

Implicit Theory domains of Technology Ability and Health related to People with
Parkinson's Engaging with a Speech Therapy Smartphone Application

by

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ABSTRACT

Impaired speech has been reported in studies by between 70% (Hartelius & Svensson, 1994) and 80% (Schulz, 2002) of people with Parkinson's. A speech therapy tool was developed, as part of a smartphone application (SAP) project supported by Parkinson's UK, aiming to help encourage improved speech. A concern for the SAP project was potential barriers to usage within this cohort, including: negative stereotypes (Mitzner et al., 2010), anxiety (Hogan, 2006), and relatively poor uptake (Pew Research Center, 2014), regarding technology; and no interest, poor health, depression, and low outcomes expectation (Forkan, Pumper, Smyth, Wirkkala, Ciol, & Shumway-Cook, 2006).

Anticipating these barriers, the Parkinson's Implicit Theory (PIT) research reported here aimed to investigate the application of Dweck and Leggett's (1988) Implicit Theory model to people with Parkinson's. This model specifies that holding an entity or an incremental theory of abilities predisposes individuals to performance or learning goals which, depending on perceived skill level, can result in stronger (mastery-oriented) or weaker (helpless) behaviour patterns. The PIT research opportunistically used development and testing stages of the SAP project as occasions to investigate Implicit Theory in people with Parkinson's. The main aims were to explore whether measured Implicit Theories of vocal and technical abilities would relate to behaviours using the SAP project's application, and whether priming-like manipulations (e.g. Bargh, Chen and Burrows, 1996) of Implicit Theories could be used to improve people with Parkinson's engagement with a technology-supported vocal therapy. Studies 1a (n = 16) and 1b (n = 22) developed initial Implicit Theory measures and manipulations, and investigated responses to these and subsequent technology-task behaviours using student participants. Studies 2a (conducted in a clinical setting, n = 12) and 2b (conducted in participants' homes, n = 10) further developed the Implicit Theory manipulations of technology and

vocal ability. In study 3 (n = 33, conducted in participants' homes) the PIT research used the two week user-testing of the SAP project's application to conduct a longitudinal investigation of behaviours related to Implicit Theories. A manipulation of Implicit Theory of technology ability was used, and Implicit Theories of technology ability and vocal issues were measured. Across all studies differences of measured Implicit Theories failed to reach significance between conditions, but in all five studies the measured Implicit Theories were in the direction expected based on the manipulations that had been presented. In a Thematic Analysis of participants' user-testing dialogue (from Studies 2a and 2b), themes emerged which were consistent with the manipulations received. No significant differences in behaviour were found between Implicit Theory conditions in the longitudinal Study 3, but are explained by low statistical power. The value and trade-offs of conducting opportunistic research alongside existing projects are discussed. Results are considered in terms of the potential implications for people with Parkinson's.

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ABBREVIATIONS

CPAG	Canada's Physical Activity Guide
DV	Dependent Variable
IV	.....	Independent Variable
LSVT	.....	Lee Silverman Voice Treatment
PIT	.....	Parkinson's Implicit Theory
Ps	.....	Participants
PUK	.....	Parkinson's UK
RA	.....	Research Assistant
SAP	.....	Smartphone APplication

DECLARATION

Whilst registered as a candidate for the above degree, I have not been registered for any other research award. The results and conclusions embodied in this thesis are the work of the named candidate and have not been submitted for any other academic award.

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DISSEMINATION

- Nolan, P.M.J., Eglin, R.C., Johnson, J., Powell, V., Chaudhuri, K.R. Testing the suitability of mobile technology in encouraging louder speech in Parkinsons' patients with dysarthria / speech impairments. In: Mental Dysfunction & Other Non-Motor Features in Parkinson's Disease and Related Disorders - 8th International Congress, 3rd – 6th May 2012, Berlin, Germany.
- Nolan, P. M. J., & Eglin, R.C. (2011). *Does experience interact with effectiveness of manipulations of Implicit Theories of Intelligence?* In: British Psychological Society - Psychology of Education Conference, 18th - 20th November 2011, Preston, UK.
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CHAPTER 1. INTRODUCTION

1.1 Parkinson's and Parkinsonian Speech

Parkinson's affects between one and two percent of people age 60 and over, with a mean onset of approximately 60 years (Marsden, 1994a; Samii, Nutt & Ransom, 2004). Parkinson's is explained by Parkinson's UK (PUK, "What is Parkinson's?," n.d.) as a progressive neurological condition, characterised by a lack of dopamine due to the death of particular nerve cells. The three main symptoms of Parkinson's are listed by PUK as tremor (Vaillancourt & Newell, 2000), slowness of movement (Marsden, 1989) and rigidity (Berardelli, Sabra, Hallett, 1983). A list of physical and other symptoms of Parkinson's includes: bladder and bowel problems; eye problems; falls and dizziness; fatigue; freezing; pain; restless legs syndrome; skin and sweating problems; sleep problems; speech and communication problems; and swallowing problems. Finally, PUK also lists mental health issues: anxiety; dementia; depression; hallucinations and delusions; and memory problems. Not all people with Parkinson's experience all of these groups of symptoms. When discussing people with idiopathic Parkinson's, Hoehn and Yahr (1967) reported tremor as being the most common initial symptom, found in 129 of 183 cases investigated. The next most common initial symptom was gait disturbance, found in 21 of 183 cases. Hoehn and Yahr also proposed a five-stage scale based on level of clinical disability, ranging from 'unilateral involvement only, usually with minimal or no functional impairment' (stage I), to 'confinement to bed or wheelchair unless aided' (stage V). They describe a wide variation between people with Parkinson's in the duration spent at each stage. The merits of the Hoehn-Yahr Scale, and alterations to it, have been discussed (Goetz et al. 2004), but it describes adequately how Parkinson's is progressive and contains a large degree of variability between

occurrences. This heterogeneity of people with Parkinson's has been noted as being particularly prominent in the earlier stages of Parkinson's (Lewis et al. 2004).

1.1.1 Parkinson's Speech Impairments

Given the variability across occurrences of Parkinson's, adequate ability to communicate these varied symptoms, and ability to request appropriate support becomes important; from carers, health professionals or others. However communication is perceived to worsen following onset (Miller, Noble, Jones, Allcock, & Burn, 2008). Hoehn and Yahr (1967) reported 'speech disturbance' as occurring as an initial symptom in seven of 183 cases of idiopathic Parkinson's. This figure represents a snapshot of early-stage symptoms, yet seems low in comparison to more current studies not focussed specifically on initial symptoms. More recently, impaired speech has been reported in studies by between 70% (Hartelius & Svensson, 1994; Logeman, Fisher, Boshes, & Blonsky, 1978) and 80% (Schulz, 2002) of people with Parkinson's. Within this category of speech and communication problems, PUK advise that not everyone has the same symptoms, and the list of issues includes: slurred speech; a monotonous voice; a hoarse or unsteady voice; and reduced facial expressions. A lot of these characteristics may occur as a result of dysarthria, which are speech problems resulting from issues with the muscles that generate speech. Hypokinetic dysarthria is the specific form of speech impairment resulting from Parkinson's, which progressively worsens over time (Enderby, Pickstone, John, Fryer, Cantrell & Papaioannou, 2009). Hypokinetic here refers to a lack of physical movement of the vocal muscles. The most common symptom of hypokinetic dysarthria is hypophonia, which is characterised by quiet or soft speech. An issue with impaired speech in Parkinson's is lack of awareness that speech might be being produced at too low a volume. When initiating speech, implicit and explicit cues should indicate appropriate volume. The Lombard effect (Lombard, 1911) describes an automatic process where speech volume increases in competition with increased

background noise. For example, when in a noisy environment people generally raise their voices automatically to match the circumstance, and to be heard. Deficits are shown by people with Parkinson's, with impaired speech, in incorporating implicit cues to automatically regulate speech volume. For example, using hypophonic subjects with Parkinson's, Ho, Bradshaw, Ianssek, and Alfredson (1999) found 'over-constancy' of speech volume, and failure to respond to implicit cues. However, it was also found possible for people with Parkinson's to regulate speech volume when provided with explicit volume instructions. This main effect of instruction-type suggested the ability to speak with an elevated volume so long as conscious attention is paid to speaking loudly. As a person with Parkinson's experiences different stages and symptoms of the illness, being able to communicate is of huge importance. Effective communication with health professionals means they are more likely to receive appropriate care in a timely manner, but also on a day-to-day basis being able to communicate with carers, friends and family enables access to emotional and social support (Kaplan, Cassel, & Gore, 1977). Any opportunity to enhance or maintain communicative abilities affected by Parkinson's could have positive effect on the experience of Parkinson's.

1.1.2 Current Speech Therapy Treatments

Several review papers have looked at the benefits of physical therapy (Keus, Bloem, Hendriks, Bredero-Cohen, & Munneke, 2007; Tomlinson et al. 2014) and physical exercise (Crizzle & Newhouse, 2006; Goodwin, Richards, Taylor, Taylor, & Campbell, 2008) for people with Parkinson's. Cognitive training has also been investigated for its role for managing cognitive function in Parkinson's (París et al. 2011). It is suggested by París et al. (2011) that cognitive training "may activate mechanisms of cerebral plasticity and slow down the progression of cognitive manifestations of the disease". Similarly, Glendinning (1997) discusses a potential trade-off between strength training and the requirement for medication in the early stages of

Parkinson's, increased physical training potentially reducing medication needs. Overall, evidence points to a wide variety of therapies and activities being of potential benefit to people with Parkinson's.

Up to 20% of people with Parkinsonian receive referrals for speech and language therapy aimed at improving their intelligibility (Yarrow, 1999). From this, a gap exists between the number of people with Parkinson's suffering voice problems (approximately 70-80%, Section 1.1.1), and the number reaching therapy. A key implementation priority highlighted by the National Institute for Health and Clinical Excellence [NICE] (2006, p7) for Parkinson's, is access to speech and language therapy. Specific needs highlighted were: improving vocal loudness and pitch range; strategies for speech intelligibility; and maintaining an effective means of communication. Unfortunately, "the effect of most PD treatments on dysarthria remains unsatisfactory" (Pinto et al., 2004, p.553).

The speech therapy programme with the greatest efficacy-data is Lee Silverman Voice Treatment (LSVT), developed specifically for people with Parkinson's. This is an intensive, high-effort treatment (Ramig, Countryman, Thompson, & Horii, 1995), shown to increase speech volume from baseline to six-month follow-up by 6dB (Ramig, Sapir, Fox, & Countryman, 2001). Increasing speech-volume improves intelligibility beyond that of mechanical-amplification, but is limited both by clinicians' finite time and because improvements during a visit with a clinician may not be sustained in everyday life. Advantages of LSVT highlighted by a report published by the National Collaborating Centre for Chronic Conditions (2006) are: its intensive nature helps people with Parkinson's recognise their voice needs strengthening; that they can achieve a louder voice; and LSVT helps people with Parkinson's become comfortable using a louder voice. The report states LSVT is not widely available yet in England and Wales. Major reasons for this are financial: the need for more speech and language therapists (S<s); and cost of training required in becoming an LSVT certified practitioner.

Provision of LSVT within the UK National Health Service remains limited due to time-demands and these associated costs. Contact-time (treatment involving 16 one-hour sessions over four weeks) provides LSVT's intensity, central to its efficacy. It has been suggested that the intensive format makes the treatment consistent with the aspects of other therapies that invoke neuroplasticity (Fox, Ebersbach, Ramig, & Sapir, 2012). Outcomes of tasks used in an LSVT efficacy study (Ramig et al., 2001) suggested significantly greater sound pressure levels (SPLs) were produced by participants receiving LSVT over controls for two less complex speech tasks (sustained vowel sounds and reading passages). This difference was not found for two more complex tasks (describing pictures and speaking freely on chosen topics), at both post-treatment and follow-up. The more complex tasks required self-generated speech. Generative speech is vital to communication (Hough, 2004), and thus should be central to any efforts to improve speech.

An extended LSVT version (LSVT-X) was compared with previous results (Spielman, Ramig, Mahler, Halpern, & Gavin, 2007). The structure of LSVT-X is similar; 16 hours of speech and language therapy contact being spread over eight weeks instead of four. Average SPLs recorded for LSVT-X were greater than for LSVT on all four tasks, at both post-treatment and follow-up. Importantly for generative speech (the more complex task), results for the task describing images were significantly greater at both measurements, and for speaking freely on chosen topics, approaching significance at post-treatment measure (taken immediately after therapy). This indicates intensive treatments spread over a longer duration can be of greater efficacy for improving speech. This longer duration however extends the period of treatments scheduled both to the speech therapist and to the person with Parkinson's.

1.1.3 Parkinson's Symptoms Related to Treatment Adherence

Forkan et al. (2006) investigated poor exercise adherence in older adults discharged from physical therapy with a home exercise program. They found eight barriers to participation including: no interest; poor health; depression; and low outcomes expectation. The importance of adherence to efficacy of exercise training programs for people with Parkinson's has been highlighted (Allen et al. 2012; Tomlinson et al. 2014) along with issues of pharmacological therapy adherence (Grosset & European PD Therapy Compliance Study Group, 2010). Without knowledge about adherence, it makes it very difficult for therapists to correctly weigh up the merits of different programs.

Barriers such as those highlighted by Forkan et al. (2006) for older adults are similarly relevant for people with Parkinson's, and often more pronounced, where 'complex interacting issues' need to be considered (O'Brien, Clemson, & Canning, 2015). The first of Forkan's factors listed, no interest, corresponds to apathy, which has a high prevalence in people with Parkinson's (Dujardin et al. 2007). Pluck and Brown (2002), investigating apathy in Parkinson's, found higher levels of apathy in Parkinson's patients when compared to similarly-disabled patients with osteoarthritis for example. The second barrier to adherence, poor health, is again particularly relevant for people with Parkinson's, who potentially have many varied symptoms of varying degrees of severity (Hoehn & Yahr, 1967). Variation also exists in terms of perceived control over these symptoms, perception of control being shown to be significantly associated with people with Parkinson's well-being (Walihagen & Brod, 1997). The third barrier, depression, also has a strong association with Parkinson's. Reijnders, Ehrt, Weber, Aarsland, and Leentjens (2008) reviewed articles suggesting depression has a range of prevalence from 2.7% to more than 90%, but they conclude that across studies prevalence of depression is substantial but lower than had been generally assumed.

Richard et al. (2007) recommend that, although frequent, depression should not be accepted as a normal symptom of Parkinson's. Also apathy is a common factor in depression, but was found to be an independent symptom among people with Parkinson's (Pluck & Brown, 2002). The fourth of eight barriers to adherence noted from Forkan et al. (2006), low outcomes expectations, is again salient for people with Parkinson's as it is a progressive neurological condition. Firstly, if a symptom being treated by a therapy is associated with Parkinson's, the expectation might be that the symptom will progress along with the condition. Secondly, Parkinson's has been found to be affected by nocebo effects (Benedetti, Lanotte, Lopiano, & Colloca, 2007), where expectation of negative outcomes leads to a symptom worsening. Conversely placebo effects have also been shown in people with Parkinson's (e.g. Espay et al. 2015), indicating that expectation of outcome could be very important in Parkinson's. These barriers to exercise adherence in older adults all hold relevance to people with Parkinson's, and so could be relevant when considering adherence to a Parkinson's speech therapy. Other symptoms of Parkinson's exist that could also be relevant for adherence to a therapy including: dementia (McKeith & Burn, 2000); fatigue (Karlsen, Larsen, Tandberg, & Jørgensen, 2009); anxiety (Walsh & Bennett, 2001); and pessimism (Gruber-Baldini, Ye, Anderson, & Shulman, 2009). These barriers and symptoms can be relevant because a therapy might be asking a person with Parkinson's to engage with a new or unfamiliar behaviour. As the research identified indicates, ideally a therapy is engaged with fully and with an expectation of improvement being possible. Any of the barriers and symptoms listed above could interrupt the possibility of this for people with Parkinson's. Engagement and motivation to pursue goals – or perusal of activities such as therapies – are fields that are the subject of psychology research. Considering psychology theory could provide a route for better understanding and supporting therapeutic engagement.

1.2 The Implicit Theory Model

1.2.1 Incremental and Entity Theories Linked to Behaviours

One psychological theory that has been extremely powerful in predicting human behaviour and behaviour change is Dweck and Leggett's (1988) model, Implicit Theory of Intelligence, which suggests that we hold theories about our intelligence. These theories alter intelligence-related goals which then affect subsequent behaviours. The Implicit Theory model outlined two types of theories that people may hold: an entity theory where one believes intelligence to be fixed; and an incremental theory where one believes intelligence to be flexible. The model suggests that if an individual believes intelligence is flexible then subsequent goal orientation will be towards learning, leading to behaviours described as 'mastery'. Conversely, if an individual believes intelligence is fixed then subsequent goal orientation will be towards performance. With high perceived ability, performance goals can also lead towards mastery behaviours, but with low perceived ability performance goals can lead towards helpless behaviours. Features of helpless behaviour include avoidance of challenges and low persistence. If an individual believes intelligence is fixed and unchanging, and also perceives their intelligence is low, goals are likely to be related to wanting to gain positive judgements or, more likely, wanting to avoid negative judgements. With ability viewed as fixed, consequences of perceived poor ability are minimised by avoiding ability-relevant situations. Consequently, as soon as something intelligence-related becomes challenging or difficult, effort is likely to be minimal. Comparatively, if one believes intelligence is flexible, goals will be related to learning and wanting to increase understanding, regardless of self-perceived ability. The model outlines a pathway describing how beliefs affect goals, which affect behaviours, with an interaction caused by beliefs about ability.

Measures of students' Implicit Theories (of Intelligence) have been captured and shown to predict learning task choices. Dweck and Leggett (1988) describe a study where students can select between tasks: difficult enough to show they are smart (challenge-seeking performance-orientated); easy enough to get nothing wrong (challenge-avoiding performance-orientated); or difficult, new and different (learning-orientated). Most students with an incremental Implicit Theory (flexible) selected the learning-oriented task. Most students with an entity Implicit Theory (fixed) selected a performance-oriented task, with half selecting the challenge-avoiding version. This demonstrates a link between an individual's measured Implicit Theory and their subsequent behaviour in terms of task selection. With an incremental theory, students were more likely to select challenging, new material. In a related study (Licht & Dweck, 1984), students were identified as prone to mastery or helpless behaviours students were and subsequently randomly assigned to conditions where new learning material was presented via a booklet, either containing or not containing confusing material. Without confusing material, both mastery- and helpless-prone students were equally likely to perform well in tests of the booklet's contents (approximately 70%). With the confusing material, the proportion of mastery-prone students who performed well was similar to both groups not shown confusing material. With the confusing material, only 35% of helpless-prone students performed well. This shows a link between behaviour styles and Implicit Theories and subsequent learning outcomes. This highlights the importance between theories when individuals are faced with challenges, for example when learning new material. In Licht and Dweck's study, an additional complication was added artificially, however complications often occur naturally in day to day tasks. Presented with the difficult learning situation, mastery behaviour, associated with an incremental Implicit Theory, led to performance similar to if the difficulty was absent, perhaps indicating perseverance. Helpless behaviour, associated with an entity Implicit Theory,

led to lower performance levels. In one example, Hong et al. (1999) studied non-fluent English speakers entering a Hong Kong University, where exams are taken in English. Following 'unsatisfactory' feedback from an English exam, individuals varied in their interest in taking a remedial class depending on their type of Implicit Theory. With an entity Implicit Theory, a participant was significantly less likely to be interested in the remedial course. With exams being in English, at the start of their academic career, any decision not to avail of available resources to improve their chances could be described as self-sabotaging. Entering University is normally a change in life circumstance for most students, and entering one where an individual is non-fluent in the language used is especially difficult. Being informed your proficiency is unsatisfactory is likely a stressful situation. Differences in Implicit Theories seem to capture some of the variation in behaviours of the students responding to this stressful situation. Incremental theorists are more likely here to show the proactive behaviour of engaging with the support available.

1.2.2 Implicit Theory Manipulation

With an Incremental Theory, individuals have been shown to be more likely to volunteer for a challenging task, more likely to maintain performance in the presence of confusing material, and more likely to accept remedial help at a key life circumstance. Thus Implicit Theories of Intelligence could provide a route to understanding therapeutic engagement for Parkinson's patient. However, it is worthy of further exploration only if incremental Theories of Intelligence might be developed. If an individual does not have an incremental theory, is it possible to develop one? If an individual holds an entity theory, are they stuck attending to performance rather than being open to learning, are they going to underperform if things are difficult, and reject help when things are difficult? Bargh, Chen and Burrows (1996) primed student participants with words related to old age and then measured – compared to controls – how these participants

took longer to walk from the research lab to the elevator, after they believed the study to be finished. In another study, Dijksterhuis and van Knippenberg (1998) found participants performed better answering general knowledge questions following a task where they thought about qualities of a University professor versus participants who initially thought about qualities of a football hooligan. In the same study as described above by Hong et al. (1999) they manipulated participants' Theories of Intelligence by getting them to read passages, presented to them as reading comprehension tasks, suggesting intelligence was either fixed or flexible. This simple variation of task was the manipulation that saw one group of participants respond to negative feedback with interest in remedial action and the other rejecting it, despite the seeming gravity of the situation (starting University non-fluent in its language and receiving poor feedback in a competency test). In a slightly less covert study, an incremental Implicit Theory was induced in 11-13 year old students by presentation of workshops describing how neurons develop new or stronger pathways and other descriptions about how learning and growth are possible through effort (Blackwell, Trzesniewski, & Dweck, 2007). The participants were a group of relatively low-achieving students, and the manipulation resulted in better-than-predicted math grades. These are examples of many priming studies that suggest that manipulation of behaviour and performance is possible. These methods have been used to alter Implicit Theories also, resulting in different behaviours. Implicit Theories can be altered by giving material demonstrating how the brain develops and grows. If an individual does hold an entity or incremental Implicit Theory, this in itself may not, or need not, be stable or fixed over time.

1.2.3 Wider Application of Implicit Theory

The Implicit Theory model was initially described more fully as Implicit Theory of Intelligence (Dweck & Legett, 1988). Much of the early research, as touched upon already, centred on education e.g. math scores and language ability. McConnell (2001)

looked at differences in social judgements between Implicit Theories. He found entity theorists make more personality judgements about a person, more quickly forming an impression of that person in comparison to incremental theorists. Implicit Theory has also been applied to romantic relationships by Knee (1998). He found if someone sees their relationship from an entity perspective they can take events as evidence of the quality of their relationship. Positive events allow the picture of a perfect relationship to remain unharmed, but negative events (such as arguments or disagreements) would be taken as a sign that the relationship is not ideal. The idea that two people should be perfect for each other makes sense to an entity theorist, and evidence to the contrary can be damning. With an incremental perspective, negative events can be taken as learning experiences, for example with the person recognising relationship problems are normal and it is good to find areas of growth. In another application, Miu and Yeager (2014) found reduced incidence of clinically significant levels of self-reported depression in adolescents at a nine month follow-up of a presentation of a brief incremental Implicit Theory intervention. Implicit Theory might have useful application in other areas where an individual facing a challenge could view their circumstances as fixed or changeable. If the belief is that circumstances are fixed, then a goal aiming for change of those circumstances would result in cognitive dissonance (Festinger, 1962). For example, if an individual with depressive symptoms believes that people cannot change, an important initial step could be to question this Implicit Theory, as shown by Miu and Yeager. For further discussion of Implicit Theory applied to different domains see Section 2.2 (below), however, to date, health-related application has been limited.

1.3 Application of Implicit Theory with Parkinson's Speech

1.3.1 Technology used for Health

In terms of the potential application of Implicit Theory to improving engagement in speech therapies there is another avenue to explore: the use of technology in

Parkinson's therapy. It could be suggested that technology is developing so that being able to use it effectively is likely to be of increasing benefit with regards to health. Links between health and technology are of particular relevance to the research here, since there is the potential for patients to utilise a speech therapy smartphone application developed for people with Parkinson's (introduced further in Section 1.3.2.1). In addition, brain training programs, linked with maintaining and developing cognitive skills such as memory, are being tested for their efficacy (Rebok et al., 2014). Programs like lumosity ("About Lumosity," n.d.) are primarily available as websites, but have also been developed as smartphone applications. Many other applications have been developed that offer health related advice and therapy (Jacobson, 2014). Many applications may have questionable value, but organisations such as the UK's National Health Service have started to create collections of the more useful and relevant ones ("Safe and trusted apps to help you manage your health," n.d.). As the technology that these applications run on is relatively new and still developing, with more time, it is likely that more and better applications will be developed. Telephone technology and telehealth (Hunkeler et al., 2000) have also been used to improve medication adherence in people with multiple sclerosis (Turner, Sloan, Kivlahan, & Haselkorn, 2014), and text messages have been used to encourage people to quit smoking (Abroms, Boal, Simmens, Mendel, & Windsor, 2014). Newer technology can quickly find health application, such as Nintendo's Wii, described as a useful addition to physiotherapy (McPhail et al. 2015). Given the widening array of health-related technology available, being able to effectively use technology is becoming increasingly advantageous. Implicit Theory, as well as being of potential value to understanding patients' engagement with therapies, could additionally be used to help understand and improve adoption of health functionality offered by new technologies. Implicit Theory might be particularly relevant where

difficulties are encountered, for example if the technology being learned is unfamiliar to the user.

1.3.2 Technology used by Older Adults and People with Parkinson's

People with Parkinson's are generally older adults (Samii et al., 2004), for whom negative stereotypes (Ansley & Erber, 1988; Mitzner et al., 2010), anxiety (Hogan, 2006), and relatively poor uptake regarding technology usage exist (Morris & Venkatesh, 2000; Pew Research Center, 2014). Perceiving stereotypes have been shown to have an impact on behaviour (Schmader et al., 2008). Negative stereotypes will have a negative impact, for example if older adults believe themselves to be less able with technology. Despite these potential obstacles, technology holds huge potential to assist people with Parkinson's. As well as the health application of technology described above (Section 1.3.1), technology has been described as important to the maintenance of autonomy by older adults (Slegers, van Boxtel, & Jolles, 2007). Nintendo's Wii, which has been investigated for efficacy in helping people with Parkinson's with balance (Mhatre et al., 2013), and telehealth has been developed for educating people with Parkinson's about complex medication schedules (Fincher, Ward, Dawkins, Magee, & Wilson, 2009). Dulude (2002) compared younger and older adult users of an automated system and found that they had similar usage issues and complaints. While the younger users were able to overcome these issues, the older adults 'failed because of age-related losses in capacities'. This included both mental and physical capacities but acknowledged that wide variation was present for both. Looking at everyday technology interactions, O'Brien, Rogers and Fisk (2012) found prior knowledge to be the most important attribute for success. They found that older adults with higher technology usage reported a similar number of problems as younger adults, but issues by this older adult group were likely to be attributed to not enough prior experience (despite being higher users). Older adults with lower technology usage were suggested to have a preference for more basic

technology, and to prefer engaging with people rather than technology. Broady, Chan and Caputi (2010) suggest that older adults could be taught to use technology with similar methods, as younger adults, with the exception of allowing more time for mastery of skills. Additionally, they suggest that instruction should be positive and they emphasise that there should be an expectation of success.

1.3.2.1 The Smartphone Application (SAP) Project. A common symptom of Parkinson's is loss of cognitive feedback of vocal volume, resulting in loss of awareness of speech volume (Ho et al., 1999). Deterioration of this automatic internal volume feedback can be supplemented by additional external cues. Thus, in 2008, a project was started at University of Portsmouth to investigate development of smartphone applications that could assist with this issue. This larger project will be referred to as the Smartphone Application project, or 'SAP project' for short. A basic aim of the SAP project was to explore provision of visual feedback of speech volume, which if achieved via a smartphone, should allow flexible usage across varied environments and circumstances. The application's purpose is to provide real-time visual representation of speech volume. With the smartphone screen visible, as the user speaks, volume is received and graphed on the screen, fluctuating as their voice volume alters. As well as providing information potentially no longer present from ordinary cognitive processes, this feedback can also act as a prompt, allowing the user to see that their volume needs to be adjusted. Another component of the speech therapy application is to incorporate the visual volume information with practice materials and performance feedback. This would allow regular usage and vocal exercises or training, over extended periods of time as was suggested as useful for LSVT (Spielman et al., 2007). Further description of the application can be found in Appendix G.1. The SAP project had some concerns however about the target audience – people with Parkinson's – embracing smartphone technology (some issues are outlined at the start of Section 1.3.2). There were also concerns about

adherence, as the application was to provide vocal exercises or form part of a therapy (some issues are outlined in Section 1.1.3). Thus, the research programme reported fits within this larger SAP project where a speech and language therapy smartphone application, for people with Parkinson's, was being developed. The research here aims to complement the SAP project by exploring further the potential issues of barriers to usage and adherence, and to enhance engagement.

1.3.3 Parkinson's Implicit Theory (PIT) Research Aims

It is proposed that Implicit Theory could be appropriate to examine for its relevance to people with Parkinson's. As a progressive condition, once a symptom emerges and starts to affect symptom-relevant abilities, thoughts about the situation could follow entity or incremental Implicit Theory patterns. With an entity theory, thoughts might be that the course of the illness will be fixed and unalterable. Each symptom experienced occurs due to Parkinson's, and is progressive. As this situation is fixed, performance-type goals might emerge – automatically with perceived low (or lowering) levels of ability due to a Parkinson's association – leading to avoidance of behaviours reliant on symptom-related abilities. Behavioural responses would likely be biased towards avoiding challenges or towards having low persistence. Alternatively, with an incremental theory – the illness may still have the same course – however, there may also be the idea that the course could be positively interrupted as much as possible. Learning-type goals could emerge where exercises might be sought out or engaged with more readily, or new ways of doing things discovered. Section 1.1.3 discussed several barriers to people with Parkinson's adhering to a therapy. One of these barriers was low expectation of outcomes, which can be related directly to Implicit Theory. Thus, if holding an entity theory, the expectation might be for an inability to influence the situation, so the barrier of low outcome expectations would likely exist automatically.

Section 1.3.2.1 (above) outlines that this research will fit within the larger SAP project, where a speech and language therapy smartphone application for people with Parkinson's was being developed. The focus of this thesis is primarily concerned with Implicit Theory as related to people with Parkinson's, which will be referred to as Parkinson's Implicit Theory research, or 'PIT research' for short. The PIT research will explore the relevance of Implicit Theory for people with Parkinson's, which could be helpful when looking at engagement with the SAP project's smartphone application. A goal of the PIT research, as part of complementing the SAP project, is thus to investigate potential domains of Implicit Theory which could be relevant to people with Parkinson's engaging with a smartphone application. Potential users could hold theories regarding their voice or vocal abilities which could affect its usage. Most people do not spend much time actively developing their voice (notable exceptions being people who take elocution or singing lessons), and their voice is something generally consistent in their lives (the occasional sore throat aside). A person with Parkinson's who starts to experience vocal issues might consider this new situation as being fixed, e.g. a vocal deterioration has started, due to Parkinson's, and a once-familiar voice will eventually be lost. This thought pattern could lead to low interest in something like the SAP project's application (Section 1.3.2.1 above), perhaps due to a perception of it highlighting the deterioration. Alternatively, if vocal ability is viewed as flexible, efforts could be made to look differently at how the voice is used, thus engaging with suggestions made by a speech therapist and exploring other options like choral groups (Shih et al., 2012) or the SAP project's application (Section 1.3.2.1) . Potential users might also hold theories regarding their abilities with technology, or their ability to engage with new technologies if they have not previously used a smartphone. Barriers to technology usage (Section 1.3.2 above) might include: limited previous technology exposure; lack of interest; anxiety; and exposure to negative stereotypes. Again, holding an entity Implicit Theory

is possible, which could involve believing the stereotypes, not engaging with anxieties or holding a self-definition of being a non-technical person. An incremental Implicit Theory might allow someone to look beyond a stereotype or, despite limited starting ability, to take steps towards engagement with new technologies. Using the SAP project's smartphone application might involve a learning curve for some of its target audience, but with an incremental Implicit Theory the goal might more likely be to progress along that learning curve, rather than focus on avoiding demonstration of current low ability. If Implicit Theory domains exist for either beliefs about vocal ability, or beliefs about ability with technology, then these could be relevant to both initial uptake and continued usage of the speech therapy smartphone application (Section 1.3.2.1 above). For either domain, possible domain-relevant barriers to engagement exist which might prevent potentially beneficial engagement. Understanding these Implicit Theory domains might be helpful for understanding usage, and how responses to these barriers might be positively altered.

An aim of the PIT research will be to present manipulations of Implicit Theories, to try to encourage either an entity or incremental theory in participants. Manipulations of Implicit Theory have been shown to be possible, and can alter behaviours relevant to an Implicit Theory domain (Section 1.2.2 above). An aim of the PIT research will be to investigate Implicit Theory domains of vocal issues and of technical abilities. This will include presentation to participants Implicit Theory manipulations of these domains. If these domains are present and manipulable then agreement with them being either fixed or flexible should be measurable. Further, domain-relevant behaviours should be predictable based on the Implicit Theory manipulation version (incremental or entity) which has been presented.

1.3.3.1 Parkinson's Implicit Theory (PIT) Central Research Question. Of the aims discussed in the section directly above a central issue for the PIT research will relate

to Implicit Theory manipulations. The first studies (Chapter 4 below) will develop Implicit Theory manipulations relevant to technology to present to University students, as a test of hypothesis before conducting research with a clinical population.

Manipulations will be designed to include versions encouraging either entity or incremental Implicit Theories. Subsequent studies (Chapters 5 and 6) will then progress these initial manipulations for presentation to people with Parkinson's.

If the domains of vocal issues and of technical abilities are similar to other Implicit Theory domains previously investigated, are manipulations of the domains possible? Can manipulation of Implicit Theories of Technology and of Vocal Issues be used to improve speech performance of people with Parkinson's engaging with a technology-supported therapy? The hypothesis for the PIT research is that, following presentation of Implicit Theory manipulations, participants will demonstrate more responses and behaviours congruent with the version of the manipulation that they received. Congruent responses would include participants shown the incremental version of the manipulation showing more agreement with incremental measure items, and less agreement with entity measure items, in comparison with participants shown the entity version of the manipulation. Also in tasks following presentation of the Implicit Theory manipulation participants would be more likely to show engagement, perseverance and learning behaviours if they had been shown an incremental version of the manipulation.

1.4 Contribution to Knowledge

The PIT research that addressed the research question (Section 1.3.3.1 above) had several contributions to knowledge. Firstly support for Implicit Theory manipulations were indicated in the domain of technology ability and the domain of vocal issues. The consideration of the potential to affect Implicit Theories in these domains has not previously been seen. In instances, such as that of the SAP project, where technology is being presented to a potentially new audience, manipulation of Implicit Theory of

technology ability could play an important role in the acceptance of that technology. Similarly, how a person thinks about health or vocal issues, will likely relate to efforts they might use to engage with something designed to help speech. Results generated through the research (Chapter 4 - 6) suggest that Implicit Theory could be applicable to people with Parkinson's. As a progressive condition, it involves challenges and setbacks, and also can include symptoms affecting innate abilities, such as movement or speech. Understanding whether Implicit Theory holds a relevance for people with Parkinson's could hold value for understanding how these challenges and setbacks are encountered and responded to.

Contributions to practice were also indicated by the application of Implicit Theory to health therapies. The PIT research shows how Implicit Theory can inform interactions between a therapist and patient, enhanced interactions leading to improved engagement with effortful treatments. There is also a contribution to motivation and goal setting in the context of people with Parkinson's. Understanding how beliefs about effort and ability can alter success with, for example, health or exercise goals is relevant both to people with Parkinson's and to carers trying to assist people with Parkinson's engage with goals such as these. Contribution to practice is also seen in the suggested relevance for both the learning of computer programming languages and the learning of new technologies. Implicit Theory could thus be used to inform teaching practices, by encouraging an incremental Implicit Theory learning approach towards the subject, it would encourage effortful learning and protect students from challenges or setbacks. Similarly with technology continually progressing, and increasingly offering health applications (Section 1.3.1 above), having theories to understand engagement, such as Implicit Theory, is increasingly relevant.

Contribution to methodology has been shown in several ways. Firstly an opportunistic research approach was used, the PIT research taking advantage of a design-

test stages being conducted as part of the SAP project (Section 1.3.2.1 above). The PIT research programme's design demonstrated trade-offs between the two endeavours that enabled a PIT research outcome that offered high external validity and access to a clinical population that might have been difficult to achieve without the collaboration. Secondly the PIT research contributed to methodology by utilising response feedback data, captured for the SAP project to inform application development, in order to conduct a thematic analysis. This approach allowed a different type of data to contribute to the findings of the PIT research, making use of data already being collected. Contribution was also made by the method demonstrating how participant support during the procedure, such as by a relative or carer, can further enhance clinical patient research. Being able to explain the device and application to two people enabled increased use of the device, with support at hand from those who had been present at the deployment. This also allowed the method to inform how a person with Parkinson's and a carer could interact together to use the device.

There was also contribution to theory, by broadening further the range of domains (Section 2.2 below) that it is applicable to. Behavioural differences already described by entity and incremental theories within Implicit Theory, were shown in the PIT research to be related to the domain of technology.

1.5 The Structure of the Thesis

To further the work on Implicit Theory the thesis will be broken down into the following chapters. Chapter 2 will primarily review literature related to the Implicit Theory model, including the range of domains to which it has been applied and research suggesting Implicit Theories are themselves malleable. Chapter 2 will also look at research involving people with Parkinson's and considerations for such research. Chapter 3 will give details of the context in which the thesis' research is placed, and outline the planned structures of the studies included in the thesis. Chapter 3 also

describes factors affecting the research and briefly describes the emergent research approach that resulted. Chapter 4 describes two studies including University students, used as an opportunity to test the thesis hypothesis and develop materials before inclusion of a clinical population. Chapter 5 and Chapter 6 describe studies testing the thesis hypothesis including people with Parkinson's. Chapter 7 then presents thesis conclusions, including a description of contributions to knowledge and suggestions for future work.

CHAPTER 2. IMPLICIT THEORY AND RESEARCH INCLUDING PEOPLE WITH PARKINSON'S

A broad range of potential foci are available when discussing development of a smartphone speech and language therapy application for people with Parkinson's. The Smartphone APplication (SAP) encompasses a broad range of fields – many of which are beyond the scope of this document. Firstly extensive consideration could be given as to why is the application needed? In the previous chapter there was focus given speech issues that arise in Parkinson's (see Section 1.1.1), types and mechanisms of existing speech therapies (see Section 1.1.2), and a brief description of Parkinson's (see Section 1.1). Secondly, the application under development, designed to help speech in the circumstance of altering cognitive performance (Ho et al., 1999), could potentially be considered in the same regard as brain training (Aamodt & Wang, 2007). There is an interesting debate in research as to the efficacy of brain training (Owen et al., 2010). The interest of the PIT research, however, is not in whether the application developed by the SAP project qualifies as 'brain training', or in the efficacy of either brain training generally or the developed application specifically.

The PIT research focus will be on Implicit Theory (described more fully in Section 2.1 below), which may help understanding of the motivations and engagement of people with Parkinson's using the speech therapy application developed by the SAP project. The specific interest is whether Implicit Theory can be related to people with Parkinson's, so research where Implicit Theory has been applied to other domains will be discussed (Section 2.2). Assuming Implicit Theory is relevant, it would equally be relevant to be aware of potential manipulations to it (Section 2.3). Some attention will then also be given to considerations for research including people with Parkinson's as participants (Section 2.4).

Attribution theory attempts to describe how people make sense of the world, and is focused on how perceived causes of experiences are interpreted by an individual (Kelley & Michela, 1980). Weiner (1985) proposed that cause of success and failure could be described using three properties: locus (caused by something internal or external to the individual); stability (caused by something fixed or likely to be different every time); and controllability (caused by whether the individual alters the outcome through their own efforts). How an individual explains, or attributes, events subsequently alters that individual's expectancy of future events, and subsequently their drives and motivations moving forward from that event. A negative event, described as having an external cause that is not controllable, will generate very different expectancies than if it were described as having an internal cause that is controllable. Attribution theory does a good job of describing how explanations or interpretations of events can drive subsequent behaviour. However, in describing the flexibility of how an event can be interpreted, attribution theory does not incorporate an individual's theories about the world, or their goals.

Incorporating personal factors – such as goals and ability levels – Dweck and Leggett's (1988) Implicit Theories of Intelligence model is described by Dweck (1999, p. 138) as being part of 'the "social-cognitive" approach to motivation, personality and the self'. This approach is described as having two branches, the first focussing on how social information is processed. The second branch, Implicit Theory, focuses on how people set up meaning systems in order to describe how they behave. These meaning systems are constructed around peoples' beliefs, values and goals (Mischel & Shoda, 1995, 1998). These systems propose a structure for how we define ourselves and our behaviours. Mischel and Shoda (1995) developed the Cognitive-Affective Personality System, which provides an explanation for variations in behaviours by an individual despite personalities traditionally being believed to be fixed (e.g. Eysenck 1982, Loehlin

1992). This system describes situational features, encoded by mediating units, with specific subsets of other mediating units then also activated. A specific situation might activate some mediating units, inhibit some, and not affect others. This activation happens according to a network of relations, unique to an individual – their Cognitive-Affective Personality System. This proposed system explains how one individual's behaviours can differ across different situations. The emphasis for a meaning system approach is to examine how people organise and understand their world. When emotions, positive or negative, result from a situation, it is not the situation causing the emotion but the meaning the individual places on the situation (Weiner, 1985). Implicit Theories can be understood as a meaning system, as they provide structures helping individuals to interpret behaviours and learning situations. The basic premise of Implicit Theories is that we view our ability for different things as either being changeable (incremental), or fixed (entity). Similar to the Cognitive-Affective Personality System, perceptions of skills and abilities are determined by our Implicit Theory, which affect resulting behaviours. The PIT research here is interested in investigating whether these ideas can be related to people with Parkinson's engaging in an effortful speech therapy, using potentially unfamiliar technology. Perceptions related to effort or ability for speech or technology, in the context of Parkinson's, could relate to outcomes using the smartphone application.

2.1 The Implicit Theories Model

Dweck and Leggett's (1988) model can be represented visually as seen in Table 2-1 (below). Briefly, having an entity or an incremental theory predisposes individuals to focus on either performance or learning goals respectively, which, depending on perceived skill level, can result in stronger (mastery-oriented) or weaker (helpless) behaviour patterns.

Table 2-1			
<i>Taken from (Dweck, & Leggett, 1988, p259). Theories, goals and behavior patterns in achievement situations.</i>			
<u>Theory of intelligence</u>	<u>Goal orientation</u>	<u>Perceived present ability</u>	<u>Behaviour pattern</u>
Entity (Intelligence is fixed)	Performance (Goal is to gain positive judgements / avoid negative judgements of competence)	High	Mastery oriented (Seek challenge; high persistence)
		Low	Helpless (Avoid challenge; low persistence)
Incremental (Intelligence is malleable)	Learning (Goal is to increase competence)	High or low	Mastery oriented (Seek challenge that fosters learning; high persistence)

The aim of the Implicit Theory of Intelligence model, outlined in the theory's seminal paper (Dweck & Leggett, 1988) was to account for major patterns of adaptive (mastery-oriented) and maladaptive (helpless) behaviour patterns. The helpless pattern is best demonstrated during situations of personal failure or where things become difficult or challenging, when behaviour is characterised by challenge-avoidance and a decline in performance. Early description of helpless behaviour patterns are found in a paper describing sudden death in rats, seemingly due to 'hopelessness' (Richter, 1957). Hopelessness developed into the theory of 'learned helplessness', which was progressed by Steven Maier and, before he became one of the key researchers of positive

psychology, Martin Seligman (Seligman & Maier, 1967, Maier & Seligman, 1976).

Learned helplessness can result when repeated failed attempts to control a situation become interpreted as that situation being uncontrollable. Learned helplessness has roots in attribution theory described above. The perception of a situation is described as being composed of three elements (Weiner, 1985): stability, e.g. the state or circumstance is understood as arising from a fixed situation; globality, e.g. the perception that the circumstances relates to everything they do; and internal, e.g. the person regards it as happening due to reasons brought about by themselves and not external. Each factor can be viewed as occurring on a continuum rather than merely present or absent. Thus for any given situation, we can look at it as having varying degrees of stability, globality and internality. When Implicit Theory refers to helpless behaviours, it does not mean the full definition of learned helplessness, all three elements being present. For Implicit Theory, helpless behaviour is usually tagged with the behavioural characteristics of challenge-avoidance and low persistence. Then for health-related behaviours this could mean low persistence or avoidance with, for example, a therapy requiring effort. The elements leading to these characteristics can vary in stability, be something an individual displays for a very narrow, or wide, range of domains or circumstances, and vary in terms of being attributed as internal, external, or maybe a mix of both. Similarly, Learned Helplessness does not explain how varying interpretations arise which is central to Implicit Theory, a person's held self-theories providing a rationale for adopting goals.

The mastery pattern of behaviour is characterised by challenge-seeking and persistence despite circumstances. The description takes origins from Benjamin Bloom's work on 'Learning for Mastery' (1968). Bloom's belief was contrary to that of his contemporary teachers - considering that they could only reasonably expect a third of their students to adequately learn what they were teaching. He suggested over 90% of students could master the material, but that a strategy for mastery learning would involve

relating students' individual differences to the learning and teaching process. Bloom discussed five factors for enabling mastery learning: Aptitude for particular kinds of learning; Quality of Instruction; Ability to Understand Instruction; Perseverance; and Time allowed for learning. Similar to the elements outlined for learned helplessness, each of the five factors for learning mastery can be considered to be on continuums. Unlike learned helplessness, however, there is no suggestion that all factors need to be present, instead it being dependent on which factors are critical for the individual. When Implicit Theory refers to mastery behaviours, it does not follow Bloom's definition for learning mastery. Several of Bloom's factors account for situational characteristics external to the individual, whereas mastery behaviour described by Implicit Theory looks at how the individual responds despite external factors. Here, an individual would be demonstrating mastery behaviour when persevering despite poor instruction. Bloom also believed students were normally distributed, and that given the same time and instruction the normal distribution across ability-levels would result. While not suggesting that normal distributions in ability are not found, Implicit Theories has its emphasis on effort and perseverance, factors internal and more readily manipulated by the individual. A central tenet of Dweck's Implicit Theory model is that aptitude and ability are ignored, and it is the amount of effort and quality of effort that affects learning. Further, Implicit Theory suggests that if people who are expert at what they do are examined, they are invariably highly engaged with – and work very hard at – what they do (Dweck 2006b). Regarding perseverance, Bloom (1968) says the following:

“It would appear to us that as a student finds the effort rewarding, he is likely to spend more time on a particular learning task. If, on the other hand, the student is frustrated in his learning, he must (in self-defence) reduce the amount of time he devotes to learning”.

Implicit Theory acknowledges someone with an entity theory can approach mastery at something while within their comfort zone, but then demonstrate failure-like behaviours as soon as things get tough. Bloom's assertion does not allow for variation of response to challenging circumstances, suggesting successful learning happens when things go smoothly. People do manage to overcome adversities however, and the Implicit Theory model offers an explanation for variation, with an individual's theories affecting goals and behaviours in challenging situations. Related to health behaviours an example might be variation in engagement with rehabilitation exercises following a hip operation (potentially involving a lot of pain), it might be expected that the individual who more readily performs the exercises will demonstrate a better recovery. Implicit Theory could help explain some of the differences seen in engagement with health behaviours.

2.1.1 Fixed versus Incremental Traits and Abilities

Herrnstein and Murray (1994) suggest that intelligence is allocated unequally, with little that government policy changes can do to alter this. They claim "IQ is substantially heritable" (p105), and that research suggests the genetic component of intelligence lies somewhere between 40% and 80%. Alfred Binet, creator of the Intelligence Quotient (IQ) test, however, is suggested to have believed intelligence to be malleable and something that should be considered to develop (Siegler, 1992). Implicit theory allows for both positions to exist with the relevance of fixed or fluid intelligence changing depending on how an individual themselves perceives intelligence, which alters their goal-types and subsequent behaviour and outcomes.

Dweck & Leggett (1988, p263) describe a study where students' Implicit Theories were measured by capturing participants' level of agreement with several statements endorsing either an entity or incremental view. In a later part of the study, participants were asked to select one of three tasks, described as: Hard enough to show

I'm smart (challenge-seeking performance goal); Not so hard that I would get any wrong (challenge-avoidant performance goal); and Hard, new and different (learning goal). Of participants who had agreed with entity theory statements, 50% selected a challenge-avoidant performance goal, and 31.8% a challenge-seeking performance goal. Of participants who had agreed with incremental statements, 60.9% selected a learning goal. This result does not show whether intelligence is fixed or malleable, however it demonstrates that how intelligence is perceived impacts task-type selection. Hong et al. (1999) describe a study that demonstrates choices made, based on Implicit Theories held, could have a dramatic effect on future academic career. Participants were students at a university in Hong Kong where all classes and exams were in English, but not all students entering were fluent. Their Implicit Theories were measured and they were given either satisfactory or unsatisfactory feedback on an English exam. Following this, participants rated their interest in different courses at the university, of which one was a remedial English course. There was a difference in interest in the remedial course between entity and incremental theorist participants who had received negative English language feedback. Incremental theorists were significantly more interested in the remedial course. It seems self-sabotaging to reject an opportunity to improve a weakness key to academic participation. Again, this does not demonstrate intelligence to be malleable or fixed, but demonstrates the role of theories affecting goals and choices. Students taking remedial action for weaknesses can be viewed as proactively giving themselves an advantage over students with similar weaknesses who decide against this option. For health behaviours this would be similar to a patient acknowledging or recognising a frailty or symptom, having been offered guidance of remedial steps, choosing to follow or not follow that guidance. Mangels, Butterfield, Lamb, Good and Dweck (2006) used event-related potentials (Bressler & Ding, 2006) to examine how entity or incremental theories influence information attended to in the context of

intelligence and error correction. They found different neural activation patterns between participants holding different theories, suggesting that they orientate differently to performance information. This difference in brain activation patterns supports the suggestion of Implicit Theory; that information is processed and attended to differently when we believe a relevant trait to be fixed or incremental. There is a potential to believe that traits such as ability with technology (see Section 2.2.2), or vocal change (see Section 2.2.1) might also be fixed or flexible, which would likely have an effect in the context of engagement with a speech therapy presented via a smartphone application.

2.1.2 Performance versus Learning Goals

Research into goals takes a number of different perspectives. Some research evaluates the effect of interactions between how we monitor goal progress and the focus of actions completed versus actions left to be taken (e.g. Koo & Fishbach, 2010; Zhang, Fishbach, & Dhar, 2007). Other research looks at how goals are activated (e.g. Fishbach & Zhang, 2008; Förster, Liberman, & Friedman, 2010), or constructed (e.g. Deci & Ryan, 2000). Although the variety of research available on goals indicates that they are complex entities, Implicit Theory research involving goals primarily focuses on the area of goal orientation, typically performance goals and learning goals (also referred to as mastery goals e.g. Darnon, Butera, & Harackiewicz, 2007; Kristof-Brown & Stevens, 2001). Attempting to define the orientations more closely, Elliot and Harackiewicz (1996) proposed performance goal orientations be categorised between performance approach and performance avoidance, meaning wanting to perform well and wanting to avoid performing badly. Further complexity was proposed by Elliot and McGregor (2001), suggesting a two-by-two matrix of achievement goal orientations including: mastery-approach; mastery-avoidance; performance-approach; and performance-avoidance. This incorporated their work on goal approach and avoidance, overlaying it with previous research establishing separate mastery and performance goals. Elliott and

Dweck (1988) described performance and learning goals as being the two major goal-types pursued in ‘achievement situations’. Performance goals are when individuals aim for positive judgements and avoid negative judgements, wanting if possible to validate ability and or to avoid discrediting it. Learning, or mastery, goals are when individuals aim to increase their ability or progress towards task-mastery. Implicit Theory research typically limits the orientations considered to two; performance goals and learning goals, however Grant and Dweck (2003) also found evidence for four types of achievement goals relatable to Implicit Theory: learning goals; outcome goals; ability-linked performance goals; and normative performance goals. They investigated to see if they could find two types of learning (or mastery) goals, similar to Elliot and McGregor, but found them to be highly correlated and loaded together, so treated them as one learning goal. Outcome goals were found to be unrelated to performance or learning goals, individuals being able to hold a goal for a positive outcome, i.e. wanting to do well, regardless of other goals held. Normative performance goals, i.e. wanting to perform well relative to others, unlike ability-linked performance goals, were not predictive of any affective, behavioural or cognitive variables in Grant and Dweck’s studies. This theory makes intuitive sense, however it is more complex than the original Implicit Theory model and has received little additional experimental follow-up.

Brophy (2005) suggests that goal theorists should avoid advocating performance goals to teachers in any circumstances, even when considering performance approach goals. Performance goals are suggested to contain a social comparison element, which can work positively when the comparison is favourable, similar to normative performance goals. These goal orientations lead very quickly to goal avoidance and helplessness however, if setbacks are encountered or comparisons are not favourable. Brophy suggests that primary focus should be on promoting learning or mastery goals,

with the exception of situations or tasks where positive performance is beneficial and outcome goals should be favoured.

Implicit Theory suggests that entity theorists are more likely to develop performance goals, and incremental theorists are more likely to develop learning goals (see Table 2-2, Section 2.1.3 above). Dweck (1999, p16) states that the ideal situation would allow both suggested goal types to be achieved, where ability would be developed and positive appraisal received. It is the holding of the goals, rather than their execution, however, where conflict arises. Situations where people can learn the most may involve uncertainty and exploration, whereas situations more likely to produce positive outcomes may be those within a comfort-zone of experience. Individual selection differences start to emerge when competing performance and learning goal choices are available alongside each other. Dweck (1999, p16) reports that, across the literature, a fairly equal preference between the two. It has also been suggested that selection between mastery and performance goals can vary between contexts, for example with different levels of peer interaction (Harris, Yuill, & Luckin, 2007). The balance of an individual's choices becomes important, if the choice is generally to opt for a learning goal or situation or a performance goal or situation.

Learning and performance goals are suggested by the Implicit Theory model to lead to mastery and helpless behaviours. In Elliott and Dweck's (1988) study students were either told that a task would be used to evaluate their ability (performance goal), or that the task would offer a valuable learning opportunity (learning goal). All students were then given the same task, which started with several easier components that both groups performed similarly well, followed by several more difficult components. Participants were then randomly provided either positive or negative feedback to the tasks. Reactions made by a significant number of participants in the performance goal-low feedback condition demonstrated a helpless response. This included making

statements of attributions (for example blaming some external factor), statements of negative affect and a deteriorated task strategies. Participants in the learning goal conditions, regardless of feedback type, were more likely to improve their task strategy and made fewer statements of these attributions and statements of negative affect. This study demonstrated a behavioural effect by priming differing goals in an achievement situation. There was no initial difference completing training trials between participants in each condition, and the only difference between conditions was the purpose assigned to the task, in creating different goal types. This suggests that environments or situations can be altered to instil different types of goals (ways that have been used to alter peoples' Implicit Theories is looked at more closely below, in Section 2.3). The difference between conditions also demonstrates that behavioural responses are possibly tied to, or have some variance with, these alterable goals. If holding different goals can lead to mastery or helpless behaviours then this could indicate importance for types of health goals. If an individual believes a health condition to be fixed or flexible, are there corresponding goals that relate to expected benefit from their health pathway that could be understood via Implicit Theory?

2.1.3 Responses to Failure

A lot of the Implicit Theory research referenced so far has been conducted within educational settings. Examples of setbacks and failures are generally: tasks that become exceedingly difficult or contain confusing material (e.g. Licht & Dweck, 1984); provision of negative feedback to a task (e.g. Elliott & Dweck, 1988); or events around a transition across educational stage, for example a transition from primary to secondary level education (e.g. Robins & Pals, 2002). The outcome of these educational failures might be negative responses, such as loss of interest or poor performance, or positive responses like altering strategies or increasing efforts. If failures happen at a key stage or for a prolonged period, then, depending on the response made by an individual, the

impact could be great. Failures can be motivating or undermining, and within Implicit Theory research responses to failure are generally considered under the terms ‘mastery’ or ‘helpless’ behaviours.

In an investigation into different responses to failure, Diener and Dweck (1978, 1980) had 5th grade students describe aloud their reasoning for their decisions as they completed a series of tasks. The first tasks were intended to be straight-forward so that all students could feel comfortable with them, followed by tasks intended to be too difficult for that age group. Participants had first responded to questionnaires constructed to allow prediction as to whether an individual would persevere in a challenging situation, allowing participants to be split into helpless- and mastery-oriented groups. In their verbalisations, participants in the helpless-oriented group focused on the cause of their failure, whereas participants in the mastery-oriented group focused on possible solutions. More than one third of helpless-oriented participants spoke negatively of their own intelligence, whereas none of the mastery-oriented participants made this description, despite both groups having encountered the same level of failure following the same initial task successes. Almost all of the mastery-oriented participants verbalised either self-instruction or self-monitoring compared with almost none of the helpless-oriented participants. When asked whether they could still complete the earlier tasks which had been completed successfully, one third of helpless-oriented participants thought that they would not be able to, compared to none of the mastery-oriented participants. The actual number of easy tasks was eight, with four impossible tasks, however when asked to recall the number of successes and failures, helpless-oriented participants recalled more failures and less successes, whereas mastery-oriented participants recalled the tasks accurately. Two thirds of helpless-oriented participants (of $n = 56$) expressed some sort of notable, negative affect during the failure tasks, compared with one individual mastery-oriented participant (of $n = 56$). This demonstrates

differences in reflections of experiences, and also demonstrates varied self-commentary between participant groups. Participants were categorised based on responses to a measure, indicating real behavioural differences can be predicted based on responses indicating mastery or helplessness. Dweck and Leggett (1988) compared the differences seen between mechanisms seen with performance and learning goal types when there is a threat of failure (see Table 2-2 below). The differences between ‘debilitative performance’ goal-associated and ‘facilitative learning’ goal-associated mechanisms detailed in Table 2-2 follow closely the response differences detailed by Diener and Dweck (1978, 1980) between the helpless and mastery-oriented groups. In terms of strategies used for the failure tasks, two thirds of helpless-oriented participants demonstrated strategy deterioration compared with over 80% of mastery-oriented participants maintaining or improving their task strategies. Dweck (1999, p7) suggests that across the available Implicit Theory research, the split between participants who have demonstrated mastery- or helpless-oriented responses to failure has been approximately equal. In terms of a mid-ground, Dweck suggests that approximately 15% of participants do not fit into either group. This suggests approximately 43% of participants would be prone to demonstrating helpless behaviours in response to failure.

Similar differences between Implicit Theories in response to failure within health domains have been seen. In a systematic review of articles, Roepke and Grant (2011) found personal mastery to be positively associated with better cardiometabolic health and reduced risk of disease and or death. Typical findings, across thirty-two included studies, were of small to medium effect size. The definition of personal mastery given is “A global sense of control or the belief that one has control over future important life circumstances”. This definition is not fully consistent with mastery-oriented behaviours as understood within Implicit Theory research, however it would still fall under the definitions of an incremental theory, associated with mastery-oriented behaviours. As

the analysis included thirty-two papers, the exact meaning of mastery is likely to have deviated also. The paper does not discuss Implicit Theory, and further research would be needed to discover the effect on health outcomes with such different mastery interpretations.

Table 2-2 <i>Taken from (Dweck, & Leggett, 1988, p259). Cognitive and Affective Mechanisms of Debilitation and Facilitation in the Face of Difficulty.</i>	
<u>Performance goal:</u> Debilitating factors	<u>Learning goal:</u> Facilitating factors
1. Loss of belief in efficacy of effort, given low ability attribution	Continued belief in efficacy of effort: Effort self-instruction instead of low ability attribution; positive rule emphasizes utility of effort
2. Defensive withdrawal of effort: Effort confirms low ability judgment; inverse rule creates conflict between task requirements and goal	No defence required: Effort is consonant with task requirements and goal
3. Attention divided between goal (worry about outcome) and task (strategy formulation and execution)	Undivided, intensified attention to task that directly serves goal
4. Negative affect can interfere with concentration or can prompt withdrawal	Affect channelled into task
5. Few intrinsic rewards from effort (or high effort progress) to sustain process.	Continuous intrinsic rewards for meeting challenge with effort

In a case study of one nine year-old individual with Cerebral Palsy, Leung, Brian and Chau (2013) assessed learning and mastery behaviours with an access technology being evaluated. Here the interpretation of mastery was simply whether the individual had mastered certain aspects of the technology's usage, although in a comparison with typically-developing children they discuss mastery-oriented behaviour consistently with Implicit Theory. It was suggested that the individual's behaviours might have been indicative of a predisposition to helpless behaviour patterns. Observations leading to this suggestion included: constant striving for perfect task performance; non-tolerance of interaction errors; a tendency to attribute errors to own-ability and not to the technology; reluctance to use the technology in public; and their perceived skill level being lower than their actual skill level. In this instance, the researchers suggest that the individual's fear and anxiety for making mistakes with the technology were not barriers to its 'mastery', but barriers to developing strategies to cope with interaction failures occurring in public. It is suggested that these helpless-oriented responses to failure could impede the utilisation of a technology with potential to enhance quality of life. This case study offers an interesting example of technology being introduced in a health-related domain and the interaction of the individual's responses to failures with the technology's potential utility. Although discussing only one individual, it demonstrates the relevance of knowing about different responses to failure and how they might arise. It also demonstrates that research in responses to failure might be of relevance when applied to a very specific domain, in this case an individual with cerebral palsy learning to use an assistive technology. A further study to see whether mastery behaviours would be demonstrated by users with incremental implicit theories would be interesting, e.g. whether they would be motivated by failure.

Parkinson's is an illness where many obstacles can be seen to occur. It is normal for the illness to be underlying for several years before any symptoms are recognised that

lead to an actual diagnosis of Parkinson's (Gaenslen, Swid, Liepelt-Scarfone, Godau, & Berg, 2011). As a degenerative illness, it has been progressing from the time of onset to that point of diagnosis, and then continues to progress from that point forward. The modified Hoehn-Yahr scale (Goetz et al. 2004) describes in stages how symptoms can progress, from unilateral involvement only up to wheelchair bound or bedridden unless aided. The scale describes seven points across five symptom stages, but severity and rate of progression between the stages varies for each individual (Hoehn & Yahr, 1967). At each stage, the body begins displaying the illness's symptoms in some new way, or loss of some previously functional body system begins to present. In parallel with these stages, an individual will typically be meeting with health professionals and receiving therapy suggestions and or varying drug prescriptions. With these treatments, improvements may be seen, however their efficacy invariably fades (Marsden, 1994b), leading to constant altering of treatments. Both the way symptoms progress and efficacy of treatments alter can present a continuous series of challenges to a person with Parkinson's. A slightly more in-depth, though far from exhaustive, discussion of Parkinson's symptoms can be found in Section 1.1. No previous research has been found that applies Implicit Theory specifically to people with Parkinson's, however given the specific relevance of Implicit Theory to behaviour in situations of setback, it could be an important area for researching. For example, if a person with Parkinson's holds an entity theory of their illness's progression, they may focus on the degenerative nature of Parkinson's. A perception that everything that happens is inevitable, and any efforts they make with treatments or therapies could be viewed as non-beneficial, which may then influence engagement and thus success with such treatment. The rate of progression of Parkinson's is, however, variable (Goetz et al. 2004; Hoehn & Yahr, 1967), and research is favouring a 'use it or lose it' philosophy (Crizzle & Newhouse, 2006; Goodwin et al. 2008; Keus et al. 2007; Tomlinson et al. 2014). If a person with Parkinson's has an

incremental theory of their illness's progression, they may be more likely to focus on what benefits could come from their actions (maintained quality of life for example), and give consideration to different strategies or actions that could help further. Implicit Theory research with people with Parkinson's could investigate whether priming individuals with an incremental mindset could help their progress with a treatment, and whether setbacks are motivating or undermining in this context. Other illnesses present similar issues or setbacks for patients, so any useful findings here about responses to failure (or to setbacks due to a degenerative disease) could hold applicability more widely.

2.1.4 High versus Low Effort

When considering engagement with learning – or in the context of the PIT research engagement with a therapy or a technology – the concept of effort is very important. Effort for schoolwork has been described by Covington and Omelich (1979) as a double-edged sword. While effort might be linked to achievement, they found that when failure occurred, negative affect was strongest in situations of high effort. When failure occurred in low effort situations, less shame was perceived and there was less of a negative reflection on ability. Low efforts made by the learner can be seen as protective of their self-esteem.

Research by Surber (1984) suggests that we are capable of evaluating the relationship between effort and ability in different ways, as being either positively or negatively related. That is, as effort is increased, evaluation of ability is either increased (positive relationship) or decreased, depending on processing used. There is a crude interpretation for these processing differences provided by the two theory-types of Implicit Theory. With an entity theory, ability is fixed. If something comes easily at the initial stages then through continued high performance it is possible to develop a high level of ability (Dweck, 2006, uses tennis player John McEnroe as a classic anecdote of

an entity theorist). If something takes a lot of effort, then this indicates low ability, conversely if something comes easily then it indicates high ability. An entity theory is compatible with the style of cognitive processing where effort and ability are negatively correlated. With an incremental theory, ability is flexible. Here, effort allows ability to develop, so if effort is being expended ability must be developing, whereas without effort, ability should not develop. An incremental theory is compatible with the style of processing where effort and ability are positively correlated. Dweck (1999, p 40) describes several unpublished findings where students of different ages - eighth-graders in one study, college students in another – would endorse differing statements depending on which Implicit Theory they held. Entity theorists were more likely to agree with statements such as “If you have to work hard on some problems, you’re probably not very good at them”. Agreeing with this statement fits with the idea of processing with a negative correlation between ability and effort. It also shows disregard for the fact that some problems are more difficult than others, or that more effort might sometimes be appropriate regardless of ability. Incremental theorists were more likely to agree with statements such as “When you’re good at something, working hard allows you to really understand it”. Agreement with this statement fits with the idea of processing with a positive correlation between ability and effort.

Stipek and Gralinski (1996) found, in a longitudinal study, children who believed that intelligence is something that is fixed also believed that performance is relatively stable, i.e. governed by fixed intelligence rather than variable with effort. When effort is not required, little difference in behaviour may be seen between people with differing theories. Rhodewalt (1994) referred to ‘self-handicapping’ behaviours made by some people when faced with evaluative performances. These behaviours included less effort, procrastination and illness. In their study with undergraduates, participants reporting these behaviours were more likely to favour performance goals. Withdrawal of effort

was displayed by people who paid attention to situations where they could display themselves in a positive or negative light, and if a negative situation were anticipated then, it is theorised, non-exertion of effort protected self-esteem. Rhodewalt also found participants displaying these behaviours were more likely to agree that abilities are innately determined, in other words that it is fixed, which is consistent with an entity Implicit Theory. Looking for predictors of self-handicapping, Midgley, Arunkumar and Urdan (1996) mediated the relationship between negative attitudes towards education and results being achieved by 8th grade students. This suggests that there are consequences towards holding theories about learning and ultimately that it is goals which predispose people to less effort. Kim, Lee and Hong (2012) found different groups endorsing negative in-group stereotypes when failure was possible. In their first study, women were more likely to endorse the stereotype of women's inferior maths skills if they were anticipating a difficult, as opposed to an easy, maths task. In their second study, men were more likely to endorse the stereotype of men's inferior verbal skills if they were anticipating a more difficult verbal ability task. These patterns suggest that protective, self-handicapping behaviours can be primed in individuals by simply telling them that a task will be difficult. If this finding has strong external validity, then it would be highly relevant to people with Parkinson's, where many tasks become more difficult due to the symptoms of the illness. If this were the case, then people with Parkinson's may be likely to endorse the difficulties related to their symptoms when a task was considered difficult.

Kim et al. (2012) did not discuss their results in terms of implicit theories, however in a third study they found self-handicapping was more likely to occur in individuals with high trait self-esteem. Participants with low trait self-esteem did not significantly change their endorsement of the stereotype two weeks after initial testing, in the absence of the math task, however participants with high trait self-esteem no longer

endorsed the negative stereotype. Discussing self-handicapping, Berglas and Jones (1978) suggest that people with little self-esteem need be less protective of it. Investing self-esteem in a trait is akin to holding a performance goal, such as paying attention to how good something looks. Within the population of people with Parkinson's, there is a high rate of depression (Reijnders et al. 2007; Riedel et al. 2013), which is associated with decreased levels of effort (Cohen, Weingartner, Smallberg, Pickar, & Murphy, 1982). There is potential for any low-levels or reduction in effort seen within people with Parkinson's to be explained by depression rather than holding of an entity theory or trait self-esteem. Alternatively, there could be an interaction between levels of depression and implicit theory held, with higher depressive response correlating with high entity agreement. Learning about Implicit Theories relevant to people with Parkinson's could help to understand further the relationship between depressions and effort. If some of the variance in this relationship can be explained by Implicit Theory then there is an increased opportunity for encouraging effort.

2.2 Implicit Theory Domains

The PIT research investigation (Section 1.3.3 above) questions that Implicit Theories of people with Parkinson's could have an impact on their behaviours. Of further interest is whether Implicit Theory informs usage of a smartphone speech therapy application. A main purpose of the application is as a vocal exercise tool (Section 1.3.2.1 above), so whether Implicit Theories impact goals related to health behaviours for vocal improvement should be relevant. Additionally, the application is presented on a smartphone, with users being predominantly older adults. As discussed in Section 1.3.2 above, older adults are more likely to be unfamiliar with new technology. Whether Implicit Theories impact goals related to using and learning to use a potentially unfamiliar medium is not clear from previous research.

Implicit theories tend to be domain-specific (Andersen & Chen, 2002; Bugental, 2000) so, for example, it is possible for the same individual to believe their math skill is fixed and overall intelligence is malleable. The adaptability of Implicit Theory is demonstrated by the variety of domains it has been established for, including: intelligence (Dweck, 1999); stereotyping (McConnell, 2001); and courage (Rate, Clark, Lindsay, & Sternberg, 2007). Despite the apparent adaptability of the theory, it has not frequently been applied to health domains (c.f. Section 2.2.1).

The importance of holding different goal types (as introduced in Section 2.1.2 above), and their impact, is explored by Grant and Dweck (2003). Their results are discussed in terms of two classes of goals, ‘learning’ and ‘performance’. Learning goals, as associated by Implicit Theory with an incremental theory, predicted better coping, sustained motivation, and higher achievement in challenge situations. Goal theories, for example Achievement Goal Theory (Pintrich, 2000; Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002), focus on two forms of goals: ‘performance’ goals and ‘mastery’ goals. These parallel the goals considered by Implicit Theory. While goal theories are important in explaining how goals influence behaviour, Implicit Theory goes further by describing how our thoughts and mindsets lead us to hold different goals. Believing traits are fixed or malleable logically will have an impact on related goals, for example if a trait is improvable then a mastery goal becomes a fitting drive. Following research suggesting willpower is a limited resource which depletes as we use it; Job, Dweck and Walton (2010) suggested there is an interaction between this depletion and our beliefs about whether it is actually limited. In one study, after presenting participants with what was described as a ‘depleting’ experience, they found enhanced, rather than diminished, self-control in participants who indicated they did not hold theories which view self-control as limited. In another longitudinal study, they found eating behaviour change, procrastination and self-regulated goal striving during depleting experiences were

predicted by participants theories about willpower. The studies by Job et al. (2010) highlight the connection between implicit theories and resultant behaviours. While goal theories, and knowing how goals operate, are important in terms of knowing about behaviour, understanding how our thoughts lead us to different goals is also important. From a health behaviour perspective, understanding how implicit theories lead people to hold helpful goals – if Implicit Theory could be applied to the health domain – which would be informative in trying to best help achieve health objectives.

The central focus of Implicit Theory is the route from theories to goals to behaviours (see Table 2-1 above). This path was not explicitly shown in the study by Job et al. (2010), which referred directly to the outcome behaviours from theories held. While Implicit Theory of Intelligence, how Implicit Theory was originally titled (Dweck & Leggett, 1988) refers directly to intelligence, and although little attention for the theory has come from health psychology, Implicit Theory has been investigated within several diverse domains. An Implicit Theory of Relationships has been developed (Knee, Nanayakkara, Vietor, Neighbors, & Patrick, 2001; Franiuk, Cohen, & Pomerantz, 2002; Knee, Patrick, & Lonsbary, 2003), which contrasts growth theories with destiny theories. With a growth theory of relationships, issues that arise during a relationship can be overcome. Relationships can require work, so this theory is compatible with that. With a destiny theory of relationships, there is a belief that people are either meant for each other, or they are not. Holding this theory, if a relationship requires work it may be an indication that it is not supposed to be. If someone were to hold strong destiny beliefs and find themselves in a relationship where things generally ran smoothly, they might believe themselves to be ‘right’ for each other, however, this belief could easily become uncertain if for example an argument were to happen. Knee et al. (2001) found participants showed lower satisfaction with their partner if they fell short of their ideal, except where participants scored high on growth measure items and low on ‘destiny’

measure items. Without comment on whether any individual relationship could or should have long term viability, these findings suggest how holding different theories will potentially lead to different reflections and behaviours in response to interactions within a relationship.

An Implicit Theory of mental toughness was explored in three different cohort types by Gucciardi, Jackson, Hodge, Anthony, and Brooke (2015). They were interested in the prevalence of an incremental theory of mental toughness across three different achievement contexts. To students ($n = 444$, mean age = 19.25) they presented a measure of Implicit Theory of mental toughness along with fear of failure and mental toughness measures. To 'white collar' employees of the Australian services sector ($n = 395$, mean age = 48.78) they presented the measure of Implicit Theory of mental toughness which was combined with performance and creativity ratings by their supervisors. To adolescent athletes ($n = 230$, mean age = 14.98) the measure of Implicit Theory of mental toughness was presented along with measures of resilience and thriving. As well as being interested in categorising participants as entity or incremental theorists, they were also interested in an in-between ambivalent group. Dweck (2006b) suggest that typically 40% of people will endorse an incremental theory, 40% an entity theory and the remaining 20% are ambivalent – although it is not clear whether this figure should hold across different domains of Implicit Theory. Gucciardi et al. (2015) found support for incremental and ambivalent groups only. Across the student and adolescent athlete cohorts the split of participants between incremental and ambivalent groups was approximately equal, but for the employee cohort there was approximately two thirds of participants who were in the incremental category. Across all three cohorts incremental theorists showed responses to the additional measures in directions consistent to what was expected comparative to the ambivalent participants. Incremental theorists in: the student cohort had lower reported fear of failure and perceived stress; the

employee cohort had higher job performance and creativity; and the adolescent athlete cohort had higher measures of resilience, learning and vitality. These findings support the existence of an Implicit Theory of mental toughness, and the research is of additional value because it compares a student sample with participants sampled from other cohorts. Of interest is that the employee sample had almost twice as many incremental theorists as ambivalent participants, compared to the other two cohorts both having a relatively equal split. As samples from all cohorts were split based on responses to the same Implicit Theory measure, one of the most salient possible causes of this difference is that the employee cohort had a mean age of more than twice that of the student cohort and more than three times that of the adolescent athlete cohort. Potentially age has an interaction with an Implicit Theory of courage or with Implicit Theory more generally.

2.2.1 Implicit Theory of Health Related Domains

Beyond Implicit Theory much current health psychology research examines a broad spectrum of behavioural factors: self-control (e.g. Myrseth, & Fishbach, 2009); motivation (e.g. Chrysochou & Grunert, 2014); temporal (e.g. Hall, & Fong, 2007); and regulatory focus (e.g. Hong & Lee, 2008). Each of these perspectives adds to what is known about health behaviours, and why patients' actions are not always what they know would be best for their well-being. When therapists provide patients courses of action for them to follow in order to best progress some health aspect, the patient is normally in agreement that the best outcome would be achieved by following that course. Yet while the best outcome is desired by the patient, these facts are not predictors of adherence (Noto, Vecchiet, Monforte, & Wu, 2002; Wu, Moser, Chung, & Lennie, 2008). The importance of understanding psychological flexibility in health was highlighted by Kashdan and Rottenberg (2010). If Implicit Theory can be related to patient adjustments in the domain of health then it could help to further enhance knowledge of health behaviours. Some patients who do not adhere to a therapy possibly possess an entity

theory about their ability to improve some health aspect, leading to formation of performance goals for that situation. This could lead avoidance of effort, or a temporary effort for the benefit of their health practitioner, and understanding this could help to explain further, and offer direction to a solution to, non-adherence. For people with Parkinson's compliance with therapy can be particularly problematic (Grosset & European PD Therapy Compliance Study Group, 2010). Of particular interest to PIT research here are the motivations and health behaviours of people with Parkinson's.

Neuroplasticity is the idea that the brain can physiologically change and develop in response to learning, changes in the environment, or cognitive changes (Draganski, Gaser, Busch, Schuierer, Bogdahn, & May, 2004; Kempermann, Gast, & Gage, 2002). This idea is in direct support of an incremental Implicit Theory, things can change and develop. Although the juvenile period is especially suited to physiological changes due to learning, neuroplasticity of the same type (but to a lesser degree) has been shown in older adults (Kempermann, Gast, & Gage, 2002; Lillard, & Erisir, 2011). Suchowersky, Gronseth, Perlmutter, Reich, Zesiewicz and Weiner (2006) states that no treatment for PD has been shown to be neuroprotective, however Vinogradov, Fisher and de Villers-Sidani (2012) advises "cognitive training approaches for mental and addictive disorders must take into account possible inherent limitations in the underlying brain 'learning machinery' due to pathophysiology". For neuropsychiatric illnesses efforts might be directed toward changing overlearned maladaptive behaviours (Vinogradov et al., 2012). Similarly for people with Parkinson's a treatment might be trying to address something that has been learned adaptively and effectively and never before considered an issue, but that is now starting to occur differently than when learned and is now either deteriorating or becoming problematic. An individual with Parkinson's may have never before had issues with, for example, balance but now requires motor-therapy to help with walking.

Learning new methods for achieving previously simple or automatic tasks requires development of new cognitive strategies and extra focus and effort that was not required before. Part of this newly required cognitive effort may be aided, or hindered, by holding implicit theories that affect the type of goals, and subsequently behaviours, that are related to these efforts. One study used neural event-related potentials in healthy participants to look at how beliefs alter focus on different types of error correction information (Mangels et al., 2006). They found that entity and incremental theorists focused on, and responded differently to, negative feedback. Thus at a neural level our beliefs bias our learning via goal-congruent focus. This area needs further exploration, and understanding the outcomes and mechanisms of training-induced neuroanatomic structural changes for patients with neurodegenerative disorders is a challenge remaining for neuroscience (Draganski, 2008). On advancing neuroplasticity towards clinical interventions, Cramer et al. (2011) discusses lessons that can be learned from other fields including learning and point to the importance of motivation and attention. From a top-down perspective, knowledge in this area can be furthered by investigating outcomes due to different Implicit Theories. If Implicit Theory is applicable to a general health domain then it suggests factors can be explored which help or inhibit health behaviours and outcomes.

Eccles, Murray and Simpson (2011) investigated perceptions of cause and control of the disease in people with Parkinson's. Through conversations with patients a lot of the emphasis for control was related to medication for control of symptoms and acceptance versus denial as a secondary control process. Although not discussed, acceptance of the illness would be more compatible with an incremental theory, acceptance leading to information seeking and other affirmative coping strategies (Felton & Revenson, 1984). Denial would be consistent with an entity theory, if the illness is not being engaged with then healthier behaviours are unlikely to be sought. Investigating

types of support at early stages of Parkinson's, Ravenek & Schneider (2009) found instrumental, emotional and informational support each had positive influence on participation in physical activity. This is useful in demonstrating that different forms of messages were able to positively impact activity, indicating that it is possible to induce variability in behaviour at early stages of Parkinson's. Participants also reported engagement in physical activity as being a means to control the progression of Parkinson's, although participant numbers were low ($n = 7$). Cantrell (2008) investigated a suggested relationship between perceived controllability of Parkinson's and types of coping strategies by making use of Implicit Theory. Parkinson's is referred to as a 'largely uncontrollable physical situation' and she was interested in how coping might be affected by dominant goal orientations in such circumstances. Forty-eight participants with Parkinson's were included in the study. Cantrell made use of a Telephone Interview for Cognitive Status (Brandt, Spencer, & Folstein, 1988) for an exclusion criterion, which resulted in only one potential participant being excluded. Included participants had a mean Hoehn-Yahr score of 2.33. Validation-seeking – similar to a performance focus of entity condition – was highlighted as important to how coping efforts were appraised. Cantrell found that validation-seeking was correlated with lower subjective well-being in people with Parkinson's.

2.2.2 Implicit Theory of Technology Related Domains

Similar to health related domains there is sparse previous research investigating Implicit Theory and technology related domains. Implicit Theory suggests that perceived present ability interacts with goals resultant from theories, and affects resultant behaviour (see Table 2-1 above). Undergraduate students completing an introductory statistics module were measured for their confidence with statistics, which was found to be the strongest link (of measured factors) with success in the module (Abd-El-Fattah, 2005). This research did not investigate Implicit Theory, but provides support for the part of

perceived present ability within the model, and relates it to a loosely technology-related area.

Mathematics more generally is an area commonly related to technology. Similar to older adults being associated with negative stereotypes related to technology (see Section 1.3.2), females are associated with negative stereotypes related to mathematics, which has received discussion in the context of Implicit Theory by Dweck (2006a). It had been found that even for females who had been performing well previously there was a vulnerability to confidence when material became challenging, which was less of an issue in males. They found a gap at 8th grade between male and female math scores, but only where math was believed to be a gift. Math being viewed as a gift is part of a stereotype that presupposes males to be more likely to be gifted at maths than females. Dweck encourages the value of effort to be highlighted over the value of ability. In order to move away from harmful stereotypes in science she suggests public dialogue should not be focused towards who has ability and start looking at how math and science abilities can be nurtured.

Flanigan, Peteranetz, Shell and Soh (2015) explored Implicit Theory in 621 undergraduate computer science students. They measured agreement with incremental and entity theories in first year students, at both the start and end of their first academic semester. At both times they found more agreement with the incremental theory, however at the end of the semester incremental theory agreement had decreased and entity theory agreement had increased. This suggests that agreement with different Implicit Theory mind-sets can change over time. The measure used here was taken from previous Implicit Theory research related to general intelligence, so an implicit theory of technology or computer science was not being measured. This seems appropriate when measuring students whose primary study is computer science, it can be reasonably assumed that their thoughts and experiences related to intelligence and learning will

relate back to science, their primary learning focus. Implicit Theory measure responses by these students would not indicate whether they thought ability to learn languages or musical instruments was fixed.

2.3 Altering Implicit Theories

It would be unwarranted to explore Implicit Theory in relation to Parkinson's if there was no opportunity to alter outcomes. Bargh, Chen and Burrows (1996) describe priming as 'the incidental activation of knowledge structures, such as trait concepts and stereotypes, by the current situational context'. Social perception, attitudes and other affective reactions are suggested to be potentially triggered automatically by appropriate objects or events. In one of their experiments participants were given a scrambled sentence task where the words related to the prime of 'elderly' (or a control version). The dependant variable was then measured, following a partial study debrief, which was how long it took participants to walk down the corridor to the elevator after they thought the study was complete. Participants who been given a task containing words priming the concept of 'elderly' took longer. The elderly-related condition intentionally avoided speed-related words, relying on exposure to the theme of older-adults to trigger an association which resulted in a measurable physical behaviour. In another paper (Williams & Bargh, 2008) participants asked to plot two points far apart from each other on a grid subsequently rated unhealthy food to have fewer calories in one study, and reported weaker attachment to family members in another study, in comparison to participants asked to plot two points closely spaced on a grid. Here psychological distance was primed by participants marking points either near or far away from each other. These studies by Bargh et al. (1996) and Williams and Bargh (2008) received some challenge for failed replication attempts (Doyen, Klein, Pichon, & Cleeremans, 2012; Lynott et al., 2014). In a rebuttal of criticisms by Bargh (2012), it is pointed out that other successful replication attempts and meta-analyses are ignored. Pashler,

Coburn and Harris (2012), in refuting Bargh's work, differentiates between types of priming and acknowledge what has been termed 'perceptual priming' has been robustly demonstrated. An example of perceptual priming is people being faster to identify the word 'nurse' as an English word having previously read the word 'doctor'. Pashler et al. (2012) refer to the type of priming in Bargh's studies as 'goal priming' and 'social priming', and argues that the route from the prime to what is activated by the prime is a lot more complex than in perceptual priming. Other examples of priming include: better performance at trivia questions were seen following participants making self-comparisons with teaching professors (Dijksterhuis, & van Knippenberg, 1998); better intelligence scores when Einstein is made salient with low relevance to the participant, but worse intelligence scores following direct comparison with Einstein (LeBoeuf & Estes, 2004); and primes can be seen to have greater or lesser effect when a priming task is easier or more difficult (Schmidt, Niehaus, & Nagel, 2006). When discussing alteration of Implicit Theories, alteration of behaviour via priming is particularly relevant. The examples of priming indicate that it is possible to present relatively simple material or manipulations, which can then be seen via behavioural change.

As well as looking at how an individual's behaviour varies depending on the Implicit Theory they express, behaviour manipulations have also been demonstrated via Implicit Theories. Elliott and Dweck's (1988) manipulated goal orientations analogously to Implicit Theory simply by advising participants that a task would be used to judge their ability (performance goal), or would be an opportunity to develop skill (learning goal). They additionally manipulated beliefs about skill level by advising that results from a pattern recognition task suggested that they had either high or low ability at the task. Participants provided with performance goal and low ability manipulations subsequently showed more deterioration in their strategies when completing ensuing difficult tasks and selected to attempt easier tasks when given a choice. Hong et al.

(1999) – discussed in Section 2.1.1 above – described in one study how participants at a Hong Kong University with entity theories were less likely to express interest in remedial English following poor feedback. In another study Hong et al. used an implicit theory manipulation, attempting to induce either an entity or incremental mind-set. The manipulation here was in the form of reading material, strongly defining intelligence as either fixed or malleable, supported by references to fabricated research. This material was presented as a comprehension exercise, participants then having to summarise what they had read and also state which evidence within the piece they had found the most compelling. This was followed by difficult intelligence test problems where feedback was manipulated so participants received either satisfactory or unsatisfactory feedback. A further stage then involved participants selecting between two tutorial exercises, one that would help improve performance on the difficult intelligence test problems previously encountered or one that was an unrelated ability task. Participants who had initially read the material describing intelligence as fixed were more likely to choose the exercise that would help performance on the previously encountered task when they had received satisfactory feedback. Participants who had encountered material describing intelligence as malleable were more likely to choose this remedial exercise regardless of feedback type received. The study then had a further stage where questionnaires were presented. Of particular interest here is the dramatic effect two similar pieces of reading material could have to subsequent selection between exercises. It is worth noting the complexity of the study, containing two manipulations (reading material and feedback valence) and multiple stages. Measures of Implicit Theory were not taken at the start of the study, which would have further lengthened the procedure, but which also means it is not known how many participants received a manipulation congruent or incongruent with how they would have scored on such a measure.

Another form of manipulation was used by Blackwell et al. (2007, mentioned briefly Section 1.2.2 above). Relatively low achieving American 11-13 year old participants were provided a series of workshops that induced an incremental theory of learning. These were presented as eight 25-minute class periods, spread over eight weeks where both the control and experimental groups learned about brain physiology, study skills and anti-stereotypic thinking. The experimental group delivered these with extra focus on the malleability of intelligence and how it can be developed, whereas the control group had extra material on memory and discussion about academic issues. Teacher reports in math, blind to student's experimental conditions, showed positive change in motivation by 27% of students in the experimental group ($n = 48$), compared to nine percent of the control group ($n = 43$). Math grades, typically captured in spring had been recorded at the end of the previous academic year (spring of 6th grade) no difference was seen between conditions. An additional test was taken partway through 7th grade prior to the experimental procedure and again there is no difference between groups, both showing a downward trajectory from their previous test scores. At spring of 7th grade, post intervention, the control group's math results show a further decrease in math performance, roughly along the trajectory established from the first two test points. Experimental group students' results show an improvement from test point-two, so reversed the downward trajectory (referenced as typical for that age), and were different from the control condition results at this point. Whereas the procedure of Hong et al.'s (1999) study 3 was quite convoluted within one 'visit', here there is only one manipulation and testing and questionnaire measures are presented months apart. Spreading the manipulation out over a period of 8 weeks maybe works well in terms of reinforcing a different perspective through which to view things; intelligence in this case. Time periods like this can be incorporated into an academic year presuming the school and researchers have resource. This method however might be less applicable to most

non-educational contexts where less time can be allocated. The aim of priming is generally to temporarily alter behaviour. With this extended manipulation a more lasting alteration of a mind-set might be expected, however there is no retest after the 7th grade mentioned. The manipulation was not covert, instead it openly taught and discussed things like neural pathways growing and reinforcing as effort is engaged, giving solid foundation for believing things to be flexible. This is in contrast to classical priming examples outlined above, where the manipulation was very subtle in relation to the variable being measured. Implicit Theories were measured by Blackwell et al. (2007) at pre and post manipulation, using a six item measure scored using a Likert scale from one to six. A difference was seen between pre- and post-test mean scores for the experimental group's endorsement of an incremental theory (4.36 to 4.95), but not for the control group's (4.62 to 4.68). It is reported that a post-intervention difference existed between the experimental and control groups ($4.95 - 4.68 = +0.27$), however it is not reported whether a difference existed between groups pre-intervention ($4.36 - 4.62 = -0.26$). It is not clear whether both groups of students would have responded similarly to the intervention procedure used if there was a difference between groups pre-intervention. Further, if there was a naturally occurring difference between groups for Implicit Theories, and Implicit Theory is a good predictor of outcomes, should a difference have been expected between math-scores at pre-test? The control group's math scores were non-significantly lower at the end of 6th grade rather than higher, however the transition into 7th grade in America is equivalent to the change from Primary to Secondary school in the UK (Year 6 to Year 7), and a point where grades traditionally suffer, many stresses occur, and it is argued that Implicit Theories are more relevant when situations are challenging.

Schroder, Moran, Donnellan and Moser (2014) attempted to integrate Implicit Theory research with cognitive neuroscience, presenting a mind-set manipulation prior to

participants completing a reaction-time task while their event-related brain potentials were being recorded. The manipulation used what they describe as ‘standard mind-set induction materials’, referencing several different papers for this material including Hong et al (1999) referred to above. This material was texts for participants to read that reported on research describing intelligence to be either fixed or variable. In a subsequent reaction-time task, participants given an entity Implicit Theory manipulation demonstrated enhanced attention on responses, but without seeing alterations in responding following errors as the task went on. Response alteration might have been expected if participants were learning about how to maximise performance. Participants given an incremental Implicit Theory showed enhanced attention to task-relevant stimuli, as well as well as response adjustments following task errors. This demonstrates superior or inferior engagement with the learning process is possible following presentation of varied manipulations. Manipulations used are often quite straight forward, for example presentation of texts with differing valence to read. The relevance for the PIT research is whether similar simple manipulations could similarly alter engagement with a speech therapy presented via a smartphone.

2.3.1 Longitudinal Studies with Implicit Theory Manipulations

Engagement with health behaviours, such as therapies, generally occurs over extended periods of time. If manipulations can have an effect on engagement, it is of relevance whether this effect is chronic or acute. Some studies apply Implicit Theory manipulations over extended periods of time, or else look at changes to Implicit Theory between two times following some other sort of manipulation. Louis (2011) assigned first year university students to either a control condition or to receive strengths interventions over four weekly class periods. The strengths interventions were either in the form of talent identification, which highlighted the value of focusing on existing strengths as they were the ones most likely to flourish, or of strengths development,

which highlighted the flexibility of strengths and encouraged efforts to develop them further. The talent identification group did not suggest that strengths and weaknesses were fixed, but was vague about ways of actually improving the talents identified. Measures of Implicit Theory were by all participants before and after the intervention period. No significant difference was seen between control and strength development conditions. Participants in the talent identification however showed a highly significant change between Implicit Theory scores, showing more entity theory agreement at post-intervention. This study by Louis does not mention research ethics, however, as most Implicit Theory research implies potential cognitive dangers associated with an entity theory it seems a relevant discussion. The materials used here, although based on pre-existing strengths interventions, and also not specifically intended to alter theories, did however have a potentially negative outcome for participants. This highlights the importance of a research debrief wherever potential harm may be caused.

Many studies using Implicit Theory manipulations will try to contrast the effects of entity and incremental versions. This is likely advantageous as each intervention would theoretically nudge participants' theories in opposite directions from a control groups predicted theories. This allows greater comparison between the two conditions than either one of the conditions would be expected to have in comparison to a control condition. One drawback of not including a control is not learning about which intervention (entity or incremental) has the greater effect, which contrast with a control would allow. A second drawback is where manipulations are being used in longitudinal studies. As noted there are potential cognitive dangers associated with entity Implicit Theories, so using an entity manipulation in a longitudinal study might be an issue. An intervention (discussed further Section 2.3 above) given to American, 11-13 year old participants in the form of a series of workshops induced an incremental theory of learning (Blackwell et al., 2007), resulting in better than predicted math grades. These

students were significantly different to those of a control group whose grades were lower. No condition with an entity manipulation was used. The incremental manipulation took place over eight sessions during the school year, and with an entity manipulation this would mean a long time period before debrief could be presented. An example of potential danger of an entity theory was demonstrated by Hong et al. (1999) where entity condition participants, following poor English ability feedback, were less interested in remedial English despite being about to embark on an educational course at an English-speaking University. Here an immediate debrief allows explanation of the different Implicit Theories before participants complete participation. This hopefully allows a more proactive attitude to remedial behaviours – if they are actually needed – and avoids unhelpful theories that may have resulted from the manipulation from becoming entrenched in the mind of the participant. If Implicit Theory manipulations were found able to affect health behaviours, strong consideration would need to be given to any chronic effects of that manipulation. If an outcome was, for example, lower inclination to engage with a therapy, then ethical consideration needs to be given to its appropriate usage.

2.3.2 Health Related Manipulations

A search for priming research with people with Parkinson's does not return much research close to the type of priming suggested by Bargh (Bargh et al., 1996; Williams & Bargh, 2008, discussed Section 2.3 above). Within people with Parkinson's the term 'priming' generally refers to the process of neural stimulation (e.g. Hallett, 2007). This process involves use of brief high intensity magnetic field for a non-invasive stimulation of the brain. Of more relevance to the type of priming under discussion here, Espay et al. (2015) has shown that altering expectations can alter outcomes for people with Parkinson's. Participants were told that they were getting either a cheap variant of a dopamine injection, or an expensive variant. Both groups heard the drugs they were

receiving had the same effect. This should have been true, as both groups were actually given the same placebo, however significant variations were found between groups for motor function and brain activation. The results are presented by Espay et al. (2015) as a manipulation of the placebo effect rather than a priming effect. The cognitive mechanisms responsible for the results seen could be similar to priming and other manipulations of Implicit Theory discussed above. More research would be needed to investigate that, but it indicates that use of varied messages – suggesting price differences here – can be used to alter outcomes for people with Parkinson's.

In the absence of prevalent use of Implicit Theory manipulations in health psychology, a study by Bray et al. (2011) used a manipulation created using social cognitive theory (Bandura, 2011). Similar to an Implicit Theory manipulation used by Hong et al. (1999), the manipulation used by Bray et al. was text based, being a two-page brochure, and was described as a 'targeted, theory-driven, print-based intervention'. Of interest to the study were physical activity behaviours in students, transitioning into university. Participants were provided either: the two-page manipulation brochure; Canada's Physical Activity Guide (CPAG); or no intervention. The theory driven intervention included, along with health and activity information, strategies for optimising self-perceptions and motivation, guided mastery strategies, outcome expectations and an interactive action planning exercise. On reports of moderate-to-vigorous physical activity the participants receiving the theory-driven manipulation showed a significant difference from control participants; and participants receiving CPAG showed a towards-significant difference. Print versions of theory-driven media are suggested to be a low-cost and easily distributed form of intervention. An issue with the effect of the intervention is drop-off rate of participants involved in the study, of 935 students meeting the inclusion criteria and 312 included in the experimental condition, 218 of 312 were lost at follow-up, not responding to emails. Similar drop-off was seen in

the other two conditions but in terms of testing an intervention the participants responding is likely to include a higher proportion of those who found the material more engaging, and with the majority of participants dropping out results could be skewed.

2.4 Research Including People with Parkinson's

Before conducting research with a clinical population – people with Parkinson's – it is important to look at factors which would influence how any studies were conducted. Considering issues that existed in previous research, with people with Parkinson's, is also important as it might show avoidable problems or confounds that have occurred in previous research, or unavoidable issues that might need to be considered when examining results.

2.4.1 Considerations for Studies with People with Parkinson's

There is a high degree of variation among people with Parkinson's as to symptoms (Lewis et al., 2005). As a progressive illness, an individual's symptoms change over time in terms of number, frequency and severity, as described by the Hoehn-Yahr scale (Hoehn & Yahr, 1967). There is 'early-onset' Parkinson's, defined as the condition experienced by individuals aged 20-50, accounting for typically 5-10% of all Parkinson's cases (Samii et al., 2004). The majority of people with Parkinson's are older adults, whom also form a demographic of individuals who experience higher co-morbidity with other health conditions compared with younger adults (Fried et al., 2001). This heterogeneity in terms of ages and of symptoms experienced has implication for designing studies with this cohort. This level of variation indicates that random allocation of people with Parkinson's into experimental or control conditions is unlikely to result in similar participants within each condition. This would make it harder to be certain that outcomes are likely to have been caused by independent variables, and also more difficult to reproduce any finding with a different set of participants.

In one review including 1673 participants, Tomlinson et al. (2012) note a mean age of onset of 60 across participants. However, they cited research suggesting a mean age of onset of 67 to 69 (Patel 2010, as cited in Tomlinson et al., 2012) and thus warned that findings may not have ecological validity for people with Parkinson's. Although studies referenced in the research (Section 1.1) suggest a mean onset of approximately 60, the warning is valid. Given the variation of age and heterogeneity of symptoms of people with Parkinson's, it may be easy for research to contain conclusions that do not relate to a general population of people with Parkinson's.

As with most experimental research studies, error variance, or variance not caused by independent variables, can be mitigated using increased participant numbers (Wilson VanVoorhis & Morgan, 2007). Many studies including people with Parkinson's, however, fail to exhibit high participant numbers. For example, reviewing physiotherapy interventions in people with Parkinson's, Tomlinson et al. (2012) found a mean of 39 participants included across 43 studies. An earlier publication of this review (Deane et al., 2001a) included seven studies with a mean of only 20 participants. Reviewing speech and language therapy versus placebo or no interventions in people with Parkinson's, Deane, Whurr, Playford, Ben-Shlomo and Clarke (2001b) found three studies with a mean of 21 participants. The spread of the number of participants experiencing the experimental conditions was six, twelve and fourteen. These participant numbers indicate a potential danger of a lack of power in studies that include people with Parkinson's. Initiatives like the Fox Trial Finder – set up by the Michael J Fox Foundation – now exist (but was not sufficiently established outside of the U.S. at the time of this research) to try to help people with Parkinson's find studies that they would like to take part in (Chowdhury, Meunier, Cappelletti, & Sherer, 2014), but appropriate recruitment remains a challenge.

When conducting research with people with Parkinson's, several issues involving the symptoms of Parkinson's may need to be considered. These include those symptoms described as barriers to adherence (Section 1.1.3). Furthermore, fatigue, found to be an independent symptom – rather than a secondary outcome of other symptoms – of Parkinson's (Karlsen, Larsen, Tandberg & Jørgensen, 1999), needs to be considered, as the process of taking part in research can sometimes be elongated and the experience of fatigue may affect engagement. People with Parkinson's are also likely to vary in the medications that they are currently taking, which can provide benefit for a number of symptoms (Chaudhuri & Schapira, 2009). There will be further variation in: which medications have been taken by the individual prior to (or during) research participation; varied timeframes of activation of each medication; and varying effects on currently-experienced Parkinson's symptoms, including on cognitive and physical states during participation. The potential for both fatigue and varying states of medication (activity, type and dosage) indicates researchers should be mindful of any resultant changes to participants during research participation.

Considerations of retention, adherence and adverse events in studies including people with Parkinson's have been shown to be poorly reported (Allen, Sherrington, Suriyarachchi, Paul, Song, & Canning, 2012; Tomlinson et al., 2012). Allen et al. (2012) consider retention could be an issue but that it is underreported, with only 62 of 90 interventions that they considered for review providing retention figures. Of these 62 studies, there was a dropout rate of 15%, which means for studies planned with smaller numbers, withdrawals are of serious consideration. Of studies included by Allen et al. (2012), 32% reported at least one participant withdrawing due to the interventions (which were related to exercise and motor training). Adherence, or compliance with the intervention, was quantified in only 30% studies reported by Tomlinson et al. (2012), and in 49% of studies reported by Allen et al. (2012). This does not suggest that adherence

itself is an issue, rather the reporting of adherence. Tomlinson et al. (2012) point out that without details of adherence, it makes it difficult for medical practitioners to effectively evaluate and select appropriate interventions. Finally, adverse events were reported in 28% of studies investigated by Allen et al. (2012). Reported events included: cardiac arrests; a fall; muscle cramps and tiredness; muscle soreness; and shoulder pain. Again, it is important for this type of information to be conveyed accurately so that interventions can be considered and assessed for appropriateness relating to not just treatment effectiveness but treatment adherence.

CHAPTER 3. RESEARCH CONTEXT

The Parkinson's Implicit Theory (PIT) programme of research was to be split into two phases. The first phase would be initial hypotheses testing using student participants (Study 1 in Section 3.2.1 and also Chapter 4). The second and main phase of PIT research would be studies involving people with Parkinson's and this part was to be synchronised with the stages of the larger SAP project (Section 1.3.2.1). The research plan designed for the SAP project aimed to comply with the awarded Parkinson's UK (PUK) grant format (Section 3.1 below) and to take into consideration the issues described above in Section 2.4.1 related to conducting research with people with Parkinson's. The larger SAP project (Section 1.3.2.1) intended to iteratively develop an assistive speech and language tool (in the form of a smartphone application), to be tested following completion of each development stage, utilising people with Parkinson's. Three iterative versions of the tool were planned to be completed. One-off tests, with low numbers of participants (Nielsen, 2000), were planned to gain feedback for the first and second versions (Studies 2a and 2b in Sections 3.2.2 and 3.2.3 and also Chapter 5). For the third version, a longitudinal test of the tool, using more participants, was planned (Study 3 in Section 3.2.4 and Chapter 6).

3.1 Parkinson's UK Innovation Grant

An 'Innovation Grant' of £35,000 was awarded to the larger SAP project by Parkinson's UK (PUK). The PUK grant application was primarily completed by the thesis author, in collaboration with Roger Eglin who was the PUK grant's principal applicant, and with input from two co-applicants: Julia Johnson, speech therapist at King's College Hospital; and Professor Chaudhuri, head of Neurology and Movement Disorders at King's College Hospital. Assistance was also sought from grant application advisors available within the University of Portsmouth. The stated aim of the PUK grant

application was to progress development of, and research the efficacy of, an existing prototype of a speech and language therapy software application for mobile phone devices. A secondary purpose was included in the PUK grant application to address the current research aims (Section 1.3.3). That was, Implicit Theory manipulations or interventions would be sought for presentation to people with Parkinson's prior to being introduced to a speech therapy software application. It was intended that encouraging an incremental view of technology and vocal abilities at this point of introduction would lead to optimal engagement, benefitting the SAP project. It was hypothesised that improving participants' cognitive approach – when engaging with the device and application – would increase and improve the speech therapy smartphone application's usage and maximise the potential speech therapy effects.

As part of the PUK grant application, an outline of how the studies would be structured was provided. A spiral model of technology development was utilised (Boehm, 1988). The plan for the SAP project was to develop three iterative versions of the smartphone application within the PUK grant's period. Also as part of the PUK grant, brief user testing and feedback would follow the first and second versions, and then a larger test of the smartphone application would follow the third version. This format was used to structure the plan of the PIT research studies (Section 3.2 below). To give an idea of timelines for the PIT research, the PUK grant award stated that the period of funding would be in place for 12 months, and this period could not commence prior to NHS ethical approval. This period was scheduled to include all the development time for the three application versions, and the testing periods also. The PUK grant also included funds for purchase of devices to use during testing, costs incurred during testing, salary costs for an additional research assistant during testing procedures and payment of software developers for the development of the application. The main phase of the PIT research (involving people with Parkinson's) was supported by the PUK grant

application, however it was as a secondary aim, so any decisions made during the research process needed to prioritise the SAP project and the PUK grant's primary aim of developing and testing the application.

3.2 Planned Structure of Studies

The following subsections (3.2.1 – 3.2.4) will outline the planned order of studies for the PIT research (as submitted in the grant application), describing the initial plan of investigation for each study. Studies are described as an ideal of how the investigations would be structured, and how each study was planned to progress from the previous study. As the ideal format for the planned studies, they are discussed terms of what will happen in the, potential, future tense. Each study is then described in full detail, along with any variations that occurred, within its relevant chapter (Chapters 4-6). Causes of variations are introduced in Section 3.3 below as it is important to be aware of deviations from a theoretically 'designed' study when interpreting results.

3.2.1 Study 1 – Initial Hypothesis Testing with Non-Clinical Population

This study will progress the aims of the research by providing an initial attempt at creating materials similar to those required in later studies, and also by investigating whether the manipulations and measures showed responses in the directions expected. The study was also designed, as the initial phase of the PIT research, to avoid using people with Parkinson's as participants at such an early stage, and prior to any attempt at a proof of concept.

Manipulations of Implicit Theory *in a technology relevant domain* will be used to create two experimental conditions. Half of the participants will be presented with material suggesting technology intelligence is fixed, and half with material suggesting it is malleable. An existing measure of Implicit Theory (Abd-El-Fattah & Yates, 2006), will be taken, and adapted to be relevant (see Appendix B.1). Abd-El-Fattah and Yates found that participants generally showed more agreement with incremental items in

comparison to entity items, by both Egyptian (n = 940, mean incremental item agreement = 18.78, mean entity item agreement = 14.87), and Australian (n = 162, mean incremental item agreement = 19.30, mean entity item agreement = 13.02) participants, in response to their measure. A measure will also be taken of technology ability and familiarity. Next, participants will take part in a technology ability test, and details of their behaviours and performance during the test noted. A summary highlighting key aspects of Study 1 can be seen in Table 3-1 (below).

Table 3-1

Summary of Research Variables for Study 1 (Full details in Sections 4.2, 4.3, and 4.6).

Main Research Goal:	To examine the viability of materials created for investigating Implicit Theory, for a domain of <i>ability with computer programming languages</i> , using student participants.
Main Hypothesis:	Participants will display more behaviours and beliefs congruent with the manipulation type (entity or incremental) that they receive.
Null Hypothesis:	There will be no difference seen between the conditions.
Main Dependent Variables:	Responses to an Implicit Theory measure, and behaviours during programming language tasks.
Main Independent Variable:	Implicit Theory manipulation (entity or incremental) of ability with computer programming languages.

The Implicit Theory manipulation received should affect Implicit Theory measure scores; also behaviours and performance during a technology-related task should demonstrate an interaction between the Implicit Theory domain and technology familiarity and ability, consistent with behaviour patterns predictable by Implicit Theory (see Table 2-1 above). Findings should contribute towards an investigation of motivational goals, related to technology and provide initial development materials to be used for Study 2. Conducting this study with student participants allowed it to be completed before the SAP project had completed ethical approval. This enhanced

learning for the PIT project prior to fixed timescales required by the subsequent project stages (see timeline, Figure 3-1 below).

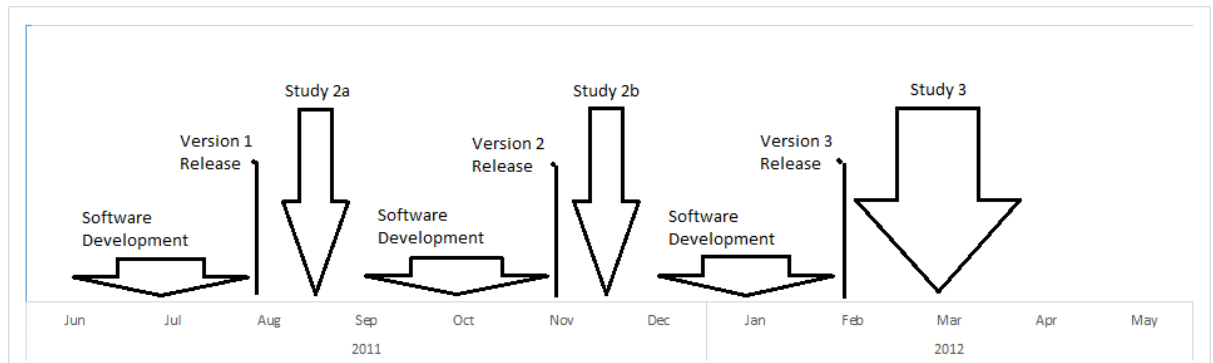


Figure 3-1: Planned timeline of studies during grant period (after Study 1a and Study 1b), with software development periods leading to version releases of the smartphone application.

3.2.2 Study 2a – First Test of Hypothesis Involving People with Parkinson’s

This study occurs at the point at which the SAP project is testing a first iteration of the smartphone application to be developed within the context of the PUK grant. It will progress the aims of the PIT research by investigating whether the manipulations and measures showed responses in the directions expected. It represents the first study of the main phase of the PIT research. This study is interested in whether there is an Implicit Theory domain for *ability with technology* that can be applied to people with Parkinson’s. This will develop work from Study 1 by progressing the initial investigation, with material presented to University students, onto an investigation using the primary target audience for the research, people with Parkinson’s. The Implicit Theory manipulation received should affect Implicit Theory measure scores; also prolonged application usage should demonstrate an interaction between the Implicit Theory and technology ability and familiarity measures, consistent with behaviour patterns predictable by Implicit Theory (see Table 2-1 above). Findings should contribute towards an investigation of motivational goals, related to technology, in people with Parkinson’s. Materials developed here for the Implicit Theory domain of

technology ability will be of further use also for Study 2b and 3, which will progress investigation of this domain further.

Table 3-2

Summary of Research Variables for Study 2a (Full details in Sections 5.2, and 5.3.3).

Main Research Goal:	To investigate an Implicit Theory domain of <i>ability with technology</i> in people with Parkinson's.
Main Hypothesis:	Participants will display more behaviours and beliefs congruent with the manipulation type (entity or incremental) that they receive.
Null Hypothesis:	There will be no difference seen between the conditions.
Main Dependent Variables:	Responses to an Implicit Theory measure, technology questionnaire, and behaviours during smartphone application usage and usability question responses.
Main Independent Variable:	Implicit Theory manipulation (entity or incremental) of ability with technology.

A summary highlighting key aspects of Study 2a can be seen in Table 3-2 (above). Manipulations of Implicit Theory in the domain of technology will be used to provide participants with either an incremental or entity theory about their ability with technology. Half of the participants will be presented with material suggesting technology intelligence is fixed, and half with material suggesting it is malleable. This will be constructed similarly to the version created in Study 1, adapting it to include learning from responses received. As in Study 1, an existing measure of Implicit Theory (Abd-El-Fattah & Yates, 2006), will be adapted to be technology-relevant, incorporating feedback received from that study. A measure will also be taken of technology ability and familiarity. Next, participants will take part in usability tests and provide feedback on that iteration of the speech therapy application, to progress the SAP project.

Information from usability tests is not planned to be directly relevant to the PIT research,

aside from a perseveration measure: the period of time participants spend interacting with the device.

3.2.3 Study 2b – Second Test of Hypothesis Involving People with Parkinson’s

This study will occur at the point at which the SAP project is testing a second iteration of the smartphone application to be developed within the context of the PUK grant. Similar to Study 2a above, it will also progress the aims of the PIT research by investigating whether the manipulations and measures showed responses in the directions expected. Study 2b represents the second study of the main phase of the PIT research. This study is interested in whether there is an Implicit Theory domain for *vocal issues* that can be applied to people with Parkinson’s.

Table 3-3

Summary of Research Variables for Study 2b (Full details in Sections 5.5, and 5.6.3).

Main Research Goal:	To investigate an Implicit Theory domain of <i>vocal issues</i> in people with Parkinson's, using more naturalistic environments.
Main Hypothesis:	Participants will display more behaviours and beliefs congruent with the manipulation type (entity or incremental) that they receive.
Null Hypothesis:	There will be no difference seen between the conditions.
Main Dependent Variables:	Responses to an Implicit Theory measure, speech questionnaire, and behaviours during smartphone application usage and usability question responses.
Main Independent Variable:	Implicit Theory manipulation (entity or incremental) of health behaviours.

A summary highlighting key aspects of Study 2a can be seen in Table 3-3 (above). This study will build on and reinforce what will be learned from Study 2a, using the same research design. A manipulation and measure of Implicit Theory in the domain of vocal ability was to be used. The manipulation will be constructed using the same template as the previous study, and the measure will again make use of existing

material (Dweck, 1999 pg 180). Materials developed here for the Implicit Theory domain of vocal ability will be of further use also for Study 3, which aims to progress investigation of this domain further. As participant numbers will be relatively low for both Studies 2a and 2b, it will be useful to compare results to see if they are in a consistent direction. As the Implicit Theory domains being examined vary (Study 2a manipulating Implicit Theory of technology ability and Study 2b manipulation Implicit Theory of vocal ability), it will not be possible for results to be combined for increased study power. Additionally, if study 2a shows that alterations are needed to any of the procedure, measure or the manipulation, this study will offer a chance for these to be tested and developed further.

3.2.4 Study 3 – Longitudinal Investigation

This study will capture actual measures of improvement and performance using the assistive technology, in addition to prolonged application usage, of that used previously in studies two and three. This will enable the main hypothesis of the research to be advanced, that manipulation of Implicit Theories can be used to *improve speech performance* and to *improve engagement* of people with Parkinson's utilising a technology-supported therapy. Motivational goals related to the technology's usage will be manipulated via the *Implicit Theory intervention*, and also measured, along with technology and vocal abilities, technology familiarity measurements, and Implicit Theory of *vocal ability measurement*.

Table 3-4

Summary of Research Variables for Study 3 (Full details in Sections 6.2, and 6.3.3).

Main Research Goal:	To further investigate an Implicit Theory domain of <i>ability with technology</i> in people with Parkinson's, using longitudinal smartphone application behaviours.
Main Hypothesis:	Participants will display more behaviours and beliefs congruent with the manipulation type (neutral or incremental) that they receive.
Null Hypothesis:	There will be no difference seen between the conditions.
Main Dependent Variables:	Responses to Implicit Theory measures, technology questionnaire, and behaviours during prolonged smartphone application usage.
Main Independent Variable:	Implicit Theory manipulation (neutral or incremental) of ability with technology.

This study will occur at the point at which the SAP project is testing a third and final iteration of the smartphone application to be developed within the context of the PUK grant. The SAP project's ambition for testing of this version is to present the application to a greater number of testers (who will be participants for the purposes of the PIT research), and leave it with them for two weeks before collecting it back from them and gathering feedback. This involves meeting testers twice, for a deployment visit and a collection visit. Data will also be captured by the application about the usage of the smartphone application during this period. This study will progress the aims of the PIT research by allowing a more substantial test of the same hypotheses (Section 1.3.3.1) with the inclusion of greater participant numbers. It will also capture behaviours more accurately – using data recorded by the application over a longitudinal period – which provide a stronger link back to Implicit Theories, both measured and manipulated, prior

to smartphone application usage. This will help investigate the effects of Implicit Theory, in domains of technology and vocal ability, on resultant behaviours. At the deployment stage this study will make use of Implicit Theory materials developed in the previous studies: the manipulation of Implicit Theory in the *domain of technology* developed in study 2a; along with Implicit Theory measures of both *technology beliefs* and *vocal ability beliefs* (from both Study 2a and 2b). If previous results are found to have been in the directions expected, half of the participants will be presented with material suggesting technology ability is malleable. The other half of the participants will act as controls and be presented with more general information about technology. This will create two randomly-assigned experimental groups.

As part of ensuring a reasonable sample size, to investigate *technology ability* Implicit Theory, the participants' vocal ability Implicit Theory will not be manipulated as part of Study 3, but will be measured, along with other measures of technology and vocal ability and vocal issues. These will all be taken prior to presentation of the technology ability beliefs manipulation, and the technology ability Implicit Theory measure taken afterwards (similar to earlier studies where Implicit Theory of the manipulated domain is measured after presentation of the manipulation).

To conclude the deployment stage's measures, a pre-test of vocal loudness will be taken. This will be the sound pressure level, in decibels, of participants reading a standard speech and language therapy text (e.g. the Rainbow Text, Fairbanks, 1960) at a fixed distance from the developed speech therapy application. Participants will then be given a mobile-device with the developed speech-tool, to use in their daily lives for a period of two weeks. The collection stage will then occur at the end of this period, and participants will be met again, the devices collected, and they will also be requested to provide feedback. A post-test of vocal loudness will also be taken at this point. Feedback data captured from users at the collection stage will not be directly relevant to

the PIT research, however performance data (comparison of the pre- and post-measures of vocal loudness, and speech-tool usage data) will be used when comparing study groups.

3.3 Factors Affecting the Parkinson's Implicit Theory Research

Some variations to the planned structure of studies (Section 3.2) occurred – and the actual studies will be described in Chapters four to six – but also the programme that is outlined varied from the planned programme (Section 3.2) to investigate the PIT research aims (Section 1.3.3). Factors shaping these variations are introduced here. The intention at this point is not to necessarily discuss each factor in detail, but to look at them collectively so they can be considered as a whole and then look at how they impacted the way the research was conducted. As the research procedure varied from the initial design, variations also needed to be considered in what conclusions could be drawn from the research, and what evidence should be used to draw those conclusions. How the research procedure developed will thus need to be considered (Section 3.4).

3.3.1 NHS Ethics Application

The first planned study for the PIT research was initial hypothesis testing (Section 3.2.1) using Undergraduate students attending the University of Portsmouth. This section of the research was covered by local research ethics approval. However, the NHS ethics application was a lengthy process, which was not initiated until the viability of the research was known through confirmation of the PUK grant application success. Initially it was planned to treat each testing stage of the application as separate research projects, which assumed three NHS ethics applications. When the scale of the task to complete one application became clear the plan was changed to complete one application for the entire SAP project and include all three studies. The NHS ethics application was primarily completed by the thesis author, with assistance and direction provided by health research ethics experts both at the University of Portsmouth and at King's College

Hospital. The application was assessed by a panel organised by Kent Research Ethics Committee in August 2011, which was attended by the thesis author to represent the SAP project. Approval was finally confirmed in September 2011; however the proposed timeline for the 12 month period of the PUK grant duration was June 2011 to May 2012. This was a flexible proposal however, as the PUK grant period could not commence until after ethical approval had been received. The PUK grant period then ran from September 2011 to August 2012. An updated study timeline to reflect these dates can be seen in Figure 3-2 (below).

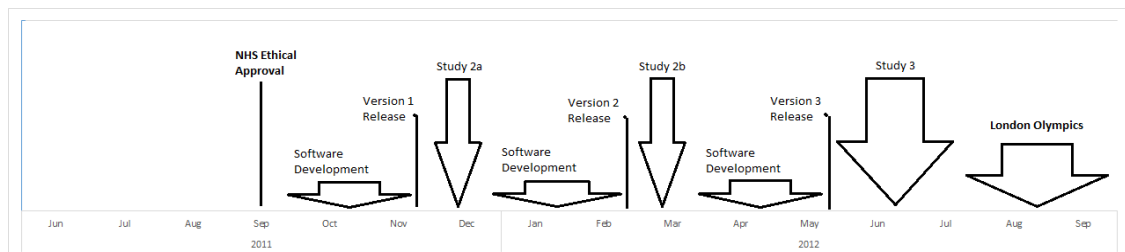


Figure 3-2: Timeline of Studies showing temporal shift in schedule from Figure 3 1 (above), to incorporate studies (2a, 2b and 3) starting after granting of NHS Ethical Approval, and finishing before the start of the London Olympics.

Completing the ethics application for all parts of the research involving people with Parkinson's in advance saved time, however it also reduced the flexibility of adapting the design (although there was a process available to request alterations). One outcome of this was the decision to not request use of audio / visual recording devices, meaning feedback had to be recorded by hand during the procedures. This decision is likely to have helped the PIT research as it reduced the complexity of the experimental setup, for example the use of recording devices would have required more calibration time when visiting participants' homes.

When completing the NHS Ethics application, one of the major considerations, in terms of potential harm to participants, was the use of Implicit Theory manipulations. Any entity manipulation would involve suggesting to participants that something is fixed

and cannot improve. In terms of generating discernible contrast between study conditions it is ideal to use both this entity as well as an incremental manipulations as this should direct participants towards the logical extremes of Implicit Theory. Risk of harm can be minimised when participation is concluded within the same visit, as all participants could be debriefed and informed about the manipulations they had been exposed to. For Implicit Theory research that contains a longitudinal component however – see Section 2.3.1 for discussion – there is generally no use made of entity manipulations, instead comparing the incremental condition to a control condition. It was thus decided that it would not be appropriate for the longitudinal study (Section 3.2.4 and Chapter 6) to include an entity manipulation suggesting that either their technology or vocal abilities were fixed. The effect of this decision has the potential for less contrast between conditions compared to a study that involved an incremental and an entity condition.

3.3.2 The Role of the Thesis Author

As mentioned above, the author here took a lead role in both the PUK grant application, and also the NHS ethics application. The success of both of these processes served the purposes of the PIT research and also those of the SAP project. Following the completion of these stages, the thesis author took on a project management role for the SAP project, whilst also conducting the separate PIT research programme. Project management involved working with the software developers who were developing the application. This involved decisions about the visual presentation and design of the application, prioritising accessibility and usability, and taking into account issues such as poor eyesight or low technology familiarity (details of final application version in Appendix G.1). This also involved providing developers with feedback following research and testing stages, to redirect development priorities. However, it was important to act for the benefit of the SAP project rather than the PIT research due to the

main aim of the grant. For example, it might have been advantageous to the PIT research for the application to have been developed to alter feedback messages in a manner congruent with Implicit Theory. This however would not have been relevant to progressing towards a completed application within the SAP project and so remained a lower-order development priority.

When the initial project was proposed, a smartphone was seen as an ideal medium to use for presenting speech volume information to users. One of the benefits of this medium is that users could bring smartphones with them into a number of environments, thus be kept with them almost permanently (Oulasvirta, Rattenbury, Ma, & Raita, 2012). It was known, however, that smartphone usage by older adults is associated with negative stereotypes (Ansley & Erber, 1988; Mitzner et al., 2010), anxiety (Hogan, 2006), and relatively poor uptake (Morris & Venkatesh, 2000). The PIT research intended to investigate Implicit Theory in the context of people with Parkinson's learning to use this application and also engaging in vocal exercise. The PIT research would complement the aims of the SAP project by potentially helping to understand more about how users might engage with the application, via Implicit Theory. Although the PUK grant (Section 3.1) was awarded to the SAP project, rather than to the PIT research, it is possible that without this PUK grant neither would have progressed. The PUK grant awarded was the maximum available under PUK's Innovation grant scheme and defined the scale of the studies that were achievable. Some limits and restrictions as a result of the PUK grant are discussed in Section 3.1 (above). Generally these limitations were of impact more to the PIT research, as opposed to the SAP project. Despite the SAP project not being optimally-designed for the PIT research, it provided a highly valid real world context for research allowing for strong ecological validity

3.3.3 Participant Recruitment

The initial phase of the PIT research makes use of University students as participants. These participants would be recruited from the University of Portsmouth. The overall aim of the PIT research is to investigate Implicit Theory with people with Parkinson's, so use of student participants is a compromise. This compromise balances considerations of often low participant numbers seen in other research with people with Parkinson's (Section 2.4.1 above), with the greater availability of proxy participants, and a reluctance to engage the time of a clinical population before conducting any initial tests of hypotheses.

An ideal candidate to be a participant for the SAP project would be one who might benefit from using the application being developed. This would likely be a person with Parkinson's and also hypokinetic dysarthria (or any other symptoms specifically affecting speech volume). An ideal participant for the main phase of the PIT research is consistent with this. Participant recruitment for the studies was coordinated by Julia Johnson, speech therapist at King's College Hospital. Of Ms Johnson's patient caseload, people with Parkinson's form only a small proportion of patients that she sees. Of these patients with Parkinson's those with volume issues form only a subset, as other symptoms (Section 1.1.1 above) also result in referral to a speech therapist. However, it would not have been possible to recruit enough 'ideal' participants, so the studies were designed to recruit people with Parkinson's who had received any speech therapy referral. This meant that some participants would not have vocal volume issues, and so were being asked to test an application not directly relevant to them. It was important to test as many people as possible however (Section 3.1), and any feedback from as wide an audience of people with Parkinson's as possible was still of benefit to testing the application for the SAP project. The impact on the PIT research however is worth highlighting. The mechanisms of an Implicit Theory (Section 2.1) are that the theory

held by an individual affects the type of goals that are made, subsequently affecting behaviours. There are potential interactions between holding a theory about flexibility of ability with technology and whether that technology is relevant to you, or holding a theory about the stability of vocal volume and whether any vocal concerns actually exist.

The limits of the studies' structures were generally consistent with the stipulations of the PUK grant award. The first and second tests of hypothesis involving people with Parkinson's (in brief Sections 3.2.2 and 3.2.3; and in detail Chapter 5) will have ideally have enough power to have effectively tested the hypothesis. Taking into account scheduling, transport and accommodation costs and considerations, these first two studies (Studies 2a and 2b) including people with Parkinson's will both take place over two-to-three day periods. The second of these studies will involve running the study at participants' homes, which adds complexity these considerations. Studies involving low participant numbers are also considered appropriate at this stage for the SAP project to obtain adequate test feedback, six testers having been proposed previously as an ideal number (Nielsen, 2000). Again, while low numbers of participants is appropriate for the SAP project, it presents challenges for the PIT research.

For the final longitudinal investigation, recruitment plans were again established around what will be plausible with the available funds. It was possible to buy 15 devices, allowing for a maximum of 15 participants to be tested at once, and the budget and timescales allowed for completing four blocks of 15 participants. Again, larger numbers would have improved the PIT research's power, however the design was considered appropriate for the SAP project. One intention (Section 3.2.4 above) had been to leave the application with participants for two weeks. A longer period might actually have been preferable for the PIT research, allowing behaviours to be observed for a longer period – without necessarily requiring any additional funding – but the 12 month PUK grant period was again a restriction. A second factor that influenced plans was the end of

the PUK grant period clashed with the London 2012 Olympics (both ending in August 2012). In terms of logistics of travel and accommodation in London, it was anticipated that this event would make conducting the study difficult. Furthermore, the researchers were mindful of participant availability during this period, with some participants likely to decide to make plans either involving the event, or to avoid the city during the event. In response to these circumstances, each block of 15 participants was fitted within a two week period. To maximise this time period, devices will be delivered as close as possible to the start of week one and collected as close as possible to the end of week two. This will result in participants having approximately eight to ten days with the application, as opposed to two full weeks.

3.4 Emergent Research Approach

The initial conception for the PIT research was that all sections could be analysed using purely quantitative means. Study 1, providing an initial test of hypotheses using a non-clinical population were set up with a task that involved observing participants' behaviours (for results see Sections 4.5.3 and 4.8.3), such as how many times participants compiled a piece of code before getting something right (perseverance) compared with how many times a task was skipped (avoidance). A main purpose of Study 1 was to learn from this procedure design, as it was planned for the studies that would test the research hypothesis (Section 1.3.3.1) using people with Parkinson's to involve a similarly-formatted task, where it would be visible to the researcher what behaviours a participant was performing on a smartphone device. It was intended to gain an understanding of what kind of behaviours might be exhibited in different circumstances.

Quantifiable application usage data was available from the first study including people with Parkinson's (Study 2a, for results see Section 5.4.4) but was not possible from the second (due to procedural time constraints, see Section 5.7.4). In the absence of data from recording equipment (see Section 3.3.1) the thesis author attempted to take

note of behaviours (what they did with the application and device) as well as everything that was said by participants during the procedures of the first two studies with people with Parkinson's (Studies 2a and 2b). The information captured in this way included many participant reflections on his or her responses to measure items and situations during application usage.

Other information, such as vocal volumes measured (see Sections 5.4.3, 5.7.3, and 6.3.3) – captured as part of the SAP project – were not initially planned to be included as part of the research here. The accumulation of different types of data sources demonstrates how the PIT research became opportunistic. This was a response largely driven by the many complexities briefly outlined in Section 3.3. Another initial expectation of the research design was that the final longitudinal study would be a larger study that would stand alone from the first two studies including people with Parkinson's. It was intended that the first two studies would allow development and testing of Implicit Theory materials, progressed from the initial studies with a non-clinical population, and the final study would avail of these. Factors affecting the research – highlighted in Section 3.3 – pushed the PIT research here towards a pragmatic approach similar to that discussed by Goldkuhl (2012). Triangulation of multimodal types of data allowed for the research hypothesis to be inspected from different directions. The first and second studies with people with Parkinson's hopefully complement the longitudinal study, rather than simply providing a platform from which it could proceed. As it was generally not possible to observe significant results from any one quantitative data source, interpretation between several sources became more important.

CHAPTER 4. INITIAL NON CLINICAL POPULATION TESTING

The Smartphone APplication (SAP) project aimed to develop a speech therapy smartphone application for use by people with Parkinson's (see Section 1.3.2.1). Several barriers were discussed which might affect potential usage (see Section 1.1.3). As part of learning more about these barriers, it was planned for the Parkinson's Implicit Theory (PIT) research to be opportunistically run alongside development and user testing stages of the SAP project (see Section 3.4). Implicit Theory (Dweck & Leggett, 1988), briefly, is a model that describes how an individual's beliefs about something (for example math skill) might suggest it is either fixed (an entity theory) or flexible (an incremental theory). These theories lend themselves to different types of goals, if something is flexible then a mastery goal (to increase ability) is predicted, and if something is fixed then a performance goal (to demonstrate high ability, or avoid demonstrating low ability) is predicted. These goal types interact with ability level, especially with a performance goal, and can lead to either mastery or helpless behaviours (see Table 2-1 above). The intention for the PIT research is to see if Implicit Theory can be applied to people with Parkinson's, specifically in the circumstance of being presented with the SAP project's smartphone application, to see if holding different Implicit Theories can affect effective engagement with the application. Prior to running studies with people with Parkinson's, the intention here was to conduct an initial test of hypothesis, and of the research approach, on a non-clinical population.

Subsequent studies intend to investigate Implicit Theories in the domains of technology ability and of vocal issues with people with Parkinson's. Investigation of these domains require manipulations aiming to encourage, in participants, either an entity or incremental Implicit Theory, along with measures of the relevant Implicit Theory domains. As these materials have not been previously developed specifically, for the

Implicit Theory domains of interest, it would be necessary as part of the PIT research to develop them. As available research time as part of the SAP project would be limited (see Section 3.1) it would be important to have materials already at least initially developed and tested prior to conducting these subsequent studies. Initial studies of the PIT research would utilise University students as participants to provide this initial testing of the Implicit Theory materials to be used subsequently in studies involving people with Parkinson's. These initial studies were not designed with the aim of informing as to how people with Parkinson's would respond to the Implicit Theory materials, or to inform of any relationship between Implicit Theories of people with Parkinson's or older adults verses Implicit Theories of students. The primary purpose was to test that materials had been developed appropriately, to trial the procedure of developing the materials and to discover whether they generated abnormal responses. A benefit of initial tests including student participants would be ease of implementation and access to participants.

4.1.1 An Implicit Theory Manipulation

The possibility of altering Implicit Theories was established by prior research (Section 2.3 above). However, some studies made use of manipulation presentation over a prolonged period of time (e.g. Blackwell et al., 2007). Thus, existing Implicit Theory manipulations were sought which disseminated adequate content to indicate what was presented to participants as they must be effective following brief exposure. An Implicit Theory manipulation is described by Hong et al. (1999, Study 3), complete with paragraph extracts for both an incremental and an entity version that showed promise for the purposes of the research here.

The example paragraph outlined for the entity version of the manipulation was as follows:

Knowles spent the last decade tracing identical twins who were raised apart. . . . According to Knowles' results, up to eighty-eight percent of a person's intelligence is due to genetic factors. About ten percent of intelligence seems to be determined during the first three years of life. This means that intelligence may be increased or decreased by only about two percent during most of a person's life. (p. 594)

The example paragraph provided for the incremental version of the manipulation, following a very similar structure, was as follows:

Knowles spent the last decade tracing identical twins who were raised apart. . . . According to his results, up to 88 percent of a person's intelligence is due to environmental factors. In an extreme case, a young girl adopted by a college professor and his wife had an IQ of 138. The genetically identical twin was raised by the real mother, who was a prostitute. This girl had an IQ of 85. (p. 594)

These paragraphs formed part of longer pieces of texts which were provided to participants to read. Alongside the text were quotations highlighted to draw additional attention from the reader, such as "...Intelligence seems to be rather fixed..." as part of the entity version, and "...Intelligence seems to be rather malleable..." as part of the incremental version. Their study included participants – University students in Hong Kong – who were given either satisfactory or unsatisfactory feedback following an English comprehension task. The behaviour measured was whether participants choose to take a remedial English course. For participants given satisfactory feedback was no difference between manipulation type received and choosing to take a remedial tutorial. For participants given unsatisfactory feedback, of those who had been exposed to the

entity manipulation 13.3% (n = 15) of participants chose to take the remedial course. In contrast, of those who had been exposed to the incremental manipulation 73.3% (n = 15) of participants chose to take the remedial course. This difference in behaviour according to the manipulation that was received is an indicator of its affect, however for the PIT research the manipulations used would be altered to be relevant for a different Implicit Theory domain.

4.1.2 An Implicit Theory Measure

In addition to the manipulation, Implicit Theory measures were also sought which quantify the relevant factors for use in the PIT research. A 14-item Implicit Theory scale is described by Abd-El-Fattah and Yates (2006, see Figure 4-1 below). They express one of their aims in developing their version was to 'construct a scale that will be of use to future researchers'. They found the scale was factorial invariant across Australian and Egyptian nationalities, and across gender within each nationality. Inspection of the items, themed around intelligence, suggested that they were constructed in a way that would make them suitable for adapting to a different Implicit Theory domain. For example most items refer to either 'intelligence' or being 'intelligent'. To make the scale relevant to the PIT research these words could be changed to 'technology ability', 'computer programming ability' or similar. Abd-El-Fattah and Yates suggest that their measure was completed by participants within five minutes. Being mindful of substituted words likely being more elongated than the original items, and potential time constraints in later PIT research studies, items with higher factor loadings would be adapted here to be relevant in a technology domain.

Item	Statement	Loadings for Egyptian	Loadings for Australian
Entity			
14	You are born with a fixed amount of intelligence.	.86	.86
7	Good performance in a task is a way of showing others that you are intelligent.	.86	.79
1	You have a certain amount of intelligence and you cannot do much to change it.	.79	.77
4	If you fail in a task, you question your intelligence.	.77	.71
8	When you exert a lot of effort, you show that you are not intelligent.	.72	.58
2	Difficulties and challenges prevent you from developing your intelligence.	.51	.56
12	Your abilities are determined by how intelligent you are.	.44	.52
Eigenvalue		3.7	3.4
Incremental			
13	Good preparation before performing a task is a way to develop your intelligence.	.70	.71
11	Performing a task successfully can help develop your intelligence.	.68	.67
6	You can develop your intelligence if you really try.	.65	.61
9	When you learn new things, your basic intelligence improves.	.62	.61
3	The effort you exert improves your intelligence.	.60	.59
10	If you fail in a task, you still trust your intelligence.	.59	.57
5	Criticism from others can help develop your intelligence.	.51	.56
Eigenvalue		2.7	2.7

Figure 4-1: Taken from Abd-El-Fattah and Yates (2006). Exploratory factor analysis with oblique rotation of the Implicit Theory of Intelligence Scale for Egyptian (N=940) and Australian (N=162) data.

4.2 Overview of Studies

Programming was chosen for its potential to incorporate challenging tasks during testing, which is relevant to investigating Implicit Theory, as without challenge there is unlikely to be situations of failure where differing behaviours can become apparent (Section 2.1.3 above). Some students involved in courses including programming may find it an easy aspect of their course, however for many others programming can be a necessary aspect of their course, for example a science or engineering degree, but an element that is struggled with. Courses such as computer science can also suffer from poor retention of students, programming being an element of this (Beauboeuf & Mason, 2005). It might have been interesting for the student participants to have provided additional feedback for the application under development as part of the SAP project, however neither using the application nor using a smart phone were anticipated to offer any challenge to University student participants. By using tasks that involve programming, the intention was to still explore Implicit Theory relevant to technology in these early studies, but

acknowledging a substantive variation from the technologies that would be utilised in subsequent studies including people with Parkinson's. Again this would allow for exploration of the Implicit Theory materials developed to be tested for a technology relevant domain, despite not being able to match closely the technologies of the SAP project.

Despite student participants being considered both a preferable option to testing initial materials with the target clinical population, and a more available and abundant resource from the position of working in a University, the first study was poorly timed. It was conducted between late May and June (of 2011), which was an assessment period at the conclusion of the academic year for most students. The outcome was only 16 participants were recruited. The initial aim had been to investigate Implicit Theories of first year students who had some exposure to programming but who potentially had less fully defined theories about learning programming, than students on later years of the course. As a result of this low participant number, a second initial study was planned for nearer to the start of the next academic year. Originally this period would have interfered with the planned date for the first PIT research study to include people with Parkinson's (Study 2a, outlined in Chapter 5). The delay to completing the full NHS ethics application however (see Section 3.3.1 in Chapter 3 above), shifted the starting point of the 12 month Parkinson's UK grant period for completing the SAP project later into the year (2011). An outcome of this was to allow time for a second initial study including student participants. This meant that the initial investigation with a non-clinical population - Study 1 - became two studies, which will be referred to as Study 1a and Study 1b. Taking place at the start of the academic year it was then be possible for Study 1b to include new first year students who would not have spent any time learning programming in a tertiary educational environment. Combined with including participants who were in their second or third year of programming courses, it was hoped

that this would provide a parallel to the population of people with Parkinson's, across which there might be a more varied level of exposure to technology. This would allow investigation of the effect of experience level on Implicit Theory using the materials developed. Despite no longer being the end of the academic year, recruitment for this second initial study was again not prolific. The inclusion of Study 1b as an additional hypothesis investigation, however, did allow further testing of the materials developed including participants with more varied programming language experience. The goals and objectives of the two studies were very similar, so the structure here is to discuss them both together. Following both studies' introduction here (including goals and hypothesis, Section 4.3 for Study 1a and Section 4.6 for Study 1b), there will be the method (Section 4.4) and results (Section 4.5) for Study 1a and the method (Section 4.7) and results (Section 4.8) for Study 1b. Discussion for both (Section 4.9) will then appear following these parts.

4.3 Goals and Hypothesis of Study 1a

The main goal of Study 1a was to investigate the viability of materials generated for investigating Implicit Theory as part of the PIT research. These materials include Implicit Theory manipulations (introduced in Section 4.1.1 above, and described further in Section 4.4.2 below) and measures (introduced in Section 4.1.2 above, and described further in Section 4.4.2 below). The materials have been adapted to be relevant to investigate for an Implicit Theory in the domain of ability with computer programming. These materials were to be presented to University students who were completing their first year in a course involving at least some element of computer programming. Participants would be presented with either an entity or an incremental version of the Implicit Theory manipulation, followed by the Implicit Theory measure and then a computer programming task. The hypothesis for Study 1a is that, following presentation of an Implicit Theory manipulation, participants will demonstrate more responses

congruent with the version of the manipulation that they received. Congruent responses will include participants shown the incremental version of the manipulation would show more agreement with incremental measure items, and less agreement with entity measure items, in comparison with participants shown the entity version of the manipulation. Responses will also be sought from participants' behaviour during the programming language task. It is expected that participants shown the incremental version of the manipulation would show more perseverance, so more repeated attempts in order to complete difficult task items, and less skipping of task items. These participants would also be more likely to show thinking about different ways to solve a task item, or behaviours indicating a learning goal, either of which would be demonstrated by asking of more questions than participants who had been shown an entity version of the manipulation.

The goals of the research have limitations. Any evidence of strong Implicit Theory manipulations or measure created here for an Implicit Theory of programming languages would be restricted in its value as part of the PIT research studies. Firstly effectiveness will be limited to the cohort of participants used here, first-year undergraduate students with at least some programming exposure. Successful materials should however point towards the effectiveness of the processes used to generate them. This would help to support use of a similar approach for the creation of materials used in the PIT research studies with people with Parkinson's (Studies 2a and 2b in Chapter 5 and Study 3 in Chapter 6 below).

4.4 Study 1a: Method

4.4.1 Participants

Participants ($n = 16$) were first-year undergraduate students of the University of Portsmouth, for whom English was their first language. Participants were taken from degrees which involved at least one software programming module (Programming

Background, n = 9), or degrees which involved no software programming (non-Programming Background, n = 7). The study occurred at the end of the academic year, so all participants had at least one academic year's experience of programming. Age and gender of participants were not recorded.

4.4.2 Materials

4.4.2.1 Implicit Theory Manipulations. Texts were developed from descriptions of manipulations used by Hong et al. (1999). Two texts were used (see Appendices A.1), both fitting onto one A4 page each and structured identically but with the language varied to support different Implicit Theories. Some extracts from each are as follows:

Entity Version: ‘...The majority of research agrees that our abilities in these areas are fixed, and cannot be improved significantly through extra effort (Abblet, 1994...’; ‘...According to Knowles’ results, up to 88% of a person’s intelligence is due to fixed genetic factors...’; ‘...In another study by Cohen and Lau (2004) comments were taken from undergraduate participants... ... “I love our software development class, it just seems to come to me without trying”, *Tina...*’.

Incremental Version: ‘...The majority of research agrees that our abilities in these areas are variable, and can be improved significantly through extra effort (Abblet, 1994...’; ‘...According to Knowles’ results, up to 88% of a person’s intelligence is due to fluid environmental factors...’, ‘In another study by Cohen and Lau (2004) comments were taken from undergraduate participants... ... “I love our software development class, I keep trying at it and I keep getting better”, *Tina...*’.

At the end of both versions there is a multiple choice question presented as a check of understanding: “What was the main point of the research described in the first two paragraphs?”

4.4.2.2 Programming Ability Questionnaire. This consisted of three questions. The first two questions required responses to be made on a visual analogue scales: ‘What is your current level of software programming ability (in any programming language)?’ (Scale marked from ‘very weak’ to ‘very strong’); and ‘How well do you feel your ability level compares to that of others on your course?’ (Scale marked from ‘very poorly’ to ‘very well’). The third question invited a yes/no response: ‘Have you ever learned the Java programming language (to even a very basic level)?’ Items were presented in the same order to all participants.

4.4.2.3 Implicit Theory Measure. This was a 12-item measure developed from items found in Abd-El-Fattah and Yates (2006), including six incremental items and six entity items (see Appendix B.1). Items were altered to relate to ‘ability with computer-programming languages’. All items required responses be made using visual analogue scales marked from ‘Strongly Disagree’ to ‘Strongly Agree’. Example entity items were: ‘Good performance in a programming task is a way of showing others your ability’; and ‘You have a certain amount of programming ability and you cannot do much to change it’. Example incremental items were: ‘You can develop your programming ability if you really try’; and ‘If you fail in a task, you still trust your programming ability’. Items were counterbalanced by creating 12 different versions where the same questions were systematically ordered differently (similar to Appendix D.1).

4.4.2.4 Programming Tasks. The Java programming language was used. A cover-sheet introduced the tasks: 13 programming items, with ten minutes to complete them (See Appendix C.1). The instructions showed clearly that only one line in a programme needed to be altered for each task, and showed an example demonstrating

clearly how to locate that line. Next there were instructions included showing how to run and test attempts at each task. The tasks were clearly numbered one to 13, and each showed a target output that the participant was aiming to get to display on the screen. If completing the task required code that could not be determined from previous tasks, a brief instruction note was shown. For example, task one had a target output of “2” with the instruction “Type in the number as ‘two’. The line should look like: `output += two;`”. Items were presented in the same order to all participants.

4.4.3 Design

The study hypothesis is described above in Section 4.3. The independent variable (IV) was the version of the Implicit Theory Manipulation participants were given. The IV had two levels, either the Entity or Incremental version. There were several dependant variables (DV): Programming Ability Questionnaire; Implicit Theory Scale; and behaviours recorded during the Programming Task.

4.4.4 Procedure

The procedure took place in a private office. Participants were greeted at the door and shown to a desk. The desk was split into two areas, one open for filling in paperwork and the other containing a standard desktop computer. Participants were then told about the study, given an opportunity to ask any questions they might have, and then signed a consent form. Participants were advised that during the procedure the researcher could be consulted if there was any issues of understanding, or if any procedural issues arose. Then at the clear desk space participants were given an Implicit Theory Manipulation to read (Section 4.4.2.1 above). Next, participants were given the Programming Ability Questionnaire (Section 4.4.2.2 above) and the Implicit Theory Measure (Section 4.4.2.3 above). Measure responses and manipulation check for understanding were returned to the researcher without the researcher looking at them. Finally, participants were introduced to the Programming Tasks (Section 4.4.2.4 above).

The programming tasks were to be completed using the computer on the desk, with all the elements required already pre-loaded onto the screen. The researcher sat next to participants so that they could comfortably see both the screen and the participant's actions. Once ready to begin the researcher starts a timer to record when ten minutes was complete. The researcher also kept a count of how many compilation attempts were made for each task, how many questions the participant asked, how many tasks were skipped, and how many successfully completed. When the timer reached ten minutes the researcher asked participants to stop, and no more compilation attempts were included. Participants were then given a verbal debrief, emphasising the different manipulation types used and that both versions had been created by the researcher. Participants are then given an additional opportunity to ask questions and provided with a debrief sheet to take away.

4.5 Study 1a: Results

4.5.1 Questionnaire Responses

To rule out a potential confound of experience, an analysis between participants from programming and non-programming course backgrounds, and their split by those with and without Java programming experience, (see Table 4-1 below). The Entity Condition had fewer participants with Java experience and the Incremental Condition had fewer participants from programming backgrounds.

Table 4-1

Breakdown of Participants' Programming Experience.

<u>Programming Background (Y/N)</u>	<u>Java Experience (Y/N)</u>	<u>Incremental Condition</u>	<u>Entity Condition</u>
Y	Y	4	2
	N	0	3
N	Y *	1	1
	N	3	2

* It was expected that participants with Java experience would be a subset of participants with programming experience, and mutually exclusive of participants with no programming experience.

To rule out a potential confound of self-rated ability, mean responses to programming ability measure items are considered (see Table 4-2 below), showing the difference between conditions for self-rated ability. Responses to these two items, recorded using a visual analogue scale, translated into scores from 0 ('very weak' / 'very poorly') to 100 ('very strong' / 'very well').

Table 4-2

Response to Programming Ability Measures.

Programming Ability	<u>Current</u>		<u>Compared to peers</u>	
	Mean	SD	Mean	SD
Incremental Condition	37.8	22.4	29.0	25.1
Entity Condition	48.5	22.4	54.1	25.0

4.5.2 Implicit Theory Measure Responses

To explore the hypothesis that following presentation of an Implicit Theory manipulation, participants would demonstrate more responses congruent with the version of the manipulation that they received (Section 4.3), agreement with entity and incremental item types is shown in Figure 4-2 (below). Comparing participants' response across the Implicit Theory measure's items between conditions, an independent t-test did not show a significant difference ($t = 1.49$, $df = 14$, $p = 0.16$, two-tailed).

Participant numbers were low, and discussion is given to interpreting low powered results below (Section 4.9.3.3).

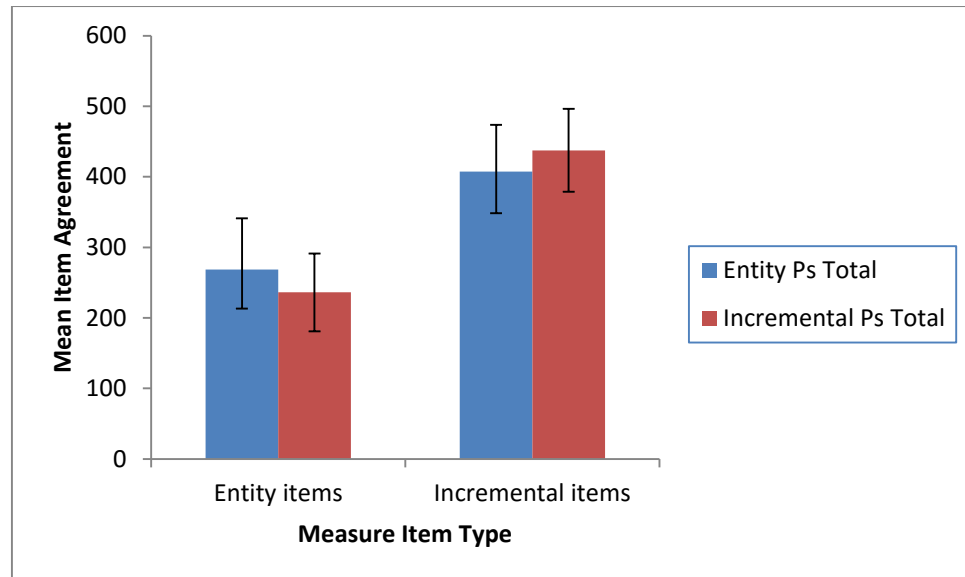


Figure 4-2: Mean Implicit Theory Measure item agreement (min=1, max=100) between Entity (n=8) and Incremental (n=8) participants and between Entity (6 items) and Incremental (6 items) measure items.

4.5.3 Programming Task Behaviours

Participants' behaviour during the programming language task were examined (Section 4.3). This was investigated with a MANOVA. The main effect of different behaviour types during the programming task was non-significant: $F(3, 12) = 2.58, p = 0.10$; Wilk's Lambda = 0.61; partial $\eta^2 = 0.39$ (see Figure 4-3 below). No minor effects were expected and, for clarity, analysis of each individual dependent variable, using a Bonferroni adjusted alpha of 0.02, showed there was no contribution: of questions asked, $F(1, 14) = 4.07, p = 0.06$, partial $\eta^2 = 0.23$; of tasks skipped, $F(1, 14) = 3.47, p = 0.08$, partial $\eta^2 = 0.20$; or of 3+ task attempts, $F(1, 14) = 1.15, p = 0.30$, partial $\eta^2 = 0.08$.

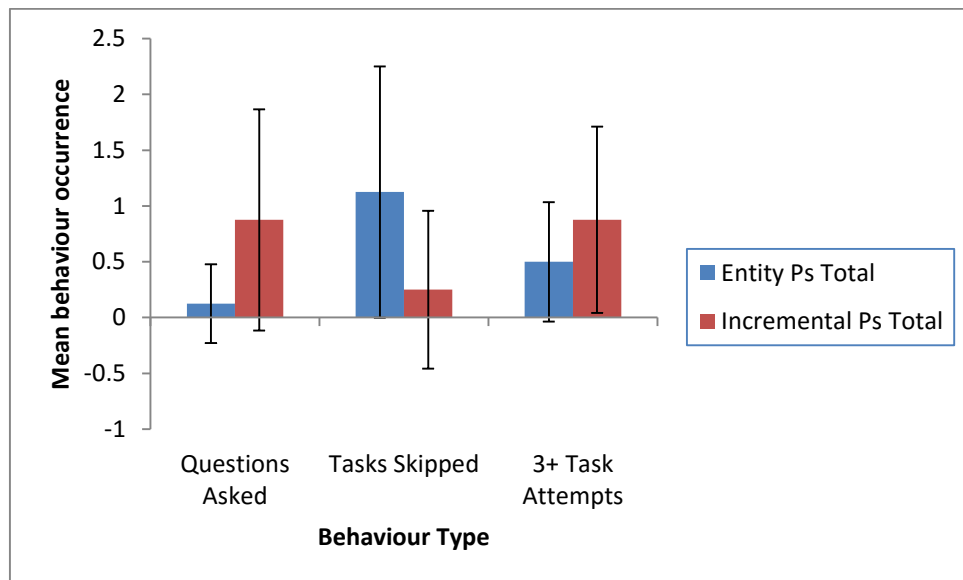


Figure 4-3: Mean occurrences of different behaviours during the programming task part of the procedure.

4.6 Goals and Hypothesis of Study 1b

The discussion of results for Study 1a will appear below (Section 4.9) in combination with a discussion of results for Study 1b. The goals for Study 1b contained only slight variations from Study 1a (Section 4.3 above). Participants of Study 1b were either new first year students (as the procedure took place at the start of the academic year), or students who had at least one full year at University studying on a course with at least some computer programming content. The Implicit Theory domain of computer programming ability remained; however, a goal of the research was to examine Implicit Theory response differences between these two experience levels. Another goal of Study 1b was to apply minor methodological variances (to those outlined in Sections 4.4.2, 4.4.3, and 4.4.4) which could then be compared to Study 1a to help determine the best format for subsequent PIT research studies. The hypothesis of Study 1b is the same as for study 1a, that following presentation of an Implicit Theory manipulation, participants will demonstrate more responses congruent with the version of the manipulation that they received. For Study 1b behaviours attended to by the researcher will include where participants pause to consider how to approach a task for more than a few seconds. It is

predicted, as part of behavioural responses, that pauses will indicate strategy change or strategy consideration, linked with an incremental Implicit Theory (Blackwell et al., 2007).

4.7 Study 1b: Method

4.7.1 Participants

Participants were undergraduate students of the University of Portsmouth, undertaking degrees involving at least one software programming module, and for whom English was their first language. Participants were either first-year students (Beginners; $n = 13$), or second- or third-year students (Experienced; $n = 9$). The study occurred at the start of the academic year, so first-year participants had very little experience of University-level programming at the point of participation. Second- and third-year participants had at least one year's experience at that level. Age and gender of participants was not recorded.

4.7.2 Materials

Materials used were the same as for Section 4.4, with three exceptions. Firstly, visual analogue scales, where used, were replaced by four-point Likert Scales.

The second change was that as part of the manipulations (see Appendix A.2). There was an additional three questions presented prior to, and consistent with, the manipulation component (Section 4.4.2). To participants receiving the entity manipulation these items appeared as: 'For subjects you find difficult, it seems very difficult to improve even with a huge amount of effort?'; 'Most people have some subjects they struggle with, for subjects you struggle with there is usually one or two people for whom it seems easy?'; and 'For subjects you find easier, you don't feel as if you need to put the same amount of effort in?'. To participants receiving the incremental manipulation these items appeared as: 'For subjects you find difficult, with a huge amount of effort you do seem to improve?'; 'Most people have some subjects they

struggle with, for subjects you struggle with there is usually one or two people who work harder and do better?'; and 'For subjects you find easier, you don't mind putting in extra effort?'. These items were marked on a four-point Likert Scales (marked from 1, strongly disagree, to 4, strongly agree).

Thirdly, the programming task used was modified slightly to include 25 questions (see Appendix C.2). Most of the new questions were repetitive variations of the same types of questions to allow participants to choose to continue with something they have already figured out, or skip ahead to something new.

4.7.3 Design

The study hypothesis is described above in Section 4.6. The design was similar to study 1a, with minor changes. There was an additional IV as participants belonged to either study condition: 'Beginners' or 'Experienced'. Participants in both conditions randomly received either the entity or incremental manipulation as part of the previously established IV (Section 4.4.3). There was also an additional DV, with participants providing a ranking of their preference for their programming module relative to their other modules being studied.

4.7.4 Procedure

The procedure was also similar to Study 1a (Section 4.4.4) but with some minor changes. Prior to being given an Implicit Theory manipulation to read, those participants were shown a list of the modules they were currently studying (obtained from their course-list). Participants were requested to mark a number (from 1 to n, where n is the number of modules) alongside each module to indicate a preference for each module from 1 (favourite) to n (least favourite). Following this, the procedure continued similarly to Study 1a's, with the exception of the behaviours noted by the researcher. In addition to the researcher keeping a count of how many compilation attempts were made for each task, and how many questions the participant asked, count was also kept of

when participants: completed a task using the wrong method (as opposed to how the task was described in the instructions); moved on from a task having obtained an incorrect answer; asked for confirmation from the researcher that they had obtained the correct answer (result check); took a long pause before proceeding; skipped a task where they were having difficulty; and skipped a task (or tasks) following successful completion of a similar task.

4.8 Study 1b: Results

4.8.1 Questionnaire Responses

To rule out a potential confound of experience, a comparison between participants from new first year and experienced programming course backgrounds and their split by those with and without Java programming experience was conducted (see Table 4-3 below). The Entity Condition had more participants with Java experience and the Incremental Condition had fewer participants from experienced programming backgrounds.

Table 4-3

Breakdown of Participants having Java Experience.

<u>Participant Group</u>	<u>Java Experience (Y/N)</u>	<u>Incremental Condition</u>	<u>Entity Condition</u>
New First Years	Y	6	7
	N	0	0
Experienced	Y	2	4
	N	1	2

A summary of programming ratings between new first year and experienced participants and between study conditions (see Table 4-4 below) showed that new first years liked their programming modules more than experienced participants. However, similar results between experimental conditions confirmed there was no confound of subject enjoyment or self-rated ability.

Table 4-4

*Breakdown of Participants' Programming Preference and Self-Rated**Ability.*

<u>Participant Group</u>	<u>Condition</u>	<u>Mean Programming Rank</u>	<u>Mean Ability 1*</u>	<u>Mean Ability 2**</u>
New First Years	Entity Condition	1.6	1.7	2.1
	Incremental Condition	1.4	1.7	2.2
Experienced	Entity Condition	3.2	2.3	2.3
	Incremental Condition	3.0	2.3	3.0

* 'What is your current level of software programming ability (in any programming language)?' (1, very weak – 4, very strong)

** 'How well do you feel your ability level compares to that of others on your course?' (1, very poorly – 4, very well)

A breakdown of participants agreement with the manipulation material's 'your beliefs about learning' (see Table 4-5 below) had responses ranging from 1 (strongly disagree) to 4 (strongly agree). All participant groups and conditions showed agreement above the scales mid-point (2.5). Also response directions between conditions were consistent with the Implicit Theory manipulation presented, thus indicating general agreement, rather than rejection, of the manipulation.

Table 4-5

*Breakdown of Participants' Agreement with 'Your Beliefs about Learning'**Manipulation Items.*

<u>Participant Group</u>	<u>Condition</u>	<u>Mean Belief</u>
New First Years	Entity Condition	3.1
	Incremental Condition	3.3
Experienced	Entity Condition	3.2
	Incremental Condition	3.3

4.8.2 Implicit Theory Measure Responses

To explore the hypothesis that following presentation of an Implicit Theory manipulation, participants would demonstrate more responses congruent with the version of the manipulation that they received (Section 4.6 above), agreement with entity and incremental item types was tested with a two-way between-subjects ANOVA. Comparing participants' response across the Implicit Theory measure's items between participant types (1st Years or Experienced, Figure 4-4 below), there was no significant difference ($F(1, 18) = 0.97, p = 0.34, \text{partial } \eta^2 = 0.05$). The same ANOVA, compared participants' response across the Implicit Theory measure's items, between study conditions (Figure 4-5 below), and there was a significant difference ($F(1, 18) = 5.07, p < 0.05, \text{partial } \eta^2 = 0.22$). However, there was no significant interaction between participant types and study condition ($F(1, 18) = 0.26, p = 0.62, \text{partial } \eta^2 = 0.01$). Similar to Study 1a, participant numbers were low, and discussion is given to interpreting low powered results below (Section 4.9.3.3).

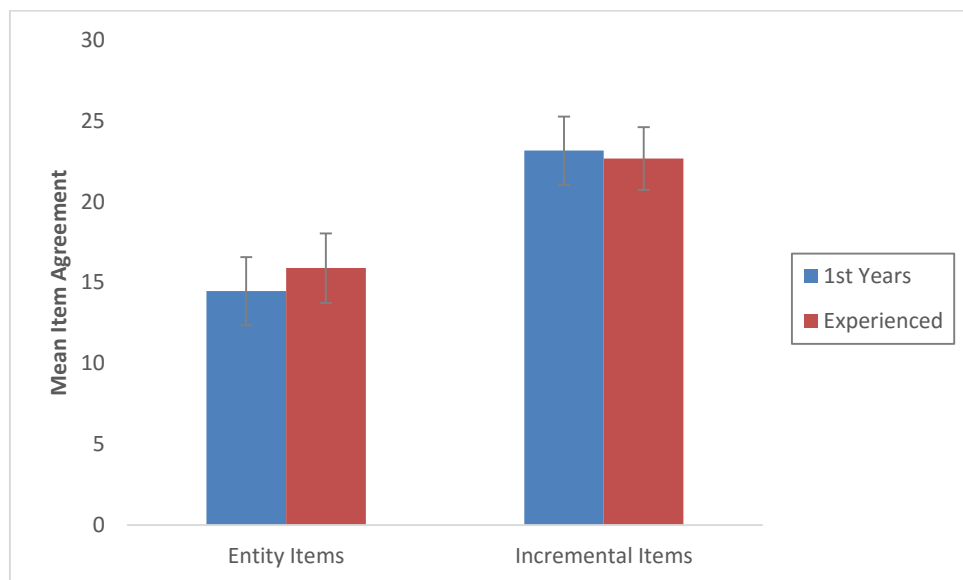


Figure 4-4: Mean Implicit Theory Measure item agreement (min=1, max=4) between First Years (n=13) and Experienced (n=9) participants and between Entity (7 items) and Incremental (7 items) measure items.

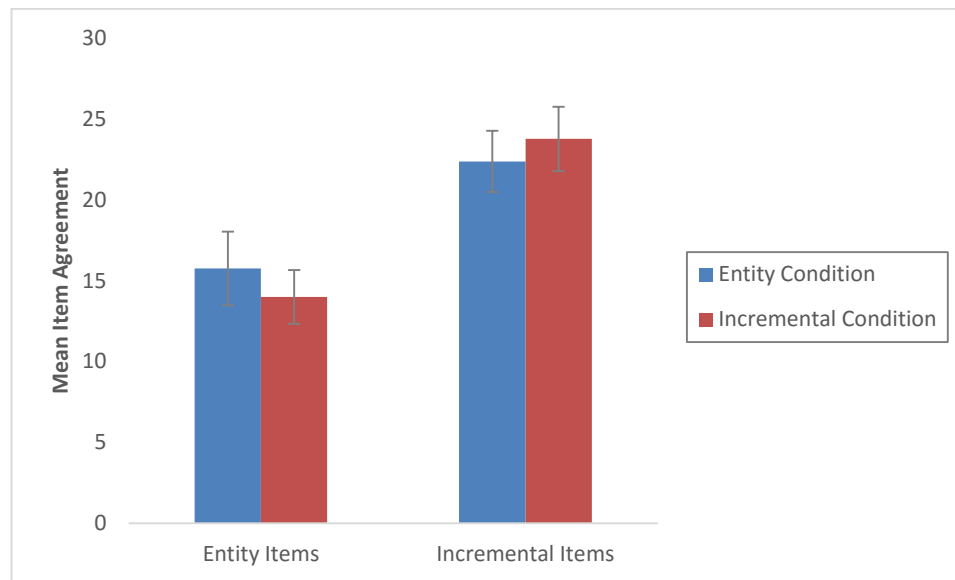


Figure 4-5: Mean Implicit Theory Measure item agreement (min=1, max=4) between Entity (n=13) and Incremental (n=9) participants and between Entity (7 items) and Incremental (7 items) measure items.

4.8.3 Programming Task Behaviours

As part of testing the studies hypothesis participants' behaviour during the programming language task were to be examined (Section 4.6). This was investigated with a MANOVA. The main effect of different behaviour types during the programming task was significant: $F(6, 108) = 7.41, p < 0.0005, \text{partial } \eta^2 = 0.29$ (see Figure 4-6 below). The behaviour types by participant types (Experienced or New First Years) interaction was not significant: $F(6, 108) = 2.11, p = 0.06, \text{partial } \eta^2 = 0.11$. The behaviour types by study condition (Entity or Incremental) interaction was not significant: $F(6, 108) = 0.18, p = 0.98, \text{partial } \eta^2 = 0.01$. The three-way interaction between behaviour types, participant types and study condition was not significant: $F(6, 108) = 1.37, p = 0.24, \text{partial } \eta^2 = 0.07$.

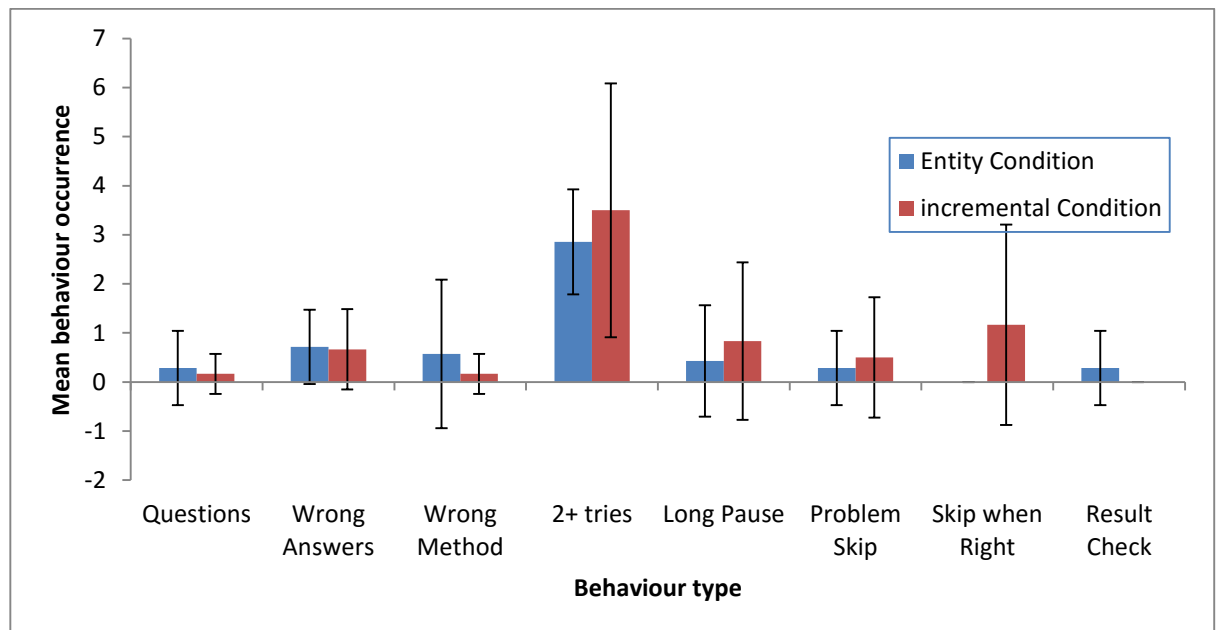


Figure 4-6: Mean occurrences of different behaviours during the programming task part of the procedure.

4.9 Study 1a and Study 1b: Combined Discussion

The PIT research studies were structured to include an initial phase with University student participants, Study 1a and Study 1b. This phase tried to tackle potential internal validity of the research programme (Section 3.2 above) in advance of studies including people with Parkinson's by first testing materials with a non-clinical population. An aim here was to establish whether an Implicit Theory domain exists that is similar to what would be investigated in the subsequent main phase – involving people with Parkinson's – of the PIT research. This investigation, of the existence of an Implicit Theory when learning programming languages, holds relevance to educational psychology (Nolan & Eglin, 2011), and by exploring a technology-relevant domain it was hoped to be of relevance to the conclusions of the PIT research here also (Section 1.3.3 above). By inclusion of Study 1a and Study 1b it was possible to set up a consistent environment when researching with student participants. This allowed the experimental manipulation to be the primary difference between study conditions, which was anticipated to be less likely in the subsequent studies of the PIT research (Section

3.3.3 above). However participant numbers were low, acting as a limiting factor when considering the results, and discussion is given to interpreting low powered results (Section 4.9.3.3 below). In response to this low power, results from Study 1a (Section 4.5 above) and Study 1b (Section 4.8 above) are discussed together, allowing for trends of results to be compared and contrasted between studies.

4.9.1 Programming Experience and Implicit Theories

Investigating possible confounds between conditions, participants in Study 1a reported similar levels of previous programming and Java experience between conditions (see Table 4-1 above). There is one point of caution when interpreting this as one of the participants in the incremental condition reported having no programming experience, but also reported that they did have Java (a programming language) experience. There was also no significant difference between conditions of self-reported programming ability (see Table 4-2 above), however, entity condition participants did report (non-significantly) higher levels of ability on both measure items. This can be considered alongside responses to the programming ability-themed Implicit Theory Measure, which was presented after participants had read the (entity or incremental) manipulation material on ability to learn and develop programming-related skills. It was hypothesised that participants would show agreement with measure items in a direction congruent with the manipulation they had been presented (Section 4.3 above). No difference was seen between conditions (see Figure 4-2 above). As the study was very low powered ($n = 16$) it is only noted here that the Implicit Theory measure responses were in the direction expected, with Incremental Condition participants showing more agreement with incremental measure items, and entity condition participants showing more agreement with entity measure items. Also both Incremental and Entity conditions agreed more with incremental items in comparison to entity items.

Similar investigation of possible confounds between conditions for Study 1b shows participants reported similar levels of previous programming and Java experience between conditions (see Table 4-3 above). Again there is a point of caution when interpreting this, as more Experienced-group participants were included in the Entity condition, although numbers are low for both. There was also no significant difference between Incremental and Entity conditions and no difference within experience groups for self-reported programming ability ($n = 22$; see Table 4-4 above). Between experience groups inexperienced programmers rated programming as a more-liked subject, but with lower self-rated ability in comparison to the Experienced-group. This might be a mixture of both enthusiasm and caution on the part of inexperienced programmers.

The Implicit Theory Manipulation included an additional stage where participants were asked questions on their beliefs about learning. These questions were altered between conditions to lead participants towards agreeing with the condition they were in. It is possible that participants might have rejected the material at this point and disagreed with it, which would likely have made them disagree with what they read in the rest of the manipulation. Agreement was observed to be generally strong and very similar across conditions and experience groups to these manipulation items (see Table 4-5 above). Again these responses can be considered alongside the programming ability related Implicit Theory Measure, which was presented after a programming-related (entity or incremental) Implicit Theory manipulation. It was again hypothesised that participants would show agreement with measure items in a direction congruent with the manipulation they had been presented (Section 4.6). No difference was seen between conditions (see Figure 4-5 above). As the study was very low powered ($n = 22$) it is again possible to suggest here that the Implicit Theory measure responses were in the direction expected (for both New First Years and Experienced groups), with Incremental Condition participants showing more agreement with incremental measure items, and

entity condition participants showing more agreement with entity measure items. Again, similar to previous studies, both conditions agreed more with incremental items in comparison to entity items.

The Implicit Theory measures used here were adapted from Abd-El-Fattah and Yates (2006), who had not presented an Implicit Theory manipulation to participants when testing their scale. They found that participants generally showed more agreement with incremental items in comparison to entity items in both Egyptian ($n = 940$, mean incremental item agreement = 18.78, mean entity item agreement = 14.87), and Australian ($n = 162$, mean incremental item agreement = 19.30, mean entity item agreement = 13.02) participants. Without being able to see significant differences between conditions in the two studies here, it is useful to be able to compare to these characteristics. In addition to both experience groups of Study 1b showing this characteristic (of more agreement with incremental Implicit Theory measure items) the same characteristic was seen across conditions in Study 1a, although it again should be acknowledged that there was statistical non significance throughout.

4.9.2 Task Behaviours Comparisons

As part of testing the studies' hypotheses (Sections 4.3 and 4.6 above) participants' behaviour during the programming language task were to be examined. It was predicted that incremental condition participants would demonstrate more mastery behaviours, and entity condition participants would demonstrate more helpless behaviours. Behaviours captured by Study 1a were mean number of questions asked, mean number of tasks skipped, and mean number of occurrences where a participant made three or more attempts at the same problem (see Figure 4-3 above). No task performance difference was found between the conditions (section 4.5.3). It was expected that Incremental Condition participants, in demonstrating mastery behaviours,

would show more effort and more variation in type of effort. In terms of the behaviours measured, behaviours were in the directions expected.

Where a participant was asking a question, this was predicted to be participants demonstrating consideration of how they were approaching the task, or looking for more information so they could either learn something about the task or decide how to vary their approach. There were (non-significantly) more questions from Incremental Condition participants, which was congruent with this prediction. The questions were not captured by the thesis author here, it was only marked when a question occurred, however the content of the questions were rarely of the type expected – often they were of the type ‘is that right?’ or ‘what is wrong with that?’ – suggesting that a simple comparison of the volume of questions between conditions would be a poor test of the hypothesis.

Where a participant was skipping a task, this was predicted to be due to participants avoiding a task, or being conscious of displaying a negative performance. There were (non-significantly) more task-skips from Entity Condition participants, which was again congruent with the prediction. There was a question, however, over the difficulty of the programming task as a whole, which made it ambiguous as to whether a task was being skipped due to challenge avoidance. It could have been the case that a task was skipped as it was seen as too easy, or too similar to previous tasks. A participant may also have elected to skip some tasks in order to get further down through the list of tasks within the time-frame of the experimental procedure.

Where a participant was attempting a task three or more times, this was predicted to be demonstration of perseverance. There were (non-significantly) more occasions of three-or-more attempts from Incremental Condition participants, which was congruent with this prediction. Interpretation of this (and the number of tasks skipped) result needs to also consider self-reported programming ability (Section 4.5.1), where Entity

Condition participants rated themselves higher. An Incremental Condition participant may need to more frequently attempt questions multiple times due to having less ability. The alternative behaviour was obviously that they could have skipped the task, which happened infrequently for Incremental Condition participants.

For Study 1b the same hypothesis was being tested as for study 1a (Section 4.6). As outlined in Section 4.7.2 there were some variations to the programming task. These variations were introduced as a result of learning from Study 1a, where some ambiguities existed in interpreting participants' programming task behaviours. The expectation was still to see more effort and perseverance from Incremental condition participants. The new task items were structured to clearly include several grouped items that were variations of the same piece of coding, once a participant had gotten one the others should be straight forward and teach nothing new. This structure allowed the researcher to look at the circumstances of a task-skip (e.g. if a participant had already completed a similar task), and what item was skipped-to (e.g. skipping to the very next item which might have been another similar task, or skipping to where the tasks changed to something different). Using these circumstances the researcher made a judgement as to whether a task was being skipped due to an issue encountered (Problem Skip), or to move to something different (Skip when Right or 'Mastered'). Other differences between Study 1a and Study 1b were mainly in the type of behaviours that were monitored by the researcher. Alongside noting when questions were asked, it was also noted when 'results checking' confirmations were sought, and not including these in the general counts of questions. As an addition to these, it was noted when participants took long pauses to consider how they were going to attempt an item. These were measured when noticed by the researcher, and were intended to indicate where participants were considering variations in approach to a task. It was also noted when questions got a

question wrong, or used a different method to obtain a result (e.g. printing the number four instead of using code to calculate two plus two).

No effect of behaviour type was seen by participant type (Experienced or New First Years) or by study condition (Entity or Incremental). Although behaviour type by participant type was the closer to reaching significance, it was of less relevance to the hypothesis being considered (Section 4.6). It was expected that different participant types would show varied behaviour in response to the task as it was expected that they would find it easier (supported by higher self-rated ability, Section 4.8.1). As there was no anticipated variation in response to difficult tasks between participant types (only that Experienced-group participants would likely encounter fewer 'difficult' tasks), both Experienced and New First Year participants were included together when comparing behaviour variation Entity and Incremental conditions in Figure 4-6 (above). It was again expected that Incremental Condition participants, in demonstrating mastery behaviours, would show more effort and more variation in type of effort. In terms of the behaviours measured, behaviours were mostly in the directions expected.

Removing some of the ambiguity of whether a question being asked was looking for information to help learn about the task, it was noted separately where participants were simply asking for confirmation about a result (demonstrative of a performance rather than a learning focus). There were (non-significantly) more results checks from Entity Condition participants - congruent with this prediction - but very similar numbers of questions asked between conditions. Overall there were very few questions asked and results checks made, which could relate to the difficulty level (or lack thereof) of the programming task (discussed further in Section 4.9.3.2). Questions were originally proposed to be an indicator of participants trying to learn something about the task, perhaps looking for information to assist alternative strategy seeking behaviour. An additional related measure, long pauses, was also captured by Study 1b. It is proposed

that when a task is challenging then a participant could choose to ask for more information, they could skip the task, or they could pause and think about it for a period. It was predicted that occurrence of long pauses would be predictive of alternative strategy seeking, a mastery-type behaviour, and would occur more in Incremental Condition participants. Similar to both Questions and Result Checks, there were very few Long Pauses, however, Long Pauses did occur more frequently with Incremental Condition participants, congruent with the prediction.

Ambiguity was also reduced from Study 1a where a participant was skipping a task. It was expected that entity-condition participants would be more likely to skip a question if they were encountering difficulties (Problem Skip), demonstrating an interest in performance. Incremental condition participants, it was expected, would more often skip when they had figured out a problem-type, so could progress onto a question-type they had yet to encounter (Skip when Right), demonstrating an interest in learning (see Figure 4-6 above). More of both skip types were performed by Incremental Condition participants, although the difference between conditions was very close for Problem Skips. No Entity Condition participants skipped on to a more challenging section of the programming task, which was congruent with the predictions.

Where a participant was attempting a task two or more times, this was predicted to be demonstration of perseverance (very few tasks received three or more attempts, as in Study 1a). There were (non-significantly) more occasions of two-or-more attempts from Incremental Condition participants, which was congruent with this prediction. Interpretation of this result (and the number of tasks skipped) again needs to also incorporate self-reported programming ability (Section 4.8.1), where – unlike participants in Study 1a – Incremental Condition participants rated themselves higher. An Entity Condition participant may need to more frequently attempt questions multiple times due to having less ability. The opposite actually occurred and Incremental

Condition participants had (non-significantly) more multiple attempts at task items, fitting with predictions that this condition would demonstrate more perseverance despite in this case having higher ability. Again it is still possible that Entity Condition participants had fewer repeated attempts due to getting to an answer more promptly. Also measured in Study 1b was occurrences where participants moved to the next task item having gotten the wrong answer or else having used the wrong method (e.g. simply printing a result instead of using code to calculate it). Both of these would indicate deterioration in task performance, and were predicted to occur more frequently in the Entity Condition. There was no difference between conditions for Wrong Answers, but Wrong Method was more frequent in the Entity Condition. This was congruent with predictions but again occurrence of both behaviours across conditions was low.

4.9.3 Reflections for Subsequent Studies

4.9.3.1 Intentionality of Behaviours. The initial non-clinical population study (Study 1a) highlighted a flaw in this design, almost immediately, in the consideration that a visible behaviour did not make the intentionality behind the behaviour known. A participant repeatedly trying the same question might be demonstrating perseverance, but may alternatively be demonstrating changes in strategy or trying different things, a comparative lack in ability necessitating multiple attempts, or an avoidance of the next – potentially more complex – question. A participant skipping a question might be demonstrating challenge avoidance, but alternatively they might have quickly assessed the question and decided they know how to do it already, in which case they might be challenge-seeking, or they might have decided that particular question was too challenging to be worth taking on in light of other questions available in the time period. Changes were made following Study 1a and before Study 1b to try to explore some of these issues. Attention was given to the difference between where participants were asking a question or simply checking what they were doing, also a difference between a

task skipped to avoid challenge or to seek challenge was explored. It would be possible to develop further studies to analyse behaviours or to help develop theories about what different behaviours mean, followed by larger studies to test those theories. This would possibly be valuable research for computing departments, helping to explore further why some students might excel at programming languages while others struggle. Recruitment should also be considered for future studies as there is a possibility that participants from non-computing courses will self-select to take part in studies that involve programming. It is not necessary for a University course to contain any relevance at all in order for a student to have an active interest in programming. The assumption in Study 1a, that recruiting participants from a course with no programming would provide participants with no programming background, was potentially a weak one. However, continuing this line of exploration was not relevant to the PIT research here. There is no clear relevance of the tasks included in these studies to people with Parkinson's, and by utilising student participants no insight into the behaviours of people with Parkinson's has been gained. For the PIT research the value of Studies 1a and 1b was exploring the development of Implicit Theory measures and manipulations, and also exploring an experimental procedure and design where participants were being observed while engaging with a piece of technology.

4.9.3.2 Level of Challenge Encountered. Another procedural issue to emerge related to task difficulty. In Studies 1a and 1b the difficulty level of programming tasks were likely to have affected the behaviours measured. Of interest to Implicit Theory, or perhaps where it is at its most useful as a model for understanding behaviour, is in interpreting how people's different (Implicit) theories lead them to respond when a situation is difficult. When things are easy or straight forward there is less of a predicted interaction between Implicit Theory held and outcome behaviour. In difficult circumstances, however, do they attempt to master the situation, or do they demonstrate

characteristics of helplessness? If the task used to measure behaviours does not present challenge then evidence of varied behaviour might be weak. The programming tasks designed for Studies 1a and 1b may or may not have been set at an adequate level of difficulty. Structuring it differently might have given opportunity for measuring evidence for different types of mastery or helpless behaviours. These programming tasks will not be used as a starting point for designing tasks used in the following sections (Chapter 5 and Chapter 6) as the structure of the tasks there will be governed by the need for testing of the SAP project's application. Learning from the tasks developed here however suggests that interpretation of any future tasks should be mindful of difficulty level. In the absence of difficulty any difference seen between conditions is potentially unlikely to be explainable by differences in Implicit Theories.

4.9.3.3 Interpretation of Low Powered Results. Another relevant point of learning from Studies 1a and 1b relates to interpretation of results in circumstances of low experimental power. These studies were intended to have more participants, but due to circumstances of timing (as outlined in Section 3.3.1 above) and recruitment, this was not the outcome. Study 1a was conducted towards the end of May 2011, when most students had already completed their exams and were few in numbers around the University. Study 1b was then conducted at the start of the next academic year, but recruitment was slow and focus needed to switch to preparing the PIT research studies involving people with Parkinson's. Higher participant numbers would have allowed a more robust investigation of the quality of the measures and manipulations that had been developed for the PIT research, admittedly using previous resources and materials that had been more robustly tested. It was known in advance that Studies 2a and 2b (Chapter 5) would also be very low powered studies. As the main objective for participant involvement in those studies was going to be user-testing the application as part of the SAP project, it was anticipated that there would be diminishing returns of useful

information with increasing participant numbers (Nielsen 2000). Having the studies here additionally being low powered gave advance knowledge for these subsequent studies of the low likelihood of being able to reach statistical significance with any of the measures to be potentially used. The studies here have provided very little statistical evidence that Implicit Theories have been modified, or that following manipulations there is varied resultant behaviours seen depending on manipulation presented. It has been possible however to take a look at directions of results within each study and see whether they were as expected. It was further possible to compare the directions of results across both Study 1a and 1b, and to see where these directions of results matched. Partial evidence in support of the Implicit Theory manipulation being able to affect Implicit Theories as captured by the measure developed was found by Incremental Condition participants consistently showing more agreement with incremental measure items and less agreement with entity measure items (including across participant types in Study 1b). Similarly partial support was gained for effect of the manipulations on behaviours by examining frequency of different behaviour types during the programming tasks. These types of comparisons of direction of effect will need to be employed again for the studies planned for Chapter 5.

CHAPTER 5. INITIAL CLINICAL POPULATION TESTING

The Smartphone Application (SAP) project (see Section 1.3.2.1), having developed an initial version of a speech therapy smartphone application, planned to conduct small user tests of the application. The development and testing were being conducted as part of work enabled by a Parkinson's UK Innovation Grant (see Section 3.1 above). User testing was intended to generate feedback for the software developers to further progress the application. As part of gaining feedback from people with Parkinson's using the application, it was also planned to investigate some of the potential barriers to this cohort effectively engaging with a compliment to speech therapy activity being delivered in this format (see Section 1.1.3 above). This strand of investigation was progressed by the Parkinson's Implicit Theory (PIT) research. Implicit Theory (Dweck & Leggett, 1988), briefly, is a model that describes how an individual's beliefs about something (for example math skill) might suggest it is either fixed (an entity theory) or flexible (an incremental theory). These theories lend themselves to different types of goals, if something is flexible then a mastery goal (to increase ability) is predicted, and if something is fixed then a performance goal (to demonstrate high ability, or avoid demonstrating low ability) is predicted. These goal types interact with ability level, especially with a performance goal, and can lead to either mastery or helpless behaviours (see Table 2-1, in Chapter 2 above). The intention for the PIT research is to see if Implicit Theory can be applied to people with Parkinson's, specifically in the circumstance of being presented with the SAP project's smartphone application, to see if holding different Implicit Theories can affect effective engagement with the application. Following on from initial investigations of developed Implicit Theory materials with University students (see Chapter 4 above), the intention here was to conduct similar studies with people with Parkinson's.

Investigating people with Parkinson's Implicit Theory domains of technology ability and of vocal issues it is hoped would progress understanding of barriers that might exist using the SAP project's application. Holding either an entity or an incremental Implicit Theory for either of these domains could alter the efficacy of an individual's engagement. Investigation of these domains require manipulations aiming to encourage either an entity or incremental Implicit Theory in participants, and also measures of the relevant Implicit Theory domains. Studies 1a and 1b (Chapter 4 above) described development of Implicit Theory measures and manipulations in the domain of computer programming ability. The manipulation will be adapted here to relate to ability with technology (Study 2a) and also vocal issues (Study 2b). The measure will be adapted here to relate to ability with technology and will be presented in both Study 2a (following manipulation presentation) and Study 2b (prior to manipulation presentation). Abd-El-Fattah and Yates (2006) mention the possibility of scale items becoming tedious, and for Study 2b it was planned to present an Implicit Theory measure of vocal issues (following manipulation presentation). This means the procedure including two Implicit Theory measures, so a different measure was sought to use as a starting point for a vocal issues measure, hopefully avoiding some tedium for participants. The 'Kind of Person' Implicit Theory measure was found, which could be related to vocal issues (Dweck, 1999). This was an eight item measure, with entity items such as 'The kind of person someone is, is something very basic about them and it can't be changed very much', and incremental items such as 'People can always substantially change the kind of person they are'. Further detail of this measure is included in Section 5.3.2 below.

5.1 Overview of Studies

Studies 2a and 2b were both conducted as part of two user-testing stages for the SAP project's speech therapy application being developed. The primary purpose for both was to gain application feedback for the benefit of further software development.

The PIT research used the occasion of these user-testing events to investigate the relevance of Implicit Theory to people with Parkinson's being introduced to the application. The studies were conducted several months apart, with the application being further developed at the point of Study 2b. Also Study 2a occurred in the relatively controlled environment of a speech therapy suite at King's College Hospital, whereas Study 2b occurred, where possible, in the more naturalistic setting of participants' homes. It is envisaged that application usage will primarily occur in users homes, so this was an obvious location for the SAP project to conduct testing.

These studies including people with Parkinson's represent a progression from the initial studies with student participants. Study 1a presented measures using visual analogue scales, whereas Study 1b made use of Likert scales. It was an outcome criteria from the NHS Research Ethics Committee meeting (see Section 3.3.1 above) that Likert scales should be used, so this version of the manipulation was carried forward for Studies 2a and 2b. Similarly, during the initial studies, attention was given to trade-offs in terms of procedure duration. Study 1a included additional pre-manipulation questions that were designed to additionally direct participants towards the same incremental or entity focus of the Implicit Theory manipulation being presented. These pre-manipulation questions were excluded from Studies 2a and 2b as it was felt that they would prolong the procedure too much. Also if the researchers were assisting participants in responding to measure items then this content would flag to researchers which manipulation version was being presented. Adjustments such as these meant that Studies 1a and 1b made further contribution in informing how subsequent studies should be conducted.

Both SAP project user-testing events engaged low numbers of people with Parkinson's. Recruitment targeted an appropriate number of people to usefully test the application. Nielsen (2000) describes diminishing returns of useful information once the number of testers exceeds five. As a low degree of homogeneity between users was

anticipated (see Section 1.1 above), inclusion of five users was considered probably too low a number for constructive feedback, but eventual numbers would still be very low in terms of statistical power for the PIT research studies. Just as in Chapter 4 (Studies 1a and 1b), the goals and objectives of the two studies were very similar, so the structure of the document here is set up to discuss them both alongside each other. Following both studies' introduction here (including goals and hypothesis, Section 5.2 for Study 2a and Section 5.5 for Study 2b), there will be the method (Section 5.3) and results (Section 5.4) for Study 2a and the method (Section 5.6) and results (Section 5.7) for Study 2b. Discussion for both (Section 5.8) will then appear following all these parts. Different to Studies 1a and 1b there will also be thematic analyses included, conducted using comments captured as part of the SAP project's user-testing. Thematic analysis followed closely exploration phases outlined by Braun and Clarke (2006). The thematic analyses are discursive in their nature so appear separately within the individual results sections of Study 2a and 2b as 'Thematic Analysis Results and Discussion' (see Sections 5.4.5, and 5.7.5). This avoids trying to disentangle the themes generated by the analysis of data from each study. An overview of the thematic analysis from each study, and how they relate to other findings of the study, is then included in the combined discussion.

5.2 Goals and Hypothesis of Study 2a (Implicit Theory Domain of Ability with Technology)

The main goal for Study 2a, as part of the PIT research, was to investigate an Implicit Theory domain of ability with technology in people with Parkinson's. Part of this goal will include progression of Implicit Theory materials developed in Studies 1a and 1b. These materials have been adapted to be relevant to investigate for an Implicit Theory in the domain of ability with technology. These materials would be presented to people with Parkinson's as part of the procedure for user-testing of the SAP project's application. Participants would be presented with either an entity or an incremental

version of the Implicit Theory manipulation, followed by the Implicit Theory measure and then introduced to the smartphone application for user-testing. The hypothesis for Study 2a is that, following presentation of an Implicit Theory manipulation, participants will demonstrate more responses congruent with the version of the manipulation that they received. Congruent responses will include participants shown the incremental version of the manipulation would show more agreement with incremental measure items, and less agreement with entity measure items, in comparison with participants shown the entity version of the manipulation. Responses will also be sought from participants' engagement with the smartphone application, and comments that they make during the procedure (which were explored separately as a Thematic Analysis in Section 5.4.5 below). It is expected that participants shown the incremental version of the manipulation would show more perseverance, so would continue to use different application components for longer. Also, as part of investigating application engagement, volumes captured by the device will be examined. Difference between volumes produced (for talking tasks and vowel-production tasks, with and without a target displayed on-screen (for task descriptions, see Appendices E.1 and E.2) will be explored. Addition of an on-screen target provides a goal during a trial, but also adds complexity due to necessarily adding more elements to the screen's display and there being something additional to attend to. The Implicit Theory manipulation did not mention beliefs about health or vocal abilities, so it is not anticipated for there to be a difference in volumes.

Verbalisations, or comments made during the procedure, were also planned to help differentiate between different participant behavioural responses. Verbalisations have been used previously in Implicit Theory research, Elliot and Dweck (1988) for example having found more negative attributions (e.g. 'I'm not very good at this') from participants with a performance rather than a learning goal. Also failure was attributed to

external factors which could not be controlled by participants with an entity-congruent performance goal. Similar patterns would be sought from responses by participants in Study 2a to help investigate the hypothesis.

5.3 Study 2a (Implicit Theory Domain of Ability with Technology): Method

5.3.1 Participants

Participants were 12 individuals with Parkinson's, all having received a referral to King's College Hospital's Speech Therapy services, from where they were informed about the study. All participants received the same letter explaining details about the study (see Appendix F.1). Six entity-condition participants had a mean age of 69.8 years, mean Hoehn-Yahr score of 1.5 (Hoehn & Yahr, 1967; This is at the lower end of the scale indicating clinical disability, described above in Section 1.1), and mean time since diagnosis of 6.7 years. Six incremental-condition participants had a mean age of 63.7 years, mean Hoehn-Yahr score of 2.3 (indicating more clinical disability compared to entity-condition participants), and mean time since diagnosis of 8.7 years.

5.3.2 Materials

All materials were presented in a large text size (Calibri font size 16).

5.3.2.1 Implicit Theory (of Ability with Technology) Manipulations. Texts were developed from descriptions of manipulations used by Hong et al. (1999). Two texts were used (see Appendices A.3 and A.4), laid out across two A4 pages and structured identically but with language varied to support different Implicit Theories. This is a departure from one-page manipulations used in Study 1a and Study 1b, due mainly to an enlarged text size. Some extracts from each are as follows:

Entity Version: '...The majority of research agrees that our abilities in these areas are fixed, and cannot be improved significantly through extra effort (Abblet, 1994...'; '...According to Fields' results, up to 88% of a person's intelligence is due to

fixed genetic factors...’; ‘...In another study by Cohen and Laud (2004) comments were taken from older-adult participants... ... “I love figuring out new technology, it just seems to come to me without trying”, *Dorothy...*’;

Incremental Version: ‘...The majority of research agrees that our abilities in these areas are variable, and can be improved significantly through extra effort (Abblet, 1994...’; ‘...According to Fields’ results, up to 88% of a person’s intelligence is due to fluid environmental factors...’, ‘In another study by Cohen and Laud (2004) comments were taken from older-adult participants... ... ““I love figuring out new technology, I keep trying at it and I keep getting better”, *Dorothy...*’;

5.3.2.2 Multiple-choice Check-for-understanding Question. This was a brief question presented following the manipulation with one option describing an entity theory, one an incremental theory, and also ‘all of the above’ or ‘none of the above’ responses.

5.3.2.3 Technology Implicit Theory Measure. This was a 12-item measure developed from items found in Abd-El-Fattah and Yates (2006), including six incremental items and six entity items (see Appendix B.2). It was presented under the title “Your beliefs about ability and new technology and devices”. Items were altered to relate to ability with, and learning to use, new technology and technology devices. Study 1a had presented measures using a visual analogue scale (see Section 4.4.2) and Study 1b had used a Likert Scale (see Section 4.7.2). At NHS ethical review (see Section 3.3.1) it was proposed to run all studies including people with Parkinson’s using a Visual Analogue Scale but at the Research Ethics Committee panel meeting it was suggested that this would be a confusing format. All items required responses be made using a four-point Likert Scale, with boxes marked from ‘Strongly Disagree’ to ‘Strongly

Agree’. Example entity items were: ‘Good performance using a device is a way of showing others that you are good with technology’; and ‘You have a certain amount of ability with new technology and you cannot do much to change it’. Example incremental items were: ‘You can develop your ability with new technology if you really try’; and ‘If you fail in a task, you still trust your technical ability’. Items were counterbalanced by creating 12 different versions where the same questions were ordered systematically differently (See Appendix D.1).

5.3.2.4 Technology Questionnaire. This consisted of five questions. The responses to the first two were recorded using four-point Likert Scales: ‘What is your current level of ability using new technology?’ marked from ‘Very Weak’ to ‘Very Strong’; and ‘How well do you feel your ability with technology compares to that of your peers?’ marked from ‘Very Poorly’ to ‘Very Well’. The responses to the final three were recorded using Yes / No boxes: ‘Have you ever used a device with a touch screen?’; ‘Do you own a mobile phone?’; and ‘Do you have your own email address?’. Items were presented in the same order to all participants.

5.3.2.5 Speech Tool Application. Details of the application can be found in Appendix G.1. This study occurs at the point at which the SAP project is testing a first iteration of the smartphone application to be developed within the context of the PUK grant.

5.3.2.6 iPod Touch. An Apple iPod Touch was used to present the Speech Tool Application for this study.

5.3.3 Design

The overall design of the study is mixed methods. The quantitative aspects included an IV for the version of the Implicit Theory Manipulation participants were given, each participant randomly receiving either version (Between groups). The IV had two levels, either the Entity or Incremental version. There were several DVs, including

responses to the Implicit Theory Measure and to the Technology Questionnaire. Other DVs were also captured during participant's usage of the Speech Tool Application in the form of decibel readings taken from the application's output at various points during the procedure. This included a structured presentation of tasks where volumes were captured while participants both talked and produced vowel-sounds. For all participants these measurements were collected both in the absence and presence of an on-screen decibel goal-bar being displayed. Following this there was a more free-form application usage where DVs captured were how many application trials participants completed of their own volition, and the volumes of these trials. The qualitative aspect of the study was a semi-structured interview.

5.3.4 Procedure

The research took place at a speech and language therapy suite, at King's College Hospital, Denmark Hill, in London and was conducted in the context of the larger SAP project (Section 1.3.2.1). Thus, the procedure was carried out by two researchers. The primary roles were fulfilled by a research assistant (RA), assisted by the thesis author here as the second researcher. The RA was not involved in the design of the design of the research being conducted, and additionally was blind to the hypotheses of the research. He has a background in physiology and also is part of the Creative Technologies department at the University of Portsmouth, but had no psychology background and had not been advised on the Implicit Theory model. The RA was however aware of the SAP project and its goals, and was aware of its priority within the context of the research being conducted. Most items and directions within the procedure were presented by the RA, so participants' primary interaction was with the RA. By having one primary person to interact with it was hoped to avoid unnecessarily fatiguing participants, and to completely eliminate researcher confounds. Alongside this, the author here was organising materials so they were available to the RA when needed, and

attempting to note down as much of what each participant was saying as possible. For measure and questionnaire items a printed sheet with the items was presented to participants, but in most instances items were read aloud to participants by the RA, with some use of paraphrasing to further assist participants' understanding.

At the start of the research, participants were advised that they were welcome to pause at any point. Additionally, participants were invited to have a family member present, if they had travelled with one and if that was their preference. The procedure was then described to participants as being in two stages, the first being referred to as 'paperwork' including direct questions and pieces of text to read. The second part was described as an activity where the participant would be introduced to the device and application, and asked for feedback and thoughts. The first item of stage one was the technology questionnaire. Next, participants were randomly given one of the Implicit Theory Manipulations. Participants were requested to read this at their own pace, rather than with the assistance of the RA's oration. Next, participants were presented a multiple-choice check-for-understanding question. Participants were requested to select the option that best matched what they had just read. Next, participants were presented with the Implicit Theory Measure, which concluded the procedure's presentation of paperwork to the participant.

In the second stage, participants were briefly introduced to the device that was running the application, (Appendix E.1). The procedure took the form of a semi-structured interview, and deviations were allowed depending on time available or particular interests of the participant. The main purpose of the procedure, not directly relevant to the PIT research here, was to gather application user-feedback from people with Parkinson's. As the primary purpose was application feedback, the author here would sometimes add additional questions if deemed relevant to gaining useful additional information, but still be responsible for transcribing responses. If the

procedure was becoming time-constrained then a priority was placed on capturing sound recordings for the SAP project, as described in Appendix E.1, with fewer elaborations being requested on participants' question responses (more relevant for the PIT research). If more time was available, and for example a participant was particularly interested in the aesthetics of the application, then avenues like this could be pursued.

After exposure to the application, participants were given a verbal debrief, emphasising that the manipulation material that they had read during the paperwork section had been created by the researchers, and that it was the researchers opinion that anyone could learn to improve their ability with effort. Participants were additionally given a debrief-sheet to take home.

5.4 Study 2a (Implicit Theory Domain of Ability with Technology): Results

5.4.1 Questionnaire Responses

To compare self-rating by participants of technology ability, two technology questionnaire items (on current ability and ability compared to peers) were combined (by adding each participant's ratings for both items together to give one score). Entity-condition participants had a mean combined-score rating of 4.66 (very weak = 2, very strong = 8), and incremental-condition participants had a mean rating of 6.33. This fails to rule out a potential confound of self-rated ability, with incremental condition participants rating themselves above mid-point (scales mid-point = 5.5), and entity condition participants rating themselves below mid-point.

To investigate a potential confound of technology familiarity, three technology questionnaire items (on previous usage of touch-screens, mobile phones and email) were combined. Treating usage of each as equivalent in terms of being an indicator of technology familiarity, indication of prior usage of each was either yes (1) or no (0). Entity condition participants had a combined-score mean familiarity of 2.16 (no familiarity = 0, familiar with all three = 3), and incremental condition participants had a

mean familiarity of 2.83. Both conditions responded above mid-point (scales mid-point = 1.5), with incremental condition participants reporting slightly more technology familiarity.

5.4.2 Implicit Theory Measure Responses

To explore the hypothesis that following presentation of an Implicit Theory manipulation, participants would demonstrate more responses congruent with the version of the manipulation that they received (Section 5.2), agreement with entity and incremental item types is shown in Figure 5-1 (below). Comparing participants' response across the Implicit Theory measure's items between conditions, an independent t -test did not show a significant difference ($t = 1.45$, $df = 10$, $p = 0.18$, two-tailed). Participant numbers were low, and discussion is given to interpreting low powered results below (Section 5.8.4.4).

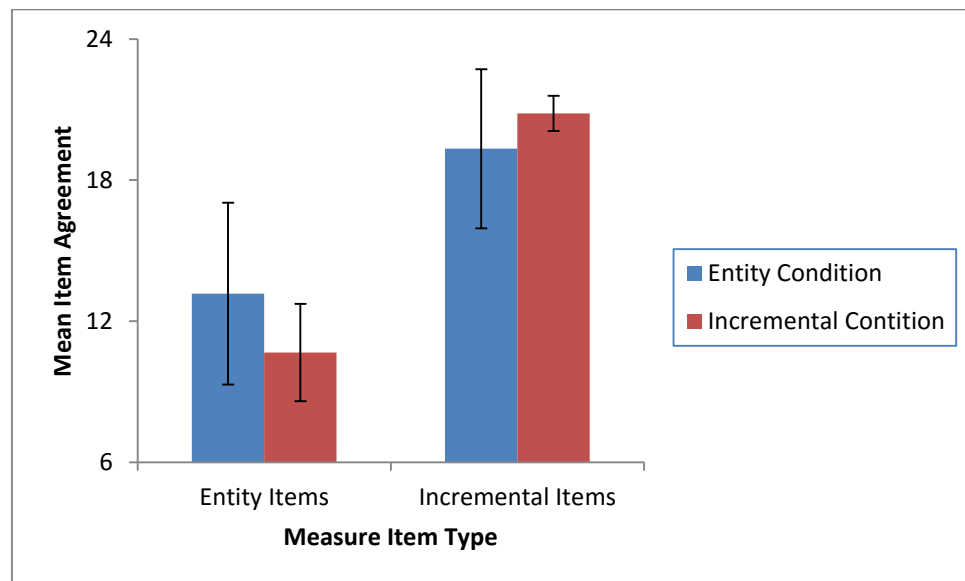


Figure 5-1: Mean Implicit Theory measure item agreement between Entity ($n=6$) and Incremental ($n=6$) participants. Showing responses compared between Entity (6 items) and Incremental (6 items) measure items (each scored from min=1 to max=4).

5.4.3 Volumes Measured

Further testing of the hypothesis, that following presentation of an Implicit Theory manipulation, participants would demonstrate more responses congruent with the

version of the manipulation that they received, was also carried out via usage of the application. Part of using the application was a structured set of application usage tasks, including generation of speech and vowel-sounds in the presence and absence of goal-bars (see Appendix E.1). As the Implicit Theory manipulation did not target health beliefs or vocal abilities, there was no direct predictions of differences between experimental conditions (see Section 5.2 above). As such non-volume related application usage is reported separately below, see Section 5.4.4).

Firstly examining participants' speech-production volumes – between conditions – in the absence and presence of a goal-bar, the main effect on mean volumes (volumes shown in Figure 5-2 below) was non-significant: $F(2, 9) = 3.10, p = 0.09$; Wilk's Lambda = 0.59; partial $\eta^2 = 0.41$. Analysis of each individual dependent variable, using a Bonferroni adjusted alpha of 0.03, showed there was no contribution to differences between Implicit Theory conditions of: goal-absent talking volume, $F(1, 10) = 0.07, p = 0.80$, partial $\eta^2 = 0.01$; or goal talking volume, $F(1, 10) = 0.54, p = 0.54$, partial $\eta^2 = 0.05$.

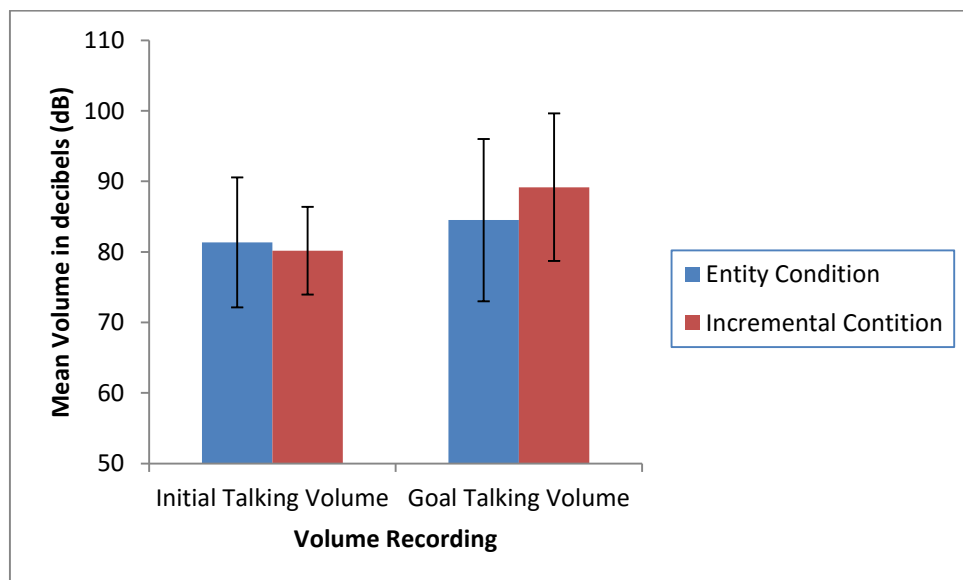


Figure 5-2: Mean volume recordings (in decibels) showing initial speech volume recordings (with no goal-bar) versus speech recordings where an on-screen decibel goal-bars were being displayed. This comparison is between Entity (n=6) and Incremental (n=6) condition participants.

Next, examining participants' vowel-sound-production volumes – between conditions – in the absence and presence of a goal-bar, the main effect on mean volumes (volumes shown in Figure 5-3 below) was non-significant: $F(2, 9) = 2.91, p = 0.11$; Wilk's Lambda = 0.61; partial $\eta^2 = 0.39$. Analysis of each individual dependent variable, using a Bonferroni adjusted alpha of 0.025, showed there was no contribution to differences between Implicit Theory conditions of: goal-absent vowel volume, $F(1, 10) = 1.61, p = 0.23$, partial $\eta^2 = 0.14$; or goal vowel volume, $F(1, 10) = 2.46, p = 0.15$, partial $\eta^2 = 0.20$.

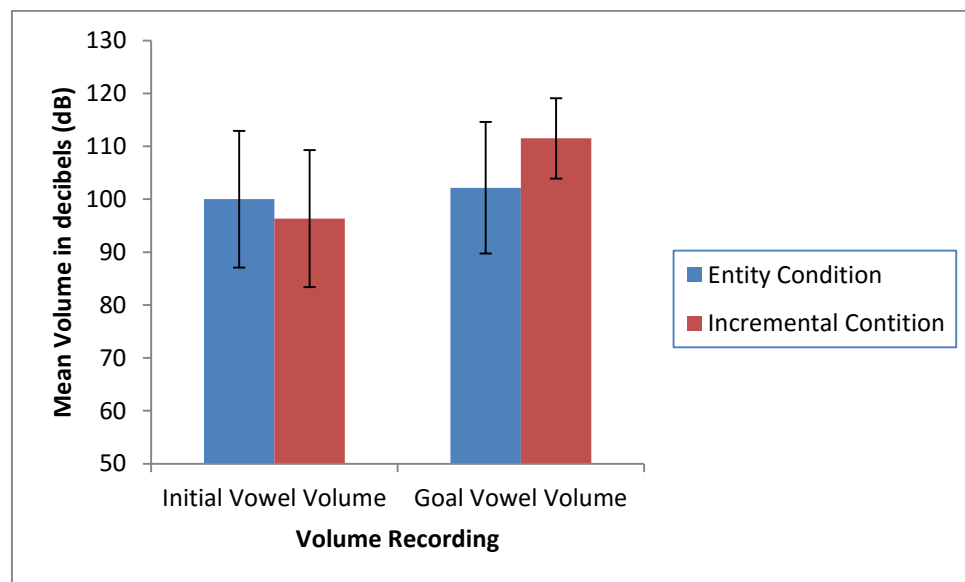


Figure 5-3: Mean volume recordings (in decibels) showing initial vowel-sound volume recordings (with no goal-bar) versus vowel-sound recordings where an on-screen decibel goal-bars were being displayed. This comparison is between Entity (n=6) and Incremental (n=6) condition participants.

5.4.4 Application Usage

The study's main hypothesis was that, following presentation of an Implicit Theory manipulation, participants would demonstrate more responses congruent with the version of the manipulation that they received (see Section 5.2). As part of testing this, it was expected to see a difference between conditions, and it was predicted that participants shown the incremental version of the Implicit Theory manipulation would

show more perseverance, and so would continue to use different application components for longer. To test this prediction information was taken from the free-form application usage, following the structured part of the application presentation (see Figure 5-4 below). The main effect of different behaviour types during testing of the application was non-significant: $F(2, 9) = 1.20, p = 0.34$; Wilk's Lambda = 0.79; partial $\eta^2 = 0.21$. Analysis of each individual dependent variable, using a Bonferroni adjusted alpha of 0.025, showed there was no contribution of: the mean number of trials completed, $F(1, 10) = 0.37, p = 0.56$, partial $\eta^2 = 0.04$; or the number of trials where the volume recorded was above the initial talking volume recorded (in the structured part of the presentation without a goal-bar) for that participant, $F(1, 10) = 2.58, p = 0.14$, partial $\eta^2 = 0.21$.

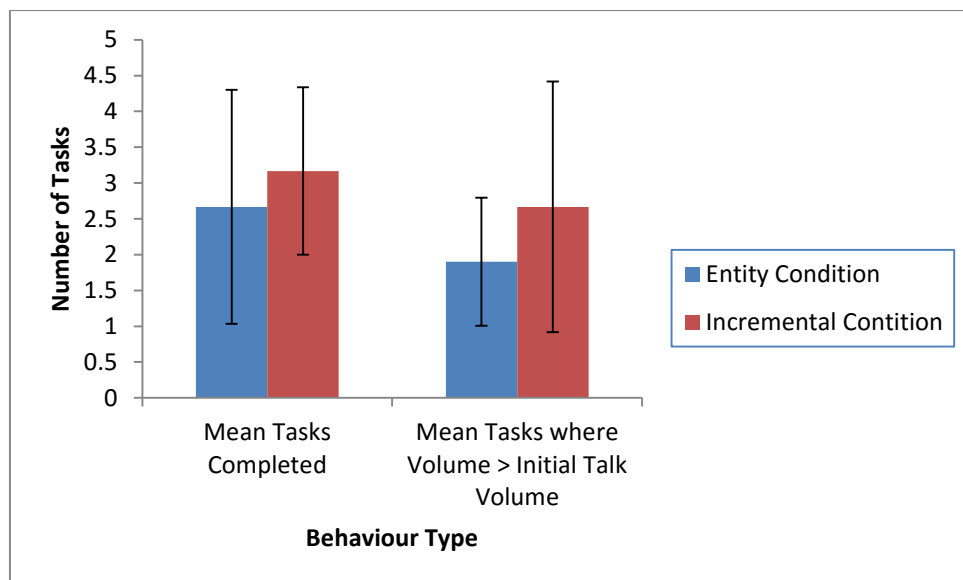


Figure 5-4: Comparison between conditions of different behaviour types during testing of the speech application.

5.4.5 Thematic Analysis Results and Discussion

5.4.5.1 Conducting a Thematic Analysis of Qualitative Data. Thematic analysis was used to identify themes contained in participant responses. All participant comments collected during the procedure were included. Responses were pooled together anonymously and without marking to indicate study condition. Thematic Analysis has been described by Braun and Clarke (2006) as having six distinct phases:

familiarisation with the data; generation of initial codes; searching for themes; reviewing themes; defining and naming themes; and producing the report. Analysis introduced here follows approximately these phases. Analysis was conducted using data captured across multiple sections of the procedure, including any comments made in response to questionnaire or measure items, comments made while completing tasks, and any feedback given, either directly in response to a question or offered freely by the participant. This allowed themes to be looked at which were occurring through the data as a whole. Repeated cycles of reading and categorising of the data allowed for themes to emerge. When potential themes were identified the data was then reprocessed with that theme in mind, to identify content analogous with it. This process was repeated for each theme, with some content or quotes aligning with more than one theme. Themes and their grouped comments were then scrutinised for suitability to be related to implicit theory. Comments grouped within appropriate themes were categorised as relating to an entity or incremental theory, not all comments could be categorised. Comments within their categories were then un-anonymised and each associated with the participant's study condition. This allowed comparison of entity and incremental theory comments made within each theme, between conditions.

5.4.5.2 Findings of Thematic Analysis of Qualitative Data. Attention here is given to themes that emerged that were associated with Implicit Theory, or relevant to the Implicit Theory domain being considered, ability with technology. These themes that emerged from the analysis below were: Failures with Technology; Plans for Usage; and Effort. For each theme, comments will be selected that represent ideas that correlate with either an entity or incremental theory. This shall be considered in the context of the version of the Implicit Theory manipulation that participant had been presented, with some having made comments which match with both. Other themes also emerged which were not relatable to Implicit Theory, such as Application Feedback Comments.

During the procedure it was evident that technology not working as hoped or expected was of common concern to participants. This led to the theme Failures with Technology. Of interest is how participants see themselves in relation to technology, and also how they respond when challenges arise (see Section 2.1.3 above). Examining Entity Condition participants first, when discussing younger generations being perceived as better with technology, Eamon (Entity Condition participants will be referred to with names beginning with 'E') said 'blame it on the war' and the fact that 'they were born with it about them' as endorsements of a generation-gap in ability. These two explanations both use examples which describe circumstances which are fixed and cannot be changed. By aligning reasons for lack of technology exposures with fixed situations Eamon was expressing an entity mind-set. Eamon also expressed that 'problems when using technology would be used [as] an excuse not to do something', describing helpless behaviour by avoiding a challenge, or a self-protective strategy which prevents their ability being perceived as a cause of failure. Eamon's comments did not all align with the Entity study condition that he was a part of. During usage of the application he was struggling with scrolling some content on the device's screen, but made the comment that he 'got used to how far up it goes'. Also for tasks requiring images to be described Eamon felt unsure of what he should say, but expressed that 'this may be helped by practice'. These examples show Eamon able to reflect on improvements being possible despite initial challenges. Earl, in response to the measure item 'If you fail in a task, you still trust your technical ability' said that 'it would be a signal to ask someone else'. Although a reasonably pragmatic next step after failure it suggests a willingness to defer to other peoples' ability. Responding to another item regarding failure with technology Earl said they would 'blame the computer usually'. Additionally when using the application Earl had issues using buttons within the application saying 'the touch screen is too sensitive' and also commenting that 'the

screen is too small'. Although the comments about the device and application were perfectly reasonable, and considered for strengthening the SAP research, the comments were also all detached from Earl's own involvement, without any referral to his own abilities, issues or mastery. This can be considered alongside the entity-Implicit Theory measure item asking whether 'Difficulties and challenges prevent you from developing your ability with new technology', to which Earl commented that it was 'difficult to think of barriers'. This suggests that Earl avoids looking at issues that he might have using technology, focusing instead on any shortcomings that might exist with the technology, thus externalising the cause of any difficulties that arise. Earl did however endorse the idea that ability improves, responding to one measure item with 'a lot of learning is from what I have achieved'. Other Entity Condition participants referred to technology issues in a similar manner to Earl. Edith commented that she found the device 'a bit small to hold' and also said that 'the buttons may be a bit small'. Edwina also commented that they found it hard to use 'mainly because of the touch screen'.

Next, examining Incremental Condition participants, Iain (Incremental Condition participants will be referred to with names beginning with 'I') when responding to an item about questioning your technical ability following a failure responded 'I know it's me, because I haven't bothered to learn it'. This suggests knowledge of a link between lack of effort and failure, consistent with an incremental mind-set. When discussing the size of text in the application Iain said 'Instructions need to be large due to my eyesight', and of the application's buttons 'they seem fine, as I've not got my glasses on'. Here Iain was discussing a potential issue with the application, items may be too small, but he discussed them in the context of his own eye-sight so that it was not solely an external issue for them. In reference to other 'complicated' digital technology that Iain uses, he credits this achievement to 'it is laid out the same as older analogue technology'. This could be interpreted as recognition of previous effort helping when learning something

new. Alternatively the interpretation could be that they automatically know the technique and that it would be difficult to acquire the ability otherwise. Ida referred to application issues, for example 'It is an elegant device but needs to be more graspable'. This comment was of a similar manner as was noted when discussing comments of Entity Condition participants above, focusing on it as being an entirely external issue. Ida also reported that they 'Don't see themselves as a technical person', language which makes being technically-minded an entity, something you are or are not. In discussing whether they still trust their ability following a failure with technology, Idris stated that 'it's me being stupid; I'll get it right next time'. This suggests that they believe their ability to change the situation remains, following a failure, which is concurrent with an incremental mind-set. Another Incremental Condition participant, Igor, said they 'blamed themselves' when describing that they had previously had issues with a touch-screen. This again contrasts the general trend of Entity Condition participants to blame the technology. Similarly Ilsa discussed issues with gripping the device in terms of their tremor, making suggestions of 'fingerless gloves or a strap could help'. Here an issue with the device is being discussed in the context of an internal issue, tremor, and additionally making constructive suggestions to improve the situation, congruent with an incremental theory.

The next theme to emerge was where participants referred to plans to use either technology or the application, i.e. Plans for Usage. These included hypothetical uses of the application, if it were to be available, or predictions of non-usage. Also some participants thought they could be using technology more, and made reference to more or less detailed plans, or reasons for or against increased technology usage. In the Entity Condition Eamon mentioned that they 'must get an email address and get my act together' and also they 'would like to go further with technology, I think I could use a computer, but feel lazy to progress this'. Here there is a plan to use email and a desire to

use a computer, but little detail around the idea and also an admission of a lack of effort. If the outcome is desired then a possible explanation for inaction could be an entity condition, maybe feeling technology usage is something that is expected of them and that they have to live up to. However, a performance focus might mean that having the explanation of being lazy is similar to saying that they could do it if they wanted to. Contrastingly, Eamon also says that they would feel comfortable to use the application in public, ‘when people ask me what I’m doing I’ll say “listen, I have Parkinson’s”’. This suggests a slightly more detailed level of planning for technology usage, thinking of peoples’ reactions and how they might respond. Additionally Eamon commented that ‘when I get something new I have to keep going to the instructions, but this gets less as I get used to it’. This supports an incremental theory from Eamon, asserting that learning can be in stages that get progressed through. Eamon, despite being in the Incremental Condition, has made comments which match both entity and incremental mind-sets. This is consistent with Eamon’s comments noted for the Failures with Technology theme.

Edith commented – in response to a measure item asking if they saw a link between good preparation and good outcomes with technology – that ‘I just start to press things, and then I lose the TV channel, and at that point I call a friend’. This suggests a lack of engagement with the process on Edith’s part, and that when it goes wrong rather than learning from the situation they defer to someone else’s ability. Also Edith said ‘the intention to use the application at home would be there, although I don’t actually know whether I would or not’. This might be considered an intention to use rather than a plan, as it contains no detail or conviction. Slightly more detail was present when asked if they would use it in public, Edith replying ‘I would be more likely if I was with a group of friends’. Here the dynamics of a potential usage situation are being considered. Other Entity Condition participants made comments which aligned with both mind-sets. Earl responded to a measure asking if they would still trust their technology ability following

a failure, suggesting 'I would take it as a symbol to ask someone else'. Edwina responded to the same item with 'I would ask for help', and to the item asking about a link between preparation and developing abilities 'I would look at the manual and give up'. These comments by Earl and Edwina are both consistent with an entity mind-set, both asking for help when the item was phrased to investigate the resilience of trust in their own ability. To the item linking preparation and ability Edward responded 'I need to read a manual to get started, followed by a period of exploration, I need enough information to kick off'. This contrasts Edwina's comment to the same item, suggesting an understanding of time and effort being needed to start something new. With regards to using the application in public Egbert made several comments 'I would use it in public with ease, though going "ahhh" without the device in sight might look strange' and 'I'd be happy to sit there with it ... in the car or when I'm stopped having lunch'. Here Egbert has suggested plans including times, places and consideration of potential issues.

Overall there was a similar volume in terms of entity and incremental mind-set comments from Entity Condition participants. This was in contrast to Incremental Condition participants, the volume of their comments being skewed in favour of incremental mind-set comments. Igor responding to the item linking preparation and ability commented 'I would probably get out the instructions and then cry', suggesting preparing to use new technology was a hopeless situation. Igor made more detailed plans for using the application saying 'I think it would probably be easiest to use when I had gone out of the house', adding 'I would maybe show it to friends' and 'use it at chorus rehearsals'. Ilsa said 'I would maybe put more effort into using the application if there were other people around'. This could be interpreted as an entity mind-set, a performance focus leading to being interested in what others think of their behaviour. Ilsa subsequently commented 'I would use it in the home; I regularly have friends or my partner saying that I am being quiet'. This suggests that their intention to use the

application around others is borne from an aim to improve their performance when speaking. It also refers to detail around a plan of usage, thinking of the location of home and circumstance of others being around. Ilsa also noted that ‘if I was tired I might not bother to use it, so it is situation dependent, but it would still be worth testing using it when I’m tired’. Here Ilsa is being realistic about usage, but also acknowledging there might still be reward from effort even when tired. Several other comments by Incremental Condition participants in relation to plans were: Idris commenting ‘it might be best to use it in a gap time or down time, when I am between activities’; Ida commenting ‘I would be interested in using it to gauge my volume against background noise’; and Iain ‘There are times when I might use it, like when I’m out watching music, I have difficulty gauging my volume’. All of these plans have some amount of additional detail, compared with Entity Condition participants who made fewer similar comments. Iain observed further that ‘the main time to use it would be when I don’t feel very well, this is when my voice is likely to be quieter. You don’t know when you’re at home if you’re in trouble’. With regards to mind-sets, having plans with more detail suggests more belief in the potential to improve a situation, linked with an incremental theory. This is similar to findings from Hong et al. (1999) where Incremental Condition participants showed more interest, versus Entity Condition participants, in a remedial English course at a Hong Kong University following negative English test feedback. It is possible that people using the application with an entity mind-set might be concerned more about getting good feedback from using the application, or avoiding negative outcomes, whereas people with an incremental mind-set might be more interested in how the application might assist them making them more open to consider circumstances for its usage.

The third theme, Effort, was formed around a collection of comments where participants refer to either aspects of effort, or its entity theory equivalent, performance

(see Section 2.1.4 above). Here if someone referred to the value of effort, or consequences of effort, it was interpreted as relevant to an incremental theory. If someone made reference to attending to performance, or endorsed a lack of effort, it was interpreted as relevant to an entity theory. In the Entity Condition Egbert made several performance-focused comments e.g. ‘Next time I’m going to go higher’, and ‘I’ve gone down, going to try and go up now’ reflecting on feedback from the application, and ‘I can’t believe how easy it is’ comparing the buttons with those on their own phone. Egbert also commented ‘I feel embarrassed reading out loud’ when explaining why they had skipped several text-reading tasks in favour of image-description tasks. This is effectively Egbert avoiding something he finds challenging due to preoccupation about appearances, which is consistent with his other comments which were all very performance focused. Edwina was another Entity Condition participant to express preference for one type of task-material ‘I’m happier using the texts, I run out of things to say with the images’. Earl emphasised his agreement with some of the entity-items on the Implicit Theory measure, endorsing one item which asked if there was a link between good performance and demonstration of ability to others with the comment ‘doing it quick and efficiently’, and saying ‘that’s the way it is’ in agreement with the item ‘when you exert a lot of effort, you show that you are not technically minded’. Edith also made comments endorsing an entity theory in response to measure items, for example ‘it doesn’t make a difference’ when responding to ‘the effort you exert improves your ability with new technologies’. There were a greater number of entity mind-set comments from Entity Condition participants under the theme of Effort. A number of these however were in response to measure items rather than during application use, with the exceptions of Egbert and Edwina whose comments were split more evenly, occurring both in response to measure items and during the exposure to the smartphone application.

Of the Incremental Condition participants Ida commented ‘I need more practice’ after two rounds of training. This is acknowledging the value of effort, in contrast to comments of entity condition participants above. Ida also commented that ‘learning depends on the environment, anyone can adapt’. This possibly is suggestive of the importance of necessity rather than effort, but this is still compatible with the idea of ability improving through learning. Ilsa responded to one measure item saying ‘you have to work at whatever you use’, and in response to another item asking about the value of effort ‘you improve as you go on’, both acknowledging the value of effort. Others reflected on effort in possibly a more pragmatic way, Ilona commenting ‘there is always more to be learned, but would you really be bothered’, and Iain in response to an item asking whether ‘if you fail to use a new device properly, you question your technical ability’ saying ‘I know it’s me because I haven’t bothered to learn it’. Both of these statements acknowledge a link between effort and outcomes, but question whether motivation exists in all circumstances. While discussing how they learned a musical instrument Ilona made a further comment ‘I have to work on it, but I know others that didn’t’. On the one hand this recognises the part that effort played for them, but it also expresses the possibility of gaining proficiency without exertion. One of the few potentially entity-mind-set comments made related to this theme was one previously discussed by Ilsa. Ilsa mentioned that they would possibly put more effort into the application in the presence of others, potentially meaning effort levels would be engaged if it was likely to demonstrate good performance. This however was discussed in the context of other comments and it seemed that Ilsa recognised a genuine need to improve their voice in the presence of others, and so that was when effort and improvement was of most relevance. The majority of comments by Incremental Condition participants collected under the theme Effort were consistent with an incremental mind-set. Also, in comparison to Entity Condition participants, there was more of a balance in terms of the

stage in the procedure from where comments were sourced (i.e. in response to measure items or while responding during smartphone application usage).

5.5 Goals and Hypothesis of Study 2b (Implicit Theory Domain of Vocal Issues)

The goals of Study 2b contained only slight variations from Study 2a. Firstly the procedure was planned to take place in participants' homes. This introduced the goal of investigating Implicit Theory in people with Parkinson's in more naturalistic environments, as this is where the application was likely to be used most. The Implicit Theory domain being investigated changes to the domain of vocal issues here, although an Implicit Theory measure of technology ability will still be presented prior to any of the target Implicit Theory domain materials being presented. The Implicit Theory manipulations used related to beliefs about health generally, and then an Implicit Theory of vocal issues measure examined beliefs about vocal abilities in the context of the health manipulation received. The hypothesis of Study 2b was the same as for Study 2a, that following presentation of an Implicit Theory manipulation, participants will demonstrate more responses congruent with the version of the manipulation that they received. Congruent responses will include participants shown the incremental version of the manipulation would show more agreement with (post-manipulation) incremental measure items, and less agreement with entity measure items, in comparison with participants shown the entity version of the manipulation. No difference in agreement is expected between conditions for Implicit Theory of technology measure items, presented pre-manipulation. Congruent responses will also be again sought from participants' engagement with the smartphone application, and comments that they make during the procedure. Unlike Study 2a participants were not shown an Implicit Theory manipulation relating to technology. However, as the application is being presented to them as a speech therapy application, in a health context, it is anticipated that usage behaviour should be similar to what was predicted previously (see Section 5.2 above). It

is expected that participants shown the incremental version of the manipulation would show more perseverance, so would continue to use different application components for longer. Also, as part of investigating application engagement, volumes captured by the device will be examined. Difference between volumes produced (for talking tasks and vowel-production tasks), with and without a target displayed on-screen (for task descriptions, see Appendix E.2) will be explored. This time, unlike Study 2a, the Implicit Theory manipulation did mention beliefs about health, and the measure that followed was related to beliefs about vocal abilities. Addition of an on-screen target provides a goal during a trial, but also adds complexity due to necessarily adding more elements to the screen's display and there being something additional to attend to. In demonstrating responses congruent with the Implicit Theory manipulation received, it is anticipated that Incremental condition participants will show improved performance, in comparison to Entity condition participants, on trials in the presence of the goal-bar (and increased complexity) versus trials in the absence of the goal-bar.

5.6 Study 2b (Implicit Theory Domain of Vocal Issues): Method

5.6.1 Participants

Participants were 10 individuals with Parkinson's, all having received a referral to King's College Hospital's Speech Therapy services, from where they were informed about the study. All participants received the same letter explaining details about the study (similar to that received by Study 2a participants, see Appendix F.1). Five entity-condition participants had a mean age of 77.2 years, mean ($n=4$, 1 Ps unknown) Hoehn-Yahr score of 2.6 (Hoehn & Yahr, 1967; This indicates moderate clinical disability, on the scale described above in Section 1.1), and mean time since diagnosis of 3.8 years. Five incremental-condition participants had a mean age of 72.0 years, mean Hoehn-Yahr score of 2.6 (indicating similar clinical disability compared to entity-condition

participants), and mean time since diagnosis of 3.0 years. No participants had taken part in Study 2a.

5.6.2 Materials

Materials used were the same as for Study 2a (Section 5.3.2), but with some alterations and additions which shall be outlined here. All materials were presented in a large text size (Calibri font size 16).

5.6.2.1 Implicit Theory (of Vocal Issues) Manipulations. The theme of the Implicit Theory manipulations was altered to relate generally to health behaviours (see Appendices A.5 and A.6). Some extracts from each are as follows:

Entity Version: ‘...The majority of research agrees that our ability, or strength, to make changes in these areas is fixed, and cannot be improved significantly through extra effort (Abblet, 1994...’; ‘...according to Fields’ results, up to 76% of a person’s behaviours in such situations are due to fixed genetic factors...’; ‘...In another study by Cohen and Laud (2004), comments were taken from older-adult participants... ... “I love seeing improvements, they just seem to come without me really trying”, *Dorothy...*’;

Incremental Version: ‘...The majority of research agrees that our ability, or strength, to make changes in these areas is variable, and can be improved significantly through extra effort (Abblet, 1994...’; ‘...according to Fields’ results, up to 76% of a person’s behaviours in such situations are due to changeable environmental factors...’, ‘In another study by Cohen and Laud (2004) comments were taken from older-adult participants... ... “I love seeing improvements, I keep really trying at it and I keep getting better”, *Dorothy...*’;

5.6.2.2 Technology Implicit Theory Measure. This was the same measure as described in Study 2a where it was referred to simply as ‘Implicit Theory Measure’. The counterbalancing order of questions is shown in Appendix D.1.

5.6.2.3 Vocal Implicit Theory Measure. This was an eight-item measure modified from items found in the “Kind of Person” Implicit Theory measure (Dweck, 1999 pg 180), including four incremental items and four entity items (see Appendix B.3). It was presented under the title “Your beliefs about speech and voice quality”. Items were altered to relate to how actions, thoughts and efforts might affect speech or vocal quality. All items required responses be made using a four-point Likert Scale with boxes marked from ‘Strongly Disagree’ to ‘Strongly Agree’. Example entity items were: ‘I believe that the voice you have is your own; it cannot intentionally be changed much’; and ‘I believe that you have certain vocal characteristics; there is not much that can be done to change them’. Example incremental items were: ‘I believe that you have the power to always greatly change the kind of voice you have, though it takes a lot of hard work’; and ‘I believe that no matter what kind of vocal capacity you currently have, you always can actively change it very much’. Items were counterbalanced by creating 12 different versions where the same questions were systematically ordered differently (as per Appendix D.2).

5.6.2.4 Speech Questionnaire. This included three items marked on a four-option scale marked from ‘none’ to ‘severe’: ‘Do you have any issues with speech volume?’; ‘Do you have any issues with stammer?’; and ‘Do you have any issues with swallowing?’. Next there was an open response question, ‘Do you have any other speech issues?’ Finally there were two items marked on a four-point Likert scales, the first marked from ‘not at all serious’ to ‘very serious’ was ‘At present, considering any current issues with speech you may have, how serious do you think these issues are for your daily life?’. The second marked from ‘not at all concerned’ to ‘very concerned’ was

‘Are issues with speech something that you are concerned may become more of an issue in the future?’

5.6.2.5 Speech Tool Application. This study occurs at the point at which the SAP project is testing a second iteration of the smartphone application to be developed within the context of the Parkinson’s UK grant.

5.6.2.6 iPhone 3GS. An Apple iPhone was used to present the Speech Tool Application for this study.

5.6.3 Design

The design was the similar to Study 2a (Section 5.3.3) with additional DVs, the Vocal Implicit Theory Measure and the Speech Questionnaire.

5.6.4 Procedure

The procedure was the same as for Study 2a (Section 5.3.4) apart from the variations outlined here. The procedure took place, where possible, at participants’ homes. This was not possible for one participant, for whom the procedure took place at a speech and language therapy suite, at King’s College Hospital. There was also variation in the order of materials presented: the Speech Questionnaire was presented immediately after the Technology Questionnaire; next the Technology Implicit Theory Measure was presented, before the Implicit Theory Manipulation; following the manipulation the Speech Implicit Theory Measure was presented. The second part of the study was presented to participants using an iPhone as opposed to an iPod Touch. The steps, outlined in Appendix E.2, were similar to Study 2a, with some variations highlighted.

5.7 Study 2b (Implicit Theory Domain of Vocal Issues): Results

5.7.1 Questionnaire Responses

To investigate a potential confound of self-rating by participants of technology ability, two technology questionnaire items (on current ability and ability compared to peers) were combined (by adding each participant’s ratings for both items together to

give one score). Entity-condition participants had a mean combined-score rating of 4.8 (very weak = 2, very strong = 8), and incremental-condition participants had a mean rating of 3.8. Both conditions rate their ability below scales mid-point (mid-point = 5.5).

To investigate a potential confound of technology familiarity, similarly to Study 2a, three technology questionnaire items (on previous usage of touch-screens, mobile phones and email) were combined. Treating usage of each as equivalent in terms of being an indicator of technology familiarity, indication of prior usage of each was either yes (1) or no (0). Entity condition participants had a combined-score mean familiarity of 1.8 (no familiarity = 0, familiar with all three = 3), and incremental condition participants had a mean familiarity of 1.2. This fails to rule out a potential confound of self-rated technology familiarity, with entity condition participants rating themselves above mid-point (scales mid-point = 1.5), and incremental condition participants rating themselves below mid-point.

To investigate a potential confound of vocal-issues and vocal-concerns, five speech questionnaire items (rating of issues with volume, stammer and swallowing and rating of severity of current speech issues and of concerns about potential future issues) were combined. Entity-condition participants had a combined-score mean rating of 9.8 (highest or most issues/concern mark = 20, lowest mark = 5), and incremental-condition participants had a mean rating of 10.2. Both conditions reported scores below the mid-point (mid-point = 12.5) for vocal-issues and concerns.

5.7.2 Implicit Theory Measure Responses

Implicit Theory of technology ability was measured prior to presentation of the Implicit Theory (of vocal issues) manipulation, in order to investigate a potential confound by an Implicit Theory in this domain. Comparing participants' response across the Technology Implicit Theory measure's items between conditions, an independent groups *t*-test did not show a significant difference ($t = 0.49$, $df = 8$, $p = 0.64$, two-tailed).

The direction of these responses can be seen in Figure 5-5 below. Prior to the Implicit Theory manipulation (of vocal issues) entity condition participants showed (non-significantly) more agreement with incremental Implicit Theory (of technology) items than shown by incremental condition participants.

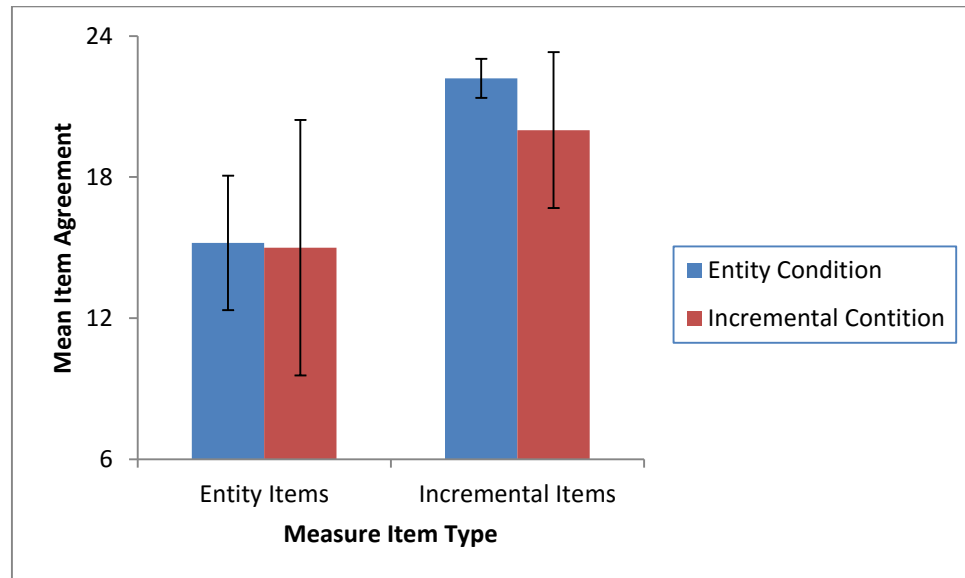


Figure 5-5: Mean Technology Implicit Theory measure item agreement (min=1, max=4) between Entity (n=5) and Incremental (n=5) participants and between Entity (6 items) and Incremental (6 items) measure items.

To explore the hypothesis that following presentation of an Implicit Theory manipulation, participants would demonstrate more responses congruent with the version of the manipulation that they received (Section 5.5), agreement with entity and incremental item types is shown in Figure 5-6 below. Comparing participants' response across the Vocal Implicit Theory measure's items between conditions, an independent *t*-test did not show a significant difference ($t = 0.33$, $df = 8$, $p = 0.75$, two-tailed).

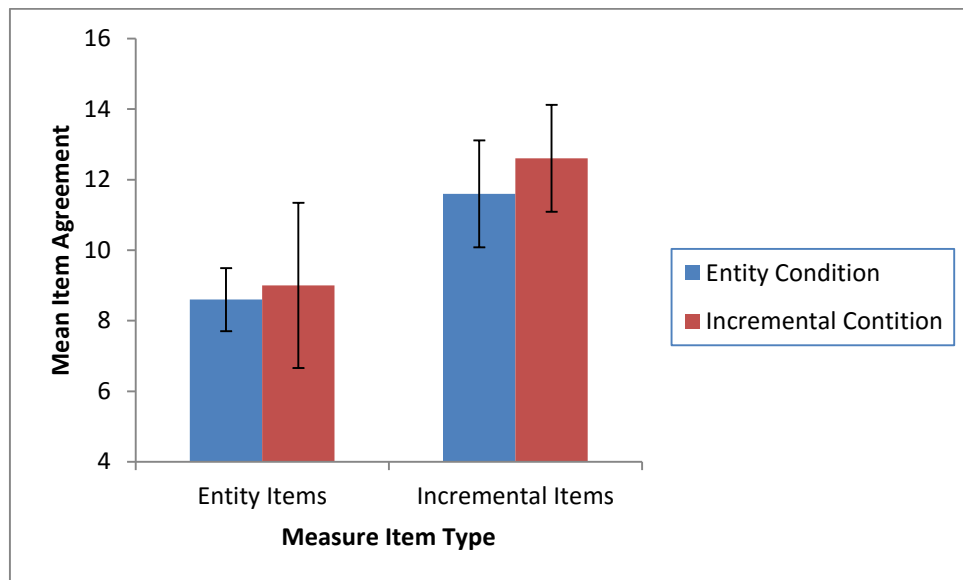


Figure 5-6: Mean Vocal Implicit Theory measure item agreement (min=1, max=4) between Entity (n=5) and Incremental (n=5) participants and between Entity (4 items) and Incremental (4 items) measure items.

5.7.3 Volumes Measured

Similar to Study 2a, part of using the application was a structured set of application usage tasks, including generation of speech and vowel-sounds in the presence and absence of goal-bars (see Appendix E.2). Unlike Study 2a, the Implicit Theory manipulation did focus on health beliefs, followed by an Implicit Theory measure accessing vocal issues. Here the hypothesis, that following presentation of an Implicit Theory manipulation, participants would demonstrate more responses congruent with the version of the manipulation that they received, was tested by comparing volumes produced while using the smartphone application during testing. It was anticipated that Incremental condition participants would show greater increases in volumes during trials with a goal-bar present (extra display complexity) versus absent, in comparison to Entity condition participants (see Section 5.5 above).

Firstly examining participants' speech-production volumes – between conditions – in the absence and presence of a goal-bar, the main effect on mean volumes (volumes shown in

Figure 5-7) was non-significant: $F(2, 6) = 0.07, p = 0.93$; Wilk's Lambda = 0.98. Analysis of each individual dependent variable, using a Bonferroni adjusted alpha of 0.025, showed there was no contribution to differences between Implicit Theory conditions of: initial goal-absent talking volume, $F(1, 7) = 0.16, p = 0.70$; or goal talking volume, $F(1, 7) = 0.04, p = 0.85$.

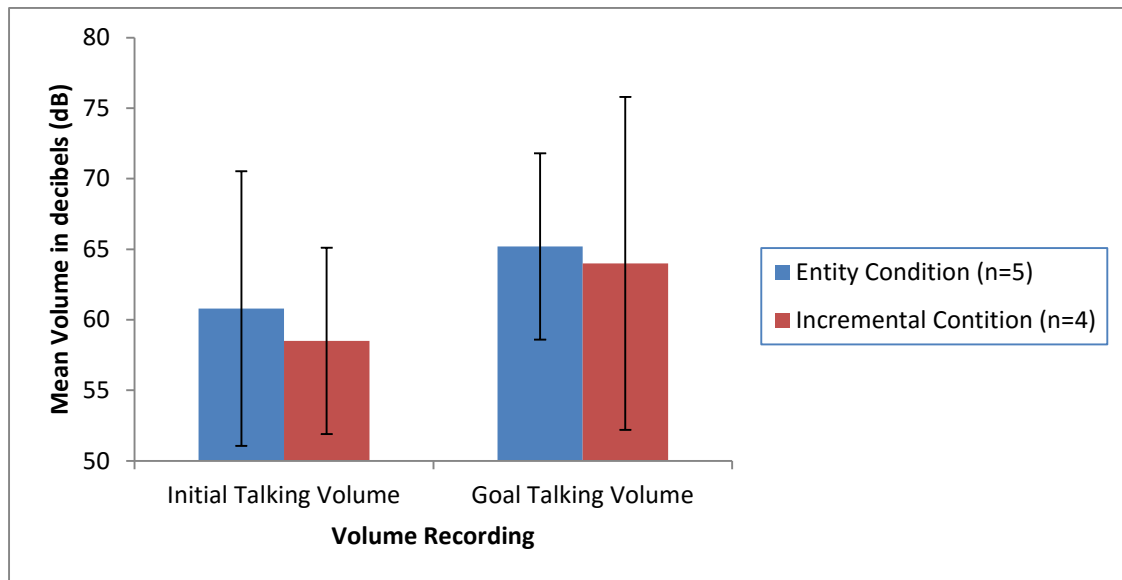


Figure 5-7: Mean volume recordings (in decibels) comparing initial speech volume recordings with speech recordings where an on-screen decibel goal-bars were being displayed. This comparison is between Entity- and Incremental-condition participants.

The main effect of average volumes captured while participants were producing vowel sounds (see Figure 5-8 below) was non-significant: $F(2, 5) = 0.63, p = 0.57$; Wilk's Lambda = 0.80. Analysis of each individual dependent variable, using a Bonferroni adjusted alpha of 0.025, showed there was no contribution to differences between Implicit Theory conditions of: initial (goal-absent) vowel volume, $F(1, 6) = 0.04, p = 0.86$; or goal vowel volume, $F(1, 6) = 1.08, p = 0.34$.

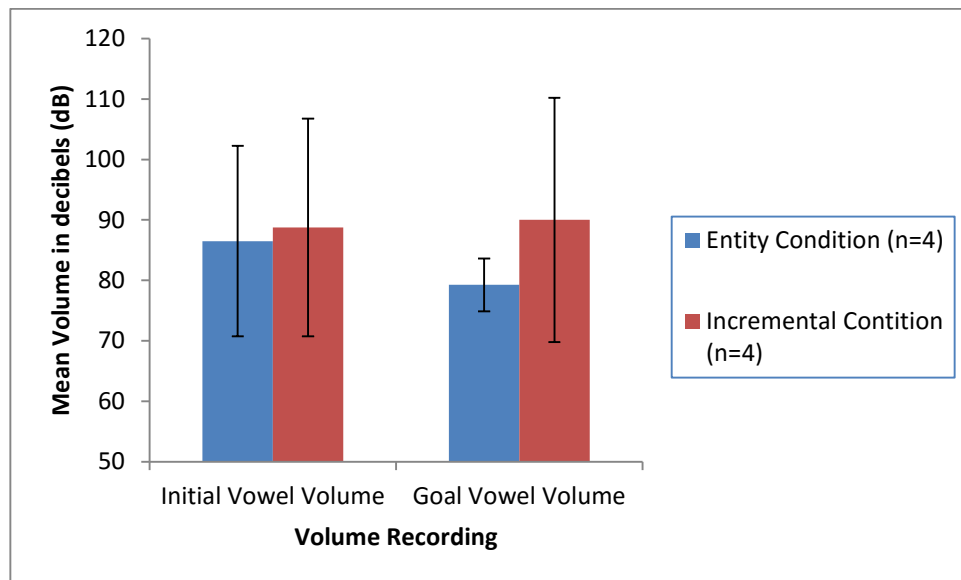


Figure 5-8: Mean volume recordings (in decibels) comparing initial vowel-sound volume recordings with vowel-sound recordings where an on-screen decibel goal-bars were being displayed. This comparison is between Entity- and Incremental-condition participants.

5.7.4 Application Usage

No results gathered (for discussion, see Section 5.8.3 below).

5.7.5 Thematic Analysis Results and Discussion

5.7.5.1 Conducting a Thematic Analysis of Qualitative Data. Thematic analysis followed a similar pattern to that of Study 2a (see Section 5.4.5.1).

5.7.5.2 Findings of a Thematic Analysis of Qualitative Data. Similar themes to those of Study 2a and relatable to Implicit Theory emerged, with the exception of Failures with Technology. Use of technology was still discussed by participants but there was less of a variation between comments and technology was less emphasised in the study materials. The themes Effort and Plans for Usage both emerged again. Also, comparable to technology failures the theme Vocal Failures emerged, which reflected the study materials with the inclusion this time of vocal Implicit Theory manipulation. Comments made during the presentation of the technology Implicit Theory measure were not included here as this measure was presented prior to receiving any manipulation.

Looking first at the theme Vocal Failures, here any comments related to speech issues or circumstances where vocal issues occur were collected. Participants discussing vocal improvements, or efforts made to use their voice would be considered. Participants interested in the performance of their voice, or looking for external causes for issues would be considered relevant for an entity mind-set.

Entity Condition participant Ellen commented ‘I definitely talk louder when in confidence [sic] of what I’m saying – however, if I have to think about things...’ Here Ellen was acknowledging that she could speak louder under more favourable circumstances or with more familiar content, the focus being on performance. In response to a question about whether the application might be useful Emily commented ‘one of the problems is my voice is very variable, it is difficult to establish a baseline, sometimes I can read out loud for 20 minutes, others five. It doesn’t seem to be related to medication’. Emily is expressing a helpless situation here, and that things are outside of her control. Rather than looking at internal causes or self-efforts for improvement she looks externally at medication as a potential explanation.

Incremental condition participants made more comments consistent with the theme of Vocal Failure, in comparison with entity condition participants.

Acknowledging the difficulty of situations of vocal failure, Imogen commented ‘I would like to use it [the application], people say “what” and I would have to say what I’ve just said all over again’. This was in addition to a question as to whether Imogen thought the application useful, to which they responded ‘Yes, I would like to speak louder, because I think I’m speaking loud’. In these comments Imogen is acknowledging a vocal issue but without looking for external cause or explanation. They also express interest in a means (the SAP project’s application in this case) to assist them in achieving louder speech. Isabel acknowledged that ‘domestically my voice is not loud’. In a comment similar to where Emily referred to her voice as variable Isabel said ‘Peoples voices are different

and change depending on circumstances’. The context of the comments and subsequent remarks varied however. Emily had been asked whether she thought the application might be useful, and subsequently referred to medication as a potential explanation (but ruled it out) and not acknowledging the potential for effort to improve the situation. Isabel had been asked whether they had any suggestions for additions to the application, and in addition to commenting that speech is variable they added if it could ‘possibly detect vowels or consonants, whichever might be the ones that are keeping your volume from being loud, some parts of speech that we’re more comfortable with – it could possibly break down the aspects of speech’. Here Isabel is looking at variability of speech in a proactive way, considering how an improved application could help highlight aspects of speech that require most effort. Other acknowledgements of vocal issues by incremental condition participants include Ivor who said ‘I may use it in company because I find I don’t speak loudly enough’ and Ingrid who said ‘I think I would use it regularly, I didn’t realise people with Parkinson’s had voice issues’ and that you ‘don’t normally think about voice in normal life’. Fewer entity condition participants had made reference to vocal issues. Also where incremental condition participants referenced vocal issues they were able to discuss it in terms of being a symptom of Parkinson’s, or an issue that they personally had, and were then able to discuss how the application or other methods could form part of efforts for working with the presence of vocal issues.

A second theme to emerge was plans for using the application. Looking first at comments made by entity condition participants, one of the questions that was put to most participants was whether they might find the application useful as part of a therapy. To this Ellen ‘I think it would, I’d use it because Julia [their speech therapist, also see Section 3.1 above] would chase me up, whether I would in a year’s time, possibly depends whether Julia is saying my voice is better, the aim is to get my voice right, if it isn’t achieving that then there isn’t any point’. This statement contains a mixture of

Implicit Theory relevant components. Firstly the intention to use it is performance orientated as it is motivated by there being a need for visible results, but also engagement is reliant on the external role of the speech therapist. Alongside this is the aim of a better functioning voice, suggesting a belief that it is something that can be improved. Ellen also comment that they could use the application outside of the home, bringing up the example of when they are out with their dog and need to be able to call for it. Eva said that they probably would not use the application, however their partner commented 'you would if I'm around you, you've got to be pushed'. Then asked if they might use it more if usage was being fed back to their speech therapist Eva said 'I think it would be used more'. Again this is consistent with a performance focus, using it if monitored rather than for any actual growth value. The comment by the participant's partner might suggest that an entity Implicit Theory was consistent with their general mind-set already, but it also highlights a possible confound, created by other peoples' beliefs. Similar comments were made by Emily 'I don't think I'd want to use it, I feel that I might start, but I'm not very disciplined, I'd give up after 3 weeks'. Again asked if usage could be monitored they said 'I think I'd still use it a bit' but then questioned whether monitoring would be possible as they do not get to the hospital very often. These comments reflect usage might be as a result of being told that they should use the application, with no great intent to use it because it might help them to engage with efforts for improved vocal abilities. There were only a few other examples of entity condition participants suggesting places or scenarios where they might use the application. Enrique when asked about using the application outside of the home said 'If I'm required to I would, If it's going to be of use to the survey', suggesting they were more focused on helping out our research purposes. They endorsed some other suggested usages, and at one suggested place that they thought of (at meetings) they said that they 'wouldn't want to use it there, a bit ostentatious, people might know me'. Emma had agreed that the

application would be useful as part of a therapy, but when asked to suggest usage scenarios they said ‘I visit friends at Twickenham, I don’t know what you could use it for, maybe maps’. Here maps were not being suggested as an idea for a vocal exercise, rather suggesting a lack of ideas for scenarios where a smartphone speech application might be useful.

Under the theme of plans for usage, comments made by incremental condition participants were also collected when asked for suggestions where they might use the application. Isabel responded ‘Probably would, might be a bit sneaky, visiting relatives, going to church’ and when asked for a specific scenario ‘Certainly Parkinson’s meetings, I’d take it out there and check my volume, also to check the volume of others? Also at children’s parties’. Similarly Ingrid when asked if the application would be useful responded ‘Unfortunately when I’m not working, I don’t give speeches any more, apart from friends having to hear, yes it would be useful’ and to using the application in public ‘Yeah, I think I would, [it would be] good to realise what you are doing rather than just carrying on’. Both Isabel and Ingrid came up with several reasons where they would use the application and also reasons why they might use it. In terms of actually using the application, plans here are more creative and have more meaning. Not all incremental condition participants were keen to use the application in more public settings, Ingrid saying ‘No, I think I would use it at home, unless to show to others who have issues’, Imelda saying ‘I don’t think I would, I wouldn’t want people to know’ and Imogen that ‘it’s a task for somewhere comfortable, I’d be worried making loud noises, a thing for the home I think’. An incremental Implicit Theory in the domain of vocal issues maybe does not have an impact on potential shyness about public usage. Ivor said that the application would ‘certainly give me an initiative to use it, encourage me to train more’ and also had the suggestion for an application feature ‘maybe it could prompt me in some way to continue using it?’. These comments by Ivor fit with the general pattern of incremental

condition participants, not just agreeing that they might use it but recognising the application as a potential trigger, not for the reason of using the application for its own sake, but because they want to train their voice. Also Ivor made one of the few suggestions of additions to the application relevant to the theme of plans for usage, but there were no relevant suggestions noted by entity condition participants.

The third Implicit Theory related theme to emerge was where effort-related comments were made. Fitting the Implicit Theory domain of vocal issues, effort-related comments were found that looked at the outcome of efforts on the voice, and likely efforts that the participants might make with a smartphone speech therapy application. Again looking at the Entity condition participants first, Enrique in disagreement to an incremental measure item, suggesting vocal change is possible through effort, said 'I don't know about that, not greatly change it – you're stuck with it to a certain extent'. Also not quite agreeing with a similar entity measure item 'I don't think it can be changed a lot, I think one can change it to some extent'. In both of these comments Enrique allows that there might be room for some change or improvement, but the possibilities are very limited. Similarly Emily said 'I don't think [that I] can change it very much'. For both of these participants, effort would be unlikely to achieve much change. Emily also said in response to whether the application might be useful 'If I did it then it would [be useful], but I'm resigned to being 81, and can't go on forever, being reminded of problems when I would rather stick head in sand'. To Emily the application might be useful, but they would rather not engage with it, and reference to sticking their head in the sand is compatible with helpless behaviours of an entity condition. In another comment made in response to an incremental measure item suggesting vocal ability can change through effort, Emma said 'I haven't really tried all that much to be honest, I don't know whether I could drastically change'. Not all entity condition participants made comments consistent with their study condition. In response to several measure

items Ellen made comments which endorsed effort and the possibility for change as a result of effort. These included 'you can concentrate on speaking to people' and 'you can change it through practice' acknowledging the value of effort in both individual situations and more long-term effort results. Ellen also said that 'you have a certain ability that you can do, but you can improve the loudness through practice'. Although these responses to measure items conflicted with their study condition, while they were actually using the application they showed less interest in effort asking 'how often do I use it?', 'how often do you envisage me using it?' and also that it was 'quite a commitment to use it every day, maybe 2/3 times a week, or all in one go'. This preoccupation with frequency of usage was more consistent with Ellen's study condition, but unusual given their earlier comments in responses to measure items.

For incremental participants too most of the effort-related comments captured were made in response to Implicit Theory measure items. Firstly Imogen said that they 'agree you change if you really tried, depending on what it is', which agrees guardedly with an incremental theory but emphasises that effort would be a key part. They also say 'I believe volume I could change', which was consistent with the manipulation they had received even if they did not at that point think that everything could change. Ingrid had a discussion about accents 'well a long time ago I tried to get rid of my accent but I couldn't, so I gave up ... there are some people that are able to imitate a Scottish or French accent, so it obviously can be done'. Here they mention that they 'tried' which implies effort and they give an example of where people have achieved the same thing, but obviously it is in the context of failed efforts. Then in disagreement with an entity item suggesting vocal ability cannot change Ingrid said 'well it can be changed, this is the thing, with effort'. Across these statements despite recalling a failure of effort, Ingrid firmly believed that change could be achieved through effort. Imelda also made comments in response to measure items, agreeing with two incremental items but

expressing very narrow agreement ‘On the volume I think you can change it’ and ‘I don’t know if I believe you can change, I’m only thinking on volume’. Both items were interested in change through effort and clearly Imelda believes that effort could affect volume but maybe not much else. Rejecting an entity Implicit Theory item Imelda said ‘I think you can, with effort’, again consistent with their experimental condition. Imelda also made an effort related comment during the application testing. Asked whether they like the application Imelda said they ‘[like the] whole thing, got to practice, the more you use your voice ...’ Mentioning that the application in this context expresses that it could facilitate vocal practicing, and could be interpreted as an indication of intention to make effort with their voice. In another comment during application testing Ivor said ‘set up could use it by [my]self and with [my] wife, if I could show her my results were improving she’d be quite impressed’. This takes quite a performance-orientated perspective of effort, focusing on being able to display outcomes. Across conditions there were few comments that got categorised into the effort-related theme that occurred during application testing and, including Ivor’s comment, not all of these were consistent with the experimental condition. Most of the comments included were made in response to the Implicit Theory vocal change measure items. These comments were generally consistent with participants’ experimental condition, a notable exception being Ellen, who mentioned the value of effort several times in response to measure items but then displayed caution about any potential need for effort during application testing.

5.8 Study 2a and Study 2b: Combined Discussion

The PIT research studies were structured to include an initial phase with people with Parkinson's, Study 2a and Study 2b. These studies were run in conjunction with user-testing stages of the SAP project. This initial phase with people with Parkinson's tried to build on methods and materials that had been developed in Study 1a and Study 1b (see Chapter 4) with a non-clinical population. An aim here was to establish whether

Implicit Theory domains exist that are relevant to the SAP project, that is, people with Parkinson's using a technology-based speech therapy application. Studies 1a and 1b investigated Implicit Theory when learning programming languages, and as a technology-relevant domain it was hoped to be of relevance to an Implicit Theory of ability with technology domain used here also (Study 2a, Section 5.2 above). Of additional relevance to the SAP project, is how people perceive their health and beliefs about vocal issues. For this purpose a second domain was investigated, Implicit Theory of vocal issues (Study 2b, Section 5.5 above). In comparison to Study 1a and Study 1b, Study 2a and 2b were conducted in less controlled environments. For Study 2b the general location to meet participants was in their homes, meaning there was very little control over the experimental environment. There were several factors related to the usage of the application and associated technology that also need to be considered. For Study 2b one factor difficult to control was the duration of time participants could spend with the application, often depending on travel-time getting between participants' homes. Additionally, it was considered beneficial to the main SAP project for feedback to be obtained from participants using the application on different types of devices. Participants in Study 2a encountered the application using an iPod Touch device, whereas participants in Study 2b encountered it using an iPhone. This apparatus variation will have introduced an additional confound for any comparisons between studies. A further technology-related factor affecting experimental validity was the incremental changes to the version of the application. Some application development occurred between the studies, meaning there were changes in application version between the studies. This was driven by the feedback collected from Study 2a, and technological errors encountered by participants during usage. Where possible, these errors were being corrected by the developers, using the time between the blocks of participants. It can be predicted that this led to the application becoming marginally

easier for participants to use with each new version. Similar to Study 1a and Study 1b, participant numbers were low, again acting as a limiting factor in these studies providing strong results, and discussion is given to interpreting low powered results below (Section 5.8.4.4). In response to this low power, results from Study 2a (Section 5.4) and Study 2b (Section 5.7) are discussed together here, including discussions of thematic analyses for each, allowing for trends of results to be compared and contrasted between studies.

5.8.1 Implicit Theories and Related Abilities

Investigating possible confounds between conditions, incremental condition participants in Study 2a reported higher scores of technology ability and technology familiarity (Section 5.4.1). This can be considered alongside the technology ability related Implicit Theory Measure, which was presented after participants read an (entity or incremental) manipulation on ability with technology. It was hypothesised that following presentation of an Implicit Theory manipulation, participants would demonstrate more responses congruent with the version of the manipulation that they received (Sections 5.2 and 5.5). However, no difference was seen between conditions (see Figure 5-1 above). As the study was very low powered ($n = 12$) it is only noted here that the Implicit Theory measure responses were in the direction expected, with Incremental Condition participants showing more agreement with incremental measure items, and entity condition participants showing more agreement with entity measure items. Also, similar to previous studies (including Studies 1a and 1b, Sections 4.5.2 and 4.8.2), both conditions agreed more with incremental items in comparison to entity items.

Similar investigation of possible confounds between conditions for Study 2b shows entity condition participants reported higher scores of technology ability and technology familiarity (Section 5.7.1). This was opposite to the direction of ability seen in study 2a, where incremental condition participants reported higher scores. A third confound of speech issues was also investigated, both conditions reporting very similar

levels (also Section 5.7.1). Two Implicit Theory measures were presented, a technology ability version presented before the Implicit Theory manipulation, and a speech issues version presented after. There was also no significant difference between conditions for the Implicit Theory measure of technology ability. Interestingly the entity condition participants, prior to any experimental manipulation, showed (non-significantly) more agreement with the incremental items, and agreement was very similar for the entity items. This may have been a reflection of greater experience and familiarity with technology as reported by entity condition participants to the questionnaire items. If this were the case it would indicate a link in people with Parkinson's, without any manipulations, between having an incremental Implicit Theory of technology and likelihood to have developed experience with technology. This link would need further investigation. The Implicit Theory Manipulation (entity or incremental) that was used related to vocal issues and ability to affect vocal abilities. Responses to the vocal issues questionnaire items can be considered alongside the vocal issues related Implicit Theory Measure, which was presented after the manipulation. Again, it was hypothesised that following presentation of an Implicit Theory manipulation, participants would demonstrate more responses congruent with the version of the manipulation that they received (Sections 5.2 and 5.5). No difference was seen between conditions (see Figure 5-6 above). As the study was very low powered ($n = 10$) it is again only noted here that the Implicit Theory measure responses were in the expected direction, with Incremental Condition participants showing more agreement with incremental measure items, although Entity Condition participants did not show more agreement with entity measure items. As Incremental Condition participants had previously shown less agreement to incremental Implicit Theory of technology ability items, this demonstrates a swing in response direction between the conditions, albeit to a measure of a different Implicit Theory domain. Again, similar to previous studies, participants in both experimental

conditions agreed more with incremental items in comparison to entity items. This is similar to the response directions reported by Abd-El-Fattah and Yates (2006, Section 3.2.1 above), and demonstrates responding patterns to the measures by people with Parkinson's similar to the responding patterns to the original version by students.

Similar to the discussion of the responses to Implicit Theory measures of Studies 1a and 1b (Section 4.9.1 above), in the absence of significant results a look is taken at the direction of results across studies. Focusing on Implicit Theory measure responses following presentation of a manipulation of Implicit Theory (so excluding Study 2b's Implicit Theory of technology ability measure), patterns of responding demonstrate more agreement to incremental items by Incremental Condition participants. This demonstrates weak (in the absence of statistical significance) support of the hypothesis, that participants would demonstrate more responses congruent with the version of the Implicit Theory manipulation that they received (Sections 5.2 and 5.5). Also looking at responses to all three Implicit Theory measures across both Study 2a and Study 2b, there is more agreement across conditions to incremental items in comparison to entity items. The only result against the direction expected were Incremental Condition participants showing more agreement to entity items on the Implicit Theory measure related to vocal issues, following the presentation of the Implicit Theory manipulation. The measure used here was developed from Dweck (1999), a different source than had been used for all the technology related Implicit Theory measures used in the PIT research here. Dweck's measure was developed for Implicit Theories of characteristics about the person – which was a better fit for adapting to investigate vocal issues and abilities. A larger test would be required to investigate whether this measure was effective.

5.8.2 Volume Comparisons

One of the tasks performed by participants in both Study 2a and Study 2b was to have volume levels recorded, both when talking (see Figure 5-2 above for Study 2a, and

Figure 5-7 above for Study 2b) and when producing a vowel sound (see Figure 5-3 above for Study 2a, and Figure 5-8 above for Study 2b), and completing each both in the presence and absence of a target goal onscreen. In terms of variation of behaviour between experimental conditions however, talking aloud with and without a target volume may not have been an experimental condition-relevant task for Study 2a where participants had received an Implicit Theory manipulation of beliefs about ability with technology. The first expectation for volumes from previous literature was that volumes might be weaker or quieter as the illness progressed. Mean Hoehn-Yahr scores in Study 2a were 1.5 for Entity Condition participants and 2.3 for Incremental Condition participants, and in Study 2b were 2.6 for both conditions. This means that Parkinson's was less severely progressed for participants in Study 2a compared to Study 2b. This was demonstrated in the volumes produced between participants across the studies, Study 2a participants generally having louder volumes recorded for both the talking and the vowel-sound tasks. Other explanations aside from Hoehn-Yahr scores exist, however, as the mean ages of participants in Study 2a were lower than that of Study 2b, also the experiment location was different between conditions which could have affected either volumes or measurement of volumes.

Comparing volumes within Studies, the prediction based on the hypothesis was that Incremental Condition participants would perform relatively better than Entity Condition participants in the presence, rather than absence, of a goal-bar indicating a target-volume (Section 5.5). This prediction relates to the goal-bar adding additional complexity to the task, and the behaviour difference should be especially salient for the talking task, rather than the vowel-sound task, as it is the more complex (see a further discussion of task complexity in Section 5.8.4 below). Results in Study 2a showed very similar volumes between conditions for the talking task without the goal-bar, and then (non-significantly) higher volumes by Incremental Condition participants in the presence

of the target. In the absence of experimental conditions it might be expected that the participants included in the Entity Condition would have higher volumes on account of having lower Hoehn-Yahr scores (and also fewer mean years since diagnosis, but not a lower mean age). The same pattern of results between conditions occurred for the vowel-sound task in Study 2a. So for both tasks Incremental Condition participants produced comparatively higher volumes when the task was more complex.

Participants included in Study 2b had the same mean Hoehn-Yahr scores between conditions. Also responses to items measuring vocal issues showed very little difference between conditions. Results showed Incremental Condition participants had slightly lower volumes on the talking task without the goal bar, and then very similar (but still lower) volumes in the presence of the goal bar. For the vowel-sound tasks results were very similar between conditions in the absence of the goal bar and then the difference widening when it was present, Incremental Condition participants recording higher volumes for both. For both task types the Incremental Condition participants raised their volumes with the inclusion of the goal-bar, relative to the performance of the Entity Condition participants. This is similar to findings above for Study 2a, for both Incremental Condition participants increasing volume more in comparison to Entity Condition participants when a volume-target goal-bar was introduced. The goal-bar represents only a subtle change in task complexity, but the direction of results seen are in agreement with the hypothesis-based prediction that following reception of an incremental Implicit Theory manipulation there should be a comparatively improved performance when a task becomes more complex (see Section 5.5).

5.8.3 Application Engagement Comparisons

Engagement was measured crudely by tracking how many times a participant voluntarily decided to repeat the same task type. This demonstrates engagement by showing that they willingly continued to use the application for more or fewer tasks.

Additionally the mean volume of tasks completed were compared to initial goal volume that had been set and the frequency of tasks completed where this volume was bettered was recorded. This demonstrates engagement by suggesting the amount of vocal effort participants were making while completing individual tasks. These measures would have been less relevant to Study 2b – where the Implicit Theory manipulation related to beliefs about vocal issues rather than technology ability – however it was not possible to capture this information as procedural time constraints allowed less free-usage or participant-directed use of the application. A large reason for this absence of time was the difference in research setting for Study 2b. Where possible Study 2b took place in participants' homes, which involved inclusion of travel time between participants, and a slightly longer set-up time upon arrival. Non-significant results in Study 2a showed more tasks completed by the Incremental Condition participants, and also a higher proportion of tasks were completed with a higher-than-initial-goal volume by Incremental Condition participants (see Section 5.4.4). These directions of results are in support of the hypothesis-based prediction that following reception of an incremental Implicit Theory manipulation there would be greater or more effective engagement with the application seen (see Section 5.2 above). It must also be noted that in Study 2a Incremental Condition participants were on average approximately six years younger than Entity Condition participants, which may have affected results in favour of Incremental Condition participants. Incremental Condition participants had also however recorded lower mean self-ratings of technology ability and technology familiarity, which would lead to lower expected technology engagement in the absence of experimental conditions.

5.8.4 Reflections for Subsequent Studies

5.8.4.1 Factor Variability. There was extra variability introduced to Studies 2a and 2b by factors that were either more controlled or less variable in Studies 1a and 1b.

Moving from students to people with Parkinson's as participants means conducting investigations with a more heterogeneous group (as discussed in Section 2.4.1). Also moving the location of studies from a more controlled University office (Studies 1a and 1b), or hospital speech therapy suite (Study 2a), to participants homes (Study 2b) which are different every time means loss of a lot of control of the experimental environment. Looking first at participants, across Study 2a and 2b there was four experimental conditions (2 x Incremental and 2 x Entity). Comparing extremes of the mean descriptions of these groups the Incremental Condition of Study 2a had a mean age of 63.7, and a mean time since diagnosis of 8.7 years, whereas the Entity Condition of Study 2a had a mean Hoehn-Yahr score of 1.5. These figures compare with both Study 2b experimental conditions having Hoehn-Yahr scores of 2.6, Study 2b's Entity Condition participants having a mean age of 77.2 years, and Study 2b's Incremental Condition participants having a mean time since diagnosis of 3.0 year. This is quite a limited set of variables to compare potential differences between groups, but these figures do indicate quite a wide variation between conditions for participants' age, time since diagnosis and progression of illness.

Variability also existed in terms of the research locations. It was not possible to capture some key metrics – similar to age, Hoehn-Yahr and time since diagnosis – that would have helped to describe some of the variability between locations. One option is to look at the measures that were captured both in Study 2a (which had a fixed procedural location) and Study 2b and to compare responses. The most saliently different response between studies was volumes captured for both talking and vowel-sound tasks. There were lower volumes recorded in Study 2b, which could be explained by the variability in experimental locations. It has not been investigated whether participants are more likely to produce louder volumes in their own homes where they are more familiar. Familiarity could lead to lower volumes if they have become

accustomed to producing low volumes in that environment, similarly they could be familiar with attending the hospitals speech therapy suites and associate there with a place where they consciously try to be loud. As part of the experimental procedure attempts were made to place equipment similar distances from participants regardless of location, however during Study 2b participants were equally likely to be in an upright kitchen chair (which might have been similar to Study 2a) or to be in a more comfortable lounge chair, which would probably affect projection. Another explanation for lower volumes in Study 2b is the factors already mentioned, such as age and Hoehn-Yahr score, which were both higher and could both reasonably explain lower volumes. Variation between studies of standard deviation was also inspected in measurements captured in both Study 2a and 2b. There was no stark difference visible between conditions, possibly slightly wider deviations seen in Study 2b, but no strong evidence present. Variation of participants and of study location was anticipated prior to the study. It was known that participants would be people with Parkinson's and that Study 2b would be conducted in multiple locations. Study 3 (see Chapter 6) intended to be completely run in participants' homes, so variability must again be expected. Rather than being able to control it, there is a need to be mindful of it when interpreting results. Any result that is significant or clearly in the direction expected, must also be assessed in terms of participants in that group. With greater participant numbers multiple regressions might be possible to control for several factors, however in the absence of that factors should be inspected to see if there are properties between groups that might have exaggerated any differences found. Similarly where a result is not found, are the factors between conditions likely to limit likelihood of any result having being found.

5.8.4.2 Level of Challenge Encountered. One of the reflections from Chapter 4 (Section 4.9.3.2) was that task difficulty would be relevant to being able to demonstrate varied behaviours resulting from holding different Implicit Theories. Vocal tasks

included in Studies 2a and 2b included recording of volume while talking and while producing a vowel-sound, and then both of these in the presence of a volume-target goal-bar. Production of a vowel-sound allows for assessment of volume with minimal cognitive effort required from participants, so it should be considered an easy task. The task of talking for thirty seconds on the other hand requires more cognitive effort. Conversation topics were chosen so as to be straight-forward for participants, however words still have to be selected and additionally some people might feel uncomfortable talking aloud on a random topic in the presence of two researchers. The addition of the volume goal should have added complexity to this task. At this point in the procedure participants did not need to do anything with the technology other than speak or make vowel-sounds in its vicinity, and attend to the goal bar (when present) on the screen. It is possible that participants might have felt more positive about doing these tasks in the presence of technology following any domain of incremental Implicit Theory manipulation, however this could not be known. In Study 2b where Implicit Theories of vocal issues had been manipulated, when the task became more complex Entity Condition participants actually demonstrated lower volumes than they had when talking without the presence of the goal bar. This could be considered congruent with a helpless behaviour in the presence of a difficult task. For both Study 2a and Study 2b Incremental Condition participants produced the higher volumes for the (more complex) talking task in the presence of the goal bar. Also in both studies there was larger performance variation seen between conditions when the task had further complexity by inclusion of the goal bar.

The second task-type where complexity could be considered in the context of whether enough challenge was present - in order to demonstrate varied behaviour - was behaviours when participants were engaging with the application. Directions of results were found to be congruent with study hypotheses, but this did not necessarily

demonstrate task difficulty. The Implicit Theory model suggests helpless behaviours are expressed in actions such as challenge avoidance and low persistence (see Table 2-1 above). The general structure of previous studies used to examine this behaviour generally involved methods such as presenting negative feedback (e.g. to an English test, Hong et al., 1999), provision of difficult to follow instructions (e.g. Licht & Dweck, 1984), or investigation occurring at a predicted period of failure (e.g. around a transition across educational stage, Robins & Pals, 2002). It could be suggested, however, that a flexible view of task difficulty could be utilised. Varied barriers to engaging with both technology and vocal issues have been identified including: negative technology-ability stereotypes (Mitzner et al., 2010); anxiety using technology (Hogan, 2006); relatively poor uptake (Pew Research Center, 2014); and general apathy, poor health, depression, and low outcomes expectations (Forkan, Pumper, Smyth, Wirkkala, Ciol, & Shumway-Cook, 2006). As there is the possibility for some, all, or none of these barriers to be present for each individual participant, there is likely to be a wide variation as to what is considered a challenge. This echoes what was discussed in Section 5.8.4.1 above about interpreting results. Where significant or congruent results do occur, factors such as experienced task difficulty should also be related back to interpretation of these results.

5.8.4.3 Intentionality of Behaviours. Section 4.9.3.1 (in Chapter 4) discussed being able to know about the intentionality behind behaviours. Where a task could have multiple interpretations relevant to Implicit Theory then it is difficult to be sure when making predictions as to what behaviours are demonstrating. Tasks used for measuring behaviours in studies 2a and 2b were generally simplistic. For Study 2a engagement with technology was measured by how many trials they completed while using the application. Participants were not advised how many trials they should complete while using the smartphone application, so extended usage could be reasonably interpreted as engagement, but potential for ambiguity still exists. Similarly while completing trials

using the smartphone application, each trial generated a mean volume which was comparable to volumes captured earlier in the procedure which could be used as baselines. Again participants were not encouraged as part of the procedure to expend more or less vocal energy when completing these trials, aside from feedback that the application itself was providing. Where participants produced trial volumes louder than a baseline volume this could reasonably be interpreted as them expending more effort during that trial, than for a trial where they do not exceed the baseline. For this measure however it is reasonable to ask whether a manipulation encouraging and incremental Implicit Theory of technology should result in more effortful volumes being produced during usage of the smartphone application.

Similarly volumes recorded prior to participants being fully introduced to the smartphone application (talking and vowel-sound, with and without the goal-bar) are simplistic as tasks and can be interpreted as higher volume equating to more effort. This has to be judged within-participant where volume changes for the same task type when the goal-bar is present or absent. This comparison allows participants to provide their own baseline volume and then when producing a second volume on the same task-type the only changes leading to variation are the inclusion of the goal-bar and participants' level of effort. There is still room for ambiguity, however, when examining the meaning of volume changes. With an entity Implicit Theory the goal-bar might be expected to result in lower volumes, as the extra challenge that the goal-bar brings might lead to helpless-behaviours. This might be more likely to occur for the talking task, however referring back to Section 5.8.4.2 it must be considered that the level of challenge experienced will vary greatly between participants. If the task is made more challenging, but is still relatively easy, for an individual with an entity Implicit Theory this can be an opportunity to prove that they are capable of a strong performance. Highlighting that a simplistic interpretation is difficult, Entity Condition participants in Study 2b increased

their volume when the goal-bar was added to the (more difficult) talking task, however they decreased their volume when the goal-bar was added to the (easier) vowel-sound task. This is contrary to what might have been predicted for Entity Condition behaviour – lower volume when the more difficult task became more complex.

5.8.4.4 Interpretation of Low Powered Results. As predicted in Section 4.9.3.3 (Chapter 4 above), low participant numbers limited the possibility of statistically significant results. Similar to the type of discussion that was possible with the results from Chapter 4, a lot of the results from Studies 2a and 2b have been discussed in terms of their direction, and whether that direction is congruent with what could be predicted from the hypothesis. Similar to Studies 1a and 1b, responses to Implicit Theory measures presented following presentation of Implicit Theory manipulation generally generated responses in directions expected. This was across both Study 2a and 2b, with the one measured exception being in Study 2b Incremental Condition participants showed slightly more agreement with entity measure items. The Implicit Theory measure of technology ability was presented before the manipulation in Study 2b, so it is not possible to combine evidence from both studies when looking for consistent response directions following manipulations. This measure however was edited from the version used in Studies 1a and 1b (developed from Abd-El-Fattah & Yates, 2006). As such the direction of response to the Implicit Theory measure of technology ability beliefs in Study 2a can be potentially considered alongside the measures of computer programming ability beliefs in Studies 1a and 1b. This does not strengthen support for Implicit Theories in people with Parkinson's particularly, but rather offers support for the construction method used for adapting Abd-El-Fattah and Yates' measure, and simultaneously supports that the construction method used for creating the manipulations also. Similar to Studies 1a and 1b, responses to Implicit Theory measures, regardless of order before or after a manipulation, received more agreement to the incremental items

across experimental conditions, in comparison to the entity items. This continued direction of responding across studies in expected directions further evidences the validity of the measures (again, in the absence of statistically significant support).

5.8.4.5 Addition of Qualitative Support. One of the reflections regarding behaviour measures already discussed (engagement with the application and volumes recorded during different tasks), was that it was not possible to be certain of what intentionality is attached to behaviour. Comments recorded during the procedure however allow more direct knowledge of what a participant is thinking. There is still interpretation required, as discussed already in Sections 5.4.5 and 5.7.5 above. Three Implicit Theory relevant themes emerged for Study 2a (Failures with Technology, Plans for Usage, and Effort) and for Study 2b (Vocal Failures, Plans for Usage, and Effort). These themes emerged from comments made in response to the Implicit Theory measure presented post-manipulation (technology ability related for Study 2a and vocal issues related for Study 2b), and comments made during user testing of the SAP project's application. The main difference between studies in the themes that emerged is the type of failures that were categorised from each study. A large portion of the included Vocal Failures and Technology Failures comments were captured while participants were responding to the Implicit Theory measure, which was obviously already related to the emergent theme. There were, however, still comments captured during user-testing which additionally supported these themes. Of primary importance for these themes to support Implicit Theory related investigations is that each included comments that could be categorised as either entity- or incremental-related. Within each theme, across each study, there were comments captured which could be categorised in this manner. The balance of comments made by participants was consistent with the experimental condition that they belonged to. This evidence supported the predicted link between Implicit Theory manipulations and resultant measured Implicit Theories. That comments

were included from during the user-testing also indicates that the manipulated Implicit Theories were still activated while engaged in the key part of the procedure. Going further, the thematic data analysed adds additional support to Section 5.8.4.4 which discussed combining low-powered evidence repeatedly found to be in the same direction. In addition to the collated evidence discussed there, the thematic analysis provides further support in a consistent direction. Where participants are able to discuss in their own words, or provide examples, with regards to being able to overcome barriers to learning, or rewards from engaging effort, versus comments about not trying because they do not see a positive outcome being likely, this offers insight to their Implicit Theories. Where these comments are consistent with their experimental condition it provides good evidence that they are processing information in a manner consistent with that condition. This evidence provides stronger support than agreement with measure items, but obviously there is still interpretation involved. Being able to combine measure responses and task behaviours with a thematic analysis of comments in this way offers a more rounded support of the effect of Implicit Theories.

Some of the comments included in the Thematic Analysis are suggestive of the value of investigating Implicit Theory via a multiple-domains approach. Some of the comments made are suggestive of already well defined ideas about ability to learn such as you 'Can train, but not to the highest level'. This level of detail goes beyond what was suggested in any of the Implicit Theory manipulations used. Additionally comments like 'If you put your mind to it you can achieve anything' are suggestive of having prolonged exposure to popular comments in the area of learning. It is possible that a more global interpretation of learning or of flexibility of ability might not be as useful as discussing ability in specific terms of technology or vocal issues. If someone already has predominantly entity-type Implicit Theory beliefs about learning they are likely to disagree with a general incremental Implicit Theory manipulation. If they believe

everyone has a fixed talent or level of ability for most things that no amount of effort would change, then a message that effortful learning generally leads to improvement will be rejected. They may however be able to agree, in the specific instance of technology ability, if they were to put effort in that they might be able to improve.

5.8.4.6 Support for an Implicit Theory of Vocal Issues. The measure used for Implicit Theory of vocal issues in Study 2b has produced results in an unexpected direction. Incremental Condition participants showed (non-significantly) more agreement with the entity items on the measure in comparison to Entity Condition participants (see Figure 5-6 above). There is the additional point that has been previously observed that the measure was developed from a different starting measure compared to the Implicit Theory measure of technology ability. The measure of technology ability was developed from Abd-El-Fattah and Yates' measure (rather than Dweck's 'kind of person' measure, Dweck, 1999) which had been tested more strongly. Also the Implicit Theory of technology ability measure used here has been developed more systematically across the stages of the PIT research, first tested in an analogous domain with University students and then edited for relevance to be used alongside the SAP project's smartphone application in studies 2a and 2b here. The Implicit Theory measure of vocal issues should still be developed further, but without the same previous testing of Dweck's base measure, and without the more thorough testing through the stages of the PIT research as the technology ability measure has received, it was not appropriate to use an Implicit Theory of vocal issues manipulation for Study 3. There is however evidence from the results here, especially the thematic analysis, which suggest the importance of Implicit Theories of vocal issues. Comments captured such as 'If I did it then it would [be useful], but I'm resigned to being 81, and can't go on forever, being reminded of problems when I would rather stick head in sand' suggest a potential

helpless response to situations. This indicates that vocal Implicit Theory warrants further investigation.

CHAPTER 6. LONGITUDINAL STUDY

The Smartphone APplication (SAP) project (see Section 1.3.2.1 above), having been developed to an intended point, was to undergo more extensive prolonged user testing, in the form of approximately ten day trials. This test stage was to be the final section of activity completed as part of the Parkinson's UK Innovation Grant (see Section 3.1 above). Longitudinal testing was designed to identify likely user engagement with the application over an extended timeframe, how frequently it might be used and whether it would get used at all in the absence of researchers. Again as part of gaining feedback from people with Parkinson's using the application, it also investigated potential barriers to effective engagement with a speech therapy smartphone application (see Section 1.1.3 above). This strand of investigation was progressed by the Parkinson's Implicit Theory (PIT) research. Implicit Theory (Dweck & Leggett, 1988), briefly, is a model that describes how an individual's beliefs about something (for example math skill) might suggest it is either fixed (an entity theory) or flexible (an incremental theory). Holding different theories predisposes people to different goals. If something is flexible then a mastery goal (to increase ability) is predicted, and if something is fixed then a performance goal (to demonstrate high ability, or avoid demonstrating low ability) is predicted. The model also suggests that goal types interact with ability level, especially with a performance goal, and can lead to either mastery or helpless behaviours (see Table 2 1 above). The intention for the PIT research is to see if Implicit Theory can be applied to people with Parkinson's, specifically in the circumstance of being presented with the SAP project's smartphone application, to see if holding different Implicit Theories can affect effective engagement with the application. Following on from initial investigations of developed Implicit Theory materials with University students (see Chapter 4 above), and then similar studies progressing this exploration with people with

Parkinson's (see Chapter 5 above), the intention here was to further explore evidence of whether Implicit Theory is relevant to people with Parkinson's and whether manipulations presented at an introductory point can have long-term benefit.

In the Studies above (see Chapter 5), some indicators for Implicit Theory domains of technology ability and of vocal issues were found in people with Parkinson's. Investigating these Implicit Theory domains in people with Parkinson's it is hoped would progress understanding of barriers that might exist using the SAP project's application. Holding either an entity or an incremental Implicit Theory for either of these domains could alter the efficacy of an individual's engagement. Investigation of these domains require manipulations aiming to encourage in participants either an entity or incremental Implicit Theory, and also measures of the relevant Implicit Theory domains. Studies 1a and 1b (Chapter 4 above) described development of Implicit Theory measures and manipulations in the domain of computer programming ability. These manipulations were be adapted to relate to ability with technology in Study 2a and also vocal issues in Study 2b (Chapter 5 above). The measure was also adapted to relate to ability with technology and was presented in both Study 2a (following manipulation presentation) and Study 2b (prior to manipulation presentation). A further measure was also developed to relate to Implicit Theory of vocal issues, which was presented in Study 2b (following manipulation presentation). Study 3 will make further use of materials developed in previous studies, in conjunction with presentation of the SAP project's smartphone application as part of prolonged user-testing.

6.1 Overview of Study

Study 3 was conducted as part of a prolonged user-test stage for the SAP project's speech therapy application. The primary purpose was to gain an understanding of how users would engage with the application when given an opportunity to use it as part of every-day life, as opposed to engagement seen during the brief user-testing scenarios

conducted previously. The PIT research used the occasion of this prolonged user-test stage to further investigate the relevance of Implicit Theory to people with Parkinson's being introduced to the application. Fifteen devices were available to provide to participants as part of the procedure at any one time. These devices would be handed out to participants in a block that included a deployment stage in week one, followed by a collection stage in week two. The time between these two stages determined how long a participant had the smartphone application. The study was conducted in four participant blocks, with the application version receiving slight modifications between blocks when participants reported bugs as part of collection.

This prolonged study including people with Parkinson's was also able to progress work from earlier studies. Studies 1a and 1b had developed some initial Implicit Theory materials and presented them to student participants. Studies 2a and 2b then progressed these materials and presented them to people with Parkinson's when being introduced to the SAP project's smartphone application. As well as utilising developed materials, these studies developed a procedure around including the materials as part of the process of presenting the application. Studies 2a and 2b also captured verbal responses from participants, which included some negative remarks from those who had been presented with an entity Implicit Theory manipulation (see Sections 5.4.5 and 5.7.5, Chapter 5 above). As an outcome of this the procedure here was altered to exclude use of an entity Implicit Theory manipulation. As the study is longitudinal in nature it was not appropriate to include a study debrief until the collection phase of the procedure, so presentation of an entity manipulation without immediate debrief was ruled out. Also the structure of Studies 2a and 2b that allowed more detailed verbal responses to be captured was not possible here. The focus for the SAP project was for participants to have an understanding of the device and application prior to deployment of the recruitment phase. The emphasis was on ensuring as best as possible that they would be able to make use of

the application in the absence of the researchers. The semi-structured questioning about different application components was replaced by further explanations and repetition of fundamentals such as turning the device on and finding the application within its menus where needed.

The SAP project's prolonged testing stage intended to engage greater numbers of people with Parkinson's than had been possible in the earlier user-testing stages (Studies 2a and 2b). Following the recruitment process of the first two studies, however, it was clear that full recruitment to the final study involving increased patient numbers would be a difficult task for the speech therapist involved. People with Parkinson's normally remain on a speech therapists caseload for a long period of time, check-ups being scheduled potentially once a year. There is not a high turnover of patients and when it came to recruiting for the final study, many of the cohort of potential participants were already aware of the earlier studies. One solution to this was that Ms Johnson (speech therapist) was aware that many of the people who had participated in the first two studies were also eager to participate in the longitudinal study. It was decided that this would provide a valuable study condition for the larger SAP project, allowing inclusion a self-selected group of 'experienced' users to test the application, albeit participants who already knew about Implicit Theory. As well as making sense for the SAP project, this also eased concerns over recruitment, which had been exacerbated by the rigid time-scale imposed in response to the impending Olympics. Again, what was appropriate for the SAP project was not necessarily good for the PIT research described here. Of 22 participants who participated in the first two studies, 18 were recruited to participate in the longitudinal study. This seemed like a good endorsement for the SAP project, however for the PIT research it meant over a quarter of participants recruited for the SAP project had already encountered Implicit Theory, the associated materials used here, and been debriefed about priming.

6.2 Goals and Hypotheses of Study 3

The main goal for Study 3, as part of the PIT research, was to further investigate an Implicit Theory domain of ability with technology in people with Parkinson's. Part of this goal will include more extended testing of Implicit Theory materials which were developed in Studies 1a and 1b (with a non-clinical population, see Chapter 4), and then subsequently built upon in Study 2a and Study 2b (with people with Parkinson's, see Chapter 5). These materials have been adapted to be relevant to investigate for an Implicit Theory in the domains of ability with technology and also vocal issues and abilities. These materials would be presented to people with Parkinson's as part of the procedure for longitudinal user-testing of the SAP project's application. Participants would be presented with either an incremental version of the Implicit Theory manipulation or control material, followed by the Implicit Theory measure and then introduced to the device and smartphone application that they would be using and keeping for approximately ten days.

The main hypothesis for Study 3 is that, following presentation of an incremental Implicit Theory manipulation of technology ability, Incremental Condition participants will demonstrate more responses congruent to an incremental Implicit Theory in comparison to Control Condition participants. Congruent responses will include participants shown the incremental version of the manipulation would show more (post manipulation) agreement with incremental measure items, and less agreement with entity measure items, in comparison with Control Condition participants. Responses will also be sought from participants' engagement with the smartphone application, which will be captured by the application during their period using it. It was predicted that responses congruent to an incremental Implicit Theory for Technology would include more effective usage of the application. The engagement behaviours captured will include how often trials are completed on the application, the duration of these trials, and when

they occurred. An incremental response, it is predicted, would be demonstrated by more usage and also usage spread more consistently across the participants period with the device. Additionally behaviours captured by the application will include volume measurements recorded during usage across the study period. In terms of supporting an effect of the Implicit Theory of technology manipulation, no specific predictions are made regarding what volumes might be expected with regards to different experimental conditions. A reason for this is that it would rely on advance knowledge of the effectiveness of the application. It is anticipated that a longer period of usage (than the time, approximately 10 days, available) would be required to demonstrate effectiveness of the application on vocal abilities of users.

A secondary goal will be to investigate differences between Implicit Theory domains for technology ability and for vocal issues. Part of this goal will include reusing materials related to the measure vocal issues, used in Study 2b, gathering further evidence to investigate their validity by presenting them to a greater number of participants. In addition to a Speech questionnaire (Section 6.3.2.3 below), the Implicit Theory measure for vocal issues (reused from Section 5.6.2.3 above) would be presented to participants as part of the same research procedure, prior to presentation of any Implicit Theory of technology ability materials. This includes it being presented prior to the Implicit Theory manipulation, meaning there should be no effect of experimental condition on responses. The prediction is that, unlike responses and behaviours relevant to an Implicit Theory of technology, responses relevant to an Implicit Theory of vocal issues will vary randomly between participants across study conditions. This includes responses to the Implicit Theory of vocal issues measure and also for volume measurements (vowel-sounds) which would be taken from participants by the researchers at both deployment and collection phases.

6.3 Study 3: Method

6.3.1 Participants

The SAP project recruited 60 participants for the longitudinal stage of testing, however only 17 were included in the PIT research here. Firstly, one participant withdrew due to illness. Next, as mentioned above (see Section 6.1), 18 people were recruited to engage in testing who had previously taken part in either Study 2a or Study 2b. For the SAP project this provided a pool of users who were able to offer feedback on how the application was progressing from earlier versions, but were excluded from the PIT due to being familiar with the research. Of the remaining 41 people testing the application, nine did not complete the Implicit Theory materials (reasons for not proceeding with these materials are outlined in the procedure below, Section 6.3.4). This left 33 potential participants, but of these, 16 were excluded due to the application not recording application usage data for these participants. Non-recording of data was a software development issue which was exposed by running this testing, and was largely fixed by the fourth block of participants from which eight of the 17 remaining included participants were recruited.

Participants were individuals with Parkinson's, all having received a referral to King's College Hospital's Speech Therapy services, from where they were informed about the study. Seven incremental-condition participants (five male and two female) had a mean age of 66 years, mean Hoehn-Yahr score of 3.1, and mean time since diagnosis of 6.1 years (SD of 5.6 years). Ten control-condition participants (five male and five female) had a mean age of 63 years, mean Hoehn-Yahr score of 2.6, and mean time since diagnosis of 5.1 years (SD of 4.5 years). The ethnicity of participants, where known, was available for the cohort as a whole but not broken down to the eventual included participants, and was as follows: 3 x Asian; 1 x Australian; 1 x Latin American; 2 x Chinese; 1 x Eritrean; 47 White British; and 3 x White European.

6.3.2 Materials

6.3.2.1 Implicit Theory Manipulations. The theme of manipulations was similar to Study 2a (see Section 5.3.2.1 above), phrased here as ability to learn new skills, specifically focused on ability with technology in this instance. An incremental version was created, but instead of an entity version a neutral piece of text of similar length was used. Both texts used can be found in Appendices A.7 and A.8.

6.3.2.2 Technology Questionnaire. This consisted of five items. The responses to the first three items were recorded using Yes / No boxes: ‘Have you ever used a device with a touch screen?’; ‘Do you own a mobile phone?’; and ‘Do you have your own email address?’. The responses to the last two items were recorded using four-point Likert Scales: ‘What is your level of ability using new technology?’ marked from ‘Very Weak’ to ‘Very Strong’; and ‘How well do you feel your ability with technology compares to that of your peers?’ marked from ‘Very Poorly’ to ‘Very Well’. Items were presented in the same order to all participants.

6.3.2.3 Speech Questionnaire. This included three items marked on a four-option scale marked from ‘none’ to ‘severe’: ‘Do you have any issues with speech volume?’; ‘Do you have any issues with stammer?’; and ‘Do you have any issues with swallowing?’. Next there was an open response question, ‘Do you have any other speech issues?’ Finally there were two items marked on a four-option Likert scales, the first marked from ‘not at all serious’ to ‘very serious’ was ‘At present, considering any current issues with speech you may have, how serious do you think these issues are for your daily life?’. The second was marked from ‘Not at all concerned’ to ‘very concerned’ was ‘Are issues with speech something that you are concerned may become more of an issue in the future?’

6.3.2.4 Vocal Implicit Theory Measure. This was the same as described in the method section of Study 2b (Section 5.6.2.3 above).

6.3.2.5 Technology Implicit Theory Measure. This was the same as described in the method section of Study 2a (Section 5.3.2.3 above).

6.3.2.6 Speech Tool Application. This study occurs at the point at which the SAP project is testing a third and final iteration of the smartphone application to be developed within the context of the Parkinson's UK grant.

6.3.2.7 Apple Devices. These were seven iPhones (the same version as used in Study 2b, Section 5.6.2.6) and eight iPod Touches (the same version as used in Study 2a, Section 5.3.2.6). Each of the iPhones had £10 pay-as-you-go credit installed at the start of the procedure for each participant.

6.3.3 Design

The main IV was which version of the Implicit Theory Manipulation participants were given. The IV had two levels, Neutral or Incremental. There were several DVs, including responses to the Vocal and Technology Implicit Theory Measures and to the Speech and Technology Questionnaires. During presentation of the application and device of the application to participants, their vocal decibel levels were recorded, and this was retested when the device was collected from the participant. Other DVs were also captured during participant's usage of the Speech Tool Application in the form of decibel levels recorded by the application, frequency of usage and type of content being used. Participants kept the device for approximately 9 days (Incremental Condition: 8.6 days; Control Condition: 9.0 days), so this content was captured longitudinally over that period.

6.3.4 Procedure

The procedure took place at participants' homes where possible. The procedure required two visits with participants, one where they were given a device with the application and shown how to use it (deployment), and one where it was collected back off them (retrieval). This took place over a two week period. With a total of 15 devices

available, the maximum number of participants that could participate in a two-week period was 15. Three days were allowed for deployment, which where possible took place from Monday to Wednesday of week one, and three days were allowed for retrieval, which where possible took place from Wednesday to Friday of week two. Participants were not available to be met in the same order for deployment as for retrieval, so participants did not have the application available to them for exactly the same period of time. The procedure was carried out by two researchers. The primary roles were fulfilled by a research assistant (RA), assisted by the author here as the second researcher. Most items and directions were presented by the RA, while the thesis author was organising materials so they were available to the RA when needed, and providing additional support and explanations to ensure the participant was comfortable using the device and application. The main purpose of the procedure, not directly relevant to the research here, was to gather application usage data from people with Parkinson's. As the primary purpose required the participant be able to use the application after the researchers had left, if there was an additional family member or friend available to observe its functioning then the RA and the author here would each demonstrate the device and application separately to one person each. For measure and questionnaire items a printed sheet with the items was presented to participants, but in most instances items were read aloud to participants by the RA, with some use of paraphrasing to further assist understanding. At the start of the procedure, participants were advised that they were welcome to pause at any point. Additionally, participants were invited to have a friend or family member present if available. For deployment the procedure was then described to participants as being in two stages, the first being referred to as 'paperwork'. The second part was described as where the participant would be introduced to the device and application, and making sure they were comfortable using them. The first item of stage one was the technology questionnaire, followed by the speech questionnaire. To

ensure enough time for adequate orientation time with the device and application, at this point the RA and the author here would assess whether it was suitable to proceed with presenting Implicit Theory Measures and Manipulations to participants. Reasons to not proceed (application-only-condition) were: if there had been comprehension issues with the items presented so far, for example if English was not a participant's first language; if the participant was visibly tiring with the paperwork section of the procedure; or if the procedure had been running very slowly up to this point and there was concerns the full procedure could not be completed within a reasonable period of time (approximately 90 minutes maximum). When included, the next item presented was the Vocal Implicit Theory Measure. Participants were randomly given one of the Implicit Theory Manipulation versions. Participants were requested to read this at their own pace, rather than with the assistance of the RA's oration. Next, participants were presented the Technology Implicit Theory Measure to conclude the paperwork stage. In the second stage, participants were briefly introduced to the device that was running the application. Participants were randomly given either an iPod Touch or an iPhone. The 'How Loud Am I' section of the application was then used to record participants' vocal volume. Participants were requested to hold the device 1ft from their mouths, measured using a 12-inch ruler, and say 'Ahhh' as loud as comfortably possible, holding it for 5 seconds. They were asked to do this three times and the volume recorded by the application was recorded each time. Next participants had a more thorough introduction to the device, giving them the opportunity to turn it off and on again, and find the application within the device after it had been shut down. Each area of the application was demonstrated to participants, its purpose explained and any questions answered. If participants were at all uncomfortable with its usage then points were gone over again. If there was time, and participants were interested, other applications on the device were introduced also. All participants were invited to make whatever use of the device they wished while it was in

their possession. The priority was not on capturing participants' thoughts about the application at this point, but if any relevant points were made or questioned these was captured by the author here. It was discussed with participants how frequently they should use the application and it was made clear to them that there was no predefined expectation about its usage, preferably they might use it on a daily basis but that this was up to them. Also they might like to use it multiple times in the day for only short periods, or for them they might be more comfortable using it seldom but for more sustained periods. To conclude deployment participants were left with a device and also email and telephone contact details for the author here, in case any assistance was required during their period with the application. Retrieval occurred in the week following deployment. Using the 'How Loud Am I' section of the application, participants were again asked to vocal volume three times, holding the device 1ft away while saying 'Ahhh' for 5 seconds as loud as was comfortably possible. Next participants were asked some brief questions about their experience using the application. Any feedback provided was noted by the author here. Participants were then verbally debriefed and given a debrief-sheet.

6.4 Study 3: Results

6.4.1 Questionnaire Responses

To investigate a potential confound mean baseline responses to technology rating and experience items (6.2.2 Materials) can be seen in Table 6-1 (below). No difference was seen between conditions for self-reporting of familiarity and ability with technology ($t = 0.65$, $df = 15$, $p = 0.53$, two-tailed).

Table 6-1

Mean Technology Ratings and Experience by Condition.

<u>Condition</u>	Familiarity with Technology (min=1, max=3)	Current Ability with Technology (min=1, max=4)	Technology Ability vs Peers (min=1, max=4)
Control (n=10)	2.7	2.7	2.7
Incremental (n=7)	2.6	2.0	2.9

To investigate another potential confound mean responses to vocal issues and ratings items (6.2.2 Materials) can be seen in Table 6-2 (below). No difference was seen between conditions comparing a combined Vocal Issues measure ($t = 0.54$, $df = 15$, $p = 0.60$, two-tailed).

Table 6-2

Mean Frequency of Vocal Issues and Mean Ratings by Condition.

<u>Condition</u>	Speech Volume Issues (min=1, max=4)	Stammer Issues (min=1, max=4)	Swallow Issues (min=1, max=4)	Having Other Issues	Severity of Speech Issues in Daily Life (min=1, max=4)	Concerns of Speech Issues in the Future (min=1, max=4)
Control (n=10)	1.8	1.4	1.7	0.9	2.2	2.5
Incremental (n=7)	2.1	1.0	1.7	0.4	1.7	2.3

6.4.2 Implicit Theory Measure Responses

The vocal Implicit Theory measure was presented prior to the Implicit Theory (of vocal issues) manipulation – in order to investigate a potential confound by an Implicit Theory in this domain – and the direction of these responses can be seen in Figure 6-1 (below). An independent t -test comparing participants' responses to the Vocal Implicit Theory measure pre manipulation – across entity and incremental items – between conditions was performed. No difference was found ($t = 0.30$, $df = 15$, $p = 0.77$, two-tailed).

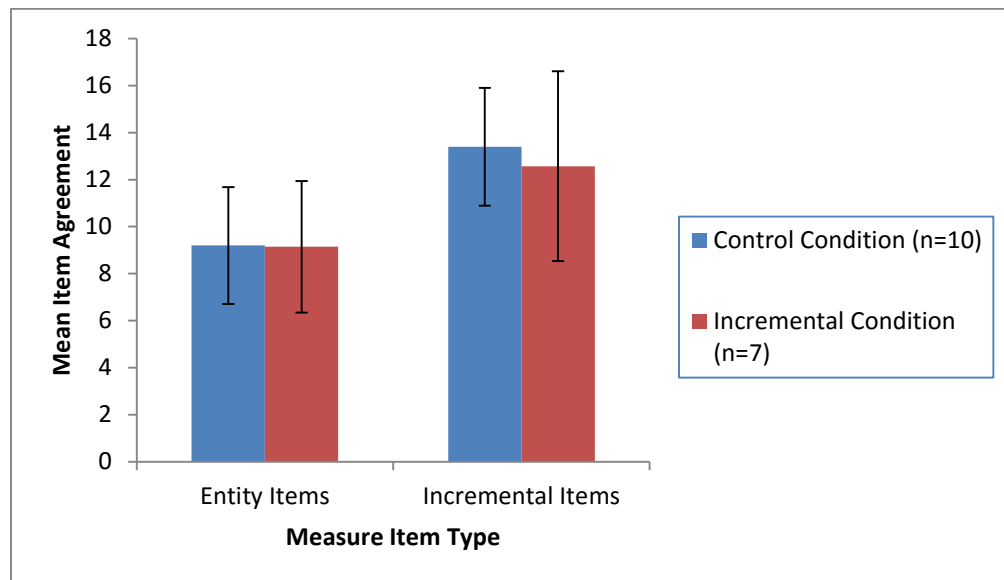


Figure 6-1: Vocal Implicit Theory Measure (pre manipulation) mean-agreement by condition to Entity and Incremental Items.

The hypothesis for Study 3 (see Section 6.2 above) was that, following presentation of an incremental Implicit Theory manipulation, Incremental Condition participants will demonstrate more responses congruent to an incremental Implicit Theory in comparison to Control Condition participants. To test this hypothesis it was expected that participants would show a different direction of responding to technology Implicit Theory measure presented post manipulation, agreement with entity and incremental item types is shown in Figure 6-2 (below). Comparing participants' response across the Technology Implicit Theory measure's items between conditions, an independent *t*-test did not show a difference ($t = 0.52$, $df = 15$, $p = 0.61$, two-tailed).

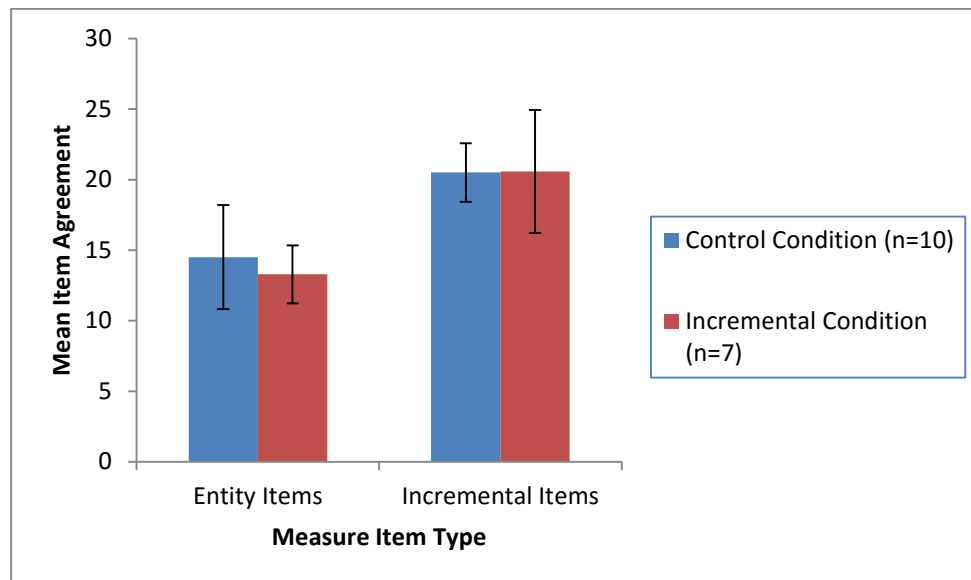


Figure 6-2: Technology Implicit Theory Measure mean-agreement by condition to Entity and Incremental items.

6.4.3 Volumes Measured

The hypothesis for Study 3 was that Incremental Condition participants would demonstrate more responses congruent with the Implicit Theory manipulation they had received (see Section 6.2 above). This prediction was not made in relation to volume measurements. To investigate potential effects of study condition on speech volume, volume measurements compared between conditions can be seen in Figure 6-3 and Figure 6-4 (below). Firstly it was predicted that responses relevant to an Implicit Theory of vocal issues would vary randomly between participants across study conditions. Comparing the difference within participants of volumes recorded by the researchers at deployment and collection stages of the procedure, between conditions, an independent t -test did not show a difference ($t = 0.09$, $df = 14$, $p = 0.93$, two-tailed). A paired t -test, across study conditions, showed that there was no difference between volumes recorded at deployment and retrieval ($t = 0.97$, $df = 16$, $p = 0.35$, two-tailed).

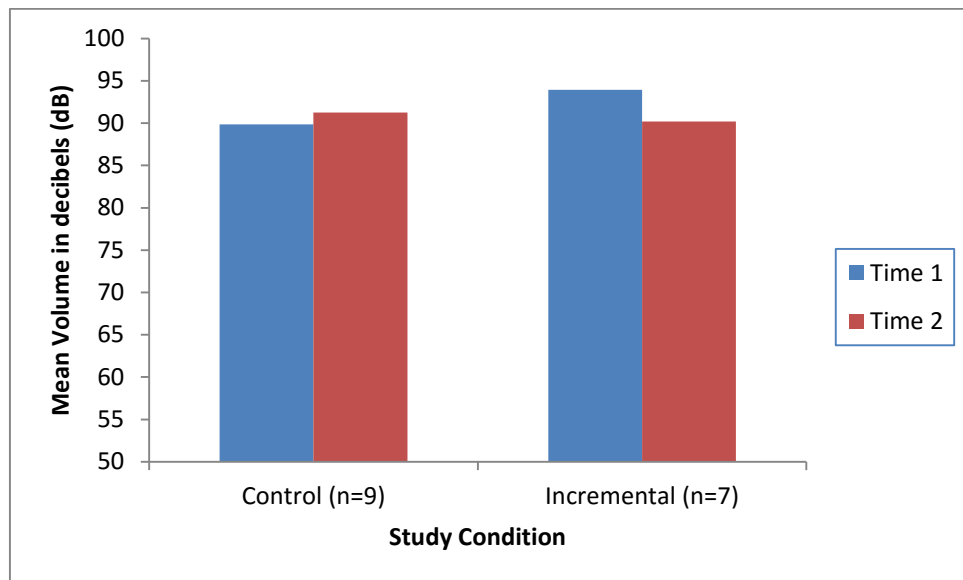


Figure 6-3: Mean Volumes of Vowel sounds recorded when the application was first presented at deployment (Time 1) compared to when the device was collected at retrieval (Time 2).

Again, contrary to the main hypothesis for Study 3, there was no specific prediction for volumes captured during usage of the application over the period of the procedure (see Section 6.2). The mean of each participant's volume, using each of the application components, was used to calculate a decibel average using the following formula: $L_p = 10 \log_{10}[(1/n) \sum_{i=1}^n \log^{-1}(L_{pi}/10)]$ (*Manipulation with Decibels*, n.d.). The main effect of average volumes produced by different application components was significant: $F(2, 26) = 8.17, p < 0.01$. The 'study condition' by 'average volume using each application component' interaction was not significant: $F(2, 26) = 0.02, p = 0.98$. The main effect of study condition was not significant: $F(1, 13) = 0.51, p = 0.46$. The direction of these volume measurements can be seen in Figure 6 4 (below). Verbal feedback from participants was not as actively captured as it had been in previously described studies (see Chapter 5). One salient piece of feedback was that several participants reported there was often a problem with the quality of the images presented to them for description. Sometimes the images were reportedly very dark, or else of obscure or undecipherable scenes or objects. To a lesser extent some of the texts were

appearing as randomised computer code – which can be complex to read even if understood – and this was reported by participants as difficult to engage with.

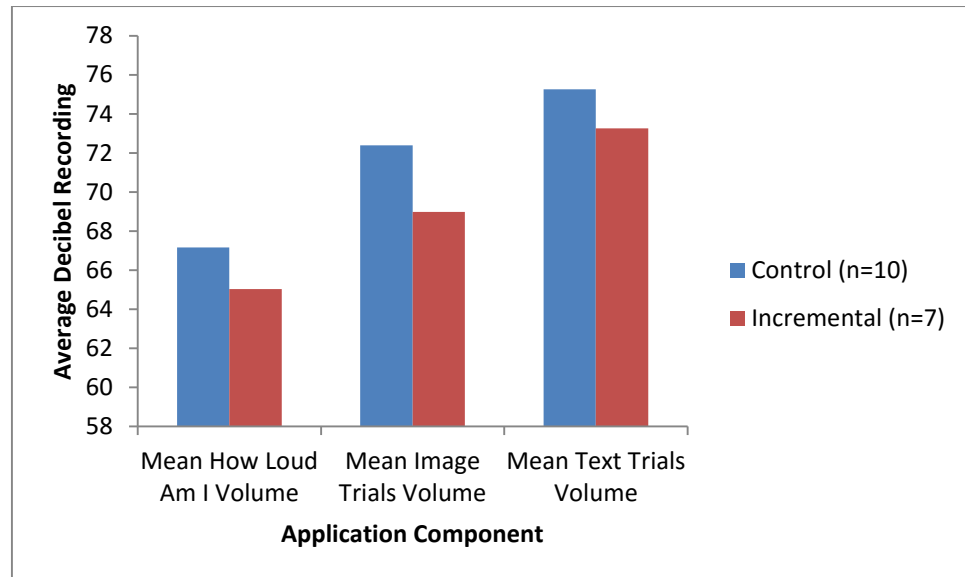


Figure 6-4: Mean of Volumes recorded by the application for three different application components, comparing between conditions.

6.4.4 Application Usage

The hypothesis for Study 3 was that Incremental Condition participants would demonstrate more responses congruent with the Implicit Theory manipulation they had received (see Section 6.2 above). It was predicted that responses congruent to an incremental Implicit Theory for Technology would include more effective usage of the application. Measures of application engagement are shown in Figure 6-5 (below), and it was predicted that engagement would be demonstrated by more usage and also usage spread more consistently across the participants period with the device. There was no significant effect of study condition on the combined dependent variable Application Engagement: $F(2, 14) = 0.16, p = 0.85$; Wilk's Lambda = 0.98; partial $\eta^2 = 0.02$. Analysis of each individual dependent variable, using a Bonferroni adjusted alpha of 0.025, showed there was no contribution: of total trials completed, $F(1, 15) = 0.26, p = 0.62$, partial $\eta^2 = 0.02$; or of percentage of trials occurring in the second-half of the procedure, $F(1, 15) = 0.21, p = 0.66$, partial $\eta^2 = 0.01$. Due to reported difficulties with

using some of the application's content, differences in trial durations were also investigated. There was no significant effect of study condition on the combined dependent variable Trial Duration: $F(2, 14) = 1.43, p = 0.27$; Wilk's Lambda = 0.83; partial $\eta^2 = 0.17$. Analysis of each individual dependent variable, using a Bonferroni adjusted alpha of 0.025, showed there was no contribution: of the duration of text-component tasks, $F(1, 15) = 2.57, p = 0.13$, partial $\eta^2 = 0.15$; or of the duration of image-component tasks, $F(1, 15) = 2.75, p = 0.12$, partial $\eta^2 = 0.16$.

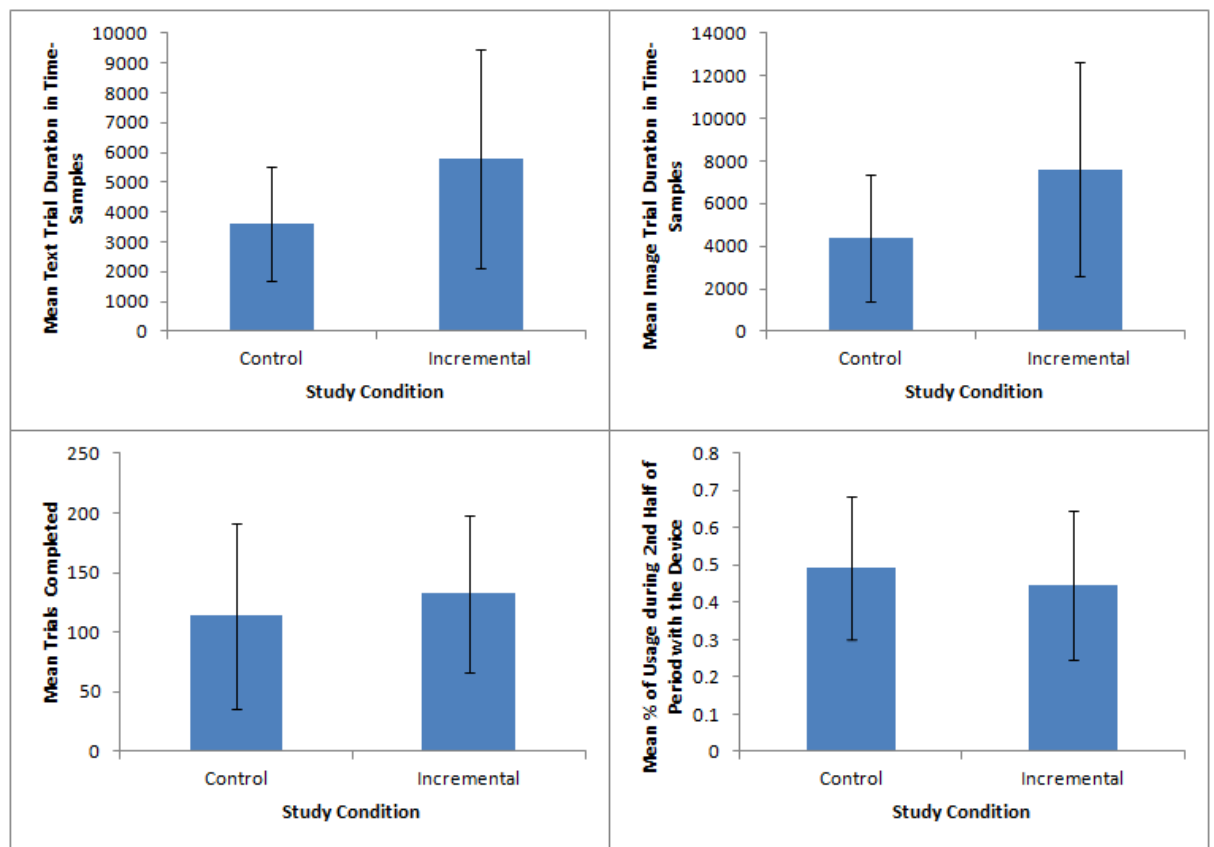


Figure 6-5: Application engagement by study condition (Control $n=10$; Incremental $n=7$), starting top-left going clockwise showing: Mean duration of Text-trials; Mean duration of Image-trials; Mean number of Trials completed; and Mean proportion of trials completed during the second versus the first half of participants' period with the device.

6.5 Study 3: Discussion

The PIT research studies were structured to include a more longitudinal phase with people with Parkinson's, Study 3. This study was again run in conjunction with user-testing of the SAP project. This final research phase with people with Parkinson's tried to utilise methods and materials that had been developed in Study 1a and Study 1b and then built upon in Study 2a and Study 2b. An aim here was to further investigate whether Implicit Theory domains exist that are relevant to the SAP project, that is, when people with Parkinson's using a technology-based speech therapy application. Studies 1a and 1b investigated Implicit Theory when learning programming languages, a technology-relevant domain. This was followed up by exploration of an Implicit Theory of ability with technology domain (Study 2a, Section 5.2 above). Of additional relevance to the SAP project, is how people perceive their health and beliefs about vocal issues. For this purpose a second domain was investigated, Implicit Theory of vocal issues (Study 2b, Section 5.5 above).

Similar to Study 2a and Study 2b, Study 3 was conducted in environments that could not be controlled or knowable in advance. For Study 3 the general location to meet participants was in their homes, meaning there was very little control over the experimental environment. Also similar to Studies 2a and 2b there were several factors related to the usage of the application and associated technology that also need to be considered. One factor difficult to control was the duration of time participants could spend with the application. Ideally, each participant would have had the same application for the same number of days. As was described in Section 6.3.3 above, each participant had a device with the application for approximately nine days. This figure is approximate as, due to participants having different events scheduled in their lives from one week to the next, it was not always possible to revisit participants in the same order or on the same days.

Additionally, it was considered beneficial to the main SAP project for feedback to be obtained from participants using the application on different types of devices. Two options were available, iPhones and iPod Touches, and approximately half of the participants completed the procedure with each type of device. Although useful for the SAP project, for the PIT research this introduced another variable, for which attempts were made to control its impact via counterbalancing device types between the conditions.

A further technology-related factor affecting experimental validity was the incremental changes to the version of the application. Some application development occurred between the studies, meaning there were changes in application version between the studies. This was due to the feedback collected over time, as technological errors were being reported by participants at the collection phase. Where possible, these errors were being corrected by the developers, using the time between the four blocks of participants. In theory, this is likely to mean that the application became easier for participants to use with each new version. This may, however, have meant minor variation between participants in terms of Implicit Theory-relevant situation challenges encountered, depending on which of the four blocks in which they participated (level of challenge encountered is discussed further, Section 6.5.5.6 below).

It was hoped that participant numbers for Study 3 would be higher than in earlier studies, fully utilising the resource of 15 devices across the maximum available four study blocks. The eventual number of participants included in the PIT research was however low (see Section 6.3.1 above). Similar to earlier studies this again acted as a limiting factor in this study providing strong results, and discussion is given to interpreting low powered results below (Section 6.5.5.4).

6.5.1 Vocal Issues and Vocal Implicit Theories

Investigating possible confounds between conditions, participants responded similarly across items included in Vocal Issues and Ratings by condition (see Table 6-2 above). Control Condition participants reported more stammer and 'other' vocal issues, and also (non-significantly) higher self-reporting of severity of speech issues in daily life and concerns for speech issues in the future. The only item that incremental condition participants reported higher agreement for was speech volume issues. Participants having different levels of speech issues or concerns between conditions could lead to different motivations for participation within the research.

The Vocal Implicit Theory Measure was presented prior to any Implicit Theory manipulations, so responses will not have been altered due to any previous Implicit Theory-related material within this procedure. Similar to the Vocal Issues and Ratings, no difference was seen between conditions in agreement between Vocal Implicit Theory Measure items (see Figure 6-1 above). Slightly more agreement to incremental items was shown by Control Condition participants, which pairs with slightly more speech issues and concerns demonstrated by this condition. This non-significant pattern could be explored with greater participant numbers. Non-agreement with incremental items could reflect helpless behaviour, and an unwillingness to demonstrate poor performance. In the context of the Vocal Implicit Theory Measure, this could materialise as less self-reporting of speech issues, not due to their actual presence or severity but due to participants not wishing to acknowledge or share those issues.

6.5.2 Technology Ability and Implicit Theories

Participants responded similarly between conditions to technology ratings and experience items (see Table 6-1 above). This can be considered alongside the Technology Implicit Theory Measure, which was presented after participants read a manipulation (or control text) on ability to learn new skills, specifically technology-

related. It was hypothesised that Incremental Condition participants would demonstrate more responses congruent to an incremental Implicit Theory (Section 6.2 above). No difference in responding was seen between conditions. Part of this might be that there was no Entity version of the manipulation – all Control Condition participants were shown non-valenced material. This may have resulted in there being less contrast between the conditions (see Figure 6-2 above). There may also have been a ceiling effect in terms of agreement with Incremental items for both Implicit Theory measures (as seen in Figure 6-1 and Figure 6-2 above). A maximum score of 24 was possible for the Technology Implicit Theory Measure, and of 16 for the Vocal version.

A response-direction was also seen when comparing Vocal and Technology Implicit Theory Measures between conditions. For the vocal version, presented prior to the Implicit Theory manipulation, Incremental Condition participants had shown (non-significantly) less agreement with incremental items in comparison to Control Condition participants. For the technology version, this difference disappeared, with Incremental Condition participants now showing (non-significantly) less agreement with entity items in comparison to Control Condition participants. This could represent a mild response change as a result of the Implicit Theory manipulation. Further investigation with greater participant numbers would be needed to confirm this. Comparing manipulation effect across Implicit Theory domains in this way could also be useful to investigate whether different domains are independent of each other. If the domains considered here were not independent then presenting an effective manipulation relevant to an Implicit Theory of Technology could also have an effect on an Implicit Theory of Vocal Ability.

6.5.3 Volume Comparison and Change

It was predicted that having an incremental Implicit Theory for Technology would lead to more effective usage of the application, vicariously improving or increasing speech volume (assuming the application was effective). It was anticipated

that the smartphone application would show to be effective or not effective over a longer period of usage than was possible in the study here, so no specific volume changes or differences were predicted (Section 6.2). Volume change was measurable from volume recordings taken by the researchers during the deployment and retrieval stages of the procedure. There was no significant difference between conditions when comparing volume-change from deployment to retrieval. However, rather than the volumes remaining stable as anticipated, Control Condition participants produced (non-significantly) louder volumes at retrieval, and Incremental Condition participants produced (non-significantly) lower volumes at retrieval. These results require further analysis as the statistical analysis carried out compared decibel values, which are logarithmic in nature. The mean volume produced by Incremental Condition participants at deployment was approximately 2 decibels louder than the mean-volume produced by Control Condition participants at retrieval (see Figure 6-3 above). Control Condition participants had shown a non-significant volume increase at retrieval, following time spent using the application. The deployment stage volumes were measured after participants had received the Technology Implicit Theory manipulation. Thus it could be suggested that an incremental manipulation increased participants' initial confidence in approaching the application, resulting additionally in more effortful volume-production when measured at this point. Subsequently, during the course of the procedure, participants approached the device with an incremental Implicit Theory for Technology, focusing on mastery of the application rather than sustaining the initial volume-production effort. The drop-off in volume recorded by Incremental Condition participants at retrieval may have been influenced by a ceiling-effect also (see Figure 6-3 above). Evidence supporting this hypothesis would be shown in future research by an initial (but not sustained) performance spike following an incremental Implicit Theory manipulation in relatable (but not the same) domains.

In the time between deployment and retrieval, Incremental Condition participants produced (non-significantly) lower volumes using the application. Volume was captured within three application components, or task-types, and incremental condition participants had lower volumes across usages on all three (see Figure 6-4 above). This direction of result was not predicted prior to the study, but is consistent with the proposed hypothesis for further testing. Incremental participants were possibly less interested in vocal performance during trials than Control participants. Following receipt of an incremental Implicit Theory of Technology manipulation, these participants may have been more focused on mastery of the device and application. The goal of producing a loud volume on a one-off occasion might have been relatively straight forward for most participants, so without the technology-learning focus suggested by the manipulation, more trials may have been approached by Control Condition participants with a performance goal to be loud in that instance. Some further input from speech and language therapy might be appropriate here, as there might be a benefit to individuals not focussing on an immediate louder volume, subsequently not necessarily sustained, versus a lower initial volume while engaging with the mechanics of voice (as provided by visual volume feedback from the application), which allows development of improved future cognitive strategies or understanding of how to engage vocal effort.

6.5.4 Variation in Application Engagement

Engagement with the application was assessed by using data captured during its usage. As the application was used by participants, the device recorded information about volumes, type of material being used (e.g. image-description or text-reading tasks), duration of each individual trial and number of trials completed. The prediction was that an incremental mind-set in the Technology Implicit Theory domain, induced by an incremental Implicit Theory manipulation, would result in more effective engagement with the application. The dependent variable predicted to be most informative for this

was how many trials participants would complete with the application over the period of use. Persistent engagement with the application could not be assumed before the study. The 'How Loud Am I' component of the application offers a blank slate to users to be creative in how they would like to make use of it, providing volume feedback and little else (Appendix G.1, see Figure G-2). Also the Training component of the application set volume goals that were continually increasing (Appendix G.1, see Figure G-6), so constant success was not possible when usage involved several trials. With these circumstances it was predicted that participants in the Incremental Condition would make more use of the application by completing more trials (see Section 6.2 above).

Incremental Condition participants did complete more trials, but no significant difference was seen between conditions. With greater participant numbers it would be predicted that this difference would approach significance. The second measure of engagement investigated was whether the number of trials completed by each participant was balanced over the duration of the procedure. It was predicted that more effective engagement would lead to a more equal split of trials between the first and second halves of a participant's procedure period. Again, there was no significant difference between conditions, but Control Condition participants' trials were closer to an equal proportion between the first and second half of the period. On reflection, if a participant in the study were to use the application with an entity mind-set and a performance goal, there are likely to be two key time periods when most usage would occur. Initial usage would likely be high, but additionally usage would be likely to pick up towards the end of the procedure, when the participant knows that researchers will be returning to conclude the study. As well as needing greater participant numbers, an extended duration of the study might help determine if there is a period during the middle of the procedure where usage drops off. It would again be predicted that Incremental Condition participants would have a more stable rate of usage across these artificial time periods. Of the two predicted

measures of engagement, neither showed a significant difference between conditions and only one (mean trials completed) was in the predicted direction. When discussing usage of the application with participants during the retrieval stage, it was clear that participants engage in a large variety of other activities during their day to day lives, both related and unrelated to Parkinson's. This factor is likely to have affected the outcome of this study, due to low homogeneity of the target audience and having low participant numbers. To investigate the relationship between Implicit Theory and application engagement, greater participant numbers would be needed.

In Section 6.4.3 (above) it was noted that several participants made reference to the usability of many of the images and texts presented by the application. This feedback was not related to study condition, and primarily was helpful to relate back to the application developers. Poor quality content represents an obstacle to usage, and something that would be eliminated, where possible, from any finished version. For the context of this study they represent a challenge that the user had to deal with. Poor quality content issues are likely to have affected the durations participants spent on different trials, however are likely to have occurred consistently for all participants. Participants controlled how long they spent on each piece of content, so when something erroneous was presented there would have been opportunity to either attempt to engage with the content, or simply to skip and move on to something else. It was not possible to retrospectively know which trials contained challenging content. It was possible, however, to know the duration spent on each trial, allowing a mean duration for each participant's use of each of the application components. Incremental Condition participants spent (non-significantly) longer engaging with each trial in comparison to the Control Condition participants. This comparison is weakened by not knowing the frequency of challenging content. An accurate reflection might require understanding of each individual participant's experience, as what may be challenging for one person may

not be for another. Deliberate inclusion of difficult material would allow a more controlled measurement, however as a training tool this would not be seriously considered as an appropriate use of application development resources. A suggested hypothesis that links behaviour to Implicit Theory of Technology is that, with an entity mind-set, when difficult content does arise engagement will be brief to avoid the challenge. These users might make brief vocal sounds unrelated to the content, or maybe skip it directly. They know that there is a variety of content available, so selection of clearer material where a good performance is possible is likely to be preferred, and spending less time on difficult material. Users with an incremental mind-set may see difficult content as an opportunity to engage in a challenge, or to learn something about the application, so may spend more time on difficult material. This hypothesis would allow the prediction that, as the proportion of challenging content increased, the variation in trial duration between Incremental and Control Condition participants would increase, with participants in an Incremental Condition spending longer with each trial than those in an Entity Condition.

6.5.5 Reflections for Subsequent Studies

6.5.5.1 Factor Variability. Similar to Study 2b above one of the main variable factors was study location, studies generally being conducted in participant's homes. As the studies here required two visits (at deployment and collection) there was some consistency in generally visiting the same location twice, but not necessarily seeing participants in the same room, or else being sat in the same arrangement, or with the same additional people present at both visits.

Similar to both Study 2a and Study 2b, the other main variable factor was the participants themselves. The mean age, Hoehn-Yahr score and mean time since diagnosis for participants of both conditions is outlined in Section 6.3.1 above. These mean characteristics are relatively similar between conditions. This suggests that factors

of age or Parkinson's severity should be less likely to be the cause of any differences seen between conditions. The mean age of participants however is quite young in comparison to an expected mean of people with Parkinson's, which might make results difficult to apply to all people with Parkinson's.

6.5.5.2 Technology Ability versus Vocal Issues as the Implicit Theory

Domain for Manipulation. Study 3 manipulated tech as it tied in better with the SAP project, and offers more crossover learning for future projects where technology is being developed, which might not necessarily be relevant to the same niche as people with Parkinson's with vocal issues. There was more confidence in the Abd-El-Fattah and Yates (2006) measure, having taken it from a source that offered strong evidence of its reliability. A different measure was used for measuring Implicit Theories of vocal issues, taken from Dweck (1999) which was designed for looking at theories about personal properties, as opposed to the more commonly studied – in respect to Implicit Theory – beliefs about learning. It was only possible to manipulate one domain when trying to investigate effects on resulting behaviours within this study. Weaker evidence had also been generated for Vocal issues measure during the PIT research prior to Study 3. The potential value of learning about the relevance of Implicit Theories of both domains to people with Parkinson's is discussed further in Section 7.1.1.3 (below).

6.5.5.3 Intentionality of Behaviours. As was discussed previously, in Sections 4.9.3.1 and 5.8.4.3 (Chapters 4 and 5 above), intentionality of behaviours is difficult to know. Similar behaviours are measured as part of the procedure when visiting participants for Study 3, and similar issues of knowledge about intentionality of behaviours exist. In terms of behaviours of interest for this study, however, to investigate a link between measured Implicit Theories following manipulation (or control information) and subsequent behaviours, the behaviours of interest for Study 3 are those captured between the deployment and collection visits. As participants use the

smartphone application it logs things like: the time of a trial; the type of trial it was; and the mean volume of the trial. There is a large amount unknown for each trial. It is assumed for the purposes of the research here that each trial is completed by the participant – although it is possible that for some trials they might be demonstrating the application to a friend or family member. Also, as part of the SAP project’s learning about the application, participants were encouraged to use the device and application in as wide a variety of locations and settings as they felt comfortable with. Within the application, each trial that was presented it is not known whether the material was comprehensible, or whether it included a glitch that could be included in the feedback reported by participants at the end of the experimental procedure period. When such content is encountered it is not known whether participants made efforts to engage with it, or simply skipped it. Also, participants were provided with contact details for the researcher here and invited to make contact if any issues were encountered. Minimal contact was made to the researcher here by participants in between the deployment and collection stages, but that does not mean that it can be assumed that no issues were found. The application allows for details to be captured as participants use the application, but there are a lot of reasons that mean intentionality of usage is unclear. It is hoped that over the course of the period participants have with the application that incremental and entity behaviours can be judged via calculations of total number of trials completed and the duration of trials, but caution must be used when interpreting these metrics.

6.5.5.4 Interpretation of Low Powered Results. There is very little difference seen between conditions for both Implicit Theory measures presented to participants. The Implicit Theory measure related to technology ability is presented following the Implicit Theory manipulation of beliefs about the same, and there is no more than marginal difference between the conditions, Control Condition participants showing

slightly more agreement with entity measure items. The lack of variation in responses to this measure may be due to a lack of variation induced in participants' Implicit Theories with no entity manipulation being used. In previous studies, regardless of experimental condition, participants have shown more agreement with incremental measure items compared with entity measure items, and the responses to both Implicit Theory measures again follow this trend.

In terms of measurements captured during usage of the application, trial volumes will not be discussed under this heading as there was a significant main effect for volume between conditions. For frequency and duration of trials, however, there were no significant effects. Figure 6-5 (above) shows that the largest differences between conditions were for duration of trials (for both text-reading and image-description tasks). It has been suggested that if a participant is engaging with an individual trial they are likely to spend more time on it. This time should not vary significantly between conditions. There might be slightly more flexibility in duration for description of an image, some may evoke more to say than others. Text trials on the other hand, assuming reading ability (which was not measured) is spread evenly between conditions should take an approximately equal amount of time. If an individual is skipping a trial, just reading the first few words of text, or providing only a minimal description around an image, however, the mean duration of trials should be lowered. These behaviours could be suggestive of an entity Implicit Theory as challenge within tasks is being avoided or short circuited. The non-significant differences between the Control and Incremental Conditions suggest that if this behavioural prediction is correct then it is possible that Control Condition participants are displaying more examples of behaviours congruent with an entity Implicit Theory.

The other behaviours captured which were predicted to be indicative of holding different Implicit Theories were total number of trials completed and also portion of

trials split between the first and second half of the experimental procedure's period. The prediction is that if a participant is engaged with the application then they will use it more, and also they would use it evenly across the period for which they have access to it. The differences between conditions are small here, with one measure congruent with Incremental Condition participants displaying more engagement and one measure being contrary to the expected direction. While the results from trial durations provide support to the hypothesis that participants encouraged to hold an incremental Implicit Theory will demonstrate increased engagement with the application, there is little other evidence for or against this.

6.5.5.5 Performance versus Learning Goals. It was suggested above (in Section 6.5.3) that Control Condition participants may have produced louder volumes due to more frequently holding performance goals (associated with entity Implicit Theories) in comparison to Incremental Condition participants who – following manipulation – were more likely to hold learning goals. While all participants were knowingly involved in the study in order to assess a speech therapy smartphone application, this incremental Implicit Theory manipulation will have directed focus for Incremental Condition participants towards learning and engaging their ability with technology. There are multiple potential merits to approaching the smartphone application with the focus of learning effective use of the technology to be considered. It is possible that this could promote longevity of usage, or may in the long term lead to increased usage. Barriers to usage considered in Section 1.3.2 above related to potential issues around technology and also Parkinson's or speech related issues. If barriers for an individual were predominantly technology-related, then it is possible that a smartphone device and a speech therapy application could be useful and learnable, however, the process might not be enjoyable. If an incremental Implicit Theory could be present when initially being introduced to the application then enhanced initial engagement could have

longer-term effects. When errors or difficulties occur this may not cause abandonment of usage. While learning goals are generally considered to be of more value, there are occasions when performance goals will show improved results (or performance). This is generally the case when tasks are simple or more straight-forward. Study 3, by including the most basic vowel-sound volume task (in the absence of a goal-bar as used for added task complexity in Studies 2a and 2b), was incorporating a task where it is possible that a performance goal could more likely lead to stronger performance.

A question should be asked about what value there is in being able to produce a loud volume on a one-off occasion for a relatively straightforward task. This measure should indicate what volume an individual is capable of, and measurement at two different times should indicate change in capability. Performance goals or experimental situation can cause participants to alter their effort on either occasion however, so in the context of the research here this measure may not have been ideal. What is of interest when using this measurement in the context here is whether using the application has led to a change in vocal capability across all participants, and whether Implicit Theory manipulations have had any effect between experimental conditions. It is less clear whether volumes produced during usage of the application should vary depending on experimental condition. This is discussed further in Section 6.5.5.8 below. From the outset however, for the SAP research, there was not an expectation that volume or vocal issues would change from a period of approximately ten days of usage. The interest was whether the application would or could be used over a prolonged period of time, and then further investigation would be required as to whether the application was effective. If vocal change was predictable by the research design, then for the PIT research if improved engagement could be encouraged then a difference might be expected with an incremental Implicit Theory. In the absence of this expectation, improved engagement was anticipated via increased frequency of usage, longer durations of usages, and that

frequency of usage would be similar in the first and second half of the longitudinal period.

6.5.5.6 Level of Challenge Encountered. Following on from discussion about difficulty levels included in tasks (see Section 5.8.4.2 in Chapter 5), it remains difficult to know at what level challenge is perceived. One point worth noting here is that the SAP project's smartphone application was developed with the aim of being simple to use in mind. Studies 2a and 2b formed part of user-testing for the application, feedback from which was organised and fed back to the developers by the author here. High on the list of priorities was anything to do with the interface that participants had found difficult to use, so usability should have increased over the period of the SAP project. Thus difficulty using the application should have progressively, if not significantly, lessened.

The priority of the time spent with participants at the deployment stage of the procedure was also to make sure that participants were as comfortable and confident with using the application as was possible within the period available. Once participants had used the application once or twice – following the departure of the researchers – it is likely that the learning curve for using the application was not very steep and that there should not have been too much new encountered. This will not have been the case for every participant, but for this additional reason it could be possible that the difficulty level of using the application was relatively low.

6.5.5.7 Smartphone Application Relevance to the Participant. To investigate whether there is likely to be prolonged technology use displayed as part of evidence for effective technology engagement should perhaps consider relevance of the technology. The speech therapy smartphone application, used as part of Studies 2a and 2b, and Study 3 here, may have been of more relevance or benefit to some participants than others. Responses to measure items related to vocal issues and concerns experienced by participants can be seen on Table 6-2 (Section 6.4.1 above). As the device has been

designed to help vocal volume the most relevant items are experience of speech volume issues, severity of speech issues in daily life, and concerns of speech issues for the future. Responses were rated from 1 (not at all serious) to 4 (very serious), so a mean response was 2.5. Participants in the Control Condition responded to the item 'concerns of speech issues in the future' at mean level, but below mean for the other two and Incremental Condition participants responded below mean for all three of these items. This indicates that speech volume issues are generally low across the included participants (although there is not great difference between conditions), and also more general speech issues experienced in daily life and concerns for the future are low. In the context of using a smartphone application over an extended period of time, if the application is targeting volume issues then lower levels of issues could relate to lower usage. As participant numbers included here were low a comparison between participants with higher and lower relevant issues has not been made. In terms of expected behaviour resulting from Implicit Theories, the manipulation used was for an incremental theory related to technology ability. If participants have been provided an appropriate introduction to the application, and they have then used it several times and feel comfortable with it, there may be little left to learn from a 'technology' point of view for simply continuing with application usage. If vocal concerns or volume issues were present then this could be the type of motivation that is required for continued usage.

6.5.5.8 Should Improved Engagement be shown by Louder Volumes? When expecting improved engagement should there be increased volumes in addition to increased usage. More effective engagement should result in louder volumes, which if not possible to interpret from application usage in the absence of researchers, should have been possible when comparing the pre and post study volumes captured. No talking task was captured at pre and post measurement. There was two reasons for this, firstly the procedure time was being minimised so that maximum time was available to

demonstrate the device. The vowel-sound task is a more standardised speech therapy task as so was considered the more beneficial measure to keep as part of the deployment and collection procedures. The second reason was that the image tasks should require self-generated speech content, similar to the talking task, so participants should be performing this type of task regularly during the experimental procedure. So if improved or more effective smartphone application engagement is predicted as a result of an incremental Implicit Theory manipulation, and improved volume with self-generated speech content tasks are a useful measure of this, then mean image trials volumes (see Figure 6-4 above) should show Incremental Condition participants with louder volumes. This is not what was seen. Comparing raw decibel scores the gap between Control and Incremental study conditions was actually widest for this measure, louder image trial scores being produced by Control Condition participants. It is possible, however, that increased engagement with the application actually led to lower scores for this trial type. Image trials received the most frequent comments at the collection stage in terms of them being very odd or difficult to decipher. With this in mind it is possible that spending time to try to decipher or engage with image trials when difficulty arose actually led to lower volumes. While spending time deciphering something, or deciding on what can be said, there is likely to be an element of silence. If a user is trying to achieve something with that trial, rather than just to keep their average volume intact, then silence will not be a problem. If however users are interested in performance then a habit might generate itself where an image gets quickly skipped when it is not straight forward. This would lead to higher mean volumes but could be considered as less effective engagement.

6.5.5.9 Support for an Implicit Theory of Vocal Issues. Following on from the discussion (see Section 5.8.4.6, Chapter 5) of the value of continued investigation for an Implicit Theory of Vocal Issues, the Implicit Theory measure of vocal issues was presented to participants of Study 3, prior to being shown the study's Implicit Theory

manipulation (or control information). Very little difference was seen between conditions, so it is difficult to suggest that any subsequent results might have been affected by Implicit Theories of vocal issues. In addition to Implicit Theories of vocal issues being similar, levels of vocal issues expressed by participants were also very similar between conditions (see Table 6-2 above). With these similarities it could be anticipated that volumes might be similar between conditions. The vowel-sound task measured at deployment and collection stages of the procedure did show very little difference between conditions (see Figure 6-3 above). For volumes measured during the period of usage of the application however, there was a main effect of study condition seen (see Figure 6-4 above). Given Implicit Theories of vocal concerns were measured similarly between conditions, this difference was not predicted by the measure. Value is still likely from being able to understand where people have entity Implicit Theories of vocal issues, as behaviour resulting from this could potentially be described as helpless.

6.5.5.4 Potential for Participants to Self-Select to Studies. Another potential consideration for subsequent studies is which participants take part. An ideal participant for the research here was described as someone who might benefit from using the application (Section 3.3.3 above). There is a potential however to have an imbalance of participants taking part purely because they are interested in technology and who find the study interesting on that basis alone. Although all participants were people with Parkinson's there is a potential for the ability level with technology amongst participants to be skewed in comparison to the population of people with Parkinson's. If this were to occur then interpretation of behaviours following presentation of Implicit Theory manipulations would need to be mindful of this, and external validity of the study might be weaker as a result. The studies here included checks related to familiarity and ability with technology, however future studies could benefit from considering how to ensure a spread of abilities at the recruitment stage.

A second potential self-selection consideration – which does not seem to have been a focus of previous Implicit Theory research – is whether people more usually disposed to an incremental Implicit Theory might be more likely to volunteer to participate in research similar to the PIT research. If the perceived aim of the research is to investigate themes that equate to improvements in the abilities or situation of people with Parkinson's then it may be that entity theorists perceive less value pursuing this knowledge and vicariously may demonstrate more reluctance to take part. Future Implicit Theory research, not just related to people with Parkinson's, could benefit from being further informed as to whether there are any potential issues with participants self-selecting to partake in studies depending on their existing Implicit Theories.

CHAPTER 7. CONCLUSIONS

7.1 Summary of Research and Contribution to Knowledge

7.1.1 Contribution to Empirical Results

7.1.1.1 Support for an Implicit Theory of Technology Ability Manipulation.

An Implicit Theory in the domain of ability with technology has been investigated. Throughout the PIT research studies presented (Chapters 4-6), the main hypothesis has consistently been that following presentation of an Implicit Theory manipulation, participants would demonstrate more behaviours consistent with the type of manipulation (entity or incremental) or material (control) presented. Study 2b (Section 5.5 above), which presented participants with a health-related Implicit Theory manipulation, will be excluded from discussion here as not relevant to a technology manipulation. The manipulations in Study 1a (Section 4.4.2 above) and Study 1b (Section 4.7.2 above) were related to ability with computer programming languages, which will be considered as a proxy for discussion of an Implicit Theory of technology ability manipulation. These studies included students on computer programming-relevant courses, so a moderate technology ability was assumed. Study 2a (Section 5.2 above) and Study 3 (Section 6.2 above) are also include here, as both used Implicit Theory manipulations of ability with technology. The manipulation used in all four of these studies were similarly composed. There was only slight variation between the manipulations used in Study 1a and Study 1b (variation described Section 4.7.2 above), and then the manipulation content was reworded for the purposes of Study 2a (Section 5.3.2 above). The manipulation of Study 3 (Section 6.3.2 above) had only minor variation from Study 2a for the incremental version, but included control material instead of an entity version. No individual study provided strong support regarding the effects of these manipulations, which in part was due to low participant numbers (Study 1a, $n = 16$; Study 1b, $n = 22$; Study 2a, $n = 12$; and

Study 3, $n = 17$). Low participant numbers has received discussion in previous chapters above (Sections 4.9.3.3, 5.8.4.4 and 6.5.5.4)

Looking at responses to Implicit Theory measures completed post-manipulation, support of the hypotheses was anticipated by incremental condition participants (compared to non-incremental condition participants) showing more agreement with incremental measure items, and less agreement with entity measure items. The expected direction of responding was found in Study 1a, but with a non-significant difference ($t = 1.49$, $df = 14$, $p = 0.16$, two-tailed). Study 1b compared participants' response across the Implicit Theory measure's items (both incremental and entity), between study conditions, and there was a significant difference ($F(1, 18) = 5.07$, $p < 0.05$, partial $\eta^2 = 0.22$). However, there was no significant interaction between participant types (first year students versus more experienced students) and study condition. Study 2a and Study 3 also found results in the expected direction of responding, although again without a significant difference (Study 2a: $t = 1.45$, $df = 10$, $p = 0.18$, two-tailed; and Study 3: $t = 0.52$, $df = 15$, $p = 0.61$, two-tailed). Despite poor levels of statistical confirmation, all four of these studies included responses to Implicit Theory measures, in the directions expected, after an Implicit Theory manipulation. Given that there was low participant numbers, the consistency of responding across studies does offer tentative support that there was some effect of the manipulations presented.

Secondly, looking at task behaviours and performance measures, support of the hypotheses was anticipated by incremental condition participants (compared to non-incremental condition participants) displaying more perseverance with difficult tasks, and more engagement with task-related activities. In Study 1a and Study 1b these were measured by way of responses during a set of computer programming tasks. Study 2a and Study 3 used the occasions of application test phases which were occurring as part of the SAP project. Results were again subject to low participant numbers, so direction of

results across these studies is also considered here. Study 1a compared participants on the numbers of questions asked, how often tasks were skipped, and how often multiple attempts were made and, for all three measures, behaviours between conditions were in the directions expected by the hypothesis prediction. However, the main effect of different behaviour types during the programming task was non-significant: $F(3, 12) = 2.58$, $p = 0.10$; Wilk's Lambda = 0.61; partial $\eta^2 = 0.39$. Study 1b did have a significant main effect of different behaviour types during the programming task, but a lot of the difference here could be accounted for by behaviour variation between different experience-levels of participants. The behaviour types by study condition (Entity or Incremental) interaction was not significant: $F(6, 108) = 0.18$, $p = 0.98$, partial $\eta^2 = 0.01$. Study 1b measured more behaviours than Study 1a, partly due to uncertainty interpreting behaviours in Study 1a - such as a task being skipped - and whether this was consistent with an entity or an incremental Implicit Theory. Thus, in all Study 1a and 1b showed eight measured elements of behaviour, despite non-significance, were in the directions predicted between experimental conditions (Section 4.9.2 above). Similarly for Study 2a, behaviours measured were also in the directions expected, again without reaching significance (Section 5.4.4 above; $F(2, 9) = 1.20$, $p = 0.34$; Wilk's Lambda = 0.79; partial $\eta^2 = 0.21$). This was consistent with Study 3, which also found no significant difference between conditions for participants' behaviours, while using the smartphone application, although behaviours measured were in the directions expected (Section 6.4.4 above; $F(2, 14) = 0.16$, $p = 0.85$; Wilk's Lambda = 0.98; partial $\eta^2 = 0.02$). Similar to Studies 1a and 1b, consideration was again given to interpretation of behaviours (Sections 5.8.4.3 and 6.5.5.3 above). Returning to Study 2a, an additional aspect of behaviour during the procedure was verbal responses made during the procedure. Three themes relevant to Implicit Theory emerged from the Thematic Analysis conducted on the responses captured (section 5.4.5 above). These themes were

Failures with Technology; Plans for Usage; and Effort. Categorising responses within each theme as either entity or incremental, across themes the balance of responses were congruent with the version of the Implicit Theory manipulation that had been presented. Although a gross measure, in combination with the other results, across these four studies the behaviours were generally found to be (non-significantly) in the direction predicted based on the hypotheses, however intentionality of behaviours cannot be assumed.

Thus, when investigating support for an Implicit Theory of technology ability manipulation, no conclusive evidence was found. However, the consistency of the results direction lends support for there being an effect of the Implicit Theory manipulations used, although it is not clear from the results here how strong that effect might be. Further considering the results, they suggest that, given the correct level of power (future studies that might address this discussed below, Section 7.2.1 below), that an Implicit Theory of ability with technology might be something that could be measureable.

The existence of an Implicit Theory of technology ability manipulation, or the potential to affect Implicit Theories in this domain, could be helpful in exploring how users of technology respond to issues or difficulties they encounter. In instances, such as that of the SAP project, where technology is being presented to a potentially new audience, Implicit Theory could play an important role in the uptake of that technology. The SAP project has the aim of aiding users with Parkinsonian speech symptoms, and if effective Implicit Theory manipulations exist then for some users this could result in improved engagement with the technology.

7.1.1.2 Support for an Implicit Theory of Vocal Issues Manipulation. The PIT research (Section 1.3.3 above) aimed to complement the SAP project (Section 1.3.2.1 above), while minimally disturbing what the SAP project was trying to achieve. Part of this was the PIT research's goal to explore Implicit Theory domains relevant to

the SAP project (Section 1.3.3 above). The primary focus of this goal was beliefs about ability with technology, but a secondary exploration was also included which investigated an Implicit Theory of vocal issues. How a person thinks about health issues, or more specifically vocal issues, is likely to relate to the effort they might engage to use something designed to help improve speech (such as the SAP project's speech therapy application). Study 2b utilised an Implicit Theory of vocal issues manipulation. The main hypothesis for this study remained that following presentation of an Implicit Theory manipulation, participants would demonstrate more behaviours consistent with the type of manipulation. The manipulation (Section 5.6.2 above) used was constructed similarly to how the manipulation for Study 2a was designed, being reformatted from earlier studies (Study 1a and Study 1b). Looking for evidence to support the hypothesised effect of the manipulation, similar to other studies discussed above (Section 7.1.1.1) strong support was absent, again in part was due to low participant numbers ($n = 10$). It was suggested that support for the hypothesis would be evident via measure responses and also behaviours during the study procedure. Following presentation of the manipulation, Implicit Theory of vocal issues were measured and there was no significant difference between the conditions ($t = 0.332$, $df = 8$, $p = 0.748$, two-tailed). Incremental condition participants showed (non-significantly) more agreement with incremental measure items, consistent with predictions, but also showed more agreement with entity measure items. A second examination of the Implicit Theory of vocal issues measure is offered by Study 3, in the absence of an Implicit Theory manipulation. Three themes emerged from the analysis, one of which was vocal failures. Fewer entity condition participants had made reference to vocal issues or failures. Also, in comparison to entity condition participants, where incremental condition participants referenced vocal issues they were likely to discuss it in terms of being a symptom of Parkinson's, or an issue that they personally had, and were then able to discuss how the application or other methods could form part

of efforts for working with the presence of vocal issues. Entity condition participants might, for example, refer to vocal failure as something caused by medication, so looking for an external cause. Other themes that emerged were those of Effort and Plans of Usage. For these themes too the balance of comments made by participants was consistent with the experimental condition that they belonged to. Valence of Implicit Theory-relatable comments being congruent with the Implicit Theory manipulation that participants had been presented with offers some support for the efficacy of the manipulation.

7.1.1.3 Support for relevance of Implicit Theory for investigating cognitions

People with Parkinson's. Sections 7.1.1.1 and 7.1.1.2 (above) discuss evidence for Implicit Theory manipulations, but without looking at whether there is a specific relevance of the considered domains for people with Parkinson's. A large amount of previous Implicit Theory research (described in Chapter 2 above) involves students in their investigations. Across these studies, Implicit Theory has been shown to be relevant to how people learn, whether people seek challenges, and how they respond to failures. No previous Implicit Theory research has focussed on people with Parkinson's. However, as a progressive condition, it involves challenges and setbacks, and also can include symptoms affecting innate abilities such as movement or speech. Understanding whether Implicit Theory holds a relevance for people with Parkinson's could hold value for understanding how these challenges and setbacks are encountered and responded to.

A first indicator of a relevance of Implicit Theory for people with Parkinson's is direction-of-response to different Implicit Theory measure item types. Across the PIT research studies, which included people with Parkinson's, five Implicit Theory measures were presented to participants. Measures were either for Implicit Theory domains of ability with technology or of vocal issues, and were presented either before or after an Implicit Theory manipulation. Regardless of the Implicit Theory domain being

examined, the experimental condition of the respondent, or whether it was being completed pre or post manipulation, the same pattern of responding emerged.

Participants always showed more agreement with the incremental measure items, over the entity items. This pattern suggests that there was a difference appreciated between the two sets of measure items by the participants of these studies.

A second indicator is verbal responses captured during Study 2a and Study 2b, which were subjected to Thematic Analysis. The primary purpose of capturing what participants were saying during the procedure was to provide an additional source of design feedback as part of the SAP project's aim of further developing the smartphone application. Aside from comments made during presentation of the Implicit Theory measures, where participants weren't instructed to discuss or elaborate on their answers but some chose to do so, participants were not being questioned about anything directly relevant to Implicit Theory. A semi-structured interview pattern was being followed, but all of this was focused on thoughts and feedback related to the application being tested. From this however there was sufficient content to form the analysis (as discussed in Sections 5.4.5 and 5.7.5 above). This demonstrates that participants were discussing things in ways that were relevant to Implicit Theory, such as the value or futility of effort, or ability being fixed or flexible.

A third indicator is the possibility that manipulations of Implicit Theory might have an effect on people with Parkinson's. The PIT research did not find any direct evidence of manipulations being affective, but evidence assessed across the studies completed (Sections 7.1.1.1 and 7.1.1.2 above) points towards a potential for effect. Similar to this accumulation of tentative support, in the absence of statistically significant evidence of Implicit Theory manipulation efficacy, there is no direct evidence of Implicit Theory being relevant as a theory for using with people with Parkinson's. Developing more effective studies to investigate Implicit Theory with people with Parkinson's is

discussed below (Section 7.2). There are however several indicators of relevance pointed to here, meaning that value of Implicit Theory demonstrated in previous research for understanding goals and motivation (see Chapter 2), could be relatable to understanding further the goals and motivations of people with Parkinson's.

7.1.2 Contribution to Practice

7.1.2.1 Application of Implicit Theory to Health Therapies. Therapies in most forms are likely to involve some form of effort on the patient's part. Generally this will be in the form of exercises suggested by the therapist, carried out either during a session with the patient or instructions to exercise between sessions. These exercises will necessarily involve some level of effort on the part of the patient. For example recovery from a hip operation might involve directing efforts to gradually build up strength and mobility, and may also involve some level of pain endurance to fully follow what has been suggested. A speech therapy program designed specifically for people with Parkinson's - LSVT (Section 1.1.2 above) - requires 16 one-hour sessions over a period of four weeks, making it intensive for both the therapist and the patient. Psychotherapy might involve a lot of mental effort for the patient, where they need to work through something emotionally difficult, or invest time trying to engage with some new habit. For any of these forms of therapy the therapist can play a large part in guiding the patient through these efforts. It is possible that Implicit Theory could help to ensure this guidance is more effective. Dweck (2006b) when discussing a 'growth mind-set workshop' suggests inducing an incremental theory could be a good first step for any training program. For the SAP project, one of the proposed values of incorporating Implicit Theory was that it could allow potential insight into where users might have difficulties engaging with the application, for example overcoming technology ability barriers or beliefs about their potential to positively improve vocal ability in the presence of Parkinson's. An incremental Implicit Theory in the context of therapy could include

appreciation of the value of effort in the absence of immediately visible improvement or an underlying belief of the current position to be changed (for the better via the therapy). An entity Implicit Theory could involve belief that therapeutic efforts are unlikely to improve much, and effort might be avoided or expended purely in the presence of the therapist. The manipulations used by the PIT research (the efficacy of which are discussed in Section 7.1.1 above) were brief, several paragraphs long, and similar content could be provided by a therapist when introducing treatment. It could be useful for the therapist to either ask directly how the patient perceives the likelihood of therapeutic success, or to include messages while speaking with the patient that highlight the importance of effort on their part to therapeutic success. A therapist, if available, can potentially impart a health message carrying more gravity than is achievable by manipulations in the form used by the PIT research. A therapist can believably tell patients about the merits of effort and the potential for improvement, and support this with their own personal experience of patients who they have seen show improvement through effort.

7.1.2.2 Implicit Theory Relevance to Motivation and Goal Setting in

Parkinson's. Implicit Theory can play a role in understanding motivation and goal setting in Parkinson's. It can be useful for carers, for example, to have an understanding of how Implicit Theory can impact goals and resultant behaviours. Forkan et al. (2006) listed several barriers to participation in exercise programs, including depression, no interest and poor outcomes expectation. Holding a goal of exercising more might be very relevant to the health needs of a person with Parkinson's, and being able to discuss underlying reasons where poor goals exist – such as Implicit Theories – could help to encourage more positive action. In addition to carers, individuals with Parkinson's could themselves benefit from having a knowledge of different processes that might be affecting their decisions. The generalisability of the PIT research to people with

Parkinson's needs to be considered, and this could be aided by considering Hoehn-Yahr scores of included participants. The extremes of included participants were Entity condition participants in Study 2a, who had a mean Hoehn-Yahr score of 1.5 and Incremental condition participants in Study 3 had a mean score of 3.1. As the scale goes up to five, participants included in the PIT research were towards the lower end of the Hoehn-Yahr scale. This suggests the research here is more specifically related to the goals and motivation of people with less progressed stages of Parkinson's.

7.1.2.3 Implicit Theory Relevance to Learning of Computer Programming Languages. Study 1a and Study 1b both conducted investigations into an Implicit Theory domain of ability with computer programming. The research here provides contribution by suggesting a relationship between computer programming abilities and Implicit Theory. Previous Implicit Theory research has a reasonably thorough grounding in academic findings (Section 2.1 above), and some focus on specific subjects such as Maths (e.g. Kim et al., 2012) or English (e.g. Hong et al., 1999). No previous research was found applying Implicit Theory to ability with programming languages. Computer programming could be viewed as suffering from similar gender stereotypes as Maths (Cvencek, Meltzoff, & Greenwald, 2011) and Implicit Theory could be applied to help address that (Dweck, 2006a). Other stereotypes might exist here, like a perception that computer programming is only for nerds (Williams, 2006). Implicit Theory can help explore underlying thoughts that a student might have for a subject in this area. Alternatively Implicit Theory could be used to inform teaching practices, perhaps trying to encourage an incremental Implicit Theory learning approach towards the subject. Students could be reminded that their peers who seem to be able to program effortlessly will have spent time learning and engaging with the basics, and that learning is gradual but requires effort on their part. Similarly it could be used to help students who are struggling and perhaps displaying helpless behavioural characteristics.

7.1.2.4 Implicit Theory Relevance to Learning New Technologies. Three of the PIT research studies presented a speech and language therapy application to participants. Many of the participants had never used a device similar to the one used to present the application to them, and none of them had previously seen that particular application. The SAP project, with a target audience of people with Parkinson's, intentionally tried to develop a simple-to-use application. Many applications may receive very little design thought, resulting in them being difficult to use, however they may still hold some intrinsic value that could make them useful to the user. If the outcome is an application that is overly technical or intimidating to use, that value may be lost to some users who do not persevere with trying to engage with it. More broadly than applications, technology is increasingly ubiquitous, understanding and using technology however can require constantly evolving skills as it changes. Being competent and comfortable with technology now should not assume competence and comfort with whatever technology is yet to be developed. Implicit Theory can inform about what goals we hold with regards to technology, and what underlying thoughts drive those goals. Holding an entity Implicit Theory could lead capable users, happy to demonstrate their ability, to respond helplessly when they do encounter a challenge. Incremental theorists on the other hand might be more accepting that they do not currently have the ability to utilise a new challenging piece of technology, but that with time and effort they should be able to understand it. With technology continually progressing, and increasingly offering health applications (Section 1.3.1 above), having theories to understand engagement, such as Implicit Theory, become increasingly relevant.

7.1.3 Contribution to Methodology

7.1.3.1 An Opportunistic Approach. The PIT research took place alongside the SAP project. The research was opportunistic in that it took advantage of design testing

stages being carried out as part of developing the smartphone application. The research was designed to complement the SAP project, in that its focus was on a field that could compliment the efficacy of the application. One of the main considerations throughout the research was avoidance of interfering with the primary purpose of the testing events as opportunities for design testing. Trade-offs existed that would have been approached differently as a piece of standalone research. For example Study 2a and Study 2b were both intentionally conducted with low participant numbers as this was adequate for design testing purposes at that point (Section 5.1 above). The usefulness of the study could be scrutinised with such low participant numbers, but taking advantage of the circumstances allowed for a study with high external validity. A second trade-off, non-inclusion of several participants for reasons such as fatigue or slow progress through the procedure, was unfortunate. It was important (for the SAP project) to allow sufficient time and resources for the application and device to be fully demonstrated so all participants had a sufficient understanding of how to use them, before being left with them. This meant reduced participant numbers for the PIT research, also meaning capture of a reduced variety of participants by the study, the heterogeneity of people with Parkinson's being a notable attribute mentioned above (Section 2.4.1). The design process can be informed upon here by maybe considering the time available to visit with each participant. There was financial constrictions in terms of how many days the research could be conducted over, and travelling between participants' locations was also required. Again, conducting the research in participants' homes provided a study with high external validity, and participants were thus providing responses to the Implicit Theory materials in their own familiar settings as opposed to at the hospital or a research lab. An alternative approach might have been to send by post to participants some of the measures and questionnaires ahead of being visited as part of the SAP research. This would have allowed more time for the remaining procedure components during the visit.

7.1.3.2 Thematic Analysis of Application Testing Feedback. Study 2a and Study 2b both included more detailed questioning of participants' impressions of the application as developed at that point, than Study 3 allowed for. Responses were captured from the semi-structured interview, along with any responses made while responding to the Implicit Theory materials. The responses made while testing the application are of interest in terms of contribution to methodology. Firstly comments made during presentation of Implicit Theory materials it can be assumed were at least partially prompted by the research procedure, when Implicit Theory will have been salient. Comments made during application testing however were not prompted from an Implicit Theory perspective, so any relationship of the feedback content with the theory can be assumed to be closer to genuine thoughts of the participant at that time (as opposed to their measured response to a prompt). The semi-structured interview was focused on gaining feedback for the SAP project, so any discussion related to themes such as effort or difficulties were removed temporally from the Implicit Theory materials which had been presented earlier in the procedure. Rather than leaving discussion of Implicit Theory to chance, it would have been perfectly relevant to the testing data to ask some Implicit Theory relevant questions. If participants were asked open questions around their thoughts on the value of investing effort with the smartphone application, or whether they perceived their (vocal or technical) ability could be altered via prolonged usage, feedback could be of relevance both to the SAP project and the PIT research.

7.1.3.3 Participant Support during the Procedure. In addition to meeting participants in differing environments, participants also received differing levels of support during the experimental procedure. Any friend or family member present with the participant was invited to remain with them during the procedure. The frequency and dynamics of this was not actually recorded as part of the study, but occurred on many occasions with varying degrees of engagement and interaction from the additional

person. This ranged from listening passively to the procedure, paraphrasing instructions for the participant when requested or supporting their understanding, to proactively questioning the purpose or meaning of different parts of the procedure. While these interactions will have changed the properties of the experimental situations, they will also have provided potential (immeasurable) benefits to the procedure. For some participants, additional help was needed to understand the procedure or how the application worked. This was particularly important for the longitudinal study, when the main priority was for participants to be able to make use of the application during their period with the device. Being able to explain the device and application to two people was often of value to the procedure, and may have led to the increased use of the device with support at hand from those who had been present at the deployment. Where the extra individual was in the role of carer for the participant, this also provided valuable information for the SAP project, in terms of how a person with Parkinson's and a carer could interact together to use the device. There is also a further strengthening to the external validity of the study, as it is likely that participants would be using technology in the presence of other people. Of benefit to future research is to work to include carers or family members, especially when exploring areas where these people might ordinarily be involved.

7.1.3.4 Backend Collection of Data. Study 3 (Chapter 6) involved participants using the smartphone application across a period of days. At the end of this period, when the device was collected, the data produced over this period was not taken directly from the device but was uploaded to a server that supported the application. This upload process could happen regularly during the procedure if the application had been set up to connect to a participant's local Wi-Fi, or else after the devices were collected if they were not connected to the Internet during the procedure. The possibility of a research programme being able to have data available during longitudinal procedures could be of

great benefit and is something that does not seem to have been applied to Implicit Theory research previously. It potentially allows for early presentation of findings at intermediate points, or in the context of health research, it might allow early intervention if any participants appeared to be having difficulty.

Collecting data via a backend server via the application, as was done here, also allows for multiple measures to be easily collected over potentially thousands of instances, in a paperless manner requiring little data-capture effort on the part of the researcher. This potentially allows for exploration of different forms of study methodologies. The device did not capture participants' speech when they were using the application, but it was able to capture much richer detail than simply duration of talking or maximum, minimum or mean volumes. Potentially more measures could be captured by the application with little extra research overhead involved.

7.1.4 Contribution to Theory

7.1.4.1 Application of Implicit Theory to an Ability with Technology Domain.

Support for the efficacy of the Implicit Theory of Technology manipulation has been discussed above (Section 7.1.1.1 above). Previous research applying Implicit Theory to technology relevant domains has been sparse (Section 2.2.2 above). The research here, although not producing statistically significant results, points towards a relevance of applying Implicit Theory to behaviours and ability with technology. This would increase the usefulness of Implicit Theory, by broadening further the range of domains (Section 2.2 above) that it is applicable to. Specifically, in terms of technology ability, the PIT research applied Implicit Theory to students learning programming languages and people with Parkinson's using a smartphone application. Both are occurrences which involve at least some amount of learning, and where some people strive or struggle more than others, which makes applying Implicit Theory relevant. From the point of view of an unfamiliar skill, during that learning process Implicit Theory can be extended to examine

how people respond to failures. Do people seek to avoid challenge, or do they seek to learn from it. Where a certain amount of knowledge has been acquired, is that situation used by an individual to demonstrate their ease and competence or is there a focus on continued effort and continued learning. These behavioural differences are already described by entity and incremental theories within Implicit Theory, but there is a potential, shown in the PIT research, to be related to the domain of technology.

7.2 Future Work

7.2.1 Opportunities for Increased Design Power

Study 1a and Study 1b were both conducted with University students and investigated an Implicit Theory of ability with programming languages. Not uncommonly for the Parkinson's Implicit Theory (PIT) research studies (Chapters 4-6 above), both of these studies had low participant numbers. Previous Implicit Theory research in educational environments have run studies including entire classes (e.g. Louis, 2011). The research established a new area that IT research might apply (Section 7.1.2.3 above). This is interesting as programming is an area that has strong gender stereotypes. Research could be carried out to further establish ability with programming languages as an IT effected domain. However, it could also be used as a way of motivating a new generation of female programmers, and so research would be invaluable in this area. Future studies could incorporate entire class groups, completing Implicit Theory measures at the start of the year and then results obtained over the course of the year could be related to responses. Implicit Theory manipulations could also be tested, comparing different versions presented to different class groups. Using an incremental manipulation and control material (similar to Study 3, Section 6.3.2.1 above), different class groups could be included in different study conditions. Students would still be required to consent - as research participants - to the data being captured, but by involving entire class groups stronger studies should be possible.

Opportunities for increased participant numbers could also be explored by future research studies including people with Parkinson's. The PIT research was the first to investigate Implicit Theory with people with Parkinson's and one route might be for Implicit Theory materials to be presented by speech therapists as part of meeting new patients with Parkinson's. This would allow therapists to be directly involved with Implicit Theory research, which could have a positive impact on their practice (Section 7.1.2.1 above). This approach could lend itself to similar study designs as proposed (in the paragraph above) for future work including students. Studies could be run over several years as people with Parkinson's form only part of a speech therapists caseload, and new patients suitable for inclusion could not be reliably anticipated. Materials being presented to patient participants by therapists would remove some of the external validity of the study that was achieved by running the procedure at participants' homes, but the trade-off would be increased internal validity for being able to have a controlled environment between participants. Additionally a speech therapist gauging Implicit Theory relevant behaviour, such as levels of effort or how a patient responds to setbacks, would observe these over a longer period of time than a lecturer as contact with patients is less frequent. It might ordinarily be 12 months between patient-therapist contacts. To partially overcome this likely prolonged research method, similar to using multiple class groups, multiple therapists could be incorporated into the study. This would allow different therapists to present different Implicit Theory materials, allowing different experimental conditions to be more easily generated without informing the speech therapists about the study hypotheses. An issue here might be NHS ethical approval, which would likely be more complex if the study involved multiple hospital sites in order to involve enough speech therapists.

7.2.2 Relating Behaviours to Implicit Theory

Sections 4.9.3.1, 5.8.4.3 and 6.5.5.3 (above) discussed interpretation of intentionality of behaviours. For Study 1a it was unclear how some of the behaviours captured should be interpreted, so further detail was captured at Study 1b. Realising ambiguities of interpretation existed was informative, but value of that understanding that could be applied here was limited as the studies involving people with Parkinson's captured different behaviours to the ones that included University students. Future work can utilise this by paying consideration to where these types of interpretations will be required. This was not optimal for the study design here, as each of Studies 2a, 2b and 3 used different versions of the smartphone application as part of the research procedure. Measurement of behaviours with improved prediction of their intentionality would allow clearer interpretation as to whether an action was indicative of an incremental or entity Implicit Theory. To allow for this a study could be planned where pilot studies gathered feedback from participants as they made behaviours, possibly using designs where they talk through their thinking process or rate factors such as effort levels as they proceed. Pilots for future work should aim to be carried out using whatever task materials is planned for post-pilot where possible, so that intentions captured remain relevant for subsequent studies.

A second procedural issue encountered, related to understanding behaviour, could also be addressed by this method of conducting pilot studies with an artefact consistent with what will be used in subsequent studies. Sections 4.9.3.2, 5.8.4.2 and 6.5.5.6 (above) discussed issues with the level of challenge encountered during testing. For future Implicit Theory research it is relevant to have an understanding of levels of challenge, as behaviours could vary depending on difficulty. Helpless behaviours, as associated with an entity Implicit Theory, are less likely in the absence of perceived challenge. Again, for the PIT research, different studies were carried out using different

materials (e.g. different versions of the smartphone application). Future work in this and similar areas could utilise a pilot study where difficulty of different task components can be discussed. Ideally future work would aim to also use the same apparatus in these pilots as would be used in subsequent studies. These pilot studies could also look for a correlation between level of task difficulty reported and responses made to the measure capturing perceived ability level.

Another consideration for relating task behaviours to Implicit Theory is the profile of participants recruited in terms of their pre-existing Implicit Theories. In Section 6.5.5.4 (above) it was suggested that there might be some possibility of individuals holding incremental Implicit Theories in research-relevant domains may be more likely to volunteer to participate. If such an effect were to exist then it would likely be relevant to Implicit Theory research more widely and not solely related to research with people with Parkinson's. Future work could explore further whether such a self-selection occurs as it might be something that skews outcomes and could be a factor in how results need to be considered.

7.2.3 Stability of Implicit Theory across Stages of Parkinson's

People with Parkinson's showed a similar responding trend (across experimental conditions) between agreement with entity and incremental measure items, in comparison to what was found by Abd-El-Fattah and Yates (2006, Section 3.2.1 above), to their original measure. That is, participants showed more agreement with incremental items in comparison to entity items. Section 7.1.1.2 (above) acknowledged that the Hoehn-Yahr scores of participants included in the PIT research were towards the lower end of this scale. Future work could explore whether this response direction is consistent across different Parkinson's severity levels as described by the Hoehn-Yahr scale. The trend of greater agreement with incremental measure items demonstrates a prevalence of believing things to be flexible over being fixed. It is encouraging to see this predominant

belief in flexibility amongst the participants included in the PIT research, but it would also be worthwhile to investigate whether this predominance is stable across Parkinson's severities. If entity measure items became more agreeable with advanced severity then it could highlight a need for people with Parkinson's to receive different types of support from carers or therapists with increased deterioration, or emphasise a relevance for (statistically-proven) effective versions of the manipulations described as part of the PIT research (Sections 5.3.2.1 and 5.6.2.1).

7.2.4 Link between Implicit Theories and Reported Abilities

Entity condition participants in Study 2b, prior to any experimental manipulation, showed (non-significantly) more agreement with the incremental items, and agreement was very similar between conditions for the entity items (Section 5.8.1 above). This may have been a reflection of greater experience and familiarity with technology as reported by entity condition participants to the questionnaire items. If this were the case it would indicate a link in people with Parkinson's, without any manipulations, between having an incremental Implicit Theory of technology and likelihood to have developed experience with technology. This link could be investigated further by utilising a simplified study design that presented similar measures of technology ability followed by an Implicit Theory measure. This study design would not rely on speech therapist contact, allowing a broader pool of people with Parkinson's to be participants. One design aspect that may have contributed to the response direction in Study 2b is that participants were anticipating that the study procedure was going to involve them testing a smartphone application which would be unfamiliar. Perhaps in the absence of an anticipated related task, or with an expectation of an easy task, it would have been the entity condition participants who reported stronger ability. This could also be examined by advising participants prior to completing the measures that afterwards they would be presented with an easy or hard task, or no task. The procedure could end without presenting a task

to any participant, but it would be predicted that participants would have completed the ability measure differently depending on their Implicit Theory and what task level had been expected.

7.2.5 Future Work Utilising Entity Manipulations versus Control Material

Studies 1a, 1b, 2a and 2b all utilised entity versions of the Implicit Theory measure. It was useful in the context of the Studies here to investigate the potential effect of holding an entity Implicit Theory. It has been suggested (Section 6.5.2 above) that comparing behaviours between participants who had received incremental versus entity manipulation versions generated a greater contrast between the conditions than would be achievable comparing an incremental manipulation with a control. Larger powered studies were needed across the PIT research (Section 7.2.1 above), including Study 3 where an incremental manipulation was investigated alongside control material. Future work conducted with a similar structure to the research here, i.e. a series of smaller studies followed by a longitudinal study utilising control material, the use of control material (in place of an entity manipulation) should be considered across the whole series of studies. The design used here allowed for more effective testing of the relevance of Implicit Theory to people with Parkinson's, however manipulations encouraging an entity Implicit Theory are unlikely to be used in non-research contexts. One of the strong aspects of the research here was external validity, and something that could further add external relevance for future work might be to avoid using an Entity condition if developed materials are unlikely to be utilised beyond research. An expected outcome on including only control and incremental conditions would be the series of smaller studies showing even less difference between conditions, but there is likely a value from exploring consistent materials across the research program.

Organising all studies within a future program of research to compare between similar experimental conditions (e.g. Control verses Incremental) would allow more

direct comparisons between studies. As seen here, this could be particularly helpful in the context of a collection of low powered studies. This would also allow more confidence to be built in the validity of the materials used for the Control condition, which in the context of the research here were only in Study 3.

7.2.6 Self-Management Implicit Theory Interventions Presented using Assistive Technology

A short-form evidence based health intervention (CPAG) was discussed briefly (Section 2.3.2 above) that showed potential to positively affect health behaviours with minimal involvement from a health professional Bray et al. (2011). The research here utilised brief pieces of text as Implicit Theory manipulations (Appendix A). Given the brevity of these manipulations, they could be ideally suited for presentation via assistive technologies, such as a smartphone. More dynamic presentation methods made available via these mediums could also enable more engaging ways of presenting manipulations, or allow ways of directly incorporating them into applications such as the SAP project's application discussed here. There is a potential for future research to investigate the suitability of Implicit Theory presented via assistive technologies for improving the outcomes of, for example, people with chronic conditions or people undergoing rehabilitation.

7.3 Closing Comments

Implicit Theory is reported to predispose people to either learning or performance goals, which depending on perceived ability can lead to mastery or helpless behaviours. The research shows that Implicit Theory holds relevance to people with Parkinson's, a progressive illness with symptoms that include deterioration of previously innate abilities such as movement or speech. Implicit Theory informs understanding of motivations and goals in the face of these challenges. This, contributes to the practice of therapists, such as speech therapists, who can utilise Implicit Theory to more effectively present therapies

and exercises to patients. The context for this is software testing, which is not known for being an opportunity to conduct psychology research. However, by working alongside the development of the smartphone application, the potential outcomes of that project have been enhanced by exploring areas relevant to engagement. Also by utilising this opportunity for a non-standard research approach it has been possible to explore the relevance of Implicit Theory to technology and health domains, and to the previously untested group of people with Parkinson's.

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APPENDIX A

A.1 Studies 1a and 1b – Entity Manipulation Text

Current Research

This study aims to follow-up previous research investigating ability to learn specialised subjects at University, such as software development, and ability at programming languages. The majority of research agrees that our abilities in these areas are fixed, and cannot be improved significantly through extra effort (Abblet, 1994; Fields, & Buck, 2001; Smyth, 2003).

Fields (2007) spent the last decade tracing identical twins who were raised apart, and one of the things looked at was programming ability. According to Fields' results, up to 88% of a person's intelligence is due to fixed genetic factors. About ten percent of intelligence seems to be determined during the first three years of life. This means that intelligence may be increased or decreased by only about two percent during most of a person's life. Part of the study included tasks which tested programming ability, and results indicated ability was similar within twin-pairings (both twins showed similar ability), despite them being raised apart under different circumstances.

In another study by Cohen and Laud (2004) comments were taken from undergraduate participants regarding how they thought of their own ability to learn software development:

“It seems there are some people in the class who just get it, they don't seem to put much effort into programming”, John.

“I struggle to learn programming languages. No matter how much work I put in I don't seem to improve”, Mark.

“I love our software development class, it just seems to come to me without trying”, Tina.

These are typical responses recorded by Cohen and Laud, and they all seem to back up what the rest of the research suggests.

Once you have finished reading this page, notify the experimenter, and they will check that you have understood what you have read here. Then in the second stage of the experiment you will be asked some brief questions about your programming ability, and what you believe about your programming ability. In the third stage you will be given an introduction to a programming task, and then you will have ten minutes to work on the task.

Check for understanding

What was the main point of the current research described?

A: The different research studies presented do not agree.

B: Our ability for learning things like programming languages is like a fixed entity, basic ability stays roughly the same.

C: Our ability for learning things like programming languages is flexible or incremental, basic ability can be increased through effort.

D: All of the above.

E: None of the above.

A.2 Studies 1a and 1b - Incremental Manipulation Text

Current Research

This study aims to follow-up previous research investigating ability to learn specialised subjects at University, such as software development, and ability at programming languages. The majority of research agrees that our abilities in these areas are variable, and can be improved significantly through extra effort (Abblet, 1994; Fields, & Buck, 2001; Smyth, 2003).

Fields (2007) spent the last decade tracing identical twins who were raised apart, and one of the things looked at was programming ability. According to Fields' results, up to 88% of a person's intelligence is due to fluid environmental factors. Only About ten percent of intelligence seems to be determined during the first three years of life. This means that intelligence may be increased or decreased by about ninety percent during most of a person's life. Part of the study included tasks which tested programming ability, and results indicated ability was significantly different within twin-pairings (both twins showed dissimilar ability), having been raised apart under different circumstances.

In another study by Cohen and Laud (2004) comments were taken from undergraduate participants regarding how they thought of their own ability to learn software development:

"It seems there are some people in the class who just get it, but they also seem to spend a lot of time programming", John.

"I struggle to learn programming languages. I never put much work in so I don't seem to improve", Mark.

"I love our software development class, I keep trying at it and I keep getting better", Tina.

These are typical responses recorded by Cohen and Laud, and they all seem to back up what the rest of the research suggests.

Once you have finished reading this page, notify the experimenter, and they will check that you have understood what you have read here. Then in the second stage of the experiment you will be asked some brief questions about your programming ability, and what you believe about your programming ability. In the third stage you will be given an introduction to a programming task, and then you will have ten minutes to work on the task.

Check for understanding

What was the main point of the current research described?

A: The different research studies presented do not agree.

B: Our ability for learning things like programming languages is like a fixed entity, basic ability stays roughly the same.

C: Our ability for learning things like programming languages is flexible or incremental, basic ability can be increased through effort.

D: All of the above.

E: None of the above.

A.3 Study 2a - Entity Manipulation

Current Research (please read carefully)

This study aims to follow-up previous research investigating ability to perform technology skills, such as how to use new technology devices, and unfamiliar applications on those devices. The majority of research agrees that our abilities in these areas are fixed, and cannot be improved significantly through extra effort (Abblet, 1994; Fields, & Buck, 2001; Smyth, 2003).

Fields (2007) spent the last decade tracing identical twins that were raised apart, now older-adults, and one of the things looked at was technology ability. According to Fields' results, up to 88% of a person's intelligence is due to fixed genetic factors, which agrees with previous research. About ten percent of intelligence seems to be determined during the first three years of life. This means that only about two percent of intelligence remains that may be increased during most of a person's life. Part of the study included tasks which tested computing and technology ability, and results indicated ability was similar within twin-pairings (both twins showed similar ability), despite them being raised apart under different circumstances when they were younger.

In another study by Cohen and Laud (2004) comments were taken from older-adult participants regarding how they thought of their own ability to learn new technology skills:

"It seems there are some people who just get it, they seem to be able to easily work new gadgets without spending much time at it", John.

"I struggle with anything technical. No matter how much effort I put in I don't seem to improve", Alfred.

"I love figuring out new technology, it just seems to come to me without trying", Dorothy.

These are typical responses recorded by Cohen and Laud, and they all seem to back up what the rest of the research suggests.

Once you have finished reading this page, notify the experimenter, and they will check that you have understood what you have read here. Then in the second stage of the experiment you will be asked some brief questions about your ability with technology, and what you believe about your ability when using new technology. In the third stage you will be given an introduction to a new mobile phone application, and then you will be allowed to use the application in your own time.

A.4 Study 2a - Incremental Manipulation

Current Research (please read carefully)

This study aims to follow-up previous research investigating ability to learn technology skills, such as how to use new technology devices, and unfamiliar applications on those devices. The majority of research agrees that our abilities in these areas are variable, and can be improved significantly through extra effort (Abblet, 1994; Fields, & Buck, 2001; Smyth, 2003).

Fields (2007) spent the last decade tracing identical twins that were raised apart, now older-adults, and one of the things looked at was technology ability. According to Fields' results, up to 88% of a person's intelligence is due to fluid environmental factors, which agrees with previous research. Only About ten percent of intelligence seems to be determined during the first three years of life. This means that about ninety percent of intelligence remains that may be increased during most of a person's life. Part of the study included tasks which tested computing and technology ability, and results indicated ability was significantly different within twin-pairings (both twins showed independent ability levels), having been raised apart under different circumstances when they were younger.

In another study by Cohen and Laud (2004) comments were taken from older-adult participants regarding how they thought of their own ability to learn new technology skills:

"It seems there are some people who just get it, but those people also seem very interested in new gadgets and seem to spend a lot of time using them", John.

"I struggle with anything technical. I never put much effort into figuring them out so I don't seem to improve", Alfred.

"I love figuring out new technology, I keep trying at it and I keep getting better", Dorothy.

These are typical responses recorded by Cohen and Laud, and they all seem to back up what the rest of the research suggests.

Once you have finished reading this page, notify the experimenter, and they will check that you have understood what you have read here. Then in the second stage of the experiment you will be asked some brief questions about your ability with technology, and what you believe about your ability when using new technology. In the third stage you will be given an introduction to a new mobile phone application, and then you will be allowed to use the application in your own time.

A.5 Study 2b – Entity Manipulation

Current Research (please read carefully)

This study aims to follow-up previous research investigating our ability to change our basic characteristics. For example one study looked at peoples' success modifying their weight, and another study looked at peoples' success sticking to difficult post-operation therapy programs. The majority of research agrees that our ability, or strength, to make changes in these areas is fixed, and cannot be improved significantly through extra effort (Abblet, 1994; Fields, & Buck, 2001; Smyth, 2003). We are interested here in how this research relates to people with Parkinson's.

Looking at some of this past research, Fields (2007), traced identical twins that were raised apart, who were then older-adults. One of the things Fields looked for was instances where both twins encountered situations demanding characteristic changes, similar to weight loss or therapy mentioned above. Looking at outcomes in these situations, according to Fields' results, up to 76% of a person's behaviours in such situations are due to fixed genetic factors (which agrees with other previous research). This means that a lot of our behaviours can be predicted by our genetics, so our success or failure may have little to do with our own efforts and thoughts. The study made a comparison with non-identical twins (so without the large genetic similarity), and their behaviour could not be predicted similarly.

In another study by Cohen and Laud (2004), comments were taken from older-adult participants regarding how they thought of their own ability to perform new health-behaviours:

“It seems there are some people who just get straight back on their feet, but those people also seem to be able to breeze through their exercises without much effort”, John.

“I struggle with sticking the course. No matter how much effort I put in I don't seem to improve”, Alfred.

“I love seeing improvements, they just seem to come without me really trying”, Dorothy.

These are typical responses recorded by Cohen and Laud, and they all seem to back up what the rest of the research suggests. For better or worse, people have patterns of behaviour which kick in and dictate their responses when trying to establish new health-behaviours.

The research here is interested in seeing if these findings generalise to people with Parkinson's, in addition to getting your feedback on the smart-phone speech and language therapy application being developed.

A.6 Study 2b – Incremental Manipulation

Current Research (please read carefully)

This study aims to follow-up previous research investigating our ability to change our basic characteristics. For example one study looked at peoples' success modifying their weight, and another study looked at peoples' success sticking to difficult post-operation therapy programs. The majority of research agrees that our ability, or strength, to make changes in these areas is variable, and can be improved significantly through extra effort (Abblet, 1994; Fields, & Buck, 2001; Smyth, 2003). We are interested here in how this research relates to people with Parkinson's.

Looking at some of this past research, Fields (2007), traced identical twins that were raised apart, who were then older-adults. One of the things Fields looked for was instances where both twins encountered situations demanding characteristic changes similar to weight loss or therapy mentioned above. Looking at outcomes in these situations, according to Fields' results, up to 76% of a person's behaviours in such situations are due to changeable environmental factors (which agrees with previous research). This means that few of our behaviours can be predicted by our genetics, so our success or failure may have a lot to do with our own efforts and thoughts. The study made a comparison with non-identical twins (so without the large genetic similarity), and their behaviour could be predicted similarly.

In another study by Cohen and Laud (2004) comments were taken from older-adult participants regarding how they thought of their own ability to perform new health-behaviours:

“It seems there are some people who just get straight back on their feet, but those people also seem very determined and put a lot of effort into their exercises”, John.

“I struggle with sticking the course. I never put enough effort in so I don't seem to improve”, Alfred.

“I love seeing improvements, I keep really trying at it and I keep getting better”, Dorothy.

These are typical responses recorded by Cohen and Laud, and they all seem to back up what the rest of the research suggests. For better or worse, people have the ability to exert different levels of effort which dictate their responses when trying to establish new health-behaviours.

The research here is interested in seeing if these findings generalise to people with Parkinson's, in addition to getting your feedback on the smart-phone speech and language therapy application being developed.

A.7 Study 3 – Incremental Manipulation

Current Research (please read carefully)

This study aims to follow-up previous research investigating our ability to learn new skills. Our focus is technology skills, such as how to use mobile devices, and applications. The majority of research agrees that our ability to learn new things is variable, but can be improved significantly through extra effort (see research by: Abblet, 1994; Fields, & Buck, 2001; Smyth, 2003). We are interested in how this relates to people with Parkinson's using our application.

Looking at some of this past research, Fields (2007), traced identical twins that were raised apart, who were then older-adults. One of the things Fields measured with these twins was their technology ability, and the skill or proficiency level they had both reached, having grown up separately. Results showed, up to 88% of a person's knowledge and ability is due to changeable environmental factors (agreeing with previous research). This means that few of our behaviours can be predicted by our genetics, so our success or failure may have a lot to do with our own efforts and thoughts.

In another study by Cohen and Laud (2004) comments were taken from older-adult participants regarding how they thought of their own ability to learn new technology skills:

“It seems there are some people who just get it, but those people also seem very interested in new gadgets and seem to spend a lot of time and effort using them”, John.

“I struggle with anything technical. I never put much effort into figuring them out so I don't seem to improve”, Alfred.

“I'm not great at figuring out new technology, but I keep trying at it and I keep getting better”, Dorothy.

These were typical responses recorded. They all back up the suggestion that, for better or worse, people have the ability to exert different levels of effort, giving different learning outcomes. We hope that, with your effort, you will find our application useful.

A.8 Study 3 – Control Material

Current Research (please read carefully)

We have previously conducted two smaller studies in the past year. As part of these studies we included a reading piece, like this, which was interested in looking at behaviour when trying to learn new skills. The first study focused on behaviour when learning to use new technology, and the second looked at behaviour when trying to improve or change your voice (for example your speech volume). We were interested in whether what people think about learning situations changes their behaviour, thus affecting the learning outcome.

What we found during these studies is that there is great diversity among the different people we met. To start with, different people have different levels of ability, which affects learning. People have different motivations, some stronger and some weaker. Also peoples' confidence in their own ability to learn and achieve things varies – both from one person to the next, and from one time of day to another.

The main aim of previous studies has been to get feedback so that we can direct development of the application. The main aim this time is again about giving you the opportunity to use the application and getting your feedback. In addition to this, we remain interested in looking at behaviour when trying to learn new skills. As a result, as well as showing you the device and application, we have retained a lot of questionnaires and forms to complete.

The questionnaires and forms that we have included today cover ability with technology, and beliefs about learning new technology skills. Also there are questionnaires about your voice and beliefs about speech and voice quality. After the study this information will provide useful additional information when looking at the strengths and weaknesses of the project. Knowing more about peoples' voices and technology usage will help us understand why the application might be useful. We hope that you will find our application useful.

APPENDIX B

B.1 Studies 1a and 1b - Implicit Theory Measure of Ability with Computer**Programming Languages**

-You are born with a fixed amount of ability for things like software development:

Strongly Disagree _____ Strongly Agree

-Good performance in a programming task is a way of showing others your ability:

Strongly Disagree _____ Strongly Agree

-You have a certain amount of programming ability and you cannot do much to change it:

Strongly Disagree _____ Strongly Agree

-If you fail in a software development task, you question your programming ability:

Strongly Disagree _____ Strongly Agree

-When you exert a lot of effort, you show that you are not an able developer:

Strongly Disagree _____ Strongly Agree

-Difficulties and challenges prevent you from developing your programming ability:

Strongly Disagree _____ Strongly Agree

-Good preparation before performing a software development task is a way to develop your programming ability:

Strongly Disagree _____ Strongly Agree

-Performing a programming task successfully can help develop your ability:

Strongly Disagree _____ Strongly Agree

-You can develop your programming ability if you really try:

Strongly Disagree _____ Strongly Agree

-When you learn new things, your basic software development ability improves:

Strongly Disagree _____ Strongly Agree

-The effort you exert improves your programming ability:

Strongly Disagree _____ Strongly Agree

-If you fail in a task, you still trust your programming ability:

Strongly Disagree _____ Strongly Agree

B.2 Studies 2a, 2b and 3 – Implicit Theory Measure of Ability with Technology

Your beliefs about ability and new technology and devices

-You are born with a fixed amount of technical ability:

Strongly Disagree Strongly Agree

-Good preparation before performing a task using a new device is a way to develop your ability with technology:

Strongly Disagree Strongly Agree

-Good performance using a device is a way of showing others that you are good with technology:

Strongly Disagree

Strongly Agree

-Performing a task successfully can help develop your technical ability:

Strongly Disagree

Strongly Agree

-You have a certain amount of ability with new technology and you cannot do much to change it:

Strongly Disagree

Strongly Agree

-You can develop your ability with new technology if you really try:

Strongly Disagree

Strongly Agree

-If you fail to use a new device properly, you question your technical ability:

Strongly Disagree

Strongly Agree

-When you learn new technical skills, your basic technology ability improves:

Strongly Disagree

Strongly Agree

-When you exert a lot of effort, you show that you are not technically minded:

Strongly Disagree

Strongly Agree

-The effort you exert improves your ability with new technologies:

Strongly Disagree

Strongly Agree

-Difficulties and challenges prevent you from developing your ability with new technology:

Strongly Disagree

Strongly Agree

-If you fail in a task, you still trust your technical ability:

Strongly Disagree

Strongly Agree

B.3 Studies 2b – Implicit Theory Measure of Vocal Change Ability

Your beliefs about speech and voice quality

Due to the nature of Parkinson's, it is possible that some aspects of your speech may change or worsen over time. For the following sentences please *do not* consider

possible speech effects due to Parkinson's, or any related fears or concerns you might have. Instead, please consider only how your own actions, thoughts, or efforts can or cannot change your speech.

-I believe that the voice you have is your own; it cannot intentionally be changed much?

Strongly
Disagree

Strongly
Agree

-I believe that you have certain vocal characteristics; there is not much that can be done to change them?

Strongly
Disagree

Strongly
Agree

-I believe that no matter what kind of vocal capacity you currently have, you always can actively change it very much?

Strongly
Disagree

Strongly
Agree

- I believe that you cannot really control your vocal capacity. As much as I hate to admit it, you cannot teach an old dog a new trick?

Strongly
Disagree

Strongly
Agree

-I believe that you have the power to always greatly change the kind of voice you have, though it takes a lot of hard work?

Strongly
Disagree

Strongly
Agree

-I believe that you can try to speak differently, but the important characteristics of your voice cannot really be changed?

Strongly
Disagree

Strongly
Agree

-I believe that you, no matter what your vocal characteristics, can intentionally change your voice quite a bit?

Strongly
Disagree

Strongly
Agree

-I believe that you can purposely change the way you speak, if you put great effort into it?

Strongly
Disagree

Strongly
Agree

APPENDIX C

C.1 Java Programming Task – Study 1a

Programming Tasks

You have 10 minutes to work on 13 programming tasks.

The programming tasks use the Java programming language. Do not worry if you have never done Java before, there are brief instructions beside each task. There is only one line of the program that needs to be edited – this line has been highlighted in yellow below, and the experimenter will highlight it for you on the program.

- If you lose track of the line that needs to be edited, ask the experimenter.

```
import java.awt.Container;
import javax.swing.*;

public class study1 {
    public static void main( String args[] )
    {
        int one, two, four, five, six, result;
        one = 1;
        two = 2;
        four = 4;
        five = 5;
        six = 6;
        String output;
        output = " ";

        //EDIT THE LINE BELOW!!!
        output += EDIT THIS AREA;
        //EDIT THE LINE ABOVE!!!

        JTextArea outputArea = new JTextArea( 7, 10 );
        outputArea.setText(output);
        JOptionPane.showMessageDialog(
            null, outputArea, "Results",
            JOptionPane.PLAIN_MESSAGE );
    }
}
```



```
        System.exit( 0 );  
    }  
}
```

You have 10 minutes to work on 13 programming tasks.

The file needs to be saved each time before you compile it, and it is compiled in the command prompt window. The file name does not need to change.

- Save the file by clicking 'file' -> 'save' or by pressing 'alt' -> 'f' -> 's'
- Save the file every time you change it (before compiling)
- Compile the file in the command prompt window
- To compile type: "javac study.java"
- To test after compiling type: "java study"

If there is anything you do not understand, or if you have any questions, please ask now.

When you are ready to start your 10 minutes, turn the page over.

No.	Target Output	Instructions
1	2	Type in the number as 'two'. Line should look like: output += two;
2	*	Use quotations around text ("xxxx"). Line should look like: output += "*";
3	2 ²	Calculate powers using multiplication. Multiply using '*' (outside of quotation marks). Line should look like: output += two * two;
4	* *	Use '\t' to create a tab space (hint: inside of quotation marks).
5	4/2	Divide using '/' (hint: outside of quotation marks).
6	4 ³	Type in the number as 'four'.
7	* * *	Use '\n' to move to a new line (hint: inside of quotation marks).

Turn page over

8	* 5 *	Type in the number as 'five' (hint: outside of quotation marks).
9	$4^2/2^3$	Use brackets '(' and ')' to make sure the calculation comes out right.
10	5^5	
11	* * * * * * * * *	
12	* * 4 * *	
13	6^2 * *	Type in the number as 'six'.

C.2 Java Programming Task – Study 1b

Programming Tasks

You have up-to 15 minutes to work on 25 JAVA programming tasks in two JAVA program files. You may attempt them in any order – be please advise the experimenter of which task number you are attempting.

You do not need to have done JAVA before. There is only one line of the program that needs to be edited, appearing below the text “//EDIT THE LINE BELOW!!!” and above the text “//EDIT THE LINE ABOVE!!!” in each program.

- If you lose track of the line that needs to be edited, ask the experimenter.

The files need to be saved each time before you compile it, and it is compiled in the command prompt window. The file names do not need to change.

- Save the file by clicking ‘file’ -> ‘save’ or by pressing ‘alt’ -> ‘f’ -> ‘s’
- Save the file every time you change it (before compiling)
- Compile the file in the command prompt window
- To compile type: “javac study2a.java” or “javac study2b.java”
- To test after compiling type: “java study2a” or “java study2b”
- Attempt the tasks in any order

If there is anything you do not understand, or if you have any questions, please ask now.

When you are ready to start the experimenter will go through the first example task with you.

Editing study2a.java

No.	Task	Instructions / sample code
E.g.	Print on screen: 2	<code>output += 2;</code>
1	Print on screen: 300	
2	Print on screen: *	<code>output += "*";</code>
3	Print on screen: A	
4	Print on screen: A sentence.	
5	Calculate: (2 + 2)	<code>output += 2 + 2;</code> -Add and subtract using + and -
6	Calculate: (387 - 124)	
7	Calculate: (2 ²)	<code>output += 2 * 2;</code> -Multiply and divide using * and /
8	Calculate: (4/2)	
9	Calculate: (4 ³)	
10	Calculate: (5 ⁵)	
11	Calculate: (4 ² /2 ³)	Use brackets (and) to make sure the calculation comes out right.
12	Calculate: ((26 + 24)/ 5 ²)	
13	Calculate: ((4 + 4) ³ / 2 ²)	
14	Print on screen: * *	<code>output += "*" \t *";</code>
15	Print on screen: A A A	
16	Print on screen: *	<code>output += "*" \n *";</code>

	*	
17	Print on screen: * * *	
18	Print on screen: * * * * * * * * *	
19	Print \ calculate: AAA(2*3)AAA	output += "AAA" + 2 * 3 + "AAA";
20	Print \ calculate: * (5 ²) *	
21	Print \ calculate: * * (4/2) * *	
22	Print \ calculate: (6 ²) * *	

Editing study2b.java

23	Draw: An arc positioned at point (15,35), with width and height 80, starting at an angle of 45° and turning through 180°	g.drawArc(15, 35, 80, 80, 45, 180);
24	Draw: The same arc with width and height of 130	
25	Draw: A complete oval (360°) with width 200 and height 100	

APPENDIX D

**D.1 Studies 2a, 2b and 3 – Counterbalancing of Implicit Theory Measure of Ability
with Technology**

		Ps											
		1	2	3	4	5	6	7	8	9	10	11	12
position	1	E1	I1	E6	I2	E5	I3	E4	I4	E3	I5	E2	I6
	2	E2	I2	E1	I3	E6	I4	E5	I5	E4	I6	E3	I1
	3	I1	E1	I2	E6	I3	E5	I4	E4	I5	E3	I6	E2
	4	E3	I3	E2	I4	E1	I5	E6	I6	E5	I1	E4	I2
	5	I2	E2	I3	E1	I4	E6	I5	E5	I6	E4	I1	E3
	6	E4	I4	E3	I5	E2	I6	E1	I1	E6	I2	E5	I3
	7	I3	E3	I4	E2	I5	E1	I6	E6	I1	E5	I2	E4
	8	E5	I5	E4	I6	E3	I1	E2	I2	E1	I3	E6	I4
	9	I4	E4	I5	E3	I6	E2	I1	E1	I2	E6	I3	E5
	10	E6	I6	E5	I1	E4	I2	E3	I3	E2	I4	E1	I5
	11	I5	E5	I6	E4	I1	E3	I2	E2	I3	E1	I4	E6
	12	I6	E6	I1	E5	I2	E4	I3	E3	I4	E2	I5	E1

**D.2 Study 2b – Counterbalancing of Implicit Theory of Measure of Vocal Change
Ability**

		Ps											
		1	2	3	4	5	6	7	8	9	10	11	12
position	1	E1	I1	E4	I2	E3	I3	E2	I4	I2	E2	I3	E1
	2	E2	I2	E1	I3	E4	I4	E3	I1	I1	E1	I2	E4
	3	I1	E1	I2	E4	I3	E3	I4	E2	E2	I2	E1	I3
	4	E3	I3	E2	I4	E1	I1	E4	I2	I4	E4	I1	E3
	5	I2	E2	I3	E1	I4	E4	I1	E3	E1	I1	E4	I2
	6	E4	I4	E3	I1	E2	I2	E1	I3	I3	E3	I4	E2
	7	I3	E3	I4	E2	I1	E1	I2	E4	E4	I4	E3	I1
	8	I4	E4	I1	E3	I2	E2	I3	E1	E3	I3	E2	I4

APPENDIX E

E.1 Study 2a - Smartphone Application Testing Procedure

Application tasks – How Loud am I

Important note before starting: The application is interested in how loud you are talking, it does not record what you are saying. The researchers will attempt to write down any comments or feedback you have about the application, but we are not using the ipod as a recording device to capture this information.

Also, where we ask for the ipod to be held at a comfortable distance, there is no ‘correct’ way to hold the ipod, the main thing is that you yourself are comfortable, that you can see the screen, and are in a position to touch the screen with your hand. Most people hold it in their weaker hand and use their stronger hand to interact with and touch the screen.

For the following tasks try to hold the ipod device a comfortable distance away from you, one that you can maintain easily.

- How loud are you speaking?
 - o Using the visual feedback to see how loud you are, speak as loud as you can for up to 30 seconds about where you are from
 - o Press the next button
 - o Read your maximum and average decibel (dB) levels from the feedback screen
 - o Reopen “How Loud am I”
 - o Use the visual feedback, and see how loud you can make a long vowel sound e.g. “ahhhh”, aim for up to 5 seconds
 - o Press the next button
 - o Read your maximum and average dB levels from the feedback screen
- Get information about decibels and loudness
 - o Found within “How Loud am I”

One of the experimenters will now set a goal bar onto the “How Loud am I” screen [to be set to the average dB level obtained when making a vowel sound].

- Speak louder than the goal bar
 - o Reopen “How Loud am I”
 - o Using the visual feedback to see how loud you are, speak as loud as you can for up to 30 seconds about the medications you take
 - o Press the next button

- o Read your maximum and average dB levels from the feedback screen
- o Reopen “How Loud am I”
- o Use the visual feedback, and see how loud you can make a long vowel sound e.g. “ahhhh”, aim for up to 5 seconds
- o Press the next button
- o Read your maximum and average dB levels from the feedback screen

For the following task one of the experimenters will hold the ipod 30 centimetres (12 inches / one foot) away from you.

- Measuring how loud you are
 - o When the experimenter indicates to start, again see how loud you can make a long vowel sound e.g. “ahhhh”
 - o Try to maintain the sound for 5 seconds, the experimenter will indicate when this time has elapsed

-Do you have any feedback on the “How Loud am I” part of the application?

-Is there anything you particularly liked about the application?

-Is there anything you particularly disliked about the application?

-Are there any places or circumstances you could see yourself using the “How Loud am I” application? (e.g. at home, before meeting someone, while on a tube journey, before talking on the phone, during talking on the phone, any others?)

-Do you think it is useful?

-Did you find it easy to use?

-What do you think the “How Loud am I” application should ideally be doing?

-Is there anything missing, or anything that could be improved?

Application tasks – Training

Important note before starting: As before, the training section of the application is not interested in the words you say, only in your volume when you are speaking. What you are saying will not be recorded by the application, but the experimenters will try to write down any comments or feedback that you have.

Also, the application contains texts for you to read and also images for you to describe while using training. There is no fixed amount of time that you need to spend

reading the texts or describing the texts, so please feel free to press the stop button at any point.

If you feel you have made a mistake, or for any other reason, would like to restart reading or describing a piece of material, please feel free to take a few moments and just leave the material on the screen, you can restart when you feel like it.

If you feel you have made a mistake, or for any other reason, would like to stop and skip to the next piece of material, please feel free to press the stop button and carry on forward through the application.

For the following tasks try to hold the ipod device a comfortable distance away from you, one that you can maintain easily.

- Working to improve speech volume
 - o Read the task description and the aim
 - o Press 'next' when you want to begin
 - o Read your average dB level from the feedback screen; was it above or below the goal? What will the goal be next time?

- o Press 'next' when you are ready to proceed
- o Complete three more pieces of training material
- o For each read your average dB level from the feedback screen; was it above or below the goal? What will the goal be next time?

- o Exit back to the home page (the start page of the application)

-Do you have any feedback on the "Training" part of the application?

-Is there anything you particularly liked about the application?

-Is there anything you particularly disliked about the application?

-Are there any places or circumstances you could see yourself using the "Training" application? (e.g. at home, before meeting someone, while on a tube journey, before talking on the phone, during talking on the phone, any others?)

-Do you think it is useful?

-Did you find it easy to use?

-What do you think the "Training" application should ideally be doing?

-Is there anything missing, or anything that could be improved?

-What did you think of the content (the text pieces and images) used in “Training”?

-Were the pieces of text too short / too long / the right length?

-Were you comfortable scrolling to read further down on a piece of text

-Is there any other content you would like to see? (e.g. landscape paintings, art pieces by famous artists, science articles, sport articles, politics articles, pieces of poetry, facts about London, parts of stories) [For each try to capture what aspects of each area are they interested in]

E.2 Study 2b - Smartphone Application Testing Procedure

Variations to Study 2a Highlighted

Application tasks – How Loud am I

Important note before starting: The application is interested in how loud you are talking, it does not record what you are saying. The researchers will attempt to write down any comments or feedback you have about the application, but we are not using the ipod as a recording device to capture this information.

Also, where we ask for the ipod to be held at a comfortable distance, there is no ‘correct’ way to hold the ipod, the main thing is that you yourself are comfortable, that you can see the screen, and are in a position to touch the screen with your hand. Most people hold it in their weaker hand and use their stronger hand to interact with and touch the screen.

For the following tasks try to hold the ipod device a comfortable distance away from you, one that you can maintain easily.

- How loud are you speaking?
 - Using the visual feedback to see how loud you are, speak as loud as you can for up to 30 seconds about where you are from
 - Press the next button
 - Read your maximum and average decibel (dB) levels from the feedback screen
 - Reopen “How Loud am I”
 - Use the visual feedback, and see how loud you can make a long vowel sound e.g. “ahhhh”, aim for up to 5 seconds
 - Press the next button
 - Read your maximum and average dB levels from the feedback screen
- ~~— Get information about decibels and loudness~~
 - ~~○ Found within “How Loud am I”~~

One of the experimenters will now set a goal bar onto the “How Loud am I” screen [to be set to the average dB level obtained when making a vowel sound].

- Speak louder than the goal bar
 - Reopen “How Loud am I”
 - Using the visual feedback to see how loud you are, speak as loud as you can for up to 30 seconds about the medications you take
 - Press the next button
 - Read your maximum and average dB levels from the feedback screen

- Reopen “How Loud am I”
- Use the visual feedback, and see how loud you can make a long vowel sound e.g. “ahhhh”, aim for up to 5 seconds
- Press the next button
- Read your maximum and average dB levels from the feedback screen

For the following task one of the experimenters will hold the ipod 30 centimetres (12 inches / one foot) away from you.

- Measuring how loud you are
 - When the experimenter indicates to start, again see how loud you can make a long vowel sound e.g. “ahhhh”
 - Try to maintain the sound for 5 seconds, the experimenter will indicate when this time has elapsed

-Do you have any feedback on the “How Loud am I” part of the application?

-Is there anything you particularly liked about the application?

-Is there anything you particularly disliked about the application?

-Are there any places or circumstances you could see yourself using the “How Loud am I” application? (e.g. at home, before meeting someone, while on a tube journey, before talking on the phone, during talking on the phone, any others?)

~~-Do you think it is useful?~~ **How useful do you think it is?**

~~-Did you find it easy to use?~~ **How easy did you find it to use?**

-What do you think the “How Loud am I” application should ideally be doing?

-Is there anything missing, or anything that could be improved?

Application tasks – Training

Important note before starting: As before, the training section of the application is not interested in the words you say, only in your volume when you are speaking. What you are saying will not be recorded by the application, but the experimenters will try to write down any comments or feedback that you have.

Also, the application contains texts for you to read and also images for you to describe while using training. There is no fixed amount of time that you need to spend

reading the texts or describing the texts, so please feel free to press the stop button at any point.

If you feel you have made a mistake, or for any other reason, would like to restart reading or describing a piece of material, please feel free to take a few moments and just leave the material on the screen, you can restart when you feel like it.

If you feel you have made a mistake, or for any other reason, would like to stop and skip to the next piece of material, please feel free to press the stop button and carry on forward through the application.

For the following tasks try to hold the ipod device a comfortable distance away from you, one that you can maintain easily.

- Working to improve speech volume
 - Read the task description and the aim
 - ~~Press 'next' when you want to begin~~
 - **Press 'start' when you want to begin**
 - Perform the task then 'stop' and 'results'
 - Read your average dB level from the feedback screen; was it above or below the goal? What will the goal be next time?
 - Press 'next' when you are ready to proceed
 - Complete three more pieces of training material
 - For each read your average dB level from the feedback screen; was it above or below the goal? What will the goal be next time?
 - Exit back to the home page (the start page of the application)

-Do you have any feedback on the "Training" part of the application?

-Is there anything you particularly liked about the application?

-Is there anything you particularly disliked about the application?

-Are there any places or circumstances you could see yourself using the "Training" application? (e.g. at home, before meeting someone, while on a tube journey, before talking on the phone, during talking on the phone, any others?)

~~-Do you think it is useful?~~ **How useful did you find it?**

~~-Did you find it easy to use?~~ **How ease to use did you find it?**

-What do you think the "Training" application should ideally be doing?

-Is there anything missing, or anything that could be improved?

-What did you think of the content (the text pieces and images) used in "Training"?

-Were the pieces of text too short / too long / the right length?

~~-Were you comfortable scrolling to read further down on a piece of text~~ Were you comfortable pressing the 'next' and 'back' buttons to read further through a piece of text?

-Is there any other content you would like to see? (e.g. landscape paintings, art pieces by famous artists, science articles, sport articles, politics articles, pieces of poetry, facts about London, parts of stories) [For each try to capture what aspects of each area are they interested in]

-Would you like to spend some more time now going through a few more training items at your own pace?

APPENDIX F

F.1 Study 2a - Letter to Participants

Stage 1 letter of invitation to participants - Version 2

Information about the research:

Developing a mobile phone software application that encourages louder speech in
Parkinson's patients



University of
Portsmouth



King's College
Hospital

Dear patient,

We would like to invite you to take part in our research study taking place at King's College Hospital, being conducted by the University of Portsmouth. The study is scheduled to take place on Monday October 3rd, and Tuesday October 4th. Before you decide we would like you to understand why the research is being done and what it would involve for you. Please read the following information sheet carefully and discuss it with others if you wish. If you have any questions after reading this information sheet please contact us using the contact details attached. It might be useful for you to know that the NHS Research Ethics Committee has approved this research project.

Stage 1 research participant information sheet - Version 2

Part 1

About the study:

Speech may be affected in people with Parkinson's. In particular the voice can become very quiet. Speech Therapy can be helpful, but it is important to keep practising regularly. It can also be difficult for people to judge how loud their voice is when speaking. We have developed a software application to run on mobile devices such as an Apple iPhone which aims to encourage louder speech in people with Parkinson's by providing visual feedback.

Purposes of the Study:

We want volunteers to spend some time using the program and give us feedback. We will then use this information to help us improve the program so it will be useful and easy to use. Another purpose of the study is to look at motivation in older adults to use new technology devices such as the Apple iPhone.

Why have I been invited?

You have been invited to participate in this study as a person with Parkinson's who has received a referral to a speech and language therapist. Being invited to participate is no indication as to whether you are suffering from speech impairment or not.

Do I have to take part?

No, taking part is entirely voluntary. If you would prefer not to participate you do not have to explain why, and it will not affect your treatment. If you do decide to participate, you may withdraw at any time without your treatment being affected in anyway whatsoever.

What will happen if I take part?

Stage 1 research participant information sheet - Version 2

Participation in this study will require a one-off attendance to meet the researcher, at King's College Hospital. The study will last approximately 50 minutes, and you would be the only participant during that time. You will be randomly allocated to take part in one of two study conditions. Both conditions will involve the exact same software application. More details about the conditions will be given at the end of the study. There will be several parts to the study. In the first part of the study you will be given information to read about research findings that look at technology usage in older

adults followed by one multiple choice question to confirm your understanding. Next you will be given two questionnaires to complete: one related to your current ability and usage of technology; then one related to your beliefs about your ability to use new technology. In the next part of the study you will be given an introduction to the mobile phone application that is being developed. You will then be invited to use the application yourself. We will monitor you using it, looking to see whether you find it difficult or easy to use, whether there are any problems with what has been developed so far, and ways that we can improve the application. Within reason we will try not to put a time-limit on this part of the study, we want to give you as much (or as little) time to use the application as you wish. When you are finished using the application, for the last part of the study we will ask you some open questions about your experience using the application on the mobile phone device. Finally we will debrief you fully about the purpose of the study and what we are hoping to achieve at the end.

Expenses and payment:

We will make £10 available to all participants to cover travel expenses. You will have to sign to receive the £10, but you will not have to provide any receipts or proof of travel.

What will I have to do if I participate?

Stage 1 research participant information sheet - Version 2

You can take this information sheet with you and discuss its contents with others if you wish. All you need to do then is contact the chief investigator, Peter Nolan, at the following number: **07970 109 412** or email: **peter.nolan@port.ac.uk** or by post: **Peter Nolan, Department of Creative Technologies, University of Portsmouth, Churchill Avenue, PO1 2DJ** to make an appointment. When you attend, we will ask you to sign a consent form before we proceed with the study.

What are the possible risks and disadvantages of taking part?

We do not anticipate any risks or disadvantages as a result of taking part.

What are the possible benefits of taking part?

We hope that by taking part you will become more aware of your speech loudness and the effect it has on your communication. Your contribution will help us to develop the assistive speech application, and learn how to optimise its function for future users.

Is there an independent contact where I can seek advice about taking part in research?

The King's College Hospital Patient Advisory Liaison Service (PALS): Ground Floor, Hambleton Wing Central. The service is available 09:00 - 17:00 Monday to Friday TEL 020 3299 3601.

'Parkinsons UK' the main UK support organisation for people with Parkinson's Helpline:
0808 800 0303

What if there is a problem?

Any complaint about the way you have been dealt with during the study or any possible harm you might suffer will be addressed. The detailed information on this is given in Part 2.

Will my taking part in the study be kept confidential?

Stage 1 research participant information sheet - Version 2

Yes. We will follow ethical and legal practice and all information about you will be handled in confidence. The details are included in Part 2.

If the information in Part 1 has interested you and you are considering participation, please read the additional information in Part 2 before making any decision.

Stage 1 research participant information sheet - Version 2

Part 2

What will happen if I don't want to carry on with the study?

During the study you can decide you no longer wish to take part at any point. We would destroy any responses or information collected during the study up to that point.

What if there is a problem?

If you have a concern about any aspect of this study, you should ask to speak to the researchers who will do their best to answer your questions (contact details at the end of this information sheet). If you remain unhappy and wish to complain formally, you can do this through the NHS Complaints Procedure. Details can be obtained from the hospital.

In the event that something does go wrong and you are harmed during the research and this is due to someone's negligence then you may have grounds for a legal action for compensation against the University of Portsmouth but you may have to pay your legal costs. The normal National Health Service complaints mechanisms will still be available to you (if appropriate).

Will my taking part in this study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential, and any information about you which leaves the hospital will

have your name and address removed so that you cannot be recognised. Also, if we receive your permission, we may use your comments during the research as direct quotations in our work, but these will be anonymised so that your name does not appear.

Will my GP be informed of my participation?

Stage 1 research participant information sheet - Version 2

Yes, we will send a letter to your GP to inform them of your participation, we will describe the purpose of the study and provide them with a copy of this information sheet.

What will happen to the results of the research study?

The main purpose of the study is to get information and feedback as to how we should proceed with development of the software application. The results will be analysed to see what parts of the application are working and what parts need to change. Also the results will be used to prioritise what should be developed next. The secondary purpose of the study is to look at how this type of technology can best be presented to participants. With the data collected for this purpose we anticipate publishing in scientific journals and presenting them at national and international meetings, but the identity of those who have participated will not be disclosed.

Who is organising and funding the research?

The sponsors of this research are University of Portsmouth. The software application was initially developed using money from a capability fund awarded by the Creative and Cultural Industries Faculty, University of Portsmouth. The research is now being supported by Parkinson's UK, who have awarded us an innovation grant, allowing us to continue development and conduct this research. The research is being organised by the Creative Technologies Department in collaboration with King's College Hospital. This project has also been adopted onto the national research portfolio via King's College Hospital.

Who has reviewed this study?

All research in the NHS is looked at by an independent group of people, called a Research Ethics Committee to protect your safety, rights, wellbeing and dignity. This study has been reviewed and given favourable opinion by South East Coast (Kent) Research Ethics Committee.

Stage 1 research participant information sheet - Version 2

Contact for further information about this research project:

Dr Roger Eglin,
Supervisor to the Chief Investigator,
Principal Lecturer,
Department of Creative Technologies, University of Portsmouth,
Churchill Avenue, PO1 2DJ,
Telephone: 0239 284 6390
Email: roger.eglin@port.ac.uk

If you have a complaint, you could address it to:

The King's College Hospital Patient Advisory Liaison Service (PALS): Ground Floor,
Hambleton Wing Central. The service is available 09:00 - 17:00 Monday to Friday TEL
020 3299 3601.

Thank you very much for giving consideration to participating in this research project.
Please feel free to contact us with any queries.

Yours Sincerely

Mr Peter Nolan

APPENDIX G

G.1 Speech Tool Smartphone Application

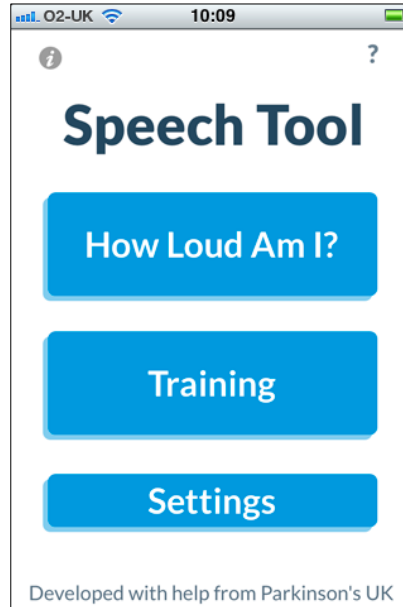


Figure G-0-1: Speech Tool 'Home' screen.

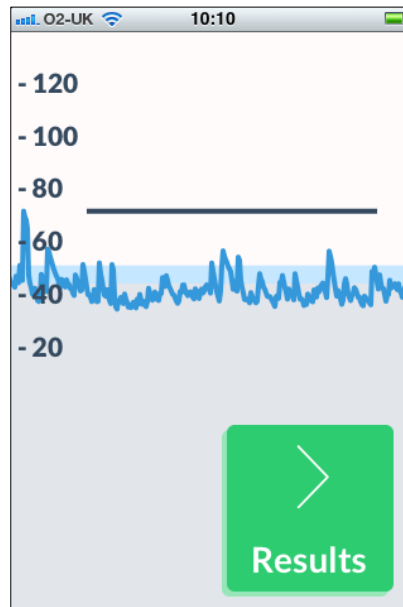


Figure G-0-2: Speech Tool 'How Loud Am I?' component, showing a goal-bar at 70dB. The blue line tracks speech volume over time and a light-blue block which moves up and down during usage, tracking speech volumes being produced to provide visual feedback.

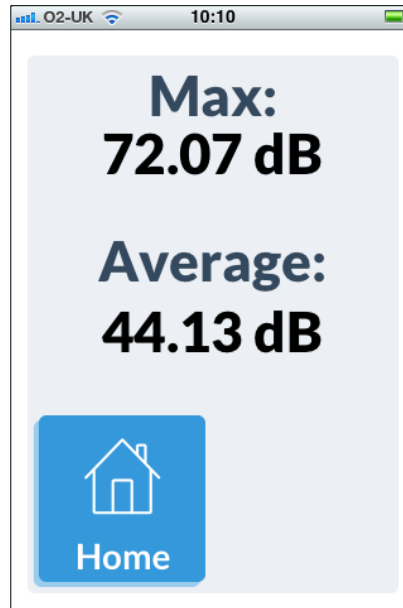


Figure G-0-3: Speech Tool feedback screen of 'How Loud Am I?' component.

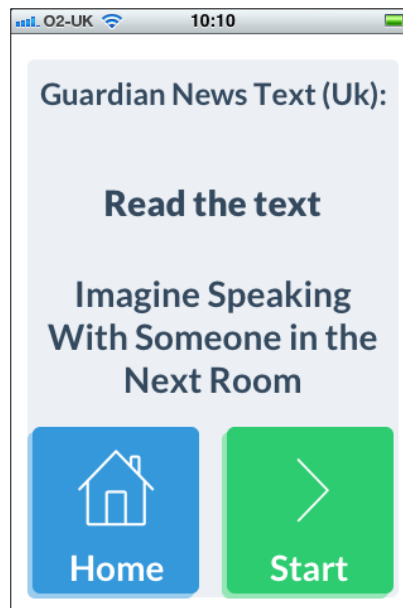


Figure G-0-4: Speech Tool 'Training' component, screen introducing a task.

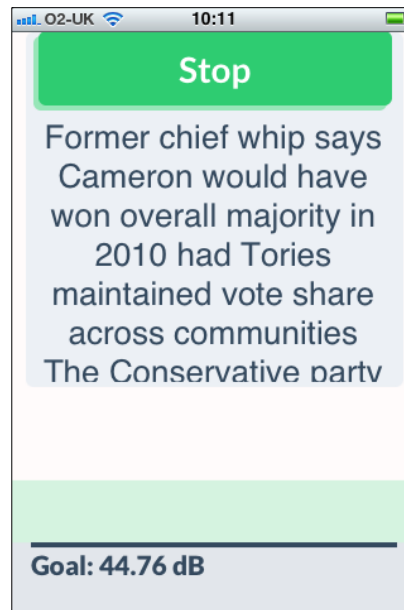


Figure G-0-5: Speech Tool ‘Training’ component, task screen showing text for the user to read at the top, a goal bar showing speech volume to aim for, and a lightly-coloured block above the goal bar which moves up and down during usage, tracking speech volumes being produced to provide visual feedback.

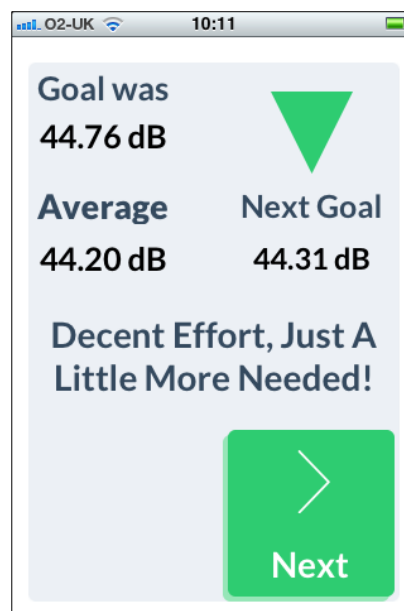


Figure G-0-6: Speech Tool ‘Training’ component, feedback screen following task.

APPENDIX H

H.1 Ethical Attachments