 4.4, there were no significant differences across time points and group allocations for the 10 main behavioural domains.

Participants had scored significantly less (t = -3.03, p = 0.0099) in the domain of *sleep* at the pre-experiment time point (M = 0.75, SD = 1.49) in comparison to the mid-experiment time point (M = 5.25, SD = 5.01). There was an estimated mean difference of -3.98, 95% CI (-3.03, -1.14). See Figure 4.2.

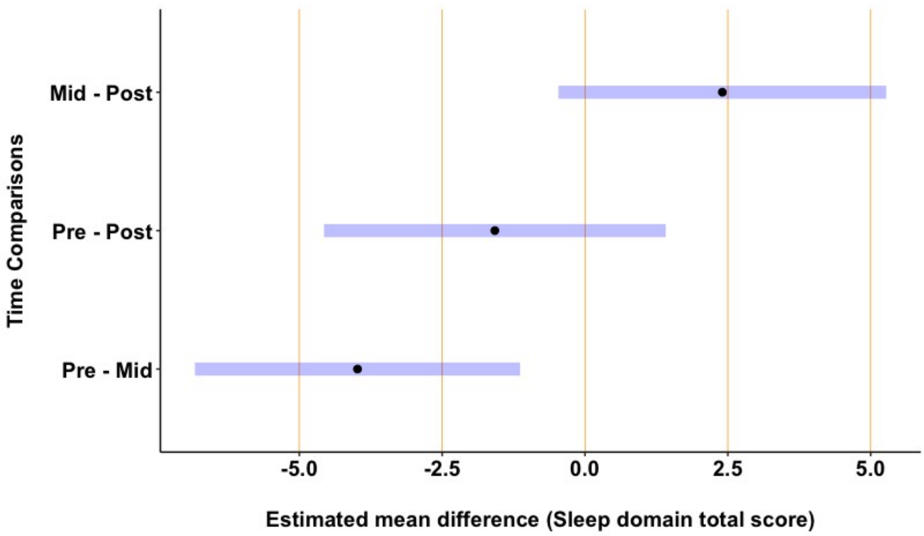


Figure 4.2: Estimated marginal means for the domain total scores of the domain sleep across time points pre-experiment (Pre), mid-experiment (Mid) and post-experiment (Post).

Figure 4.2 represented the estimated marginal means for the domain total scores of the domain sleep across time points pre-experiment (Pre), mid-experiment (Mid) and post-experiment (Post). This style of graph is predominantly used within the current research results as it represents the comparison between individually specified time-points or conditions. The two variables that are being compared are represented on the y-axis. Figure 4.2 shows that three comparison have been conducted with each line representing a different comparison. The above graph shows the comparison between mid-experiment to post-experiment, pre-experiment to post-experiment and then pre-experiment to mid-experiment. The black dot on the x-axis that correspond with the two comparison conditions represents the value in which the mean of the first variable relates to the mean of the second variable. As seen on the bottom line of the figure, there is an estimated mean difference of -4.5 for the domain total score of the domain sleep at time point pre-experiment compared to mid-experiment. The purple bars on either side of the black dot show the confidence interval and therefore the range of the estimated marginal means. Whereby, there is a 95% confidence that the true mean difference between the two variables lies within the purple bar boundaries. As seen in the above figure, it can be seen that there is a 95% confidence that the true mean difference in the domain total score for the domain sleep at time point pre-experiment compared to post-experiment is between (-3.03, -1.14).

Participants had scored significantly higher (t = 2.226, p = 0.0494) in the domain of *appetite* at the mid-experiment time point (M = 5.57, SD = 4.61) in comparison to the post-experiment time point (M = 3.43, SD = 4.86). There was an estimated mean difference of 2.54, 95% CI (0.01, 5.07). See Figure 4.3.

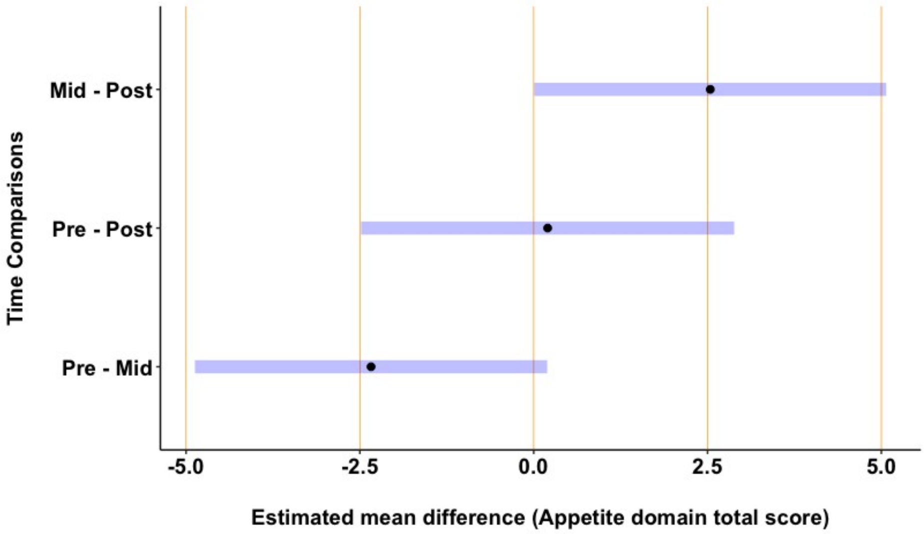


Figure 4.3: Estimated marginal means for the domain total scores of the domain appetite across time points pre-experiment (Pre), mid-experiment (Mid) and post-experiment (Post).

4.6.3 Total occupational disruptiveness scores

Participants with a lower MMSE score were found to have significantly higher occupational disruptiveness scores compared to participants with a higher MMSE score (t = -2.882, p = 0.0254). As can be seen in Figure 4.4, participant with high MMSE scores, indicated by lighter blue lines, scored less on OD across time points, compared to participants with lower MMSE scores, who scored higher on the OD scale, indicated by darker blue lines.

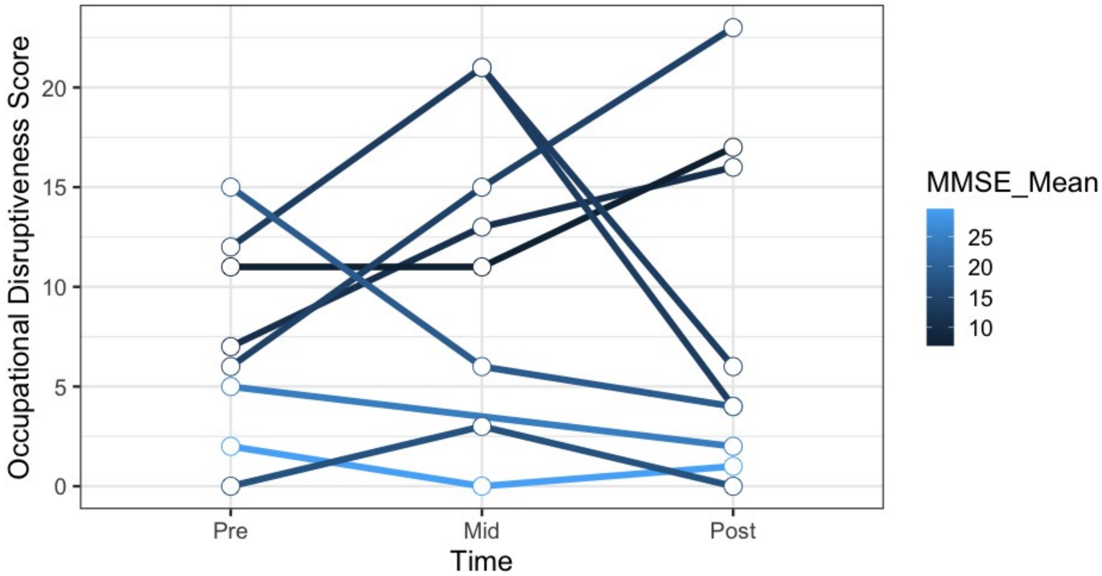


Figure 4.4: Occupational disruptiveness scores of participants at time points pre-experiment (Pre), mid-experiment (Mid), and post-experiment (Post). Participants with a high cognitive capacity and MMSE score have a light blue line. As MMSE score decline representing the increase in cognitive impairment, the colour gradient changes to a dark blue.

This is consistent with Migliaccio et al. (2020), that greater cognitive impairment, which is correlated with reduced cognitive and behavioural inhibition deficits, causes greater occupational disruptiveness to carers.

There was no significant difference in occupational disruptiveness when comparing time points Pre and Mid (p = 0.5643), Pre and Post (p = 0.9824) and Mid and Post (p = 0.6483). There were also no significant differences found in the comparison of groups L->H and H->L (p = 0.6224). As a covariate, MMSE scores did not significantly impact the total NPI-NH scores (p = 0.0521).

4.6.4 Domain Occupational disruptiveness sub-scores

Table 4.5 shows the mean and standard deviation descriptive statistics for occupational disruptiveness score for the NPI domains at each time point. As can be seen in Table 4.5 the occupational disruptiveness of the domains does not increase or decrease consistently across the time points. This indicates the variance in neuropsychiatric profiles across the experiment.

Table 4.6 shows p values for the 12 individual NPI-NH occupational disruptiveness score (frequency x severity) comparisons across time points (Pre, Mid and Post) and group allocations (L->H, H->T), using mixed method analysis. As can be seen in Table 4.6, there were no significant differences across time points and group allocations for nine of the main behavioural domains.

Participants had scored significantly less (t = -2.216, p = 0.0442) in the domain of *apathy* at the pre-experiment time point (M = 0.88, SD = 1.36) in comparison to the mid-experiment time point (M = 2.13, SD = 1.46). There was an estimated mean difference of -1.17, 95% CI (-2.30, -0.04). Participants had scored significantly greater (t = 2.465, p = 0.0284) in the domain of *apathy* at the mid-experiment time point (M = 2.13, SD = 1.46) in comparison to the post-experiment time point (M = 0.86, SD = 0.9). There was an estimated mean difference of 1.333, 95% CI (0.165, 2.5018). See Figure 4.5.

Table 4.5: Mean and standard deviation [mean(sd)] for the occupational disruptiveness score of each NPI domain at the pre-experiment (Pre), mid-experiment (Mid), and post-experiment (Post) time points.

	Time Point		
NPI-NH Domain	Pre	Mid	Post
Delusion	0.38 (0.74)	0.63 (1.19)	0.43 (0.79)
Hallucination	0.13 (0.35)	0.88 (1.13)	1.00 (1.53)
Agitation	0.50 (1.07)	1.38 (1.51)	0.43 (0.79)
Depression	0.50 (0.76)	1.13 (0.99)	0.86 (1.21)
Anxiety	1.13 (1.13)	0.50 (0.76)	1.14 (0.90)
Elation	0.25 (0.71)	0.13 (0.35)	0.00 (0.00)
Apathy	0.88 (1.36)	2.13 (1.46)	0.86 (0.90)
Disinhibition	0.38 (0.74)	1.13 (1.46)	0.43 (0.53)
Irritability	1.38 (1.41)	1.38 (1.41)	0.71 (1.11)
AMB	1.00 (1.60)	2.00 (2.14)	1.00 (1.00)
Sleep	0.63 (1.41)	2.13 (2.03)	0.71 (0.95)
Appetite	0.71 (1.25)	1.86 (1.95)	1.00 (1.29)

Table 4.6: Statistical p-values for the NPI-NH occupational disruptiveness scores. Comparisons are between individual time points (Pre, Mid, Post) and group allocations (L->H, H->L). Statistically significant values are in bold and indicated with an asterisk (*). AMB = aberrant motor behaviour.

	Time Point Comparisons			Group Comparison
NPI-NH Domain	Pre vs Mid	Pre vs Post	Mid vs Post	L->H vs H->L
Delusion	0.3638	0.7635	0.5502	0.7633
Hallucination	0.1155	0.0878	0.8128	0.9983
Agitation	0.1632	0.6927	0.0872	0.2969
Depression	0.1600	0.5157	0.4516	0.7518
Anxiety	0.1081	0.7840	0.1807	0.3300
Elation	0.5797	0.3182	0.6273	0.8589
Apathy	**0.0442***	0.7639	**0.0284***	0.0687
Disinhibition	0.1156	0.9331	0.1401	0.5103
Irritability	0.7038	0.2024	0.3304	0.3770
AMB	0.2124	0.9435	0.2411	0.7028
Sleep	**0.0233***	0.8468	**0.0363***	0.2782
Appetite	**0.0061***	0.2553	0.0546	0.6837

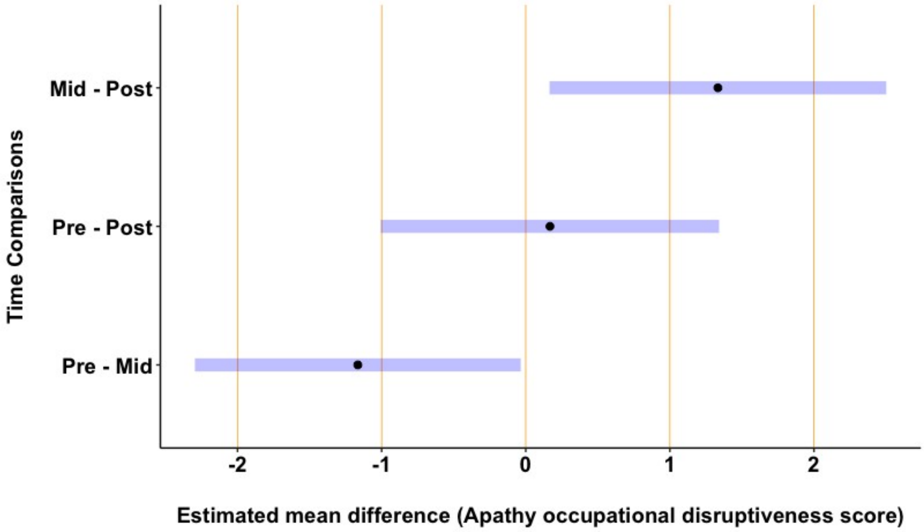


Figure 4.5: Estimated marginal means for the occupational disruptiveness scores of the domain apathy across time points pre-experiment (Pre), mid-experiment (Mid) and post-experiment (Post).

Participants had scored significantly less (*t* = -2.573, *p* = 0.0233) in the domain of *sleep* at the pre-experiment time point (M = 0.63, SD = 1.41) in comparison to the mid-experiment time point (M = 2.13, SD = 2.03). There was an estimated mean difference of -1.503, 95% CI (-2.767, -0.240). Participants had scored significantly greater (*t* = 2.349, *p* = 0.0363) in the domain of *sleep* at the mid-experiment time point (M = 2.13, SD = 2.03) in comparison to the post-experiment time point (M = 0.71, SD = 0.95). There was an estimated mean difference of 1.382, 95% CI (0.103, 2.660). See Figure 4.6.

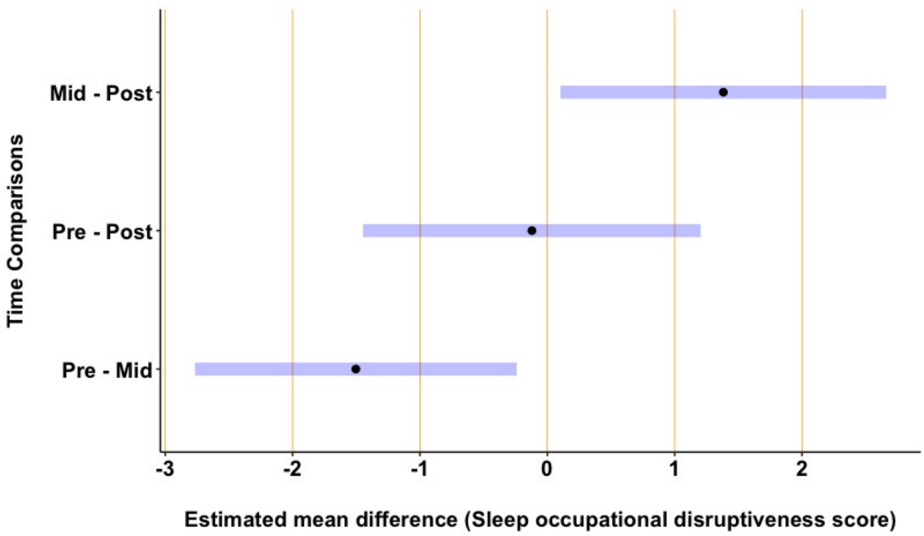


Figure 4.6: Estimated marginal means for the occupational disruptiveness scores of the domain sleep across time points pre-experiment (Pre), mid-experiment (Mid) and post-experiment (Post).

Participants had scored significantly less (*t* = -3.452, *p* = 0.0061) in the domain of *appetite* at the pre-experiment time point (M = 0.71, SD = 1.25) in comparison to the mid-experiment time point (M =

1.86, SD = 1.95). There was an estimated mean difference of -0.957, 95% CI (-1.573, -0.340). See Figure 4.7.

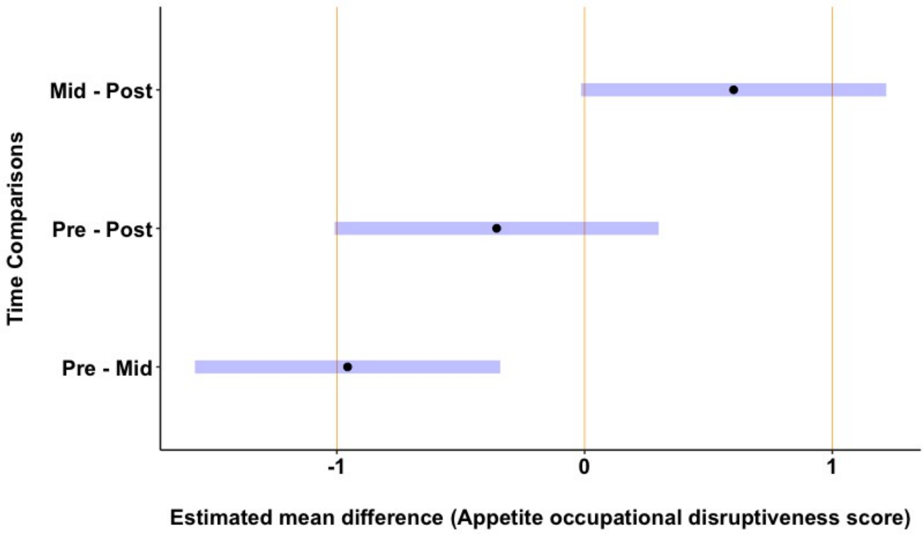


Figure 4.7: Estimated marginal means for the occupational disruptiveness scores of the domain appetite across time points pre-experiment (Pre), mid-experiment (Mid) and post-experiment (Post).

4.7 NPI-NH Discussion

In addressing the first research question of this chapter, the NPI-NH was administered pre-experiment, mid-experiment and post-experiment. Contrary to the first hypothesis, that the BPSD would improve across the duration of the experiment, there were no significant differences found in *total NPI-NH score* and the *total occupational disruptiveness score* post-experiment compared to pre-experiment. These are calculated by summing the individual *total domain score* (severity x frequency) and the individual occupational disruptiveness scores of the ten main behavioural domains (*delusion, hallucination, agitation, depression, anxiety, elation, apathy, disinhibition, irritability and aberrant motor behaviour*). These results are contrary to the findings from Francis et al., (2019) and Li et al., (2020), who found RT to improve the short-term BPSD. This demonstrates that the overall BPSD of participants are maintained across the TTT experiment.

When analysing the individual ten main behaviour domains, there were also no significant differences across the time points (pre, mid, post) for all domains except *apathy*. This also does not support the first hypothesis where it was predicted *depression* would have reduced scores post-experiment compared to pre-experiment. There were no significant changes in the depression sub-score which further does not support the findings of Song et al., (2014). Participants did, however, have a greater *apathy* score during the mid-experiment measure, compared to the pre-experiment and post-experiment time points. There were, however, no significant difference found post-experiment compared to pre-experiment. Therefore, the individual BPSD sub-domains remain stable across the TTT experiment.

Unlike the ten main behavioural domains, the two forms of neurovegetative changes (sleep and night-time behaviour disorders – *sleep*; appetite and eating disorders - *appetite*) had significant variance across the experiment. Participants had greater *total domain scores* in the *sleep* domain mid-experiment compared to pre-experiment. Though, there were no significant differences found post-experiment compared to pre-experiment. In terms of occupational disruptiveness, there was a greater impact of *sleep* on carers mid-experiment compared to both pre-experiment and post-experiment, with no significant differences found post- compared to pre-experiment.

For the *appetite* domain, there was a greater *total domain score* mid-experiment compared to post-experiment and no significant differences found pre-experiment compared to post-experiment. Interestingly though, for the occupational disruptiveness of the appetite and eating disorders, there was significantly greater impact on carers mid-experiment compared to pre-experiment only.

To summarise, variability was evident in behavioural presentations over the duration of the experiment. However, there were no significant differences found in the neuropsychiatric profile of participants or the occupational disruptiveness on carers at the end of the experiment compared to the beginning of the experiment. In addressing the first research question of this chapter, the BPSD were maintained across the TTT experiment.

4.8 Composite Discourse Interview Results

The second research question of this chapter was: 'Are the narrative, procedural and abstract discourse characteristics of older adults maintained or improved across the TTT experiment?'. In addressing this question, a discourse interview was used to create a verbal communication profile for the participants. As mentioned in Chapter 3, the discourse interview consisted of three discourse tasks; narrative discourse, procedural discourse and abstract discourse. The discourse interview was delivered to participants at three time points (pre-experiment, mid-experiment and post-experiment) to ensure repeated baseline sampling and to monitor stability of discourse. RT has been shown to be beneficial for the discourse skills of people with mild-cognitive impairment. Later stages of cognitive decline have shown immunity to this effect with outcomes of reduced discourse production (Rose et al., 2020). Therefore, it was hypothesised, that participants with MMSE scores of 20 or above will have maintain or improved discourse measures post-experiment compared to pre-experiment. This effect will not be seen with participants with greater cognitive decline, classified with an MMSE score of 20 and below. For all discourse interview statistical output, see Appendix G.

4.6.1 Narrative Discourse

The narrative discourse task assesses the ability to tell a story from visual information of an emotional scene that is commonplace to day to day life. Participants were handed an image and asked, 'Look at this picture. Can you tell me a story about what's happening in the picture?'. Figure 4.8 shows the three images that were used in the narrative task. The images were chosen as they represent scenes in which there are people showing facial expressions that can be related to the environmental scene which surrounds them.

As mentioned in Chapter 3 the total possible score for the narrative task was 15 points. This is inclusive of 5 points for the main idea on a scale of 0 (incorrect) – 5 (interpretive) and a possible 10 points for the lesson on a scale of 0 (incorrect) – 10 (global). Table 4.7 shows examples narrative discourses with a low and high score for each scene.

Figure 4.8: Pictures used in the narrative discourse task.
Image A shown in the first discourse interview. From Sorapop, U. (n.d.). Family happy mother mom send children kid son boy kindergarten to school, education back and back to school concept. https://www.shutterstock.com/image-photo/family-happy-mother-mom-send-children-112469938.
Image B shown in the second discourse interview. From Kent, James. (Director). (2015). Testament of Youth. [Film]. BBC Films and Heyday Films.
Image C shown in the third discourse interview. From Stockbyte. (n.d.). Elevated view of a mother father son and daughter (8-11) having a picnic and chatting. https://www.gettyimages.com.au/detail/photo/elevated-view-of-a-mother-father-son-and-daughter-royalty-free-image/57305984?adppopup=true.

Table 4.7: Examples of low and high scoring responses for the narrative task in the discourse interviews.

	Low score example	High score example
Image A Pre-experiment	*'Erm, she's either greeting him from school or she's seeing him off to school.'* – 3/15	*'Yes, a mother is talking to her daughter about getting into the car to go to school. I think she's school because she's got a pack on her back and - but I'm not quite sure whether she'd be five years old. I think she might even be a little bit older because she just strikes me she's just a little bit older, and she's just ready to be into the car to go to school.'* – 11/15
Image B Mid-experiment	*'They go far away from each other.'* – 2/15	*'Oh, it's a train. There's a train, and people are in a train and they're waving goodbye to people. And this particular girl she, she's his sweetheart and they've, ah, it's time for her to go home, for him to go home, time for him to go home, and she's saying goodbye to him because he's going home for Christmas and she's got to stay home and she not married to him yet.'* – 13/15
Image C Post-experiment	*'There on the picnic. Yeah, daughter, son, husband and wife. And they're out there way out to Woop Woop having a picnic.'* – 5/10	*It's a family. Mother, father, boy, girl. They've got a table cloth on the grass and they're going to have a lunch. And it's not sandwiches. Maybe it is sandwiches in the middles. It um got onions and ah carrots and oranges and then some green vegetables and they're saying were going to have a lunch. That's um a healthy lunch with fruit and vegetables.'* – 10/15

The descriptive statistics for participant scores across the three interviews at time points pre-experiment, mid-experiment and post-experiment and shown in Table 4.8, along with the mean and standard deviation. As can be seen in Table 4.8 there are fluctuations in responses by participants across the time points with some participant providing responses that scored higher and others that scored lower.

Table 4.8: Descriptive statistics for narrative discourse task at time points pre-experiment, mid-experiment and post-experiment. The mean and standard deviation (SD) for each participant is shown.

	Narrative Task				
Participant	Pre	Mid	Post	Mean	SD
Angela	6	9	7	8.33	2.08
Amy	11	13	10	11.33	1.53
Barbara	5	2	10	5	3.00
Charlie	8	9	8	8.33	0.58
Colette	9	2	8	6.33	3.79
Diana	5	6	8	5.33	0.58
Jana	3		5	4	1.41
Julia	4	4	5	5	1.73
Nora	9	9	7	7.67	1.15

There was no significant difference in the narrative discourse task when comparing time points Pre and Mid ($p = 0.6611$), Pre and Post ($p = 0.3726$) and Mid and Post ($p = 0.2040$). There were also no significant differences found in the comparison of groups L->H and H->L ($p = 0.3990$). As a covariate, MMSE scores did not significantly impact the narrative task scores ($p = 0.0918$).

This indicates that the narrative discourse skill of participants did not significantly change across the experiment.

4.6.2 Procedural Discourse

The procedural discourse tasks assess the ability to coordinate and arrange items in a sequential order. It was valuable to ask a question around a process that involved multiple steps to understand the level of detail in procedural recall. Table 4.9 shows the different procedural task questions asked in each discourse interview. It also includes the marking criteria for a total of 11 points, inclusive of 4 gist points and 7 core points. The procedural task question at the pre-experiment time point, along with the gist and core points marking criteria, are replicated from Chapman et al. (2014). The procedural task question and marking criteria at time-points mid-experiment and post-experiment are unique to this research.

Table 4.10 gives two examples of responses from each interview based off the marking criteria in Table 4.9. A lower and higher score response from participants is provided to give an understanding of the range of procedural recall abilities across participants.

Table 4.9: Procedural task questions used in the discourse interview at time points pre-experiment, mid-experiment and post-experiment.

Interview Time Point	Procedural task question	Gist Points	Core Points
Pre-experiment	*'Now, can you tell me how do you make scrambled eggs? What do you do?'*	- Crack the eggs - Stir the eggs - Add ingredients - Cook the eggs	- Get the eggs - Mention of pan - Turn on heat - Put butter in skillet - Pour in milk - Stir while cooking - Put eggs on plate
Mid-experiment	*'Now, can you tell me how do you make chicken schnitzel? What do you do?'*	- Prepare ingredients - Coat chicken in ingredients - Heat oil - Cook the chicken	- Crack eggs/whisk eggs - Order of coating chicken - Mention of pan/skillet - Turn on heat - Put oil in pan/skillet - Flip Chicken in pan/skillet - Put chicken on plate
Post-experiment	*'Now, can you tell me how do you make a salad? What do you do?'*	- Get the ingredients - Chop up ingredients - Put salad together - Dress the salad	- Mention specific salad ingredients - Mention of bowl - Washing items - Type of dressing - Shake the dressing - Toss the salad - Serve the salad

Table 4.10: Examples of low and high scoring responses for the procedural task in the discourse interviews at time points pre-experiment, mid-experiment and post-experiment.

	Low score example	High score example
Pre-experiment	*'Okay. You beat, depends how many eggs you want to break… You mix it up…. And put it in a frying pan. And that's how you…'* - 3/11	*'Well, you go to the fridge and you get two eggs, and you get some milk and some salt and pepper and a little bit of milk and you beat the eggs and the milk and then you put it in a frying pan on the stove, and you just leave it and then you stir it just a bit, then you dish it up and put it on a plate and you - you put a piece of toast with it.'* – 8/11
Mid-experiment	*'Sch-ni .. nit – soop .. how do you do that?... You have to make the…?'* – 0/11	*'Chicken schnitzel? Oh, you flatten out a chicken breast and coat it with breadcrumbs. Oh, first you put it in mixed, egg mixture and then flour and then the egg mixture again and then the breadcrumbs.'* – 3/11
Post-experiment	*'I use, umm, lettuce, tomato, cucumber, couple of slices of onion. That's it.'* – 1/11	*'Oh well I vary them. It nearly always has, I like the old-fashioned iceberg lettuce. And I either rip it apart or shred it and then I put cooked sweet corn through it either raw or pickled onions finely sliced. And, sometimes chickpeas, and umm, sliced beetroot, tomato, and then, umm, we would have umm canned salmon or tuna fish or one of our favourite meats is brawn. Yeh and sometime we have umm, no meat, we have a cheese and hard-boiled egg salad with the same sort of thing.'* – 5/11

The procedural task questions in Table 4.9 were chosen as it was thought that the food dishes of *scrambled eggs, chicken schnitzel* and *salad*, would be known by all participants. Table 4.11 shows the descriptive statistics for the procedural task scores across time points pre-experiment, mid-experiment and post-experiment. It can be seen in Table 4.11 that there was a reduced ability to recall the procedure of how to make *chicken schnitzel* in the mid-experiment interview, compared to the pre-experiment and post-experiment interview. It is thought that this is due to cultural backgrounds and participants not knowing being familiar with *chicken schnitzel*. Considering the consistency in participant responses in the mid-experiment interview, this highlights the importance in using discourse measures that are culturally relevant to all participants.

Table 4.11: Descriptive statistics for procedural discourse task at time points pre-experiment, mid-experiment and post-experiment.

	Procedural Task				
Participant	Pre	Mid	Post	Mean	SD
Angela	7	3	5	5.00	2.00
Amy	8	0	2	3.33	4.16
Barbara	5	2	4	3.67	1.53
Charlie	5	1	4	3.33	2.08
Colette	2	0	4	2.00	2.00
Diana	3	0	1	1.33	1.53
Jana	4		4	4.00	0.00
Julia	0	0	3	1.00	1.73
Nora	4	0	4	2.67	2.31

The scoring of the procedural discourse task at the pre-experiment time point (M = 4.22, SD = 2.44) was significantly higher (t = 4.741, p = 0.0002), compared to the mid-experiment time point (M = 0.75, SD = 1.16). The estimated mean difference is 3.385, 95% CI (1.868, 4.90). The scoring of the procedural discourse task at the mid-experiment time point (M = 0.75, SD = 1.16) was significantly lower (t = -3.651, p = 0.0022), compared to the post-experiment time point (M = 3.44, SD = 1.24). The estimated mean difference is -2.606, 95% CI (-4.122, -1.09). See Figure 4.9.

The L->H group (M = 4.00, SD = 1.61) was significantly higher (t = 2.585, p = 0.0414), compared to H->L group (M = 2.07, SD = 2.31). The estimated mean difference is 1.55, 95% CI (0.0838, 3.01). See Figure 4.10.

There was, no significant difference in the procedural discourse task when comparing time points Pre and Post (p = 0.2750). As a covariate, MMSE scores did not significantly impact the procedural task scores (p = 0.129181).

This indicates that the ability for participants to recall a procedural memory did not significantly change across the experiment. This further provides support that the low scoring on the mid-experiment task was due to participants not being familiar with *chicken schnitzel*.

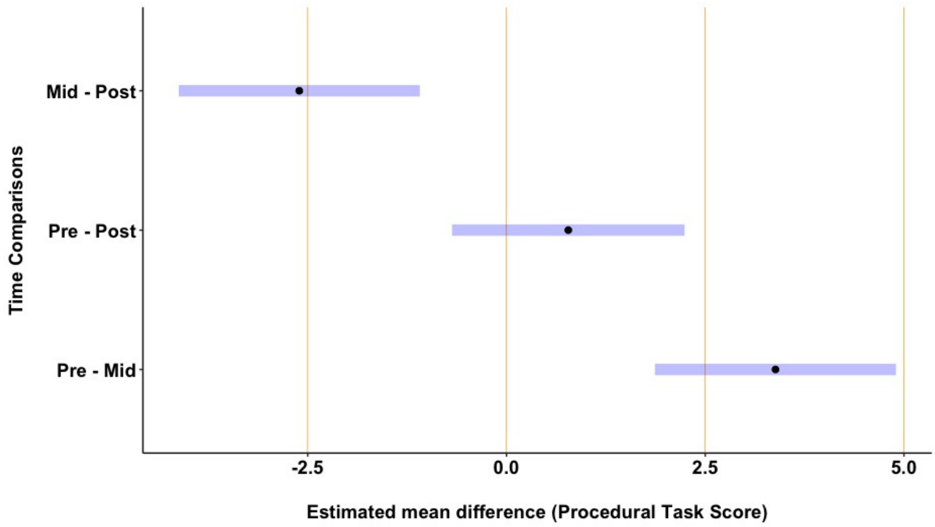


Figure 4.9: Estimated marginal means for the procedural discourse task across time points pre-experiment (Pre), mid-experiment (Mid) and post-experiment (Post).

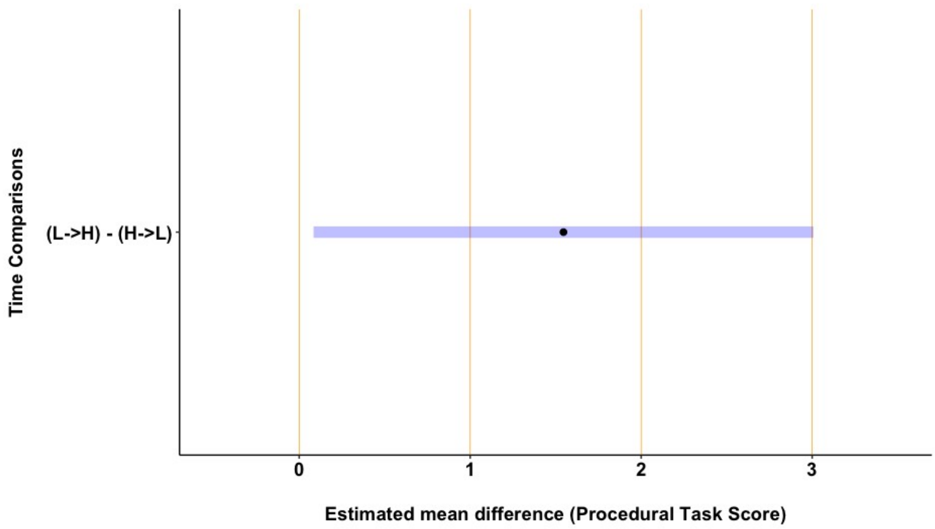


Figure 4.10: Estimated marginal means for the procedural discourse task across groups low->high (L->H) and high->low (H->L).

4.8.2 Abstract Discourse

The proverb test is based off the Delis-Kaplan Executive Function System (D-KEFS) Proverb Test (Delis et al., 2001). This proverb test was formally known as the California Proverb Test, and is referred to as the California Proverb Test in the discourse interview schedule which this schedule is adapted from (Chapman et al., 2014). The proverb test assesses the ability to make abstract inferences and demonstrate novel abstract discourse skills. Three difference proverbs were asked in each discourse interview. Before being read the proverb, participants were asked, *'What does this saying mean? If you haven't heard it, what do you think it means?'*. Table 4.12 shows the proverbs asked at time points pre-experiment, mid-experiment and post-experiment.

Table 4.12: Proverbs used in the abstract discourse task at time points pre-experiment, mid-experiment and post-experiment.

	Proverbs
Pre-experiment	*Don't count your chickens before they are hatched.* *While the cat's away, the mice will play.* *The long way home is often the fastest.*
Mid-experiment	*Don't cross the bridge until you come to it.* *Too many cooks spoil the broth.* *It's no use crying over spilt milk.*
Post-experiment	*There is no point reinventing the wheel* *The nail that sticks out the farthest, gets hammered the hardest* *Judge a day by the seeds that you plant than the crops that you harvest*

A total of 10 points were assigned for the accuracy and quality of a proverb explanation, on a scale of 0 (incorrect) – 10 (correct abstract). Therefore, there was a total of 30 points for the proverb test in each discourse interview. Table 4.13 gives two examples of responses from each interview. A lower and higher score response is provided to give an understanding of the range in abstract discourse skills across participants.

Table 4.13: Examples of low and high scoring responses for the abstract task in the discourse interviews at time points pre-experiment, mid-experiment and post-experiment.

	Proverb	Example 1	Example 2
Pre-experiment	*Don't count your chickens before they are hatched.*	*'Oh, they, they put the chickens, chickens on top of their eggs. The chicken's got to sit there for about, I don't know, I forget how, how many weeks, and then when they're ready to come out the chickens, the baby chickens break the egg and they come out..'* – 0/10	*'Don't, don't make up your mind on something in the future if you're not sure if it's going to work, or that what you want to happen is going to happen, I think.'* – 8/10
Mid-experiment	*Too many cooks spoil the broth.*	*'Too many cooks... yeah... too many cooks spend their time busy yapping. Cos they don't finish it. Is that right?'* – 1/10	*'Okay yeah, if there are too many people, most of the time it doesn't work because everyone puts in something and then it doesn't work. If there are two or three people who agree on everything then it's easy.'* – 6/10
Post-experiment	*There is no point reinventing the wheel.*	*'A wheel? Like you're making a wheel? Or you're fixing your car wheel?'* – 0/10	*'It just, it does the job and no other thing could take its place.'* – 3/10

Table 4.14 shows the descriptive statistics for the abstract test scores across time points pre-experiment, mid-experiment and post-experiment. As can be seen in Table 4.14, some participants scored better and some participants scored worse in the mid-experiment abstract test compared to the pre-experiment abstract test. However, all participants scored the worst in the post-experiment

abstract test compared to both the pre-experiment and the mid-experiment time slots. It is unknown why this may be. It may be due to the familiarity of the proverbs. However, the data to verify this was not collected.

Table 4.14: Descriptive statistics for abstract discourse task at time points pre-experiment, mid-experiment and post-experiment.

	Abstract Test				
Participant	Pre	Mid	Post	Mean	SD
Angela	15	22	2	13.00	10.15
Amy	7	13	5	8.33	4.16
Barbara	6	3	1	3.33	2.52
Charlie	7	7	4	6.00	1.73
Colette	12	14	5	10.33	4.73
Diana	2	4	1	2.33	1.53
Jana	11		3	7.00	5.66
Julia	6	8	3	5.67	2.52
Nora	6	1	4	3.67	2.52

The scoring of the abstract discourse test at the pre-experiment time point (*M* = 8, *SD* = 3.94) was significantly higher (*t* = 2.936, *p* = 0.0102), compared to the post-experiment time point (*M* = 3.11, *SD* = 1.54). The estimated mean difference is 4.89, 95% CI (2.936, 8.44). The scoring of the abstract discourse task at the mid-experiment time point (*M* = 9, *SD* = 6.97) was significantly higher (*t* = -3.444, *p* = 0.0035), compared to the post-experiment time point (*M* = 3.11, *SD* = 1.54). The estimated mean difference is 5.99, 95% CI (2.29, 9.69). See Figure 4.11.

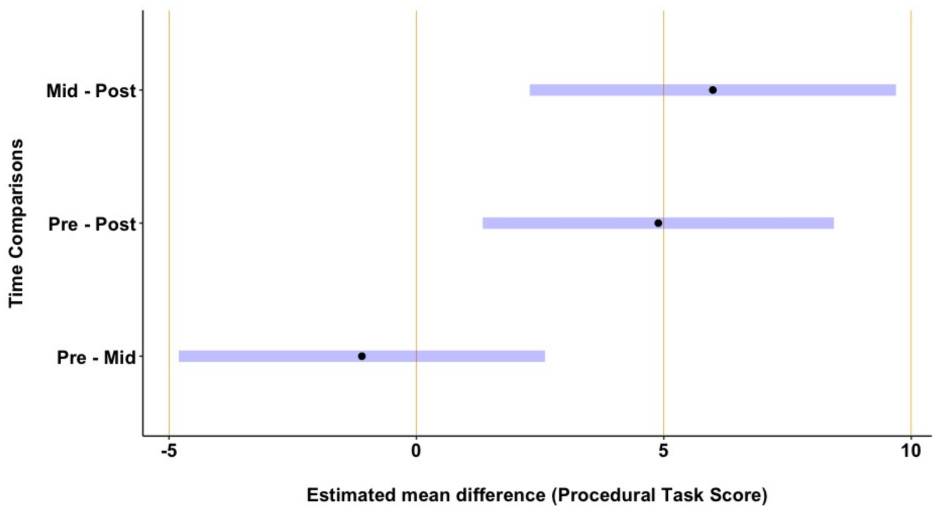


Figure 4.11: Estimated marginal means for the abstract discourse test across time points pre-experiment (Pre), mid-experiment (Mid) and post-experiment (Post).

There was no significant difference in the abstract discourse task when comparing pre-experiment and mid-experiment time points (*p* = 0.5357). There was no significant difference in the abstract discourse task when comparing the L->H group and the H->L group (*p* = 0.7279). As a covariate, MMSE scores did not significantly impact the procedural task scores (*p* = 0.1292).

4.8.3 Discourse Composite Score

The discourse composite score is calculated by adding the narrative, procedural and abstract discourse tasks together. Across the three discourse interviews, participants were scored on a total of 56 points for the summation of the three discourse tasks. Table 4.15 shows the discourse composite score for participants across time points pre-experiment, mid-experiment and post-experiment. As can be seen in Table 4.15 there is variance across participants and across time-points.

Table 4.15: Descriptive statistics for the summation of the individual discourse tasks (narrative, procedural and abstract) of the discourse interview at time points pre-experiment, mid-experiment and post-experiment. There was a total score for each discourse interview of 56 points.

	Overall Discourse				
Participant	Pre	Mid	Post	Mean	SD
Angela	28	34	17	26.33	8.62
Amy	26	26	17	23.00	5.20
Barbara	16	7	13	12.00	4.58
Charlie	20	17	16	17.67	2.08
Colette	23	16	17	18.67	3.79
Diana	10	10	7	9.00	1.73
Jana	18		12	15.0	4.24
Julia	10	12	13	11.67	1.53
Nora	19	8	15	14.00	5.57

There were no significant differences found in the discourse composite score when comparing pre-experiment and mid-experiment (*p* = 0.0758), pre-experiment and post-experiment (*p* = 0.0581), or mid-experiment and post-experiment (*p* = 0.8886). There were no significant differences in discourse composite score when comparing the L->H and the H->L group (*p* = 0.9432). As a covariate, MMSE scores did not significantly impact the discourse composite scores (*p* = 0.2484).

4.9 Composite Discourse Discussion

The composite discourse interview included three components, a narrative discourse task, procedural discourse task and an abstract discourse task. The overall discourse of participants, inclusive of all three discourse tasks, did not significantly change across the duration of the TTT experiment. These results do not support the hypothesis that participants with an MMSE of 20 or above would have significant improvements in discourse post-experiment compared to pre-experiment. However, it was further hypothesised that an improvement would not be seen with MMSE scores of 20 or below, which was supported. There were no significant differences found across all MMSE scores. These results contradict Rose et al., (2020) who had found participant with MMSE scores of 20 and above had improved discourse, and participants with MMSE scores of 20 and below had reduced discourse scores. In addressing the second research question of this chapter, the narrative, procedural and abstract discourse characteristics of older adults were maintained across the TTT experiment.

In relation to the individual discourse tasks, there were no significant differences found in the narrative and procedural discourse tasks post-experiment compared to pre-experiment. However, the procedural discourse task was significantly lower in the mid-experiment interview compared to the pre-experiment and the post-experiment interviews. Considering all participants, regardless of cognitive capacity as measured by the MMSE, had reduced scores in the mid-experiment procedural discourse task, it is unlikely that the reduced procedural skill is due to cognitive decline. As mentioned earlier, the reduced scores may be due to participants not knowing what *chicken schnitzel* is. This interpretation of the results was supported by the lack of significant differences in the abstract discourse scores, when comparing the pre-experiment and the post-experiment scores.

For the abstract discourse task, there was a reduction in scoring across the experiment. The abstract discourse skill was significantly lower in the post-experiment test compared to both the pre-experiment and the mid-experiment test. This was similar to the reduced scoring in the mid-experiment interview procedural task. Whereby, all participants, regardless of cognitive capacity had reduced scores in the post-experiment abstract task. It is similarly unlikely that the reduced abstract discourse skill is due to cognitive decline. There may be multiple factors that influenced this change in abstract discourse skill. For example, participants may have been more familiar with the proverbs used in the pre-experiment and the mid-experiment interviews, compared to the post-experiment interview. If participants were more familiar, they may have been able to interpret the meaning more so than if all proverbs were novel.

In summary the MMSE, NPI-NH and composite discourse interview were maintained across the TTT experiment. Taking this into account, the interpretation of the effect of the TTT experiment on engagement outcomes were attributed to the independent variables of the experiment. This included the level of technology (LT condition and HT condition) and location specificity (Person-Specific locations condition and Non-Specific locations condition). With respect to the variations of the discourse interview, it is a complex task designing a discourse schedule that is appropriate for people who may be linguistically and culturally diverse (CALD). The discourse interview was effective in understanding the maintenance of the individual discourse skills across the experiment. However, as a tool to compare discourse skills across participants, this type of discourse interview is not appropriate for people who speak English as a second language. Future research should investigate the validity of the discourse schedule for CALD people and adapt the discourse interview to different languages.

Chapter 5: Facial movement as a measure of engagement

5.1 Introduction

The overall research question of this thesis concerns the extent to which technology delivered through Time Travelling with Technology (TTT) impacts the engagement of older adults in respite aged care. In section 2.3.1 the Comprehensive Process Model of Group Engagement framework (CPMGE; Cohen-Mansfield et al., 2017) was discussed, which outlines behaviour as a measurable outcome of engagement. In section 2.4.3 the importance of understanding non-verbal forms of communication for people with dementia was discussed. Understanding that with the progression of dementia, it becomes more difficult to communicate verbally, means that carestaff and peer awareness of non-verbal forms of communication become important during interaction (Elalouoi Faris, 2015; Hoffman et al., 2014; Taler & Phillips, 2008). By appreciating the different forms of communication used by people with dementia, there is a greater potential to support well-being, identity and address the needs of these people with dementia.

Facial expressions, as a form of non-verbal communication, are one of the most telling descriptors of affect-driven behavioural engagement (Ekman et al, 1965). They reflect behaviour changes that are driven by the affective state of a person. They are a main avenue through which emotions are expressed (Ekman, 1965), and are indicative of the behavioural intentions of a person as well as action requests they have for others (Fridlund, 1994; Horstmann, 2003). Facial expressions have great influence in communication. This is especially seen in relation to influencing a perceiver's motivational tendency to either approach or avoid a person (Adams & Kleck, 2016). They also have impact on decision making when interacting with others. For example, judging whether to trust a person or not, particularly if the person is a stranger (Campellone et al., 2013).

Facial expressions are constructed from the activation of different facial muscle movements. For example, smiling with the lip corner puller muscles combined with raising of the cheek muscles, conveys the facial expression of happiness. The current chapter focuses on facial movements, as an indicator of facial expressions, to characterise older adult engagement. In relation to affect-driven behavioural engagement, greater engagement would be indicated by greater presence and intensity of facial muscle movements.

The three questions relating to facial movement that will be addressed in this chapter are:

1. What are the facial movement characteristics of older adults during the TTT experiment and how does this differ to a structured dyadic reminiscence therapy (RT) interview?
2. To what extent does the dynamic and immersive nature of technology mediate facial movement differences when participating in a Low-Tech version (LT) compared to a High-Tech version (HT) of TTT?
3. To what extent does the reminiscence and personal familiarity of a location mediate facial movement differences when viewing Non-Specific compared to Person-Specific locations?

To address these questions and measure facial movement, the presence and intensity of Action units (AUs) as dependent variables outlined in, section 3.9 were measured. Affective facial expressions are comprised from the presence of multiple AUs and varying intensities, with different AUs contributing to different expressions. For example, the emotion of happiness is a combination of AU06 and AU12, and sadness is the combination of AU01, AU04 and AU15. Therefore, a specific affective or semantic meaning is unable to be deciphered from a singular AU (Koelstra & Patras, 2013). The five chosen dependent variable AUs for the current analysis include AU04 – brow lowerer, AU06 – cheek raiser, AU12 – lip corner puller, AU15 – lip corner depressor, and AU17 – chin raiser. These five AUs were chosen as they correspond with a wide range of affective states. Typically, AU04, AU15 and AU17 are associated with negative affect and AU06 and AU12 are associated with positive affect (Ekman & Friesen, 1978; Jakobs et al., 2001; McDuff et al., 2010; Mortillaro et al., 2011).

The first question of this chapter concerns facial movement characteristics of older adults during the TTT experiment, and how they differ to a structured dyadic RT interview. Technology driven interventions promote enjoyment and positive experiences for people with dementia (Astell et al., 2010; Samuelsson & Ekström, 2019). Further group activities provide an environment that encourages engagement and social interaction (Cohen-Mansfield et al., 2017). TTT combines technology in a group environment for the delivery of RT. In addressing the first question, the first hypothesis of this chapter is: If the TTT experiment promotes engagement in older adults compared to a non-technology structured dyadic RT interview, then the presence and intensity of AUs will be greater in the TTT condition compared to the Baseline dyadic RT interview condition.

As outlined in Chapter 2, there is a lack of technology driven RT experiments represented in previous research. The most prominent are the CIRCA (Computer Interactive Reminiscence and Conversation Aid) experiment, the "Memory Box", and a digital storybook, that all draw on personalised media to encourage reminiscence (Astell et al., 2010; Davison et al., 2016; Samuelsson & Ekström, 2019; Subramaniam and Woods, 2016). However, the research has only investigated a single level of technology which has not been within a group setting. It is currently unknown how the level of technology impacts on outcomes of engagement. However, if technology compared to no technology is engaging and promotes positive affect, then it is expected that a higher level of technology will be more engaging than a lower level technology. In addressing the second question, the second hypothesis of this chapter is: If a more dynamic, interactive and immersive technology promotes engagement more than a less dynamic, interactive and immersive technology, then the presence and intensity of facial AUs will be greater in the HT condition compared to the LT condition.

As discussed in Chapter 2, RT is a pleasurable activity that facilitates social engagement, connection with others, assertion of identity and promotion of communication (Cotelli et al., 2012; Fels & Astell, 2011; Hsin-Yen & Li-Jung, 2018; Pinquart & Forstmeier, 2012; Redulla, 2019; Schrauf & Müller, 2014). In addressing the third question, the third hypothesis of this chapter is: If reminiscence stimuli are more engaging than ordinary stimuli, then the presence and intensity of facial AUs will be greater in the Person-Specific locations condition compared to the Non-Specific locations condition.

This chapter provides method and results for the analysis of facial movement during TTT sessions. The chapter describes the method for using the OpenFace software for processing the visual recordings, and describes the approach to analysis for facial movement. The results include the presence and intensity of the facial AUs across the different conditions (Baseline, LT and HT) when viewing Person-Specific and Non-Specific locations in the TTT experiment. A greater affect-driven behavioural response to one condition, compared to another, would be indicated by an increase in the presence and/or intensity of the AUs. How participants' facial movements change when viewing Person-Specific compared to Non-Specific locations was then discussed.

5.2 Preparing OpenFace input

OpenFace software is a facial recognition program (Baltrušaitis, 2019) used to analyse the five dependent variable AUs, as introduced in Chapter 3; 04 – brow lowerer, 06 – cheek raiser, 12 – lip corner puller, 15 – lip corner depressor and 17 – chin raiser. OpenFace is able to register the facial properties for multiple people in a frame. It has limitations however and is unable to link the individual people to themselves across multiple frames in a video. To be able to analyse the features of an individual participant in a video, their face had to be isolated which was done by cropping the frame.

To prepare the video files for OpenFace processing, the Person-Specific locations and Non-Specific locations videos for each participant as described in section 3.10 were cropped using the 'crop' function in Adobe Premiere. The files were then saved as a MPEG2 (.mpg; 1920 x 1080, 25 fps, 48kHz, Stereo, 16 bit) file and processed using OpenFace on a Dell Latitude E7270 Laptop.

There were a few complications that arose when initially using OpenFace where the experiment would crash in the middle of processing a video file. The developers were contacted through the Issues tab on the TadasBaltrusaitis/OpenFace GitHub website (Baltrušaitis, 2019). After support from the developers, it was identified that these problems were associated with the Graphic User Interface (GUI), which is the programming of an application that allows a user to interact with a program. To bypass using the GUI, OpenFace was run using the computer terminal and the following script:

C:\OpenFace-master1\Debug>FeatureExtraction.exe -verbose -f "path-to-video"

A snapshot of the cropped file being processed by OpenFace is shown in Figure 5.1. Within the image, the red outlined dots represent the Facial Landmark Detection, the blue cube represents head pose tracking and the green line represent eye gaze tracking.

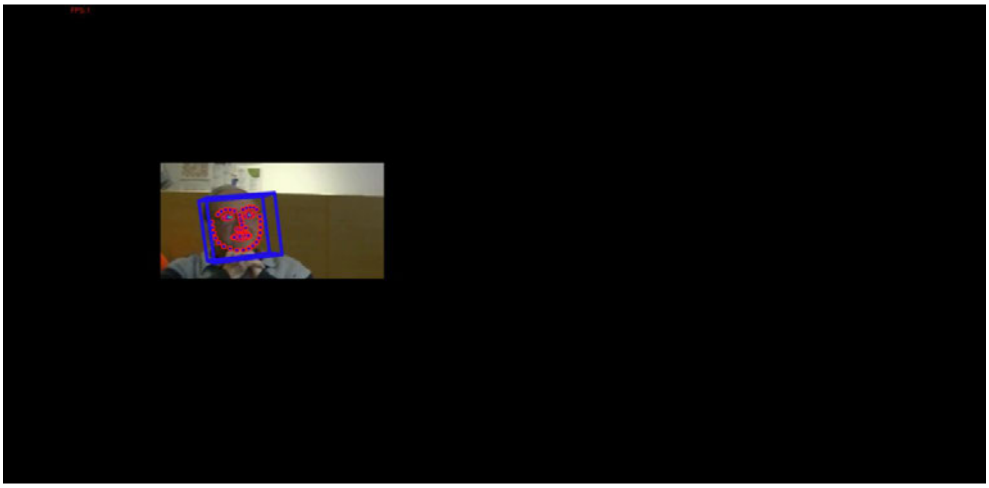


Figure 5.1: A screenshot of a cropped video recording of a TTT session being processed through OpenFace.

5.3 Transforming OpenFace output

The output of OpenFace is a comma-separated values file (.csv) that contains values relating to various facial features at a sampling rate of 0.04 seconds from the video recording. These features include the frame number, face_id, timestamp, confidence, success, gaze related values, pose related values, landmark locations in 2D and 3D spatial awareness, rigid and non-rigid shape parameters, and facial AUs.

The essential columns of the file for the analysis include the 'frame', 'timestamp',' confidence', 'success' and the facial AU columns. The 'frame' specifies the number of the video frame that was captured for the sample. The 'timestamp' indicates the time of the video that the frame was captured and is in seconds. 'Confidence' is on a scale of 0 to 1 and represents how confident the tracker is in determining the current landmark detection estimate. 'Success' of the trial and of tracking the facial features is represented as a 1 and an unsuccessful frame is represented as a 0 (for example the head is turned away or is too small). The facial AUs are detected and are represented as either a '0' – absent or a '1' – present. This applies for 18 AUs and has a title of 'AUnumber_c'. The system detects the intensity of the AUs on a scale of 0 to 5 across 17 AUs and has a title of 'AUnumber_r'.

The Excel spreadsheet generated from OpenFace output is a large file that may take 15 seconds to a minute to load. It was decided to reduce the output file to present the essential columns for analysis. To reduce the size of the .csv file, columns that were not relevant to the research (columns F to ZC) were deleted. The top row of the spreadsheet was then highlighted and 'Freeze Top Row' was selected make navigation of the spreadsheet easier. Trials that represented frames as unsuccessful were deleted. This involved sorting the 'success' column from smallest to largest, selecting the trials that were numbered '0' in the 'success' column and deleting the highlighted rows. Before the trials were averaged across the session, to indicate the presence and intensity of the AUs, it was important to ensure that cells with a '0' under the intensity columns were removed. This is important to determine how intense the AU motion is when engaging in the movement and the '0' indicating no intensity would dilute the averaged response. The averaging of the specific AU intensity will then represent the average intensity when the motion of the AU was detected, rather than across the entire session. This was done by selecting the columns that ended with a '_r', selecting the find and replace, and replacing every '0' with nothing inserted in the 'Replace with:' field. The 'Find entire cells only' check box was ticked and 'Replace All' was then selected. At the bottom of the document, the trials were then averaged using the command '=AVERAGE()'.

Each AU column had an averaged value that was calculated. These values were then highlighted and copied into one of two master OpenFace .csv files representing session averages from either Person-Specific or Non-Specific locations, by using the commands 'Copy' and 'Paste Values'. The 'Paste Values' function allowed the values to be copied across to the master spreadsheet without the formulas being copied across. Within both of the two master spreadsheets, several columns were added to ensure to variables needed for analysis were present. These included ID, MMSE_pre, condition, group, and location (Person-Specific or Non-Specific). These two master OpenFace .csv files were then used for analysis in R.

5.4 Linear mixed model for analysis

For the presence and the intensity of each AU, a linear mixed model was used to analyse the data using R software (RStudio version 1.2.5042; RStudio Team, 2013). A linear mixed model takes into consideration fixed effects and random effects. Fixed effects are the independent variables of the study which are controlled by the experimenter. Within the analyses, the fixed effects were the condition (Baseline, LT, HT) and group (L->H, H->L, i.e. counterbalancing), categories. Random effects are those which are unable to be controlled. They vary across the sample naturally and are unrelated to the independent variables. Because the experiment was a repeated measures design, where the same participant undergoes each condition several times, the individual participants were included as a random effect.

There were two models that were used within the analysis. The first is a linear mixed model which included the following effects:

Fixed effects: Condition (B, LT, HT) and Group (L->H, H->L).
Random effects: ID (Participants)

The equation used for the linear mixed model was:

res2=lmer(AU ~ Con + Group + (1|ID), data=BC_data)

Within this model 'res 2' is the name of the linear mixed model, 'lmer' is identifying the linear mixed model package R software package "lme4" (Bates et al., 2015), 'AU' is where the specific AU variable is identified, 'Con' and 'Group' represent the fixed effects of the conditions and the groups, '(1|ID)' indicates the participant ID as a random effect and 'data=BC_data' identifies the data set.

The second model used within the analysis was similar to the first but also included random slopes. Random slopes for mixed linear models consider that different participants may present with a different trend in their response to the experimental conditions. This is observed with different slopes (gradients) in graphs for participants across conditions. For each model, the slope of the individual participants was observed.

The mixed linear model with random slopes included the following effects:

Fixed effects: Condition (B, LT, HT) and Group (L->H, H->L).
Random effects: ID (Participants)
Random slopes: participants across conditions

The equation used for the random slopes model was:

res3 = lmer(AU ~ Con + Group + (1 + Con|ID), REML = TRUE, data = BC_data)

Within this model 'res 3' is the name of the linear mixed model, 'lmer' is identifying the linear mixed model R software package, 'AU' is where the specific AU variable is identified, 'Con' and 'Group' represent the fixed effects of the conditions and the groups, '(1+Con|ID)' indicates the participant ID as a random effect and that random slopes are considered for the participants across the conditions, 'REML = TRUE' tells the model to include random effects when estimating the variance in the model, and 'data = BC_data' identifies the data set.

Random slopes were included in the model if 1) it made the model stronger whereby for variance was accounted for, and 2) if there was a statistically significant difference between the two models.

The Akaike's Information Criterion (AIC; Sakamoto et al., 1986) function was used to determine if the random slopes model was stronger than the mixed linear model. AIC function in R generates a log-likelihood value to determine the fit of a model. It makes an estimate of how well the model fits the data by generating an out-of-sample prediction error. That is, by seeing how well the model is able to predict the outcome of values outside the data set. In general, a lower AIC indicates a better fitting model. That is, the closer the numeric value is to 0, the better the fit of the model. For example, if the linear mixed model had an AIC value of -48, and the random effects model has an AIC value of -20, then the random effects model would have a better fit of the data.

To determine if the two models were significantly different, an ANOVA (analysis of variance; Fox, 2016) was used to compare the two models. Within the ANOVA analysis, a Pearson's Chi-squared (χ^2) probability value is calculated. If the probability value (p) is < 0.5 then it means that there is a significant difference between the two models.

If the random slopes model was a better fitting model compared to the linear mixed model (a lower AIC) and was also significantly different (a Chi-squared value of < 0.5), then the random slopes model was used for the analysis of the AU variables.

If the random slopes model was a better fitting model compared to the linear mixed model (a lower AIC) and was not significantly different (a Chi-squared value of ≥ 0.5), then the mixed linear model was used for the analysis of the AU variables. This is to reduce the potential effect of overfitting the data, especially with a small number of participants. Overfitting the data occurs when a model becomes complex with many variables and starts to describe the random effects and noise in the data, rather than the relationship between the dependent and independent variables.

To compare the individual conditions within the model, the 'emmeans' r package was used (Lenth et al., 2020). This is the estimated marginal means package, otherwise known as least-square means. Estimated marginal means are more appropriate to use in a linear model as they account for factors within a model and adjust the means accordingly. Using the 'contrast' function, pairwise comparisons between the groups provided a detailed output including, but not limited to, the coefficient, 95% confidence limits, the *t* ratio, and *p* value for the two factors being compared.

For further information on linear mixed model effects, please refer to Thomas and Monin (2016) and Winter (2013). For further information on the 'emmeans' r package please refer to Lenth et al., (2020). For all facial movement as a measure of engagement statistical output, see Appendix H.

5.5 FACIAL MOVEMENT AS AN INDICATOR OF ENGAGEMENT

The first hypothesis of this chapter is that facial movement as a measure of engagement, and expressed through the presence and intensity of facial AU, would be greater in the TTT experiment compared to the Baseline RT dyadic interview. The second hypothesis is that there would be an increase in facial AU expression and intensity in the HT condition compared to the LT condition. The third hypothesis is that there would be an increase in facial AU expression and intensity in the Person-Specific locations condition compared to the Non-Specific locations condition. To address these hypotheses, the presence and intensity of AUs 4, 6, 12, 15 and 17 were analysed and used for the comparison between conditions. For descriptions of the AUs, refer to Table 5.1.

Linear mixed method analysis was performed for Baseline, LT and HT conditions across both groups H->L and L->H. This section describes the first set of analyses, where comparisons focus on facial movement, as an indicator of affect-driven behavioural engagement, across the different levels of technology and groups. Separate analysis was conducted for Person-Specific and Non-Specific locations. This was to minimise overfitting the model.

Table 5.1: This table describes the five AUs that were used for analysis. Each AU was chosen as they were associated with a generally clear direction of emotional affect. For each AU the Facial Action Coding System (FACS) name is listed, as well as the muscle involved in the movement and the emotion/s that the AU contributes to.

AU	FACS name	Muscle	Emotions
4	Brow lowerer	depressor glabellae, depressor supercilii, corrugator supercilii	sadness, fear, anger, confusion
6	Cheek raiser	orbicularis oculi (pars orbitalis)	happiness
12	Lip corner puller	zygomaticus major	happiness, contempt
15	Lip corner depressor	depressor anguli oris (triangularis)	sadness, disgust, confusion
17	Chin raiser	mentalis	interest, confusion

5.6 Facial movement when viewing Person-Specific locations

Descriptive statistics for the presence and intensity of the five AUs (AU04 – brow lowerer, AU06 – cheek raiser, AU12 – lip corner puller, AU15 – lip corner depressor and AU17 – chin raiser) when viewing Person-Specific locations are provided in Table 5.2. As can be seen in Table 5.2, for both the presence and intensity of all AUs across conditions, there was quite a large range and a wide standard deviation (SD). This shows the variability in the movement of the muscles associated with the AUs across participants. The presence represents the percentage of time the AU movement was expressed in the sessions from 0 (not present) to 1 (always present). Intensity represents the degree of movement and engagement of the AU on a continuous scale from 0 – least intense to 5 – most intense. Across all conditions the intensity of the AU movement stayed quite low and never exceeded a value of 2. This will be discussed further in Chapter 8.

5.6.1 Presence of facial action units viewing Person-Specific locations

For the analysis of the presence of all AUs (AU04 – brow lowerer, AU06 – cheek raiser, AU12 – lip corner puller, AU15 – lip corner depressor and AU17 – chin raiser) when viewing Person-Specific locations, the general linear mixed model was used as it met the criteria for a stronger model as outlined in section 5.4.

The linear mixed methods analysis showed significantly less presence of AU04 (brow lowerer), (t = -2.137, p = 0.035), when viewing Person-Specific locations in the LT condition (M = 0.64, SD = 0.35) compared to viewing Person-Specific locations in the HT condition (M = 0.70, SD = 0.28). There was an estimated mean difference of -0.118 on the OpenFace continuous scale, 95% CI (-0.227, -0.008). See Figure 5.2.

For the presence of all other AUs, there were no significant differences when comparing the LT and the HT conditions when viewing Person-Specific locations [AU06 – cheek raiser, (p = 0.637); AU12 – lip corner puller, (p = 0.4537); AU15 – lip corner depressor, (p = 0.1992); AU17 – chin raiser, (p = 0.8052)].

Table 5.2: Descriptive statistics for facial AUs of participants in groups Low-Tech -> High Tech (L->H) and High-Tech -> Low-Tech (H->L), during Baseline (B) and when viewing Person-Specific locations in conditions LT and HT. The presence of the AUs represent the percentage of time the AU was present from 0 (not present) to 1 (always present). The intensity of the AUs represent the intensity of the AU movement on a continuous scale from 0 (min) to 5 (max).

	Meaningful Location					
	L->H Group (*n* = 5)			H->L Group (*n* = 4)		
Action unit	B	LT	HT	B	LT	HT
Presence						
AU04 brow lowerer						
Min-Max	0.08 – 1.00	0.07 – 0.95	0.05 – 0.98	0.07 – 0.93	0.08 – 0.95	0.10 – 0.99
Mean (SD)	0.63 (0.33)	0.37 (0.21)	0.56 (0.26)	0.62 (0.24)	0.48 (0.29)	0.53 (0.25)
AU06 cheek raiser						
Min-Max	0.00 – 0.08	0.03 – 0.68	0.02 – 0.82	0.00 – 0.48	0.00 – 0.76	0.01 – 0.90
Mean (SD)	0.04 (0.03)	0.28 (0.17)	0.30 (0.23)	0.13 (0.18)	0.29 (0.25)	0.28 (0.28)
AU12 lip corner puller						
Min-Max	0.00 – 0.02	0.00 – 0.65	0.00 – 0.47	0.00 – 0.16	0.00 – 0.63	0.04 – 0.75
Mean (SD)	0.01 (0.01)	0.15 (0.16)	0.10 (0.13)	0.06 (0.05)	0.25 (0.21)	0.32 (0.22)
AU15 lip corner depressor						
Min-Max	0.04 – 0.35	0.09 – 0.47	0.09 – 0.48	0.00 – 0.48	0.03 – 0.48	0.12 – 0.59
Mean (SD)	0.18 (0.12)	0.29 (0.09)	0.29 (0.11)	0.25 (0.14)	0.27 (0.13)	0.34 (0.22)
AU17 chin raiser						
Min-Max	0.06 – 0.33	0.15 – 0.67	0.28 – 0.55	0.06 – 0.50	0.18 – 0.59	0.19 – 0.68
Mean (SD)	0.17 (0.09)	0.43 (0.13)	0.42 (0.08)	0.28 (0.13)	0.42 (0.13)	0.44 (0.13)
Intensity						
AU04 brow lowerer						
Min-Max	0.11 – 1.86	0.31 – 0.82	0.23 – 0.82	0.20 – 1.42	0.21 – 1.78	0.33 – 1.28
Mean (SD)	0.87 (0.60)	0.54 (0.16)	0.57 (0.20)	0.81 (0.40)	0.75 (0.46)	0.79 (0.30)
AU06 cheek raiser						
Min-Max	0.08 – 0.66	0.19 – 1.04	0.28 – 1.27	0.19 – 0.91	0.14 – 0.93	0.07 – 1.19
Mean (SD)	0.33 (0.18)	0.52 (0.18)	0.56 (0.24)	0.49 (0.24)	0.55 (0.23)	0.59 (0.31)
AU12 lip corner puller						
Min-Max	0.13 – 0.37	0.14 – 0.65	0.17 – 0.60	0.11 – 0.66	0.14 – 1.19	0.14 – 0.62
Mean (SD)	0.25 (0.08)	0.37 (0.11)	0.37 (0.11)	0.43 (0.14)	0.69 (0.33)	0.62 (0.29)
AU15 lip corner depressor						
Min-Max	0.22 – 0.63	0.19 – 0.98	0.22 – 1.20	0.15 – 0.95	0.20 – 1.25	0.17 – 1.30
Mean (SD)	0.34 (0.12)	0.47 (0.18)	0.60 (0.26)	0.46 (0.23)	0.58 (0.31)	0.58 (0.29)
AU17 chin raiser						
Min-Max	0.40 – 1.03	0.44 – 1.07	0.51 – 1.24	0.24 – 0.96	0.40 – 1.65	0.51 – 1.32
Mean (SD)	0.64 (0.19)	0.80 (0.18)	0.83 (0.19)	0.65 (0.21)	0.81 (0.30)	0.86(0.23)

The presence of AU04 – brow lowerer, (t = 3.176, p = 0.035), was significantly higher in the Baseline condition (M = 0.84, SD = 0.49) compared to viewing Person-Specific locations in the LT condition (M = 0.64, SD = 0.35). There was an estimated mean difference of 0.120 on the OpenFace continuous scale, 95% CI (0.074, 0.322). See Figure 5.2.

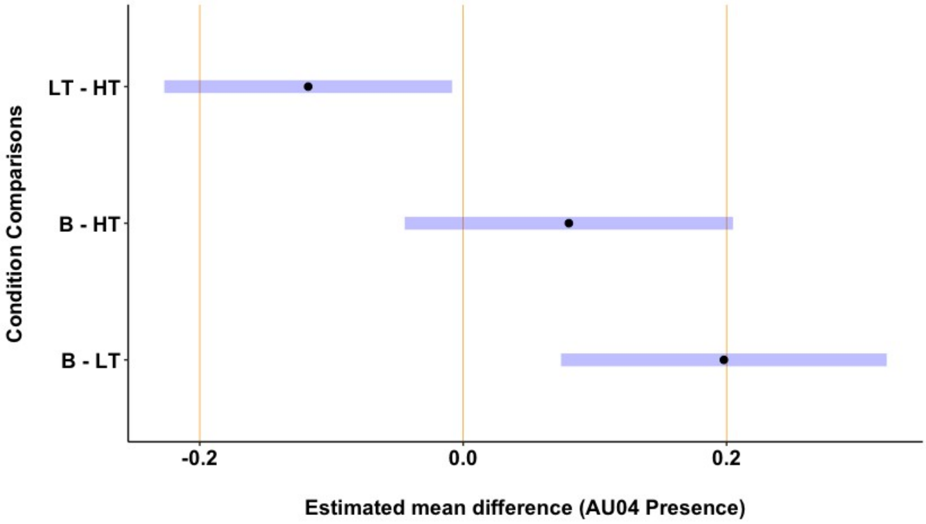


Figure 5.2: Estimated marginal means for the presence of AU04 (brow lowerer) between experimental conditions when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

There were significant differences in the presence of all AUs in the Baseline condition compared to viewing Person-Specific locations in the LT condition. There were significant differences in the presence of all AUs in the Baseline condition compared to viewing Person-Specific locations in the HT condition, except AU04 – brow lowerer (p = 0.2043).

The presence of AU06 (cheek raiser) in the Baseline condition (M = 0.43, SD = 0.22) was significantly lower (t = -4.228, p = 0.0001) compared to viewing Person-Specific locations in the LT condition (M = 0.53, SD = 0.21). There was an estimated mean difference of -0.185 on the OpenFace continuous scale, 95% CI (-0.272, -0.098). The presence of AU06 (cheek raiser) in the Baseline condition (M = 0.43, SD = 0.22) was also significantly lower (t = -4.608, p < 0.0001) compared to viewing Person-Specific locations in the HT condition (M = 0.58, SD = 0.28). There was an estimated mean difference of -0.204 on the OpenFace continuous scale, 95% CI (-0.291, -0.116). See Figure 5.3.

The presence of AU12 (lip corner puller) in the Baseline condition (M = 0.36, SD = 0.15) was significantly lower (t = -5.258, p < 0.0001) compared to viewing Person-Specific locations in the LT condition (M = 0.52, SD = 0.29). There was an estimated mean difference of -0.172 on the OpenFace continuous scale, 95% CI (-0.238, -0.107). The presence of AU12 (lip corner puller) in the Baseline condition (M = 0.36, SD = 0.15) was also significantly lower (t = -5.875, p < 0.0001) compared to viewing Person-Specific locations in the HT condition (M = 0.51, SD = 0.26). There was an estimated mean difference of -0.194 on the OpenFace continuous scale, 95% CI (-0.260, -0.129). See Figure 5.4.

The presence of AU15 (lip corner depressor) in the Baseline condition (M = 0.41, SD = 0.20) was significantly lower (t = -2.462, p = 0.0155) compared to viewing Person-Specific locations in the LT condition (M = 0.52, SD = 0.26). There was an estimated mean difference of -0.058 on the OpenFace continuous scale, 95% CI (-0.104, -0.011). The presence of AU15 (lip corner depressor) in the Baseline condition (M = 0.41, SD = 0.20) was also significantly lower (t = -3.575, p = 0.0005) compared to viewing Person-Specific locations in the HT condition (M = 0.59, SD = 0.27). There was an estimated mean difference of -0.0843 on the OpenFace continuous scale, 95% CI (-0.131, -0.038). See Figure 5.5.

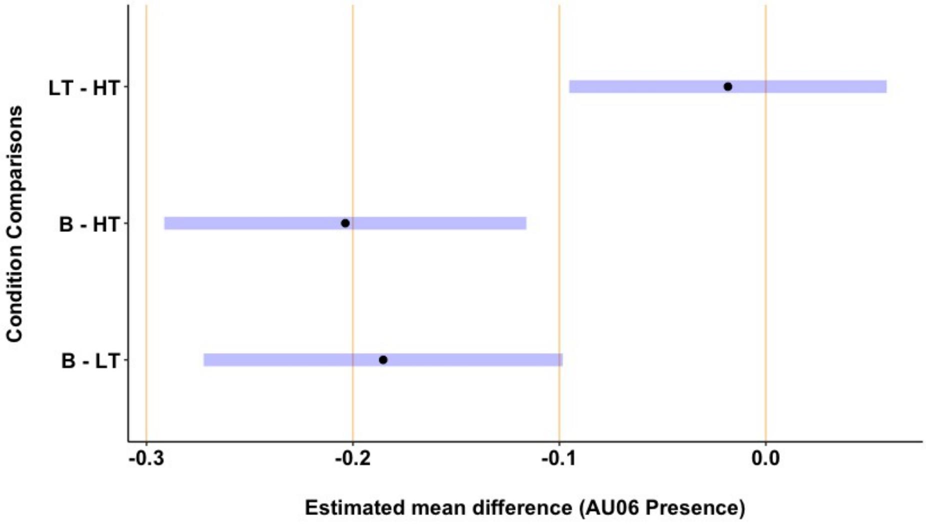


Figure 5.3: Estimated marginal means for the presence of AU06 (cheek raiser) between experimental conditions when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

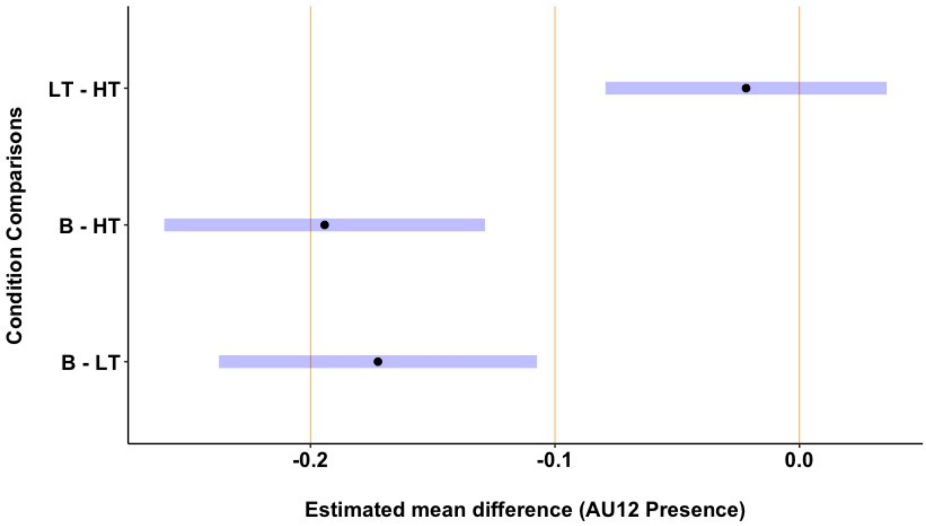


Figure 5.4: Estimated marginal means for the presence of AU12 (lip corner puller) between experimental conditions when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The presence of AU17 (chin raiser) in the Baseline condition ($M = 0.65$, $SD = 0.16$) was significantly lower ($t = -8.259$, $p < 0.0001$) compared to viewing Person-Specific locations in the LT condition ($M = 0.80$, $SD = 0.24$). There was an estimated mean difference of -0.194 on the OpenFace continuous scale, 95% CI (-0.240, -0.148). The presence of AU17 (chin raiser) in the Baseline condition ($M = 0.65$, $SD = 0.16$) was also significantly lower ($t = -8.408$, $p < 0.0001$) compared to viewing Person-Specific locations in the HT condition ($M = 0.85$, $SD = 0.21$). There was an estimated mean difference of -0.199 on the OpenFace continuous scale, 95% CI (-0.246, -0.152). See Figure 5.6.

Participants showed no significant differences in the presence of all AUs when viewing Person-Specific locations in the L->H group compared to the H->L group [AU04 – brow lowerer, ($p = 0.6635$); AU06 –

cheek raiser, (p = 0.8879); AU12 – lip corner puller, (p = 0.1387); AU15 – lip corner depressor, (p = 0.5502); AU17 – chin raiser, (p = 0.5621)].

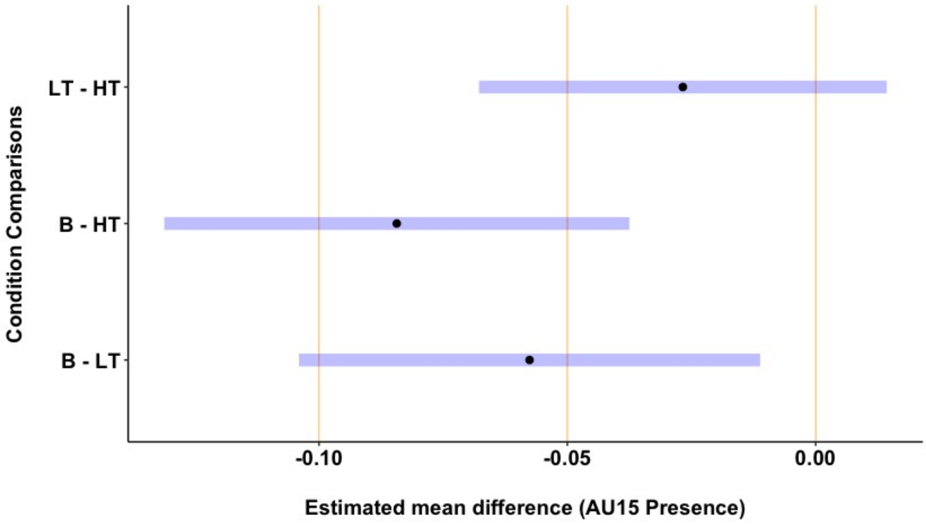


Figure 5.5: Estimated marginal means for the presence of AU15 (lip corner depressor) between experimental conditions when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

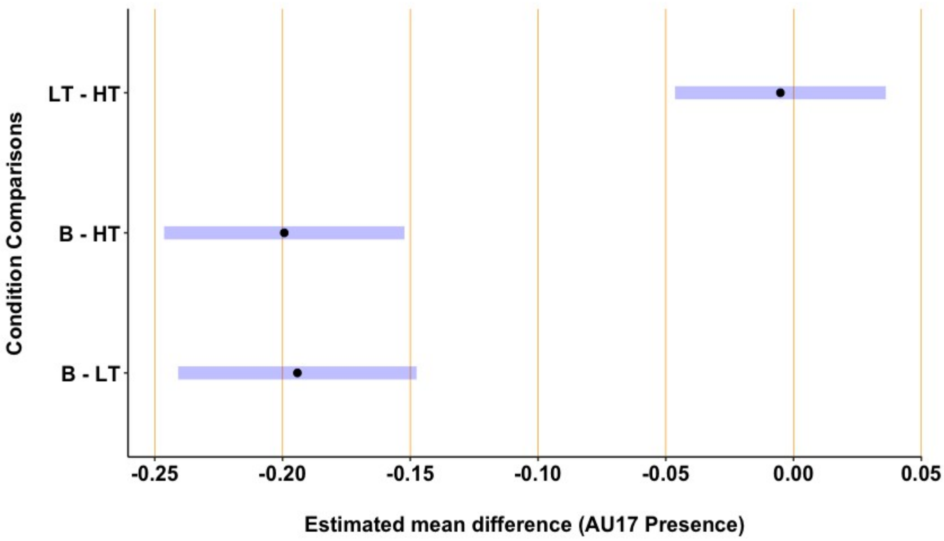


Figure 5.6: Estimated marginal means for the presence of AU17 (chin raiser) between experimental conditions when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

5.6.2 Intensity of facial action units viewing Person-Specific locations

For the analysis of the intensity of AU04 (brow lowerer) when viewing Person-Specific locations, the random slopes model was used. For all other AUs, the general linear mixed model was used as it met the criteria for a stronger model as outlined in section 5.4.

The Linear mixed methods analysis showed no significant differences in the intensity of all AUs between the LT and the HT conditions when viewing Person-Specific locations [AU04 – brow lowerer, (p = 0.6279); AU06 – cheek raiser, (p = 0.2673); AU12 – lip corner puller, (p = 0.2725); AU15 – lip corner depressor, (p = 0.169); AU17 – chin raiser, (p = 0.3518)].

There were significant differences in the Baseline condition compared to viewing Person-Specific locations in the LT condition across all AUs except AU04 – brow lowerer (p = 0.2444). There were also differences between the Baseline condition compared to viewing Person-Specific locations in the HT condition across all AUs, except AU04 (p = 0.3984).

The intensity of AU06 (cheek raiser) in the Baseline condition (M = 0.09, SD = 0.14) was significantly lower t = -2.387, p = 0.0189) compared to viewing Person-Specific locations in the LT condition (M = 0.29, SD = 0.21). There was an estimated mean difference of -0.113 on the OpenFace continuous scale, 95% CI (-0.208, -0.019). The intensity of AU06 (cheek raiser) in the Baseline condition (M = 0.09, SD = 0.14) was also significantly lower (t = -3.346, p = 0.0012) compared to viewing Person-Specific locations in the HT condition (M = 0.29, SD = 0.26). There was an estimated mean difference of -0.160 on the OpenFace continuous scale, 95% CI (-0.255, -0.065). See Figure 5.7.

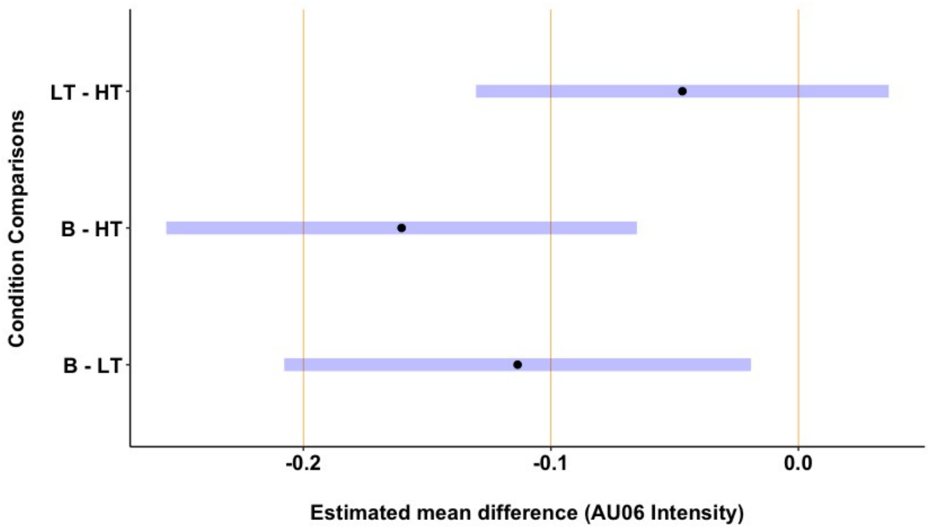


Figure 5.7: Estimated marginal means for the intensity of AU06 (cheek raiser) between experimental conditions when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The intensity of AU12 (lip corner puller) in the Baseline condition (M = 0.04, SD = 0.05) was significantly lower (t = -5.183, p < 0.0001) compared to viewing Person-Specific locations in the LT condition (M = 0.20, SD = 0.19). There was an estimated mean difference of -0.197 on the OpenFace continuous scale, 95% CI (-0.272, -0.121). The intensity of AU12 (lip corner puller) in the Baseline condition (M = 0.04, SD = 0.05) was also significantly lower (t = -4.173, p = 0.0001) compared to viewing Person-Specific locations in the HT condition (M = 0.23, SD = 0.22). There was an estimated mean difference of -0.160 on the OpenFace continuous scale, 95% CI (-0.236, -0.084). See Figure 5.8.

The intensity of AU15 (lip corner depressor) in the Baseline condition (M = 0.22, SD = 0.13) was significantly lower (t = -2.316, p = 0.0226) compared to viewing Person-Specific locations in the LT condition (M = 0.28, SD = 0.11). There was an estimated mean difference of -0.117 on the OpenFace continuous scale, 95% CI (-0.218, -0.017). The intensity of AU15 (lip corner depressor) in the Baseline condition (*M* = 0.22, *SD* = 0.13) was also significantly lower (*t* = -3.512, *p* = 0.0007) compared to viewing Person-Specific locations in the HT condition (*M* = 0.31, *SD* = 0.12). There was an estimated mean difference of -0.179 on the OpenFace continuous scale, 95% CI (-0.281, -0.078). See Figure 5.9.

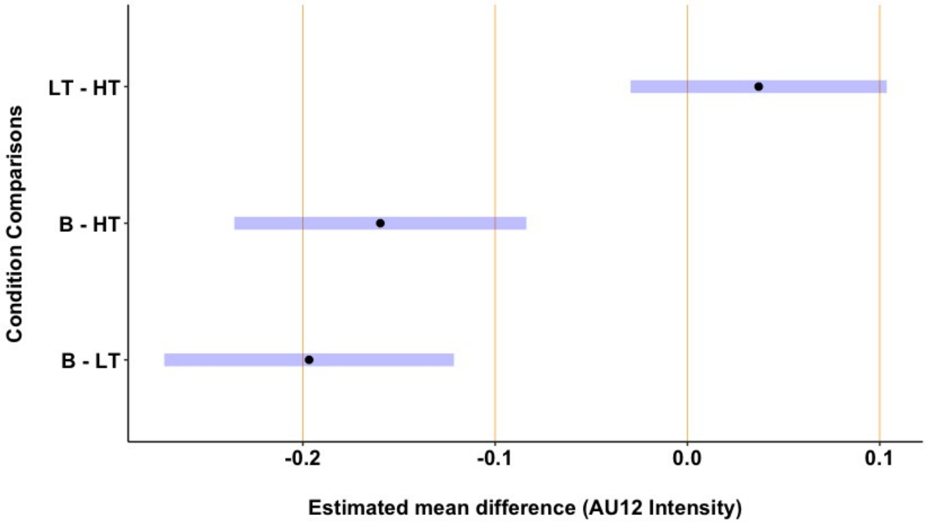


Figure 5.8: Estimated marginal means for the intensity of AU12 (lip corner puller) between experimental conditions when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

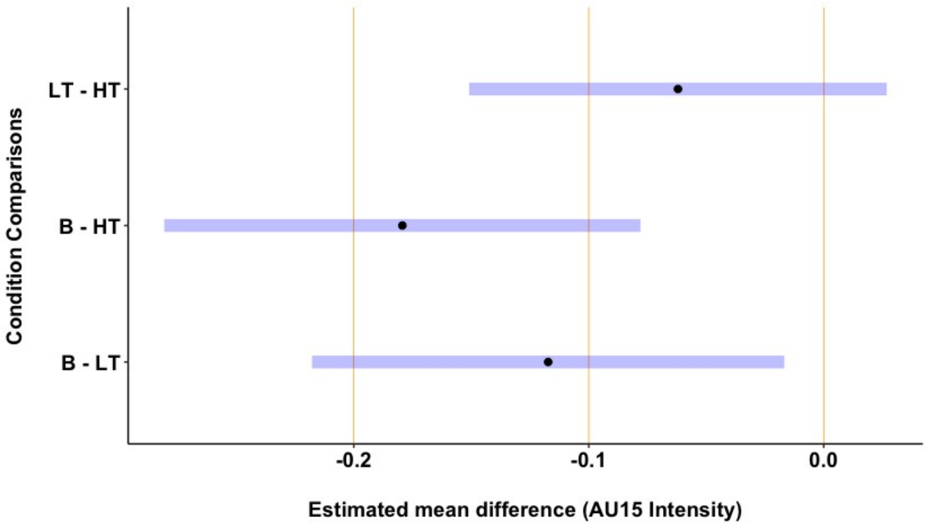


Figure 5.9: Estimated marginal means for the intensity of AU15 (lip corner depressor) between experimental conditions when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The intensity of AU17 (cheek raiser) in the Baseline condition (*M* = 0.23, *SD* = 0.13) was significantly lower (*t* = -3.858, *p* < 0.0002) compared to viewing Person-Specific locations in the LT condition (*M* = 0.42, *SD* = 0.13). There was an estimated mean difference of -0.161 on the OpenFace continuous scale, 95% CI (-0.243, -0.078). The intensity of AU17 (cheek raiser) in the Baseline condition (*M* = 0.23, *SD* = 0.13) was also significantly lower (*t* = -4.647, *p* < 0.0001) compared to viewing Person-Specific locations in the HT condition (*M* = 0.43, *SD* = 0.11). There was an estimated mean difference of -0.195 on the OpenFace continuous scale, 95% CI (-0.279, -0.112). See Figure 5.10.

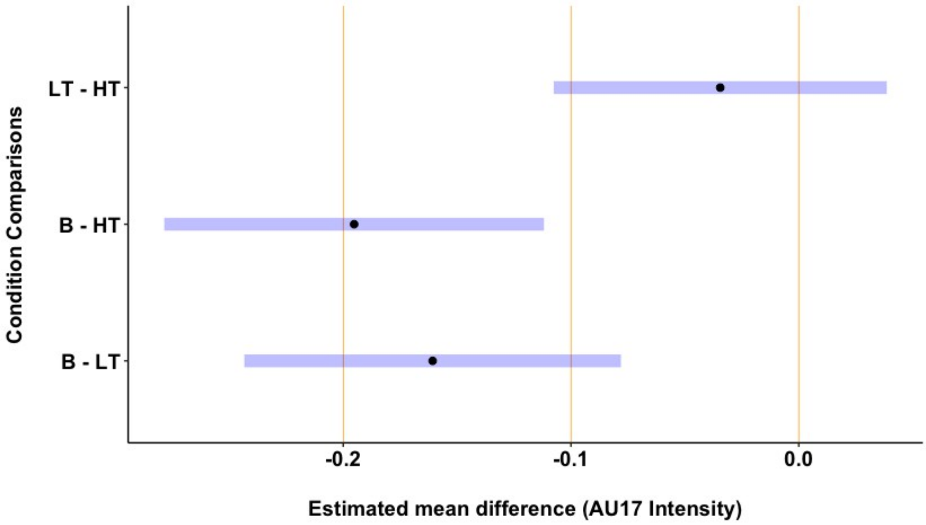


Figure 5.10: Estimated marginal means for the intensity of AU17 (chin raiser) between experimental conditions when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

Participants showed no significant differences in the intensity of all AUs between the L->H group compared to the H->L group when viewing Person-Specific locations [AU04 – brow lowerer, (p = 0.1873); AU06 – cheek raiser, (p = 0.5956); AU12 – lip corner puller, (p = 0.0567); AU15 – lip corner depressor, (p = 0.5529); AU17 – chin raiser, (p = 0.7917)].

5.6.3 Discussion

When viewing Person-Specific locations, facial movement is greater in the TTT conditions (LT and HT) compared to the Baseline condition. This pattern of responding was seen across all AUs (6 - cheek raiser, 12 - lip corner puller, 15 – lip corner depressor and 17 - chin raiser), except AU04 (brow lowerer). This supports the first hypothesis of this chapter. However, the second hypothesis of this chapter was not supported. Participants did not show an increase in facial movement in the HT condition compared to the LT condition. When looking at Person-Specific locations, neither the presence or the intensity of most AUs differed between the LT and HT technology dependent variable conditions. Only the presence of AU04 (brow lowerer) was significantly greater in the HT condition compared to the LT condition.

AU04 (brow lowerer), which is typically associated with sadness, fear, anger and confusion/perplexity (Ekman, 1979), behaved quite differently compared to the other AUs. Only for AU04, was there no significant difference in intensity across all conditions. The findings further show no significant differences in the L->H tech group compared to the H->L tech group. In short, there was greater facial movement during the TTT intervention when viewing Person-Specific locations, as observed through increased presence and intensity of AUs 06 (cheek raiser), 12 (lip corner puller), 15 (lip corner depressor) and 17 (chin raiser).

5.7 Facial movement when viewing Non-Specific locations

Descriptive statistics for the presence and intensity of the five AUs (AU04 – brow lowerer, AU06 – cheek raiser, AU12 – lip corner puller, AU15 – lip corner depressor and AU17 – chin raiser) when viewing Non-Specific locations are provided in Table 5.3. As can be seen in Table 5.3, there are similar patterns when viewing Non-Specific locations as was seen with Person-Specific locations. Both the presence and intensity of all AUs across conditions have a large range and a wide standard deviation (SD). This shows the variability in the movement of the muscles associated with the AUs across participants. Similarly, presence represents the percentage of time the AU movement was expressed in the sessions from 0 (not present) to 1 (always present). The intensity represents the degree of movement and engagement of the AU on a continuous scale from 0 – least intense to 5 – most intense. Across all conditions the intensity of the AU movement stayed quite low and never exceeded a value of 3. This will be discussed further in Chapter 8.

5.7.1 Presence of facial action units viewing Non-Specific locations

For the analysis of the presence of all AUs (AU04 – brow lowerer, AU06 – cheek raiser, AU12 – lip corner puller, AU15 – lip corner depressor and AU17 – chin raiser) when viewing Non-Specific locations, the general linear mixed model was used as it met the criteria for a stronger model, as outlined in section 5.4.

The linear mixed methods analysis showed significantly less presence of AU04 (brow lowerer) (t = -2.816, p = 0.0059), when viewing Non-Specific locations in the LT condition (M = 0.43, SD = 0.25) compared to viewing Non-Specific locations the HT condition (M = 0.59, SD = 0.24). There was an estimated mean difference of -0.148 on the OpenFace continuous scale, 95% CI (-0.252, -0.044). See Figure 5.11. For the presence of all other AUs, there were no significant differences when comparing the LT and the HT conditions when viewing Non-Specific locations [AU06, (p = 0.6723); AU12, (p = 0.954); AU15, (p = 0.3949); AU17, (p = 0.5822)].

There were significant differences in the presence of all AUs in the Baseline condition compared to viewing Non-Specific locations in the LT condition. There were significant differences in the presence of all AUs in the Baseline condition compared to viewing Non-Specific locations in the HT condition, except the presence of AU04 – brow lowerer (p = 0.6055).

Participants had a significantly higher presence of AU04 (brow lowerer), (t = 3.011, p = 0.0033), in the Baseline condition (M = 0.63, SD = 0.14) compared to viewing Non-Specific locations in the LT condition (M = 0.43, SD = 0.25). There was an estimated mean difference of 0.179 on the OpenFace continuous scale, 95% CI (0.061, 0.2967). See Figure 5.11.

The presence of AU06 (cheek raiser) in the Baseline condition (M = 0.09, SD = 0.14) was significantly lower (t = -4.262, p < 0.0001) compared to viewing Non-Specific locations in the LT condition (M = 0.29, SD = 0.25). There was an estimated mean difference of -0.188 on the OpenFace continuous scale, 95% CI (-0.275, -0.100). The presence of AU06 (cheek raiser) in the Baseline condition (M = 0.09, SD = 0.14) was also significantly lower (t = -3.855, p < 0.0002) compared to viewing Non-Specific locations in the HT condition (M = 0.26, SD = 0.26). There was an estimated mean difference of -0.171 on the OpenFace continuous scale, 95% CI (-0.259, -0.083). See Figure 5.12.

Table 5.3: Descriptive statistics for facial AUs of participants in groups Low-Tech -> High Tech (L->H) and High-Tech -> Low-Tech (H->L), during Baseline (B) and when viewing Non-Specific locations in conditions LT and HT. The presence of the AUs represent the percentage of time the AU was present from 0 (not present) to 1 (always present). The intensity of the AUs represent the intensity of the AU movement on a continuous scale from 0 (min) to 5 (max).

	Non-Specific locations					
	L->H Group (*n = 5*)			H->L Group (*n = 4*)		
Action unit	B	LT	HT	B	LT	HT
Presence						
AU04 brow lowerer						
Min-Max	0.08 – 1	0.10 – 0.86	0.07 – 0.98	0.07 – 0.93	0.06 – 1	0.06 – 1.0
Mean (SD)	0.63 (0.33)	0.4 (0.2)	0.58 (0.27)	0.62 (0.24)	0.52 (0.26)	0.6 (0.23)
AU06 cheek raiser						
Min-Max	0 – 0.08	0.02 – 0.55	0.02 – 0.85	0 – 0.48	0 – 0.88	0.01 – 0.94
Mean (SD)	0.04 (0.03)	0.21 (0.15)	0.26 (0.23)	0.13 (0.18)	0.31 (0.31)	0.25 (0.29)
AU12 lip corner puller						
Min-Max	0 – 0.02	0 – 0.53	0 – 0.33	0 – 0.16	0 – 0.68	0 – 0.75
Mean (SD)	0.01 (0.01)	0.1 (0.11)	0.07 (0.1)	0.06 (0.05)	0.21 (0.2)	0.27 – 0.21
AU15 lip corner depressor						
Min-Max	0.04 – 0.35	0.14 – 0.43	0.16 – 0.39	0 – 0.48	0.11 – 0.48	0.09 – 0.58
Mean (SD)	0.18 (0.12)	0.27 (0.08)	0.26 (0.07)	0.25 (0.14)	0.28 (0.08)	0.36 (0.12)
AU17 chin raiser						
Min-Max	0.06 – 0.33	0.19 – 0.52	0.27 – 0.62	0.06 – 0.5	0.14 – 0.65	0.21 – 0.65
Mean (SD)	0.17 (0.09)	0.4 (0.52)	0.42 (0.09)	0.28 (0.13)	0.42 (0.15)	0.43 (0.12)
Intensity						
AU04 brow lowerer						
Min-Max	0.11 – 1.86	0.20 – 0.91	0.26 – 0.84	0.20 – 1.42	0.33 – 2.55	0.40 – 1.52
Mean (SD)	0.87 (0.6)	0.53 (0.19)	0.58 (0.20)	0.81 (0.4)	0.82 (0.52)	0.89 (0.34)
AU06 cheek raiser						
Min-Max	0.08 – 0.66	0.28 – 0.88	0.3 – 1.17	0.19 – 0.91	0.24 – 1.19	0.11 – 1.40
Mean (SD)	0.33 (0.18)	0.43 (0.13)	0.49 (0.22)	0.49 (0.24)	0.58 (0.26)	0.57 (0.34)
AU12 lip corner puller						
Min-Max	0.13 – 0.37	0.1 – 0.46	0.16 – 0.50	0.11 – 0.66	0.01 – 1.10	0.13 – 1.05
Mean (SD)	0.25 (0.08)	0.33 (0.08)	0.33 (0.11)	0.43 (0.14)	0.6 – 0.26	0.57 (0.28)
AU15 lip corner depressor						
Min-Max	0.22 – 0.63	0.21 – 0.80	0.34 – 0.96	0.15 – 0.95	0.23 – 1.35	0.17 – 1.75
Mean (SD)	0.34 (0.12)	0.48 (0.16)	0.56 (0.21)	0.46 (0.23)	0.69 (0.38)	0.61 (0.36)
AU17 chin raiser						
Min-Max	0.40 – 1.03	0.49 – 1.15	0.47 – 1.00	0.24 – 0.96	0.33 – 1.19	0.43 – 1.40
Mean (SD)	0.64 (0.19)	0.82 (0.19)	0.77 (0.15)	0.65 (0.21)	0.76 (0.22)	0.23)

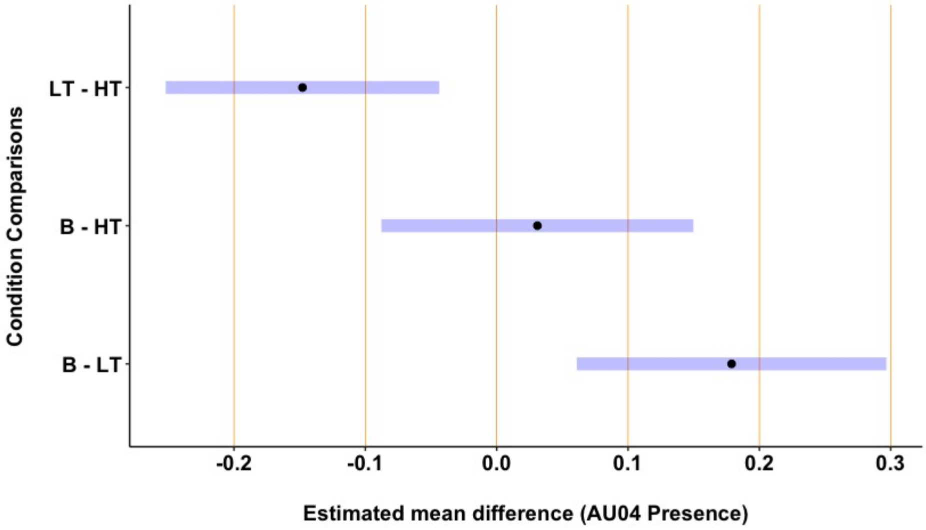


Figure 5.11: Estimated marginal means for the presence of AU04 (brow lowerer) between experimental conditions when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

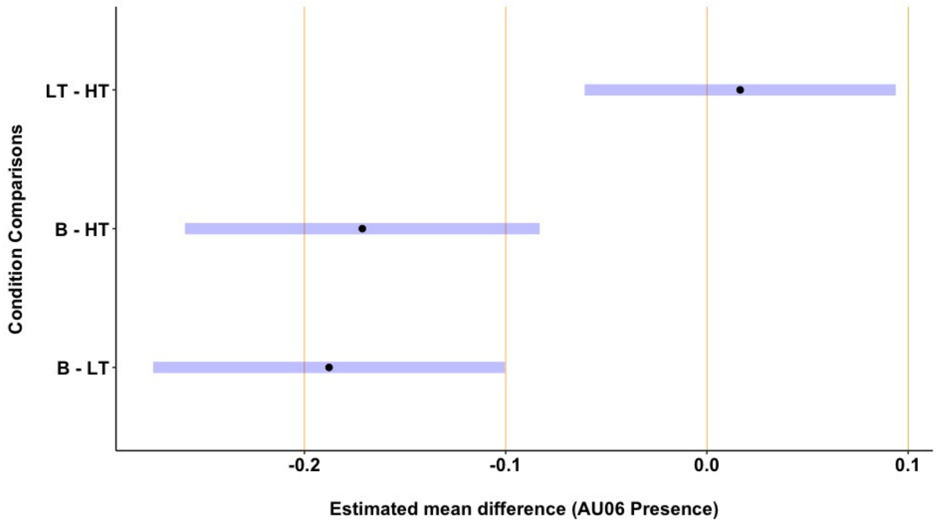


Figure 5.12: Estimated marginal means for the presence of AU06 (cheek raiser) between experimental conditions when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The presence of AU12 (lip corner puller) in the Baseline condition (M = 0.04, SD = 0.05) was significantly lower (t = -4.609, p < 0.0001) compared to viewing Non-Specific locations in the LT condition (M = 0.17, SD = 0.18). There was an estimated mean difference of -0.144 on the OpenFace continuous scale, 95% CI (-0.206, -0.082). The presence of AU12 (lip corner puller) in the Baseline condition (M = 0.04, SD = 0.05) was also significantly lower (t = -4.828, p < 0.0001) compared to viewing Non-Specific locations in the HT condition (M = 0.19, SD = 0.20). There was an estimated mean difference of -0.152 on the OpenFace continuous scale, 95% CI (-0.215, -0.090). See Figure 5.13.

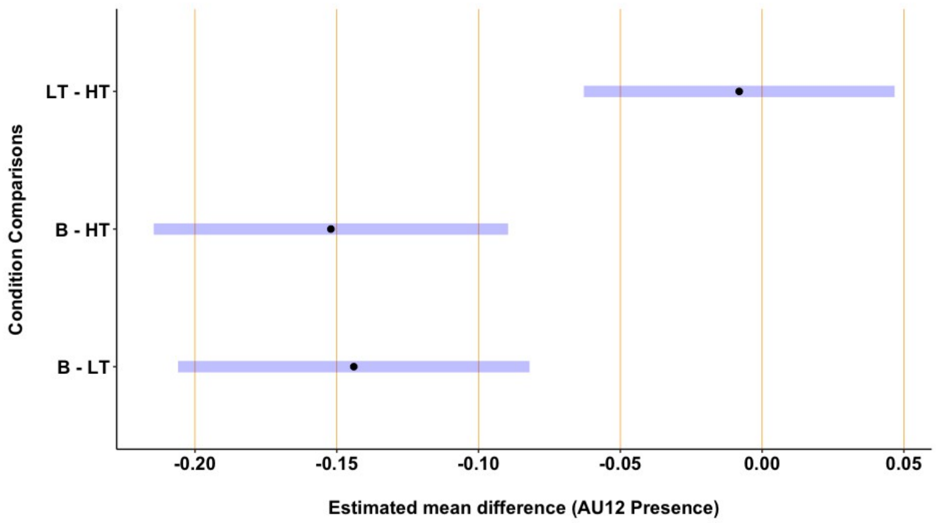


Figure 5.13: Estimated marginal means for the presence of AU12 (lip corner puller) between experimental conditions when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The presence of AU15 (lip corner depressor) in the Baseline condition (*M* = 0.22, *SD* = 0.13) was significantly lower (*t* = -2.407, *p* = 0.0179) compared to viewing Person-Specific locations in the LT condition (*M* = 0.28, *SD* = 0.08). There was an estimated mean difference of -0.058 on the OpenFace continuous scale, 95% CI (-0.106, -0.010). The presence of AU15 (lip corner depressor) in the Baseline condition (*M* = 0.22, *SD* = 0.13) was also significantly lower (*t* = -3.533, *p* = 0.0006) compared to viewing Person-Specific locations in the HT condition (*M* = 0.32, *SD* = 0.12). There was an estimated mean difference of -0.086 on the OpenFace continuous scale, 95% CI (-0.134, -0.0376). See Figure 5.14.

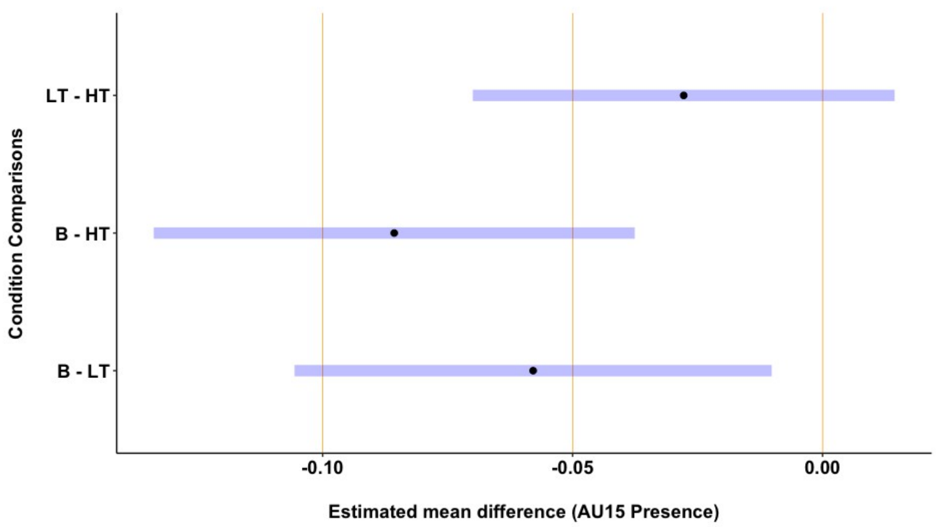


Figure 5.14: Estimated marginal means for the presence of AU15 (lip corner depressor) between experimental conditions when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The presence of AU17 (chin raiser) in the Baseline condition (*M* = 0.23, *SD* = 0.13) was significantly lower (*t* = -7.081, *p* < 0.0001) compared to viewing Non-Specific locations in the LT condition (*M* = 0.40, *SD* = 0.13). There was an estimated mean difference of -0.174 on the OpenFace continuous scale, 95% CI (-0.223, -0.126). The presence of AU17 (chin raiser) in the Baseline condition (*M* = 0.23, *SD* = 0.13) was also significantly lower (*t* = -7.895, *p* < 0.0001) compared to viewing Non-Specific locations in the HT condition (*M* = 0.43, *SD* = 0.11). There was an estimated mean difference of -0.196 on the OpenFace continuous scale, 95% CI (-0.245, -0.147). See Figure 5.15.

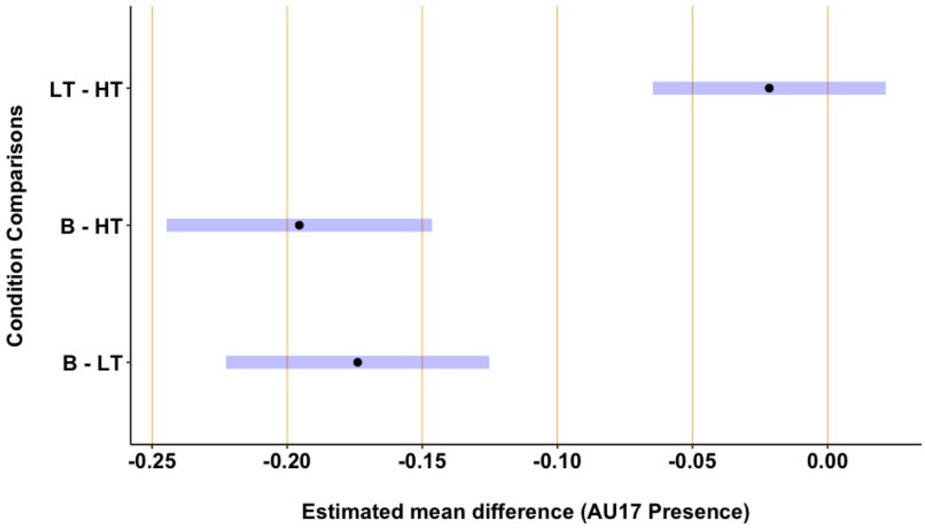


Figure 5.15: Estimated marginal means for the presence of AU17 (chin raiser) between experimental conditions when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

Participants showed no significant differences in the presence of all AUs (AU04 – brow lowerer, AU06 – cheek raiser, AU12 – lip corner puller, AU15 – lip corner depressor and AU17 – chin raiser) when viewing Non-Specific locations in the L->H group compared to the H->L group [AU04, (*p* = 0.4808); AU06, (*p* = 0.6478); AU12, (*p* = 0.0873); AU15, (*p* = 0.1586); AU17, (*p* = 0.4304)].

5.7.2 Intensity of facial action units viewing personally? Non-Specific locations

For the analysis of the intensity of AU04 (brow lowerer) when viewing Non-Specific locations, the random slopes model was used. For all other AUs, the general linear mixed model was used as it met the criteria for a stronger model as outlined in section 5.4.

The Linear mixed methods analysis showed no significant differences in the intensity of all AUs between the LT and the HT conditions when viewing Non-Specific locations [AU04 – brow lowerer, (*p* = 0.7734); AU06 – cheek raiser, (*p* = 0.548); AU12 – lip corner puller, (*p* = 0.377); AU15 – lip corner depressor, (*p* = 0.8315); AU17 – chin raiser, (*p* = 0.9985)].

There were significant differences between the Baseline condition compared to viewing Person-Specific locations in the LT condition across all AUs, except AU04 – brow lowerer (*p* = 0.5815). There were also differences between the Baseline condition compared to viewing Person-Specific locations in the HT condition across all AUs, except AU04 – brow lowerer (*p* = 0.7635).

The intensity of AU06 (chin raiser) in the Baseline condition (*M* = 0.42, *SD* = 0.23) was significantly lower (*t* = -2.246, *p* = 0.0269) compared to viewing Person-Specific locations in the LT condition (*M* = 0. 14, *SD* = 0.22). There was an estimated mean difference of -0.098 on the OpenFace continuous scale, 95% CI (-0.184, -0.011). The intensity of AU06 (chin raiser) in the Baseline condition (*M* = 0.42, *SD* = 0.23) was also significantly lower (*t* = -2.756, *p* = 0.0070) compared to viewing Person-Specific locations in the HT condition (*M* = 0.54, *SD* = 0.30). There was an estimated mean difference of -0.121 on the OpenFace continuous scale, 95% CI (-0.208, -0.034), Figure 5.16.

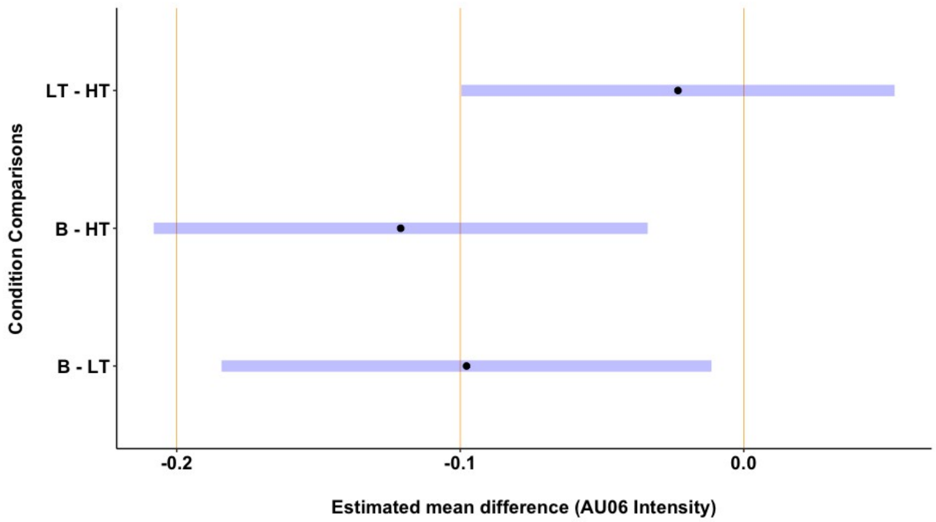


Figure 5.16: Estimated marginal means for the intensity of AU06 (cheek raiser) between experimental conditions when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The intensity of AU12 (lip corner puller) in the Baseline condition (*M* = 0.36, *SD* = 0.15) was significantly lower (*t* = -4.186, *p* < 0.0001) compared to viewing Non-Specific locations in the LT condition (*M* = 0.47, *SD* = 0.25). There was an estimated mean difference of -0.142 on the OpenFace continuous scale, 95% CI (-0.209, -0.075). The intensity of AU12 (lip corner puller) in the Baseline condition (*M* = 0.36, *SD* = 0.15) was also significantly lower (*t* = -3.373, *p* = 0.0011) compared to viewing Non-Specific locations in the HT condition (*M* = 0.47, *SD* = 0.25). There was an estimated mean difference of -0.115 on the OpenFace continuous scale, 95% CI (-0.183, -0.048). See Figure 5.17.

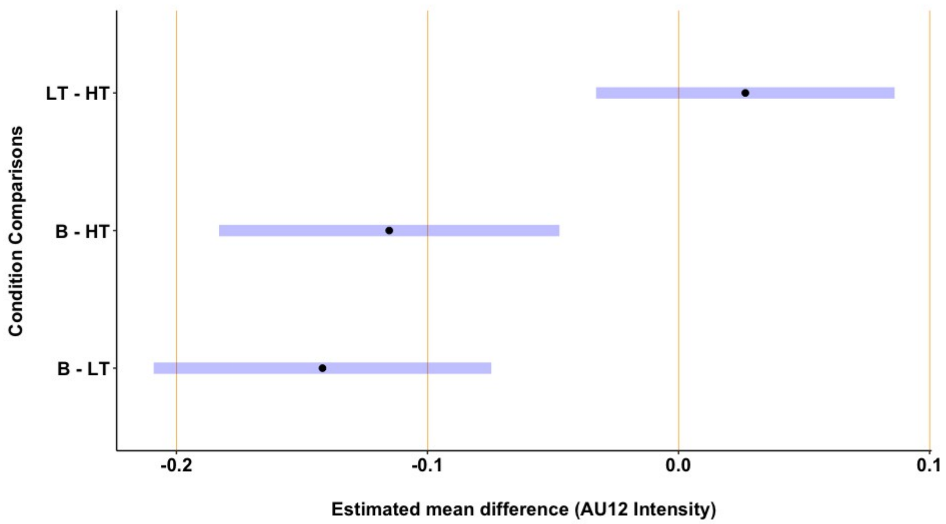


Figure 5.17: Estimated marginal means for the intensity of AU12 (lip corner puller) between experimental conditions when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The intensity of AU15 (lip corner depressor) in the Baseline condition (*M* = 0.41, *SD* = 0.20) was significantly lower ($t = -2.845$, $p = 0.0054$) compared to viewing Non-Specific locations in the LT condition (*M* = 0.55, *SD* = 0.28). There was an estimated mean difference of -0.154 on the OpenFace continuous scale, 95% CI (-0.261, -0.047). The intensity of AU15 (lip corner depressor) in the Baseline condition (*M* = 0.41, *SD* = 0.20) was also significantly lower ($t = -3.330$, $p = 0.0012$) compared to viewing Non-Specific locations in the HT condition (*M* = 0.59, *SD* = 0.30). There was an estimated mean difference of -0.181 on the OpenFace continuous scale, 95% CI (-0.289, -0.073). See Figure 5.18.

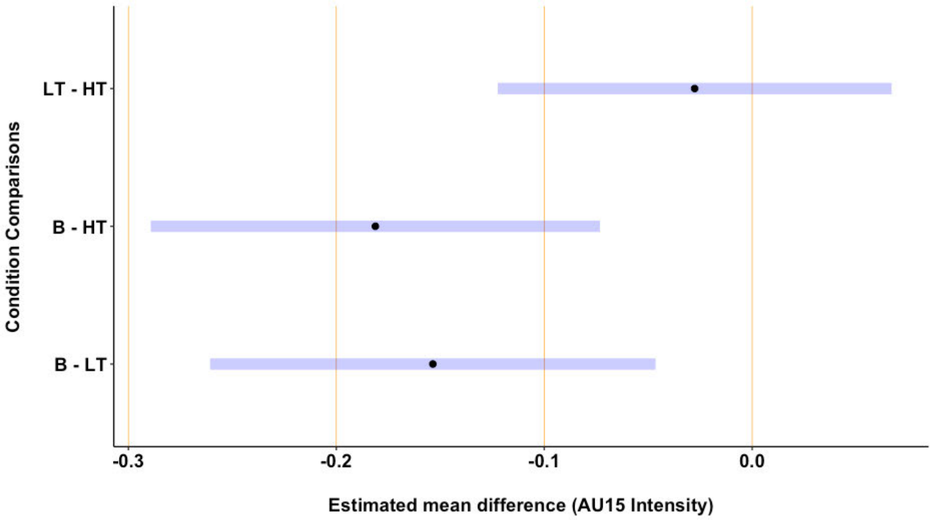


Figure 5.18: Estimated marginal means for the intensity of AU15 (lip corner depressor) between experimental conditions when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

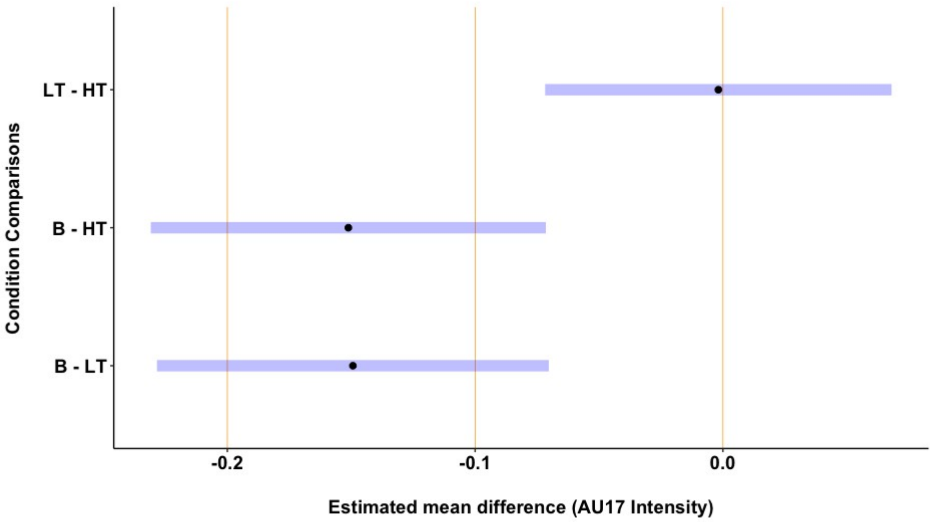


Figure 5.19: Estimated marginal means for the intensity of AU17 (chin raiser) between experimental conditions when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The intensity of AU17 (chin raiser) in the Baseline condition (*M* = 0.65, *SD* = 0.20) was significantly lower ($t = -3.747$, $p < 0.0003$) compared to viewing Non-Specific locations in the LT condition (*M* = 0.79, *SD* = 0.20). There was an estimated mean difference of -0.149 on the OpenFace continuous scale, 95% CI (-0.228, -0.070). The intensity of AU17 (chin raiser) in the Baseline condition (*M* = 0.65, *SD* = 0.20) was also significantly lower (*t* = -3.762, *p* = 0.0003) compared to viewing Non-Specific locations in the HT condition (*M* = 0.80, *SD* = 0.20). There was an estimated mean difference of -0.151 on the OpenFace continuous scale, 95% CI (-0.231, -0.071). See Figure 5.19.

The linear mixed methods analysis showed the intensity of AU12 (lip corner puller) was significantly lower (*t* = -2.471, *p* = 0.0428) in the L->H group (*M* = 0.31, *SD* = 0.10) compared to the H->L group (*M* = 0.56, *SD* = 0.26). There was an estimated mean difference of -0.26 on the OpenFace continuous scale, 95% CI (-0.512, -0.011). See Figure 5.20. For all other AUs, there was no significant difference between the LT and the HT conditions [AU04 – brow lowerer, (*p* = 0.1234); AU06 – cheek raiser, (*p* = 0.4102); AU15 – lip corner depressor, (*p* = 0.3465); AU17 – chin raiser, (*p* = 0.908)].

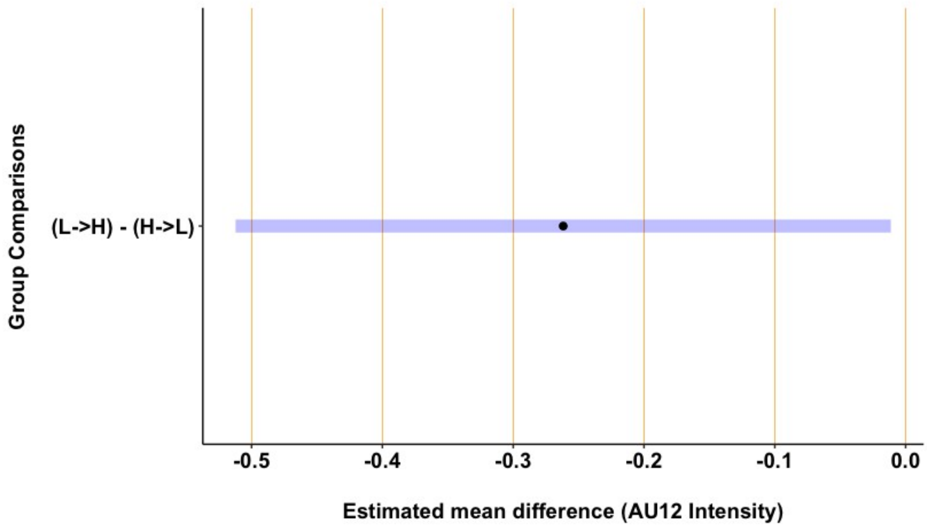


Figure 5.20: Estimated marginal means for the intensity of AU12 (lip corner puller) between experimental groups when viewing Non-Specific locations; L->H = Low-Tech to High-Tech group and (H->L) = High-Tech to Low-Tech group.

5.7.3 Discussion

The results for participant facial movements when viewing Non-Specific locations were similar to the findings when participants viewed Person-Specific locations. The results support the first hypothesis, but not the second hypothesis. Both the LT and the HT conditions had greater presence and intensity of AU06 (cheek raiser), AU12 (lip corner puller), AU15 (lip corner depressor) and AU17 (chin raiser) compared to the Baseline condition. This effect was not greater for the HT condition compared to the LT condition.

AU04 (brow lowerer) responded with a different pattern to the other AUs in that it was once again the only AU to have a greater presence in the HT condition compared to the LT condition. There was also no significant difference in the intensity of AU04 across all conditions. The was one observable difference in the patterns of the presence and intensity of AUs in the Non-Specific locations condition compared to the Person-Specific locations condition. Within the Non-Specific locations condition only AU12 (lip corner puller) showed a greater intensity in the H->L tech group compared to the L->H tech group.

In short, there was greater facial movement during the TTT intervention when viewing Non-Specific locations, as observed through increased presence and intensity of AUs 06 (cheek raiser), 12 (lip corner puller), 15 (lip corner depressor) and 17 (chin raiser).

5.8 Facial action unit comparisons between Person-Specific and Non-Specific locations

As discussed in chapter 2, RT is used widely in aged care facilities to promote engagement and socialisation (Woods, 2018). It is important to understand the effects that visiting Person-Specific locations have on engagement. This will provide insight into the impact of the TTT experiment on older adults with known and unknown personal history. Essentially, there will be an understanding of whether the TTT activity is beneficial for people in aged care facilities who do not have known Person-Specific locations. For example, when first entering a facility or when an older adult may not remember their past and may not have family to assist in suggesting locations.

In the previous section 5.6 similar patterns in AU responses for the Person-Specific and the Non-Specific locations across conditions were noted. Here, the impact these locations on the facial movement are compared as third hypothesis of this chapter is addressed. That is, if reminiscence stimuli is more engaging than ordinary stimuli, then the presence and intensity of facial AUs will be greater when viewing Person-Specific locations compared to viewing Non-Specific locations. By comparing the degree of effect on the intensity and presence of the AUs, the impact of viewing Person-Specific locations compared to Non-Specific locations will be explored.

For the comparison of Person-Specific and Non-Specific locations, linear mixed model analysis was conducted. The group variable was removed from the analysis model as it was shown to have no significant effect on the individual groups, except for the intensity of AU12 (lip corner puller). This was decided so that the model would not be overfitted with too many variables when including location as a factor. The Baseline measures were also removed as the interest was in the type of location, either being Person-Specific or Non-Specific, within the TTT experiment. The model followed the same format and criteria as outlined in 5.4.

The equation used for the linear mixed model was:

```
res2=lmer(AU ~ Con + Location + (1|ID), data=BC_data)
```

The equation used for the random slopes model was:

```
res3 = lmer(AU ~ Con + Location + (1 + Con|ID), REML = TRUE, data = BC_data)
```

Where, ‘location’ now represents either Person-Specific (PS) or Non-Specific (NS).

For the analysis of the presence and intensity of all AU04 (brow lowerer), AU06 (cheek raiser), AU12 (lip corner puller), and AU17 (chin raiser), except the intensity of AU15 (lip corner depressor), the general linear mixed model was used as it met the criteria for a stronger model as outlined in section 5.4. For the intensity of AU15 (lip corner depressor), the random slopes model was used as it had a better fit.

Descriptive statistics for the presence and intensity of the AU04 (brow lowerer), AU06 (cheek raiser), AU12 (lip corner puller), AU15 (lip corner depressor) and AU17 (chin raiser) when viewing Person-

Specific and Non-Specific locations are provided in Table 5.4. As can be seen in Table 5.4, there are similar patterns in the range, means and standard deviation across conditions for the presence and intensity of AUs. As previously mentioned, presence represents the percentage of time the AU movement was expressed in the sessions from 0 (not present) to 1(always present). The Intensity represent the degree of movement and engagement of the AU on a continuous scale from 0 – least intense to 5 – most intense. Two of the main figures that stand out are firstly, the range of intensity for AU04 (brow lowerer) and AU12 (lip corner puller) in the Non-Specific locations condition compared to the Person-Specific locations condition.

Table 5.4: Descriptive statistics for the presence and intensity of facial AUs of participants when viewing Non-Specific (NS) and Person-Specific (PS) locations. NS and PS locations include both LT and HT conditions for that location. The presence of the AUs represent the percentage of time the AU was present from 0 (not present) to 1 (always present). The intensity of the AUs represent the intensity of the AU movement on a continuous scale from 0 (min) to 5 (max).

	Presence		Intensity	
Action unit	NS	PS	NS	PS
AU04				
brow lowerer				
Min-Max	0.057 – 1.00	0.048 – 0.991	0.203 – 2.548	0.206 – 1.776
Mean (SD)	0.51 (0.26)	0.479 (0.258)	0.706 (0.380)	0.666 (0.316)
AU06				
cheek raiser				
Min-Max	0.004 – 0.943	0 – 0.905	0.110 – 1.403	0.067 – 1.27
Mean (SD)	0.272 (0.260)	0.288 (0.234)	0.526 (0.260)	0.556 (0.244)
AU12				
lip corner puller				
Min-Max	0 – 0.752	0 – 0.752	0.01 – 1.098	0.139 – 1.188
Mean (SD)	0.179 (0.189)	0.212 (0.202)	0.468 (0.251)	0.519 (0.275)
AU15				
lip corner depressor				
Min-Max	0.092 – 0.575	0.028 – 0.585	0.167 – 1.746)	0.17 – 1.305
Mean (SD)	0.284 (0.101)	0.298 (0.118)	0.569 (0.289)	0.554 (0.265)
AU17				
chin raiser				
Min-Max	0.139 – 0.654	0.154 – 0.683	0.334 – 1.403	0.397 – 1.65
Mean (SD)	0.414 (0.117)	0.428 (0.118)	0.795 (0.199)	0.827 (0.229)

For the presence and intensity of all AUs, except the intensity of AU12 (lip corner puller), there were no significant differences when viewing Person-Specific compared to Non-Specific locations [Presence: AU04 – brow lowerer, (p = 0.3788); AU06 – cheek raiser, (p = 0.5782); AU12 – lip corner puller, (p = 0.1177); AU15 – lip corner depressor, (p = 0.7746); AU17 – chin raiser, (p = 0.3298); Intensity: AU04, (p = 0.3606); AU06, (p = 0.2741); AU15, (p = 0.6780); AU17, (p = 0.2408)].

Participants had a greater intensity of AU12 (lip corner puller) when viewing Person-Specific locations (M = 0.52, SD = 0.28) compared to viewing Non-Specific locations (M = 0.47, SD = 0.25). There was an estimated mean difference of 0.050 on the OpenFace continuous scale, 95% CI (0.006, 0.095). See Figure 5.21.

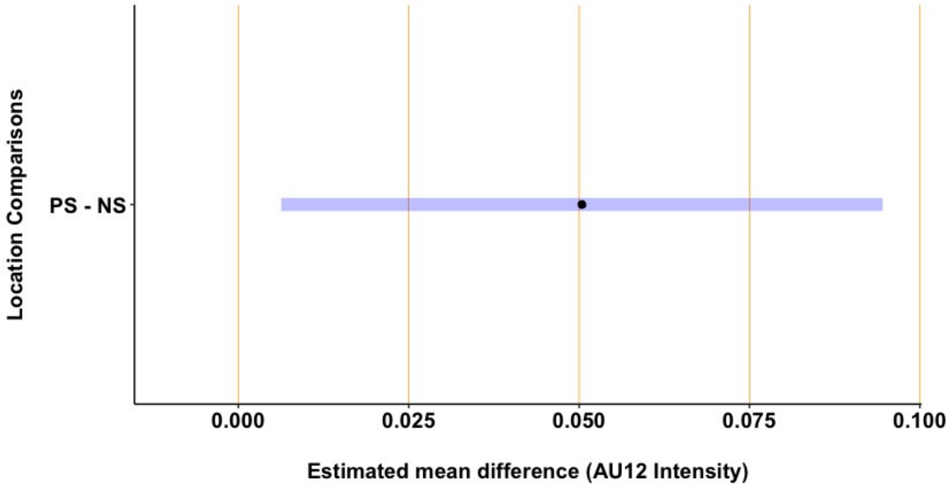


Figure 5.21: Estimated marginal means for the intensity of AU12 (lip corner puller) when participants viewed Person-Specific locations (PS) compared to Non-Specific locations (NS).

5.9 Discussion of facial movement

The first question of this chapter was, 'What are the facial movement characteristics of older adults during the TTT experiment and how does this differ to a structured dyadic RT interview?'. Based on previous research it was predicted that the TTT experiment would promote greater presence and intensity of facial AUs compared to the Baseline RT interview. The results show that facial movement as a measure of engagement, has greater expression and intensity, when participating in the TTT experiment compared to a structured dyadic RT interview. This was seen with greater AU presence and intensity in both the Non-Specific locations condition and Person-Specific locations condition, compared to the Baseline dyadic RT interview. Thus, the first hypothesis was supported.

The second question of this chapter was, 'To what extent does the dynamic and immersive nature of technology mediate facial movement differences when participating in a LT version compared to a HT version of TTT?'. Based on previous research where technology compared to no technology elicits greater engagement and positive affect, it was predicted that the HT version of TTT would have greater engagement outcomes compared to the LT version of TTT. There were, however, no significant differences in the LT condition compared to the HT condition when viewing Non-Specific and Person-Specific locations. This does not support the second hypothesis and suggests that a more dynamic, interactive and immersive technology does not increase facial movement more than a less dynamic, interactive and immersive technology.

Lastly, the third research question was, 'To what extent does the reminiscence and personal familiarity of a location mediate facial movement differences when viewing Non-Specific compared to Person-Specific locations?'. Based on previous evidence from studies of RT, it was predicted that the Person-Specific locations would have greater engagement outcomes compared to the Non-Specific locations. The findings show only AU12 (lip corner puller), which is associated with happiness, had significantly greater intensity when viewing Person-Specific locations compared to Non-Specific locations. This means that the number of times AU12 (lip corner puller) was expressed across locations was comparable. However, the response was more intense when viewing Person-Specific locations. All other presence and intensity of AUs were not significantly different between locations. Therefore, the third hypothesis was partially supported.

AU04 (brow lowerer) which contributes to sadness, fear, anger, and to confusion, was most prominent in being different in the trend of behaviour across the conditions. For both Person-Specific and Non-Specific conditions, participants had reduced expression of AU04, the brow lowerer, in the LT condition, compared to the Baseline and HT conditions. This difference was only seen in the presence of AU04, as the results show a comparable intensity of AU04 across location specificity conditions or technology conditions.

Contextually, the discourse interview which was the baseline, was different to the TTT sessions as the TTT sessions involved a group environment as well as digital technology. Therefore, the difference that is seen between the TTT condition and the Baseline interview is, in part, due to multiple interactions explained by the CPMGE framework (Cohen-Mansfield et al., 2017). First, there would be person-environment interactional differences. With the inclusion of peers in the TTT environment, there is the social expectation and influence to accommodate for other people in the room when interacting. Second, person-stimulus interactions with the inclusion of digital technology to interact with, which may be more stimulating. Third, environment-stimulus interactions with other clients encouraging engagement with the shared experience of the technology and locations visited.

In regards to reminiscence, the Person-Specific locations condition was comparable to the Non-Specific locations condition for AU04 (brow lowerer), AU06 (cheek raiser), AU15 (lip corner depressor) and AU17 (chin raiser). This suggests that the inclusion of a digital technology is beneficial compared to no digital technology. The dynamic nature and interactiveness of the TTT interface, whether LT or HT, and group factors, promotes facial movements in older adults, regardless of whether the location is Person-Specific to a participant. It should be noted, however, that some of the interviews did include a guest in the room that was either a family client, or for two of the occasions another researcher. This could technically be classified as a group, however, the way the interviews were constructed, the conversation was generally limited to myself, being the interviewer, and the participant.

One of the main differences between the Non-Specific locations condition and the Person-Specific locations condition was seen with AU12 (lip corner puller). In the Non-Specific locations condition, participants in the H->L tech group had greater intensity of AU12 (lip corner puller), compared to the L->H tech group. This was not seen for the intensity of AU12 when viewing Person-Specific locations, whereby there was no significant difference found between the groups. It is unknown what may have contributed to the variation in this specific AU between the two groups. It may be that since two of the four clients in the H->L group are married, they socially may elicit a greater tendency to use AU12 (lip corner puller). This is compared to the L->H tech group who do not have the same history in social connection. AU12 contributes to the emotions of happiness and contempt. Happiness involves the expression of AU12 from both sides of the face and contempt involves the expression of AU12 from one side of the face. Happiness is associated with a positive affect and contempt is associated with negative affect. In the context of facial movement analysis, AU12 is typically associated with positive affect (Ekman, 1965; Ekman et al., 1980; Mortillaro et al., 2011). This is due to facial analysis programs measuring AU12 as a combination of both sides of the face compared to the analysis of AU12 from one side of the face. Therefore, technology driven reminiscence programs is shown to increase engagement as seen through affect-driven behavioural facial movements, associated with positive affect.

When comparing the Person-Specific and Non-Specific locations, another significant difference was that participants had a greater intensity of AU12 (lip corner puller) when viewing the Person-Specific locations compared to the Non-Specific locations. The lip corner puller is involved in the emotions of happiness and is associated with positive affect (Mortillaro et al., 2011). The findings suggest viewing Person-Specific locations increases the intensity of positive affect-driven behavioural facial movements compared to viewing Non-Specific locations.

In conclusion, it is suggested that the participation in TTT experiment promoted the presence and intensity of facial movements. There is ambiguity as to the affective outcome of the facial movement when interpreting singular AUs. Specific facial expressions involve the expression of multiple AUs at the same time. However, with consideration to previous research, the current findings suggest viewing Person-Specific locations may increase positive affect-driven behavioural engagement.

5.10 Cognitive capacity as a covariate

It was originally thought that the cognitive capacity of the participants would be a covariate for the observed effects on engagement. A few studies have shown that facial expressions of negative affective states in people with cognitive decline, such as pain and apathy, are greater when compared to people without cognitive impairment (Kunz et al., 2007; Seidl et al., 2012). It has been suggested that this increase in emotional expression is due to a reduced control of negative emotion (Smith, 1995).

Unfortunately, there is a limitation in previous research describing the intensity of facial expression of positive affective states in people with dementia. As people with dementia often have difficulties providing self-reported ratings, most of previous research focuses on facial expressions of negative affect, as it is important to understand facial expressions as an indicator of pain (Helme, 2006; Herr et al., 2006). When observing facial expressions across the lifespan, it was found that there were no significant differences in the intensity of positive (Rohr et al., 2017) and negative emotions (Borod et al., 2004). With a predominant interest in the expression of negative affect, there is a limitation in the understanding of how positive affect is expressed in people with dementia.

Within this study, the Mini-Mental State Examination (MMSE; Folstein et al., 1975) was used to measure the cognitive capacity of the participants and to ensure that the experimental groups had similar MMSE mean and standard deviation, described in section 3.2. As a covariate, it was expected that people with a lower MMSE, and therefore greater cognitive impairment, would have lower presence of AUs and greater intensity of AU expression. Surprisingly there were no significant interactions between MMSE and the AU presence or intensity.

5.10.1 MMSE covariate effect on facial movement

As an example, Figure 5.22 and Figure 5.23 show the presence of AU06 (brow lowerer) when viewing Person-Specific locations and AU15 (lip corner depressor) when viewing Non-Specific locations, respectively, for individual participants across the different conditions. The colours of the lines are scaled to each participant's MMSE score. As seen in the graph there are no specific clusters of MMSE responses. If people with cognitive impairment were to be less reactive, then it would have been predicted that they would have a lower presence score across the conditions and that would be reflected with darker lines at the bottom of the graph and lighter lines at the top of the graph. When MMSE was included as a variable in the model, there was no significance found for variation in the presence AU06 (*p* = 0.305) when viewing Person-Specific locations, or AU15, (*p* = 0.422) when viewing Non-Specific locations.

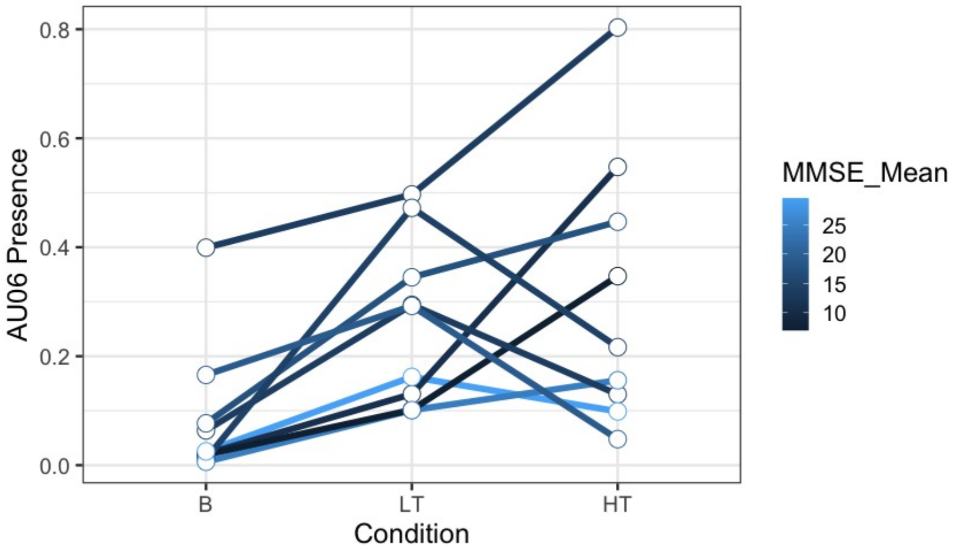


Figure 5.22: The presence of AU06 (cheek raiser) for individual participants when viewing Person-Specific locations across conditions: B = Baseline, LT = Low-Tech and HT = High-Tech. The lines are coloured to reflect the MMSE of the individual with a lighter colour representing a higher cognitive capacity and a darker colour representing a lower cognitive capacity.

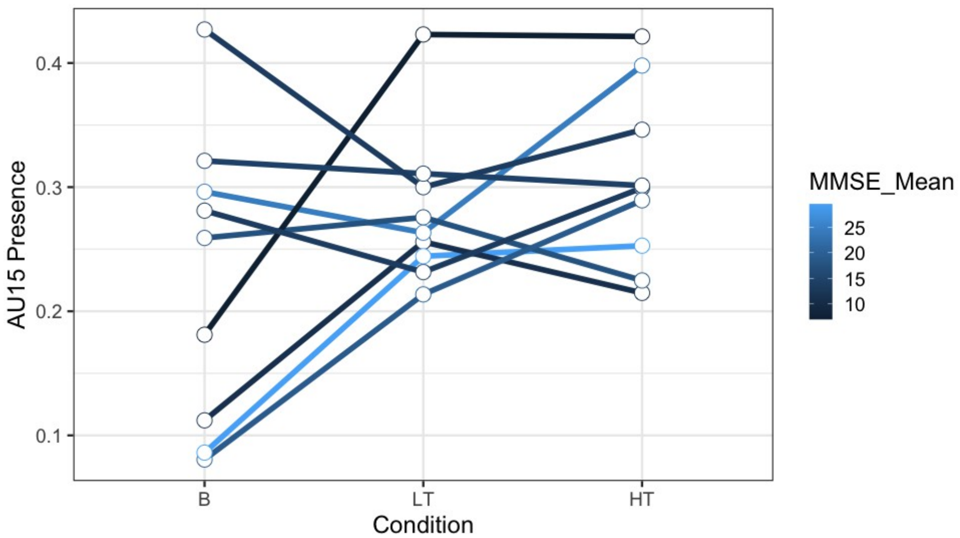


Figure 5.23: The presence of AU15 (lip corner depressor) for individual participants viewing Non-Specific locations across conditions: B = Baseline, LT = Low-Tech and HT = High-Tech. The lines are coloured to reflect the MMSE of the individual with a lighter colour representing a higher cognitive capacity and a darker colour representing a lower cognitive capacity.

Figure 5.24 and Figure 5.25 show the intensity of AU06 when viewing at Person-Specific locations and AU15 when viewing Non-Specific locations, respectively, for individual participants across the different conditions. The colours of the lines are scaled to each participant's MMSE score. As seen in the graph there are no specific clusters of MMSE responses. If people with cognitive impairment were to have greater intensity of facial expressions, then it would have been predicted that they would have a higher intensity score across the conditions and that would be reflected with darker lines at the top of the graph and lighter lines at the bottom. When MMSE, as a variable was included in the model, there was no significance found for variation in the intensity AU06 (*p* = 0.544) when viewing Person-Specific locations, or AU15, (*p* = 0.611) when viewing Non-Specific locations.

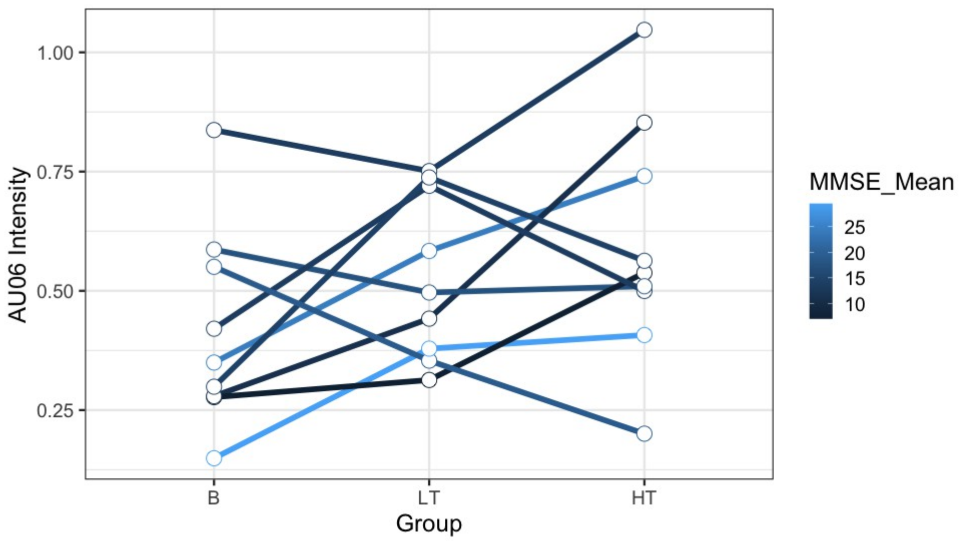


Figure 5.24: The intensity of AU06 (cheek raiser) for individual participants viewing Person-Specific locations across conditions: B = Baseline, LT = Low-Tech and HT = High-Tech. The lines are coloured to reflect the MMSE of the individual with a lighter colour representing a higher cognitive capacity and a darker colour representing a lower cognitive capacity.

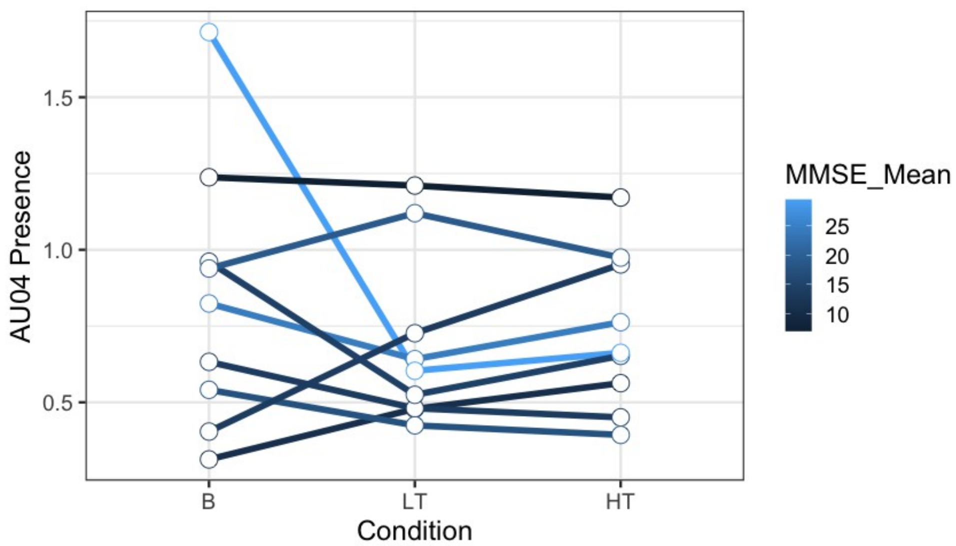


Figure 5.25: The intensity of AU15 (lip corner depressor) for individual participants viewing Non-Specific locations across conditions: B = Baseline, LT = Low-Tech and HT = High-Tech. The lines are coloured to reflect the MMSE of the individual with a lighter colour representing a higher cognitive capacity and a darker colour representing a lower cognitive capacity.

This effect may be due to a limitation in the number of participants representing different scorings on the MMSE. For this reason, the MMSE was not included as a variable in the analysis of facial movement.

Chapter 6: Lexical use as a measure of engagement

6.1 Introduction

Language is one the most powerful tools used to socialise and connect with others. In everyday language use, people communicate who they are, how they are feeling and what their needs are. They do so through complex set of language choices; the selection of which specific words to convey a message and the formulation of structure of an utterance work together to convey many emotional and social conditions in which the language was produced. This chapter focuses on the lexical use of personal pronouns, affective word use and emotional tone, as dependent variables, to indicate behavioural outcomes of engagement. As outlined in section 3.8.2, measuring personal pronoun use within dialogue indicates the amount of personalisation within speech. Measuring personal pronoun use further indexs a participant's sense of self and others (Davis & Brock, 1975; Small et al., 1998).

This chapter also focuses on the use of words which have an affective association. Affective semantics are the meaning behind words that relate to the affective state. For example, the word 'good' is associated with positive meaning, and the word 'bad' is associated with a negative meaning. Affective words as a percentage of total speech, will be measured, to determine the degree of affect-driven behavioural engagement within dialogue. Emotional and affective expression is derived from the combination of words that give the interaction a more positive or negative association. For example, saying 'I felt really good dancing today', is associated with a positive affective expression. Whereas, 'I did not feel good going for a run', is associated with a negative affective expression. Both of these sentences include the word 'good', which is generally associated with a positive meaning. However, when interpreted within the context of a sentence, may have a negative association. From the affective semantics of words in speech and their relationship to one another, affect-driven behavioural engagement can be measured (Borelli et al., 2018).

In this chapter, emotional and affective expressions are measured as an overall valence of affect within dialogue. This dependent variable measure is the emotional tone of speech. For example, if a participant's speech contains more positive emotional and affective expressions, then the emotional tone of the participant will be positive. Through investigating affective language, there will be a greater understanding of how the Time Travelling with Technology (TTT) intervention, may impact affect-driven behavioural engagement of older adults. By measuring affective words, both positive and negative, as well as the emotional tone of the language, the current research will provide greater insight into the affective response of participants. As described in Chapter 3, the Linguistic Inquiry and Word Count (LIWC; Pennebaker & Francis, 1999) was used to measure these dependent variables.

This chapter focuses on the dependent variables of pronoun use, affective language use and the emotional tone of language. The three questions relating to lexical use as a measure of engagement that will be addressed in this chapter are:

1. What are the proper pronoun use, affective word use and emotional tone of speech characteristics of older adults during the TTT experiment and how does this differ to a structured dyadic reminiscence therapy (RT) interview?
2. To what extent does the dynamic and immersive nature of technology mediate proper pronoun use, affective word use and emotional tone of speech differences when participating in a Low-Tech version (LT) compared to a High-Tech version (HT) of TTT?

3 To what extent does the reminiscence and personal familiarity of a location mediate proper pronoun use, affective word use and emotional tone of speech differences when viewing Non-Specific compared to Person-Specific locations?

Group activities, held in enriching, stimulating and novel environments are shown to be of great benefit for people with dementia (Materne et al., 2014). Therefore, as previously discussed, a technology driven group reminiscence session is predicted to promote greater engagement and communication compared to a structured dyadic RT interview (Astell et al., 2010; Cohen-Mansfield et al., 2017; Samuelsson & Ekström, 2019). In addressing the first question, the first hypothesis of this chapter is: If technology driven group RT encourages greater affective communication and positive affect, then there will be greater pronouns use, greater amount of affective language used and a more positive tone of speech in the TTT experiment compared to the Baseline dyadic RT interview.

As mentioned previously, the impact of the level of technology on engagement is unknown as previous research has typically investigated one level of a technology driven intervention. Compared to no technology, reminiscence interventions have been shown to promote engagement and positive affect (Astell et al., 2010; Davison et al., 2016; Silva, Pinho, Macedo, Moulin, Caldeira et al., 2017; Silva, Pinho, Macedo & Moulin, 2017; Subramaniam and Woods, 2016). In addressing the second question, the second hypothesis of this chapter is: If a more dynamic, interactive and immersive technology promotes engagement more than a less dynamic, interactive and immersive technology, then there will be greater pronouns use, greater amount of affective language used and a more positive tone of speech in the HT condition compared to the LT condition.

The use of personal pronouns can give an indication of the personalised nature of speech and a marker for the focus on self and others. That is, if a person uses more words such as 'I', 'we', and 'they', it indicates that what is being said may relate to a personal story or experience, and thereby a sharing of identity and personal history. As a personalised activity, RT has been shown to enhance engagement and positive affect (Cohen-Mansfield et al., 2007). In addressing the third question, the third hypothesis of this chapter is: If RT encourages a connection with identity and promotes communication and positive affect, then there will be greater pronouns use, greater amount of affective language used and a more positive tone of speech in the Person-Specific condition compared to the Non-Specific condition.

This chapter provides the method and results for the analysis of engagement through lexical use, complementing the approach in Chapter 5 which investigated facial movement as a measure of engagement. The chapter describes the method for using the LIWC program, and describes the approach to analysis. The results include the use of personal pronouns, affective word use and emotional tone of participant speech across conditions (Baseline, LT and HT), when viewing Non-Specific and Person-Specific locations in the TTT experiment. How these lexical markers change when viewing Person-Specific compared to Non-Specific locations is discussed.

6.2 Preparing LIWC Input

In Chapter 3 the process was described for creating transcript files for each participant across each location (baseline, Person-Specific, Non-Specific) and condition (LT and HT). These transcripts included all speakers in the session. The LIWC program analyses all the text in a file. LIWC does not have the ability to identify different speakers in a document. Therefore, to prepare for LIWC processing, it was important to delete all the dialogue within this file that was not the speech of the target participant.

To do this, the entire document was copied and pasted into a blank Microsoft Excel file (.xlsx). The Microsoft Word transcript files had a layout where each speaker was identified with an initial in one column and then their dialogue in a second column. This meant that when the entire document was copied and pasted into an .xlsx file, one column was the initial relating to a speaker and the second column was the spoken dialogue. There was a row of output per turn of someone speaking. The first column was sorted using the 'Sort A to Z' function in Excel. It was then easier to delete all rows that did not correspond with the target participant. The second column, with the dialogue, was then highlighted, copied, and pasted back into a new Microsoft Word document using the 'Paste values only' function. This new document now included only the words spoken for the target participant at one of three timepoints: baseline, when viewing Person-Specific locations in a session, or when viewing Non-Specific locations in a session. The document was saved with an appropriate name and was then ready to run through the LIWC.

To make organisation of the LIWC output files easier, three folders were created. One was for the baseline and one was for each location condition. The corresponding transcripts were placed in each folder. LIWC has the capability of processing multiple files in a folder. Each folder was processed through LIWC with the chosen output file as a comma separated values file (.csv).

6.3 Transforming LIWC Output

The .csv output file from LIWC contains columns that represent the parameters captured by the experiment and the rows represent each file processed. The three output files were consolidated into a master LIWC output .csv file. Within the master .csv file, new columns were created that included the participant ID, the group they were in (i.e. High->Low Tech (H->L) or Low->High Tech (L->H)), the condition of the session (Baseline (B), Low-Tech (LT) or High-Tech (HT)), the average MMSE of the participant, and the location as either Baseline (B), Non-Specific (NS) or Person-Specific (PS).

As the LIWC output file captures 93 different parameters, the columns that were not necessary for analysis were deleted. The parameters that were kept for analysis included the summary language variables of 'Tone' (emotional tone), personal pronouns 'ppron' (e.g. 'I', 'we', 'you', 'she', 'he', 'they'), and affective processes 'affect', which includes both positive and negative emotion words (e.g. the words 'good' and 'happy' are positive, and the words 'bad' and 'sad' are negative).

The 'Tone' (emotional tone) parameter includes both positive and negative dimensions. The algorithm was constructed by Cohn et al., (2004) and is presented on a continuous scale from 1 (most negative) to 100 (most positive). A number lower than 50 is related to a more negative tone displaying greater anxiety, sadness or hostility. A number higher than 50 is related to a more positive, upbeat and vivid tone. A neutral number around 50 suggests a lack of emotional valence in tone or varying levels of ambivalence, that is, contradictory or mixed feelings (Pennebaker et al., 2015).

For 'ppron' (personal pronouns) and 'affect' (affective processes), the value within each column is the percentage of text that is represented by the parameter. For example, within the column 'ppron', a value of 6.47 indicated that 6.47 percent of all the words spoken by the participant were personal pronoun words. These will be discussed in detail in section 6.5.

6.4 LINEAR MIXED MODEL FOR ANALYSIS

To analyse lexical use data, a linear mixed model using R software (RStudio version 1.2.5042; RStudio Team, 2013), was used similarly to the analysis of facial movement, as outlined in section 5.4. Below is a summary of the process. Please refer to section 5.4 for a more in-depth account of the analysis.

As described, there were two models that were used within the analysis. The first is linear mixed model which included the following effects:

> Fixed effects: Condition (B, LT, HT) and Group (L->H, H->L).
> Random effects: ID (Participants)

The equation used for the linear mixed model was:

> res2=lmer(parameter ~ Con + Group + (1|ID), data=BC_data)

The second is a linear mixed model with random slopes, which included the following effects:

> Fixed effects: Condition (B, LT, HT) and Group (L->H, H->L).
> Random effects: ID (Participants)
> Random slopes: participants across conditions

The equation used for the random slopes model was:

> res3 = lmer(parameter ~ Con + Group + (1 + Con|ID), REML = TRUE, data = BC_data)

These models were performed using the R software package "lme4" (Bates et al., 2012. Within these models, 'parameter' refers to the lexical parameter that is being measured; ppron (personal pronouns), affect (affective language) or tone (emotional tone).

Either the linear mixed model or the random slopes model was used if it met the appropriate criteria for being a stronger fitting model, using the AIC (AIC; Sakamoto et al., 1986) and ANOVA (analysis of variance; Fox, 2016) functions in R. That is, if it accounted for more of the variance in the data. Based on this requirement, for the analysis of all lexical markers, except personal pronouns when viewing Person-Specific locations, the simpler linear mixed model was used. For the personal pronouns analysis when viewing Person-Specific locations the random slopes model was used.

To compare the individual conditions within the model, the 'emmeans' r package was used (Lenth et al., 2020).

For further information on linear mixed model effects, please refer to Thomas & Monin (2016) and Winter (2013). For further information on the 'emmeans' r package please refer to Lenth et al., (2020). For all lexical use as a measure of engagement statistical output, see Appendix I.

6.5 LEXICAL USE AS A MEASURE OF ENGAGEMENT

The percentage of personal pronoun use within participant speech was the first lexical marker explored, in the investigation of lexical use as a measure of engagement. During the TTT experiment, participants were shown both Person-Specific locations (places from their past and history such as schools, homes, favourite holiday destinations and where they worked), as well as Non-Specific locations (places that were not known to be significant in the participant's personal life history). By measuring the amount of personal pronoun use, the degree to which the participant, when conversing or telling a story, are talking about themselves and others is measured. Through this, there is an understanding of the degree of personalisation in participant speech when looking at the different locations (Small et al., 1998).

Affect-driven behavioural engagement of participants was then explored, as indicated in the use of affective words. The LIWC analyses lexical items and their relationship and has been shown to accurately identify emotion in language (Tausczik & Pennebaker, 2010). The LIWC parameter of 'affect' incorporates both the negative and positive emotion words. Even though the LIWC also categorises positive emotion and negative emotion words as a subcategory, it was decided to only include the overall use of affective words in speech. This is because within 'affect' the LIWC program marks words for their affective nature. For example, the word 'good' is classified as a positive emotive word. However, when used in the context of 'not good', it would not be appropriate to classify the 'good' as positive. Therefore, to reduce the over interpretation of affective words that may come from only using the 'affect' marker, the analysis focuses on expressions and phrases as a whole, including combinations of words to give an indication of the affective valence of the dialogue.

The LIWC parameter of emotional tone ('Tone') was used to determine the affective valence of speech. 'Tone' indicates whether the affective expression of dialogue is more positive (closer to 100), or more negative (closer to 0). This is a stronger marker compared to relying on the 'affect' parameter and the amount of positive or negative emotion words, as 'Tone' in the LIWC analyses the relationship of words to one another. The lexical markers used for analyses are described in Table 6.1.

Table 6.1: This table describes the three lexical markers used for analysis. For each marker, the LIWC parameter name is listed, the description of the parameter and the units of measurement.

LIWC marker	Description	Measure
ppron	personal pronouns	percent of total speech (%)
affect	words associated with positive and negative emotion	percent of total speech (%)
tone	emotional tone of language	continuous scale 0 (most negative) – 100 (most positive)

Linear mixed method analysis was performed for Baseline, LT and HT conditions across both groups H->L and L->H. The focus of this chapter is the comparisons of lexical markers, as an indicator of engagement, across the different levels of technology and groups. Separate analysis was conducted for Person-Specific and Non-Specific locations. This was decided to minimise overfitting the model.

6.6 Lexical use when viewing Person-Specific locations

Descriptive statistics for the lexical markers ('ppron' - personal pronouns, 'affect' – positive and negative affective language, and 'tone' - emotional tone of language) when viewing Person-Specific locations are provided in Table 6.2.

As can be seen in Table 6.2, there is a greater range in the use of personal pronouns in the H->L tech group across all conditions compared to the L->H tech group. This indicates a greater variance in participants' use of personal pronouns in the H->L tech group, despite similar means when compared to the L->H tech group. For both groups, it seems the participants in the Baseline condition have a higher use of personal pronouns during speech compared to both the LT and HT condition, which have similar means.

The range in use of affective language across all conditions in the L->H tech group is greater than in the H->L tech group. This indicates that the participants in the L->H tech group have more variance in their affective language use. They also consistently have a higher mean for across conditions compared to the H->L tech group. However, the standard deviation for all groups and conditions are quite large indicating considerable variance in affective language used across all participants in both groups.

The range of emotional tone across all conditions and groups indicate that participants expressed negative as well as positive tone over the course of the experiment when viewing Person-Specific locations. Except for the Baseline condition in the H->L tech group, all means where above 50. This indicates on average participants expressed a more positive tone. It is only the Baseline condition of the H->L tech group, with a mean of 47.21, did participants use a more negative tone. Considering it is close to 50, it could be seen as a more neutral tone.

Table 6.2: Descriptive statistics for lexical markers of participant speech in groups Low-Tech -> High Tech (L->H) and High-Tech -> Low-Tech (H->L), during Baseline (B) and when viewing Person-Specific locations in conditions LT and HT. The use of personal pronouns (ppron) is measured as a percentage of all speech. Affective language (affect) incorporates both positive and negative emotive words and is measured as a percentage of all speech. The emotional tone of the speaker (tone) is measured from 0 (most negative) – 100 (most positive).

	Person-Specific locations					
	L->H Group (*n* = 5)			H->L Group (*n* = 4)		
Lexical marker	B	LT	HT	B	LT	HT
ppron personal pronouns						
Min-Max	10.75 – 17.30	6.15 – 14.18	4.00 – 11.51	4.92 – 21.24	0 – 15.29	0 – 18.92
Mean (SD)	14.14 (1.88)	9.25 (2.24)	8.59 (2.10)	14.58 (5.07)	9.92 (3.93)	10.63 (3.80)
affect affective language						
Min-Max	1.61 – 6.63	0 – 8.16	0.72 – 8.80	1.04 – 4.14	0 – 5.77	0 – 4.55
Mean (SD)	4.03 (1.84)	3.23 (2.42)	3.09 (2.43)	2.59 (0.94)	2.16 (1.71)	2.22 (1.269)
tone emotional tone						
Min-Max	22.21 – 92.14	9.71 – 99.00	18.67 – 99.00	22.62 – 83.88	25.77 – 98.66	12.61 – 93.61
Mean (SD)	61.34 (22.40)	56.63 (29.52)	55.48 (23.91)	47.21 (18.88)	52.40 (24.62)	50.53 (22.53)

6.6.1 Pronouns when viewing Person-Specific locations

The percentage of personal pronouns spoken in the Baseline condition (M = 14.40, SD = 3.98) was significantly higher (t = 3.628, p = 0.0067) compared to viewing Person-Specific locations in the LT condition (M = 9.56, SD = 3.12). There was an estimated mean difference of 4.53%, 95% CI (1.65, 7.41). The percentage of personal pronouns spoken in the Baseline condition (M = 14.40, SD = 3.98) was also significantly higher (t = 4.835, p = 0.0013) compared to viewing Person-Specific locations in the HT condition (*M* = 9.87, *SD* = 3.33). There was an estimated mean difference of 4.50%, 95% CI (2.35, 6.65). See Figure 6.1.

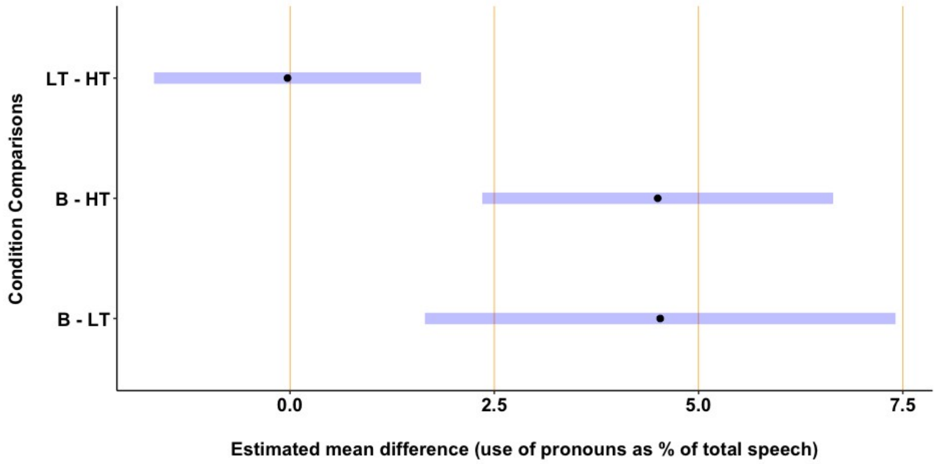


Figure 6.1: Estimated marginal means for the percentage of personal pronoun use in participant speech when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

Whilst viewing Non-Specific locations, there were no significant differences found in the percentage of pronouns spoken when comparing the LT and the HT conditions (p = 0.9664). There were no significant differences found in the percentage of pronouns spoken when comparing the L->H tech and the H->L tech group (p = 0.6526).

6.6.2 Affective words when viewing Person-Specific locations

There were no significant differences in the percentage of affective words spoken across all conditions [BvsLT (p = 0.0614); BvsHT (p = 0.0701); LTvsHT (p = 0.9592)] when viewing Person-Specific locations. There was also no significant difference in the percentage of affective words spoken when comparing the L->H tech group to the H->L tech group (p = 0.3539). For the descriptive statistics of affective word use when viewing specific locations see Table 6.2.

6.6.3 The emotional tone of speech when viewing Person-Specific locations

There were no significant differences in the emotional tone of speech across all conditions [BvsLT (p = 0.8766); BvsHT (p = 0.9906); LTvsHT (p = 0.8711)] when viewing Person-Specific locations. There was also no significant difference in the emotional tone of speech when comparing the L->H tech group to the H->L tech group (p = 0.5512).

6.6.4 Discussion

When viewing Person-Specific locations, the percentage of personal pronoun used was greater in the Baseline condition compared to the LT and the HT conditions. These results do not support the first hypothesis that there would be greater pronoun use in the TTT conditions compared to the Baseline dyadic RT interview condition. Further, there were no significant differences found between the LT and HT conditions. This does not support the second hypothesis that the HT condition would have greater personal pronoun use compared to the LT condition. There were also no significant differences between the L->H tech group and the H->L tech group.

In regards to both the use of affective words and the tone of speech, there were no differences found across conditions or between the groups when viewing Non-Specific locations. In other words, the amount of affective words spoken was similar and there were no conditions that resulted in a significantly more positive or a more negative tone. This does not support the first and second hypothesis that there would be greater use of affective words and a more dynamic tone range in the TTT experiment compared to the Baseline dyadic RT interview condition, and in the HT condition compared to the LT condition.

6.7 Lexical use when viewing Non-Specific locations

Descriptive statistics for the lexical markers ('ppron' - personal pronouns, 'affect' – positive and negative affective language, and 'tone' - emotional tone of language) when viewing Non-Specific locations are provided in Table 6.3.

As can be seen in Table 6.3, there is a greater range across participants in the use of personal pronouns in the Baseline and HT conditions compared to the LT condition. The use of personal pronouns in the L->H tech group had a much smaller range and SD compared to the H->L tech group, despite similar means. This was similarly seen for the HT condition across the groups, which showed a greater range in the L->H tech groups. This indicates greater participant variation in the H->L tech group compared to the L->H tech group. For personal pronoun use across both groups, the LT and HT condition had similar means which were lower than that of the Baseline condition.

The LT condition showed greater range across participants in both groups for the use of affective language, when compared to the Baseline and HT conditions. All the standard deviations across the groups and conditions for affect are quite large indicating variance in the affective language across all participants.

Table 6.3: Descriptive statistics for lexical markers of participant speech in groups Low-Tech -> High Tech (L->H) and High-Tech -> Low-Tech (H->L), during Baseline (B) and when viewing Non-Specific locations in conditions LT and HT. The use of personal pronouns (ppron) is measured as a percentage of all speech. Affective language (affect) incorporates both positive and negative emotive words and is measured as a percentage of all speech. The emotional tone of the speaker (tone) is measured from 0 (most negative) – 100 (most positive).

	Non-Specific locations					
	L->H Group (*n* = 5)			H->L Group (*n* = 4)		
Lexical marker	B	LT	HT	B	LT	HT
ppron personal pronouns						
Min-Max	10.75 – 17.30	0 – 11.65	0 – 14.44	4.92 – 21.24	0 – 12.80	2 – 22.47
Mean (SD)	14.14 (1.88)	6.50 (3.74)	6.95 (3.63)	14.58 (5.07)	6.79 (4.80)	7.53 (4.93)
affect affective language						
Min-Max	1.61 – 6.63	0 – 12.16	0 – 7.69	1.04 – 4.14	0 – 14.63	0 – 8.04
Mean (SD)	4.03 (1.84)	2.98 (2.59)	3.15 (2.29)	2.59 (0.94)	3.76 (4.63)	3.03 (2.28)
tone emotional tone						
Min-Max	22.21 – 92.14	8.87 – 99.00	5.47 – 99.00	22.62 – 83.88	25.77 – 99.00	19.71 – 99.00
Mean (SD)	61.34 (22.40)	61.75 (29.88)	66.42 (30.97)	47.21 (18.88)	59.92 (31.53)	65.92 (28.57)

The range of emotional tone across all conditions and groups indicate that participants expressed negative as well as positive tone over the course of the experiment. Except for the Baseline condition in the H->L tech group, all means where close to, or above 60. This indicates on average participants expressed a slightly positive tone. It is only the Baseline condition of the H->L tech group, with a mean of 47.21, did participants use a more negative tone. Considering it is close to 50, it could be seen as a more neutral tone.

6.7.1 Pronouns when viewing Non-Specific locations

The percentage of personal pronouns spoken in the Baseline condition (*M* = 14.4, *SD* = 3.98) was significantly higher ($t = 8.328$, $p < 0.0001$) compared to viewing Non-Specific locations in the LT condition (*M* = 6.63, *SD* = 4.22). There was an estimated mean difference of 7.54%, 95% CI (5.74, 9.33). The percentage of personal pronouns spoken in the Baseline condition (*M* = 14.4, *SD* = 3.98) was also significantly higher ($t = 7.739$, $p < 0.0001$) compared to viewing Non-Specific locations in the HT condition (*M* = 7.28, *SD* = 4.37). There was an estimated mean difference of 7.062%, 95% CI (5.25, 8.87). See Figure 6.2.

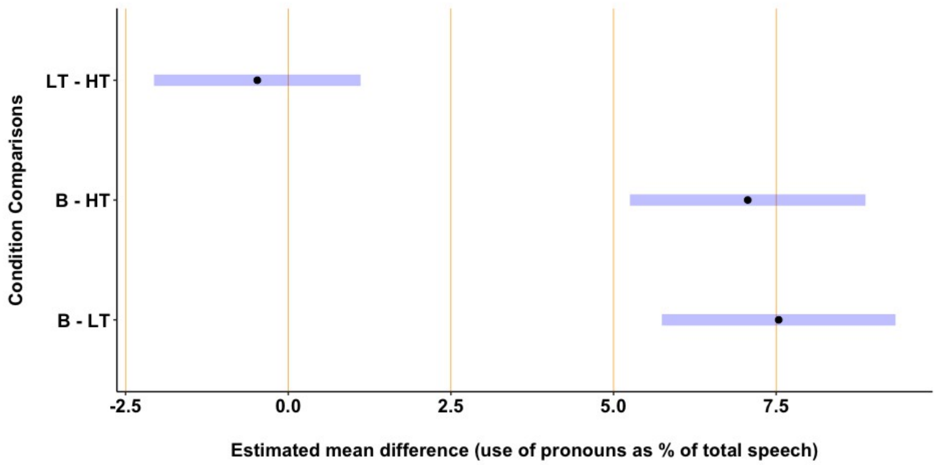


Figure 6.2: Estimated marginal means for the percentage of personal pronoun use in participant speech when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

Whilst viewing Person-Specific locations, there were no significant differences found in the percentage of pronouns spoken when comparing the LT and the HT conditions ($p = 0.5533$). There were also no significant differences found in the percentage of pronouns spoken when comparing the L->H tech and the H->L tech group ($p = 0.6698$).

6.7.2 Affective words when viewing Non-Specific locations

Whilst viewing Non-Specific locations, there were no significant differences in the percentage of affective words spoken across all conditions [BvsLT ($p = 0.9082$); BvsHT ($p = 0.8148$); LTvsHT ($p = 0.691$)]. There was also no significant difference in the percentage of affective words spoken when comparing the L->H tech group to the H->L tech group ($p = 0.9109$). For the descriptive statistics of affective word use when viewing Non-Specific locations see Table 6.3.

6.7.3 The emotional tone of speech when viewing Non-Specific locations

There were no significant differences in the emotional tone of speech across all conditions [BvsLT ($p = 0.3072$); BvsHT ($p = 0.0798$); LTvsHT ($p = 0.3932$)] when viewing Non-Specific locations. There was also no significant difference in the emotional tone of speech when comparing the L->H tech group to the H->L tech group (p = 0.6355). For the descriptive statistics of the emotional tone of language when viewing Non-Specific locations see Table 6.3.

6.7.4 Discussion

The use of personal pronouns across conditions when viewing Non-Specific locations was similar to the findings when viewing Person-Specific locations. That is, there was significantly greater use of personal pronouns in the Baseline condition compared to the LT and the HT conditions. This further does not support the first hypothesis, that the TTT experiment would elicit a greater use of personal pronouns, affective word use and a more dynamic emotional tone compared to the Baseline dyadic RT interview. There were also no significant differences between the LT and HT condition. This also does not support the second hypothesis, that the HT condition would elicit a greater use of personal pronouns, affective word use and a more dynamic emotional tone compared to the LT condition. Additionally, there were no significant differences between the L->H tech group and the H->L tech group. Greater use of personal pronouns in participant speech in the baseline condition will be discussed further in Chapter 8.

Similar to the Person-Specific locations, when viewing Non-Specific locations, there were no differences found across conditions (B, LT and HT) or between the groups (L->H and H->) in the use of affective words or in the tone of speech. In other words, the amount of affective words spoken was similar and there were no conditions that resulted in a significantly more positive or a more negative tone.

6.8 Comparing lexical use between Person-Specific and Non-Specific locations

As discussed in Chapter 2, RT involves evoking and sharing stories and memories from objects of familiarity (Woods, 2018). The TTT experiment encourages reminiscence through viewing Person-Specific locations. These locations range from places that a participant may be familiar with; such as a previous home, the school they went to, a favourite holiday destination and so forth. As outlined in the third hypothesis of this chapter, it is expected that by viewing Person-Specific locations, participants will have greater affect-driven behavioural engagement through the sharing of personal stories and experiences. This would be reflected by greater personal pronoun use when viewing Person-Specific locations compared to viewing Non-Specific locations. Additionally, by viewing Person-Specific locations, is was expected that participants would experience a greater affective response which would be expressed through the use of more affective language and a more intense emotional tone. By understanding the impact that Person-Specific locations, and therefore RT, may have on affective language, the second research question of this chapter is addressed. As a general outcome, there will be an improved understanding of how the TTT experiment effects engagement.

For the comparison of Person-Specific and Non-Specific locations, linear mixed model analysis was conducted. Similar to the comparison of locations when analysing facial movement, the group variable was removed from the analysis model as it was shown to have no significant effect on the individual groups. This was decided so that the model would not be overfitted with too many variables when including location as a factor. The Baseline measures were also removed as the interest was in the type of location, either being Person-Specific or Non-Specific, within the TTT experiment. The model followed the same format and criteria as outlined in section 5.4.

The equation used for the linear mixed model was:

res2=lmer(AU ~ Con + Location + (1|ID), data=BC_data)

The equation used for the random slopes model was:

res3 = lmer(AU ~ Con + Location + (1 + Con|ID), REML = TRUE, data = BC_data)

Where, 'location' now represents either Person-Specific (PS) or Non-Specific (NS).

Either the linear mixed model or the random slopes model was used if it met the appropriate criteria for being a stronger fitting model, using the AIC (AIC; Sakamoto et al., 1986) and ANOVA (analysis of variance; Fox, 2016) functions in R. That is, if it accounted for more of the variance in the data. Based on this requirement, for the analysis of all lexical markers the linear mixed model was used.

Descriptive statistic for the lexical markers ('ppron' - personal pronouns, 'affect' – positive and negative affective language, and 'tone' - emotional tone of language) when viewing Non-Specific locations and Person-Specific locations are provided in Table 6.4. As can be seen in Table 6.4 there was a greater range in the percentage of speech that personal pronouns were spoken, as well as the range in affective language use, when viewing Non-Specific locations compared to viewing Person-Specific locations. For tone there was a similar range across both locations.

Despite a greater range, there was a high mean for personal pronoun use when viewing Person-Specific locations compared to viewing Non-Specific locations. Both affective language and emotional tone have a higher mean when participants viewed Non-Specific locations compared to Person-Specific locations. However, the standard deviation across both locations indicate high variability between participants in affective response.

Table 6.4: Descriptive statistics for lexical markers of participant speech when viewing Non-Specific (NS) and Person-Specific (PS) locations. Non-Specific and Person-Specific locations include both LT and HT conditions for that location. The use of personal pronouns (ppron) is measured as a percentage of all speech. Affective language (affect) incorporates both positive and negative emotive words and is measured as a percentage of all speech. The emotional tone of the speaker (tone) is measured from 0 (most negative) – 100 (most positive).

Lexical marker	Non-Specific	Person-Specific
ppron		
personal pronouns		
Min-Max	0 – 22.47	0 – 18.92
Mean (SD)	6.95 (4.28)	9.67 (3.21)
affect		
affective language		
Min-Max	0 – 14.63	0 – 8.80
Mean (SD)	3.22 (3.04)	2.66 (2.02)
tone		
emotional tone		
Min-Max	5.47 – 99	9.71 – 99
Mean (SD)	63.46 (29.74)	53.65 (25.04)

6.8.1 Pronouns when viewing Person-Specific locations compared to Non-Specific locations

The percentage of personal pronouns spoken when viewing Person-Specific locations (*M* = 9.67, *SD* = 3.21) was significantly higher (t = 5.658, $p < 0.0001$) compared to viewing Non-Specific locations (*M* = 22.47, *SD* = 6.95). There was an estimated mean difference of 2.72%, 95% CI (1.77, 3.67). See Figure 6.3.

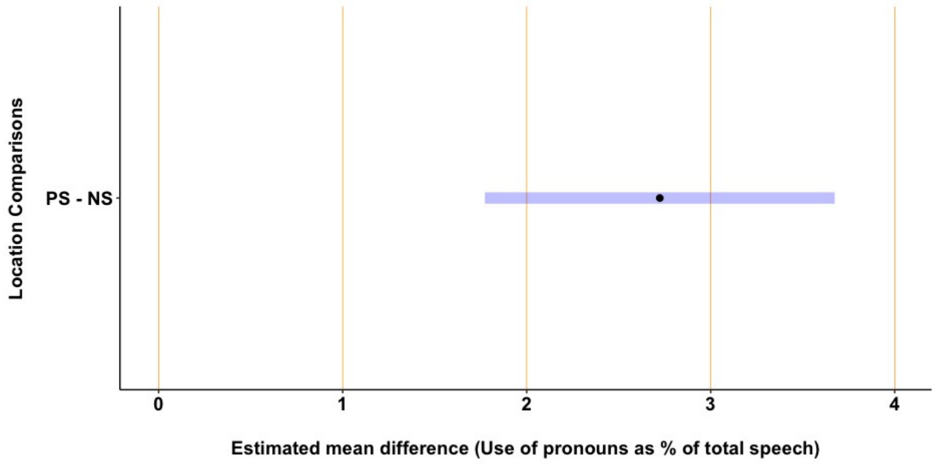


Figure 6.3: Estimated marginal means for the percentage of personal pronoun use when participants viewed Person-Specific locations (PS) compared to Non-Specific locations (NS).

6.8.2 Affective word use when viewing Person-Specific locations compared to Non-Specific locations

There was no significant difference in the percentage of affective words spoken when viewing Person-Specific locations compared to Non-Specific locations (p = 0.1298). For the descriptive statistics of affective word use when viewing Non-Specific locations compared to Person-Specific locations , see table 6.4.

6.8.3 The emotional tone of speech when viewing Person-Specific locations compared to Non-Specific locations

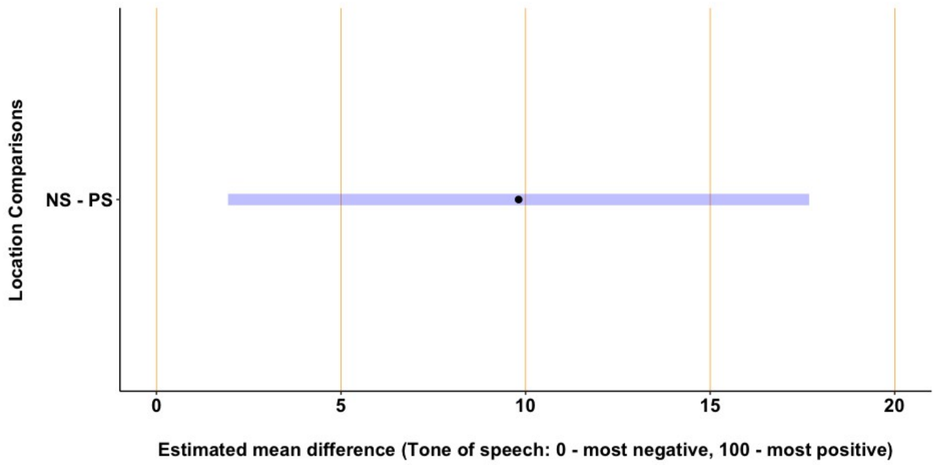


Figure 6.4: Estimated marginal means for the emotional tone of speech when participants viewed Non-Specific locations (NS) compared to Person-Specific locations (PS).

The emotional tone of participants when viewing Non-Specific locations (*M* = 63.46, *SD* = 29.74) was significantly higher ($t = 2.462$, $p = 0.0149$) compared to viewing Person-Specific locations (*M* = 53.65, *SD* = 25.04). There was an estimated mean difference of 9.81, 95% CI (1.94, 17.7). See Figure 6.4.

6.9 Discussion of lexical use when viewing Person-Specific and Non-Specific locations

The first question of this chapter was, 'What are the proper pronoun use, affective word use and emotional tone of speech characteristics of older adults during the TTT experiment and how does this differ to a structured dyadic RT interview?'. Based on the previous research, it was predicted that there would be greater pronoun use, affective word use and a greater valence of emotional tone in the TTT experiment compared to the Baseline dyadic RT interview. The results indicate that there were great differences found in lexical use in the TTT experiment compared to the Baseline dyadic RT interview. First, within both the Non-Specific locations condition and the Person-Specific locations, the percentage of personal pronouns, as a dependent variable, was significantly greater in the Baseline condition, compared to the LT and the HT conditions. Second, there were no significant differences found in the amount of affective word use or emotional tone, as dependent variables, across all conditions. Therefore, the Baseline condition presented with more personalised content compared to the TTT condition. Thus, the first hypothesis was not supported.

These findings may be attributed to different factors and interactions as outlined within the Comprehensive Process Model of Group Engagement (CPMGE; Cohen-Mansfield et al., 2017). The Baseline dyadic RT interview resulting in greater personal pronoun use may be due to the style of questions that were asked during the discourse interview. This would represent variance within the stimulus that would promote different engagement by participants, therefore altering the person-stimulus interaction. The main questions asked during the dyadic RT Baseline dyadic RT interview included 'Tell me about where you grew up?', 'Where did you go to school? Did you like it?', 'Where did you work, when you were younger?', 'Did you get married and have a family?' and 'Where did you used to go on holidays?'. These questions are very specific to the recall of personal stories and experiences. In the TTT sessions the facilitator would ask questions centred around the location, for example 'Where are we?' and 'What do we do here?'. These styles of questions may promote responses that are more activity and place focused, rather than on the individual, which may account for less personal pronoun use in the TTT conditions. This type of speaking is a group-inclusive style of talking often used in classroom discussions. By using a personal pronoun in the phrasing of the question, the participants are able to reference their own experiences, rather than making abstract generalisation about the location (Rymes, 2016). Therefore, this style of speech is more inclusive for any group client to respond. The phrasing of these open questions within TTT were also chosen to reduce the risk of upsetting participants. This could occur if they were at a location that was Person-Specific and they did not recognise it was one of their locations. For example, if a school of a participant was shown, the question of 'Where are we?' was asked, rather than 'Who's school are we at?', which would indicate it was a Person-Specific location to a participant. If the participant did not recognise their school during that session, then they could potentially become upset at forgetting the location, particularly if they remember visiting their school in a previous session.

The environment-person interaction in the group environment of TTT compared to the dyadic RT interview may be an explanation for the observed effects. In the group environment of TTT, conversations are created between the participants with group clients becoming engaged in the stories of others. This was not possible in the dyadic interview where the participant was to talk about their own experience and did not have the opportunity to engage with another's. This may contribute to greater proper pronoun use in the Baseline dyadic RT interview compared to the TTT experiment.

The second question of this chapter was, 'To what extent does the dynamic and immersive nature of technology mediate proper pronoun use, affective word use and emotional tone of speech differences when participating in a LT version compared to a HT version of TTT?'. There has been a gap in the understanding of how different levels of technology impact the outcomes of RT. However, technology compared to no technology has shown increased engagement. Therefore, it was predicted that the greater dynamic, immersive and interactive technology within the HT condition would have greater engagement outcome than a simpler version of the technology within the LT condition. The results showed no significant difference in the LT condition compared to the HT condition across all lexical markers. Thus, level of technology within the TTT experiment did not have an effect on personal pronouns or effect the affective response of participants. Therefore, the second hypothesis was not supported. In other words, a higher level of technology did not seem to provide a more personalised experience and did not evoke a stronger emotional response. Similarly, to facial movement, the level of digital technology was inconsequential to the behavioural outcomes of engagement.

The third research question was, 'To what extent does the reminiscence and personal familiarity of a location mediate proper pronoun use, affective word use and emotional tone of speech differences when viewing Non-Specific compared to Person-Specific locations?'. Based on previous evidence from studies of RT, it was predicted there would be greater engagement when viewing Person-Specific locations compared to Non-Specific locations. As predicted in the third hypothesis, there was a significantly greater personal pronoun use in participant speech when viewing Person-Specific locations compared to viewing Non-Specific locations. This indicates a greater personal experience when viewing the Person-Specific locations as participants recalled stories and memories relating to themselves and others. Previous research by Mühlhäusler & Harré (1990) supports these findings, that through the use of personal pronouns social and personal identities are expressed. Contrary to the hypothesis, the prediction that the Person-Specific locations would evoke a greater affective response, as seen through the standard deviation of emotional tone, was not seen. There was a comparable standard deviation when viewing both locations. Additionally, there was a more positive emotional tone in participant speech when viewing Non-Specific locations compared to viewing Person-Specific locations. Thus, the third hypothesis was partially supported. It is unknown exactly why viewing Non-Specific locations would evoke a more positive tone. This is contradictory to previous research that suggests technology driven RT promotes an enjoyable and positive experience for people with dementia (Astell et al., 2010; Samuelsson & Ekström, 2019). However, an overall less positive emotional tone expressed when viewing Person-Specific locations may be due to participants experiencing melancholy and nostalgia when reminiscing on past locations. These feelings are typically classified as mixed emotions incorporating both positive and negative affect (Kraxenberger, 2018).

It should be noted that having a mean of 53.65 (SD:25.04), for the emotional tone of participants when viewing Person-Specific locations, does not necessarily indicate a negative experience. As mentioned earlier, an emotional tone of 0 is most negative, of 100 is most positive and around 50 suggests a lack of emotional valence in tone or varying levels of ambivalence, that is, contradictory or mixed feelings (Pennebaker et al., 2015). This could mean, and as indicated by a relatively large SD that during the Person-Specific locations condition, participants are experiencing a comparable amount of both positive and negative emotions. However, it is still significantly less positive than when participants viewed the Non-Specific locations, which had a mean of 63.45 (SD: 29.74).

6.10 COGNITIVE CAPACITY AS A COVARIATE

There is a wealth of research on the effects of cognitive aging and cognitive decline of lexical processing and expression. Interestingly, over the course of natural aging, some language abilities have been shown to improve and stabilise, such as knowledge of words and vocabulary (Kavé et al., 2009; Salthouse, 2009; Singer et al., 2003). However, aging, particularly in the later years of life, naturally slows down a person's ability to process and retrieve lexical information (Daselaar et al., 2005; Ulatowska et al., 1986; Verhaegen & Poncelet, 2013). This has been attributed to the slowing down of executive functions in the brain (Baciu et al., 2105).

Even though the later years of aging is associated with a decline in the speed of language processing, dementia is characterised with an abnormal decline in language comprehension and production, and particularly the expression of words (Pekkala et al., 2013). Difficulties in retrieving words and producing coherent sentences are an early indicator of dementia, and particularly Alzheimer's disease (Pekkala et al., 2013). It was initially thought that with a reduced ability to comprehend situations and with reduced capacity to produce linguistic information, due to a reduction in semantic processing (Bayles et al., 2018), participants with lower cognitive capacity would use less affective language. Unfortunately, there is a limitation in previous research investigating affective language of older adults with dementia and most of previous research focuses on indicators of pain, as mentioned in section 5.8.

Another symptom of dementia is episodic memory deficit, whereby there is difficulty remembering events, place and past experiences and engagement. It was thought that with a reduced ability to recall episodic memories or at least to the same detail as a person with higher cognitive capacity, there would be a reduced affective response. People with episodic memory deficits are also known to replace pronouns with proper nouns (Bayles et al., 2018). For example, instead of saying 'Bob went to the shops, as he needed milk', a person with episodic memory deficit is more likely to say 'Bob went to the shops, as Bob needed milk', (Almor et al., 1999). Therefore, it was expected that participants with reduced cognitive capacity would express a reduction in the use of proper pronouns.

Within this study, the Mini-Mental State Examination (MMSE; Folstein et al., 1975) was used to measure the cognitive capacity of the participants and to ensure that the experimental groups had similar MMSE mean and standard deviation, described in section 3.2. As a covariate, it was expected that people with a lower MMSE, and therefore potentially reduced episodic memory, and lexical processing and production, would use less pronouns and affective words when speaking, and have a narrower emotional tone. However, there were no significant relationships between MMSE and lexical use.

6.10.1 MMSE covariate effect on lexical use as a measure of engagement

As an example, Figure 6.5 shows the use of pronouns as a percentage of total speech when participants were viewing Person-Specific locations across the conditions. The colours of the lines are scaled to each participant's MMSE score. As seen in the graph there are no specific clusters of MMSE responses. If people with cognitive impairment had produced fewer pronouns, then it would have been reflected with darker lines at the bottom of the graph and lighter lines at the top of the graph. When MMSE was included as a variable in the model, there was no significance found for the percentage of pronouns used in overall speech (p = 0.588419) when viewing Person-Specific locations.

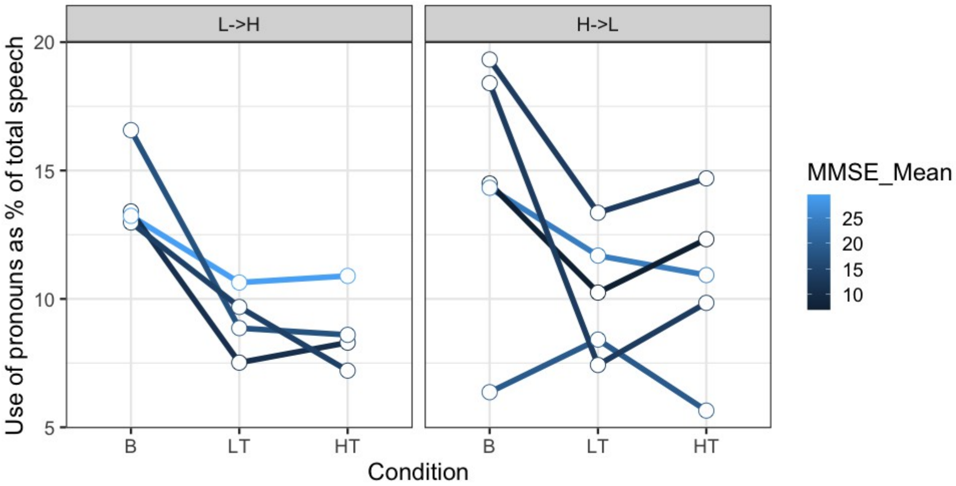


Figure 6.5: The use of proper pronouns as a percentage (%) of total speech) for individual participants viewing Person-Specific locations across conditions: Baseline = Baseline, LT = Low-Tech and HT = High-Tech. The lines are coloured to reflect the MMSE of the individual with a lighter colour representing a higher cognitive capacity and a darker colour representing a lower cognitive capacity.

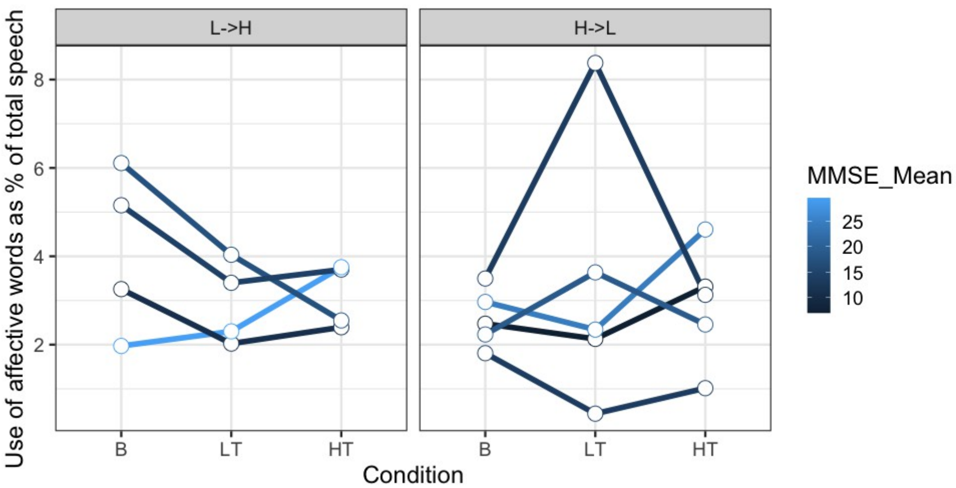


Figure 6.6: The use of affective words as a percentage (%) of total speech) for individual participants viewing Person-Specific locations across conditions: Baseline = Baseline, LT = Low-Tech and HT = High-Tech. The lines are coloured to reflect the MMSE of the individual with a lighter colour representing a higher cognitive capacity and a darker colour representing a lower cognitive capacity.

As a second example, Figure 6.6 shows the use of affective language as a percentage of total speech when participants were viewing Person-Specific locations across the conditions. The colours of the lines are scaled to each participant's MMSE score. As seen in the graph there are no specific clusters of MMSE responses. If people with cognitive impairment were to produce less affective words, then it would have been reflected with darker lines at the bottom of the graph and lighter lines at the top of the graph. When MMSE was included as a variable in the model, there was no significance found for the percentage of affective words used in overall speech ($p = 0.36601$) when viewing Non-Specific locations.

Similar to the MMSE as a covariate to facial movement processing, this effect may be due to a limitation in the number of participants representing different scorings on the MMSE. For this reason, the MMSE was not included as a variable in the analysis of lexical use as a measure of engagement.

Chapter 7: Prosodic patterns of speech as indicators of engagement

7.1 Introduction

Prosodic linguistics is the study of the acoustic measures of speech, i.e. intonation and rhythm in speech. These are acoustic components of speech that are not directly related to the lexical meaning of words, but may contribute to meaning within the act of speaking (e.g. relative emphasis, force of emotions, sarcasm). Prosodic patterns include patterns such as intonation, tone, stress, F0 and rhythm. One aspect of the study of prosodic patterns of speech is how acoustic properties of speech change as a representation of different emotional states (Leitman et al., 2010). As such prosodic patterns provide an interesting in road into assessing patient's engagement in reminiscence therapy (RT). The three questions relating to engagement as signalled through prosodic patterns that will be addressed in this chapter are:

1. What is the duration of utterance, words per utterance and variation in F0 during the Time Travelling with Technology (TTT) experiment and how does this differ to a structured dyadic RT interview?
2. To what extent does the dynamic and immersive nature of technology mediate duration of utterance, words per utterance and variation in F0 differences when participating in a Low-Tech version (LT) compared to a High-Tech version (HT) of TTT?
3. To what extent does the reminiscence and personal familiarity of a location mediate duration of utterance, words per utterance and variation in F0 differences when viewing Non-Specific compared to Person-Specific locations?

In addressing the above research questions this chapter focuses on prosodic dependent variable measures. These are inclusive of the length of speech without pauses (mean duration of utterance), the words per utterance (mean number of words per utterance), the speed in which the older adults speak (articulation rate; which is derived from dividing the mean duration of utterance by the mean number of words per utterance) and the variation in pitch (calculated as the standard deviation of the fundamental frequency, F0).

The human voice has been referred to as 'the mirror to the soul' for its ability to convey the emotional state of a person (Sundberg, 1998). It has been suggested that the pitch of a person's voice and the rate in which they speak are one of the main cues for understanding the emotional state of another person (Planalp, 1998). Whereby, the most direct expression of emotion in speech is through pitch (Levelt, 1999). It has been shown, for example, that happy emotions are associated with a higher pitch level and more variability compared to sad emotions, and angry emotions are associated with a higher rate of speech compared to sad emotions (Juslin et al., 2018; Stolarski, 2015). In essence, the voice acts as a medium to express the dimensional properties of emotions including intensity and valence (Bachorowski & Owren, 1995). Therefore, it is predicted that a more emotional experience would be seen with greater variance in F0.

The amount of speech produced without gaps is a pattern for discourse production and engagement (Yu et al., 2004; Rose et al., 2020). It is therefore predicted that greater engagement would result in more words per utterance and a longer duration of utterance as dependent variables. This in turn would result in a faster articulation rate. That is, more words spoken per minute would indicate more energy investment in speech and a greater engagement.

As outlined in the previous analysis chapters, it is predicted that a group RT experiment would promote greater engagement outcomes compared to a structured dyadic RT interview. Further, a HT digital technology is predicted to be more engaging than a LT digital technology. Lastly, person-centred stimulus is predicted to be more engaging than ordinary stimulus.

In addressing the first question, the first hypothesis of this chapter is: If the TTT experiment promotes engagement in older adults compared to a non-technology dyadic RT interview, then there will be a longer duration of words, more words per utterance, a faster articulation rate and greater variance in F0 in the TTT experiment compared to the Baseline dyadic RT interview.

In addressing the second question, the second hypothesis of this chapter is: If a more dynamic, interactive and immersive technology promotes engagement more than a less dynamic, interactive and immersive technology, then there will be a longer duration of words, more words per utterance, a faster articulation rate and greater variance in F0 in the HT condition compared to the LT condition.

In addressing the third question, the third hypothesis of this chapter is: If RT are more engaging than ordinary stimuli, then there will be a longer duration of words, more words per utterance, a faster articulation rate and greater variance in F0 when in the Person-Specific locations condition compared to Non-Specific locations condition.

This chapter provides the method and results for the analysis of engagement as measured through prosodic pattern dependent variables. The chapter describes the method for using the various programs for processing the data, including the Montreal Forced Aligner (McAuliffee et al., 2017), Praat (Boersma & Weenink, 2020) and ELAN (ELAN Version 5.7, 2019), and describes the approach to analysis. The results include the properties of utterances and articulation rate, as well as variability in fundamental frequency (F0, acoustic correlate of pitch) across conditions (Baseline, LT and HT), when viewing Non-Specific and Person-Specific locations in the TTT experiment. How these prosodic patterns are affected when viewing Person-Specific compared to Non-Specific locations, are explored.

7.2 Preparing Montreal Forced Aligner input

The Montreal Forced Aligner (MFA) is a forced alignment software. The MFA time-aligns a transcript to its audio file. In the analysis of prosodic patterns in this chapter, aligning the transcript to its audio was the first step in a scripted analysis of prosodic measures. There were several steps to prepare the audio and transcript files for processing using the MFA. The MFA requires a down-sampled single-channel audio file with an associated Praat .TextGrid file containing the transcript.

In section 3.9, the process for creating a .mpg movie file for each participant across each location (baseline, Non-Specific, Person-Specific) and condition (LT and HT) was described. To capture the audio of a particular session, the related mpg. movie file was opened in Adobe Premiere and exported the clip as a .wav audio file (waveform audio, stereo, 48 kHz sampling rate, 16-bit resolution). The audio files were then downsampled in Praat using a script (Chodroff, 2019) that converted the stereo 48kHz .wav file to a mono 16kHz .wav file (with 16-bit resolution). The downsampled audio file was then run through Praat with a script (Chodroff, 2019) that created a .TextGrid file of equal length.

Section 3.9 also describes the process for creating a transcript file for each participant, across each location specificity condition (baseline, Non-Specific, Person-Specific) and technology condition (LT and HT). These transcripts included the first initial of a speaker followed by what they had said. The transcripts needed to be cleaned up and converted from a Microsoft Word document (.doc) file to a Plain Text (.txt) file. The transcripts were opened in Microsoft Word and the first initials indicating the speaker were deleted. So that the MFA was able to capture the words properly, any time stamp in the transcript that indicated a period of speech that was unable to be interpreted was deleted, any indication of an action or behaviour within the text was deleted (these were found within brackets in the transcript), and punctuation marks were also deleted. These included; '!', '?', ',', '.', ';', ':', '"'. To remove unnecessary spacing, all tab (^t) and paragraph (^p) symbols were deleted, and any double spacing was reduced to single spacing, using the advanced find and replace functions. The file was then saved as a .txt file with a Unicode UTF-8 encoding. The .txt transcript file was opened in TextEdit. The Microsoft word symbol of an apostrophe is different to the default in a txt file. All apostrophes were therefore replaced with the standard .txt font apostrophe using the find and replace function in TextEdit. This was to ensure the MFA was able to read the word if it contained an apostrophe.

When using the MFA to process files greater than a few minutes in length, it was found to be best to have boundaries in the .TextGrid file with approximately 1-minute intervals. These segments are to contain the words spoken in the corresponding time segment of the audio file. To do this, the .wav audio file and the .TextGrid file was opened in ELAN. Two boundary markings in the text grid was placed at around 1-minute intervals. The boundary was chosen, where there was a pause in speaking to allow easier identification, and a clear beginning and end to the words spoken in the segment. To ensure the segments contained the corresponding words spoken in the audio file, the beginning of the segment was listened to and the words spoken were found in the .txt transcript using the 'Find' function. At the beginning of the words in the .txt file, the 'Enter' button on the keyboard was pressed twice, to indicate a new paragraph with these words for easy identification. The end of the segment ELAN was listened to and similarly identified in the .txt transcript file. At the end of the segment words in the transcript, the 'Enter' button was pressed a couple of times to move down the rest of the transcript that did not belong to this specific segment. This remaining isolated paragraph contained the spoken words that now correlate to the particular segment in the text grid. The paragraph in the .txt file was copied across to the text grid using the copy and paste functions. This was repeated across all segments in the text grid.

The downsampled .wav audio file and the .TextGrid were now ready to be processed by the MFA. It was important to ensure both files had the same name so that the MFA would be able to process the corresponding files together. An Apple iMac desktop computer was used to run the MFA using a Terminal script. All transformed .wav and .TextGrid files were placed into a folder for MFA processing. The MFA has the capability of aligning text using pretrained models. The English acoustic model and the English dictionary were used for this processing, which were downloaded from the website (Montreal Corpus Tools, 2016).

7.3 TRANSFORMING MFA DATA OUTPUT FOR ANALYSIS

As mentioned in section 7.2, the Montreal Forced Aligner (MFA) was used to align the transcripts of the sessions to the .wav sound recording files. The output of the MFA is a new .TextGrid file (which I will refer to as MFA.TextGrid file). This captures what has been said at a particular point in time. Python 2.7 (van Rossum & Python Development Team, 2015) was then used to write and run a script to assign utterances to individual speakers. Python 2.7 was used within the Anaconda integrated development environment. The Anaconda environment is a convenient interface that allows for a better user experience when using Python.

As previously mentioned, the transcripts created in section 3.9 indicate a speaker with an initial, followed by what they had spoken. A Python script used these transcripts from section 3.9 and the MFA.TextGrid files to create a tier for each speaker in a text grid. Each speaker tier contained the utterances spoken separated by boundaries. An utterance was defined as a period of speaking that did not contain a break of more than 0.5 seconds. In other words, when combining words in an utterance, if the time between the two words was greater than 0.5 seconds, then the Python script would indicate this as being the beginning of a new utterance. If the gap was less than 0.5 seconds, then the two words would be contained within the one utterance. The output file was a new TextGrid file (which I will refer to as Split_Tier.TextGrid file) containing different tiers for each speaker. Each speaker tier comprised of utterances separated by boundary markings.

7.4 Utterance data output

A Python script was run to extract utterance information from the Split_Tier.TextGrid file. The output file was a Microsoft Excel (.xlsx) file which contained the filename(filename), participant (sub), number of utterances (no_utt), total duration of utterances (tot_dur_utt), mean duration of utterance (mean_dur_utt), total number of words (tot_no_wd), and the mean number of words per utterance (mean_no_wd_per_utt). A different row was created for each speaker in the transcript. The information of the target speaker in the session was copied and pasted into a main utterance .csv file. Within this .csv file, new columns were created that included the participant ID, the group they were in, being High->Low Tech (H->L) or Low->High Tech (L->H), the condition of the session (Baseline (B), Low-Tech (LT) or High-Tech (HT), the average MMSE of the participant, and the location as either Baseline (B), Non-Specific (NS) or Person-Specific (PS). A new column was also created for the articulation rate (sp_rate). The articulation rate for each row was calculated using the formula (sp_rate = mean_no_wd_per_utt / mean_dur_utt). Three master utterance .csv files were then created. One for baseline and Person-Specific locations data, one for baseline and Non-Specific locations data, and one for Non-Specific and Person-Specific locations data. The data in the main utterance .csv file was sorted by the location column. The baseline, Person-Specific and Non-Specific rows were copied into their respective master pitch .csv files. These master files were used for analysis in R.

7.5 Fundamental frequency data output

Praat was used to extract the variability in pitch of each speaker measured through the standard deviation of the fundamental frequency (F0). A Praat script was run to extract the F0 information from the .wav down sampled audio file alongside the Split_Tier.TextGrid file. These two files were used to identify what part of the audio corresponded to which speaker. With female voices, in particular, Praat sometimes produces doubling or halving errors in estimating F0. In response to this, the Praat script was designed to be able to set the fundamental frequency range for detection. For a female target speaker, the F0 range was set to 120-400 Hz and for a male speaker 60-200 Hz.

The output of the Praat script was a comma separated values (.csv) file that included the name of the file (file_name), the speaker of the utterance (tier_name), the gender of the speaker (speaker_gender), start time of the utterance (start), duration of utterance in seconds (duration_s), the mean of the fundamental frequency (F0_mean) the standard deviation of the fundamental frequency (F0_sd), fundamental frequency minimum (F0_min) and maximum value (F0_max). It should be noted that any comma in the ‘utterance’ column was replaced with a semicolon, as a comma is used as a reserved symbol for column separation in .csv files. This Praat .csv output file contains a row for each utterance.

The .csv file was sorted by tier_name. To be able to analyse this output file, it was necessary to delete any rows that represented speakers that were not the target of the specific file. All rows that did not correspond with the target tier_name (speaker) for that file were deleted. All rows that contained '--undefined--' in the 'F0_sd' row, and all rows that contained all 0's in the F0_mean, f_sd, F0_min and F0_max columns were deleted. This represented utterances that were able to be read from the .TextGrid file, but were unable to capture voicing in the .wav file. This may have been due to voicing being spoken below a loudness detection threshold for Praat or for short/weak vowels for the utterance.

For both the male and female speaker .csv output files, several columns were added to ensure the variables needed for analysis were present. These columns included ID, group, MMSE_pre, location (Non-Specific or Person-Specific) and condition. Three master F0 .csv files were then created. One for baseline and Person-Specific locations data, one for baseline and Non-Specific locations data, and one for Non-Specific and Person-Specific locations data. The data in both the female and male speaker .csv files were then sorted by the location column. The baseline, Person-Specific and Non-Specific rows were copied into their respective master F0 .csv files. These master files were used for analysis in R.

7.6 LINEAR MIXED MODEL FOR ANALYSIS

To analyse prosodic data, a linear mixed model using R software (RStudio version 1.2.5042; RStudio Team, 2013) was used similarly to the analysis of facial movement, as outlined in section 5.4. Below is a summary of the process. Please refer to section 5.4 for a more in-depth account of the analysis.

As described, there were two models that were used within the analysis. The first is linear mixed model which included the following effects:

Fixed effects: Condition (B, LT, HT) and Group (L->H, H->L).
Random effects: ID (Participants)

The equation used for the linear mixed model was:

res2=lmer(pattern ~ Con + Group + (1|ID), data=BC_data)

The second is a linear mixed model with random slopes, which included the following effects:

Fixed effects: Condition (B, LT, HT) and Group (L->H, H->L).
Random effects: ID (Participants)
Random slopes: participants across conditions

The equation used for the random slopes model was:

res3 = lmer(pattern ~ Con + Group + (1 + Con|ID), REML = TRUE, data = BC_data)

These models were performed using the R software package "lme4" (Bates et al., 2012. Within these models, 'pattern' refers to the prosodic pattern that is being measured; mean_dur_utt (mean duration of utterance), mean_no_wd_per_utt (mean number of words per utterance), sp_rate (articulation rate) or F0_sd (mean standard deviation of the fundamental frequency).

Either the linear mixed model or the random slopes model was used if it met the appropriate criteria for being a stronger fitting model, using the AIC (AIC; Sakamoto et al., 1986) and ANOVA (analysis of variance; Fox, 2016) functions in R. That is, if it accounted for more of the variance in the data. For the analysis of all utterance measures including mean duration of utterance, mean number of words per utterance and the articulation rate when viewing Non-Specific and Person-Specific locations, the linear mixed model was used. For the variance in F0 when viewing both Non-Specific and Person-Specific locations, the random slopes model was used.

To compare the individual conditions within the model, the 'emmeans' r package was used (Lenth et al., 2020).

For further information on linear mixed model effects, please refer to Thomas and Monin (2016) and Winter (2013). For further information on the 'emmeans' r package please refer to Lenth et al., (2020). For all patterns in prosodic patterns as a measure of engagement statistical output, see Appendix J.

7.7 Prosodic patterns as an indicator of engagement

At the beginning of this chapter, the prosodic pattern dependent variables were discussed as a direct measurable outcome of engagement. To address the hypothesis of this chapter, articulation as an indicator of engagement was measured through the mean duration of utterances, the mean number of words per utterance and the articulation rate. The articulation rate is essentially the number of words per utterance divided by the time length of utterance, expressed as words per second. To measure the emotive valence of speech as an affect-driven behavioural outcome of engagement, variability in the F0 was measured. It was predicted that greater engagement would be seen through greater mean length of utterances, mean number of words per utterance, articulation rate and variability in F0 (standard deviation). See Table 7.1.

Table 7.1: This table describes the four prosodic pattern dependent variables used for analysis. For each measure, the analysis coding name is listed, the description of the measure and the units of measurement.

Prosodic marker	Description	Measure
mean_dur_utt	mean duration of utterance	seconds (s)
mean_no_wd_per_utt	mean number of words per utterance	numeric count
sp_rate	articulation rate	words per second (words/s)
F0_sd	fundamental frequency	hertz (Hz)

Linear mixed method analysis was performed for Baseline, LT and HT conditions across both groups H->L and L->H. The focus of this chapter is the comparisons of prosodic patterns, as measures of engagement, across the different levels of technology and groups. Separate analysis was conducted for Person-Specific and Non-Specific locations. This was decided to minimise overfitting the model.

7.8 Prosodic patterns when viewing Person-Specific locations

Descriptive statistic for the prosodic patterns (mean duration of utterance, mean number of words per utterance, articulation rate and variance in F0) when viewing Person-Specific locations are provided in Table 7.2.

As can be seen in Table 7.2, when viewing Person-Specific locations, the mean duration of utterance and the mean number of words per utterance had a greater range, a higher mean and a larger standard deviation in the Baseline condition compared to the LT and the HT conditions for both groups. However, the mean articulation rate seems to be lower in the Baseline condition compared to the LT and HT conditions. The values for the LT compared to HT condition are quite similar.

As for the F0, there were large ranges across all conditions. The mean variation in F0 in the conditions in the L->H Group appear to be slightly lower compared to the corresponding condition in the H->L Group. The standard deviations seemed similar across the conditions.

Table 7.2: Descriptive statistics for prosodic patterns of speech in the different order of condition groups Low-Tech -> High Tech (L->H) and High-Tech -> Low-Tech (H->L), and during the different conditions Baseline (B) and when viewing Person-Specific locations in conditions LT and HT. The mean duration of utterance is measured in seconds (s). The mean number of words per utterance is a numerical count value. The articulation rate is the number of words spoken per second calculated from utterances. The F0 is measured in Hertz (Hz).

	Person-Specific locations					
	L->H Group (*n* = 5)			H->L Group (*n* = 4)		
Prosodic pattern	B	LT	HT	B	LT	HT
mean duration of utterance						
Min-Max	2.01 – 18.07	0.98 – 3.11	0.99 – 3.01	0.77 – 19.45	0.36 – 3.83	0.65 – 4.28
Mean (SD)	5.50 (5.16)	1.93 (2.13)	1.67 (0.47)	4.45 (5.24)	1.63 (0.94)	1.82 (0.90)
mean number of words per utterance						
Min-Max	5.61 – 36.00	2.77 – 7.77	3.19 – 7.41	2.31 – 37.40	1.20 – 8.89	2.09 – 10.82
Mean (SD)	13.97 (10.45)	4.76 (41.28)	4.84 (1.09)	10.17 (9.55)	4.19 (2.06)	4.86 (2.06)
articulation rate						
Min-Max	1.75 – 3.59	2.09 – 3.88	2.02 – 3.83	1.91 – 3.45	1.97 – 4.31	2.16 – 3.82
Mean (SD)	2.84 (0.48)	2.93 (0.45)	2.96 (0.41)	2.61 (0.39)	2.73 (0.56)	2.77 (0.38)
variation in F0						
Min-Max	0.71 – 90.43	0.12 – 89.95	0.62 – 124.59	0.17 – 95.41	0.55 – 91.35	0.01 – 116.55
Mean (SD)	26.10 (16.42)	24.26 (20.26)	27.58 (19.51)	27.59 (16.06)	28.05 (18.12)	28.09 19.22)

7.8.1 Mean duration of utterances spoken when viewing Person-Specific locations

The mean duration of utterances spoken in the Baseline condition (M = 4.96, SD = 5.15) was significantly higher (t = 5.542, p < 0.0001) compared to viewing Person-Specific locations in the LT condition (M = 1.64, SD = 0.7). There was an estimated mean difference of 3.21, 95% CI (2.06, 4.355). The mean duration of utterances spoken in the Baseline condition (M = 4.96, SD = 5.15) was also significantly higher (t = 5.662, p < 0.0001) compared to viewing Person-Specific locations in the HT condition (M = 1.75, SD = 0.73). There was an estimated mean difference of 3.14, 95% CI (2.04, 4.237). See Figure 7.1.

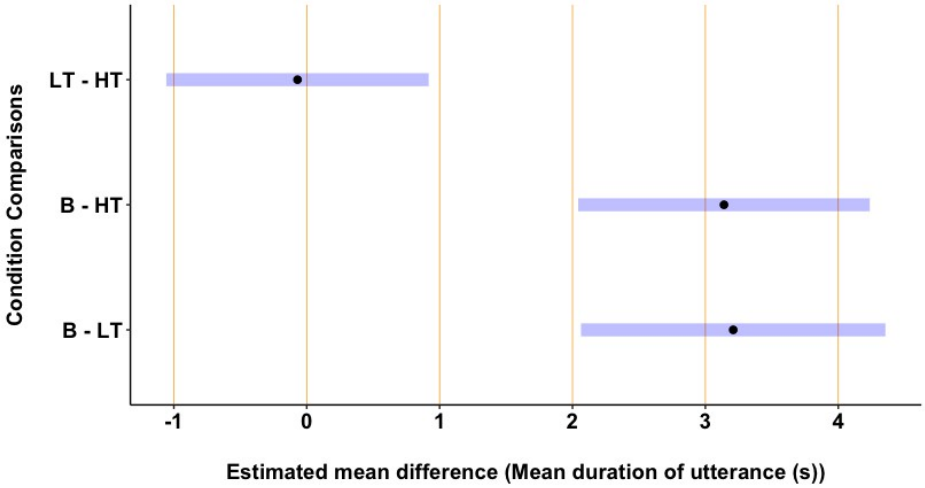


Figure 7.1: Estimated marginal means for the mean duration of utterance, measured in seconds, when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

Whilst viewing Person-Specific locations, there were no significant differences found in the mean duration of utterances spoken when comparing the LT and the HT conditions (p = 0.8896). There were also no significant differences found in the mean duration of utterances spoken when comparing the L->H tech and the H->L tech group (p = 0.7057).

7.8.2 Mean number of words per utterance when viewing Person-Specific locations

The mean number of words per utterance spoken in the Baseline condition (M = 12.01, SD = 10.03) was significantly higher (t = 6.455, p < 0.0001) compared to viewing Person-Specific locations in the LT condition (M = 4.52, SD = 1.65). There was an estimated mean difference of 7.3 95% CI (5.08, 9.56). The mean number of words per utterance spoken in the Baseline condition (M = 12.01, SD = 10.03) was also significantly higher (t = 6.446, p < 0.0001) compared to viewing Person-Specific locations in the HT condition (M = 4.85, SD = 1.67). There was an estimated mean difference of 7.0, 95% CI (4.85, 9.15). See Figure 7.2.

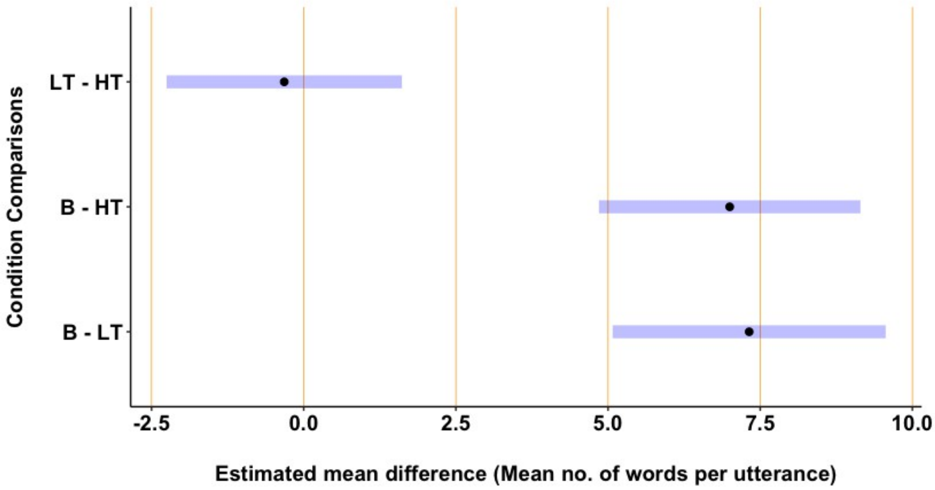


Figure 7.2: Estimated marginal means for the mean number of words per utterance when viewing Person-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

Whilst viewing Person-Specific locations, there were no significant differences found in the mean number of words per utterance spoken when comparing the LT and the HT conditions (p = 0.7438). There were also no significant differences found in the mean duration of utterances spoken when comparing the L->H tech and the H->L tech group (p = 0.3780).

7.8.3 Articulation rate when viewing Person-Specific locations

For Person-Specific locations, there were no significant differences found in the articulation rate (words/s) when comparing Baseline and LT conditions (p = 0.5764), Baseline and HT conditions (p = 0.2025) or LT and HT conditions (p = 0.4411). There were also no significant differences found in the articulation rate (words/s) when comparing the L->H tech and the H->L tech group (p = 0.4409).

7.8.4 F0 variability when viewing Person-Specific locations

For Person-Specific locations, there were no significant differences found in F0 variability when comparing Baseline and LT conditions (p = 0.4521), Baseline and HT conditions (p = 0.956) or LT and HT conditions (p = 0.4507). There were also no significant differences found in F0 variability when comparing the L->H tech and the H->L tech group (p = 0.979).

7.8.5 Discussion

For Person-Specific locations condition, the average length of utterances and the number of words per utterance was greater in the Baseline condition compared to the LT and the HT conditions. There were no significant differences found between the LT and HT conditions in regard to utterance measures, and there were no significant differences between the L->H tech group and the H->L tech group. Despite greater length in utterance and more words per utterance in the Baseline compared to the LT and HT conditions, there were no significant differences in the articulation rate across conditions or groups. There were also no significant differences in F0 variability across conditions or between the groups when viewing Person-Specific locations. Thus, in the Person-Specific locations condition, the first and second hypothesis of this chapter are not supported. The TTT experiment did not have greater engagement outcomes than the Baseline dyadic RT interview, and the HT condition would have greater engagement outcomes compared to the LT condition.

7.9 PROSODIC PATTERNS WHEN VIEWING NON-SPECIFIC LOCATIONS

Descriptive statistic for the prosodic patterns (mean duration of utterance, mean number of words per utterance, articulation rate and variance in F0) when viewing Non-Specific locations are provided in Table 7.3.

As can be seen in Table 7.3, the pattern for the prosodic patterns is similar when viewing Non-Specific locations as it is when viewing Person-Specific locations. The mean duration of utterance and the mean number of words per utterance had a greater range, a higher mean and a larger standard deviation in the Baseline condition compared to the LT and the HT conditions for both groups. However, the mean articulation rate in the Baseline condition compared to the LT and HT conditions are lower in the L->H Group and higher in the H->L group. The values for the LT compared to HT condition are quite similar for the mean duration and mean number of words per utterance, although the mean articulation rate is higher in the L->H group compared to the H->L group.

As for F0 variability, there were large ranges across all conditions. The Baseline condition has a lower mean compared to the other conditions and had a smaller standard deviation in the variance in the mean.

Table 7.3: Descriptive statistics for prosodic patterns of speech in the different order of condition groups Low-Tech -> High Tech (L->H) and High-Tech -> Low-Tech (H->L), during Baseline (B) and when viewing Non-Specific locations in conditions LT and HT. The mean duration of utterance is measured in seconds (s). The mean number of words per utterance is a numerical count value. The articulation rate is the number of words spoken per second calculated from utterances. The F0 is measured in Hertz (Hz).

	Non-Specific locations					
	L->H Group (*n* = 5)			H->L Group (*n* = 4)		
Prosodic pattern	B	LT	HT	B	LT	HT
mean duration of utterance						
Min-Max	2.01 – 18.07	0.36 – 3.84	0.16 – 2.79	0.77 – 19.45	0.45 – 4.05	0.69 – 3.96
Mean (SD)	5.50 (5.16)	1.37 (0.78)	1.30 (0.37)	4.45 (5.24)	1.34 (0.95)	1.44 (0.63)
mean number of words per utterance						
Min-Max	5.61 – 36.00	1.20 – 8.56	1.00 – 6.60	2.31 – 37.40	1.17 – 10.00	2.00 – 8.65
Mean (SD)	13.97 (10.45)	3.85 (1.67)	3.93 (1.59)	10.17 (9.55)	3.30 (2.20)	3.60 (1.58)
articulation rate						
Min-Max	1.75 – 3.59	1.87 – 5.30	2.11 – 6.85	1.91 – 3.45	1.47 – 3.65	1.30 – 4.35
Mean (SD)	2.84 (0.48)	3.02 (0.65)	3.46 (1.36)	2.61 (0.39)	2.56 (0.46)	2.54 (0.63)
variation in F0						
Min-Max	0.71 – 90.43	0.65 – 116.44	0.53 – 105.66	0.17 – 95.41	0.16 – 88.96	0.24 – 98.34
Mean (SD)	26.10 (16.42)	29.29 (21.35)	30.29 (19.08)	27.59 (16.06)	29.58 (19.58)	28.37 19.48)

7.9.1 Mean duration of utterances spoken when viewing Non-Specific locations

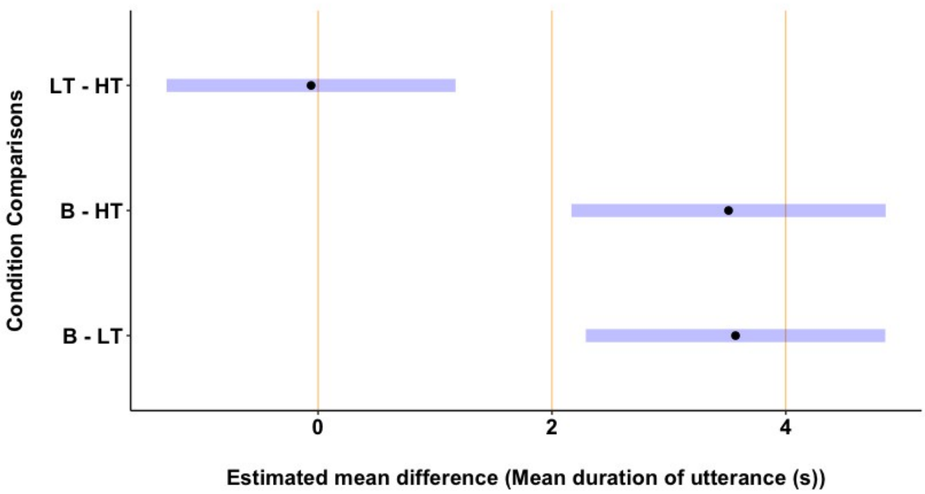


Figure 7.3. Estimated marginal means for the mean duration of utterance, measured in seconds, when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

The mean duration of utterances in the Baseline condition (*M* = 4.96, *SD* = 5.15) was higher (*t* = 5.525, *p* < 0.0001) compared to viewing Non-Specific locations in the LT condition (*M* = 1.36, *SD* = 0.85). There was an estimated mean difference of 3.57, 95% CI (2.29, 4.85). The mean duration of utterance at Baseline was also higher (*t* = 5.176, *p* < 0.0001) compared to viewing Non-Specific locations in the

HT condition (*M* = 1.38, *SD* = 0.66). There was an estimated mean difference of 3.51, 95% CI (2.17, 4.85). See Figure 7.3.

For Non-Specific locations, there were no significant differences found in the mean duration of utterances between the LT and the HT conditions ($p = 0.9237$). There were also no significant differences found in the mean duration of utterances when comparing the L->H tech and the H->L tech group ($p = 0.6304$)

7.9.2 Mean number of words per utterance when viewing Non-Specific locations

The mean number of words per utterance spoken in the Baseline condition (*M* = 12.01, *SD* = 10.03) was significantly higher ($t = 6.656$, $p < 0.0001$)) compared to viewing Non-Specific locations in the LT condition (*M* = 3.6, *SD* = 1.93). There was an estimated mean difference of 8.4, 95% CI (5.92, 10.94) and significantly higher ($t = 6.092$, $p < 0.0001$) compared to viewing Non-Specific locations in the HT condition (*M* = 3.73, *SD* = 1.57). There was an estimated mean difference of 8.1, 95% CI (5.46, 10.73). See Figure 7.4.

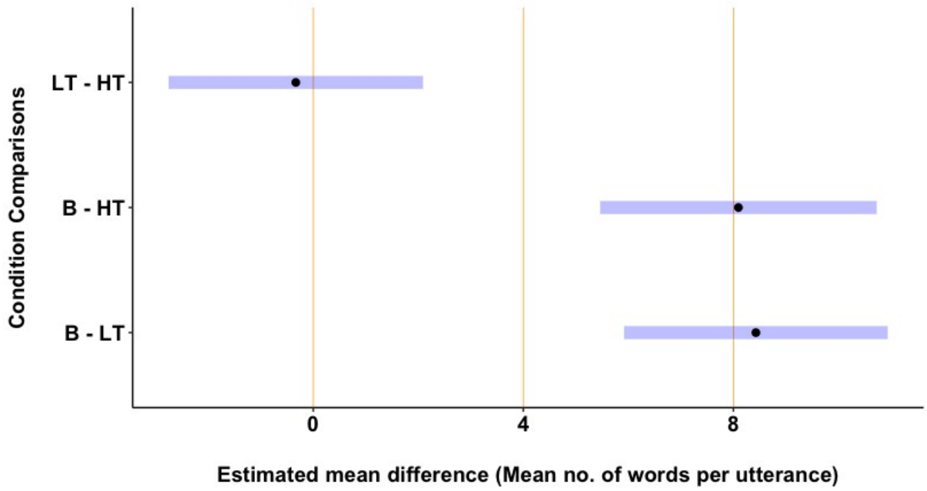


Figure 7.4 Estimated marginal means for the mean number of words per utterance when viewing Non-Specific locations; Baseline = B, Low-Tech = LT, and High-Tech = HT.

For Non-Specific locations, there were no significant differences found in the mean number of words per utterance between the LT and the HT conditions ($p = 0.7863$). There were also no significant differences found in the mean duration of utterances spoken when comparing the L->H tech and the H->L tech group ($p = 0.2329$).

7.9.3 Articulation rate when viewing Non-Specific locations

For Non-Specific locations, there were no significant differences found in the articulation rate (words/s) when comparing Baseline and LT conditions ($p = 0.8125$), Baseline and HT conditions ($p = 0.2327$) or LT and HT conditions ($p = 0.2911$). There were also no significant differences found in the articulation rate (words/s) when comparing the L->H tech and the H->L tech group ($p = 0.0856$).

7.9.4 F0 variability when viewing Non-Specific locations

For Non-Specific locations, there were no significant differences found in the F0 variability when comparing Baseline and LT conditions ($p = 0.4888$), Baseline and HT conditions ($p = 0.9384$) or LT and

HT conditions (*p* = 0.5827). There were also no significant differences found in the F0 variability when comparing the L->H tech and the H->L tech group (*p* = 0.7926).

7.9.5 Discussion

The Non-Specific locations condition had similar dependent variable prosodic pattern outcomes compared to the Person-Specific locations condition. That is, the average length of utterances spoken and the average number of words per utterance spoken were greater in the Baseline condition compared to the LT and the HT conditions. There were also no significant differences between the LT and HT condition, and there were no significant differences between the L->H tech group and the H->L tech group. Despite greater length in utterance and more words per utterance in the Baseline condition, compared to the LT and HT conditions, there were no significant differences in the articulation rate across conditions or groups. Similar to the Person-Specific locations, when viewing Non-Specific locations, there were no differences found across conditions or between the groups in F0 variability. Thus, the first and second hypothesis of this chapter are not supported, that the TTT experiment would have greater engagement outcomes than the Baseline dyadic RT interview and that the HT condition would have greater engagement outcomes compared to the LT condition.

7.10 Comparing prosodic patterns between Person-Specific and Non-Specific locations

As discussed in previous chapters, the Person-Specific locations within TTT experiment encourage reminiscence and sharing of personal stories. In the third hypothesis of this chapter, it was predicted that there would be greater affective prosodic patterns of engagement, represented through a greater mean duration of utterance, greater mean words per utterance, and therefore a faster articulation rate, when viewing Person-Specific locations, compared to viewing Non-Specific locations. It was also expected that participants would experience greater affect-driven behavioural engagement as measured through a greater F0 variability. That is, there would be a greater standard deviation of the F0 in the Person-Specific locations condition, compared to the Non-Specific locations condition. Through understanding the impact of reminiscence on the acoustic patterns of speech, the second research question of this chapter is addressed and an improved appreciation of how the TTT experiment effects engagement is gained.

Similar to facial analysis and lexical analysis in the previous chapters, linear mixed model analysis was conducted to compare the prosodic patterns as a measure of engagement responses in the Person-Specific and Non-Specific locations. The group variable was also removed from the analysis model as it was shown to have no significant effect on the individual groups. This was decided so that the model would not be overfitted with too many variables when including location as a factor. The Baseline measures were also removed as the interest was in the type of location, either being Person-Specific or Non-Specific, within the TTT experiment. The model followed the same format and criteria as outlined in section 5.4.

The equation used for the linear mixed model was:

```
res2=lmer(prom ~ Con + Location + (1|ID), data=BC_data)
```

The equation used for the random slopes model was:

```
res3 = lmer(prom ~ Con + Location + (1 + Con|ID), REML = TRUE, data = BC_data)
```

Where, ‘prom’ represents the prosodic pattern and ‘location’ represents either Person-Specific (PS) or Non-Specific (NS).

For the analysis of the utterance measures including mean duration of utterance, mean number of words per utterance and articulation rate, the general linear mixed model was used as it met the criteria for a stronger model as outlined in in section 5.3. For the variation in F0 (F0_sd), the random slopes model was used as it had a better fit.

Descriptive statistic for the prosodic patterns (mean duration of utterance, mean number of words per utterance, articulation rate and variance in F0) when viewing Non-Specific locations and Person-Specific locations are provided in Table 7.4.

Table 7.4: Descriptive statistics for prosodic patterns of participant speech when viewing Non-Specific (NS) and Person-Specific (PS) locations. Non-Specific and Person-Specific locations include both LT and HT conditions for that location. The mean duration of utterance is measured in seconds (s). The mean number of words per utterance is a numerical count value. The articulation rate is the number of words spoken per second calculated from utterances. The F0 is measured in Hertz (Hz).

Prosodic pattern	Non-Specific	Person-Specific
mean duration of utterance		
Min-Max	0.16 – 4.05	0.36 – 4.28
Mean (SD)	1.37 (0.77)	1.70 (0.72)
mean number of words per utterance		
Min-Max	1 – 10	1.2 – 10.82
Mean (SD)	3.66 (1.77)	4.7 (1.66)
articulation rate		
Min-Max	1.30 – 6.85	1.97 – 4.31
Mean (SD)	2.85 (0.84)	2.85 (0.45)
variation in F0		
Min-Max	0.16 – 116.44	0.01 – 124.59
Mean (SD)	29.28 (19.93)	26.93 (19.51)

As can be seen in Table 7.4 the range for each pattern was quite similar when viewing both locations. Despite the range, there was a higher mean and a smaller standard deviation for both the utterance duration and mean number of words per utterance when viewing Person-Specific compared to the Non-Specific locations. The mean of the variation in F0 was higher and the standard deviation was greater when viewing Non-Specific locations compared to Person-Specific locations.

7.10.1 Mean duration of utterances spoken when Person-Specific locations compared to Non-Specific locations

The mean duration of utterance in the Person-Specific locations condition (M = 1.70, SD = 0.72) was higher (t = 3.768, p = 0.0002) compared to Non-Specific locations condition (M = 1.37, SD = 0.77). There was an estimated mean difference of 0.31, 95% CI (0.15, 0.479). See Figure 7.5.

7.10.2 Mean number of words per utterance when viewing Person-Specific locations compared to Non-Specific locations

The mean number of words per utterance in the Person-Specific locations condition (M = 4.7, SD = 1.66) was higher (t = 4.946, p < 0.0001) compared to Non-Specific locations condition (M = 3.66, SD = 1.77). There was an estimated mean difference of 0.10, 95% CI (0.582, 1.35). See Figure 7.6.

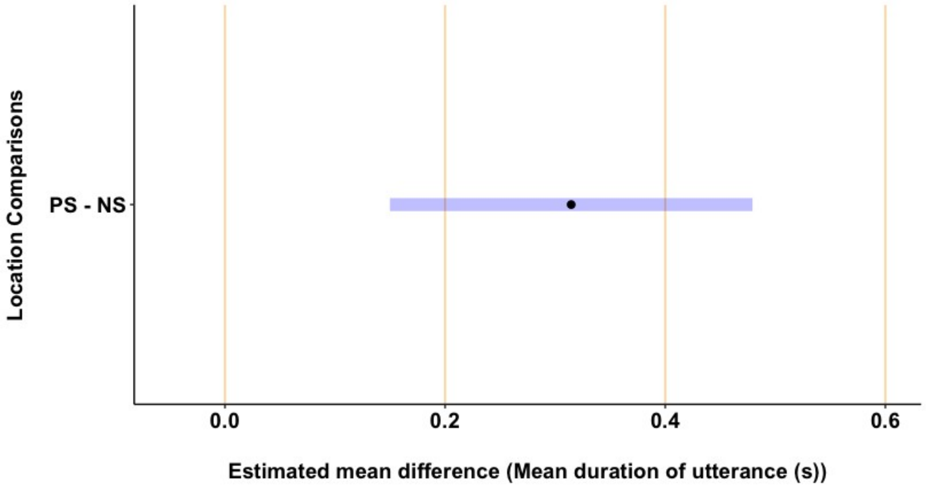


Figure 7.5: Estimated marginal means for the mean duration of utterance, measured in seconds (s), when participants viewed Person-Specific locations (PS) compared to Non-Specific locations (NS).

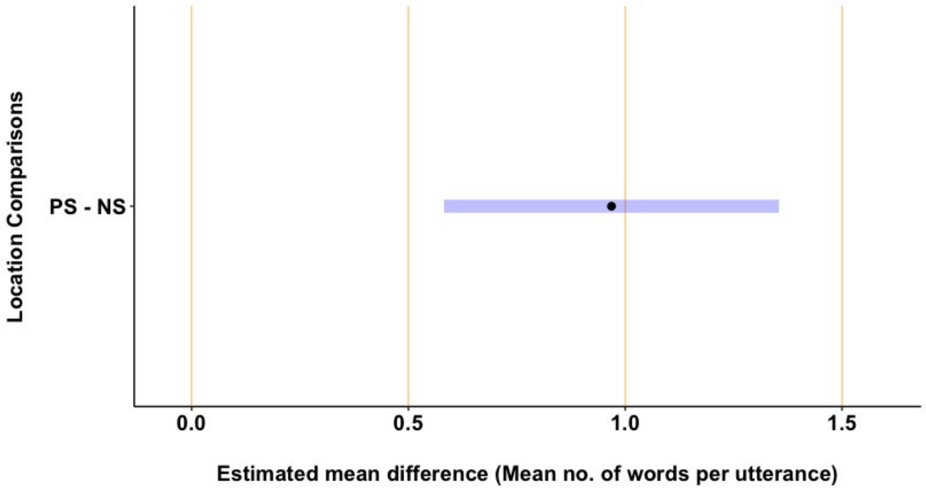


Figure 7.6: Estimated marginal means for the mean number of words per utterance when participants viewed Person-Specific locations (PS) compared to Non-Specific locations (NS).

7.10.3 Articulation rate when viewing Person-Specific locations compared to Non-Specific locations

There were no significant differences in the articulation rate (words/s) when viewing Person-Specific locations compared to Non-Specific locations (p = 0.8461).

7.10.4 F0 variability when viewing Person-Specific locations compared to Non-Specific locations

There were no significant differences found in F0 variability spoken when viewing Person-Specific locations compared to Non-Specific locations (p = 0.8522).

7.11 Discussion of prosodic patterns when viewing Person-Specific and Non-Specific locations

Based on previous research as outlined in section 7.1, utterance properties and articulation of speech as dependent variables, are indicators of behavioural engagement, and the variation of F0 as an indicator of affect-driven behavioural engagement. The temporal patterns of utterance length and the number of words per utterance were the first prosodic pattern dependent variables analysed. From these patterns, the articulation rate is calculated. This is achieved by measuring the length of utterances and dividing it by the number of words per utterance. This articulation rate is then used as a measure of the amount of energy expended when speaking across conditions. In wanting to capture affect through pitch, the variation in the F0 as a dependent variable was analysed as an affect-driven behavioural measure of engagement.

The first question of this chapter was, 'What is the duration of utterance, words per utterance and variation in F0 during the TTT experiment and how does this differ to a structured dyadic RT interview?'. Based on previous research, it was hypothesised that for the dependent variables there would be a longer duration of words, more words per utterance, a faster articulation rate and greater variance in F0 in the TTT experiment compared to the Baseline dyadic RT interview. The results show a higher mean utterance duration and words per utterance in the Baseline condition compared to both of the technology dependent variable conditions. Even though there was a greater engagement in terms of length of utterance and number of words per utterance, in the Baseline condition compared to the technology conditions, there was no difference in the articulation rate or the variation of F0 across all conditions and groups, when viewing Non-Specific and Person-Specific locations. This suggests that there is a greater fluidity in speech in the Baseline condition compared to the TTT experiment conditions. That is, the rate of speaking was comparable however, there were less silent gaps in speech in the Baseline condition.

A factor influencing greater duration and number of words per utterance, as measures of engagement, would be the interaction structure. Within the different interactional formats of a dyadic interview and a group environment, there are different expectations. Within the group environment, there is more turn taking and negotiation of turns. Therefore, there will be more silence and breaks within speech, compared to an interview, which will have long stretches of speech by a single participant. The engagement outcomes within the different interaction structures can be explained by interaction factors outlined within the CPMGE (Cohen-Mansfield et al., 2017), see section 2.3.1. Within the TTT sessions, the TTT interface would contribute to the stimulus attributes, the presence of group members as part of environmental attributes, and the personality of the individual as part of the person attributes. However, in the dyadic RT interview, there is no TTT interface or other group members to consider, when responding to the questions of the facilitator. Further, the TTT screen could be distracting, capturing the attention of the participant. With participant attention being split across multiple variables (attention towards screen, facilitator and group clients) that are not all present in a dyadic interview, there is reduced capacity for dialogue output (Vanthornhout et al., 2019).

The second question of this chapter was, 'To what extent does the dynamic and immersive nature of technology mediate duration of utterance, words per utterance and variation in F0 differences when participating in a LT version compared to a HT version of TTT?'. With respect to previous research, it was hypothesised that there will be a longer duration of words, more words per utterance, a faster articulation rate and greater variance in F0 when viewing Person-Specific locations compared to viewing Non-Specific locations. The results show that the level of technology did not impact utterance duration or number of words per utterance, articulation rate or the variation in F0 when viewing Non-Specific and Person-Specific locations. Thus, the second hypothesis was not supported. Similar to the previous chapters, this suggests that the level of digital technology within the stimulus factor is inconsequential to engagement outcomes.

The third question of this chapter was, 'To what extent does the reminiscence and personal familiarity of a location mediate duration of utterance, words per utterance and variation in F0 differences when viewing Non-Specific compared to Person-Specific locations?'. Based on the previous research, it was hypothesised that the Person-Specific locations would evoke a greater engagement response. This would be seen in the dependent variable outcomes, with a greater length of utterances, a higher number of words per utterance, a faster articulation rate and a greater variance in tone, when viewing Person-Specific locations compared to viewing Non-Specific locations. The results partially support the third hypothesis. There was a greater duration of utterance and a greater number of words per utterance when viewing Person-Specific locations compared to Non-Specific locations. There were however, no significant differences found in the articulation rate or the F0 variability in the Person-Specific locations condition compared to Non-Specific locations condition. This suggests that there is a greater fluidity in speech when viewing Person-Specific locations. That is, the rate of speaking was comparable however, there were less silent gaps in speech when viewing Person-Specific locations compared to Non-Specific locations. This interaction highlights person-stimulus interactions. Stimulus being personalised to the older adults influences the expectation the older adult has to how they will participate in the interaction how long they are able to speak for. With knowledge that the location of interest is relevant to their lives, the older adult has greater social comfort and epistemic rights in talking for longer periods of time without pausing for the input of other group members.

7.12 Cognitive capacity as a covariate

Prosodic pattern characteristics are known to change across the life span. When comparing younger adults to older adults, Smith et al, (1987) showed that older adults typically have a slower articulation rate. However, despite a slower speech, it was shown that for older adults the length of speech segment, syllable length and sentence durations were 20-25% greater. Greater variability across older adults has also been demonstrated, in comparison to younger adults (Linville, 2001).

Even though natural variations in speech production occur as people age, there is a greater impairment of prosodic expression in people with dementia. For example, people with Alzheimer's disease have been shown to have ~30% reduction in the length of utterance produced compared to healthy controls, relying more on a smaller syntactic sentence when speaking. This reduction has been shown to occur mostly at the beginning and the end of a conversation and is suggested to have a wind up and wind down period (Stickle & Wanner, 2019).

There is contradiction within the previous research as to how prosodic patterns of speech is impaired in people with dementia. Despite maintaining the range in pitch production, people with Alzheimer's Disease have been shown to have significantly less variation in F0 and F0 modulation when speaking, as well as a reduced speaking rate in comparison to people without cognitive decline (Horley et al., 2010). Similarly, it has also been shown that a reduced variation in pitch, measured through the F0, reflects difficulties in prosodic expression in people with behavioural variant frontotemporal dementia (Nevler et al., 2017; Leyton & Hillis, 2017). These reductions in F0 are contradictory to Misiewicz (2018), which suggests that people with mild cognitive impairment have a greater standard deviation and mean of the F0 compared to normal controls. The cause for the mild cognitive disorder in these cases were unknown. This suggests that people with different forms of dementia may have different prosodic profiles.

As previously mentioned, the Mini-Mental State Examination (MMSE; Folstein et al., 1975) was administered to participants to measure their cognitive capacity, described in section 3.2. As a covariate, it was expected that people with a lower MMSE, and therefore reduced prosodic abilities, would have reduced utterance length, less words per utterance, a reduced articulation rate and a reduction in the variation of F0. The outcomes show that there were no significant interactions between MMSE and the prosodic measures.

7.12.1 MMSE covariate effect on prosodic patterns as a measure of engagement

As an example, Figure 7.7 shows the mean duration of utterances (s) when viewing Person-Specific locations across the conditions. The colours of the lines are scaled to each MMSE score. As seen in the graph there are no specific clusters of MMSE responses. If participants with greater cognitive impairment had had more pauses in their speech and therefore shorter utterances, then it would have been reflected with darker lines at the bottom of the graph and lighter lines at the top of the graph. When MMSE was included as a variable in the model, there was no significant difference found across conditions for the mean duration of utterances (p = 0.85756) when viewing Person-Specific locations.

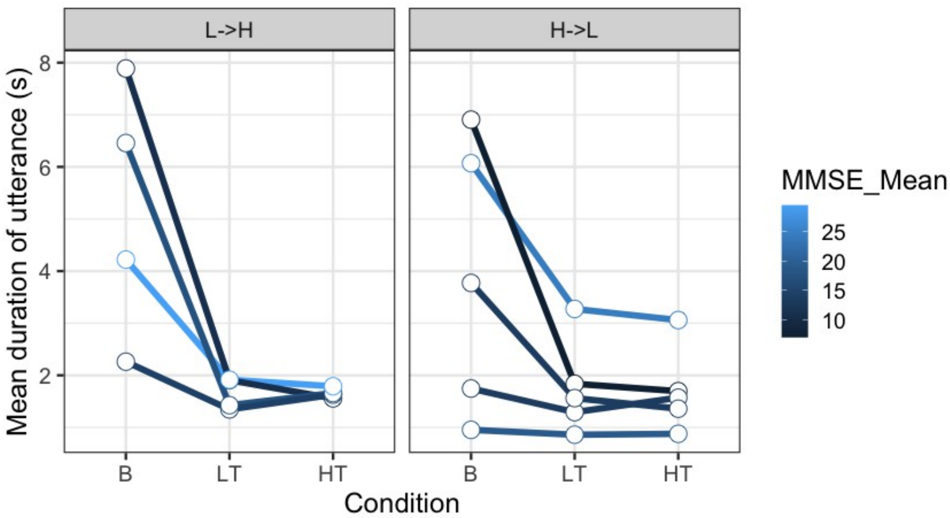


Figure 7.7: The mean duration of utterance (s) for individual participants viewing Person-Specific locations across conditions: Baseline = Baseline, LT = Low-Tech and HT = High-Tech. The lines are coloured to reflect the MMSE of the individual with a lighter colour representing a higher cognitive capacity and a darker colour representing a lower cognitive capacity.

As a second example, Figure 7.8 shows the articulation rate (words/s) when viewing Non-Specific locations across the conditions. The colours of the lines are scaled to each participant's MMSE score. As seen in the graph there are no specific clusters of MMSE responses. If people with cognitive impairment were to have slower speech in terms of pronouncing words at a slower rate, then it would have been reflected with darker lines at the bottom of the graph and lighter lines at the top of the graph. When MMSE was included as a variable in the model, there was no significant difference found across conditions for the mean duration of utterances (p = 0.825534) when viewing Person-Specific locations.

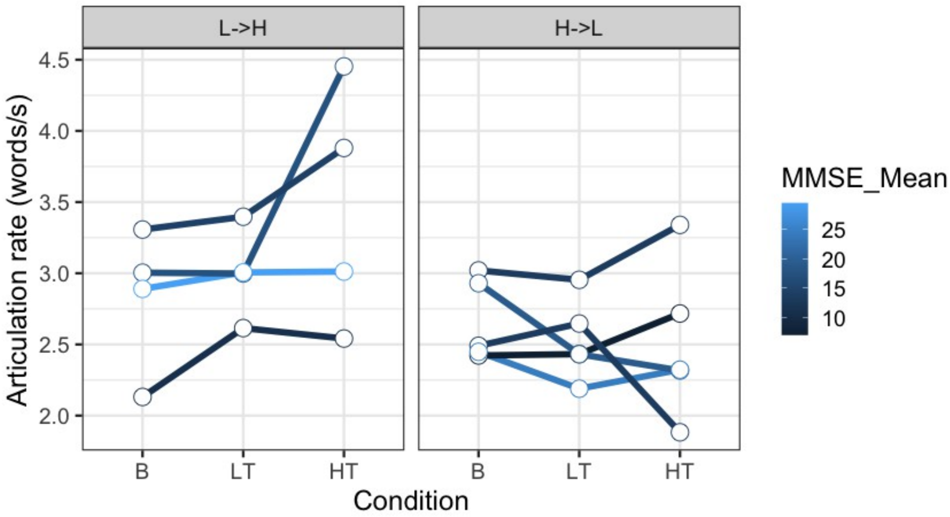


Figure 7.8: Articulation rate (words/s) for individual participants viewing Non-Specific locations across conditions: Baseline = Baseline, LT = Low-Tech and HT = High-Tech. The lines are coloured to reflect the MMSE of the individual with a lighter colour representing a higher cognitive capacity and a darker colour representing a lower cognitive capacity.

Similar to the MMSE as a covariate to facial movement and lexical use, the effect seen with prosodic patterns of speech may be due to a limitation in the number of participants representing different scorings on the MMSE. For this reason, the MMSE was not included as a variable in the analysis of prosodic patterns as a measure of engagement.

Chapter 8: Discussion

The aim of this thesis was to characterise older adult engagement through the medium of group reminiscence therapy (RT), delivered through digital technology. The Comprehensive Process Model of Group Engagement (CPMGE) framework (Cohen-Mansfield et al., 2017) was introduced to define engagement and motivate research questions, through the interaction of environment, personal and stimuli factors, see Figure 8.1.

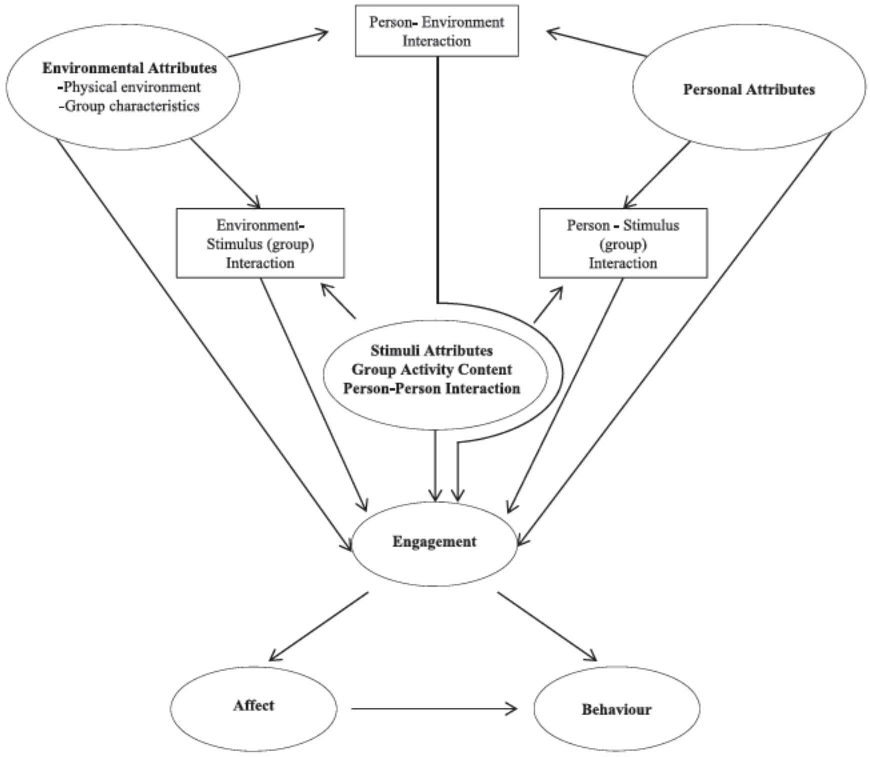


Figure 8.1: Comprehensive Process Model of Group Engagement. Reprinted from Cohen-Mansfield, J., Hai, T., & Comishen, M. (2017). Group engagement in persons with dementia: The concept and its measurement. Psychiatry Res, 251, 237-243.

Using a multi-dimensional approach, the study was designed to understand older adult engagement during the Time Travelling with Technology (TTT) experiment and measure how this compares to a structured dyadic RT interview. The central research question that was addressed is:

> To what extent does technology delivered through TTT impact the engagement of older adults in respite aged care?

The overall hypotheses were:

> **H1:** If reminiscence therapy, technology and group environments promote engagement of older adults, it is hypothesised that the TTT intervention has greater engagement outcomes compared to the dyadic reminiscence therapy interview.
> **H2:** If dynamic, interactive and immersive digital technology promotes engagement of older adults, it is hypothesised that there is a positive association between the level of technology and the engagement outcomes of older adults.

H3: If personalised stimuli within reminiscence therapy promote engagement, it is hypothesised that the Person-Specific locations condition will elicit greater engagement outcomes compared to the Non-Specific locations condition.

The analysis focused on three dimensions as indicators of engagement. These dependent variables included facial movements, lexical use and prosodic patterns of speech, see chapters 5, 6 and 7, respectively. In this chapter a summary of the findings will be discussed, along with the theoretical underpinnings of the psychological and communicative mechanisms underlying engagement in dyadic and group settings.

It should be noted that across all groups and conditions, there were no significant interactions between the cognitive capacity of participants, as measured through the MMSE, and engagement outcomes. For information on MMSE as a covariate for the dependent variable outcomes, refer to sections 5.10, 6.10 and 7.12.

8.1 SUMMARY OF KEY FINDINGS

8.1.1 Summary of facial movement as a measure of engagement

The findings regarding facial movements suggest that there is greater presence and intensity of Action units AUs, as dependent variables, during the TTT experiment compared to a dyadic RT interview. This is regardless of whether the locations were Non-Specific or Person-Specific. The findings suggest that it is the use of digital technology compared to not using any digital technology, that promotes the presence and intensity of facial movements in older adults, as measured by facial movements through AUs. Previous research has demonstrated that group activities promote engagement (Materne et al., 2014) and that using digital technology to deliver RT is beneficial to older adults (Subramaniam & Woods, 2016). The current findings expand on this by showing that there is a greater affect-driven behavioural engagement, as seen through facial movement, in group activities compared to dyadic interviews.

The difference in the facial movement dependent variable outcomes in the TTT context as compared to the dyadic RT interview context is still not properly understood. One suggestion is the social context that is within the TTT context. As participants share stories from visiting Person-Specific locations, interact with the stories of the other group members and socialise with each other when viewing novel locations, they are more expressive in their communication and in doing so build a greater relationship with one another. This draws on the importance of the interactions between the person, environment, and stimuli attributes within the CPMGE.

In relation to the levels of the technology independent variable in the TTT context, only AU04 – brow lowerer dependent variable showed reduced presence in the Low-Tech (LT) condition compared to the High-Tech (HT) condition. AU04 is associated with sadness, fear, anger, and confusion. These results support the hypothesis that the HT condition would promote engagement compared to the LT condition. Why there is a reduced presence of AU04 in the LT condition compared to the HT condition is not yet fully understood. One suggestion is that the HT condition caused greater confusion than the LT condition. That is, with a highly dynamic and immersive environment in the HT condition, older adults may be confused when processing the environment. It suggests that using a simpler version of a digital technology maybe more accessible and comfortable for older adults to interact with, compared to a more advanced interactive experience.

Another explanation may be that with the incorporation of a group environment and digital technology, a person reaches their capacity in expressive facial movements and are naturally unable to be more expressive. The images shown within the LT condition of TTT are suggested to be very effective at cuing autobiographical memories and the stories that accompany these memories. The LT TTT condition may also be very effective at cueing socialisation and conversation with the display of novel locations. Therefore, the HT version of TTT may not actually contribute any information, to further the effect of such technology, on affective facial movement as a measure of engagement.

In relation to the levels of the location specificity independent variable, the only significant difference was greater intensity of AU12 – lip corner puller when viewing Person-Specific locations compared to viewing Non-Specific locations. Since, AU12 – lip corner puller is associated with positive affect, the results suggest that viewing Person-Specific locations increases positive affect-driven behavioural engagement. The meaningful activity of reminiscing within a group environment, and the subsequent cueing of autobiographical memory, may promote positive affect-driven engagement of older adults. The findings emphasise the benefit of person-centered care and individualising non-pharmacological interventions, with respect to the identity and needs of an individual. Tailoring stimuli to the individual and designing interventions to cue elements of a person's life, promotes positive affect through the recall of autobiographical memories and personal identity. This aligns with the stimuli-personal attribute interaction within the CPMGE.

8.1.2 Summary of lexical use as a measure of engagement

The results of lexical use as a measure of engagement show that there was a greater use of personal pronouns, as a dependent variable, in the dyadic RT interview context compared to the TTT experiment. This shows there is more personalisation of the interaction between the dyad of the dyadic RT interview. A greater use of pronouns was explained by the nature of the dyadic environment, as the older adult was the focus of attention with the directive questions. Whereas, within the TTT condition, older adults share the focus of attention amongst themselves and engage with each other rather than solely focusing on their own stories. Therefore, within TTT older adults are engaging in their own story, the stories of others, and discussions of new places.

As predicted, there was a greater use of personal pronouns, as a dependent variable, when viewing Person-Specific locations during TTT compared to Non-Specific locations. This is supported by the theory of person-centered care, whereby the use of the history of an individual promotes a connection to their identity (Fazio et al., 2018). Therefore, a benefit of TTT is the ability to connect with identity and have a personalised experience, through cueing autobiographical memory and sharing stories. This positive connection is evidenced with the dependent variable outcomes of greater pronoun use in correlation with an increase in positive affective facial movements, when viewing Person-Specific locations, compared to Non-Specific locations.

Within the Non-Specific locations condition, there was a more positive emotional tone of speech as a dependent variable compared to the Person-Specific locations condition. There was, however, no significant difference found in affective words use, as a dependent variable, across all conditions. This shows that despite a comparable number of affective words used across all conditions, there were more positively associated phrases used when viewing Non-Specific locations compared to Person-Specific locations. On the scale of emotional tone, when viewing Person-Specific locations, the overall emotional tone was classified as ambiguous. That is, the affective valence of the phrasing of words were neither positively or negatively more inclined. As discussed earlier in the lexical use as a measure of engagement results, autobiographical memories evoke feelings of nostalgia and melancholy. These are deemed mixed emotions as they incorporate both positive and negative affect (Kraxenberger, 2018). Mercer (2016) demonstrated that viewing nostalgic stimuli produces greater expressions of happiness through facial movements and self-reported measures compared to non-nostalgic stimuli. Further, sadness and negative affect was seen to be greater when viewing non-nostalgic stimuli compared to nostalgic stimuli. The current research shows that affective-driven behaviour and the expression of happiness when viewing nostalgic content may be expressed through affect-driven facial movements, rather than affect-driven lexical use. The current findings showed greater intensity of AU12 (lip corner puller) when viewing Person-Specific locations compared to Non-Specific locations. AU12 is associated with positive affect. It is suggested by the previous studies on nostalgia that these ambiguous results between the lexical use and facial movement as measures of engagement can be interpreted as older adults having increased positive affect when viewing Person-Specific locations.

If lexical use was used as a singular dimension to measure engagement, then it would have been deemed from the emotional tone results alone, that viewing Non-Specific locations promotes greater positive affect than viewing Person-Specific locations. However, with previous research findings that nostalgic stimuli produce greater expressions of happiness and the current findings of greater positive affect expressed through facial movement when viewing Person-Specific compared to Non-Specific locations, a better understanding of older adult engagement is constructed. That is, when reminiscing, the language use of older adults suggests mixed emotions, while facial movements suggest more positive affective. This approach enables a more nuanced interpretation of older adult's emotional state.

8.1.3 Summary of prosodic patterns of speech as a measure of engagement

The results from the analysis of the prosodic patterns of speech show there was a greater mean duration of utterance and words per utterance in the dyadic interview, compared to the TTT experiment. This does not support previous research that group reminiscence would promote greater engagement. As mentioned earlier, within the dyadic interview, older adults are asked questions about their lives in which the focus was solely on their experiences and past history. Within the TTT environment, older adults do not have their attention focused on only their own stories. They are also engaging in the stories of others that may be cued by their own stories or the images that are Person-Specific to the other older adults, as well as conversing about novel locations. Their attention is split in the communication within the group environment as well as in directing their attention towards the TTT interface. These factors could account for the reduction in prosodic patterns as measures of engagement.

As predicted, there was a greater mean duration of utterance and words per utterance when viewing Person-Specific locations compared to Non-Specific locations. There was, however, no significant difference in the articulation rate across all conditions. Participants did not speak faster in the Baseline condition or when viewing Person-Specific locations. Therefore, the context of TTT increases the length of time in which older adults speak. This means, whilst reminiscing when viewing Person-Specific locations, older adults are speaking with fewer silent gaps in their speech compared to interacting when viewing Non-Specific locations.

In regard to F0 variability, there were no significant differences seen across all conditions and locations. There was also no significant difference in the level of technology across location or conditions for all lexical use markers or prosodic patterns. Impact of TTT environment on engagement outcomes

The central research question of this thesis was, 'To what extent does technology delivered through TTT impact the engagement of older adults in respite aged care?'. Based on previous research the first central hypothesis of this thesis was, if RT, technology, and group environments promote engagement of older adults, then the TTT experiment will have greater engagement outcomes compared to the dyadic reminiscence therapy interview. In reference to the findings of this research, the TTT experiment elicited greater facial movement presence and intensity. However, the dyadic RT interview elicited greater personal pronoun use, longer mean duration of utterances and more words per utterance compared to the TTT experiment.

These findings show great variation in the behavioural outcomes of engagement in the different intervention settings, which can be interpreted using the CPMGE (Cohen-Mansfield et al., 2017). Even though the individual person attributes were controlled for, there is influence of person-environment and person-stimuli interactions, which vary across the group. The TTT environment incorporates the group element of the activity as well as the technology factor of the stimuli, further providing sources to capture the attention of the participant. This attention is split amongst the different elements within the intervention and may retract from a focus on speaking (Vanthornhout et al., 2019). The results show greater facial movement and intensity in the TTT experiment suggesting there is greater affect-driven behavioural engagement when compared to the dyadic RT interview. This increase in affect-driven behavioural engagement was not seen in the lexical use results, with no significant difference in the amount of affective word use between the interview and TTT experiment. However, the interview condition had greater engagement outcomes as seen through the dependent variables with a greater mean words per utterance and longer mean duration of utterance. Overall, these results are supported by previous research that the enriched and stimulating TTT group environment promotes affect-driven behaviour. The interactional structure of a dyadic RT interview promotes a certain style of verbal communication.

These research findings further highlight how the multi-dimensional approach to measuring engagement is important in capturing the different ways older adults interact in an activity. For example, if TTT was only measured with the prosodic patterns of speech, it would have been deduced that the dyadic interview would have greater engagement overall with greater mean utterance length and mean words per utterance, and with no difference in F0 variability across the two settings. With the inclusion of a multi-dimensional approach and analysing facial movement as well as lexical use, a broader understanding on engagement is achieved with the TTT experiment promoting greater affective facial movements. Even though the dyadic interview had greater prosodic patterns associated with behavioural engagement, there was no evidence of greater affect-driven behavioural engagement within those results. As facial movement as a measure of engagement was more prominent in the TTT experiment, it is deduced that there was more affect-driven behavioural engagement during the TTT experiment. With the understanding that affect-driven behavioural engagement can be expressed through multiple avenues, there is a need for research practices to adopt a multi-dimensional approach to gain a more comprehensive indexing of how interventions effect the affective and behavioural outcomes of engagement. Alternative approaches to understand affect-driven engagement may include interviews with participants and carestaff. These were not possible in the current research due to residential care lockdowns during COVID-19 in 2020.

8.2 Impact of level of technology on engagement outcomes

To further explore the central research question, varying levels of technology as a feature to enhance RT was explored. As previously discussed in Woods et al., (2018), there is a research gap in understanding the effects of RT on engagement. With this in mind, the third central hypothesis was, 'If personalised stimuli within RT promote engagement, it is hypothesised that the Person-Specific locations condition will elicit greater engagement outcomes compared to the Non-Specific locations condition.'

Across all measures of engagement there were minimal significant differences found between the LT and the HT conditions. It was only the expression of AU04 – brow lowerer, which is typically related to sadness, fear, anger, and confusion (Ekman & Friesen, 1978) that was lower in the LT condition compared to the HT condition. This may be attributed to a highly technical interface causing confusion for older adults with greater difficulty in processing the virtual environment. Thus, the second central hypothesis was not supported by the findings. As mentioned previously, it is currently unknown as to why the measures of affect-driven behavioural engagement where greater with the use of digital technology compared to a dyadic interview, and not between the levels of digital technology. This is a factor to be explored further in future research.

The results show that the levels of the digital technology independent variables did not significantly differ. Therefore, the more dynamic and immersive HT condition did not promote greater engagement outcomes compared to the LT condition. However, it did show significant difference when you manipulate interactional conditions, such as that seen between the dyadic RT interview compared to the group TTT sessions. This shows that you can get different types of interactional engagement. Within the dyadic RT interview, older adults are more self-focused. Within the nature of the interview format, older adults are able to talk more about themselves, as seen through increased use of pronouns, as well leave less space between turns of speaking, as seen through longer duration of utterances and words per utterance. In group conversation, as seen in the TTT sessions, they are more other-focused and leave space for others to participate and share views. In doing so, they create supportive conditions for others to share. The results show that participants are successful interactants in both types of contexts: interviews versus group conversations. Both settings required different responses and different management of the structure of interaction. The participants successful management of this has been demonstrated through appropriate social interaction skills in all conditions.

Across the different measures of engagement cognitive impairment as measured through the MMSE did not have a significant contribution to the variance in engagement outcomes. This contradicts the previous research, which has shown engagement outcomes vary with cognitive impairment and dementia. For example, previous research shows that emotions such as pain have a greater expression of intensity in people with dementia (Kunz et al., 2007; Seidl et al., 2012). Further, people with dementia have also been shown the have reduced use of pronouns as there is a replacement of pronouns with proper nouns (Bayles et al., 2018). With 9 participants in the current research, it is thought that the findings do not support previous research due to sample limitations in the number of people representing different cognitive levels. Future research into the impact of cognitive profiling and engagement outcomes when participating in TTT should be explored.

8.3 Impact of location specificity on engagement outcomes

A key feature of the TTT interface is the reminiscence; the ability to take older adults to landmarks in their history and cue autobiographical memories. In addressing the inconsistency within previous research on the benefits of RT (Woods et al., 2018), the current research had a Person-Specific locations condition and Non-Specific locations condition. It was expected that Person-Specific locations evoke greater dependent variable outcomes, as measures of engagement, compared to Non-Specific locations.

When viewing Person-Specific locations, the intensity of AU12 (lip corner puller) was significantly greater compared to Non-Specific locations. AU12 is usually correlated with positive emotions (Ekman, 1978). Considering no other AU measured showed a significant difference between conditions, it is suggested that Person-Specific locations elicited a more intense positive affective state. When viewing Person-Specific locations, as expected there was also a greater use of personal pronouns compared to Non-Specific locations. Therefore, Person-Specific locations invoke a greater sense of self and other awareness. Within TTT this self-knowledge is cultivated through visiting past known locations. The TTT environment further supports the sharing of the recalled awareness of one's history and promotes socialisation amongst the older adults. In addition to greater pronoun use, there was a greater mean duration of utterance and mean number of words per utterance within the Person-Specific locations condition compared to Non-Specific locations condition. Therefore, there was a greater utterance rate (being the number of words per utterance per minute) when reminiscing, suggesting greater behavioural outcomes of engagement. This is supported by the theory of person-centered care (Kitwood, 1997). Within TTT interpersonal relationships are supported through delivering Person-Specific stimuli and supporting identity through the recalled past events. The enhanced and enriched environment of TTT is personalised to the individual. This along with its delivery within a group setting promotes the affective and behavioural engagement seen in this research. These results support the use of TTT as an effective intervention for the delivery of RT. Thus, the central third hypothesis is partially supported.

As mentioned previously, different emotions alter prosodic pitch. For example, happy emotions are associated with a higher pitch level compared to sad emotions (Juslin et al., 2018). If there was no significant difference in the number of affective words used, then it is to be expected that there would not be a significant difference in pitch variation. This is because both pitch and affective word use are modulated by the affective state of a person (Borelli et al., 2018; Sundberg, 1998). This is supported by the research findings. As discussed in the results of lexical use as a measure of engagement, in Chapter 6, there were no significant differences found across groups or conditions for the percentage of affective words used within participant speech. This coincides with the prosodic parameter of F0 variance, which was shown to also have no significant differences across groups or conditions. This means that during the dyadic interview and the TTT experiment, the amount of affect-driven behavioural engagement as measured through lexical use and prosodic patterns were comparable.

The findings show a contradiction to the correlation above, when comparing the results of the dependent variables between the location specificity conditions. Non-Specific locations had a significantly more positive emotional tone than Person-Specific locations. As previously mentioned, this may be due to the experience of reminiscing. Reminiscing evokes feelings of melancholy and nostalgia which are classified as mixed emotions, as they incorporate both positive and negative affect (Kraxenberger, 2018). The difference in the location specificity results may also be due to the interactional expectations and group dynamics that form within the TTT environment.

It is to be expected that a more positive emotional tone would be reflected with a significantly greater variance of F0. This is because happy dialogue tends to increase the variability of pitch (Stolarski, 2015). However, there were no significant differences found in the F0 between Non-Specific and Person-Specific locations. This may be due to the ambiguity of affect within speech for both locations. Despite a more positive emotional tone used when viewing Non-Specific locations (M = 63.46, SD = 29.76) compared to Person-Specific locations (M = 53.65, SD = 25.04), both means where around 50 which indicates ambivalence or mixed feelings, with 0 being most negative and 100 being most positive. Therefore, a non-significant variation in F0 may be justified. Further, a non-significant variance of F0 indicates that there is comparable variability in the range of emotions experienced when viewing Non-Specific and Person-Specific locations. This means that despite a more positive emotional tone when viewing Non-Specific locations, the range of intensity of the emotional experience is comparable to viewing Person-Specific locations. When engaged in each other's personal stories, older adults can sympathise with each other's emotions. They may not be as deep or complex as those experienced when viewing one's own Person-Specific locations (e.g., nostalgia and melancholy), as seen with a more ambivalent emotional tone, but the range in emotions is still prominent. This is a factor of socialisation that is important when establishing social identity and shared identity in group environments.

If, for instance, Non-Specific locations had a mean of 80 and Person-Specific locations had a mean of 40, then it would be more alarming if a significant difference in F0 was not seen. This is because the difference would be much greater with a clearly more positive emotional tone in Non-Specific locations. Such a finding would be justified if the differences in cognitive capacity caused significant variance in the research sample. If that were to be the case, then it could be expected that a higher emotional tone may be used with the absence of F0 variation as people with dementia have been shown to have reduced range and variation in F0 (Horley et al., 2010; Leyton & Hillis, 2017; Nevler et al., 2017). However, as the results show that cognitive capacity did not cause significant variance across all variables, then significant variance in F0 would be hypothesised.

Overall, taking into consideration all these dependent variable results outlined in sections 8.1.1 to 8.1.3, RT coupled with technology in the TTT context indicates some support of older adult engagement, encourages a sense of identity, and evokes positive affect. These results show how meaningful activities (Havighurst, 1961; Kitwood, 1997) promote engagement as seen through the dependent variables. More specifically, increased presence and intensity of facial movement, the increased use of pronouns as a percentage of speech, and greater mean duration of utterance and words per utterance, when viewing Person-Specific locations as compared to Non-Specific locations.

8.4 SOCIAL INTERACTION IN DYADIC AND GROUP ENVIRONMENTS

8.4.1 Affective and supportive interaction during storytelling

The current research findings show the interactional context of TTT promotes supportive and affective interactions between older adults. During the TTT sessions, when viewing Non-Specific locations, older adults used a comparative percentage of affective words within their speech. However, their speech had a more positive valence in emotional tone compared to when participants viewed Person-Specific locations. When viewing Non-Specific locations, participants are, in general, on the receiving side of a story within the interaction, and therefore act as the recipient to another person's account. Whilst being a recipient and viewing Non-Specific locations, the general emotional valence of the phrasing of dialogue was more positive. It has already been discussed how the difference in emotional tone, when viewing Non-Specific locations compared to Person-Specific locations, can be correlated with emotions associated with melancholy and nostalgia when viewing Person-Specific locations. This show of affect-driven behavioural engagement and a more positive tone by a recipient is speculated to be attributed to affiliative behaviour, that occur in group environments. This concept comes from research in the fields of Interactional Linguistics and Conversation Analysis.

The outcome of affect-driven behavioural engagement when viewing Non-Specific locations, as seen with comparable percentage of affective word use when viewing Non-Specific locations compared to Person-Specific locations, could be due to affiliation and emotional reciprocity. Affiliation refers to how responding actions/turns in interaction and storytelling are associated with preceding aspects of the interaction. Affiliation is typically used to talk about social solidarity between participants in interaction, being an agreement in regard to feelings and actions. Affiliation is also used to talk about affective cooperation and displaying an affective stance towards the storyteller to encourage the speaker to continue and show an alliance in feelings towards the events (Stivers, 2008). Within group environments there is a strong preference for people in interaction to affiliate and build social connection. This affective cooperation is linked to emotional reciprocity, whereby social signals are reciprocated by the recipients within an interaction, to show their affiliation. This draws on the theory of emotions being a co-constructed interactional resource built from the multiple interactants within conversation (Couper-Kuhlen, 2009).

By having a more positive emotional valence when being a recipient in interaction, older adults could be showing the use of interaction upgrades that are part of a suite of affiliative tools available to interactants. Upgrades are typically used in an evaluation and assessment context in conversation. In response to an interactant's stance on a subject or view towards a situation, the recipient will show agreement by providing an upgrade to their position (Heritage, 2004). For example, in one of the sessions the facilitator stated, 'It's a beautiful river in the Gold Coast area.', Charlie responded 'It is, it is.' which was then followed by Angela showing agreeance and elevation in her response by stating 'Absolutely, yes.' The results may further indicate that upgrades may not be limited to a singular dimension of engagement. During TTT sessions, older adults when viewing locations of their own, showed greater positive affect through facial movement, despite having a neutral emotional tone of speech. That is their overall phrasing did not have a particular positive valence or negative valence. However, the older adult recipients had a more positive emotional tone in speech when responding. Therefore, as a recipient, when viewing an interactant's affective facial expressions when storytelling, the recipient may respond in agreement with verbal upgrades as a tool for affiliation and affective cooperation. This shows the complexity and motivates future research in understanding the psychological and communicative mechanisms that underlies engagement and understanding social interaction.

8.4.2 The impact of stimuli and environmental attributes on cognitive reserve

As previously mentioned, dependent variable outcomes of the study show that a dyadic interview, compared to the TTT experiment, had greater lexical use as a measure of engagement. This was seen with a great mean words per utterance, mean duration of utterance and therefore a greater utterance rate. This finding, aside from social conversational expectations and group dynamics, as outlined in section 8.2.1, may be attributed to cognitive reserve and the distribution of attention amongst various factors.

Tappen et al. (2002) suggest a dyadic structured interview improves the relevance of information and conciseness of speech, compared to combined interventions. This supports the current findings with greater behavioural engagement outcomes seen through prosodic dependent variables. In the dyadic interview, participants only had the facilitator and the questions that the facilitator asked, to focus on. Whereas, in the TTT experiment, there was the technology aspect of the stimuli, the other group clients and the facilitator as environmental factors. It is thought that the extra elements of the technology and the other group clients occupy more cognition than the simplified environment of the interview. In response, participants gave more of their attention to the television screen and other clients, than to speaking and telling stories. Interestingly though, the presence and intensity of AU06 – cheek raiser, AU12 – lip corner puller, AU15 – lip corner depressor and AU17 – chin raiser, and therefore overall facial movement, was greater in the TTT conditions compared to the dyadic RT interview. This suggests a greater affect-driven behavioural engagement response in the TTT experiment.

It takes directed attention to produce language. However, the production of affective facial expressions is often spontaneous in response to stimuli (Dimberg et al., 2000) and an unconscious reflection of a person's affective state. This is not to say that facial expression cannot be manipulated, but that when focusing attention externally, then facial expressions are often unconsciously produced. Therefore, even though the attention was split amongst various factors in the TTT environment, facial movement as a measure of engagement shows how group TTT is effective at promoting affect-driven behavioural engagement in older adults.

8.5 CPMGE PERSON-ATTRIBUTES AND THEIR IMPACT ON ENGAGEMENT OUTCOMES

Despite cognitive capacity being a predictor for engagement in social groups (Cohen-Mansfield, 2017), there are other factors, such as personality trait, that influence the sociability and engagement of people with dementia in group activities. The influence of personality as a variable may also be extended to the facilitator. With the same facilitator delivering the sessions each week, a bias in participant engagement outcomes may be seen to correlate with the personality or expertise of the individual facilitating the session. Within the current findings, there was great inconsistency in how participants responded in the dyadic RT interview context compared to the group TTT context. Even when cognitive functioning was considered, there was a great discrepancy and lack of predictability as to how each individual would engage in the group conditions. For example, Barbara had a similar cognitive capacity to Jana measured through the MMSE, with scores of 13 and 14 respectively. Despite this similar cognitive function rating, they both responded very differently in the interview compared to the group environments. Both participants spoke fluently and avidly in the interview conditions and were in the same experiment group throughout the duration of the intervention. Despite similarity in the interview setting, Barbara spoke minimally and had reduced participation within the TTT sessions than Jana, who spoke with similar mannerisms to how she responded in the interview setting.

The variance may be drawn from a variety of influencers such as personality trait. Both Barbara and Jana demonstrated their ability to recall autobiographical memories in the discourse interviews, however differences in personality and group roles and dynamics contributed to their change in behaviour in the group setting. Previous research shows that personality traits can account for around 48% of engagement variance (Young et al., 2018). Within the same group as Barbara and Jana, was Charlie who presented with a dominating personality. This was seen with greater gestures, words spoken, and turns taken speaking within the sessions. Such an extroverted personality may have influenced Barbara who appeared to be quite introverted, to reduce her engagement within the group setting. Future research should be focused on understanding the influence of personality traits on an individual's engagement in group settings.

Another form of variance contributing to the discrepancy in autobiographical recall produced in interviews compared to group reminiscence may include attitudes towards other clients in the group. Diana had outwardly spoken unbecoming remarks about Colette. Diana and Colette were in the same group and this dislike of Diana by Colette was recognised post allocation to times and groups. It was fascinating to see the difference in the inter-personal behaviours of Colette and Diana when they were placed solely together compared to when they had other participants in the session with them.

Other factors may further contribute to the variance in engagement such as how the group environment is structured to encourage participation. Participants sat on a three-person couch and an armchair in a V-shaped arrangement in front of the television screen to encourage greater social inclusion by allowing participants to face each other more easily and interact. Nevertheless, there were still limitations in being able to properly face participants to each other. This was due to the need of positioning the participants to face the screen and ensuring that the recording camera was able to capture the facial features of the participants. This may have contributed to the ease and accessibility the participants had in communicating with a participant at the further end of the seating arrangement. Such factors contribute to the environment attributes and how person-environment interactions play out.

8.6 The benefit of Non-Specific locations in TTT

During the experiment, participants visited Person-Specific locations that were drawn from locations of their past that they had visited. Participants also visited Non-Specific locations. Such Non-Specific locations include those that may have been Person-Specific to another older adult in the group, or those that may have been public places drawn from popular culture, but never personally visited. For example, Westminster Abbey and The Louvre. It was interesting to conduct the sessions and understand how visiting new Non-Specific locations also encourages shared new experiences amongst participants. The findings that viewing Non-Specific locations bring about, in general, comparable engagement as when viewing Person-Specific locations demonstrates the positive effect and translatability that TTT would have in aged care facilities. The two main differences between the locations were that Person-Specific locations had greater intensity of AU12 – lip corner puller as a dependent variable, and Non-Specific locations had a more positive emotional tone of speech as a dependent variable. There may not be as much connection to personal identity through reminiscence, however the findings show comparable engagement overall.

A benefit of TTT is that older adults can socialise in groups and share in the stories of others. This is due to the stories from one older adult having the ability to cue similar stories of another older adult. The shared experience of going to novel locations and the experience of engaging in the locations that are Person-Specific to another older adult in the group is suggested within the findings to encourage socialisation and positive affect. Therefore, even if Person-Specific locations may not be known for all clients, there is still great benefit in participating in TTT. This is of great relevance to residential care. Within residential care, clients may have unknown histories. They may be new to a facility or no longer have family or personal belongings to indicate Person-Specific locations from the past. It is beneficial to learn through this study that the TTT experiment is appropriate for all clients of a facility and can bring about engagement for clients that may or may not have Person-Specific locations to visit.

8.7 TTT TO PROMOTE POSITIVE CLIENT-CARESTAFF RELATIONS

The relationship with carestaff is a key social connection for clients. At times it is also the most important and frequent social contact for clients with the frequency of daily care routines. Unfortunately, within residential care, there is a lack of carestaff to meet the basic and high needs of clients (Australian Nursing and Midwifery Federation, 2019). With imbalanced carestaff/client ratios, there is a strain on the amount of time carestaff can give to clients outside their immediate caring duties. This can hinder the ability for carestaff to put time into a meaningful relationship with clients and to provide passive socialisation.

Looking after the older adults and people with dementia may also cause great psychological distress, and greatly increase the risk of depression and anxiety for carestaff (Ma et al., 2017). As cognitive and behavioural symptoms of dementia for the older adults increase, so too does the demand of carestaff and the subsequent stress. This impacts positive carestaff/client relations, which become increasingly difficult to maintain and uphold (Ma et al., 2017). Promoting positive relations between clients and carestaff is important for the wellbeing of both interactants. These relationships also highly impact the satisfaction of work and the mental health of carestaff. It was originally intended to deliver the TTT experiment to another residential care facility and involve carestaff in facilitating the sessions. This would have given insight into the impact of the TTT experiment on carestaff relationships. Unfortunately, this was unable to go ahead due to the Covid-19 pandemic and subsequent restrictions.

The positive impact on myself as the facilitator of the TTT experiment and the relations I built with the individual participants delivering the experiment was extremely rewarding, leaving me with fond memories. There is great promise to the benefit that TTT can bring to promoting positive relationships between clients and carestaff. Especially in regard to establishing personal identities and to share new memories. Through the TTT experiment and having shared experiences, carestaff may learn about client histories and identities. This knowledge maybe integrated into care routines, such as drawing on past experiences when passively socialising. Future research should investigate the impact the TTT experiment may have on client-carestaff relationships, particularly in relation to social isolation and loneliness of clients, carestaff attitudes and impact on care routines.

8.8 LIMITATIONS

8.8.1 Small sample size

With the impact of COVID-19 on the opportunity to conduct research with older adults, there was a less than ideal sample size in the current study. Eight out of the nine participants were female. This distribution was unintentional. Future research would aim to have a more comparable representation across genders. With the relatively small sample size, results are to be interpreted with caution.

8.8.2 Expanded multi-dimensional approach to measuring engagement

This thesis focuses on three dimensions, inclusive of the dependent variables of facial movement, lexical use, and prosodic patterns of speech, as measures of engagement. A limitation of this study is that it does not incorporate more behavioural identifiers of engagement which are associated with communication in people with dementia. For example, movements of the head, torso, and arms (Perugia et al., 2018). Behavioural gestures have been suggested to have value in communicating a sense of self through embodied memories, particularly when verbal communication is limited (Hydén, 2018). Behavioural gestures have been deemed a viable dependent variable to measure engagement for people with dementia, as illustrated by research capturing wrist motion with a wrist-worn triaxial accelerometer (Perugia et al., 2018). The benefit of such a measuring tool is that it may be applicable for people with dementia that are non-verbal. This is particularly relevant for people who are in the later stages of dementia. Incorporating further behavioural identifiers, such as wrist motion, was not feasible in the timeframe and scope of this project. Future research should investigate behavioural indicators of engagement within an extended multi-dimensional approach to gain a greater understanding of older adult engagement.

8.8.3 OpenFace software training models

The two OpenFace output parameters where the dependent variables of the presence and the intensity of AUs. The intensity of an AU was scored on a continuous scale from 0 (not present) to 5 (maximum intensity). Across all analysis, AU04 – brow lowerer had the greatest maximum intensity recorded. AU04 reached a maximum intensity of 2.55/5 when viewing Non-Specific locations. This poses the question of the validity of the OpenFace training models to be able to capture the accurate range of a participant's ability to use their facial muscles.

The OpenFace models are trained and evaluated with various databases (Baltrušaitis, 2019). Ideally, a system would be able to calibrate the intensity scale to individual faces. This would normalise how each participant is responding to experiment conditions. OpenFace recognition of AUs can be trained before processing videos. However, this is a lengthy process and was not feasible in the timeframe and scope of this project to retrain the model before the processing of each video. Furthermore, as each participant was their own baseline, it was unnecessary to train the models individually as this was taken into consideration post hoc.

8.8.4 TTT for CALD populations

A strength of the current research is that it represents a culturally diverse sample with 44% of participants identifying as culturally and linguistically diverse (CALD). With over 30% of older adults in Australia being from CALD backgrounds it's of value when conducting research with this population to include similar samples (DSS, 2015). The breakdown of cultures within the current sample was not analysed as the sample size was too small to be able to identify cultural differences.

A limitation within the analysis involves the accuracy of the lexical measures of CALD participants. A couple of the participants would swap to their native language throughout the sessions which is a common occurrence with the progression of dementia (Strandroos & Antelius, 2016). Within the analysis, only English was considered when measuring the dependent variables of proper pronouns, affective word use and the emotional tone of speech. A consequence of this is that participant speech was omitted when it was in another language. This may cause an underreporting of these measures. It is suggested that future research take into consideration the native languages of participants and incorporate them into the analyses.

Despite a small sample size, the diversity across the participants shows how the results of this intervention are beneficial for older adults from different cultural backgrounds and with varying native languages. With TTT creating a shared experience, and with the sharing of culture and identity, a positive environment for fostering cultural diversity and acceptance can be created. As mentioned by Xiao et al., (2017) such an environment that encourages positive relationships through cultural diversity is necessary for wellbeing and positive care experiences. Future research would benefit from exploring the impact TTT on cultural experience and cultural acceptance.

8.8.5 Influence of driving TTT technology as the facilitator

There were challenges in having one facilitator (the author) to deliver and mediate the TTT experiment. As the only facilitator in the room, I had to operate the equipment whilst interacting with the participants. This meant that my attention was split between driving the technology and communicating with the older adults. This was particularly seen within the HT condition which had a greater focus on driving the technology and hence reduced capacity to interact with the older adults. The findings in this research suggest that the level of digital technology did not have a major contribution to the engagement outcomes. A benefit of this finding is that if only one facilitator is conducting the session, they can spend less time occupied with driving the technology through the tablet and more time actively listening and communicating with the older adults. This study did not explore the effects of facilitator behaviour, e.g., whether the facilitator operating the technology as well as facilitating the sessions influenced engagement outcome. Such an interaction could contribute to current results which found that the level of technology not having a significant influence on engagement: with more attention directed to the tablet to drive TTT in the HT condition, there is less attention in prompting communication and conversation in comparison to the LT condition. Future research will investigate the comparison between the LT and HT conditions when there are two facilitators. One to drive the technology and the other to give undivided attention to facilitating the session. This would provide a greater understanding of how a more dynamic, interactive, and immersive technology, compared to a less dynamic, interactive, and immersive technology influences older adult engagement.

8.9 FUTURE DIRECTIONS

A limitation within the baseline composite discourse interview was the construction of discourse profiles for CALD participants. As identified in section 4.9, features of the discourse interview may not have been understood by CALD participants. To gain a great understanding of the narrative, procedural and abstract discourse of CALD older adults, it is suggested that future research develops discourse schedules that are appropriate for people from diverse backgrounds.

To gain an improved understanding of the dynamics between the group attributes, technological stimulus and environmental factors, there are multiple suggestions for future research. First, a condition in which there is the TTT interface, one participant and one facilitator, would give insight into the impact of the group dynamic of the group TTT experiment. It would also give a greater understanding of the person-environment factor of the CPMGE. Second, to further the understanding of the impact of the technology, participation in a group RT session without digital technology should be investigated. Third, the type of questions that were asked within the interview and the group TTT sessions contribute to the type of responses from participants. For example, the effect on the personalisation of their responses. This was seen with the interview questions being more person-focused and the group TTT session questions were more place-focused. Future research should control impact of the question form to better understand the personalisation of dialogue within the conditions.

Another factor which should be explored in future research is the impact of personality and individual variation on engagement. That is, how the interaction between personality, cognitive capacity, and group environment impact on engagement. Along related lines future research would benefit from optimising measures for culturally and linguistically diverse populations. This will assist better understand dialogue profiles of participants and how different older adults from different backgrounds interact.

The current research has shown that a multi-dimensional approach to measuring engagement is necessary to get a comprehensive understanding of the different behavioural patterns that occur, when participating in dyadic interviews and group environments. To gain a greater understanding of the interaction and expression of engagement outcomes of older adults, future research should incorporate the role of gesture and body movement into the multi-dimensional approach. This would enrich the understanding on how older adults interact with the technology, and interact with group members, when speaking about locations that are specific to themselves as well as to others.

The current research has highlighted that older adult engagement is dependent on interaction expectations within a contextual environment. There are explanations, such as affiliative linguistic behaviour, that are speculated to fit with the patterns of the current research. Further qualitative linguistic analysis of these patterns would be of value to determine when and to what degree they explain the results reported in this study. It is further suggested that future research investigate the impact of novel places compared to other-specific places on measures of engagement. That is, in the current research, places that were completely novel and places that were specific to another older adult (which could be respectively termed Novel and Other-Specific) where combined together as Non-Specific locations for a participant. If explanations such as affiliative linguistic behaviours contribute to the current findings when viewing Other-Specific locations, then it is expected that participants would show greater affect-driven behavioural engagement, compared to when viewing Novel locations that are Non-Specific to everyone within the group. Such research into the communicative mechanisms that underlies establishing a social identity as well as supporting other members in the group would be beneficial in understanding how people with dementia and older adults build positive peer relationships.

Lastly, future research should investigate the dynamics of peer-relationships, as well as carestaff-client relationships within a reminiscence group, to further understand social proximity and the role of relationships. For example, that impact of the variable where participants know each other and don't know each other. Such research would provide insight into how previous friendships and spouse relationships impact engagement of older adults in group settings. It would also be able to ascertain how engagement of older adults is impacted by the presence of carestaff as well as how such a program as TTT could affect the carestaff-client relationship.

8.10 CONCLUSION

In conclusion, this thesis presents some evidence in support of the TTT experiment for older adult engagement and socialisation in residential care. This has been achieved through taking a unique multifaceted approach in measuring the dependent variables of facial movement, lexical use, and prosodic patterns of speech, to characterise older adult engagement.

The results highlight how TTT as a meaningful activity is partially supported to promote affect-driven behavioural engagement, socialisation and encourage a sense of identity. TTT is beneficial in addressing the need for person-centred care in aged care facilities. It has impact and there is evidence to suggest it is beneficial to persons with known and unknown history. This has been evidenced by the engagement outcomes when viewing Person-Specific and Non-Specific locations.

An important finding in the research is the difference in engagement outcomes in different contexts. The findings show how a technology driven reminiscence activity, such as TTT, may express more affect-driven behavioural engagement compared to a dyadic RT context. This is despite having more behavioural engagement in the interview, as seen through duration of utterance and words per utterance results. This current multi-dimensional approach of characterising older adult engagement through different engagement measures is a powerful method in analysing the impact of nonpharmacological interventions.

The Royal Commission into Aged Care Quality and Safety in Australia has stressed the importance of quality care and relationships in aged care facilities (Ratcliffe et al., 2020). These research findings may also have significance for practice and policy, particularly in relation to person-centered care and providing TTT as an interactive non-pharmacological intervention for engagement and promoting peer relationships. It is hoped that these findings will further stimulate greater research into characterising older adult engagement, through multi-dimensional approaches and in evaluating the effectiveness of older adult interventions.

References

Adams, R. B., Jr, & Kleck, R. E. (2003). Perceived gaze direction and the processing of facial displays of emotion. *Psychological science*, *14*(6), 644–647. https://doi.org/10.1046/j.0956-7976.2003.psci_1479.x

Aguirre, E., Spector, A., & Orrell, M. (2014). Guidelines for adapting cognitive stimulation therapy to other cultures. *Clinical interventions in aging*, 9, 1003–1007. https://doi.org/10.2147/CIA.S61849

Aikhenvald, A. Y. (2013). Shifting language attitudes in north-west Amazonia. *International Journal of the Sociology of Language*, *2013*(222), 195. http://doi.org/10.1515/rela-2015-0016

Aline Nunes Da Cruz, M., Tatiane Machado, L., & Lenisa, B. (2017). Language and communication non-pharmacological interventions in patients with Alzheimer's disease: a systematic review. Communication intervention in Alzheimer. *Dementia & Neuropsychologia*, *11*(3), 227-241. http://doi.org/10.1590/1980-57642016dn11-030004/

Alkhaldi, G., Hamilton, F. L., Lau, R., Webster, R., Michie, S., & Murray, E. (2015). The Effectiveness of technology-based strategies to promote engagement with digital interventions: A systematic review protocol. *JMIR Research Protocols*, *4*(2), e47. https://doi.org/10.2196/resprot.3990

Almor, A., Kempler, D., MacDonald, M. C., Andersen, E. S., & Tyler, L. K. (1999). Why do Alzheimer patients have difficulty with pronouns? Working memory, semantics, and reference in comprehension and production in Alzheimer's disease. *Brain and language*, *67*(3), 202–227. https://doi.org/10.1006/brln.1999.2055

American Geriatrics Society Expert Panel on Person-Centered Care (2016). Person-Centered Care: A Definition and Essential Elements. *Journal of the American Geriatrics Society*, *64*(1), 15–18. https://doi.org/10.1111/jgs.13866

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. American Psychiatric publishing. https://doi.org/10.1016/j.jagp.2015.10.003

Aronstein, Z., Olsen, R., & Schulman, E. (1996). The nursing assistants use of recreational interventions for behavioral management of residents with Alzheimer's disease. *American Journal of Alzheimer's Disease*, *11*(3), 26-31. https://doi.org/10.1177/153331759601100304

Astell, A. J., Ellis, M. P., Bernardi, L., Alm, N., Dye, R., Gowans, G., & Campbell, J. (2010). Using a touch screen computer to support relationships between people with dementia and caregivers. *Interacting with Computers*, *22*(4), 267-275. http://doi.org/10.1016/j.intcom.2010.03.003

Australian Healthcare Associates. (2018). *Evaluation of the Partners in Culturally Appropriate Care Program.* Australian Government Department of Health. https://www.health.gov.au/resources/publications/partners-in-culturally-appropriate-care-picac-program-evaluation-report.

Australian Nursing and Midwifery Federation. (2019). *ANMF National Aged Care Survey 2019 – Final Report*. Australian Nursing and Midwifery Federation (Federal Office), Melbourne, Victoria.

Australian Institute of Health and Welfare. (2016). *Australia's health 2016.* (No. AUS 199). Canberra: AIHW.

Australian Institute of Health and Welfare. (2017). *Australia's welfare 2017*. (No. AUS 214). Canberra: AIHW.

Australian Institute of Health and Welfare. (2020) *Deaths in Australia*. (Cat. no. PHE 229). Canberra: AIHW.

Australian Institute of Health and Welfare. (2007). *Older Australia at a glance*. (fourth edition, Cat. no. AGE 52). Canberra: AIHW.

Australian Institute of Health and Welfare. (2018). *Older Australia at a glance*. (Cat. no. AGE 87). Canberra: AIHW.

Azcurra, D. J. (2012). A reminiscence program intervention to improve the quality of life of long-term care residents with Alzheimer's disease. A randomized controlled trial. *Revista Brasileira De Psiquiatria*, *34*(4), 422-433. http://doi.org/10.1016/j.rbp.2012.05.008

Bachorowski, J. A., & Owren, M. J. (1995). Vocal expression of emotion: Acoustic properties of speech are associated with emotional intensity and context. *Psychological Science*, 6, 219–224. https://doi.org/10.1111/j.1467-9280.1995.tb00596.x

Baciu, M., Boudiaf, N., Cousin, E., Perrone-Bertolotti, M., Pichat, C., Fournet, N., Chainay, H., Lamalle, L., & Krainik, A. (2016). Functional MRI evidence for the decline of word retrieval and generation during normal aging. *Age (Dordrecht, Netherlands)*, *38*(1), 3. https://doi.org/10.1007/s11357-015-9857-y

Baek, M. J., Kim, K., Park, Y. H., & Kim, S. (2016). The validity and reliability of the mini-mental state examination-2 for detecting mild cognitive impairment and Alzheimer's disease in a Korean population. *PloS one*, *11*(9), e0163792. https://doi.org/10.1371/journal.pone.0163792

Baker, R., Angus, D., Smithconway, E. R., Baker, K. S., Gallois, C., Smith, A., Wiles, J., & Chenery, H. J. (2015). Visualising conversations between care home staff and residents with dementia. *Ageing & Society*, *35*(2), 270–297. https://doi-org.ezproxy.uws.edu.au/10.1017/S0144686X13000640

Baltrušaitis, T., Zadeh, A., Lim, Y., & Morency, L. P . (2018). *OpenFace 2.0: Facial Behavior Analysis Toolkit*. 2018 13th IEEE International Conference on Automatic Face & Gesture Recognition, Xi'an, China. http://doi.org/10.1109/FG.2018.00019.

Ballard, C., Brown, R., Fossey, J., Douglas, S., Bradley, P., Hancock, J., . . . Howard, R. (2009). Brief psychosocial therapy for the treatment of agitation in Alzheimer disease (The CALM-AD trial). *The American Journal of Geriatric Psychiatry*, *17*(9), 726-733. https://doi.org/https://doi.org/10.1097/JGP.0b013e3181b0f8c0

Ball, M. M., Lepore, M. L., Perkins, M. M., Hollingsworth, C., & Sweatman, M. (2009). ''They are the reason I come to work'': The meaning of resident–staff relationships in assisted living. *Journal of Aging Studies*, *23*(1), 37–47. https://doi.org/10.1016/j.jaging.2007.09.006

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1), 1 - 48. http://dx.doi.org/10.18637/jss.v067.i01

Bayles, K., McCullough, K., & Tomoeda, C. K. (2018). *Cognitive-communication disorders of dementia: definition, diagnosis, and treatment, third edition.* (3rd ed.). Plural Publishing Inc..

Baltrušaitis, T. (2019). *TadasBaltrusaitis/OpenFace*. GitHub. https://github.com/TadasBaltrusaitis/OpenFace/wiki/Datasets

Bharucha, A. J., Anand, V., Forlizzi, J., Dew, M. A., Reynolds III, C. F., Stevens, S., & Wactlar, H. (2009). Intelligent assistive technology applications to dementia care: current capabilities, limitations, and future challenges. *American Journal Geriatric Psychiatry*, *17*(2), 88-104. https://doi.org/10.1097/JGP.0b013e318187dde5

Binder, R. J. (2015). The Wernicke area: Modern evidence and a reinterpretation. *Neurology*, *85*(24), 2170-2175. https://doi.org/10.1212/WNL.0000000000002219

Boersma, P., & Weenink, D. (2020). *Praat: doing phonetics by computer [Computer program]*. Version 6.1.36. http://www.praat.org/

Borod, J. C., Yecker, S. A., Brickman, A. M., Moreno, C. R., Sliwinski, M., Foldi, N. S., Alpert, M., & Welkowitz, J. (2004). Changes in posed facial expression of emotion across the adult life span. *Experimental aging research*, *30*(4), 305–331. https://doi.org/10.1080/03610730490484399

Borelli, E., Crepaldi, D., Porro, C. A., & Cacciari, C. (2018). The psycholinguistic and affective structure of words conveying pain. *PloS one*, *13*(6), e0199658. https://doi.org/10.1371/journal.pone.0199658

Brooker, D., & Latham, I. (2015). *Person-centred dementia care : Making services better with the vips framework.* ProQuest Ebook Central https://ebookcentral.proquest.com

Brown Wilson, Christine R. (2007) *Exploring relationships in care homes: a constructivist inquiry.* Vol.1. PhD thesis, University of Sheffield.

Brownie, S., & Horstmanshof, L. (2011). The management of loneliness in aged care residents: an important therapeutic target for gerontological nursing. *Geriatric Nursing (New York)*, *32*(5), 318-325. http://doi.org/10.1016/j.gerinurse.2011.05.003/

Buettner, L. L., Lundegren, H., Lago, D., Farrell, P., & Smith, R. (1996). *Therapeutic recreation as an intervention for persons with dementia and agitation: An efficacy study*. American Journal of Alzheimer's Disease, 11(5), 4–12. https://doi.org/10.1177/153331759601100503

Burgio, L. D., Scilley, K., Hardin, J. M., Janosky, J., Bonino, P., Slater, S. C., & Engberg, R. (1994). Studying disruptive vocalization and contextual factors in the nursing home using computer-assisted real-time observation. *Journal of Gerontology*, *49*(5), 230-239. http://doi.org/10.1093/geronj/49.5.p230

Campellone, T. R., & Kring, A. M. (2013). Who do you trust? The impact of facial emotion and behaviour on decision making. *Cognition & emotion*, *27*(4), 603–620. https://doi.org/10.1080/02699931.2012.726608

Cerejeira, J., Lagarto, L., Mukaetova-Ladinska, E. B. (2010). Behavioral and psychological symptoms of dementia. *Frontiers in Neurology*, *73*(3), 1-21. https://doi.org/10.3389/fneur.2012.00073

Chapman, S. B., Weiner, M. F., Rackley, A., Hynan, L.S., & Zientz, J. (2004). Effects of cognitive-communication stimulation for Alzheimer's disease patients treated with donepezil. *Journal of Speech, Language, and Hearing Research*, *47*(5), 1149-1163. http://doi.org/10.1044/1092-4388(2004/085)

Charlesworth, G., Burnell, K., Crellin, N., Hoare, Z., Hoe, J., Knapp, M., Russell, I., Wenborn, J., Woods, B., & Orrell, M. (2016). Peer support and reminiscence therapy for people with dementia and their family carers: a factorial pragmatic randomised trial. *Journal of neurology, neurosurgery, and psychiatry*, 87(11), 1218–1228. https://doi.org/10.1136/jnnp-2016-313736.

Chodroff, E. (2019). *4 Montreal forced aligner | corpus phonetics tutorial*. Corpus Phonetics Tutorial. https://eleanorchodroff.com/tutorial/montreal-forced-aligner.html#setup

Clare, L., Rowlands, J., Bruce, E., Surr, C., & Downs, M. (2008). The experience of living with dementia in residential care: An interpretative phenomenological analysis. *The Gerontologist*, 48, 711–720. https://doi.org/10.1093/geront/48.6.711

Cohen-Mansfield, J. (2017). Activity groups for persons with dementia: Personal predictors of participation, engagement and mood. Psychiatry Research, *257*(2017), 375-380. https://doi.org/10.1016/j.psychres.2017.07.045

Cohen-Mansfield, J., Dakheel-Ali, M., & Marx, M. S. (2009). Engagement in persons with dementia: the concept and its measurement. *Am J Geriatr Psychiatry*, *17*(4), 299-307. https://doi.org/10.1097/JGP.0b013e31818f3a52

Cohen-Mansfield, J., Hai, T., & Comishen, M. (2017). Group engagement in persons with dementia: The concept and its measurement. *Psychiatry Res*, 251, 237-243. https://doi.org/10.1016/j.psychres.2017.02.013

Cohen-Mansfield, J., Libin, A., & Marx, M. S. (2007). Nonpharmacological Treatment of Agitation: A Controlled Trial of Systematic Individualized Intervention. *The Journals of Gerontology: Series A*, *62*(8), 908-916. https://doi.org/10.1093/gerona/62.8.908

Cohen-Mansfield, J., Marx, M. S., Dakheel-Ali, M., Regier Natalie, G., Thein, K., & Freedman, L. (2010). Can agitated behavior of nursing home residents with dementia be prevented with the use of standardized stimuli? Journal of the *American Geriatrics Society*, *58*(8), 1459-1464. https://doi.org/10.1111/j.1532-5415.2010.02951.x

Cohen-Mansfield, J., Marx, M. S., Freedman, L. S., Murad, H., Regier, N. G., Thein, K., & Dakheel-Ali, M. (2011). The comprehensive process model of engagement. *Am J Geriatr Psychiatry, 19*(10), 859-870. https://doi.org/10.1097/JGP.0b013e318202bf5b

Cohen-Mansfield J, Parpura-Gill A, & H, G. (2006). Utilization of self-identity roles for designing interventions for persons with dementia. *Gerontol B Psychol Sci Soc Sci*, *61B*(4), 202-212. http://doi.org/10.1093/geronb/61.4.p202/

Cohen-Mansfield, J., Thein, K., Dakheel-Ali, M., & Marx, M. S. (2010). Engaging nursing home residents with dementia in activities: The effects of modeling, presentation order, time of day, and setting characteristics. *Aging & Mental Health*, *14*(4), 471-480. https://doi.org/10.1080/13607860903586102

Cohn, M. A., Mehl, M. R., & Pennebaker, J. W. (2004). Linguistic markers of psychological change surrounding September 11, 2001. *Psychological science*, *15*(10), 687–693. https://doi.org/10.1111/j.0956-7976.2004.00741.x

Commonwealth of Australia (Department of Social Services). (2015). *National ageing and aged care strategy for people from culturally and linguistically diverse (CALD) backgrounds.* https://agedcare.health.gov.au/sites/g/files/net1426/f/documents/07_2015/dss1582_aged_care_strategy_cald_a4_vaccessible.pdf

Commonwealth of Australia (Department of Health). (2017). *2016 National Aged Care Workforce Census and Survey – The Aged Care Workforce, 2016.* https://www.gen-agedcaredata.gov.au/www_aihwgen/media/Workforce/The-Aged-Care-Workforce-2016.pdf

Communication. (n.d.). In *Oxford English dictionary*. Oxford University Press.

Cooney, A., Murphy, K., & O'shea, E. (2009). Resident perspectives of the determinants of quality of life in residential care in Ireland. *Journal of Advanced Nursing*, *65*(5), 1029-1038. https://doi.org/10.1111/j.1365-2648.2008.04960.x

Coope, B., & Richards, F. A. (Eds.). (2014). ABC of dementia. ProQuest Ebook Central https://ebookcentral.proquest.com

Cotelli, M., Manenti, R., & Zanetti, O. (2012). Reminiscence therapy in dementia: a review. *Maturitas*, *72*(3), 203–205. https://doi.org/10.1016/j.maturitas.2012.04.008

Couch, E., Lawrence, V., Co, M., & Prina, M. (2020). Outcomes tested in non-pharmacological interventions in mild cognitive impairment and mild dementia: a scoping review. *BMJ open, 10*(4), e035980. https://doi.org/10.1136/bmjopen-2019-035980

Couper-Kuhlen, E. (2009), A sequential approach to affect: The case of 'disappointment', In (M. Haakana, M. Laakso & J. Lindström (Eds.), *Talk in Interaction: Comparative Dimensions* (pp. 94–123). Helsinki, Finnish Literature Society (SKS)

Cox, C. B. (2007). Culture and Dementia. In C. B. Cox (Eds.), *Dementia and social work practice: research and interventions* (pp. 173-182). Springer Publishing Company.

Cummings, J. L., Mega, M., Gray, K., Rosenberg-Thompson, S., Carusi, D. A., & Gornbein, J. (1994). The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. *Neurology*, *44*(12), 2308–2314. https://doi.org/10.1212/wnl.44.12.2308

Custers, A. F. J., Westerhof, G. J., Kuin, Y., Gerritsen, D. L., & Riksen-Walraven, J. M. (2012). Relatedness, autonomy, and competence in the caring relationship: The perspective of nursing home residents. *Journal of Aging Studies, 26*(3), 319-326. https://doi.org/10.1016/j.jaging.2012.02.005

Daselaar, Sander M, Veltman, Dick J, Rombouts, Serge A.R.B, Raaijmakers, Jeroen G.W, & Jonker, Cees. (2005). Aging affects both perceptual and lexical/semantic components of word stem priming: An event-related fMRI study. *Neurobiology of Learning and Memory, 83*(3), 251-262. https://doi.org/10.1016/j.nlm.2005.01.005

Davies, S., & Brown, W. C. (2007). Creating a sense of community. (2007). In *National Care Homes Research and Development (NCHR and D) Forum* ('My Home Life'. Quality of Life in Care Homes: A Review of previous research. ed., pp. 65–84). Help the Aged.

Davis, D., & Brock, T. C. (1975). Use of first person pronouns as a function of increased objective self-awareness and performance feedback. *Journal of Experimental Social Psychology*, *11*(4), 381-388. https://doi.org/10.1016/0022-1031(75)90017-7

Davison, T. E., Nayer, K., Coxon, S., de Bono, A., Eppingstall, B., Jeon, Y. H., van der Ploeg, E. S., & O'Connor, D. W. (2016). A personalized multimedia device to treat agitated behavior and improve mood in people with dementia: A pilot study. *Geriatric nursing (New York, N.Y.)*, *37*(1), 25–29. https://doi.org/10.1016/j.gerinurse.2015.08.013

De Simone, M.S., Fadda, L., Perri, R., Aloisi, M., Caltagirone, C., & Carlesimo, G.A. (2016). Does retrieval frequency account for the pattern of autobiographical memory loss in early Alzheimer's disease patients? *Neuropsychologia*, 80, 194–200. http://dio.org/10.1016/j.neuropsychologia.2015.11.024

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan Executive Function System (D-KEFS)*. The Psychological Corporation.

Department of Health. (2018). *Aged care data snapshot—2017.* Australian Institute of Health and Welfare. https://gen-agedcaredata.gov.au/Resources/Access-data/2018/January/Aged-care-data-snapshot%E2%80%942017

Department of Health. (2020*). Aged care data snapshot—2020*. Australian Institute of Health and Welfare. https://gen-agedcaredata.gov.au/Resources/Access-data/2020/October/Aged-care-data-snapshot%E2%80%942020

Dijkstra, K., Bourgeois, M. S., Allen, R. S., & Burgio, L. D. (2004). Conversational coherence: discourse analysis of older adults with and without dementia. Journal of Neurolinguistics, *17*(4), 263-283. https://doi.org/10.1016/S0911-6044(03)00048-4

Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological science*, 11(1), 86–89. https://doi.org/10.1111/1467-9280.00221

Douglas, I. J., & Smeeth, L. (2008). Exposure to antipsychotics and risk of stroke: self-controlled case series study. *BMJ*, 337, a1227. https://doi.org/10.1136/bmj.a1227

Dourado, M., Torres Mendonça de Melo Fádel, B., Simões Neto, J. P., Alves, G., & Alves, C. (2019). Facial Expression Recognition Patterns in Mild and Moderate Alzheimer's Disease. *Journal of Alzheimer's disease: JAD*, *69*(2), 539–549. https://doi.org/10.3233/JAD-181101

Dourish, P., & Friday, A. (2006). SenseCam: A retrospective memory aid. Paper presented at the Ubicomp, LNCS 4206.

Drageset, J. (2004). The importance of activities of daily living and social contact for loneliness: a survey among residents in nursing homes. *Scandinavian Journal of Caring Sciences*, *18*(1), 65-71. https://doi.org/10.1111/j.0283-9318.2003.00251.x

Dunn, M., Greenhill, S., Levinson, S., & Russel, D.G. (2011). Evolved structure of language shows lineage-specific trends in word-order universals. *Nature,* 473, 79–82. https://doi-org.ezproxy.uws.edu.au/10.1038/nature09923

Dyer, S. M., Harrison, S. L., Laver, K., Whitehead, Graing., & Crotty, M. (2018). An overview of systematic reviews of pharmacological and non-pharmacological interventions for the treatment of behavioral and psychological symptoms of dementia. *International Psychogeriatrics*, *30*(3), 295-309. https://doi.org/10.1016/j.cger.2014.04.001

Ekman, P. (1965). Differential communication of affect by head and body cues. Journal of *Personality and Social Psychology*, *2*(5), 726–735. https://doi.org/10.1037/h0022736

Ekman, P. (1979). About brows: emotional and conversational signals. In M. von Cranach, K. Foppa, W. Lepenies, & D. Ploog, (Eds). *Human ethology*, 169–248). Cambridge University Press.

Ekman, P., & Friesen, W.V. (1978). *Facial Action Coding System: A technique for the measurement of facial movement*. Consulting Psychologist Press.

Ekman, P., Freisen, W. V., & Ancoli, S. (1980). Facial signs of emotional experience. *Journal of Personality and Social Psychology, 39*(6), 1125-1134. https://doi.org/10.1037/h0077722

Elalouoi Faris, M. (2015). Language in dementia. *Journal of the Neurological Sciences*, 357, E478. https://doi.org/10.1016/j.jns.2015.09.222

ELAN (Version 6.0) [Computer software]. (2020). Nijmegen: Max Planck Institute for Psycholinguistics, The Language Archive. Retrieved from https://archive.mpi.nl/tla/elan

Ellis, M., & Astell, A. (2017). Communicating with people living with dementia who are nonverbal: The creation of Adaptive Interaction. *PloS one*, *12*(8), e0180395. https://doi.org/10.1371/journal.pone.0180395

Engelman, K. K., Altus, D. E., & Mathews, R. M. (1999). Increasing engagement in daily activities by older adults with dementia. *Journal of Applied Behavioural Analysis*, 32, 107-110. http://10.1901/jaba.1999.32-107

Fazio, S., Pace, D., Flinner, J., & Kallmyer, B. (2018). The fundamentals of person-centered care for individuals with dementia. The Gerontologist, 58(suppl_1), S10–S19. https://doi.org/10.1093/geront/gnx122

Fels, D. I., & Astell, A. J. (2011). Storytelling as a model of conversation for people with dementia and caregivers. *American Journal of Alzheimer's Disease and Other Dementias*, *26*(7), 535–541. https://doi-org.ezproxy.uws.edu.au/10.1177/1533317511429324

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state": A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*(3), 189-198. https://doi.org/10.1016/0022-3956(75)90026-6

Fox, J. (2016). *Applied Regression Analysis and Generalized Linear Models*, (Third Edition). Sage.

Francis, E. R., Smith, J. G., Qayyum, M., Lee, J., Woodgate, P., & Lawrence, R. M. (2019). Biographical films as a person-centered approach to reduce neuropsychiatric symptoms of dementia in residential care: A feasibility study. *Journal of clinical psychology*, *76*(1), 137–145. https://doi.org/10.1002/jclp.22853

Frederiksen, K. S., & Waldemar, G. (2017). Aggression, agitation, hyperactivity, and irritability. In A. Verdelho & M. Gonçalves-Pereira (Eds.), *Neuropsychiatric Symptoms of Cognitive Impairment and Dementia* (pp. 199-236). Springer International Publishing.

Fridlund, A., & ScienceDirect. (1994). *Human facial expression an evolutionary view.* Academic Press.

Garland, K., Beer, E., Eppingstall, B., & O'Connor, D. (2007). A comparison of two treatments of agitated behavior in nursing home residents with dementia: Simulated family presence and preferred music. *The American Journal of Geriatric Psychiatry*, *15*(6), 514-521. https://doi.org/10.1097/01.JGP.0000249388.37080.b4

Gitlow, Lynn. (2014). Technology use by older adults and barriers to using technology. *Physical & Occupational Therapy in Geriatrics,* 32. 10.3109/02703181.2014.946640.

Goldstein. (2002). Are emotions feelings?: A further look at hedonic theories of emotions. *Consciousness & Emotion*, 3(1), 21-33. https://doi.org/10.1075/ce.3.1.04gol

Gonzalez-Moreira, Eduardo, Torres-Boza, Diana, Kairuz, Héctor Arturo, Ferrer, Carlos, Garcia-Zamora, Marlene, Espinoza-Cuadros, Fernando, & Hernandez-Gómez, Luis Alfonso. (2015). Automatic prosodic analysis to identify mild dementia. *BioMed Research International*, 2015, 916356-6. http://doi.org/10.1155/2015/916356

Grafsgaard, J., Wiggins, J., Boyer, K., Wiebe, E., & Lester, J. (2013). Automatically recognizing facial indicators of frustration: A learning-centric analysis. *Proceedings - 2013 Humaine Association Conference on Affective Computing and Intelligent Interaction*, ACII 2013. 159-165. 10.1109/ACII.2013.33.

Guaita, A., Malnati, M., Vaccaro, R., Pezzati, R., Marcionetti, J., Vitali, S. F., & Colombo, M. (2009). Impaired facial emotion recognition and preserved reactivity to facial expressions in people with severe dementia. *Archives of gerontology and geriatrics*, 49 Suppl 1, 135–146. http://doi.org/10.1016/j.archger.2009.09.023

Haight, B. K., Gibson, F., & Michel, Y . (2006). The Northern Ireland life review/life storybook project for people with dementia. *Alzheimer's & Dementia*, *2*(1), 56-58. http://doi.ord/10.1016/j.jalz.2005.12.003

Harada, C. N., Natelson Love, M. C., & Triebel, K. L. (2013). Normal cognitive aging. *Clinics in geriatric medicine*, *29*(4), 737–752. https://doi.org/10.1016/j.cger.2013.07.002

Harris, C. B., Rasmussen, A. S., & Berntsen, D. (2014). The functions of autobiographical memory: an integrative approach. *Memory* (Hove, England), 22(5), 559–581. https://doi.org/10.1080/09658211.2013.806555

Harris, P. B. (2012). Maintaining friendships in early stage dementia: Factors to consider. Dementia, 11(3), 305–314. https://doi.org/10.1177/1471301211421066

Havighurst, R. J. (1961). Successful Aging. *The Gerontologist*, *1*(1), 8-13. https://doi.org/10.1093/geront/1.1.8

Havighurst, R. J., & Albrecht, R. (1953). *Older People*. Logman, Greens.

Heinz, M., M.S., Martin, P., PhD., Margrett, J. A., PhD., Yearns, M., PhD., Franke, W., PhD., Yang, H., PhD., Wong, J., PhD., & Chang, C. K., PhD. (2013). Perceptions of technology among older adults. *Journal of Gerontological Nursing,* 39(1), 42-51. http://dx.doi.org.ezproxy.uws.edu.au/10.3928/00989134-20121204-04

Heliker D. (2009). Enhancing relationships in long-term care: through story sharing. *Journal of gerontological nursing*, 35(6), 43–49. https://doi.org/10.3928/00989134-20090428-04

Helme, R. D. (2006). How useful are currently available tools for pain evaluation in elderly people with dementia? *Nature Clinical Practice Neurology*, *2*(9), 474-475. https://doi.org/10.1038/ncpneuro0268

Heritage, J., 2004. Conversation analysis and institutional talk: analyzing data. In: D. Silverman (ed.), *Qualitative research: theory, method and practice* (pp.222-245). Sage.

Herr, K., Bjoro, K., Decker, S. (2006). Tools for assessment of pain in nonverbal older adults with dementia: a state-of-the-science review. *J Pain Symptom Manage*, *31*(2), 170-192. http://doi.org/10.1016/j.jpainsymman.2005.07.001

Hoff, E., & Tian, C. (2005). Socioeconomic status and cultural influences on language. *Journal of communication disorders*, 38(4), 271–278. https://doi.org/10.1016/j.jcomdis.2005.02.003

Hoffman, P., Meteyard, L., & Patterson, K. (2014). Broadly speaking: Vocabulary in semantic dementia shifts towards general, semantically diverse words. *Cortex: A Journal Devoted to the Study of the Nervous System and Behavior*, 55, 30–42. https://doi-org.ezproxy.uws.edu.au/10.1016/j.cortex.2012.11.004

Holland, A. C., & Kensinger, E. A. (2010). Emotion and autobiographical memory. *Physicals of life reviews*, *1*(7), 88-131. https://doi.org/10.1016/j.plrev.2010.01.006.

Horley, K., Reid, A., & Burnham, D. (2010). Emotional prosodic patterns perception and production in dementia of the Alzheimer's type. *Journal of speech, language, and hearing research*, *53*(5), 1132–1146. https://doi.org/10.1044/1092-4388(2010/09-0030)

Horstmann, G. (2003). What do facial expressions convey: feeling states, behavioral intentions, or action requests?. *Emotion (Washington, D.C.)*, *3*(2), 150–166. https://doi.org/10.1037/1528-3542.3.2.150

Hsin-Yen, Y., & Li-Jung, L. (2018). A systematic review of reminiscence therapy for older adults in Taiwan. *Journal of Nursing Research*, *26*(2), 138-150. http://doi.org/10.1097/jnr.0000000000000233

Huang, H. C., Chen, Y. T., Chen, P. Y., Huey-Lan Hu, S., Liu, F., Kuo, Y. L., & Chiu, H. Y. (2015). Reminiscence therapy improves cognitive functions and reduces depressive symptoms in elderly people with dementia: A meta-analysis of randomized controlled trials. *Journal of the American Medical Directors Association*, *16*(12), 1087-1094. http://doi.org/10.1016/j.jamda.2015.07.010

Hugo, J., & Ganguli, M. (2014). Dementia and cognitive impairment: Epidemiology, diagnosis, and treatment. *Clinics in Geriatric Medicine, 30*(3), 421-442. https://doi.org/10.1016/j.cger.2014.04.001

Hydén, L.-C. (2018). Dementia, embodied memories, and the self. *Journal of Consciousness* Studies, *25*(7–8), 225–241.

Iverson, G., Hopp, G., DeWolfe, K., & Solomons, K. (2002). Measuring change in psychiatric symptoms using the Neuropsychiatric Inventory: Nursing Home version. *International Journal of Geriatric Psychiatry*, *17*(5), 438-443. http://doi.org/10.1002/gps.617

Janner, M., & Delaney, K. R. (2012). Safety Issues on British Mental Health Wards. *Journal of the American Psychiatric Nurses Association*, *18*(2), 104-111. https://doi.org/10.1177/1078390312438552

Jakobs, E., Manstead, A. S., & Fischer, A. H. (2001). Social context effects on facial activity in a negative emotional setting. *Emotion (Washington, D.C.)*, *1*(1), 51–69. https://doi.org/10.1037/1528-3542.1.1.51

Jao, Y.-L., Loken, E., Macandrew, M., Van Haitsma, K., & Kolanowski, A. (2018). Association between social interaction and affect in nursing home residents with dementia. *Aging & Mental Health*, *22*(6), 778-783. https://doi.org/10.1080/13607863.2017.1304526

Joanne, B., Camille, C., Marlon, S., & Omorogieva, O. (2018). The intersection of culture in the provision of dementia care: A systematic review. *Journal of Clinical Nursing*, *27*(17-18), 3241-3253. https://doi.org/https://doi.org/10.1111/jocn.13999

Johnstone Young, T., Manthorp, C., Howells, D., & Tullo, E. (2011). Developing a carer communication intervention to support personhood and quality of life in dementia. *Ageing and Society*, *31*(6), 1003-1025. https://doi.org/10.1017/S0144686X10001182

Jones, C., & Moyle, W. (2016). Staff perspectives of relationships in aged care: A qualitative approach. *Australasian Journal on Ageing, 35*(3), 198-203. https://doi-org.ezproxy.uws.edu.au/10.1111/ajag.12276

Juslin, P. N., Laukka, P., & Bänziger, T. (2018). The mirror to our soul? Comparisons of spontaneous and posed vocal expression of emotion. *Journal of Nonverbal Behavior*, *42*(1), 1–40. https://doi.org/10.1007/s10919-017-0268-x

Kacewicz, E.a, Pennebaker, J. W., Davis, M., Jeon, M., & Graesser, A. C. (2013). Pronoun use reflects standings in social hierarchies. *Journal of Language and Social Psychology*, *33*(2), 125-143. http://doi.org/10.1177/0261927x13502654

Kang, H. (2012). Correlates of social engagement in nursing home residents with dementia. *Asian Nursing Research*, *6*(2), 75-81. https://doi.org/https://doi.org/10.1016/j.anr.2012.05.006

Kavé, G., Samuel-Enoch, K., & Adiv, S. (2009). The association between age and the frequency of nouns selected for production. Psychology and Aging, 24(1), 17–27. https://doi-org.ezproxy.uws.edu.au/10.1037/a0014579

Keller, S. S., Crow, T., Foundas, A., Amunts, K., & Roberts, N. (2009). Broca's area: Nomenclature, anatomy, typology and asymmetry. *Brain and Language*, *109*(1), 29-48. https://doi.org/10.1016/j.bandl.2008.11.005

Kemper, D., & Zeinski, E. M. (1994). Language in dementia and normal aging. In F. A. Huppert, C. Brayne, & D. W. O'Connor (Eds.), *Dementia and Normal Aging*. Cambridge University Press.

Kempler, D., Curtiss, S., Jackson, C. (1987). Syntactic preservation in Alzheimer's disease. *Journal of Speech and Hearing Research,* 30, 343–50. https://doi.org/10.1044/jshr.3003.343

Kent, James. (Director). (2015). *Testament of Youth.* [Film]. BBC Films and Heyday Films.

Kiely, D. K., & Flacker, J. M. (2003). The protective effect of social engagement on 1-year mortality in a long-stay nursing home population. *Journal of Clinical Epidemiology*, *56*(5), 472-478. https://doi.org/https://doi.org/10.1016/S0895-4356(03)00030-1

Kim, Y. Y. (1977). Communication patterns of foreign immigrants in the process of acculturation. *Human Communication Research*, *4*(1), 66-77. https://doi.org/10.1111/j.1468-2958.1977.tb00598.x

Kindell, J., Keady, J., Sage, K., & Wilkinson, R. (2017). Everyday conversation in dementia: a review of previous research to inform research and practice. *Int J Lang Commun Disord*, *52*(4), 392-406. https://doi.org/10.1111/1460-6984.12298

Kindell, J., Sage, K., Keady, J., & Wilkinson, R. (2013). Adapting to conversation with semantic dementia: Using enactment as a compensatory strategy in everyday social interaction. *International Journal of Language & Communication Disorders*, *48*(5), 497–507. https://doi-org.ezproxy.uws.edu.au/10.1111/1460-6984.12023

Kirshner, H. (2014). Frontotemporal dementia and primary progressive aphasia, a review. *Neuropsychiatric Disease and Treatment*, 2014, 1045-1055. http://doi.org/10.2147/NDT.S38821

Kitwood, T. (1997). *Dementia reconsidered: The person comes first.* Open University Press.

Kitwood T. (1998). Toward a theory of dementia care: ethics and interaction. *The Journal of clinical ethics*, 9(1), 23–34.

Koelstra, Sander, & Patras, Ioannis. (2013). Fusion of facial expressions and EEG for implicit affective tagging. *Image and Vision Computing, 31*(2), 164-174. https://doi.org/10.1016/j.imavis.2012.10.002

Kolanowski, A., Bossen, A., Hill, N., Guzman-Velez, E., & Litaker, M. (2012). Factors associated with sustained attention during an activity intervention in persons with dementia. *Dementia and Geriatric Cognitive Disorders*, *33*(4), 233-239. https://doi.org/10.1159/000338604

Kramsch, C. (2014). Language and Culture. *AILA Review*, 27, 30-55. https://doi.org/10.1075/aila.27.02kra

Kraxenberger, M., Menninghaus, W., Roth, A., & Scharinger, M. (2018). Prosodic patterns -based sound-emotion associations in poetry. *Frontiers in Psychology*, 9, 1284. https://doi.org/10.3389/fpsyg.2018.01284/

Kruper, K. R., & Smith, N. R. (1994). *Reminiscence activity and increased communication interaction among cognitively disabled elderly women* [Paper presentation]. Commission on Communication and Aging Speech Communication Association Conference. New Orleans, Louisiana.

Kutner, N. G., Brown, P. J., Stavisky, R. C., Clark, W. S., & Green, R. C. (2000). ''Friendship'', interactions and expression of agitation among residents of a dementia care unit. *Research on Aging*, 22, 188–205. https://doi.org/10.1177/0164027500222005

Kunz, M., Scharmann, S., Hemmeter, U., Schepelmann, K., & Lautenbacher, S. (2007). The facial expression of pain in patients with dementia. *Pain*, 133(1-3), 221–228. https://doi.org/10.1016/j.pain.2007.09.007

Lazar, A., Thompson, H. J., & Demiris, G. (2016). Design recommendations for recreational systems involving older adults living with dementia. *Journal of Applied Gerontology, 37*(5), 595-619. https://doi.org/10.1177/0733464816643880

Lange, R., Hopp, G., & Kang, N. (2004). Psychometric properties and factor structure of the Neuropsychiatric Inventory Nursing Home version in an elderly neuropsychiatric population. *International Journal of Geriatric Psychiatry*, *19*(5), 440-448. http://doi.org/10.1002/gps.1108

Lautenbacher, S., Hofer, W., & Kunz, M. (2016). Age differences in decoding pain from the facial expression of healthy individuals and patients with dementia. *Pain Medicine (Malden, Mass.), 17*(4), 685-691. https://doi.org/10.1111/pme.12927

Lautenbacher, S. & Kunz, M. (2016). Facial pain expression in dementia: a review of the experimental and clinical evidence. *Current Alzheimer Research*, 13, 1-1. http://doi.org/10.2174/1567205013666160603010455.

Lehrer, A. (1974). *Semantic Fields and Lexical Structure.* North-Holland.

Leitman, D. I., Wolf, D. H., Ragland, J. D., Laukka, P., Loughead, J., Valdez, J. N., Javitt, D. C., Turetsky, B. I., & Gur, R. C. (2010). "It's not what you say, but how you say it": A reciprocal temporo-frontal network for prosodic patterns of speech. *Frontiers in human neuroscience*, 4, 19. https://doi.org/10.3389/fnhum.2010.00019

Lenth, R., Buerkner, P., Herve, M., Love, J., Riebl, H., & Singmann, H. (2020). emmeans: Estimated Marginal Means, aka Least-Squares Means. R package version 1.5.0. https://CRAN.R-project.org/package=emmeans

Leone, E., Deudon, A., Piano, J., Robert, P., & Dechamps, A. (2012). Are dementia patient's engagement using tailored stimuli the same? The apathy dilemma in nursing home residents. *Curr Gerontol Geriatr Res*, 2012, 942640. https://doi.org/10.1155/2012/942640

Levelt, W. (1999). A Blueprint of the speaker. In C. Brown & P. Hagoort (Eds.), *The neurocognition of language* (chapter 4). Oxford Press.

Levinson, S. C. (1998). Studying spatial conceptualization across cultures: Anthropology and cognitive science, Ethos, *26*(1), 7–24. http://doi.org10.1525/eth.1998.26.1.7

Leyton, C. E., & Hillis, A. E. (2017). Prosodic patterns of speech in frontotemporal dementia: The importance of "pitching it right". *Neurology*, *89*(7), 644–645. https://doi.org/10.1212/WNL.0000000000004245

Li, M., Lyu, J., Zhang, Y., Gao, M., Li, R., Mao, P., Li, W., & Ma, X. (2020). Efficacy of group reminiscence therapy on cognition, depression, neuropsychiatric symptoms, and activities of daily living for patients with Alzheimer disease. *Journal of Geriatric Psychiatry and Neurology*, *33*(5), 272–281. https://doi.org/10.1177/0891988719882099

Lin, Y., Chu, H., Yang, C.-Y., Chen, C.-H., Chen, S.-G., Chang, H.-J., . . . Chou, K.-R. (2011). Effectiveness of group music intervention against agitated behavior in elderly persons with dementia. *International Journal of Geriatric Psychiatry*, *26*(7), 670-678. https://doi.org/10.1002/gps.2580

Linville, S.E. (2001). *Vocal Ageing*. Singular Publishing Group.

Loewenstein, D. A., & Acevedo, A. (2006). Training of cognitive and functionally relevant skills in mild Alzheimer's disease: an integrated approach. In D. K. Attix & K. A. Welsh-Bohmer (Eds.) *Geriatric Neuropsychological Assessment and Intervention*. (pp. 261-274). Guilford Press.

Lopes, T. S., Afonso, R. M., & Ribeiro, Ó. M. (2016). A quasi-experimental study of a reminiscence program focused on autobiographical memory in institutionalized older adults with cognitive impairment. *Archives of gerontology and geriatrics*, 66, 183–192. https://doi.org/10.1016

Ma, M., Dorstyn, D., Ward, L., & Prentice, S. (2018). Alzheimers' disease and caregiving: a meta-analytic review comparing the mental health of primary carers to controls. *Aging & mental health*, *22*(11), 1395–1405. https://doi.org/10.1080/13607863.2017.1370689

Maeda, S., & Toda, M. (2003, August). Mechanical properties of lip movements: How to characterize different speaking styles? *The 15th International Congress of Phonetic Sciences (ICPhS -03)* (pp. 189–192).

Mansbach, W. E., Mace, R. A., Clark, K. M., & Firth, I. M. (2017). Meaningful activity for long-term care residents with dementia: A comparison of activities and raters. *Gerontologist*, *57*(3), 461-468. https://doi.org/10.1093/geront/gnv694

Materne, C. J., Luszcz, M. A., & Goodwin-Smith, I. (2014). Increasing constructive engagement and positive affect for residents with severe and very severe dementia through group-based activities. *Australasian Journal on Ageing*, *33*(1), E7-E10. https://doi.org/https://doi.org/10.1111/ajag.12127

Mercer, M.J. (2016. University of Tennessee Honors Thesis Projects. https://trace.tennessee.edu/utk_chanhonoproj/1917

McAuliffe, M., Michaela, S., Sarah, M., Michael, W., & Morgan, S. (2017). *Montreal Forced Aligner [Computer program].* Version 0.9.0. http://montrealcorpustools.github.io/Montreal-Forced-Aligner/

McDuff, Daniel, El Kaliouby, Rana, Kassam, Karim, & Picard, Rosalind. (2010). Affect valence inference from facial action unit spectrograms. *IEEE Computer Society Conference on Computer Vision and Pattern Recognition – Workshops,* 17-24.

Mehraby, N. (2005). Body language in different cultures. *Psychotherapy in Australia*, *11*(4), 27-28.

Migliaccio, R., Tanguy, D., Bouzigues, A., Sezer, I., Dubois, B., Le Ber, I., Batrancourt, B., Godefroy, V., & Levy, R. (2020). Cognitive and behavioural inhibition deficits in neurodegenerative dementias. *Cortex; a journal devoted to the study of the nervous system and behavior*, 131, 265–283. https://doi.org/10.1016/j.cortex.2020.08.001

Misiewicz, S., Brickman, A. M., & Tosto, G. (2018). Prosodic Impairment in Dementia: Review of previous research. *Current Alzheimer research*, *15*(2), 157–163. https://doi.org/10.2174/1567205014666171030115624

Mohammad, Saif M, & Turney, Peter D. (2013). Crowdsourcing a word–emotion association lexicon. *Computational Intelligence*, 29(3), 436-465.

Mok, Z., & Müller, N. (2014). Staging casual conversations for people with dementia. *Dementia (London, England), 13*(6), 834-853. https://doi.org/10.1177/1471301213488609

Montreal Corpus Tools. (2016). *Pretrained models — Montreal Forced Aligner 1.0 documentation*. Montreal Forced Aligner. https://montreal-forced-aligner.readthedocs.io/en/stable/pretrained_models.html

Moos, I., & BjÖRn, A. (2006). Use of the life story in the institutional care of people with dementia: a review of intervention studies. *Ageing and Society*, 26(3), 431-454. https://doi.org/10.1017/S0144686X06004806

Mortillaro, M., Mehu, M., & Scherer, K. R. (2011). Subtly different positive emotions can be distinguished by their facial expressions. *Social Psychological and Personality Science, 2*(3), 262-271. http://doi.org/10.1177/1948550610389080

Moyle, W., Venturto, L., Griffiths, S., Grimbeek, P., McAllister, M., Oxlade, D., & Murfield, J. (2011). Factors influencing quality of life for people with dementia: A qualitative perspective. *Aging & Mental Health*, *15*(8), 970-977. https://doi.org/10.1080/13607863.2011.583620

Mühlhäusler, P., & Harré, Rom. (1990). *Pronouns and people: The linguistic construction of social and personal identity*. Cambridge, Mass., B. Blackwell.

Nakamae, T., Yotsumoto, K., Tatsumi, E., & Hashimoto, T. (2014). Effects of productive activities with reminiscence in occupational therapy for people with dementia: A pilot randomized controlled study. *Hong Kong Journal of Occupational Therapy*, *24*(1), 13–19. https://doi.org/10.1016/j.hkjot.2014.01.003

Neal, I., du Toit, S., & Lovarini, M. (2020). The use of technology to promote meaningful engagement for adults with dementia in residential aged care: A scoping review. *International psychogeriatrics*, *32*(8), 913–935. https://doi.org/10.1017/S1041610219001388

Nelunova, E. D., Grigoreva, V. V., & Okhlopkova, Y. V. (2016). Problems of inculturation and acculturation of a person in a multilingual polycultural environment. *Russian Linguistic Bulletin*, *2016*(1), 12-14. https://doi.org/10.18454/RULB.5.14

Nevler, N., Ash, S., Jester, C., Irwin, D. J., Liberman, M., & Grossman, M. (2017). Automatic measurement of prosodic patterns in behavioral variant FTD. *Neurology*, *89*(7), 650–656. https://doi.org/10.1212/WNL.0000000000004236

Noftle, E. E., & Fleeson, W. (2010). Age differences in big five behavior averages and variabilities across the adult life span: moving beyond retrospective, global summary accounts of personality. *Psychology and aging*, *25*(1), 95–107. https://doi.org/10.1037/a0018199

Okken, V., van Rompay, T., & Pruyn, A. (2013). Room to Move: On Spatial Constraints and Self-Disclosure During Intimate Conversations. *Environment and Behavior*, 45(6), 737–760. https://doi.org/10.1177/0013916512444780

Okumura, Y., Tanimukai, S. and Asada, T. (2008). Effects of short-term reminiscence therapy on elderly with dementia: A comparison with everyday conversation approaches. *Psychogeriatrics*, 8, 124-133. https://doi.org/10.1111/j.1479-8301.2008.00236.x

Oosterman, J. M., Zwakhalen, S., Sampson, E. L., & Kunz, M. (2016). The use of facial expressions for pain assessment purposes in dementia: a narrative review. *Neurodegenerative disease management*, 6(2), 119–131. https://doi.org/10.2217/nmt-2015-0006

Oppert, M. L., O'Keeffe, V. J., & Duong, D. (2018). Knowledge, facilitators and barriers to the practice of person-centred care in aged care workers: a qualitative study. *Geriatric nursing (New York, N.Y.)*, *39*(6), 683–688. https://doi.org/10.1016/j.gerinurse.2018.05.004

Pang, B., & Lee, L. (2008). Opinion mining and sentiment analysis. *Foundations and Trends in Information Retrieval*, *2*(1–2), 1-135.

Pekkala, S., Wiener, D., Himali, J. J., Beiser, A. S., Obler, L. K., Liu, Y., McKee, A., Auerbach, S., Seshadri, S., Wolf, P. A., & Au, R. (2013). Lexical retrieval in discourse: an early indicator of Alzheimer's dementia. *Clinical linguistics & phonetics*, *27*(12), 905–921. https://doi.org/10.3109/02699206.2013.815278

Pennebaker, J.W., Booth, R.J., Boyd, R.L., & Francis, M.E. (2015). *Linguistic Inquiry and Word Count: LIWC2015* [Computer software]. Austin, TX: Pennebaker Conglomerates. http://www.LIWC.net

Pennebaker, J.W., & Francis, M.E. (1999). *Linguistic Inquiry and Word Count (LIWC): A computer-based text analysis program*. Lawrence Erlbaum Associate.

Perugia, G., Rodriguez-Martin, D., Boladeras, M. D., Mallofré, A. C., Barakova, E., & Rauterberg, M. (2018). Quantity of movement as a measure of engagement for dementia- *The influence of motivational disorders. American Journal of Alzheimer's Disease & Other Dementias*, *33*(2), 112-121. https://doi.org/10.1177/1533317517739700

Petty, S., Harvey, K., Griffiths, A., Coleston, D. M., & Dening, T. (2018). Emotional distress with dementia: A systematic review using corpus-based analysis and meta-ethnography. *International Journal of Geriatric Psychiatry*, *33*(5), 679–687. https://doi-org.ezproxy.uws.edu.au/10.1002/gps.4870

Phinney, A. (2006). Family strategies for supporting involvement in meaningful activity by persons with dementia. *Journal of Family Nursing*, *12*(1), 80-101. http://doi.org/10.1177/1074840705285382/

Phinney, A., Chaudhury, H., & O'Connor, D. L. (2007). Doing as much as I can do: the meaning of activity for people with dementia. *Aging Ment Health*, *11*(4), 384-393. https://doi.org/10.1080/13607860601086470

Pilarska, A. (2015). Contextualized self-views and sense of identity. *Personality and Individual Differences*, 86, 326-331. https://doi.org/10.1016/j.paid.2015.06.042

Pinquart, M., & Forstmeier, S. (2012). Effects of reminiscence interventions on psychosocial outcomes: A meta-analysis. *Aging & Mental Health*, 16, 541–558. http://doi.org/10.1080/13607863. 2011.651434

Planalp, S. (1998). Communicating emotion in everyday life: Cues, channels, and processes. In P. A. Andersen & L. K. Guerrero (Eds.), *Handbook of communication and emotion* (pp. 29–48). Academic Press.

Prieto-Flores, M. E., Fernandez-Mayoralas, G., Forjaz, M. J., Rojo-Perez, F., & Martinez-Martin, P. (2011). Residential satisfaction, sense of belonging and loneliness among older adults living in the community and in care facilities. *Health & Place*, *17*(6), 1183-1190. http://doi.org/10.1016/j.healthplace.2011.08.012

Raskin, N. J., & Rogers, C. R. (2005). *Person-centered therapy*. In R. J. Corsini & D. Wedding (Eds.), Current psychotherapies (p. 130–165). Thomson Brooks/Cole Publishing Co.

Ratcliffe, J., Chen, G., Cleland, J., Kaambwa, B., Khadka, J., Hutchinson, C., Milte, R. (2020). *Australia's aged care system: assessing the views and preferences of the general public for quality of care and future funding*. Caring Futures Institute, Flinders University, South Australia.

Redulla, R. (2019). Reminiscence therapy for dementia. *Mental Health Nursing*, *3*(41), 265-266. https://doi.org/10.1080/01612840.2019.1654572

Robert, P., Mulin, E., Mallea, P., & David, R. (2010). Review: apathy diagnosis, assessment, and treatment in Alzheimer's disease. *CNS Neurosci Ther*., *16*(5), 263-271. http://doi.org/10.1111/j.1755-5949.2009.00132.x

Robert, P. H., Verhey, F. R., Byrne, E. J., Hurt, C., De Deyn, P. P., Nobili, F., . . . Vellas, B. (2005). Grouping for behavioral and psychological symptoms in dementia: clinical and biological aspects. *Consensus paper of the European Alzheimer disease consortium*. Eur Psychiatry, *20*(7), 490-496. https://doi.org/10.1016/j.eurpsy.2004.09.031

Roberts, T. J. (2018). Nursing home resident relationship types: What supports close relationships with peers & staff? *Journal of Clinical Nursing*, *27*(23-24), 4361-4372. https://doi.org/10.1111/jocn.14554

Rohr, M. K., Wieck, C., & Kunzmann, U. (2017). Age differences in positive feelings and their expression. *Psychology and aging*, *32*(7), 608–620. https://doi.org/10.1037/pag0000200

Rose, N., Whitworth, A., Smart, S., Oliver, E., & Cartwright, J. (2020). "I remember when ... ": The impact of reminiscence therapy on discourse production in older adults with cognitive impairment. *International Journal of Speech Language Pathology*, *22*(3), 359-371. https://doi.org/10.1080/17549507.2020.1747542

Røsvik, J., Kirkevold, M., Engedal, K., Brooker, D., & Kirkevold, Ø. (2011). A model for using the VIPS framework for person-centred care for persons with dementia in nursing homes: a qualitative evaluative study. International journal of older people nursing, 6(3), 227–236. https://doi.org/10.1111/j.1748-3743.2011.00290.x

RStudio Team. (2020). RStudio: Integrated Development for R [Computer software]. Boston, MA. http://www.rstudio.com/

Rymes, B. (2016). *Classroom discourse analysis: A tool for critical reflection* (Second ed.). Hampton Press

Yasuda, M., & Sakakibara, H. (2017). Care staff training based on person-centered care and dementia care mapping, and its effects on the quality of life of nursing home residents with dementia. *Aging & mental health*, *21*(9), 991–996. https://doi.org/10.1080/13607863.2016.1191056

Sakamoto, Y., Ishiguro, M., and Kitagawa G. (1986). Akaike Information Criterion Statistics. D. Reidel Publishing Company.

Salthouse, T. (2009). *Major issues in cognitive aging.* Oxford University Press.

Samuelsson, C., & Ekström, A. (2019). Digital communication support in interaction involving people with dementia. *Logopedics, phoniatrics, vocology*, *44*(1), 41–50. https://doi.org/10.1080/14015439.2019.1554856

Scales, K., Zimmerman, S., & Miller, S. J. (2018). Evidence-based nonpharmacological practices to address behavioral and psychological symptoms of dementia. *The Gerontologist*, *58*(suppl_1), S88–S102. https://doi.org/10.1093/geront/gnx167

Schrauf, R., & Müller, N. (2014). *Dialogue and dementia: Cognitive and communicative resources for engagement*. Taylor & Francis Group.

Seidl, U., Lueken, U., Thomann, P. A., Kruse, A., & Schröder, J. (2012). Facial expression in Alzheimer's disease: impact of cognitive deficits and neuropsychiatric symptoms. *American journal of Alzheimer's disease and other dementias*, *27*(2), 100–106. https://doi.org/10.1177/1533317512440495

Silva, A. R., Pinho, M. S., Macedo, L., Moulin, C., Caldeira, S., & Firmino, H. (2017). It is not only memory: effects of sensecam on improving well-being in patients with mild alzheimer disease. *International Psychogeriatrics*, 29(5), 741-754. https://doi.org/10.1017/S104161021600243X

Silva, A. R., Pinho, M. S., Macedo, L., & Moulin, C. (2017). The cognitive effects of wearable cameras in mild alzheimer disease - an experimental study. *Current Alzheimer research*, *14*(12), 1270–1282. https://doi.org/10.2174/1567205014666170531083015

Singer, T., Verhaeghen, P., Ghisletta, P., Lindenberger, U., & Baltes, P. B. (2003). The fate of cognition in very old age: six-year longitudinal findings in the Berlin Aging Study (BASE). *Psychology and aging*, *18*(2), 318–331. https://doi.org/10.1037/0882-7974.18.2.318

Skinner, E. A., Kindermann, T. A., Connell, J. P., and Wellborn, J. G. (2009). Engagement and disaffection as organizational constructs in the dynamics of motivational development. K. Wentzel & A. Wigfield (Eds.), *Handbook of Motivation in School* (223–246.). https://doi.org/10.4324/9781315773384

Small, J. A., Geldart, K., Gutman, G., & Clarke Scott, M. A. (1998). The discourse of self in dementia. Ageing and Society, 18(3), 291-316. https://doi.org/10.1017/S0144686X98006928

Smith, M. C. (1995). Facial expression in mild dementia of the Alzheimer type. *Behavioural Neurology*, *8*(3-4), 149–156.

Smith, B. L., Wasowicz, J., & Preston, J. (1987). Temporal characteristics of the speech of normal elderly adults. *Journal of speech and hearing research*, *30*(4), 522–529. https://doi.org/10.1044/jshr.3004.522

Song, D., Shen, Q., Xu, T. Z., & Sun, Q. H. (2014). Effects of group reminiscence on elderly depression: A meta-analysis. *International Journal of Nursing Sciences*, *4*(1), 416-422. http://doi.org/10.1016/j.ijnss.2014.10.001

Sorapop, U. (n.d.). *Family happy mother mom send children kid son boy kindergarten to school, education back and back to school concept.* https://www.shutterstock.com/image-photo/family-happy-mother-mom-send-children-112469938

Spector, A., Orrell, M., Davies, S., & Woods, B. (2001). Can reality orientation be rehabilitated? Development and piloting of an evidence-based programme of cognition-based therapies for people with dementia. *Neuropsychol Rehabilitat*, 11, 193–6. https://doi.org/10.1080/09602010143000068.

Spector, A., Thorgrimsen, L., Woods, B., Royan, L., Davies, S., Butterworth, M., & Orrell, M. (2003). Efficacy of an evidence-based cognitive stimulation therapy programme for people with dementia: randomised controlled trial. *The British journal of psychiatry : the journal of mental science*, 183, 248–254. https://doi.org/10.1192/bjp.183.3.248

Stickle, T., & Wanner, A. (2019). Transivitity Patterns Exhibited by Persons with Dementia in Conversation. *Applied Linguistics*, *40*(1), 43-63. http://doi.org/10.1093/applin/amx001

Stivers, T. (2008). Stance, alignment, and affiliation during storytelling: when nodding is a token of affiliation. *Research on Language and Social Interaction*, *41*(1), 31-57, http://doi.org/10.1080/08351810701691123

Stolarski, L. (2015). Pitch patterns in vocal expression of "happiness" and "sadness" in the reading aloud of prose on the basis of selected audiobooks. *Research in Language*, *13*(2), 141-162. http://doi.org/10.1515/rela-2015-0016/

Strandroos, L., & Antelius, E. (2016). Interaction and common ground in dementia: Communication across linguistic and cultural diversity in a residential dementia care setting. *Health*, *21*(5), 538-554. https://doi.org/10.1177/1363459316677626

Stockbyte. (n.d.). *Elevated view of a mother father son and daughter (8-11) having a picnic and chatting*. https://www.gettyimages.com.au/detail/photo/elevated-view-of-a-mother-father-son-and-daughter-royalty-free-image/57305984?adppopup=true

Subramaniam, P., & Woods, B. (2016). Digital life storybooks for people with dementia living in care homes: an evaluation. *Clinical interventions in aging*, 11, 1263–1276. https://doi.org/10.2147/CIA.S111097

Sundberg, J. (1998). Expressivity in singing: A review of some recent investigations. *Logopedics Phoniatrics Vocology*, 23, 121–127. https://doi.org/10.1080/140154398434130

Taler, V., & Phillips, N. A. (2008). Language performance in Alzheimer's disease and mild cognitive impairment: A comparative review. *Journal of Clinical and Experimental Neuropsychology*, *30*(5), 501-556. https://doi.org/10.1080/13803390701550128

Tausczik, Yla R, & Pennebaker, James W. (2010). The psychological meaning of words: LIWC and computerized text analysis methods. *Journal of Language and Social Psychology, 29*(1), 24-54. https://doi.org/10.1177/0261927X09351676

Ting-Toomey, S., & Dorjee, T. (2018). *Communicating across cultures.* The Guilford Press.

Tappen, R. M., Williams, C. L., Barry, C., & Disesa, D. (2002). Conversation Intervention with Alzheimer's Patients: Increasing the Relevance of Communication. *Clinical gerontologist*, *24*(3-4), 63–75. https://doi.org/10.1300/J018v24n03_06

Thomas & Monin. (2016). *Section Week 8 - Linear Mixed Models: Statistical Methods for Behavioral and Social Sciences*. Stanford. https://web.stanford.edu/class/psych252/section/Mixed_models_tutorial.html

Tombaugh, T., and N. J. Mcintyre. (1992). The mini mental state examination - A comprehensive review. *Journal of The American Geriatrics Society, 40*(9), 922-35. http://doi.org/10.1111/j.1532-5415.1992.tb01992.x

Torres, B., Santos, R. L., de Sousa, M. F. B., Simões Neto, J. P., Nogueira, M. M. L., Belfort, T. T., Dias, R., & Dourado, M. C. N. (2015). Facial expression recognition in Alzheimer's disease: a longitudinal study. *Arquivos de Neuro-Psiquiatria*, *73*(5), 383-389. https://doi.org/10.1590/0004-282X20150009

Turney, P., & Littman, M. (2003) Measuring praise and criticism: Inference of semantic orientation from association. *ACM Transactions on Information Systems*, *21*(4), 315-346.

Udomsri, S. (n.d.). Family happy mother mom send children kid son boy kindergarten to school, education back and back to school concept [Photograph]. Shutterstock. https://www.shutterstock.com/image-photo/family-happy-mother-mom-send-children-1124699387

Ulatowska, H. K., Hayashi, M. M., Cannito, M. P., & Fleming, S. G. (1986). Disruption of reference in aging. *Brain and language*, *28*(1), 24–41. https://doi.org/10.1016/0093-934x(86)90088-x

van Beek, A. P. A., Frijters, D. H. M., Wagner, C., Groenewegen, P. P., & Ribbe, M. W. (2011). Social engagement and depressive symptoms of elderly residents with dementia: a cross-sectional study of 37 long-term care units. *International Psychogeriatrics*, *23*(4), 625-633. https://doi.org/10.1017/S1041610210002061

van de Glind, E. M. M., van Enst, W. A., van Munster, B. C., Olde Rikkert, M. G. M., Scheltens, P., Scholten, R. J. P. M., & Hooft, L. (2013). Pharmacological Treatment of Dementia: A Scoping Review of Systematic Reviews. *Dementia and Geriatric Cognitive Disorders*, *36*(3-4), 211-228. https://doi.org/10.1159/000353892

Van der Ploeg, E. S., Eppingstall, B., & O'Connor, D. W. (2016). Internet video chat (Skype) family conversations as a treatment of agitation in nursing home residents with dementia. *International Psychogeriatrics*, *28*(4), 697-698. https://doi.org/10.1017/S1041610215001854/

Van der Roest, H. G., Wenborn, J., Pastink, C., Droes, R. M., & Orrell, M. (2017). Assistive technology for memory support in dementia. *Cochrane Database of Systematic Reviews*, 6, CD009627. https://doi.org/10.1002/14651858.CD009627.pub2

Van Manen, Annick S, Aarts, Sil, Metzelthin, Silke F, Verbeek, Hilde, Hamers, Jan P.H, & Zwakhalen, Sandra M.G. (2021). A communication model for nursing staff working in dementia care: Results of a scoping review. *International Journal of Nursing Studies*, 113, 103776. https://doi.org/10.1016/j.ijnurstu.2020.103776

van Rossum, G., & Python Development Team. (2015). *Python 2.7.10 Language Reference*. Samurai Media Limited.

Verhaegen, C., & Poncelet, M. (2013). Changes in naming and semantic abilities with aging from 50 to 90 years. *Journal of the International Neuropsychological Society*, *19*(2), 119–126. https://doi.org/10.1017/S1355617712001178

Verma, M., & Howard, R. J. (2012). Semantic memory and language dysfunction in early Alzheimer's disease: a review. *International Journal of Geriatric Psychiatry, 27*(12), 1209-1217. https://doi.org/10.1002/gps.3766

van Rossum, G., & Python Development Team. (2015). *Python 2.7.10 Language Reference* [Computer program]. London; GBR, Samurai Media Limited.

Vanthornhout, J., Decruy, L., & Francart, T. (2019). Effect of Task and Attention on Neural Tracking of Speech. *Frontiers in neuroscience*, *13*, 977. https://doi.org/10.3389/fnins.2019.00977

Vaportzis, E., Clausen, M. G., & Gow, A. J. (2017). Older adults perceptions of technology and barriers to Interacting with tablet computers: A focus group study. *Frontiers in psychology*, 8, 1687. https://doi.org/10.3389/fpsyg.2017.01687

Villagran, M., Hajek, C., Zhao, X., Peterson, E., & Wittenberg-Lyles, E. (2012). Communication and culture: predictors of treatment adherence among Mexican immigrant patients. *Journal of health psychology*, *17*(3), 443–452. https://doi.org/10.1177/1359105311417194

Wang, D., & Villarosa, A. R. (2017). Food choices -- letting aged care residents have their cake, and eat it as well. *Australian nursing & midwifery journal*, 24(7), 39.

Ward, Richard, Vass, Antony A, Aggarwal, Neeru, Garfield, Cydonie, & Cybyk, Beau. (2008). A different story: Exploring patterns of communication in residential dementia care. *Ageing and Society, 28*(5), 629-651. https://doi.org/10.1017/S0144686X07006927

Walker, M. P., Ayre, G. A., Cummings, J. L., Wesnes, K., McKeith, I. G., O'Brien, J. T., & Ballard, C. G. (2000). Quantifying fluctuation in dementia with Lewy bodies, Alzheimer's disease, and vascular dementia. *Neurology*, *54*(8), 1616–1625. https://doi.org/10.1212/wnl.54.8.1616

Wardhaugh, R. (2015). *An introduction to sociolinguistics* (7th ed). John Wiley & Sons

Watson, K., Parker, D., Leahy, A., Piepers, D., & Stevens, C. J. (2018). Time travelling with technology. *Australian Journal of Dementia Care, 7*(4), 16-17.

Werner, P., Cohen-Mansfield, J., Fischer, J., & Segal, G. (2000). Characterization of family-generated videotapes for the management of verbally disruptive behaviors. *Journal of Applied Gerontology*, *19*(1), 42-57. https://doi.org/10.1177/073346480001900103

Westmacott, R., Freedman, M., Black, S. E., Stokes, K. A., & Moscovitch, M. (2004). Temporally graded semantic memory loss in Alzheimer's disease: Cross-sectional and longitudinal studies. *Cognitive Neuropsychology*, *21*(2-4), 353-378. https://doi.org/10.1080/02643290342000375

Wey, S. (2005). *One size does not fit all: Person-centred approaches to the use of assistive technology*. Jessica Kingsley.

Wilcoxon, F. (1945). Individual comparisons by ranking methods. *Biometrics Bulletin*, *1*(6), 80-83. http://doi.org/10.2307/3001968

Wilson, C. B., & Davies, S. (2009). Developing relationships in long term care environments: the contribution of staff. *Journal of Clinical Nursing*, 18(12), 1746–1755. https://doi.org/10.1111/j.1365-2702.2008.02748.x

Wilson, C. B., Davies, S., & Nolan, M. (2009). Developing personal relationships in care homes: realising the contributions of staff, residents and family members. *Ageing and Society*, 29(7), 1041–1063. https://doi.org/10.1017/S0144686X0900840X

Winter, B. (2013). *Linear models and linear mixed effects models in R with linguistic applications. CoRR,* abs/1308.5499. http://arxiv.org/abs/1308.5499

Wood, S., Cummings, J., Hsu, M., Barclay, T., Wheatley, M., Yarema, K., & Schnelle, J. (2000). The use of the neuropsychiatric inventory in nursing home residents: Characterization and measurement. *The American Journal of Geriatric Psychiatry*, *8*(1), 75-83. https://doi.org/10.1097/00019442-200002000-00010

Woods, B., O'Philbin, L., Farrell, E. M., Spector, A. E., & Orrell, M. (2018). Reminiscence therapy for dementia. *Cochrane Database of Systematic Reviews*, *2018*(3), CD001120. https://doi.org/10.1002/14651858.CD001120.pub3

Woods, P., & Ashley, J. (1995). Simulated presence therapy: Using selected memories to manage problem behaviors in Alzheimer's disease patients. *Geriatric Nursing*, *16*(1), 9-14. https://doi.org/https://doi.org/10.1016/S0197-4572(05)80072-2

Woods, R. T., Bruce, E., Edwards, R. T., Elvish, R., Hoare, Z., Hounsome, B., Keady, J., Moniz-Cook, E. D., Orgeta, V., Orrell, M., Rees, J., & Russell, I. T. (2012). REMCARE: reminiscence groups for people with dementia and their family caregivers - effectiveness and cost-effectiveness pragmatic multicentre randomised trial. *Health technology assessment* (Winchester, England), 16(48), v–116. https://doi.org/10.3310/hta16480

Woodward, M. (2013). Aspects of communication in Alzheimer's disease: clinical features and treatment options. *International Psychogeriatrics*, *25*(6), 877-885. https://doi.org/10.1017/S1041610213000318

World Health Organization. (2017, December 12). Mental health of older adults. https://www.who.int/news-room/fact-sheets/detail/mental-health-of-older-adults

Wray, A. (2014). Dementia and Language. In C. Chapelle (Ed.), *The Encyclopedia of Applied Linguistics.* John Wiley and Sons, Inc..

Xiao, L. D., Willis, E., Harrington, A., Gillham, D., De Bellis, A., Morey, W., & Jeffers, L. (2017). Resident and family member perceptions of cultural diversity in aged care homes. *Nurs Health Sci*, *19*(1), 59-65. https://doi.org/10.1111/nhs.12302

Yeboah, C., Bowers, B., & Rolls, C. (2013). Culturally and linguistically diverse older adults relocating to residential aged care. *Contemporary nurse*, *44*(1), 50–61. https://doi.org/10.5172/conu.2013.44.1.50

Young, H. R., Glerum, D. R., Wang, W., & Joseph, D. L. (2018). Who are the most engaged at work? A meta-analysis of personality and employee engagement. *J Organ Behav*, 39, 1330– 1346. https://doi.org/10.1002/job.2303

Yu, C., Aoki, P., & Woodruff, A. (2004). Detecting User Engagement in Everyday Conversations [Paper presentation]. 8th International Conference on Spoken Language Processing, Jeju Island.

Zhou, W., He, G., Gao, J., Yuan, Q., Feng, H., & Zhang, C. K. (2011). The effects of group reminiscence therapy on depression, self-esteem, and affect balance of Chinese community-dwelling elderly. *Archives of Gerontology and Geriatrics*, *54*(3), E440-E447. http://doi.org/10.1016/j.archger.2011.12.003

APPENDICES

Appendix A: Participant information sheets

WESTERN SYDNEY
UNIVERSITY

Participant Information Sheet – Client

How is the study being paid for?

Madeleine is supported by a federal government scholarship.

What will I be asked to do?

At first, you will be asked to be interviewed before the program begins to get information about places and locations you would like to visit. You will then be asked to join a video recorded small group session, to travel to places of your past and share stories with the other people in the room. At the beginning of each session you will be welcomed and briefed by a facilitator. In some of these sessions, you will be able to visit places that interest you, that you have never been to before. A facilitator will ask questions about the locations shown on the screen. You will also be asked to wear a wristband to measure movement.

How much of my time will I need to give?

The program will run over three months. The interview before the beginning of the program will be half an hour. The program will then run for half an hour each week over 12 weeks, with two weeks off in the middle.

What benefits will I, and/or the broader community, receive for participating?

You might enjoy sharing your stories with others and remembering your past. The study will bring long-term benefit to the community but that may not be seen straight away.

Will the study involve any risk or discomfort for me? If so, what will be done to rectify it?

The study does not intend to deliver any discomfort or risk. You are free to stop at any time.

How do you intend to publish or disseminate the results?

Maddie will write a thesis, present conference papers and write reports. You will not be named or identified.

Will the data and information that I have provided be disposed of?

Only the researchers will have access to the data. Data may be used in similar projects up to 7 years.

Can I withdraw from the study?

Participation is entirely voluntary and you are not obliged to be involved. If you do participate you can withdraw at any time without giving reason.

Can I tell other people about the study?

Yes, you can tell other people about the study.

What if I require further information?

Please contact Professor Kate Stevens: (02) 9772 6324 kj.stevens@westernsydney.edu.au

What if I have a complaint?

WESTERN SYDNEY
UNIVERSITY

Participant Information Sheet – Family/Carer

Project Title: Time Travelling with Technology (TTT)

Project Summary:

You are invited to participate in a research study being conducted by Madeleine Radnan (PhD candidate) under the supervision of Professor Kate Stevens. The aim of the project is to evaluate a technology-based activity. The technology will allow the client you care for to travel to locations around the world that is of significant interest.

How is the study being paid for?

Madeleine is supported by a federal government scholarship.

What will I be asked to do?

You will be asked to take part in an interview before the commencement of the program to discuss the history of the client and locations of their past. You may be asked to complete a pre-measure and post-measure questionnaire about the client. You are welcome to attend the program sessions the client you care for attends. In these sessions, you may contribute to the conversation as the client shares their story.

How much of my time will I need to give?

The program will run over three months. The interview before the beginning of the program will be half an hour. The program will then run for half an hour each week over 12 weeks, with two weeks off in the middle. It is not a requirement that you come to the half-hour program sessions. You will be welcome to join any session that the person you care for attends.

What benefits will I, and/or the broader community, receive for participating?

You might enjoy sharing stories of the person you care for and joining them in the sessions. The study will bring long-term benefit to the community but that may not be seen straight away.

Will the study involve any risk or discomfort for me? If so, what will be done to rectify it?

The study does not intend to deliver any discomfort or risk. You are free to stop at any time.

How do you intend to publish or disseminate the results?

Maddie will write a thesis, present conference papers and write reports. You will not be named or identified.

Will the data and information that I have provided be disposed of?

Only the researchers will have access to the data. Data may be used in similar projects up to 7 years.

Can I withdraw from the study?

Participation is entirely voluntary and you are not obliged to be involved. If you do participate you can withdraw at any time without giving reason.

Can I tell other people about the study?

Appendix B: Participant consent forms

WESTERN SYDNEY
UNIVERSITY

Consent Form – Client

Project Title: Time Travelling with Technology (TTT)

I hereby consent to participate in the above named research project.

I acknowledge that:

- I have read the participant information sheet (or where appropriate, have had it read to me) and have been given the opportunity to discuss the information and my involvement in the project with the researcher/s
- The procedures required for the project and the time involved have been explained to me, and any questions I have about the project have been answered to my satisfaction.

I under the study will involve:

☐ Participating in an interview and/or focus group

☐ Completing pre-measure and post-measure questionnaire

☐ Having my information video and audio recorded

☐ Attending TTT intervention sessions

☐ Having the information I provide used in TTT sessions

I consent for my data and information provided to be used in this project and other related projects for an extended period of time.

I understand that my involvement is confidential and that the information gained during the study may be published and stored for other research use but no information about me will be used in any way that reveals my identity.

I understand that my participation in this study will have no effect on my relationship with the researcher/s, and any organisations involved, now or in the future. I understand that I will be unable to withdraw some of my data and information from this project, as the TTT group session recordings will be used as data for multiple participants.

Signed:

Name:

Date:

This study has been approved by the Human Research Ethics Committee at Western Sydney University. The ethics reference number is: H13117

What if I have a complaint?

If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through Research Engagement, Development and Innovation (REDI) on Tel +61 2 4736 0229 or email humanethics@westernsydney.edu.au.

Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

WESTERN SYDNEY
UNIVERSITY

Consent Form – Family/Carer

Project Title: Time Travelling with Technology (TTT)

I hereby consent to participate in the above named research project.

I acknowledge that:

- I have read the participant information sheet (or where appropriate, have had it read to me) and have been given the opportunity to discuss the information and my involvement in the project with the researcher/s
- The procedures required for the project and the time involved have been explained to me, and any questions I have about the project have been answered to my satisfaction.

I consent to:

☐ Participating in an interview and/or focus group

☐ Completing pre-measure and post-measure questionnaire

☐ Having my information video and audio recorded

☐ Attending TTT intervention sessions

☐ Having the information I provide used in TTT sessions

I consent for my data and information provided to be used in this project and other related projects for an extended period of time.

I understand that my involvement is confidential and that the information gained during the study may be published and stored for other research use but no information about me will be used in any way that reveals my identity.

I understand that my participation in this study will have no effect on my relationship with the researcher/s, and any organisations involved, now or in the future. I understand that I will be unable to withdraw some of my data and information from this project, as the TTT group session recordings and focus group recordings will be used as data for multiple participants.

Signed:

Name:

Date:

This study has been approved by the Human Research Ethics Committee at Western Sydney University. The ethics reference number is: H13117

What if I have a complaint?

If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through Research Engagement, Development and Innovation (REDI) on Tel +61 2 4736 0229 or email humanethics@westernsydney.edu.au.

Appendix C: Discourse interviews

Discourse Interview V1

1. Look at this picture. Can you tell me a story about what's happening in the picture?

2. Now, can you tell me how you make scrambled eggs? What do you do?

3. What does this saying mean? (If you haven't heard it, what do you think it means?)

   - Don't count your chickens before they are hatched.
   - While the cat's away, the mice will play.
   - The long way home is often the fastest.

4. I'd like to learn more about your life, can you help me:
   - Tell me about where you grew up?
   - Where did you go to school? Did you like it?
   - Where did you work, when you were younger?
   - Did you get married and have a family?
   - Where did you used to go on holidays?

Discourse Interview V2

1. Look at this picture. Can you tell me a story about what's happening in the picture?

2. Now, can you tell me how you make chicken schnitzel? What do you do?

3. What does this saying mean? (If you haven't heard it, what do you think it means?)

    - Don't cross the bridge until you come to it.
    - Too many cooks spoil the broth.
    - It's no use crying over spilt milk.

4. I'd like to learn more about your life, can you help me:
    - Tell me about where you grew up?
    - Where did you go to school? Did you like it?
    - Where did you work, when you were younger?
    - Did you get married and have a family?
    - Where did you used to go on holidays?

Discourse Interview V3

1. Look at this picture. Can you tell me a story about what's happening in the picture?

2. Now, can you tell me how do you make a salad?

3. What does this saying mean? (If you haven't heard it, what do you think it means?)

   - There is no point reinventing the wheel
   - The nail that sticks out the farthest, gets hammered the hardest
   - Judge a day by the seeds that you plant than the crops that you harvest

4. I'd like to learn more about your life, can you help me:
   - Tell me about where you grew up?
   - Where did you go to school? Did you like it?
   - Where did you work, when you were younger?
   - Did you get married and have a family?
   - Where did you used to go on holidays?

Appendix D: Discourse interview marking matrices

Discourse Interview V1 Marking Matrix

Participant ID _____

Date: __________

Interview No. 1

Measure	Task	Ability Assessed		Score
Narrative Ability	Generate a narrative from a picture requiring interpretation of complex visual information. (Picture depicts a mother crouching down alongside a car and comforting her young child on their way to school.)	- Integrating visual information - Generating Story around emotions expressed and life events - Generating implications for past and future	15 Possible Point: - Main Idea (5) 0 (Incorrect) – 5 (Interpretive) - Lesson (10) 0 (Incorrect) – 10 (Global)	
Procedural Discourse	Provide a detailed description of steps involved in preparing and cooking scrambling eggs, Steps evaluated in terms of the following: Gist steps: - Crack the eggs - Stir the eggs - Add ingredients - Cook the eggs Core steps: - Get the eggs - Mention of pan - Turn on heat - Put butter in skillet - Pour in milk - Stir while cooking - Put eggs on plate	- Organising and sequencing steps	11 Possible Points - Gist Steps (4) - Core Steps (7)	
California Proverb Test	Interpret familiar and unfamiliar proverbs - Don't count your chickens before they are hatched. - While the cat's away, the mice will play. - The long way home is often the fastest.	- Making abstract inferences	30 Possible Points (3 Proverbs) - 0 (Incorrect) – 10 (Correct Abstract)	

Total (Composite Discourse Score): ________

Discourse Interview V2 Marking Matrix

Participant ID _____ Date: __________

Interview No. 2

Measure	Task	Ability Assessed		Score
Narrative Ability	Generate a narrative from a picture requiring interpretation of complex visual information. (Picture depicts a woman reaching out and holding onto her partner's hand as he departs on a train.)	- Integrating visual information - Generating Story around emotions expressed and life events - Generating implications for past and future	15 Possible Point: - Main Idea (5) 0 (Incorrect) – 5 (Interpretive) - Lesson (10) 0 (Incorrect) – 10 (Global)	
Procedural Discourse	Provide a detailed description of steps involved in preparing and cooking chicken schnitzel. Steps evaluated in terms of the following: Gist steps - Roll chicken in flower - Dip chicken in egg - Roll chicken in bread crumbs - Cook the chicken Core steps - Crack eggs/whisk eggs - Flip chicken in batter ingredients - Mention of pan/skillet - Turn on heat - Put oil in pan/skillet - Flip Chicken in pan/skillet - Put chicken on plate	- Organising and sequencing steps	11 Possible Points - Gist Steps (4) - Core Steps (7)	
California Proverb Test	Interpret familiar and unfamiliar proverbs - Don't cross the bridge until you come to it. - Too many cooks spoil the broth. - It's no use crying over spilt milk.	- Making abstract inferences	30 Possible Points (3 Proverbs) - 0 (Incorrect) – 10 (Correct Abstract)	

Total (Composite Discourse Score): ________

Discourse Interview V3 Marking Matrix

Participant ID _____ Date: __________

Interview No. 3

Measure	Task	Ability Assessed		Score
Narrative Ability	Generate a narrative from a Picture requiring interpretation of complex visual information. (Picture depicts a family of four smiling to each other whilst enjoying their picnic in a park.)	- Integrating visual information - Generating Story around emotions expressed and life events - Generating implications for past and future	15 Possible Point: - Main Idea (5) 0 (Incorrect) – 5 (Interpretive) - Lesson (10) 0 (Incorrect) – 10 (Global)	
Procedural Discourse	Provide a detailed description of steps involved in making a salad, Steps evaluated in terms of the following: Gist steps - Get the ingredients - Chop up ingredients - Put salad together - Dress the salad Core steps - Mention specific salad ingredients - Mention of bowl - Washing items - Type of dressing - Shake the dressing - Toss the salad - Serve the salad	- Organising and sequencing steps	11 Possible Points - Gist Steps (4) - Core Steps (7)	
California Proverb Test	Interpret familiar and unfamiliar proverbs - There is no point reinventing the wheel - The nail that sticks out the farthest, gets hammered the hardest - Judge a day by the seeds that you plant than the crops that you harvest	- Making abstract inferences	30 Possible Points (3 Proverbs) - 0 (Incorrect) – 10 (Correct Abstract)	

Total (Composite Discourse Score): _________

Appendix E: Mini-Mental State Examination results

```r
#MMSE Pre-experiment group comparison
# x = L->T group
# y = H->T group
x <- c(26, 9, 15, 17, 12)
y <-  c(29, 13, 17, 14)
t.test(x, y)

##
##  Welch Two Sample t-test
##
## data:  x and y
## t = -0.5235, df = 6.0953, p-value = 0.6191
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -13.858296   8.958296
## sample estimates:
## mean of x mean of y
##     15.80     18.25

#MMSE Post-experiment group comparison
# x = L->T group
# y = H->T group
x <- c(23, 5, 12, 21, 15)
y <-  c(30, 9, 18, 15)
t.test(x, y)

##
##  Welch Two Sample t-test
##
## data:  x and y
## t = -0.51172, df = 5.8209, p-value = 0.6277
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -16.2894  10.6894
## sample estimates:
## mean of x mean of y
##      15.2      18.0

#MMSE Pre-experiment compared to post-experiment
# x = Pre-experiment
# y = HT condition
x <- c(29,13,17,14,26,9,15,17,12)
y <- c(30,9,18,15,23,5,12,21,15)

wilcox.test(x, y, paired = TRUE, alternative = "two.sided")

## Warning in wilcox.test.default(x, y, paired = TRUE, alternative = "two.
sided"):
## cannot compute exact p-value with ties

##
##  Wilcoxon signed rank test with continuity correction
##
```

```
## data:  x and y
## V = 26, p-value = 0.7194
## alternative hypothesis: true location shift is not equal to 0
```

Appendix F: Neuropsychiatric Inventory – Nursing Home Version results

F.1 Total NPI-NH score comparisons

```
#### Total NPI-NH Score Comparison
setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Discourse\
Interview/NPI-NH/")
library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)
BC_data <- read.csv("NPI-NH_Scores.csv", header=TRUE)
BC_data$Time <- factor(BC_data$Time, levels = c("Pre", "Mid", "Post"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))

res2 = lmer(FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

Within_Timed<-emmeans(res2, ~Time)
pairs(Within_Timed)

##  contrast    estimate   SE   df t.ratio p.value
##  Pre - Mid  -10.07329 7.72 15.2 -1.305  0.4137
##  Pre - Post -10.06838 7.41 14.6 -1.358  0.3872
##  Mid - Post   0.00492 7.43 14.5  0.001  1.0000
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## P value adjustment: tukey method for comparing a family of 3 estimates

Within_group<-emmeans(res2, ~Group)
pairs(Within_group)

##  contrast        estimate  SE   df t.ratio p.value
##  (L->H) - (H->L)    -0.26 6.9 5.85 -0.038  0.9712
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger

### Graphing Times

Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast    estimate   SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid  -10.07329 7.72 15.2    -26.5     6.36 -1.305  0.2112
##  Pre - Post -10.06838 7.41 14.6    -25.9     5.77 -1.358  0.1950
##  Mid - Post   0.00492 7.43 14.5    -15.9    15.88  0.001  0.9995
##
## Results are averaged over the levels of: Group
```

```
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
##  contrast         estimate  SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     -0.26 6.9 5.85    -17.2     16.7 -0.038  0.9712
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

F.2 Domain total sub-scores

```
# NPI-NH Domain Total Scores
setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Discourse\
Interview/NPI-NH/")

library(doBy)
library(emmeans)
library(lme4)

## Loading required package: Matrix

BC_data <- read.csv("NPI-NH_Subscores.csv", header=TRUE)
BC_data$Time <- factor(BC_data$Time, levels = c("Pre", "Mid", "Post"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))

## DELLUSIONS FxS
res1 = lmer(Delusions_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_dat
a)

Within_Timed<-emmeans(res1, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -0.818 0.692 12.7    -2.32    0.681 -1.182  0.2590
##  Pre - Post   -0.929 0.728 12.9    -2.50    0.646 -1.275  0.2248
##  Mid - Post   -0.111 0.694 12.2    -1.62    1.399 -0.160  0.8754
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

Within_group<-emmeans(res1, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate  SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     1.17 1.3 6.02    -2.01     4.34 0.898   0.4039
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## HALLUCINATIONS FxS
res3 = lmer(Hallucinations_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=B
C_data)

Within_Timed<-emmeans(res3, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
```

```
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -1.448 0.936 13.1    -3.47    0.574 -1.547  0.1458
##  Pre - Post   -1.821 0.984 13.4    -3.94    0.297 -1.851  0.0862
##  Mid - Post   -0.373 0.946 12.4    -2.43    1.680 -0.395  0.6997
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

Within_group<-emmeans(res3, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     1.06 1.28 5.95    -2.08     4.19 0.825   0.4413
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AGITATION FxS
res5 = lmer(Agitation_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_dat
a)

## boundary (singular) fit: see ?isSingular

Within_Timed<-emmeans(res5, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -0.484 0.652 13.7    -1.89    0.919 -0.741  0.4711
##  Pre - Post   -0.264 0.680 14.3    -1.72    1.192 -0.388  0.7041
##  Mid - Post    0.220 0.671 13.0    -1.23    1.669  0.328  0.7483
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

Within_group<-emmeans(res5, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    0.177 0.583 5.49    -1.28     1.64 0.304   0.7723
##
## Results are averaged over the levels of: Time
```

```
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## DEPRESSION FxS
res7 = lmer(Depression_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_da
ta)

Within_Timed<-emmeans(res7, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -1.326 0.974 13.7    -3.42    0.769 -1.361  0.1956
##  Pre - Post   -0.898 1.017 14.3    -3.07    1.278 -0.883  0.3917
##  Mid - Post    0.428 1.002 13.0    -1.74    2.593  0.427  0.6761
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

Within_group<-emmeans(res7, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE  df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0323 0.876 5.5    -2.22     2.16 -0.037  0.9719
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## ANXIETY FxS
res9 = lmer(Anxiety_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

Within_Timed<-emmeans(res9, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     1.099 0.904 13.7   -0.844    3.042  1.216  0.2445
##  Pre - Post   -0.403 0.943 14.3   -2.422    1.616 -0.427  0.6755
##  Mid - Post   -1.502 0.928 12.9   -3.508    0.504 -1.618  0.1297
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

Within_group<-emmeans(res9, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
```

```
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.797 0.83 5.54    -2.87     1.28 -0.960  0.3771
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## ELATION FxS
res11 = lmer(Elation_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data
)

Within_Timed<-emmeans(res11, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     0.420 0.740 13.7   -1.171     2.01 0.567   0.5797
##  Pre - Post    0.798 0.772 14.3   -0.854     2.45 1.034   0.3182
##  Mid - Post    0.378 0.761 13.0   -1.266     2.02 0.497   0.6273
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

Within_group<-emmeans(res11, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.123 0.662 5.49    -1.78     1.53 -0.186  0.8589
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## APATHY FxS
res13 = lmer(Apathy_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

## boundary (singular) fit: see ?isSingular

Within_Timed<-emmeans(res13, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate   SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -2.872 1.57 13.7    -6.24    0.493 -1.835  0.0884
```

```
## Pre - Post   -0.929 1.63 14.3    -4.42    2.566 -0.569  0.5782
## Mid - Post    1.943 1.61 13.0    -1.54    5.422  1.207  0.2490
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
Within_group<-emmeans(res13, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
## contrast        estimate  SE   df lower.CL upper.CL t.ratio p.value
## (L->H) - (H->L)    -2.93 1.4 5.49    -6.43    0.574 -2.093  0.0856
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
## DISINHIBITION FxS
res15 = lmer(Disinhibition_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=B
C_data)

Within_Timed<-emmeans(res15, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs
```

```
## contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
## Pre - Mid    -1.499 0.982 12.8    -3.62    0.624 -1.527  0.1510
## Pre - Post   -0.393 1.033 13.2    -2.62    1.836 -0.381  0.7096
## Mid - Post    1.106 0.988 12.3    -1.04    3.253  1.119  0.2844
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
Within_group<-emmeans(res15, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
## contrast        estimate   SE df lower.CL upper.CL t.ratio p.value
## (L->H) - (H->L)    -1.66 1.57  6    -5.51     2.19 -1.056  0.3314
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
## IRRITABILITY FxS
res17 = lmer(Irritability_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC
_data)
```

```
Within_Timed<-emmeans(res17, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate   SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -0.547 1.17 13.7    -3.06     1.97 -0.467  0.6478
##  Pre - Post    0.933 1.22 14.3    -1.68     3.55  0.764  0.4572
##  Mid - Post    1.480 1.20 13.0    -1.12     4.08  1.230  0.2407
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

Within_group<-emmeans(res17, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE  df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    0.706 1.05 5.5    -1.93     3.34 0.671   0.5294
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## ABERRANT MOTOR BEHAVIOUR FxS
res19 = lmer(AMB_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

Within_Timed<-emmeans(res19, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate   SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -2.918 1.87 13.0    -6.96     1.13 -1.559  0.1430
##  Pre - Post   -2.297 1.97 13.4    -6.54     1.94 -1.167  0.2636
##  Mid - Post    0.622 1.89 12.4    -3.48     4.73  0.329  0.7477
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

Within_group<-emmeans(res19, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    -2.59 2.65 5.96    -9.08     3.89 -0.980  0.3653
```

```
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## SLEEP FxS
res21 = lmer(Sleep_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

Within_Timed<-emmeans(res21, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate   SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     -3.98 1.31 12.7   -6.827    -1.14 -3.030  0.0099
##  Pre - Post    -1.58 1.38 12.9   -4.568     1.41 -1.140  0.2748
##  Mid - Post     2.40 1.32 12.2   -0.465     5.27  1.822  0.0930
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

Within_group<-emmeans(res21, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    -1.26 2.41 6.02    -7.15     4.63 -0.523  0.6195
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## APPETITE FxS
res23 = lmer(Appetite_FxS ~ Group + Time + MMSE_Mean + (1|ID), data=BC_dat
a)

Within_Timed<-emmeans(res23, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate   SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     -2.34 1.14 10.3 -4.87233    0.194 -2.050  0.0668
##  Pre - Post     0.20 1.21 10.6 -2.48291    2.884  0.165  0.8719
##  Mid - Post     2.54 1.14 10.3  0.00852    5.071  2.226  0.0494
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
Within_group<-emmeans(res23, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)      2.6 3.25 6.15    -5.31     10.5 0.799   0.4542
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

F.3 Total occupational disruptiveness scores

```r
# NPI-NH OD Total Scores
setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Discourse\
Interview/NPI-NH/")

library(doBy)
library(emmeans)
library(lme4)

## Loading required package: Matrix

BC_data <- read.csv("NPI-NH_Scores.csv", header=TRUE)
BC_data$Time <- factor(BC_data$Time, levels = c("Pre", "Mid", "Post"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))

res2 = lmer(OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

# NPI-NH OD Total Scores Time Comparisons
Within_Timed<-emmeans(res2, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate   SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -3.154 3.03 15.2    -9.62     3.31 -1.039  0.3149
##  Pre - Post   -0.523 2.92 14.6    -6.75     5.71 -0.179  0.8600
##  Mid - Post    2.631 2.92 14.5    -3.61     8.87  0.901  0.3823
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# NPI-NH OD Total Scores Group Comparison
Within_group<-emmeans(res2, ~Group)

Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast         estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     -1.41 2.71 5.85    -8.08     5.26 -0.520  0.6224
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

F.4 Domain occupational disruptiveness sub-scores

```
# NPI-NH Domain OD Scores
setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Discourse\
Interview/NPI-NH/")

library(doBy)
library(emmeans)
library(lme4)

## Loading required package: Matrix

BC_data <- read.csv("NPI-NH_Subscores.csv", header=TRUE)
BC_data$Time <- factor(BC_data$Time, levels = c("Pre", "Mid", "Post"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))

## DELUSIONS OD

res2 = lmer(Delusions_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data
)

# Delusions OD time comparison
Within_Timed<-emmeans(res2, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -0.364 0.386 12.8   -1.199    0.472 -0.942  0.3638
##  Pre - Post   -0.125 0.406 13.2   -1.001    0.752 -0.307  0.7635
##  Mid - Post    0.239 0.389 12.3   -0.606    1.083  0.614  0.5502
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Delusions OD group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.194 0.615  6     -1.7     1.31 -0.315  0.7633
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## HALLUCINATIONS OD
res4 = lmer(Hallucinations_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC
_data)
```

```
# Hallucination OD time comparison
Within_Timed<-emmeans(res4, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid   -0.6858 0.407 13.2   -1.564    0.192 -1.685  0.1155
##  Pre - Post  -0.7856 0.427 13.6   -1.704    0.133 -1.839  0.0878
##  Mid - Post  -0.0998 0.412 12.5   -0.995    0.795 -0.242  0.8128
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Hallucination OD group comparison
Within_group<-emmeans(res4, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L) -0.00113 0.507 5.89    -1.25     1.24 -0.002  0.9983
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AGITATION OD
res6 = lmer(Agitation_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data
)

# Agitation OD time comparison
Within_Timed<-emmeans(res6, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -0.774 0.525 13.6   -1.903    0.355 -1.474  0.1632
##  Pre - Post    0.221 0.549 14.2   -0.954    1.397  0.403  0.6927
##  Mid - Post    0.995 0.537 12.8   -0.167    2.158  1.852  0.0872
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Agitation OD group comparison
Within_group<-emmeans(res6, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
```

```
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.591 0.514 5.64    -1.87    0.687 -1.149  0.2969
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## DEPRESSION OD
res8 = lmer(Depression_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_dat
a)

# Depression OD time comparison
Within_Timed<-emmeans(res8, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -0.483 0.325 13.2   -1.184    0.217 -1.489  0.1600
##  Pre - Post   -0.227 0.341 13.7   -0.960    0.505 -0.667  0.5157
##  Mid - Post    0.256 0.330 12.5   -0.459    0.971  0.777  0.4516
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Depression OD group comparison
Within_group<-emmeans(res8, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.129 0.389 5.86    -1.09    0.829 -0.332  0.7518
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## ANXIETY OD
res10 = lmer(Anxiety_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

# Anxiety OD time comparison
Within_Timed<-emmeans(res10, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs
```

```
##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     0.672 0.389 13.0   -0.169    1.513   1.726  0.1081
##  Pre - Post    0.114 0.409 13.3   -0.767    0.996   0.280  0.7840
##  Mid - Post   -0.557 0.393 12.4   -1.411    0.296  -1.419  0.1807
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
# Anxiety OD group comparison
Within_group<-emmeans(res10, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.592 0.558 5.97    -1.96    0.776 -1.060  0.3300
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
## ELATION OD
res12 = lmer(Elation_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

# Elation OD time comparison
Within_Timed<-emmeans(res12, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Timed_pairs
```

```
##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     0.140 0.247 13.7   -0.390    0.670 0.567  0.5797
##  Pre - Post    0.266 0.257 14.3   -0.285    0.817 1.034  0.3182
##  Mid - Post    0.126 0.254 13.0   -0.422    0.674 0.497  0.6273
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
# Elation OD group comparison
Within_group<-emmeans(res12, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0411 0.221 5.49   -0.594    0.511 -0.186  0.8589
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
## APATHY OD
res14 = lmer(Apathy_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

## boundary (singular) fit: see ?isSingular

# Apathy OD time comparison
Within_Timed<-emmeans(res14, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -1.165 0.526 13.7   -2.296  -0.0351 -2.216  0.0442
##  Pre - Post    0.168 0.548 14.3   -1.006   1.3417  0.306  0.7639
##  Mid - Post    1.333 0.541 13.0    0.165   2.5018  2.465  0.0284
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Apathy OD group comparison
Within_group<-emmeans(res14, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast          estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     -1.06 0.47 5.49    -2.24    0.115 -2.260  0.0687
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## DISINHIBITION OD
res16 = lmer(Disinhibition_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC
_data)

# Disinhibition OD time comparison
Within_Timed<-emmeans(res16, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -0.731 0.434 13.1   -1.667    0.205 -1.685  0.1156
##  Pre - Post   -0.039 0.456 13.6   -1.019    0.941 -0.086  0.9331
##  Mid - Post    0.692 0.439 12.4   -0.261    1.644  1.576  0.1401
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```r
# Disinhibition OD group comparison
Within_group<-emmeans(res16, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.394 0.563 5.92    -1.78    0.988 -0.700  0.5103
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## IRRITABILITY OD
res18 = lmer(Irritability_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_
data)

# Irritability OD time comparison
Within_Timed<-emmeans(res18, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     0.173 0.446 12.9   -0.790     1.14 0.389   0.7038
##  Pre - Post    0.628 0.469 13.3   -0.382     1.64 1.341   0.2024
##  Mid - Post    0.455 0.449 12.3   -0.521     1.43 1.013   0.3304
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Irritability OD group comparison
Within_group<-emmeans(res18, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    0.632 0.663 5.98    -0.99     2.25 0.954  0.3770
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## ABERRANT MOTOR BEHAVIOUR OD
res20 = lmer(AMB_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

# Aberrant motor behaviour OD time comparison
Within_Timed<-emmeans(res20, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
```

```
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -0.794 0.605 12.7   -2.104    0.516 -1.313  0.2124
##  Pre - Post   -0.046 0.637 12.9   -1.423    1.331 -0.072  0.9435
##  Mid - Post    0.748 0.607 12.2   -0.572    2.068  1.232  0.2411
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Aberrant motor behaviour OD group comparison
Within_group<-emmeans(res20, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.449 1.12 6.02    -3.19     2.29 -0.400  0.7028
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## SLEEP OD
res22 = lmer(Sleep_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

# Sleep OD time comparison
Within_Timed<-emmeans(res22, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -1.503 0.584 12.9   -2.767    -0.24 -2.573  0.0233
##  Pre - Post   -0.121 0.615 13.2   -1.447     1.20 -0.197  0.8468
##  Mid - Post    1.382 0.589 12.3    0.103     2.66  2.349  0.0363
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Sleep OD group comparison
Within_group<-emmeans(res22, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    -1.08 0.902 5.99    -3.28     1.13 -1.192  0.2782
##
```

```
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## APPETITE OD
res24 = lmer(Appetite_OD ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data
)

# Appetite OD time comparison
Within_Timed<-emmeans(res24, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid    -0.957 0.277 10.1  -1.5730   -0.340 -3.452  0.0061
##  Pre - Post   -0.355 0.295 10.3  -1.0091    0.299 -1.205  0.2553
##  Mid - Post    0.602 0.277 10.2  -0.0143    1.218   2.171  0.0546
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Appetite OD group comparison
Within_group<-emmeans(res24, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    0.475 1.11 6.08    -2.23     3.18 0.428   0.6837
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

Appendix G: Discourse interview schedule results

```
## Discourse Interview Schedule Results

setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Discourse\
Interview/Discourse/")
library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)
BC_data <- read.csv("Discourse_Interview.csv", header=TRUE)
BC_data$Time <- factor(BC_data$Time, levels = c("Pre", "Mid", "Post"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))


## NARRATIVE
res2 = lmer(Narrative ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

# Narrative Discourse Task Time Comparison
Within_Timed<-emmeans(res2, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     0.452 1.010 15.3    -1.70    2.601   0.447  0.6611
##  Pre - Post   -0.889 0.967 15.0    -2.95    1.172  -0.919  0.3726
##  Mid - Post   -1.341 1.010 15.3    -3.49    0.809  -1.327  0.2040
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Narrative Discourse Task Group Comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    -1.29 1.42 6.05    -4.76     2.18  -0.907  0.3990
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## PROCEDURAL
res3 = lmer(Procedural ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

## boundary (singular) fit: see ?isSingular
```

```r
# Procedural Discourse Task Time Comparison
Within_Timed<-emmeans(res3, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate    SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     3.384 0.714 15.6    1.868     4.90   4.741  0.0002
##  Pre - Post    0.778 0.687 15.1   -0.685     2.24   1.133  0.2750
##  Mid - Post   -2.606 0.714 15.6   -4.122    -1.09  -3.651  0.0022
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Procedural Discourse Task Group Comparison
Within_group<-emmeans(res3, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     1.55 0.598 6.02   0.0838     3.01 2.585   0.0414
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## ABSTRACT
res4 = lmer(Abstract ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)

# Abstract Discourse Task Time Comparison
Within_Timed<-emmeans(res4, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs

##  contrast   estimate   SE   df lower.CL upper.CL t.ratio p.value
##  Pre - Mid     -1.10 1.74 15.3    -4.80     2.60 -0.634  0.5357
##  Pre - Post     4.89 1.67 15.0     1.34     8.44  2.936  0.0102
##  Mid - Post     5.99 1.74 15.3     2.29     9.69  3.444  0.0035
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Abstract Discourse Task Group Comparison
Within_group<-emmeans(res4, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
## contrast          estimate   SE   df lower.CL upper.CL t.ratio p.value
## (L->H) - (H->L)      0.892 2.45 6.05    -5.08     6.86 0.364   0.7279
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
## COMPOSITE DISCOURSE SCORE
res5 = lmer(Total ~ Group + Time + MMSE_Mean + (1|ID), data=BC_data)
```

```
# Composite Discourse Score Time Comparison
Within_Timed<-emmeans(res5, ~Time)
Timed_pairs <- contrast(Within_Timed, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Timed_pairs
```

```
## contrast   estimate   SE df lower.CL upper.CL t.ratio p.value
## Pre - Mid     4.444 2.34 16   -0.518     9.41 1.898   0.0758
## Pre - Post    4.778 2.34 16   -0.185     9.74 2.041   0.0581
## Mid - Post    0.333 2.34 16   -4.629     5.30 0.142   0.8886
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
# Composite Discourse Score Group Comparison
Within_group<-emmeans(res5, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
## contrast          estimate  SE df lower.CL upper.CL t.ratio p.value
## (L->H) - (H->L)     -0.267 3.6  6    -9.07     8.54 -0.074  0.9432
##
## Results are averaged over the levels of: Time
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

Appendix H: Facial movement as a measure of engagement results

H.1 Facial movement person-specific location results

```
# Facial Movement Person-Specific Analysis Output
setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Split\ Fram
es\ Analysis/R\ -\ Linear\ Mixed\ Effects\ Models/Person-Specific/OpenFace
")
library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)

BC_data <- read.csv("Open_Face_M_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("B", "LT", "HT"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))
BC_data$Location <- factor(BC_data$Location, levels = c("Baseline", "Meani
ngful"))

## AU04-Brow Lowerer PRESENCE
res2 = lmer(AU04_c ~ Group + Con + (1|ID), data=BC_data)

#Person-Specific AU04-Brow Lowerer presence conditon comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE    df lower.CL upper.CL t.ratio p.value
##  B - LT     0.1979 0.0623  99.5   0.0743  0.32158   3.176  0.0020
##  B - HT     0.0803 0.0628 100.0  -0.0444  0.20488   1.278  0.2043
##  LT - HT   -0.1177 0.0551 100.3  -0.2269 -0.00842  -2.137  0.0350
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Person-Specific AU04-Brow Lowerer presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate     SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0314 0.0692 6.99   -0.195    0.132  -0.454  0.6638
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```r
## AU04-Brow Lowerer INTENSITY
res3 = lmer(AU04_r ~ Con + Group + (1 + Con|ID), REML = TRUE, data = BC_da
ta)

#Person-Specific AU04-Brow Lowerer intensity conditon comparison
Within_cond<-emmeans(res2, ~Con)
pairs(Within_cond)

##  contrast estimate     SE   df t.ratio p.value
##  B - LT     0.1860 0.1481 8.00  1.256  0.4561
##  B - HT     0.1527 0.1711 7.99  0.892  0.6599
##  LT - HT   -0.0334 0.0662 7.88 -0.504  0.8714
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## P value adjustment: tukey method for comparing a family of 3 estimates

Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT     0.1860 0.1481 8.00   -0.155    0.528  1.256  0.2444
##  B - HT     0.1527 0.1711 7.99   -0.242    0.547  0.892  0.3984
##  LT - HT   -0.0334 0.0662 7.88   -0.186    0.120 -0.504  0.6279
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Person-Specific AU04-Brow Lowerer intensity group comparison
Within_group<-emmeans(res2, ~Group)
pairs(Within_group)

##  contrast        estimate    SE   df t.ratio p.value
##  (L->H) - (H->L)   -0.206 0.141 6.95 -1.463  0.1873
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger

Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.206 0.141 6.95   -0.541    0.128 -1.463  0.1873
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU06-Cheek Raiser PRESENCE
res2 = lmer(AU06_c ~ Group + Con + (1|ID), data=BC_data)
```

```r
#Person-Specific AU06-Cheek Raiser presence conditon comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.1853 0.0438 99.1  -0.2723  -0.0984 -4.228  0.0001
##  B - HT    -0.2037 0.0442 99.2  -0.2914  -0.1160 -4.608  <.0001
##  LT - HT   -0.0183 0.0388 99.3  -0.0953   0.0586 -0.473  0.6370
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Person-Specific AU06-Cheek Raiser presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0151 0.103  7   -0.259    0.229 -0.146  0.8879
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU06-Cheek Raiser INTENSITY
res2 = lmer(AU06_r ~ Group + Con + (1|ID), data=BC_data)

#Person-Specific AU06-Cheek Raiser intensity conditon comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.1134 0.0475 99.1   -0.208  -0.0191 -2.387  0.0189
##  B - HT    -0.1603 0.0479 99.2   -0.255  -0.0652 -3.346  0.0012
##  LT - HT   -0.0469 0.0420 99.3   -0.130   0.0365 -1.115  0.2673
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Person-Specific AU06-Cheek Raiser intensity group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
##  contrast         estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.064 0.115  7   -0.336    0.208 -0.556  0.5956
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU12-Lip Corner Puller PRESENCE
res2 = lmer(AU12_c ~ Group + Con + (1|ID), data=BC_data)

#Person-Specific AU12-Lip Corner Puller presence conditon comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.1724 0.0328 99.1  -0.2375  -0.1073 -5.258  <.0001
##  B - HT    -0.1942 0.0331 99.2  -0.2598  -0.1286 -5.875  <.0001
##  LT - HT   -0.0218 0.0290 99.3  -0.0793   0.0357 -0.752  0.4537
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Person-Specific AU12-Lip Corner Puller presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast         estimate     SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.135 0.0808  7   -0.326   0.0561 -1.671  0.1387
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU12-Lip Corner Puller INTENSITY
#Person-Specific AU12-Lip Corner Puller intensity conditon comparison
res2 = lmer(AU12_r ~ Group + Con + (1|ID), data=BC_data)
  Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT     -0.197 0.0380 99.1  -0.2721  -0.1214 -5.183  <.0001
##  B - HT     -0.160 0.0383 99.1  -0.2356  -0.0838 -4.173  0.0001
##  LT - HT     0.037 0.0336 99.2  -0.0296   0.1036  1.104  0.2725
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
#Person-Specific AU12-Lip Corner Puller intensity group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.273 0.12  7   -0.555   0.0103 -2.279  0.0567
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU15-Lip Corner Depressor PRESENCE
res2 = lmer(AU15_c ~ Group + Con + (1|ID), data=BC_data)

#Person-Specific AU15-Lip Corner Depressor presence conditon comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.0576 0.0234 99.1  -0.1040  -0.0112 -2.462  0.0155
##  B - HT    -0.0843 0.0236 99.2  -0.1312  -0.0375 -3.575  0.0005
##  LT - HT   -0.0267 0.0207 99.3  -0.0678   0.0143 -1.292  0.1992
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Person-Specific AU15-Lip Corner Depressor presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate     SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0369 0.0588  7   -0.176    0.102 -0.628  0.5502
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU15-Lip Corner Depressor INTENSITY
res2 = lmer(AU15_r ~ Group + Con + (1|ID), data=BC_data)

#Person-Specific AU15-Lip Corner Depressor intensity conditon comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs
```

```
##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT     -0.117 0.0506 99.1   -0.218  -0.0168 -2.316  0.0226
##  B - HT     -0.179 0.0511 99.2   -0.281  -0.0780 -3.512  0.0007
##  LT - HT    -0.062 0.0448 99.3   -0.151   0.0268 -1.385  0.1690
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
#Person-Specific AU15-Lip Corner Depressor intensity group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
##  contrast        estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0715 0.115  7   -0.343      0.2 -0.623  0.5529
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
## AU17-Chin Raiser PRESENCE
res2 = lmer(AU17_c ~ Group + Con + (1|ID), data=BC_data)
```

```
#Person-Specific AU17-Chin Raiser presence conditon comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs
```

```
##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT   -0.19418 0.0235 99.1  -0.2408  -0.1475 -8.259  <.0001
##  B - HT   -0.19932 0.0237 99.2  -0.2464  -0.1523 -8.408  <.0001
##  LT - HT  -0.00514 0.0208 99.3  -0.0464   0.0361 -0.247  0.8052
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
#Person-Specific AU17-Chin Raiser presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs
```

```
##  contrast        estimate     SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0355 0.0584  7   -0.174    0.103 -0.608  0.5621
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```r
## AU17-Chin Raiser INTENSITY
res2 = lmer(AU17_r ~ Group + Con + (1|ID), data=BC_data)

#Person-Specific AU17-Chin Raiser intesnity conditon comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.1607 0.0417 99.1   -0.243  -0.0781 -3.858  0.0002
##  B - HT    -0.1952 0.0420 99.2   -0.279  -0.1119 -4.647  <.0001
##  LT - HT   -0.0345 0.0368 99.2   -0.108   0.0386 -0.936  0.3518
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Person-Specific AU17-Chin Raiser intensity group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0314 0.114  7   -0.302    0.239 -0.274  0.7917
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

H.2 Facial movement non-specific location results

```r
# Facial Movement Non-Specific Analysis Output
setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Split\ Fram
es\ Analysis/R\ -\ Linear\ Mixed\ Effects\ Models/Non-Specific/OpenFace")
library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)

BC_data <- read.csv("Open_Face_UM_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("B", "LT", "HT"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))
BC_data$Location <- factor(BC_data$Location, levels = c("Baseline", "Unmea
ningful"))

## AU04-Brow Lowerer PRESENCE
res2 = lmer(AU04_c ~ Group + Con + (1|ID), data=BC_data)

#Non-Specific AU04-Brow Lowerer presence condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT      0.179 0.0594 99.3   0.0610   0.2967   3.011  0.0033
##  B - HT      0.031 0.0599 99.7  -0.0878   0.1498   0.518  0.6055
##  LT - HT    -0.148 0.0525 99.9  -0.2520  -0.0437  -2.816  0.0059
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU04-Brow Lowerer presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate     SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0608 0.0817  7   -0.254    0.132 -0.745  0.4808
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU04-Brow Lowerer INTENSITY
res3 = lmer(AU04_r ~ Con + Group + (1 + Con|ID), REML = TRUE, data = BC_da
ta)

## boundary (singular) fit: see ?isSingular
```

```r
#Non-Specific AU04-Brow Lowerer intensity condition comparison
Within_cond<-emmeans(res2, ~Con)
pairs(Within_cond)

##  contrast estimate     SE   df t.ratio p.value
##  B - LT     0.1510 0.1470 7.99  1.027  0.5816
##  B - HT     0.1049 0.1474 7.99  0.712  0.7636
##  LT - HT   -0.0461 0.0664 7.78 -0.695  0.7734
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## P value adjustment: tukey method for comparing a family of 3 estimates

Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT     0.1510 0.1470 7.99   -0.188    0.490  1.027  0.3343
##  B - HT     0.1049 0.1474 7.99   -0.235    0.445  0.712  0.4968
##  LT - HT   -0.0461 0.0664 7.78   -0.200    0.108 -0.695  0.5076
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU04-Brow Lowerer intensity group comparison
Within_group<-emmeans(res2, ~Group)
pairs(Within_group)

##  contrast        estimate    SE df t.ratio p.value
##  (L->H) - (H->L)   -0.323 0.184  7 -1.751  0.1234
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger

Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.323 0.184  7   -0.759    0.113 -1.751  0.1234
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU06-Cheek Raiser PRESENCE
res2 = lmer(AU06_c ~ Group + Con + (1|ID), data=BC_data)

#Non-Specific AU06-Cheek Raiser presence condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
```

```
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.1878 0.0441 99.1  -0.2752  -0.1003  -4.262  <.0001
##  B - HT    -0.1712 0.0444 99.2  -0.2594  -0.0831  -3.855  0.0002
##  LT - HT    0.0165 0.0390 99.2  -0.0608   0.0938   0.424  0.6723
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU06-Cheek Raiser presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast          estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0599 0.126  7   -0.357    0.237 -0.477  0.6478
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU06-Cheek Raiser INTENSITY
res2 = lmer(AU06_r ~ Group + Con + (1|ID), data=BC_data)

#Non-Specific AU06-Cheek Raiser intensity condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.0978 0.0435 99.1  -0.1842  -0.0114  -2.246  0.0269
##  B - HT    -0.1210 0.0439 99.1  -0.2081  -0.0339  -2.756  0.0070
##  LT - HT   -0.0232 0.0385 99.2  -0.0996   0.0532  -0.603  0.5480
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU06-Cheek Raiser intensity group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast          estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     -0.12 0.137  7   -0.444    0.204 -0.876  0.4102
##
## Results are averaged over the levels of: Con
```

```
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU12-Lip Corner Puller PRESENCE
res2 = lmer(AU12_c ~ Group + Con + (1|ID), data=BC_data)

#Non-Specific AU12-Lip Corner Puller presence condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT   -0.14399 0.0312 99.1  -0.2060  -0.0820 -4.609  <.0001
##  B - HT   -0.15207 0.0315 99.2  -0.2146  -0.0896 -4.828  <.0001
##  LT - HT  -0.00808 0.0276 99.3  -0.0629   0.0467 -0.292  0.7705
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU12-Lip Corner Puller presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate     SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.139 0.0701  7   -0.305   0.0265 -1.986  0.0873
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU12-Lip Corner Puller INTENSITY
#Non-Specific AU12-Lip Corner Puller intensity condition comparison
res2 = lmer(AU12_r ~ Group + Con + (1|ID), data=BC_data)
  Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.1418 0.0339 99.1  -0.2091  -0.0746 -4.186  0.0001
##  B - HT    -0.1152 0.0342 99.1  -0.1830  -0.0475 -3.373  0.0011
##  LT - HT    0.0266 0.0300 99.2  -0.0329   0.0860  0.887  0.3770
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU12-Lip Corner Puller intensity group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
```

```
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast         estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.262 0.106  7   -0.512  -0.0113 -2.471  0.0428
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU15-Lip Corner Depressor PRESENCE
res2 = lmer(AU15_c ~ Group + Con + (1|ID), data=BC_data)

#Non-Specific AU15-Lip Corner Depressor presence condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.0579 0.0241 99.3   -0.106  -0.0102 -2.407  0.0179
##  B - HT    -0.0857 0.0242 99.5   -0.134  -0.0376 -3.533  0.0006
##  LT - HT   -0.0278 0.0213 99.7   -0.070   0.0144 -1.307  0.1944
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU15-Lip Corner Depressor presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast         estimate     SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0587 0.0372  7   -0.147   0.0293 -1.578  0.1586
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU15-Lip Corner Depressor INTENSITY
res2 = lmer(AU15_r ~ Group + Con + (1|ID), data=BC_data)

#Non-Specific AU15-Lip Corner Depressor intensity condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.1536 0.0540 99.1   -0.261  -0.0465 -2.845  0.0054
##  B - HT    -0.1812 0.0544 99.2   -0.289  -0.0732 -3.330  0.0012
```

```
## LT - HT    -0.0277 0.0477 99.3   -0.122   0.0671 -0.579  0.5637
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU15-Lip Corner Depressor intensity group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

## contrast          estimate    SE df lower.CL upper.CL t.ratio p.value
## (L->H) - (H->L)    -0.126 0.125  7   -0.421    0.169 -1.009  0.3465
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU17-Chin Raiser PRESENCE
res2 = lmer(AU17_c ~ Group + Con + (1|ID), data=BC_data)

#Non-Specific AU17-Chin Raiser presence condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

## contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
## B - LT    -0.1739 0.0246 99.1  -0.2226  -0.1252 -7.081  <.0001
## B - HT    -0.1955 0.0248 99.3  -0.2446  -0.1464 -7.895  <.0001
## LT - HT   -0.0216 0.0217 99.4  -0.0647   0.0215 -0.994  0.3225
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU17-Chin Raiser presence group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

## contrast          estimate     SE df lower.CL upper.CL t.ratio p.value
## (L->H) - (H->L)   -0.0444 0.0531  7    -0.17   0.0811 -0.837  0.4304
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU17-Chin Raiser INTENSITY
res2 = lmer(AU17_r ~ Group + Con + (1|ID), data=BC_data)
```

```
#Non-Specific AU17-Chin Raiser intesnity condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE   df lower.CL upper.CL t.ratio p.value
##  B - LT   -0.14933 0.0398 99.1  -0.2284  -0.0703 -3.747  0.0003
##  B - HT   -0.15116 0.0402 99.2  -0.2309  -0.0714 -3.762  0.0003
##  LT - HT  -0.00183 0.0352 99.3  -0.0717   0.0681 -0.052  0.9587
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Non-Specific AU17-Chin Raiser intensity group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate     SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)  -0.0115 0.0959  7   -0.238    0.215 -0.120  0.9080
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

H.3 Facial movement non-specific compared to person-specific location results

```
# Facial movement non-specific compared to person-specific location Analys
is Output

setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Split\ Fram
es\ Analysis/R\ -\ Linear\ Mixed\ Effects\ Models/PSvsNS/OpenFace")

library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)
BC_data <- read.csv("Open_Face_PSvsNS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("LT", "HT"))
BC_data$Location <- factor(BC_data$Location, levels = c("NS", "PS"))

## AU04-Brow Lowerer PRESENCE
# AU04-Brow Lowerer presence location comparison
res2 = lmer(AU04_c ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS    0.0313 0.0355 157  -0.0387    0.101 0.883   0.3788
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU04-Brow Lowerer INTENSITY
# AU04-Brow Lowerer intensity location comparison
res2 = lmer(AU04_r ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS    0.0401 0.0437 157  -0.0463    0.126 0.917   0.3606
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```r
## AU06-Cheek Raiser PRESENCE
# AU06-Cheek Raiser presence location comparison
res2 = lmer(AU06_c ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS   -0.0163 0.0292 157   -0.074   0.0414 -0.557  0.5782
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU06-Cheek Raiser INTENSITY
# AU06-Cheek Raiser intensity location comparison
res2 = lmer(AU06_r ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS   -0.0299 0.0273 157  -0.0839    0.024 -1.097  0.2741
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU12-Lip Corner Puller PRESENCE
# AU12-Lip Corner Puller presence location comparison
res2 = lmer(AU12_c ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate    SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS    -0.033 0.021 157  -0.0744  0.00843 -1.573  0.1177
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU12-Lip Corner Puller INTENSITY
# AU12-Lip Corner Puller intensity location comparison
res2 = lmer(AU12_r ~ Location + Con + (1|ID), data=BC_data)
```

```
Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS   -0.0504 0.0223 157  -0.0945 -0.00629 -2.257  0.0254
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU15-Lip Corner Depressor PRESENCE
# AU15-Lip Corner Depressor presence location comparison
res2 = lmer(AU15_c ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate    SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS  -0.00402 0.014 157  -0.0317   0.0237 -0.287  0.7746
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU15-Lip Corner Depressor INTENSITY
# AU15-Lip Corner Depressor intensity location comparison
res3 = lmer(AU15_r ~ Con + Location + (1 + Con|ID), REML = TRUE, data = BC
_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS    0.0147 0.0334 149  -0.0513   0.0808 0.441   0.6601
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU17-Chin Raiser PRESENCE
# AU17-Chin Raiser presence location comparison
res2 = lmer(AU17_c ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
```

```r
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS   -0.0141 0.0145 157  -0.0427   0.0144 -0.977  0.3298
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AU17-Chin Raiser INTENSITY
# AU17-Chin Raiser intensity location comparison
res2 = lmer(AU17_r~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS   -0.0316 0.0268 157  -0.0845   0.0214 -1.178  0.2408
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

Appendix I: Lexical use as a measure of engagement results

I.1 Lexical use when viewing person-specific locations results

```
# Lexical use person-specific Analysis Output

setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Split\ Fram
es\ Analysis/R\ -\ Linear\ Mixed\ Effects\ Models/Person-Specific/LIWC")

library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)
BC_data <- read.csv("LIWC_PS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("B", "LT", "HT"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))
BC_data$Location <- factor(BC_data$Location, levels = c("Baseline", "Perso
n-Specific"))

## PRONOUNS WORDS
res3 = lmer(ppron ~ Con + Group + (1 + Con|ID), REML = TRUE, data = BC_dat
a)

# Percentage of pronoun use viewing person-specific location condition com
parison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate    SE   df lower.CL upper.CL t.ratio p.value
##  B - LT     4.5308 1.249 8.00     1.65     7.41   3.628  0.0067
##  B - HT     4.5000 0.931 7.98     2.35     6.65   4.835  0.0013
##  LT - HT   -0.0307 0.708 7.94    -1.66     1.60  -0.043  0.9664
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Percentage of pronoun use viewing person-specific location group compari
son
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast         estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    -0.789 1.68 6.88    -4.77     3.19  -0.470  0.6526
##
## Results are averaged over the levels of: Con
```

```
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AFFECTIVE WORDS
res2 = lmer(affect ~ Group + Con + (1|ID), data=BC_data)

# Percentage of affective word use viewing person-specific location condit
ion comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate    SE   df lower.CL upper.CL t.ratio p.value
##  B - LT      0.585 0.309 99.0  -0.0285    1.198   1.892  0.0614
##  B - HT      0.571 0.312 99.1  -0.0476    1.189   1.831  0.0701
##  LT - HT    -0.014 0.273 99.2  -0.5562    0.528  -0.051  0.9592
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Percentage of affective word use viewing person-specific location group
comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     1.03 1.04  7    -1.43      3.5 0.993   0.3539
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## EMOTIONAL TONE
res2 = lmer(Tone ~ Group + Con + (1|ID), data=BC_data)

#Emotional tone of language viewing person-specific location condition com
parison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate   SE   df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.7794 5.00 99.1   -10.71     9.15 -0.156  0.8766
##  B - HT    -0.0594 5.05 99.3   -10.07     9.95 -0.012  0.9906
##  LT - HT    0.7199 4.42 99.4    -8.06     9.50  0.163  0.8711
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```r
#Emotional tone of language viewing person-specific location group compari
son
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     6.71 10.7  7    -18.6     32.1 0.626   0.5512
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

I.2 Lexical use when viewing non-specific locations results

```
# Lexical use non-specific Analysis Output

setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Split\ Fram
es\ Analysis/R\ -\ Linear\ Mixed\ Effects\ Models/Non-Specific/LIWC")

library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)
BC_data <- read.csv("LIWC_NS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("B", "LT", "HT"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))
BC_data$Location <- factor(BC_data$Location, levels = c("Baseline", "Non-S
pecific"))

## PRONOUNS WORDS
res2 = lmer(ppron ~ Group + Con + (1|ID), data=BC_data)

# Percentage of pronoun use viewing non-specific location condition compar
ison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate    SE   df lower.CL upper.CL t.ratio p.value
##  B - LT      7.538 0.905 99.2     5.74     9.33  8.328  <.0001
##  B - HT      7.062 0.913 99.3     5.25     8.87  7.739  <.0001
##  LT - HT    -0.476 0.800 99.4    -2.06     1.11 -0.595  0.5533
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Percentage of pronoun use viewing non-specific location group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)   -0.791 1.78  7       -5     3.41 -0.445  0.6698
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AFFECTIVE WORDS
res2 = lmer(affect ~ Group + Con + (1|ID), data=BC_data)
```

```
# Percentage of affective word use viewing non-specific location condition
comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate    SE    df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.0761 0.659  99.4   -1.383     1.23 -0.116  0.9082
##  B - HT     0.1559 0.664  99.7   -1.161     1.47  0.235  0.8148
##  LT - HT    0.2320 0.582 100.0   -0.923     1.39  0.399  0.6910
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Percentage of affective word use viewing non-specific location group com
parison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)      0.1 0.862  7    -1.94     2.14 0.116   0.9109
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## EMOTIONAL TONE
res2 = lmer(Tone ~ Group + Con + (1|ID), data=BC_data)

#Emotional tone of language viewing non-specific location condition compar
ison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate   SE    df lower.CL upper.CL t.ratio p.value
##  B - LT      -6.81 6.63  99.4    -20.0     6.35 -1.026  0.3072
##  B - HT     -11.83 6.69  99.8    -25.1     1.43 -1.770  0.0798
##  LT - HT     -5.03 5.86 100.0    -16.7     6.60 -0.857  0.3932
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Emotional tone of language viewing non-specific location group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
```

```
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     4.28 8.64  7    -16.1     24.7 0.495   0.6355
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

I.3 Lexical use when viewing non-specific compared to person-specific locations results

```
# Lexical use non-specific compared top person-specific Analysis Output

setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Split\ Fram
es\ Analysis/R\ -\ Linear\ Mixed\ Effects\ Models/PSvsNS/LIWC")

library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)
BC_data <- read.csv("LIWC_PSvsNS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("LT", "HT"))
BC_data$Location <- factor(BC_data$Location, levels = c("NS", "PS"))

## PERSONAL PRONOUNS
# Percentage of personal pronoun use when viewing non-specific compared to
person-specific locations
res2 = lmer(ppron ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate    SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS     -2.72 0.481 157    -3.67    -1.77 -5.658  <.0001
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## AFFECT
# Percentage of affective word use when viewing non-specific compared to p
erson-specific locations
res2 = lmer(affect ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate    SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS     0.558 0.366 157   -0.166     1.28 1.523   0.1298
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
## EMOTIONAL TONE
# Emotional tone of language when viewing non-specific comapred to person-
specific locations
res2 = lmer(Tone ~ Location + Con + (1|ID), data=BC_data)
Within_Location<-emmeans(res2, ~Location)

Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate   SE  df lower.CL upper.CL t.ratio p.value
##  NS - PS      9.81 3.99 157     1.94     17.7 2.462   0.0149
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

Appendix J: Prosodic patterns of speech as a measure of engagement results

J.1 Prosodic patterns of speech when viewing non-specific locations results

```
# Prosodic patterns person-specific Analysis Output

setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Split\ Fram
es\ Analysis/R\ -\ Linear\ Mixed\ Effects\ Models/Person-Specific/Prosodic
")

library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)

BC_data <- read.csv("Utterances_PS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("B", "LT", "HT"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))
BC_data$Location <- factor(BC_data$Location, levels = c("Baseline", "Perso
n-Specific"))

## DURATION OF UTTERANCE
res2 = lmer(mean_no_wd_per_utt ~ Group + Con + (1|ID), data=BC_data)

# Duration of utterance when viewing person-specific locations condition c
omparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate    SE  df lower.CL upper.CL t.ratio p.value
##  B - LT       7.32 1.134 131     5.08     9.56   6.455 <.0001
##  B - HT       7.00 1.086 130     4.85     9.15   6.446 <.0001
##  LT - HT     -0.32 0.977 130    -2.25     1.61  -0.328 0.7438
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Duration of utterance when viewing person-specific locations group compa
rison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)      1.1 1.17 6.77    -1.68     3.89 0.943   0.3780
```

```
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## WORDS PER UTTERANCE
res2 = lmer(sp_rate ~ Group + Con + (1|ID), data=BC_data)

#Words per utterance when viewing person-specific locations condition comp
arison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.0463 0.0826 129   -0.210   0.1172 -0.560  0.5764
##  B - HT    -0.1013 0.0791 128   -0.258   0.0551 -1.281  0.2025
##  LT - HT   -0.0550 0.0712 128   -0.196   0.0858 -0.773  0.4411
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Words per utterance when viewing person-specific locations group comparis
on
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    0.171 0.209 6.97   -0.325    0.667 0.817   0.4409
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## ARTICULATION RATE
res2 = lmer(sp_rate ~ Group + Con + (1|ID), data=BC_data)

#Articulation rate viewing person-specific locations condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.0463 0.0826 129   -0.210   0.1172 -0.560  0.5764
##  B - HT    -0.1013 0.0791 128   -0.258   0.0551 -1.281  0.2025
##  LT - HT   -0.0550 0.0712 128   -0.196   0.0858 -0.773  0.4411
##
## Results are averaged over the levels of: Group
```

```
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Articulation rate viewing person-specific locations group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast          estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     0.171 0.209 6.97   -0.325    0.667 0.817   0.4409
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95


## FUNDAMENTAL FREQUENCY
BC_data <- read.csv("Pitch_PS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("B", "LT", "HT"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))
BC_data$Location <- factor(BC_data$Location, levels = c("Baseline", "Perso
n-Specific"))

res3 = lmer(f0_sd ~ Con + Group + (1 + Con|ID), REML = TRUE, data = BC_dat
a)

## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$check
Conv, :
## Model failed to converge with max grad  = 0.00239765 (tol = 0.002, comp
onent 1)

emm_options(pbkrtest.limit = 6657)

#Fundamental frequency when viewing person-specific locations condition co
mparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate    SE   df lower.CL upper.CL t.ratio p.value
##  B - LT     0.3390 2.222 7.93    -4.79     5.47 0.153   0.8825
##  B - HT     0.4338 2.475 7.96    -5.28     6.15 0.175   0.8653
##  LT - HT    0.0948 0.864 7.77    -1.91     2.10 0.110   0.9154
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Fundamental frequency when viewing person-specific locations group compar
ison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
```

```
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast          estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)       1.47 8.13 6.99    -17.8     20.7 0.181   0.8613
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

J.2 Prosodic patterns of speech when viewing person-specific locations results

```
# Prosodic patterns person-specific Analysis Output

setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Split\ Fram
es\ Analysis/R\ -\ Linear\ Mixed\ Effects\ Models/Non-Specific/Prosodic")

library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)

BC_data <- read.csv("Utterances_NS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("B", "LT", "HT"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))
BC_data$Location <- factor(BC_data$Location, levels = c("Baseline", "Non-S
pecific"))

## DURATION OF UTTERANCE
res2 = lmer(mean_no_wd_per_utt ~ Group + Con + (1|ID), data=BC_data)

# Duration of utterance when viewing non-specific locations condition comp
arison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate   SE  df lower.CL upper.CL t.ratio p.value
##  B - LT      8.428 1.27 111     5.92    10.94   6.656 <.0001
##  B - HT      8.096 1.33 113     5.46    10.73   6.092 <.0001
##  LT - HT    -0.332 1.22 111    -2.75     2.09  -0.272 0.7863
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

# Duration of utterance when viewing non-specific locations group comparis
on
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast         estimate   SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)      1.42 1.09 6.76    -1.16     4.01 1.310   0.2329
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```
## WORDS PER UTTERANCE
res2 = lmer(sp_rate ~ Group + Con + (1|ID), data=BC_data)

#Words per utterance when viewing non-specific locations condition compari
son
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate    SE  df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.0359 0.151 108   -0.335    0.264 -0.238  0.8125
##  B - HT    -0.1906 0.159 108   -0.505    0.124 -1.200  0.2327
##  LT - HT   -0.1547 0.146 107   -0.444    0.134 -1.061  0.2911
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Words per utterance when viewing non-specific locations group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    0.504 0.252 6.96  -0.0921      1.1 2.002   0.0856
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## ARTICULATION RATE
res2 = lmer(sp_rate ~ Group + Con + (1|ID), data=BC_data)

#Articulation rate viewing non-specific locations condition comparison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate    SE  df lower.CL upper.CL t.ratio p.value
##  B - LT    -0.0359 0.151 108   -0.335    0.264 -0.238  0.8125
##  B - HT    -0.1906 0.159 108   -0.505    0.124 -1.200  0.2327
##  LT - HT   -0.1547 0.146 107   -0.444    0.134 -1.061  0.2911
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Articulation rate viewing non-specific locations group comparison
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
```

```
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate    SE   df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)    0.504 0.252 6.96  -0.0921      1.1 2.002   0.0856
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95


## FUNDAMENTAL FREQUENCY
BC_data <- read.csv("Pitch_NS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("B", "LT", "HT"))
BC_data$Group <- factor(BC_data$Group, levels = c("L->H", "H->L"))
BC_data$Location <- factor(BC_data$Location, levels = c("Baseline", "Non-S
pecific"))

res3 = lmer(f0_sd ~ Con + Group + (1 + Con|ID), REML = TRUE, data = BC_dat
a)
emm_options(pbkrtest.limit = 6657)

#Fundamental frequency when viewing non-specific locations condition compa
rison
Within_cond<-emmeans(res2, ~Con)
Cond_pairs <- contrast(Within_cond, method="pairwise", adjust="none") %>%
  summary(infer=c(TRUE, TRUE))
Cond_pairs

##  contrast estimate   SE   df lower.CL upper.CL t.ratio p.value
##  B - LT     -0.585 2.20 7.90    -5.67     4.50 -0.266  0.7970
##  B - HT      1.517 2.89 7.94    -5.15     8.18  0.526  0.6134
##  LT - HT     2.102 1.45 7.29    -1.29     5.50  1.453  0.1880
##
## Results are averaged over the levels of: Group
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

#Fundamental frequency when viewing non-specific locations group compariso
n
Within_group<-emmeans(res2, ~Group)
Group_pairs <- contrast(Within_group, method="pairwise", adjust="none") %>
%
  summary(infer=c(TRUE, TRUE))
Group_pairs

##  contrast        estimate   SE df lower.CL upper.CL t.ratio p.value
##  (L->H) - (H->L)     1.74 8.11  7    -17.4     20.9 0.214   0.8364
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

J.3 Prosodic patterns of speech when viewing non-specific compared to person-specific locations results

```
#Prosodic patterns of speech when viewing non-specific locations compared
to person-specific locations
setwd("/Users/madeleineradnan/Documents/Baptist\ Care/Analysis/Split\ Fram
es\ Analysis/R\ -\ Linear\ Mixed\ Effects\ Models/PSvsNS/Prosodic")

library(lme4)

## Loading required package: Matrix

library(emmeans)
library(doBy)

BC_data <- read.csv("Utterances_PSvsNS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("LT", "HT"))
BC_data$Location <- factor(BC_data$Location, levels = c("PS", "NS"))

## DURATION OF UTTERANCE
# Duration of utterance when viewing non-specific compared to person-speci
fic locations
res2 = lmer(mean_dur_utt ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  PS - NS     0.315 0.0835 179     0.15    0.479 3.768   0.0002
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## MEAN WORDS PER UTTERANCE
# Mean words per utterance when viewing non-specific compared to person-sp
ecific locations
res2 = lmer(mean_no_wd_per_utt ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate    SE  df lower.CL upper.CL t.ratio p.value
##  PS - NS     0.968 0.196 179    0.582     1.35 4.946   <.0001
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```

```r
## ARTICULATION RATE
# Articulation rate when viewing non-specific compared to person-specific
locations
res2 = lmer(sp_rate ~ Location + Con + (1|ID), data=BC_data)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate     SE  df lower.CL upper.CL t.ratio p.value
##  PS - NS   -0.0164 0.0844 179   -0.183     0.15 -0.194  0.8461
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95

## FUNDAMENTAL FREQUENCY

BC_data <- read.csv("Pitch_PSvsNS_All.csv", header=TRUE)
BC_data$Con <- factor(BC_data$Con, levels = c("LT", "HT"))
BC_data$Location <- factor(BC_data$Location, levels = c("PS", "NS"))


# Fundamental frequency when viewing non-specific compared to person-speci
fic locations
res3 = lmer(f0_sd ~ Con + Location + (1 + Con|ID), REML = TRUE, data = BC_
data)
emm_options(pbkrtest.limit = 6302)

Within_Location<-emmeans(res2, ~Location)
Location_pairs <- contrast(Within_Location, method="pairwise", adjust="non
e") %>%
  summary(infer=c(TRUE, TRUE))
Location_pairs

##  contrast estimate   SE   df lower.CL upper.CL t.ratio p.value
##  PS - NS    -0.137 0.52 6276    -1.16    0.882 -0.264  0.7920
##
## Results are averaged over the levels of: Con
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
```