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An ecological examination of proximal psychological mechanisms related to the experience of and therapy for distressing voices

By
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Statement

This thesis conforms to an 'article format' in which the middle chapters consist of discrete articles written in a style that is appropriate for publication in peer-reviewed journals in the field. The first, second, third and final chapters present synthetic overviews and discussions of the field and the research undertaken.

Chapter Four is written in the style of an article appropriate for Psychological Medicine.

The author contributions are as follows: SFS was responsible for all aspects of data collection, data analysis, writing of the manuscript; SFS, MH, KG and EP were collectively responsible for the initial conception of the research; MH, KG, EP and MW were responsible for providing feedback on study design/corrections to the manuscript.

Chapter Five is written in the style of an article appropriate for Psychological Medicine.

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I hereby declare that this thesis has not been and will not be, submitted in whole or in part to another University for the award of any other degree.

Sarah Fielding Smith
3rd January 2017

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An ecological examination of proximal psychological mechanisms related to the experience of and therapy for distressing voices

Summary

Voice hearing (or auditory verbal hallucinations) is a commonly reported experience across a range of psychiatric diagnoses, and is often associated with high levels of distress and disruption to everyday functioning. Many people troubled by voices see little benefit from antipsychotic medication, prompting attempts to understand and target psychological mechanisms underlying both the emergence of voices and associated distress.

Research to date has typically adopted a cross-sectional approach, identifying factors associated with the tendency to hear distressing voices. However, less is known about the 'proximal' mechanisms associated with fluctuations in voices and distress during the daily lives of voice hearers. Psychological therapies for distressing voices have demonstrated limited success in reducing voice-related distress, and it is suggested that a better understanding of the proximal mechanisms underlying voices may facilitate advancements in these interventions.

The studies within this thesis utilise the Experience Sampling Method (ESM), an ecological momentary assessment (EMA) approach that allows the intensive, 'micro-longitudinal' sampling of voice hearing experiences in the natural contexts in which they are experienced. First, ESM is used to investigate the antecedent and modulating roles of stress and dissociative experiences in voice hearing (*N*=31). Next, the role of behavioural responses and voice appraisals in the maintenance of voice-related distress during daily life are explored (*N*=31). Then, a data-based illustration of the potential of ESM for delineating key psychological mechanisms underlying gains in psychological interventions for distressing voices is provided (*N*=2). Finally, factors associated with stress-induced depersonalisation as a proximal mechanism for voice hearing are explored (*N*=29).

Current findings support the role of depersonalisation as a mediator in the observed relationship between daily life stress and increases in voice intensity. Findings additionally support a role for negative voice appraisals in the experience of momentary voice distress, and a role of behavioural responses in maintaining both distress and voice appraisals over time. Preliminary evidence was obtained for a range of processes involving changes in voice appraisals and emotional reactivity potentially underlying therapeutic gains during cognitive behavioural therapy for psychosis.

These findings encourage a greater focus of interventions on targeting mechanisms associated with daily life voice hearing and associated distress, including stress-induced depersonalisation, negative voice appraisals, and maladaptive behavioural responses to voices. They also suggest a parallel use for ESM as a means of enhancing treatment efficacy within the context of psychological interventions.

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1 Chapter One: Introduction

1.1 Chapter Overview

The experience of hearing a voice or voices that other people do not hear has been construed in various ways throughout history and across cultures: divine messages from the angels, Gods or spirits; a call from the ancestors; possession by demons; a sign of madness (McCarthy-Jones, 2012). Within the modern scientific community, the term 'auditory verbal hallucinations' is favoured when referring to these experiences; however, this term is considered pejorative by many people with lived-experience of hearing voices, and as such, the more neutral terms 'voice hearing' and 'hearing voices' are preferred (Longden, Madill, & Waterman, 2012).

A clear consensus regarding the definition of voice hearing experiences has yet to be achieved, largely due to the sheer heterogeneity of these experiences (Aleman & Larøi, 2008a; McCarthy-Jones, 2012), which can range from hearing a clear voice originating from the external world when there is none there, through to inaudible, soundless voices located within one's own head, and experiences that are more 'thought-like' than voice-like (Moritz & Larøi, 2008; Woods, Jones, Alderson-Day, Callard, & Fernyhough, 2015). However, for present purposes, voice hearing will be defined according to the following parameters: (a) a percept-like experience in the absence of appropriate stimulus, which manifests as (b) a human vocalization, which is experienced in (c) a conscious state and is (d) not induced by organic or state-dependent circumstances (Bentall, 1990; Longden, Madill, et al., 2012; Slade & Bentall, 1988).

The present chapter aims to introduce the reader to the research and theories that form the backbone to the empirical papers presented within this thesis, the central aim of which is to build on understandings of the psychological mechanisms related to; i) the fluctuation and maintenance of voices and associated distress during daily life, and ii) 'real-world' experiential changes occurring over the course of psychological interventions for distressing voices. This thesis comprises three empirical chapters, united in their use of a common methodological approach, known as the Experience Sampling Method (ESM). ESM allows for the assessment of voice hearing experiences in the contexts in which they arise naturally during daily life, via means of repeated self-report.

The first empirical paper explores the roles of stress and dissociation in momentary fluctuations in voice hearing during daily life, requiring an introduction to models that

attempt to explain the emergence of voice hearing experiences. The second empirical chapter tests some of the predictions of cognitive behavioural models of voices, by exploring the role of behavioural responses to voices, such as resistance or compliance with voice commands, in the moment-to-moment maintenance of voice distress and appraisals of the power and controllability of voices. The third and final empirical chapter delineates the psychological mechanisms underlying treatment gains over the course of psychological interventions for distressing voices, through a data-based illustration using ESM.

Following an initial orientation to the research considering the prevalence and phenomenology of voice hearing, these literatures will each be introduced and discussed in turn, with reference to the key questions to be addressed via the use of ESM. In the final section, the aims and predictions of each empirical study will be summarised.

1.2 Prevalence of Voice Hearing

Hearing voices tends to be regarded as rare and extraordinary, belonging to the realms of pathology (Beavan & Read, 2010). However, general population studies challenge the view that voices are necessarily a symptom of severe mental illness, suggesting instead that they may be a relatively common experience. Whilst prevalence rates vary greatly according to definition and measurement tool, a recent review of general population studies reported an estimated lifetime prevalence rate of between 2-4%, for those studies employing strict definitions of voice hearing (Beavan, Read, & Cartwright, 2011). It has however been suggested that this is likely to be a conservative estimate, given the probability of under-reporting of phenomena to which a great deal of stigma is associated (Beavan & Read, 2010; McCarthy-Jones, 2012). Indeed, across all studies reviewed, Beavan, Read, & Cartwright (2011) reported a median prevalence rate of 13.2%.

It has been observed that individuals who hear voices vary widely in their need for clinical support or treatment, and as such, a distinction is often made within the literature between voice hearers with and without a ‘need for care’ (Baumeister, Sedgwick, Howes, & Peters, 2017; Johns et al., 2014). Prevalence estimates in individuals with a need for care indicate that voice hearing is a ‘trans-diagnostic’ experience, being reported relatively commonly by individuals who receive diagnoses including dissociative identity disorder (DID; c.90%); schizophrenia and related psychotic disorders (c.70%); post-traumatic stress disorder (PTSD; c.50%); borderline personality disorder (BPD; c.32%); bipolar disorder (BD; c.30%); and major depressive disorder (MDD; c.10%) (McCarthy-Jones, 2012).

Of course, these prevalence rates at least partly reflect the degree to which voice hearing is considered central within the diagnostic criteria for each particular disorder. For example, whilst voice hearing is now considered a core feature of schizophrenia, this was not the case prior to the publication of the DSM-III and the influence from Schneiderian psychopathology (Berrios, 1996). In contemporary psychiatric classifications, voice hearing is listed as a potential diagnostic feature in over 50 conditions, including many not counted as primary psychotic syndromes (e.g., PTSD, DID, MDD, BPD, etc.; American Psychiatric Association, 2013).

1.3 Phenomenology of Voice Hearing

1.3.1 The 'typical' experience of voice hearers with a need for care

Based on findings from a series of studies employing quantitative and mixed-methods approaches (Garrett & Silva, 2003; Hoffman, Varanko, Gilmore, & Mishara, 2008; Leudar, Thomas, McNally, & Glinski, 1997; McCarthy-Jones et al., 2012; Moritz & Larøi, 2008; Nayani & David, 1996; Woods et al., 2015), McCarthy-Jones and Resnick (2014) proposed that a 'typical' voice-hearing experience could be discerned amongst voice hearers with a 'need for care'.

Within this description, voice-hearers with a psychiatric diagnosis typically report hearing more than one voice (Daalman et al., 2011; McCarthy-Jones et al., 2012; Nayani & David, 1996; Woods et al., 2015), which may be heard via the ears and/or inside the head (Daalman et al., 2011; Woods et al., 2015), and may sound much like hearing other people speak (Garrett & Silva, 2003; Leudar et al., 1997), or possess more 'thought-like' qualities, whist still being clearly distinguishable from the hearers 'own' thoughts or inner speech (Woods et al., 2015). Voices will typically be heard several times a day or most of the time, with the length of each instance being highly variable (McCarthy-Jones et al., 2012; Nayani & David, 1996).

The experience of hearing voices is often highly interpersonal. Typically, voices are described as being characterful in some way, i.e., people or person-like entities with distinct characteristics or identities, such as gender, age, emotional responses, or intentions (Bell, 2013; McCarthy-Jones et al., 2012; Nayani & David, 1996; Woods et al., 2015). Furthermore, whilst usually being repetitive in terms of their 'general' theme (Hoffman et al., 2008; McCarthy-Jones et al., 2012), voices will often engage directly with the voice-hearer using second- or third-person forms of address (McCarthy-Jones et al., 2012) and comment on specific aspects of the hearer's ongoing experience (Woods et al., 2015). For example, voices may direct highly critical or abusive comments

towards the hearer (McCarthy-Jones et al., 2012; Nayani & David, 1996; Woods et al., 2015), and may also attempt to influence the voice-hearer's activity by issuing commands to perform specific actions (McCarthy-Jones et al., 2012; Nayani & David, 1996). In turn, some hearers are able to talk interactively with their voices, attempting to argue with or appease the voices, or asking questions and getting answers back (Garrett & Silva, 2003; Leudar et al., 1997).

Although some voices may evoke positive emotions, hearers with a need for care will typically experience moderate to severe distress in relation to their voices (Daalman et al., 2011), including high levels of fear, anxiety, depression and/or anger (Woods et al., 2015). Voices will often cause significant disturbance to daily functioning (Daalman et al., 2011; Romme & Escher, 2000), including direct effects such as voices interrupting conversation with others, and general negative effects including experiences of stigma and loneliness (McCarthy-Jones, 2014; Woods et al., 2015). As a result, hearers will usually have developed a range of strategies to cope with their voices (Farhall, Greenwood, & Jackson, 2007). For example, whilst hearers typically report having a limited degree of direct control or influence over their voices (either their content and/or their activity; Moritz & Larøi, 2008; Nayani & David, 1996; Woods et al., 2015), they can sometimes identify contextual factors, such as mood or being alone (Nayani & David, 1996) which impact on the frequency of their voices.

1.3.2 Voices across diagnostic boundaries

The account above describes the typical experience of voice hearers with a need for care, and is derived largely from studies which have primarily investigated the experiences of individuals receiving a diagnosis of schizophrenia. Researchers have explored the degree to which these experiences may differ in voice hearers with other psychiatric diagnoses (Dorahy et al., 2009; Goodwin, Alderson, & Rosenthal, 1971; Honig & Romme, 1998; Kingdon et al., 2010; McCarthy-Jones & Longden, 2015; Nayani & David, 1996; Slotema et al., 2012), and of hearers with no need for care (Baumeister et al., 2017; de Leede-Smith & Barkus, 2013; Johns et al., 2014).

The largest phenomenological differences are found when comparing the experiences of voice hearers with and without a need for care (Peters et al., 2016). Whilst voices are broadly similar in terms of number, loudness, location, personification, gender and identity (Baumeister et al., 2017; de Leede-Smith & Barkus, 2013; Johns et al., 2014), these experiences typically occur less frequently and for shorter duration (on average every 3 days, for 2–3 min; Daalman et al., 2011; Honig & Romme, 1998), are

characterised by more neutral or pleasant content (Daalman et al., 2011; Honig & Romme, 1998; Sommer et al., 2010), with hearers reporting a higher degree of control over the onset and/or intensity of their voices (Daalman et al., 2011; Romme & Escher, 2000), and voices eliciting less distress and interference to functioning (Daalman et al., 2011; Sommer et al., 2010; Woods et al., 2015).

There is less evidence for consistent differences between the experiences of voice hearers with different psychiatric diagnoses. Historically, a distinction has been made between voice hearing experiences that are associated with primary psychotic disorders and those that are of a lesser nature, including those referred to as 'pseudohallucinations' (Merrett, Rossell, & Castle, 2016). This term has been used to describe experiences that have an 'inner' location, and are perceived by the hearer to be a product of their own mind (Gelder, Gath, & Mayou, 1985). Schneider (1959) made the further suggestion that 'schizophrenic' voices can be distinguished from those occurring in the context of other diagnosis by the presence of running commentary and conversing voices. However, the predictive validity and clinical utility of these concepts has largely been debunked (Van Der Zwaard & Polak, 2001), with research demonstrating that neither pseudohallucinations, nor 'Schneidarian' hallucinations, are predictive of diagnosis or clinical characteristics (Copolov, Trauer, & Mackinnon, 2004; Daalman et al., 2011).

Furthermore, recent reviews have indicated broad similarities in the phenomenology of voice hearing arising in the context of schizophrenia and those reported by hearers diagnosed with BPD (Merrett et al., 2016), PTSD (McCarthy-Jones & Longden, 2015), DID (Renard et al., 2016) and BD and MDD (Toh, Thomas, Russell, & Rossell, 2015).

In the case of BPD, individual studies have indicated that voices are similar to those in schizophrenia in their phenomenology (e.g. in distress levels and negative, critical content; Hepworth, Ashcroft, & Kingdon, 2013; Pearse, Dibben, Ziauddeen, Denman, & McKenna, 2014; Slotema et al., 2012) and location (Tschoeke, Steinert, Flammer, & Uhlmann, 2014), but may be perceived as more negative and distressing (Kingdon et al., 2010) whilst causing less disruption to life (Slotema et al., 2012).

Non-comparative studies exploring the phenomenology of voices in PTSD provide evidence that these experiences are similar to those appearing in schizophrenia in terms of negative content, presence of commands, clarity, form of address, frequency, number and controllability (Anketell et al., 2010; Brewin & Patel, 2010; Scott, Nurcombe, Sheridan, & McFarland, 2007). Direct phenomenological comparisons also suggest

similarities, although suggest that internally located, negative and distressing voices may be more common in PTSD , whilst the frequency and duration of voices may be higher in schizophrenia (Jessop, Scott, & Nurcombe, 2008; Scott et al., 2007).

Fewer studies have assessed the phenomenology of voices reported in DID, but two small-scale studies have again suggested striking similarities in the voice experiences of individuals diagnosed with DID and schizophrenia in terms of duration, location, form of address, negativity, controllability, and emotional and functional impact (Dorahy et al., 2009; Honig & Romme, 1998). Some differences were noted by Dorahy et al. (2009), in that patients with a DID diagnosis reported more voices, and more commenting voices.

In the case of BD and MDD, these experiences appear similar to those arising in the context of schizophrenia, with no known qualitative differences reported (Toh et al., 2015). However, individual studies have demonstrated that voices occurring in BD/MDD may be less frequent, less likely to be externally located, less negative and disabling, but also, more intensely distressing in BD/MDD compared to schizophrenia (Kumari et al., 2013; Okulate & Jones, 2003). Voice hearers with BD/MDD may also be less likely to hear voices conversing, and more likely to hear voices in second-person (Kumari et al., 2013; Shinn et al., 2012). Furthermore, a recent 20-year longitudinal study demonstrated that voice hearers with a diagnosis of BD/MDD are less likely than schizophrenia patients to experience chronic hallucinations (Goghari, Harrow, Grossman, & Rosen, 2013).

This research indicates that the phenomenology of voice hearing experiences when compared between individuals with different psychiatric diagnoses such as PTSD, DID, schizophrenia, BD and BPD show many more similarities than differences (Larøi et al., 2012; McCarthy-Jones, 2012); where differences do appear, these are quantitative rather than qualitative.

1.3.3 Within- and between-person variation in voice hearing experiences

Despite attempts to outline the typical properties of voices, McCarthy-Jones (2014) points out that for every typical property of voice hearing experiences, there are many people who experiences voices with alternative properties. Furthermore, individuals will often report a combination of experiences, such as both positive and negative voices, and voices with inner and outer localization (Woods et al., 2015).

The heterogeneity of voice phenomenology has led many authors to propose that distinct voice subtypes may exist, with each having both shared and distinct underlying neurocognitive mechanisms (Garwood, Dodgson, Bruce, & McCarthy-Jones, 2013;

Jones, 2010; Larøi, 2006; McCarthy-Jones, 2012). A recent large-scale phenomenological study demonstrated that the common phenomenological features of voices fall into three 'clusters', defined according to the tendency of these features to co-occur within participants (McCarthy-Jones et al., 2012). The first comprised repetitive "constant commanding and commenting" voices. The second, "replay" voices were characterised by being experienced as identical to previously heard words/conversations. The third, "own thought" voices, did not address the person, spoke in the first person, were similar but not identical to words/conversations that had previously been heard, and were rated as possibly being one's own voice/thoughts. However, the majority of participants in this study experienced multiple voice subtypes, suggesting the presence of shared and related mechanisms between subtypes.

In addition to the demonstrated between and within-person heterogeneity of voice hearing experiences, a growing body of research has additionally highlighted the significant degree of within-person variability in voice phenomenology over time. This can involve longer-term structural transformations in voice phenomenology, beliefs or associated distress (Woods et al., 2015), which has been termed dynamic developmental progression (DDP; Jones, 2010); or moment-to-moment fluctuations occurring during the course of daily life (Peters, Lataster, et al., 2012).

With regard to the development of voice hearing experiences, research within schizophrenia populations has indicated the possibility of a developmental progression from 'pre-hallucinatory' experiences into full-blown voices (Handest, Klimpke, Raballo, & Larøi, 2015; Raballo & Larøi, 2011). These include subtle experiential changes such as thought interference, thought perseveration and pressured thinking. Whilst subclinical 'psychotic-like' experiences are common in the general population, and will typically be transient (Hanssen, Bak, Bijl, Vollebergh, & van Os, 2005), it is suggested that in some individuals they may transition into higher-order phenomena such as audible thoughts, and finally the emergence of commenting voices (Klosterkötter, 1992).

Once voices have emerged, research has suggested that they will typically become more complex over time, with the addition of more voices and extended dialogues (Nayani & David, 1996). Qualitative studies have additionally indicated changes in the lived experience of hearing voices. Whilst this trajectory can be highly variable (Hayward, Awenat, McCarthy-Jones, Paulik, & Berry, 2015), it has been conceptualized as a process of adaptation (Romme & Escher, 1989), whereby hearers may attempt to resist their voices following their initial emergence, before entering a phase of discovery and adjustment that may result in increased acceptance of these experiences over time

(Csipke & Kinderman, 2005; Hayward et al., 2015; Milligan, McCarthy-Jones, Winthrop, & Dudley, 2013).

Alongside this longer-term dynamic developmental progression of voices, research utilizing the Experience Sampling Method (ESM) has suggested that the phenomenological features of voices may also fluctuate during daily life, over periods of hours or days. The Experience Sampling Method (Csikszentmihalyi & Larson, 1987; see Section 1.3.4.2) is a momentary assessment approach that allows the intensive sampling of experiences as they occur during daily life. Typically, this involves repeated delivery of self-report surveys via a smartphone (or, prior to the availability of this technology, a personal digital assistant, or programmed watch in conjunction with paper-based surveys) as individuals go about their daily activities. These questionnaires are designed to assess experiences occurring 'in-the-moment', at the time of each sampling point. As such, ESM allows for the examination of phenomena in the contexts in which they naturally arise (Palmier-Claus et al., 2011).

ESM research has demonstrated that during daily life, voices are on average reported as being of 'moderate' intensity (i.e. loudness), and as slightly below moderate in terms of levels of associated distress and interference (Peters, Lataster, et al., 2012). However, studies using this method have indicated substantial within-person variation around these mean levels, indicating that voice intensity, distress and interference fluctuate significantly during day-to-day life (Delespaul, DeVries, & van Os, 2002; Peters, Lataster, et al., 2012). Furthermore, a more recent ESM study has indicated that changes in voice phenomenology might reflect important changes in clinical state, with mean voice intensity during daily life being higher in voice hearers experiencing a current psychotic episode, compared to those in remission (Oorschot, Lataster, Thewissen, Lardinois, et al., 2012).

Overall, this research suggests that there is great variation in the phenomenology of voice hearing experiences, both between and within individuals. Voice hearing experiences are both multidimensional and dynamic, evolving over the course of development, and fluctuating during daily life.

1.3.4 Implications for research and theories of voice hearing

The research reviewed thus far has indicated striking phenomenological similarities between the 'typical' voice hearing experiences of hearers who receive different psychiatric diagnoses, including schizophrenia, DID, PTSD, BPD, BD and MDD. Furthermore, whilst a typical experience can be discerned amongst hearers with a need

for care, it is clear that there is great diversity in these experiences, both between and within individuals, leading researchers to posit the existence of voice 'subtypes', underpinned by distinctive (in addition to shared) mechanisms. Moreover, research has indicated that voices are not a static experience, evolving over the course of development, and fluctuating significantly during daily life.

As such, theories seeking to explain voice hearing experiences, whether addressing the emergence of voices, or associated distress, must be able to account both for the typical phenomenological features of voices, along with the evidence of significant between- and within-person variation in these experiences.

1.3.4.1 The case for a trans-diagnostic, symptom-oriented research approach

The observed phenomenological similarities between voice hearing experiences across psychiatric diagnoses have led some investigators to suggest the presence of similar underlying cognitive and neural mechanisms (Waters, Allen, et al., 2012), and provided support for the utility of a trans-diagnostic, symptom-oriented research approach in furthering our understanding of the aetiology of voice hearing experiences. The symptom-oriented approach was first promoted by Richard Bentall and colleagues in response to research findings which cast doubt upon the reliability, validity and aetiological specificity of Kraepelinian diagnostic categories, including schizophrenia (Bentall, Jackson, & Pilgrim, 1988). Bentall argued that aetiological research based on these diagnoses was unlikely to produce convincing explanations of severe psychiatric disorders, instead advocating a focus on investigating specific symptoms such as voice hearing. The wide-scale adoption of this approach over the past 30 years has led to a proliferation of studies into the psychological mechanisms underlying voice hearing experiences and associated distress (Bentall, 2014).

However, whilst these studies have made huge contributions to our understanding by focusing specifically on individuals who hear voices, the vast majority continue to be conducted in schizophrenia populations, with studies that include voice hearers with other diagnoses being the exception to the rule. In recent years, researchers have called for more trans-diagnostic research into voice hearing, proposing that such studies may shed further light on the mechanisms that are specific to voices, independently of other symptoms associated with schizophrenia (McCarthy-Jones, 2012; Waters, Allen, et al., 2012).

1.3.4.2 The case for an ecological momentary research approach

Contemporary models of voices (reviewed in the following section) have most often focused on accounting for the typical features of voices, supported by findings from cross-sectional research identifying the factors and processes most closely associated with 'trait' or dispositional levels of voice hearing or voice-related distress. This 'cross-sectional' research approach has again been highly successful, identifying a number of processes that demonstrate specific associations with the tendency to hear voices, and factors that are predictive of the degree of distress associated with these experiences.

However, an assumption that appears to be made by these models is that associations identified in cross-sectional research are reflective of the processes operating on a moment-to-moment basis within the daily lives of patients who hear distressing voices. Yet, it is well established that associations observed at the population level are not necessarily reflective of processes occurring within individuals (Hamaker, 2012).

An oft-cited illustration of this apparent paradox is provided by an Experience Sampling study assessing the association between anxiety and low mood (Reise, Ventura, Nuechterlein, & Kim, 2005). In line with previous research, this study demonstrated a positive cross-sectional relationship between anxiety and low mood, indicating that individuals who are in general more anxious also tend to experience low mood. However, repeated sampling of these emotions within individuals allowed for further analysis of the within-person associations between 'states' of anxiety and low mood over the course of the study. This analysis indicated that within individuals, states of anxiety and low mood were *negatively* correlated, indicating that whilst these emotions do co-occur within an individual, they tend not to co-occur at any one point in time. This within-person relationship was found to be consistent across individuals, suggesting that there may be fundamental differences between these two emotional states, including the processes underlying their momentary activation. These results thus represent a finding that is generalizable across people, but different to that obtained using cross-sectional methods.

This example illustrates the problems inherent in drawing conclusions about within-person processes from cross-sectional findings (Hamaker, 2012). In relation to voice hearing, this suggests that if we wish to understand the psychological processes underlying the onset of voices and fluctuations in distress during the day-to-day lives of patients, it is not sufficient to generalize from cross-sectional research findings. The

pursuit of this goal is best achieved using methods that allow the repeated assessment of experiences within individuals, in the moments in which they occur, such as ESM.

This is not to suggest that momentary assessment strategies are 'superior' to cross-sectional approaches; the latter can provide important information about how people experience or understand events in their lives, given time to reflect on them (Reis, 2012). However, when the goal is to develop understanding of processes that operate in 'real-time' within individuals, momentary assessment strategies confer several conceptual and methodological advantages compared to cross-sectional approaches.

First, cross-sectional research typically utilizes self-report assessments and clinician-administered measures assessing individuals' past or 'typical' experiences (Kimhy, Myin-Germeys, Palmier-Claus, & Swendsen, 2012). These measures primarily assess reconstructed experience, and rely heavily on retrospective recall, which is known to be influenced by a multitude of cognitive and memory biases (Schwarz, 2012). As such, these reports are unlikely to provide an accurate picture of the ways in which people feel, think, or behave in response to voices during their daily lives (Ben-Zeev, McHugo, Xie, Dobbins, & Young, 2012).

Furthermore, these retrospective reports are highly 'decontextualized'. Recent research across many areas of psychological science has demonstrated the context-sensitivity of human experiences, including cognition, emotion and behaviour (Reis, 2012). A key premise of the ecological momentary approaches is that a comprehensive understanding of experience and behaviour necessarily requires taking contextual factors into account (Vilardaga, McDonell, Leickly, & Ries, 2015). In assessing experiences in the contexts in which they occur, ESM findings can also be considered to possess high ecological validity, and bear a closer 'relation to life' than can be achieved using retrospective methods.

A final advantage of ESM is its potential for investigating the dynamic, 'micro-longitudinal' relationships between variables, as they fluctuate over time. Past research has demonstrated the utility of ESM for identifying the temporal antecedents and consequences of different experiential states (Delespaul et al., 2002; Hartley, Haddock, Vasconcelos e Sa, Emsley, & Barrowclough, 2015; Oorschot, Lataster, Thewissen, Bentall, et al., 2012).

The potential of ESM for contributing to understanding of voice hearing experiences has been demonstrated in a number of studies (Hartley et al., 2015; Hartley, Haddock,

Vasconcelos e Sa, Emsley, & Barrowclough, 2014; Henquet et al., 2010; Oorschot, Lataster, Thewissen, Bentall, et al., 2012; Palmier-Claus et al., 2014; Palmier-Claus, Dunn, & Lewis, 2012; Peters, Lataster, et al., 2012; So, Peters, Swendsen, Garety, & Kapur, 2013; Varese, Udachina, Myin-Germeys, Oorschot, & Bentall, 2011). These studies have provided ecological validation of some aspects of contemporary psychological models, but critical questions remain. The following section will provide an overview of some of the most influential contemporary models of voice hearing, first exploring the cross-sectional evidence for various aspects of these theories, before describing the contributions made by ESM research to date. Evidence for the trans-diagnostic applicability of these theories will be discussed, and key research questions with relevance to the present thesis identified.

1.4 Psychological Models of Voice Hearing

Psychological models of voice hearing can be broadly divided into those models which endeavour to understand the origin or emergence of voices – both in terms of their distal (i.e. developmental) and proximal (i.e. temporally immediate) causes - and models which attempt to account for the significant levels of distress experienced by some, but by no means all, voice hearers. The emergence of voices has largely been addressed by neurocognitive models, which describe the cognitive deficits and information processing biases that are proposed to underlie the emergence of voice hearing experiences. Distress in relation to voices is the primary focus of cognitive behavioural models, which primarily address the role of cognitive appraisals, behaviour and affect in the emergence and maintenance of voice-related distress.

1.4.1 Neurocognitive models

The vast majority of contemporary neurocognitive theories tend to regard voices as internally-generated events that are experienced as alien to the self (Bentall, 2014; McCarthy-Jones, 2012). These theories however make different proposals as to what types of internally-generated events might comprise the 'raw material' of voices, with memories (Waters, Badcock, Michie, & Maybery, 2006), inner speech (Jones & Fernyhough, 2007), thoughts (Morrison, Haddock, & Tarrier, 1995) and verbal images (Seal, Aleman, & McGuire, 2011) all having been suggested. Further, theories propose different explanations as to the processes via which these internally generated cognitions come to be perceived as alien voices, including self-monitoring deficits (Jones & Fernyhough, 2007), source-monitoring biases (Bentall, 1990), deficits in intentional inhibition and contextual memory (Waters et al., 2006), dissociative processes (Perona-

Garcelán, Pérez-Álvarez, García-Montes, & Cangas, 2015) and inner-speech re-expansion (Fernyhough, 2004).

To date, no theory has been entirely successful in accounting for the various phenomenological characteristics of voices, and it has been suggested on this basis that different models might be appropriate for different voice experiences (Bell, 2013; Jones, 2010; McCarthy-Jones, 2012, 2014).

1.4.1.1 The 'raw material' of voices; inner speech?

One popular contemporary cognitive account is that voice hearing experiences result from the misattribution of the voice-hearer's own inner speech. It has been suggested that such inner speech models provides the best current account of "commanding and commenting voices", which are typically complex and dynamic, involving commands, advice or suggestions, as well as evaluative comments (McCarthy-Jones, 2012). Inner speech can be defined as the subjective experience of language in the absence of overt and audible articulation (Alderson-Day & Fernyhough, 2015). Whilst this concept is sometimes used interchangeably with thinking, cognitive scientists have emphasised that whilst thought may occur in the medium of inner speech (i.e. verbal thought), much thought occurs in other, non-verbal forms of representation (McCarthy-Jones, 2012).

The notion that inner speech represents the raw material of voice hearing experiences gains support from neuroimaging studies, including those demonstrating activation of language networks during voice hearing (Allen et al., 2012). Furthermore, research has demonstrated phenomenological correspondences between the experiences of voices and inner speech. Based on the work of Vygotsky (1987), Fernyhough (2004) proposed that inner speech, as a product of ontogenetic development, retains the dialogical qualities of socially mediated exchanges, involving an ongoing interplay between various internalised, simultaneously held perspectives on reality. In other words, "by its very nature, inner speech involves the coordination of multiple voices" (Fernyhough, 2004, pp. 53). Indeed, research has demonstrated that both inner speech and voice hearing are commonly reported to possess dialogical properties similar to those of external communication, with individuals typically engaging in an inner dialogue with themselves and with their voices (Hayward, 2003; Leudar et al., 1997; McCarthy-Jones & Fernyhough, 2011). In addition, both inner speech and voices have been demonstrated to retain the 'pragmatic' properties of social exchanges, appearing to serve communicative or self-regulatory functions, such as reminding, warning, condemning,

commanding, informing, etc. (Alderson-Day et al., 2014; Leudar et al., 1997; McCarthy-Jones & Fernyhough, 2011).

However, there are key differences in the phenomenology of voices and inner speech that are problematic for the notion that inner speech forms the basis of voice hearing experiences. First, inner speech is typically experienced as a person's own voice (Hurlburt, Heavey, & Kelsey, 2013), talking to oneself in the first person (e.g. 'I'd better do such and such now'; Langdon, Jones, Connaughton, & Fernyhough, 2009), whilst voices usually possess vocal qualities that are different to those of the hearers own voice (Nayani & David, 1996), and typically address the hearer in the second or third person (i.e. 'you'd/he'd/she'd better do such and such now'; McCarthy-Jones, Trauer, et al., 2012). Whilst the use of second- and third-person pronouns is not uncommon in the inner speech of voice hearers, being reported by 57% and 14% of voice hearers (respectively) in a recent study, the same study found low within-person concordance between inner speech and voices in terms of their use of second or third-person pronouns (Langdon et al., 2009).

These findings present difficulties for some inner speech theories, which make the prediction that if inner speech is the origin of commanding and commenting voices, there should be consistency between the phenomenology of these experiences within individuals. However, the opposite prediction may be equally valid; if certain types of inner speech come to be perceptualized as voices, such as utterances in second or third person, we might expect to see a reduction in these features of inner speech in voice hearers compared to non-hearers, resulting in within-person phenomenological discordance between voices and inner speech. Unfortunately, this prediction was not borne out; Langdon et al. (2009) detected no significant differences in the frequency of inner speech, or the use of second-person pronouns in the inner speech, of voice hearers compared to non-hearers, alongside significantly higher rates of third-person inner speech in voice hearers.

More promising results have been found in studies assessing the presence of the verbalizations of other people in inner speech. Two large-scale student studies have found that 22-26% of participants report the presence of other people's voices in their inner speech, and that this type of inner speech is significantly associated with voice proneness (Alderson-Day et al., 2014; McCarthy-Jones & Fernyhough, 2011). Thus, it remains a possibility that inner speech or auditory verbal imagery produced in the voice of another may represent the raw material of voice hearing experiences.

1.4.1.2 The transformation of inner speech into voices

Assuming that inner speech may represent the raw material for at least some types of voice hearing experiences, cognitive theories must explain how internally generated inner-speech might come to be perceived as alien to the self. Two main explanations have been proposed for such failures of self-recognition, and the presumed subsequent misattribution of inner speech to external sources. Cognitive deficit, or 'bottom up' theories, propose impairments in self-monitoring processes, whose role consists in predicting the sensory consequences of one's intended actions and inner speech (Frith, Rees, & Friston, 1998; Jones & Fernyhough, 2007; Swiney & Sousa, 2014). A dysfunction in this system is thought to result in incorrect sensorimotor predictions, and an ensuing failure to recognize self-generated thoughts and actions. Cognitive bias, or 'top-down' explanations (Bentall, 1990; Morrison et al., 1995) suggest that in addition to this self-monitoring impairment, voice hearers present a specific cognitive bias (a source monitoring, or externalising bias) towards the misattribution of internal cognitive events to *external* (i.e. non-self) sources (Brookwell, Bentall, & Varese, 2013). Such biases are distinct from the cognitive deficits proposed by bottom-up accounts, which are generally assumed to reflect some underlying neurobiological abnormality. Instead, cognitive bias accounts suggest that some forms of information are processed preferentially in comparison with others (Aleman & Larøi, 2008b).

Evidence supporting the link between voices and self- and source-monitoring deficits is strong, and few studies have failed to replicate these findings. Two recent meta-analyses showed that self- and source- monitoring impairments were consistently reported across a range of paradigms, inter-stimulus intervals, and modalities in patients with schizophrenia and particularly those who hear voices (Brookwell et al., 2013; Waters, Woodward, Allen, Aleman, & Sommer, 2012). Studies have demonstrated similar self-monitoring deficits in voice hearers with a diagnosis of BD (Johns, Gregg, Allen, & McGuire, 2006), and hearers with no need for care (Brébion et al., 2016) suggesting that this may represent a trans-diagnostic mechanism of voice hearing.

1.4.1.3 The selectivity problem

However, an issue with these models that must be reconciled is what Gallagher (2004) refers to as the selectivity problem; why, if inner speech is the raw material of voices, is not all the inner speech of voice hearers experienced as alien? Whilst some voice hearers may experience voices continuously, many hearers report intervals of minutes or hours between voice 'episodes' (McCarthy-Jones et al., 2012; Nayani & David, 1996).

Furthermore, voice hearers report being able to clearly differentiate between their own self-talk and their voices (Hoffman et al., 2008), often answering their voices in their own thoughts and not out loud (Langdon et al., 2009).

In response to this, recent inner speech–based models have attempted to explain why only some inner speech may be perceptualized (Fernyhough, 2004; Perona-Garcelán et al., 2015). The majority of these models have focused on explaining the observed discontinuity of voice hearing, suggesting that it is only under conditions of stress and cognitive challenge that inner speech comes to be experienced as voices. Indeed, a large body of research has indicated that increases in stress and anxiety (Slade, 1972), negative affect (Corstens & Longden, 2013; Nayani & David, 1996) and associated physiological arousal (Cooklin, Sturgeon, & Leff, 1983) may represent antecedent conditions for many voice hearing experiences.

Within his top down account, Bentall (1990) has described how high levels of arousal may disrupt the cognitive operations involved in source monitoring. In line with this, Morrison and Haddock (1997a) observed that voice hearers with a schizophrenia diagnosis revealed a greater bias towards attributing emotional material to the experimenter on an immediate reality monitoring task, compared with non-voice hearing patients and non-patients. This, along with other similar findings (Larøi, Van Der Linden, & Marczewski, 2004) suggests that emotional arousal may have a disruptive effect on the cognitive processes that allow accurate source monitoring. An alternative theory has been presented by Fernyhough (2004). Briefly, Fernyhough suggests that inner speech can occur in more than one form, and that voices are experienced when normally ‘abbreviated’ inner speech is re-expanded under conditions of stress and cognitive challenge. The subjective experience of expanded inner dialogue suddenly, in absence of any external stimulus, leads the person to express hearing voices.

Alongside these theoretical developments, there has been growing interest in the potential role of dissociative processes in both the development and moment-to-moment modulation of voice hearing experiences (Varese, Udachina, et al., 2011), and recent findings have suggested that such explanations might address aspects of the selectivity problem. Evidence for a role of dissociation in voice hearing is reviewed in the following section.

1.4.1.4 The role of dissociation

Recent iterations of inner speech models suggest a fundamental role of dissociation in the transformation of inner speech into voices (Perona-Garcelán et al., 2015). Dissociation refers to a ‘‘lack of normal integration of thoughts, feelings and experiences into the stream of consciousness and memory’’ (Bernstein & Putnam, 1986, p.727), and is typified by experiences of depersonalisation/derealisation (i.e., experiencing a sense of unreality, detachment or disconnection in relation to one's body and surroundings; Hunter et al., 2004), absorption (i.e., the experience of losing contact with one's present moment experience and becoming immersed in internal events such as thoughts and imagery; Waller, Putnam, & Carlson, 1996); and dissociative amnesia (i.e., the inability, distinct from ordinary forgetfulness, to consciously retrieve autobiographical, personal information that would ordinarily be readily accessible to recall; Spiegel et al., 2011).

Specific links between dissociation and voice-hearing have been proposed (Moskowitz & Corstens, 2008), with dissociative experiences potentially playing a predisposing role or acting as a preliminary stage in the development of voice hearing experiences (Pérez-Álvarez, García-Montes, Vallina-Fernández, Perona-Garcelán, & Cuevas-Yust, 2011; Varese, Barkus, & Bentall, 2012). A recent meta-analysis found that the relationship between dissociation and voice hearing was strong and consistent across diagnoses and non-clinical groups (Pilton, Varese, Berry, & Bucci, 2015), suggesting that dissociation represents a trans-diagnostic mechanism for voice hearing. Research had additionally shown that dissociation is higher in those reporting current voice hearing experiences, compared to ‘remitted’ voice hearers (Varese et al., 2012).

A number of studies have additionally indicated strong and specific trans-diagnostic associations between experiences of early adversity, especially childhood sexual abuse and both voice hearing (Hammersley et al., 2003; Read, Agar, Argyle, & Aderhold, 2003; Shevlin, Dorahy, & Adamson, 2007; Whitfield, Dube, Felitti, & Anda, 2005) and dissociation (Holowka, King, Saheb, Pukall, & Brunet, 2002; Van Ijzendoorn & Schuengel, 1996). Three recent studies have found that the relationship between voices and childhood trauma is mediated by dissociation (Perona-Garcelán et al., 2014; Perona-Garcelán, Carrascoso-López, et al., 2012; Varese et al., 2012), suggesting that dissociation may represent a mechanism leading to increased risk for voices in individuals exposed to adverse and traumatic events.

Whilst a recent meta-analysis (Pilton et al., 2015) found a large and consistent relationship between the presence of voices and all dissociation subtypes

(depersonalisation/derealisation, amnesia and absorption), individual studies have indicated that depersonalisation/derealisation might be particularly important. Kilcommons and Morrison (2005) and Perona-Garcelán et al. (2008; 2012) found that depersonalisation/derealisation was the only specific predictor of the presence of voices, and other research has indicated that depersonalisation/derealisation is specifically associated with voice episodes (Perona-Garcelán et al., 2008; Perona-Garcelán, García-Montes, Ductor-Recuerda, et al., 2012). Furthermore, Perona-Garcelán, Carrascoso-López, et al. (2012) found that depersonalisation/derealisation alone mediated the relationship between childhood trauma and voices in a schizophrenia sample.

This research indicates that dissociative experiences generally, and depersonalisation/derealisation specifically, may be involved in voice hearing. However, the mechanisms via which dissociation might be linked to voice hearing have received less research attention to date. Two studies have assessed the relationship between dissociation, source monitoring biases and voice hearing, in an attempt to explore whether dissociation may partly explain the tendency of voice hearers to attribute internally-generated events to external sources. In a large sample of non-clinical participants, Varese, Barkus, and Bentall (2011) found significant negative associations between the awareness subscale of the Five Factors Mindfulness Questionnaire (which has shown robust associations with other dissociative experiences measures in non-clinical samples) and both voice-proneness and response bias scores on a signal detection task (a paradigm frequently used to assess source monitoring biases). This finding was suggested to indicate that dissociation may influence the ability of people to discriminate reality, and favour external attribution of self-generated events. However, a subsequent study did not replicate this finding using a more robust measure of dissociation (the Dissociative Experiences Scale; DES) in a schizophrenia population (Varese et al., 2012); whilst patients with pathological dissociative symptoms demonstrated somewhat elevated response biases compared to non-dissociative patients, this between-group difference was not significant.

These findings suggest that there may be no direct relationship between dissociation and reality discrimination, instead implying a ‘two-hit model’, in which impaired reality discrimination is an enduring vulnerability factor, perhaps predating the onset of voice hearing, but increased dissociation (possibly representing a sequela of traumatic experiences) triggers the actual onset of hallucinatory experiences (Varese et al., 2012). However, it should be noted that in this study, the pathological dissociation group

comprised just 14 patients (compared to 31 in the non-dissociative patient group), and these findings should thus be interpreted with caution.

Another recent study has explored whether dissociation might represent a mechanism via which inner speech becomes transmuted into voice hearing experiences (Alderson-Day et al., 2014). This study found that associations between voice proneness and the reported presence of other people's voices in inner speech (McCarthy-Jones & Fernyhough, 2011) are fully mediated by levels of dissociation. On the basis of this evidence, the authors suggest a role for dissociative traits in the development of voice hearing experiences, whereby characteristics of inner speech could develop into voices via a dissociative stage. This finding has clear implications for addressing Gallagher's 'selectivity problem', as it suggests a mechanism via which only some aspects of inner speech may come to be perceived.

Models derived from the phenomenological and dialogical traditions have addressed the other aspect of the selectivity problem, making suggestions as to the possible role of dissociative processes in the onset of specific voice episodes (Parnas, 2003; Perona-Garcelán et al., 2015). These models propose that what facilitates the start of a voice episode is the activation of intense states of absorption, which consist of the appearance of high levels of self- focused attention. It is suggested that this intense focus on inner experience - and in particular, on certain aspects of inner dialogue - results in a loss of metacognitive perspective, and the resulting perceptualization of components of inner speech (Perona-Garcelán, García-Montes, Ductor-Recuerda, et al., 2012; Perona-Garcelán et al., 2015).

In support of this account, a wealth of research has demonstrated high self-focused attention in voice hearers (Allen et al., 2005; Ensum & Morrison, 2003; Morrison & Haddock, 1997). Whilst later research has demonstrated that it is not a variable that specifically affects people with voices, but rather people with psychoses in general (Perona-Garcelán et al., 2008), research has demonstrated a stronger association between trait levels of self-focused attention and absorption in voice hearers (Perona-Garcelán et al., 2008), leading researchers to suggest that voice hearers may pay more attention to dissociative experiences. Indeed, research has found that the relationship between self-focused attention and voice hearing is not direct, instead being mediated by depersonalisation (Perona-Garcelán et al., 2011).

Overall, the evidence presented provides a convincing case for a relationship between dissociation and voice hearing, with preliminary findings suggesting that it may provide some means of accounting for the observed selectivity of voice hearing experiences.

1.4.1.5 Neurocognitive models: summary and outstanding questions

In summary, there seems to be a consensus that voices occur when a private event is misattributed to a source that is external or alien to the self. Theories make different suggestions as to the types of internally-generated events that comprise the raw materials of voices, including memories, verbal images and inner speech, and it is possible that different mechanisms might underlie different types of voice experience. Furthermore, theories propose various explanations as to the processes via which these internally generated cognitions come to be perceived as alien voices.

Inner speech models have gained traction within the research community in providing an explanation for the experience of dynamic, commenting voices. However, a key question to be addressed is why voices are not always experienced continuously, and furthermore, why only some inner speech might come to be perceived as alien. The role of stress as an antecedent condition to voice hearing has been suggested as an explanation for observed fluctuations in voice hearing within individuals. Furthermore, given evidence of robust, specific and trans-diagnostic associations between dissociative tendencies and voice hearing, it has been suggested that these processes might play a role in the perceptualization of inner speech as voices.

The research discussed has relied exclusively on trait measures of both voices and dissociation, indicating only that voice hearers possess a general disposition towards dissociative experiences. The finding that dissociation is particularly common in patients who report current voice hearing (i.e. hearing voices over the past two weeks) compared to ‘remitted’ voice hearers suggests that further explorations of the ‘state’ relationship between voice hearing and dissociation are warranted.

Given the proposed role of stress as a proximal antecedent to the onset of voice hearing, and the finding from ESM research that dissociative states in individuals with BPD might be triggered by minor daily life stressors (Stiglmayr et al., 2008), a recent ESM study has considered the role of stress and dissociation in voice hearing during the course of daily life (Varese, Udachina, et al., 2011). This study demonstrated a close temporal link between stress, voices and dissociative experiences, finding that voices were significantly more likely to be present in moments where greater dissociation was

reported, and that this relationship was strongest during moments of high self-reported stress (Varese, Udachina, et al., 2011). Furthermore, voice-hearing patients were more vulnerable to dissociative states in response to stress compared to non-voice-hearing patients and healthy controls.

Whilst these findings are suggestive of a proximal role of stress and dissociation in voice hearing experiences, this study was limited by its use of a 'momentary' approach, which whilst based on 'real time' data, is still cross-sectional and thus limited in its ability to assess the directionality of effects. As such, understandings of the links between stress, voice hearing and dissociation during daily life would be advanced by the application of micro-longitudinal analysis approaches.

1.4.2 Cognitive behavioural models

The neurocognitive models described previously seek to account for the emergence of voice hearing experiences. However, as we have seen, a body of research has demonstrated that voice hearing experiences in themselves are not inherently pathological, being experienced by many people who have no need for care (Johns et al., 2014). As a result, clinically-oriented researchers have sought to understand the factors that might contribute to the emergence of distress and impact on function in relation to these experiences.

The finding that voices are not always associated with distress is what would be expected based on cognitive models of distress (Beck, Rush, Shaw, & Emery, 1979; Ellis, 1991; Muran, 1991) where emotional consequences of events are seen not to be caused by the events themselves but by thoughts and beliefs about those events.

Thus, whilst early research proposed that voice content was 'directly responsible' for a person's behavioural and affective response to their voices (Benjamin, 1989), the cognitive model as applied to voice hearing (Chadwick & Birchwood, 1994) makes the prediction that it is the beliefs a person holds about their voices - rather than merely voice activity or content – that mediate associated levels of distress and disability. In this framework, voices are viewed as 'activating events' (A), with beliefs (B) about voices' power and purpose being key mediators between voice occurrence and the person's affective and behavioural responses (C).

1.4.2.1 Beliefs about voices

Since its initial development, the cognitive model has been elaborated by several authors, with two main types of belief having been proposed as important in determining voice-related distress.

The first, and more widely studied, set of beliefs was described by Chadwick and Birchwood (1994), who highlighted the importance of explanatory beliefs associated with seeing voices as sentient others interacting with the person. Beliefs about the identity, purpose (i.e. malevolent or benevolent intentions) and power/omnipotence of voices were suggested to be of particular importance in predicting a person's emotional and behavioural response to voices (Chadwick, Birchwood, & Trower, 1996). In support of the mediating role of such beliefs between voice occurrence and related distress, a consistent finding across studies (reviewed by Mawson, Cohen, & Berry, 2010) is that appraisals of voice malevolence and power are significantly and positively associated with voice-related distress, after controlling for the influence of variables such as voice duration and frequency (Andrew, Gray, & Snowden, 2008; Birchwood & Chadwick, 1997; Gilbert et al., 2001; Hacker, Birchwood, Tudway, Meaden, & Amphlett, 2008; Lucas & Wade, 2001; Morrison & Baker, 2000; Peters, Williams, Cooke, & Kuipers, 2012; van der Gaag, Hageman, & Birchwood, 2003; Vaughan & Fowler, 2004).

A second category of beliefs about voice experience was described by Morrison (Morrison, 1998; Morrison et al., 1995; Morrison, Wells, & Nothard, 2002), who highlighted the potential importance of 'metacognitive' beliefs about the personal meaning of voice-hearing experiences in predicting voice-related distress. In particular Morrison discussed the relevance of beliefs involving perceived threat of harm, shame or loss of control from voices, including beliefs about possession or impending madness (Morrison, 1998). Research has indicated that this type of belief falls into three distinct clusters (Morrison et al., 2002); positive beliefs (e.g. "I would not cope without them"); negative meta-physical beliefs (e.g. "they mean I am possessed"), and interpretations of loss of control (e.g. "they will make me go crazy"), with negative metaphysical beliefs demonstrating consistent associations with voice-related distress after controlling for the physical characteristics of voices (Morrison, Nothard, Bowe, & Wells, 2004; Morrison et al., 2002; Varese et al., 2016).

Other research has supported the notion that appraisals of threat are central to emotional responses to voices, with a recent study demonstrating that a majority of voice hearers reported beliefs relating to threat of harm, public shaming, and/or threat of loss of control

as a result of voices (Hacker et al., 2008). These authors also suggest that perceived threat of harm, shame and loss of control are intrinsic to the concepts of voice power and malevolence, whereby voice malevolence can be conceptualized as beliefs about the intent of the voice to cause harm, whilst power beliefs constitute the ability of the voice to carry out its threatening intent. Indeed, in support of this, Hacker et al. (2008) demonstrated significant associations between threat appraisals and beliefs about voice omnipotence and malevolence.

1.4.2.2 Beliefs about self and others

In explaining the formation of beliefs about voices, a central idea within cognitive models is that appraisals of ongoing events are influenced by more generalized cognitive representations of prior experience, often referred to as schema (Thomas, Farhall, & Shawyer, 2015).

Within the cognitive model of voice hearing, beliefs about the personal and social meaning of voices are proposed to be influenced by schema the person holds about themselves and the social world (Chadwick et al., 1996; Morrison, 2001; Paulik, 2012). This notion has received indirect support from observations that extreme negative evaluations of self are readily endorsed by voice hearers (Close & Garety, 1998), that the content of, and beliefs about, voices is often associated with the hearer's early life experiences (Romme & Escher, 1989), and that hearers' relationships with their voices typically mirror broader patterns of social relating (Birchwood et al., 2004; Hayward, 2003).

Cross-sectional studies directly examining this issue have provided convincing evidence that interpersonal schema concerning power (e.g. "I am weak"– "other people are strong") and negative beliefs about the self (e.g. "I am weak", "I am bad") are associated with beliefs about voice power (Birchwood et al., 2004; Birchwood, Meaden, Trower, Gilbert, & Plaistow, 2000; Paulik, 2012; Thomas et al., 2015). In other words, these studies suggest that people who perceive themselves as relatively powerless in social relationships, or who perceive themselves in a negative way, are more likely to view their voices as powerful. However, whilst these findings are consistent with the suggestion that beliefs about voice power develop in the context of pre-existing interpersonal schema, it has been noted that it is possible that voice activity/content may influence schematic representations, or indeed that the relationship between these two constructs is bi-directional (Strauss, Berry, Bucci, & Strauss, 2014).

1.4.2.3 Behavioural responses to voices

Chadwick and Birchwood's ABC model (1994) proposed that distress is not the only consequence of negative voice beliefs. As discussed previously, hearers commonly report being drawn in to reacting or responding to their voices (Thomas, Morris, Shawyer, & Farhall, 2013), either via direct and reciprocal acts of communication with voices (Hayward, Berry, & Ashton, 2011), or via the use of actions to mitigate their activation or negative impact (Farhall et al., 2007). A number of possible behavioural responses to voices have been described within the cognitive behavioural literature, including engagement, resistance and indifference; compliance with command hallucinations; and safety behaviours, and the cognitive model proposes that these 'behavioural consequences' of voices are also mediated by voice beliefs.

Early research identified three types of response in relation to voices; engagement (e.g. elective listening, willing compliance, and doing things to bring on the voices), resistance (e.g. arguing and shouting, non-compliance or reluctant compliance when pressure is extreme, avoidance of cues that trigger voices, and distraction) and indifference (Chadwick & Birchwood, 1994). These responses have been investigated primarily in relation to their association with beliefs about voice power and intent, with voice malevolence and power consistently predicting resistance responses (Birchwood & Chadwick, 1997; Hayward et al., 2008; van der Gaag et al., 2003; Vaughan & Fowler, 2004), and perceived voice benevolence being reliably associated with voice engagement (Birchwood et al., 2004; Birchwood & Chadwick, 1997; Chadwick & Birchwood, 1994, 1995; Close & Garety, 1998; Peters, Williams, et al., 2012; van der Gaag et al., 2003).

Other cognitive research has looked more specifically at acts of compliance with command hallucinations. Command hallucinations (CH) are a particular type of voice hearing experience wherein the voice commands the hearer to perform a particular action (Mackinnon, Copolov, & Trauer, 2004). CHs are common, being reported by approximately half of voice hearers with a psychiatric disorder (Shawyer, Mackinnon, Farhall, Trauer, & Copolov, 2003). Whilst commands are often benign, they may sometimes stipulate harmful or dangerous actions, and when heard, CHs often exert great pressure for obedience (Beck-Sander, Birchwood, & Chadwick, 1997).

Three types of behavioural responses have been discussed specifically in relation to command hallucinations (Byrne, Birchwood, Meaden, & Trower, 2006): compliance; appeasement (e.g. resisting more serious commands by acting on innocuous

commands); and resistance (i.e. transgressing on compliance). Research has suggested that up to 30% of voice hearers who experience harmful CHs may engage in at least partial compliance with voice commands (Shawyer et al., 2003), indicating that these experiences are associated with significant risks of harm to self and others.

Given these risks, cognitive research has focused on the factors predicting compliance with CHs. This research has demonstrated that compliance with CHs is associated with beliefs about voice power (Bucci et al., 2013; Fox, Gray, & Lewis, 2004; Joireman, Anderson, & Strathman, 2003), voice rank (Fox et al., 2004; Reynolds & Scragg, 2010), and perceptions of consequences for non-compliance (Barrowcliff & Haddock, 2010), whilst resistance is more likely when voices are perceived as malevolent (Chadwick & Birchwood, 1994; Joireman et al., 2003). Whilst perceptions of voice benevolence have been linked to compliance with commands to harm others (Joireman et al., 2003), this finding has not been replicated in a more recent study (Bucci et al., 2013).

Within the cognitive literature, responses such as compliance, appeasement, and resistance have been conceptualized as safety behaviours (i.e. behaviours subjectively designed to avoid, escape from, or mitigate a perceived threat; Michail & Birchwood, 2010; Morrison, 1998; Salkovskis, 1991). A recent study in 30 voice hearers found that the majority reported using safety behaviours in order to reduce the perceived threat from voices (Hacker et al., 2008), the most common of which were avoidance (e.g. avoiding being alone for fear of compliance with self-harm commands), in-situation behaviours (e.g. engaging voices in conversation to prevent them from disclosing shameful information), escape (e.g. leaving home because the voices said they were coming), aggression (e.g. shouting back at voices to refuse commands), and compliance/appeasement (e.g. hitting others to avoid repercussions from voices). In line with the predictions of the cognitive model, this study identified that safety behaviour use was associated with perceived voice omnipotence, after controlling for the effects of voice content and loudness.

1.4.2.4 Maintenance of voices and beliefs

Rather than simply representing a neutral consequence of voice beliefs, Chadwick and Birchwood (1994) proposed a role for behavioural responses to voices in the maintenance of voice-related distress, whereby particular responses may serve to strengthen or weaken beliefs about voice power. This maintenance cycle was further elaborated by Morrison (2001; Morrison et al., 1995), who proposed a role for affective

and behavioural responses in the maintenance of both beliefs about voices, and in the recurrence of voices themselves.

Specifically, based on previous findings of an association between heightened states of emotional arousal and voice occurrence, Morrison (1998) suggested that the distress elicited due to a perceived threat from voices can result in further increases in the frequency and/or intensity of voices, leading to a vicious cycle similar to the catastrophic misinterpretation of bodily sensations that is central to the cycle of a panic attack. At the same time, threat appraisals elicit a range of safety behaviours that may serve to increase the occurrence of voices. For example, it has been proposed that perceived threat and high arousal can lead to an active search (or hypervigilance) for further sources of physical or social threat, which may increase the chance of auditory "false-positives", i.e. hearing things that confirm current fears of persecution or of public exposure of shaming information (Dodgson & Gordon, 2009). Indeed, recent experimental research indicates that hypervigilance to auditory threat cues increases under conditions of arousal (Dudley et al., 2014).

Morrison (1998) further proposes that safety behaviours may serve to prevent the disconfirmation of threat beliefs (therefore maintaining them). For example, safety behaviours that are designed to mitigate the perceived threat of voices (e.g. shouting back at a voice in order to avoid doing what the voice says or attempting to distract oneself from the voice to avoid going mad) may be removing the possibility for disconfirmation of the interpretation of the voice.

In line with this view, a study by Hacker et al. (2008) demonstrated that safety behaviour use is associated with increased voice-related distress, and that this relationship is mediated by beliefs about voice omnipotence. Thus, whilst such behaviours may bring a temporary and subjective sense of relief, there was no suggestion that safety behaviours act to minimize distress in the longer term. Furthermore, in line with a cognitive formulation, the relationship between safety behaviour use and distress was almost fully mediated by beliefs about the omnipotence of the voice, suggesting that the purpose of these behaviours is to mitigate perceived threat from powerful voices, rather than attempts at distress reduction per se. The long term use of such behaviours as a means of mitigating perceived threat will presumably serve to prevent the disconfirmation of such beliefs, maintaining beliefs and distress in relation to these experiences.

1.4.2.5 Cognitive behavioural models: summary and outstanding questions

In summary, there is now robust evidence for a role of voice beliefs in determining the emotional and behavioural consequences of voice hearing experiences. Findings suggest that beliefs about voices may in turn be shaped by self-related and interpersonal cognitive schema. Voice hearers are typically not passive observers of their voice hearing experiences, engaging in a range of behavioural responses that appear to be mediated by beliefs about the threat posed by voices. There are indications that these responses may be harmful in and of themselves, or maladaptive in the sense of acting to maintain unhelpful beliefs about voices and associated distress.

However, once again the cross-sectional nature of this body of research precludes understanding of the directionality of these effects. Furthermore, whilst these studies typically use the terms voice 'beliefs' and voice 'appraisals' interchangeably (Mawson et al., 2010) influential cognitive theories of emotion make important distinctions between general, 'dispositional' beliefs, and appraisals of situations as they unfold in real time (Lazarus & Smith, 1988). Namely, consistent with the ideas presented by contextual behavioural approaches (Hayes, Barnes-holmes, & Wilson, 2012; Vilardaga et al., 2015), these theories suggest that momentary appraisals of experiences are inextricably linked with the contexts in which they arise.

As such, whilst beliefs about voices are likely to make significant contributions to evaluations of ongoing voice hearing experiences, momentary voice appraisals are likely to fluctuate based on the influence of situational factors (which may be internal or external to the hearer). Furthermore, in line with the suggestions of Morrison (1998), these theories propose that negative emotional responses do not arise directly from beliefs, but are instead activated by momentary appraisals of the personal significance of experiences in terms of their potential harm or benefit to wellbeing, coupled with 'secondary' appraisals about the current ability of the individual to adapt to, change or cope with the situation. Farhall (2005) further investigated the applicability of this model to voice hearing, resulting in the development of the Stress–Appraisal–Coping Model of Voices (the SACMOV model). Whilst demonstrating clear parallels with cognitive behavioural models, this approach has the advantage of being situational, in that it describes the processes that are hypothesized to occur during specific episodes or occasions of hearing a voice (Farhall, 2010).

In line with the predictions of these theories, a recent longitudinal study assessing beliefs about omnipotence over a period of twelve months found that these beliefs remain

relatively stable in the absence of specific intervention (Hartigan, McCarthy-Jones, & Hayward, 2014). In contrast, an ESM study assessing momentary appraisals of voice power and control (two aspects central to the voice omnipotence construct) demonstrated significant within-person variation in these constructs from moment-to-moment (Peters, Lataster, et al., 2012). Furthermore, this study demonstrated significant associations between levels of momentary voice power and control and concurrent levels of voice-related distress, providing preliminary evidence for the applicability of the cognitive model to voice hearing experiences as experienced during daily life.

This study highlights the potential of ESM for developing situational models of voice hearing, by allowing the exploration of inter-relationships between voice hearing experiences and momentary appraisals, responses and emotions. A recent study Hartley and colleagues has further demonstrated how the application of micro-longitudinal approaches to analysis might advance understanding, finding that increases in voice intensity and distress were preceded by attempts to control thoughts (Hartley et al., 2015). This study provides indirect support for the notion that attempts to resist or control voices may have a similar effect, motivating the specific exploration of these questions.

These studies have provided preliminary support for the relevance of aspects of the cognitive model to voices experienced during daily life. However, to date, the proposed relationship between appraisals and voice responses, and the contribution of responses to distress, has not been assessed. ESM might be particularly useful in assessing behavioural responses, given previous evidence that the use of coping behaviours may be under-reported when assessed retrospectively (Stone et al., 1998). Furthermore, the application of dynamic approaches to analysis might shed light on the directionality of effects.

1.5 Psychological Interventions for Distressing Voices

1.5.1.1 The need for psychological interventions for distressing voices

Antipsychotic medications are typically the first line of treatment for distressing voices when experienced in the context of schizophrenia (National Collaborating Centre for Mental Health, 2014). However, there is emerging evidence that anti-psychotic medication is of limited effectiveness for voices, with 35-50% of patients experiencing persistent voices despite pharmacological treatment (McEvoy et al., 2007; Robinson et al., 2006). Furthermore, discontinuation rates for atypical antipsychotic medications are as high as 70% (McEvoy et al., 2007) for reasons including the common experience of

adverse side-effects (Johnstone, Nicol, Donaghy, & Lawrie, 2009). There hence remains the need for either alternative or adjunctive interventions, to assist hearers who are distressed by their voices.

A myriad of psychological intervention approaches have been developed to help people who experience distressing voices, including Acceptance and Commitment Therapy (Bach & Hayes, 2002), Avatar Therapy (Leff, Williams, Huckvale, Arbuthnot, & Leff, 2013), Compassion Focused Therapy (Mayhew & Gilbert, 2008), Competitive Memory Training (Van Der Gaag, Van Oosterhout, Daalman, Sommer, & Korrelboom, 2012), Hallucination-focused Integrative Therapy (Jenner, Nienhuis, van de Willige, & Wiersma, 2006), Person-Based Cognitive Therapy (Chadwick et al., 2015), Relating Therapy (Hayward, Overton, Dorey, & Denney, 2009), and the Maastricht Interview Approach of the Hearing Voices Movement (Longden, Corstens, Escher, & Romme, 2012). However, by far the most well-established psychological intervention for distressing voices is cognitive behaviour therapy for psychosis (CBTp), which has emerged as the standard recommended treatment in clinical practice guidelines in the United Kingdom (National Collaborating Centre for Mental Health, 2014), United States of America (American Psychiatric Association, 2004; Dixon et al., 2010) and Australia (Royal Australian and New Zealand College of Psychiatrists, 2005).

1.5.1.2 Cognitive behavioural therapy for psychosis

1.5.1.2.1 Therapeutic approach

CBTp is a psychological therapy intended to reduce distress and impact on function experienced in relation to the positive symptoms of psychosis, including voice hearing, delusions and paranoia. The introduction of this therapy was a turning point in mental healthcare delivery as it advocated the open discussion of psychotic experiences which, prior to the emergence of this therapy, was thought to constitute a poor approach to care.

The journey through therapy (usually at least 16 sessions over 6–9 months) allows for the collaborative development of a ‘shared formulation' of distressing psychotic experiences, by making links between emotional states, thoughts, problematic behaviours and earlier life events (Wykes, 2014). The aim is to develop a personal account of the development and maintenance of distressing experiences that is more adaptive, and less threatening, than the beliefs that are currently held (Steel, 2012).

CBTp is based on an individualized formulation approach, addressing the issues that are of most concern to the patient (Morrison & Barratt, 2010). When applied in relation to

distressing voices, CBTp involves collaborative attempts to make sense of voices within a developmental and often interpersonal framework, with a focus on exploring beliefs about voices that are linked with distress or interference with functioning (Morrison & Barratt, 2010). Patients are guided to re-evaluate their appraisals of voices using methods such as Socratic questioning, and encouraged to identify and test out different ways of responding to these experiences. Within this framework, unhelpful beliefs about voice power and control are a particularly important target of therapy, as is compliance with harmful voice commands, which may both be challenged using behavioural experiments (Meaden, Keen, Aston, Barton, & Bucci, 2013). Therapy may also involve discussion of helpful coping strategies, and identification of unhelpful maintenance cycles (e.g. through behavioural avoidance, or safety behaviours; McCarthy-Jones, Thomas, Dodgson, et al., 2014).

1.5.1.2.2 Efficacy of CBTp

Interestingly, given that the goal of CBTp is to reduce distress experienced in relation to psychotic experiences, the effects of CBTp have most frequently been evaluated by examining the efficacy of CBTp, as an adjunct to routine care, on the overall 'severity' of positive symptoms (Birchwood & Trower, 2006; Thomas et al., 2014). Despite the fact that measures of symptom severity include items that might not be expected to change over CBTp (such as frequency and duration of symptoms), meta-analyses of randomized controlled trials (RCTs) are consistent in demonstrating evidence for beneficial but modest effects of CBTp on this outcome (Jauhar et al., 2014; Pfammatter, Junghan, & Brenner, 2006; Wykes, Steel, Everitt, & Tarrier, 2008).

However, compared with this large body of research examining the effects of CBTp on psychotic symptoms in general, there is much less direct evidence regarding effects on hearing voices specifically. A recent systematic review identified 16 studies that had assessed the efficacy of CBTp on voice-related outcomes (McCarthy-Jones, Thomas, Dodgson, et al., 2014). Of these studies, 11 were blinded RCTs, with four examining the effect of CBTp tailored to voice hearing specifically (McLeod, Morris, Birchwood, & Dovey, 2007; Penn et al., 2009; Shawyer et al., 2012; Trower et al., 2004), and seven assessing changes in voice severity as a secondary outcome in the context of generic CBTp (Cather et al., 2005; Durham et al., 2003; Garety et al., 2008; Lewis et al., 2002; Morrison et al., 2014; Pinninti, Rissmiller, & Steer, 2010; Valmaggia, Van Der Gaag, Tarrier, Pijnenborg, & Slooff, 2005). The remaining five studies were non-randomised and/or non-blinded controlled trials of CBTp (Haddock et al., 1999; Kuipers et al., 1997; Morrison et al., 2004; Peters et al., 2010; Wykes et al., 2005).

This review concluded that there is some evidence that CBT is more effective than treatment as usual (TAU) for command hallucinations, and evidence that CBT may be effective for specifically the cognitive (e.g. beliefs re. origin, disruption, control) and physical (e.g. frequency, location, duration and loudness) characteristics of voices, but found there was only limited evidence for effects generalisable beyond command hallucinations, and no clear evidence for the effects being specific to CBT as opposed to control interventions. Furthermore, the evidence for an effect of CBT on voice-related distress – the main target of CBT when applied to voices – was limited. Indeed, a recent large multicenter trial of cognitive therapy for command hallucinations demonstrated significant effects of CBT on rates of compliance, and perceived voice power, but not on overall voice severity or voice-related distress (Birchwood et al., 2014).

However, the review authors note that the potential existence of a medium-small specific effect of CBT on voice hearing cannot be ruled out due to methodological limitations within the studies reviewed. The majority of studies were insufficiently powered to detect anything but large effects, which is particularly problematic in the case of studies comparing CBT to an active control. This limitation is compounded by the observation that the proportion of time spent addressing voices in non-voice specific CBTp trials may be small (Farhall, Freeman, Shawyer, & Trauer, 2009). Furthermore, many of the included trials examined the effects of CBT in specific populations who were likely to be rapidly recovering due to recent medication changes, and where effects of CBT would hence be small.

These issues of statistical power have been addressed in two recent meta-analyses examining the effect of CBTp on voice severity, both of which observed moderate effects of CBTp on post-treatment voice severity versus any control (Jauhar et al., 2014; Van der Gaag, Valmaggia, & Smit, 2014). Thus, whilst the research reviewed provides some evidence for an effect of CBTp in reducing some of the problematic aspects of voices, findings have been mixed, particularly in relation to the effect of CBTp in reducing voice distress. Furthermore, the clinical-significance of these effects remains unclear – it has been suggested CBTp may result in significant improvements in only 50-60% of people who receive it (Garety, Fowler, & Kuipers, 2000).

As such, whilst researchers have advocated for methodological refinements in clinical trial protocols (Thomas, 2015), there have been parallel calls for research to move beyond establishing overall efficacy, towards attempts to improve interventions by developing a greater understanding of therapeutic processes (Thomas et al., 2014). Specifically, it has been suggested that a focus on understanding which elements of

CBTp interventions are the most important in producing change (Steel, 2012) could enable the refinement and enhancement of this intervention approach (Birchwood & Trower, 2006; Turkington, Kingdon, & Chadwick, 2003).

1.5.1.2.3 Understanding therapeutic processes

This call for a greater research focus on the mechanisms of change underlying treatment gains in CBTp echoes an on-going dialogue within the psychotherapy literature more broadly (Emsley, Dunn, & White, 2010; Kazdin, 2007, 2009; Kraemer, Wilson, Fairburn, & Agras, 2002; Murphy, Cooper, Hollon, & Fairburn, 2009).

Such an approach is important for several reasons. First, whilst the selection of potential therapeutic targets is often theoretically driven, theories in themselves tell us little about the amenability of these mechanisms to change during therapy (Kazdin, 2007; Murphy et al., 2009). Concurrent measurement of specific candidate processes alongside assessment of therapeutic outcomes can identify whether interventions are successfully targeting intended change mechanisms, helping to identify the critical components of therapy, alongside highlighting any redundant elements. Increased knowledge about the critical components of interventions (i.e. which components must not be diluted to achieve change) would help in optimizing generality of treatment effects observed in clinical trials to real world clinical settings, with associated clinical and economic benefits (Kazdin, 2007). Furthermore, such findings could promote the development of more targeted, simpler intervention methods, which may not only be more effective, but also easier and more cost effective to deliver (Kazdin, 2007; Murphy et al., 2009; Thomas et al., 2014).

This is particularly important in the case of CBTp, given that access to this intervention is currently limited, due at least in part to under-resourcing of routine mental health services (Waller et al., 2013). For example, in the UK, only 10% of those who could benefit currently have access to CBTp (Schizophrenia Commission, 2012), and it has been suggested that this figure might be even lower in the US and Australia (Farhall & Thomas 2013). However, considering these incentives for isolating therapeutic change processes, to date, there has been remarkably little research into mechanisms of change in CBTp as applied to voice hearing.

Within trials assessing CBTp for voices, only a few assessed proposed change mechanisms, with fewer still finding changes in both the primary outcome and proposed mediators. The most promising results have come from work on cognitive therapy for

command hallucinations, where an early trial (Trower et al., 2004) demonstrated that reductions in compliance with command hallucinations and voice related distress (the primary outcomes) occurred alongside significant reductions in beliefs about voice power, omniscience and uncontrollability (the proposed mediators). A subsequent trial which combined this protocol with acceptance and commitment therapy methods found significant changes in three out of nine proposed mechanisms (insight, voice power, and acceptance of voices), which occurred alongside increases in confidence to cope with (but not resist) command hallucinations (Shawyer et al., 2012). However, changes in these process measures were not specific to the treatment group. Finally, a recent full-scale trial of cognitive therapy for command hallucinations demonstrated significant reductions in both compliance and perceived voice power (Birchwood et al., 2014). However, whilst reductions in voice distress were observed in the CBTp group, the treatment effects for distress were not significant.

1.5.1.3 Psychological interventions for distressing voices: summary and outstanding questions

The literature reviewed above presents a mixed picture of the state of the evidence for CBTp as applied to distressing voices. Meta-analyses have demonstrated moderate effects of CBTp on general measures of voice severity, but studies have been inconsistent in demonstrating significant treatment effects on voice-related distress, the intended target of CBTp for voices. The lack of mechanism assessment in trials for CBTp for distressing voices further clouds this picture; is CBTp not effective in reducing voice distress, or are we simply failing to successfully target the mechanisms assumed to underlie distress? Furthermore, these studies have relied exclusively on 'trait' measures of voice characteristics and proposed change mechanisms, assessed 'retrospectively' during one-off study assessments.

There are good reasons to believe that the effects of therapy would be more easily observed in between therapy sessions, during the day-to-day lives of patients. Such an approach could help to determine whether the processes targeted in therapy translate into real-world cognitive, behavioural and emotional changes. As such, our understanding of the mechanisms underlying therapeutic changes could be greatly enhanced via the application of momentary assessment methods such as the Experience Sampling Method (ESM).

This approach has recently been utilised within a large-scale RCT of mindfulness training for depression, resulting in novel insights into the mechanisms via which this therapy

might influence real-life affective experiences (Bakker et al., 2014; Bringmann et al., 2013; Garland, Geschwind, Peeters, & Wichers, 2015; Geschwind, Peeters, Drukker, van Os, & Wichers, 2011). This research has additionally highlighted the advantages of ESM for understanding individual differences in therapy response (Bringmann et al., 2013). It is well known that findings from mediation analyses in the context of RCTs mask a large degree of between-person heterogeneity in both treatment response and change mechanisms (Barlow, Bullis, Comer, & Ametaj, 2013). It has been suggested that an intensive idiographic focus on individuals who respond to treatment might represent an efficient means of generating hypotheses regarding the processes underlying individual differences in therapy response (Barlow et al., 2013; Hayes, Long, Levin, & Follette, 2013). In this respect, ESM has the additional advantage of providing intensive longitudinal data on changes occurring within individuals over the course of therapy. However, whilst ESM would appear to have huge potential for furthering our understanding of the mechanisms underlying changes during CBTp, the feasibility of this approach in the context of interventions for distressing voices has not yet been demonstrated.

1.6 Summary and overview of empirical chapters

The literature reviewed above demonstrates that voice hearing is a common experience in many mental health disorders, often being associated with significant distress and disability. A number of theories have been put forward to account for the emergence of voices and associated distress, gaining support from cross-sectional studies. These theories have stimulated the development of a range of psychological interventions for distressing voices, most notably CBTp, which is currently recommended by international treatment guidelines. However, whilst CBTp and other intervention approaches are effective for many who are distressed by their voices, evidence suggests that up to 50% of voice hearers may see limited benefit.

A recent paper by members of the International Consortium on Hallucinations Research (Thomas et al., 2014) identified a number of issues that are critical for ongoing research into psychological interventions for voices, making a number of recommendations which included a strategic focus on; i) identifying psychological processes associated with hearing voices; ii) extending research beyond schizophrenia populations; iii) identifying therapeutic change mechanisms; iv) understanding individual differences in hearing voices.

In service to these aims, the overarching goal of the present thesis is to contribute to understandings of the within-person mechanisms related to the momentary fluctuation and maintenance of voices and associated distress during daily life, as well as those underlying clinical improvements following psychological intervention. The studies within this thesis utilise the Experience Sampling Method (ESM) in order to explore the ecological validity, and trans-diagnostic applicability, of key aspects of neurocognitive and cognitive behavioural models of voice hearing, with a particular focus on identifying psychological mechanisms that might serve to maintain voices and associated distress during the day to day lives of service users. Furthermore, a data-based illustration of the potential of ESM for understanding critical therapeutic change mechanisms will be provided, with applications to understanding individual differences in response to therapy.

In **Chapter Two**, issues pertinent to ESM study design and data analysis are summarised, and a rational presented for the approaches adopted within subsequent empirical chapters.

Chapter Three describes preliminary analyses undertaken prior to the use of substantive inferential tests, including a comprehensive study of missing data and ESM item psychometrics.

Following from cross-sectional evidence that dissociation may play a trans-diagnostic role in the aetiology of voice hearing experiences, and suggestions of a contribution of stress-induced dissociation in the fluctuation of voice episodes during daily life, **Chapter Four** investigates the temporal relationship between reports of voices, subjective stress and a specific component of dissociation, namely depersonalisation, in the daily lives of voice hearers, testing the prediction that depersonalisation would mediate the relationship between daily life stress and fluctuations in voice intensity.

Chapter Five focuses on the factors that may predict levels of voice-related distress during daily life, testing predictions of cognitive models that behavioural responses to voices – such as compliance and resistance – may serve to maintain both distress and maladaptive appraisals about voice power and uncontrollability.

Chapter Six assesses the potential contributions of ESM towards delineating mechanisms of change in psychological interventions for distressing voices, investigating within-person changes in voice appraisals and stress-reactivity in two patients engaged in cognitive behavioural therapy for psychosis (CBTp).

In **Chapter Seven** utilises an idiographic mediation approach to explore the generalisability of stress-induced depersonalisation as a proximal mechanism for voice hearing, alongside exploration of clinical and phenomenological factors associated with the presence of this effect.

Finally, **Chapter Eight** presents an integrated overview of findings from the present thesis, alongside a discussion of the strengths and limitations of the research. Implications for research and potential therapeutic applications will be discussed.

2 Chapter Two: Design, Methods and Analytic Approaches

2.1 Chapter Overview

The previous chapter provided a rationale for the use of ecological momentary assessment (EMA) approaches, such as the Experience Sampling Method (ESM) for investigating voice hearing experiences as they occur during the daily lives of patients. However, despite the promise of ESM, this method raises a number of important practical issues of design, measurement and analysis. In this chapter, issues pertinent to Experience Sampling Method study design and data analysis are summarised, and a rational presented for the approaches adopted within the subsequent empirical chapters.

2.2 Design considerations

2.2.1 Sampling Strategy

2.2.1.1 Event versus time sampling

Within ESM research a distinction is made between time-based and event-based sampling (Kimhy et al., 2012). Event-based sampling involves assessment of experience during or immediately following a predefined event (for example, when a person is actively hearing a voice or voices), whilst time-based sampling involves assessment at random or fixed times throughout the day, regardless of whether the experience of interest is currently occurring. The choice between event- and time-sampling is typically made on the basis of the frequency of the phenomenon of interest (Conner & Lehman, 2012). When the target experience is expected to occur frequently or continuously, time-based sampling approaches are usually recommended, whilst event-based approaches may be more appropriate when the phenomena of interest is rare, and thus unlikely to coincide with random or fixed sampling occasions (Palmier-Claus et al., 2011).

Whilst event-based sampling appears intuitively useful, since the phenomena of interest is almost guaranteed to be captured, a draw-back is that it provides no information about experiences occurring outside of the context of the target experience (Palmier-Claus et al., 2011), and thus is not ideal for exploring time-based trends (e.g. temporal antecedents of experience). Since the aim of this study was to assess dynamic, micro-longitudinal associations between variables, and phenomenological studies have demonstrated that voices typically occur frequently or continuously in voice hearers with

a need for care, a time-based sampling strategy was deemed most appropriate for the present study.

2.2.1.2 Random versus fixed time sampling

Time-based sampling approaches can be further divided into signal- and interval-contingent sampling approaches; interval-contingent sampling involves sampling experiences at set times throughout the day (e.g. every two hours), whilst signal-contingent sampling involves sampling events at random times (although note that in practice, moments are typically sampled randomly from within fixed time intervals, and thus should be considered 'semi-random').

Sampling at fixed time points with regular periodicity has clear advantages in terms of statistical modelling, such as time series analyses that have been developed initially to deal with data collected at stable time intervals (Kimhy et al., 2012). However, the regularity of sampling has its disadvantages; participants may begin to anticipate the assessments, engaging in mental preparation, or adapting their activities around the timing of assessments (Conner & Lehman, 2012). Furthermore, data obtained using interval-contingent designs are not fully representative of the daily experiences of participants. In contrast, using a signal-contingent designs, each 'moment' within a day has an equal probability of being sampled. As such, an advantage of signal-contingent sampling is that it allows generalization of findings to the *population of experiences* during waking hours (Conner & Lehman, 2012). For these reasons, a signal-contingent design was selected for the present study.

2.2.1.3 Sampling schedule

The number of moments to be sampled per day, and the duration of the sampling period, are two more key design considerations in ESM studies.

1. *Number of signals*

In selecting the number of moments to be sampled per day, researchers are required to balance the need to achieve a representative picture of the process/experiences under investigation, whilst minimising participant burden and reactivity. The expected time-course of processes is key, and observations each day should occur frequently enough to capture important fluctuations in experience. In particular, a higher sampling load is required in studies where time-lagged analyses are planned (i.e. where data from previous moments predict current state).

Previous ESM studies have typically used between 4–10 signals per day, with about 6 being normative (Conner & Lehman, 2012). Interestingly, researchers have observed that higher sampling loads are not necessarily perceived as more burdensome by participants; it is suggested that with a higher frequency of assessments, the procedure may quickly become routine, and participants will experience less anxiety around the possibility of missing individual assessments (Kimhy et al., 2012).

Previous ESM research investigating voice hearing experiences have used ten measurement occasions per day (e.g. Delespaul et al., 2002; Hartley et al., 2015; Oorschot, Lataster, Thewissen, Bentall, et al., 2012; Peters, Lataster, et al., 2012; Varese, Udachina, et al., 2011). The studies presented within this thesis will follow suit, using ten assessments occurring at semi-random time points between 7:30 A.M. and 10:30 P.M. Each signal will take place randomly within equal intervals of 90 minutes; for example, the first signal will occur randomly between 7:30 A.M. and 9:00 A.M., the second signal will appear at a random time between 9:00 A.M. and 10:30 A.M., and so on (because there are ten 90 minute intervals in those 13 hours). Within this schedule, a minimum interval between signals of 30 minutes will be specified, in order to prevent signals occurring too close together (Conner & Lehman, 2012).

2. Duration of the sampling period

Statistical power plays an important role in deciding the duration of the study (Conner & Lehman, 2012). Within ESM research, statistical power to detect significant effects is determined not only by the number of participants that take part, but also by the number of measurement occasions on which participants provide valid data (see Section 2.3.3 for a more detailed exposition of these issues).

Studies involving multiple reports per day typically run from 3 days to 3 weeks (Kimhy et al., 2012), and past ESM research into voice hearing experiences occurring in the context of schizophrenia has most often used a six-day sampling period. However, given evidence that voice frequency might be lower in voice hearers with diagnoses other than schizophrenia (Waters, Allen, et al., 2012), there was deemed to be a significant risk within the present study of a lower frequency of voice reports compared to these previous studies. As such, in order to ensure adequate power to detect effects, the decision was made to extend the sampling period to nine days[1].

[1] Note that a six-day sampling period was selected by researchers involved in the design of the study described in Chapter Six.

2.2.2 ESM Questionnaire Development

2.2.2.1 Item development

The central component of any experience sampling study is the items used in the questionnaire. The initial step of questionnaire preparation is the identification and selection of items to be included. These differ fundamentally from the items used in standard, cross sectional questionnaires, in that they assess experiential 'states' that are likely to arise on a moment-to-moment basis, rather than trait-like constructs. As such, whilst development of ESM items can be guided by items from cross-sectional questionnaires, care should be taken to ensure that items are applicable during day-to-day life, and this is likely to require the creation of novel items.

A number of recommendations for the construction of ESM items have been suggested (Kimhy et al., 2012; Palmier-Claus et al., 2011). Item wording should reflect how people describe their own behaviour and experiences. Furthermore, it is important to bear in mind the likely frequency and specificity of items; extreme or negatively worded items are less commonly endorsed, and may demonstrate low within-person variation. These authors also highlight the importance of avoiding reflexive questions which link two constructs (e.g. "in this social context, I feel down"); such associations are best assessed statistically. Finally, it is recommended that the total time to fill out one questionnaire should not exceed 2–3 min (or include more than 60 items) to encourage compliance.

2.2.2.2 Response format

Researchers must also consider the number of response options available to participants. Larger numbers of response options allow for fine gradations, potentially revealing subtler psychological differences among or within participants than is possible with scales that possess fewer options (Furr, 2011). However, there may be limits to the number of categories that can be meaningfully differentiated by participants (Smithson, 2006). As such, the 'optimal' number of response options has been the subject of great debate within the psychometric literature. However, research has suggested that scales with around seven response categories may present the optimal balance in terms of reliability, validity, discriminating power and participant preference (Preston & Colman, 2000).

Indeed, the majority of ESM studies exploring voice hearing experiences have utilised a 7-point Likert scale (1; not at all; 7; very much; Delespaul et al., 2002; Oorschot, Lataster,

Thewissen, Bentall, et al., 2012; Varese, Udachina, et al., 2011), and on this basis, this response format was utilised consistently within the current study.

2.2.2.3 Item order

The order in which items are presented is a further consideration of ESM questionnaire design. It is possible that current mood states may potentially influence recall or interpretation of previous experiences (Kimhy et al., 2012). It has therefore been recommended that transient experiences such as thoughts, mood, or symptoms are presented at the beginning of the questionnaire, followed by more stable items such as context, with 'retrospective' items (which involve recalling events or experiences that have occurred in the time since the previous measurement occasion) being presented last.

2.2.2.4 Branching/balancing

A final consideration when designing the ESM questionnaire was how to deal with occasions on which voices are not heard, or on which people are alone. In order to avoid any temptation by participants to endorse the answer with the least additional questions attached (i.e. stating that they did not hear a voice in order to avoid follow up questions), it is important to 'balance' the questionnaire so that the same number of follow up questions are asked regardless of whether voice hearing is reported or not (Palmier-Claus et al., 2011).

Whilst such 'conditional branching' was not possible in the past, where ESM data was typically collected using pen and paper questionnaires (see study in Chapter Six), the introduction of mobile technology has allowed for the presentation of specific items dependent upon responses to previous questions.

2.2.3 Delivery Method

The method of questionnaire delivery can have important implications for the quality of data obtained. Traditionally, ESM research has used pen and paper diaries, in combination with a pre-programmed digital watch in order to signal participants (this approach is employed in the study presented in Chapter Six). The major disadvantage of this approach is that there is little to stop participants from 'back-filling' questionnaires that they might have missed (Palmier-Claus et al., 2011). Furthermore, data-entry is time-consuming and prone to error, and conditional branching of items is not possible (Kimhy et al., 2012).

More recently, ESM researchers have experimented with technological approaches, including the use of personal digital assistants (PDAs), and smartphone applications. The advantages of these approaches include automated data input, exact information on response times, possibility for branching, and increased speed of assessment completion. The respective disadvantages of this second generation of ESM/EMA methods include technical problems (e.g., battery problems, broken screens, software issues), ‘‘user friendliness’’ (especially for computer-unfamiliar participants), and the difficulty of including open-ended questions (Kimhy et al., 2012)

However, despite these limitations, the feasibility, acceptability and reliability of technology for the use of ESM data capture has been demonstrated in individuals with severe mental illness (Granholm, Loh, & Swendsen, 2008; Kimhy et al., 2006; Palmier-Claus, Ainsworth, et al., 2012). Furthermore, a recent study demonstrated high rates of smartphone ownership amongst psychiatric outpatients, alongside significant levels of interest in using a mobile application on a daily basis to monitor mental health (Torous, Friedman, & Keshvan, 2014). Given the rising popularity of computerised ESM, a number of platforms and applications are now available to support the delivery of this method.

The studies described in Chapters Four, Five and Seven therefore incorporated the use smartphones as the ESM questionnaire delivery method, with phones being made available to participants not in possession of their own. We opted to use the movisensXS platform (https://xs.movisens.com/), due its flexibility, reliability and enhanced security features. An illustration of ESM item administration via the movisensXS app is displayed in Figure 2.1.

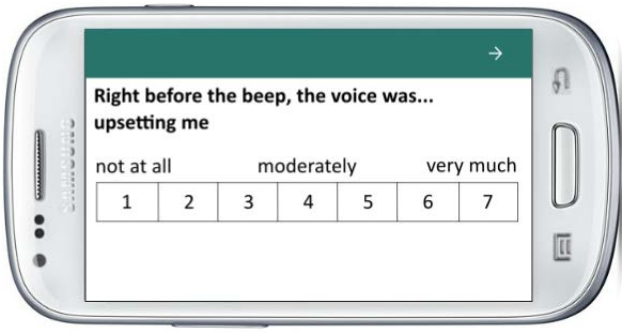

Figure 2.1. Participant view of ESM questionnaire administered using movisensXS Experience Sampling Application.

2.2.4 Service User Involvement

Active involvement of service users in research can lead to research of greater quality and relevance owing to the unique perspective that users can bring to a research project. There is increasing recognition of the value of the active involvement of service users in the design and delivery of mental health research (Brett et al., 2014). Feedback on all aspects of the design and methodology (for Chapters Four, Five and Seven) was sought from six service users who were members of the Psychosis Themed Group, a branch of the Lived Experience Advisory Forum linked to Sussex Partnership NHS Foundation Trust. Similar lived experience input was obtained during the design phases of the study described in Chapter Six. This feedback led to significant revisions of the ESM questionnaire and study procedure, including a reduction in the number of ESM items, and the re-phrasing of several items.

2.2.5 Piloting

Researchers are strongly advised to pilot newly developed items and delivery platforms before starting their research (Palmier-Claus et al., 2011). Items designed for use in the studies presented in Chapters Four, Five and Seven were initially piloted informally on the smartphone by the lead researcher, and technical issues resolved. Following this, the full questionnaire was piloted by two lived experience consultants, both of whom reported current voice hearing experiences. This pilot determined that the average time to complete one questionnaire was 2 minutes; within the 2-3 minute range recommended by Palmier-Claus et al. (2011). Problematic items (based on feedback from participants and inspection of item descriptive statistics) were identified and removed or reworded. Further technical problems relating to questionnaire delivery on the smartphone were resolved. A similar piloting process was employed for items included in Chapter Six.

2.2.6 Final ESM questionnaire

Based on the recommendations outlined above, the ESM items used in the current study were produced following a rigorous process involving several stages.

Keeping in mind the importance of theoretical coherence and design when conducting ESM research, the literature was first examined in order to identify ESM items and cross-sectional questionnaires that assessed constructs relevant to the hypotheses described in Section 1.6. For example, in order to assess momentary depersonalisation, the ESM literature was reviewed in an attempt to identify validated ESM items assessing this

construct. Since no previous ESM study had assessed depersonalisation experiences during daily life, standardised cross-sectional assessments were examined in order to identify relevant items. Items from the Cambridge Depersonalisation Scale (CDS; Sierra & Berrios, 2000) provided a starting point for the development of a momentary item of depersonalisation experiences. This item was revised to produce a phrase that were clear, concise, and of the correct format to facilitate endorsement 'in the moment' or over short time periods. Input from lived experience consultants was sought in order to ensure that items were meaningful to individuals who hear voices.

A similar process was undertaken in the development of ESM items assessing stress, voice characteristics, appraisals, and behavioural and emotional responses (along with a number of other constructs, which were not assessed within the present thesis; see Appendix C for the full ESM questionnaire). Finally, the full questionnaire was piloted and descriptive statistics (entailing the calculation of item means, frequency, and within- and between person variability) examined in order to remove problematic items. This led to the removal of several items that were reported rarely during daily life, and the revision of items demonstrating very low within-person variability. The final ESM items, along with the sources from which they were originally derived, are displayed in Table 2.1. All ESM items are rated on a 7-point Likert scale (1 *not at all* to 7 *very much*), and prefaced by the phrase "Right before the beep…".

Table 2.1. ESM Constructs and Items assessed in Chapters Four, Five and Seven

Category	Construct	*Item*	*Source*
Voice characteristics	Voice intensity	…I could hear a voice or voices that other people couldn't hear	Kimhy et al. (2006)
	Negative voice content	…the voice* was saying negative things	Psychotic Symptoms Rating Scale – Auditory Hallucinations (PSYRATS-AH; Haddock et al., 1999)
Voice appraisals	Voice dominance	… I felt inferior to the voice*	Voice Rank Scale (Birchwood et al., 2000)
	Voice uncontrollability	…I felt that the voice* was out of my control	Peters, Lataster, et al., (2012).
	Voice intrusiveness	…I felt that the voice* was intruding on my personal space	Voice and You Scale (Hayward et al., 2008)
Behavioural responses	Voice resistance	… I was trying to ignore the voice* or stop it from talking	Voice Rank Scale (Birchwood et al., 2000);
	Voice compliance	… I was doing what the voice* was telling me to do	Voice Compliance Scale (VCS; Beck-Sander, Birchwood, & Chadwick, 1997)
Emotional response	Voice-related distress	…the voice* was upsetting me	Voice Compliance Scale (VCS; Beck-Sander, Birchwood, & Chadwick, 1997)
Contextual variables	Depersonalisation	…I felt detached or unreal	Cambridge Depersonalisation Scale (CDS; Sierra & Berrios, 2000)
	Momentary stress	…I felt stressed	Vilardaga, Hayes, Atkins, Bresee, & Kambiz (2013)

*note: on sampling occasions when more than one voice was reported, all voice-relevant items referred to the 'voices' rather than the 'voice', with appropriate associated grammar (e.g. the voices *were* as opposed to the voice *was; them* as opposed to *it*, etc.).

Within the present study, a number of alternative follow up questions were designed (see full questionnaire in Appendix D) to be presented in the event that the participant reports being alone, or that their voices are not currently present. Efforts were made to balance the length of these questions, so that the overall administration time of the questionnaire remained constant regardless of the experiences reported.

This branching approach was additionally utilised to ensure that item wording reflected the current experiences of the participant, in terms of the number of voices they were currently hearing. For example, on each measurement occasion, participants were asked to indicate how many voices they were currently hearing; in moments where participants reported hearing a single voice, all voice-related questions referred to the

'voice'; whilst in moments where more than one voice was reported, items referred to the 'voices'.

2.2.7 Participant inclusion/exclusion criteria

As described in previous sections, ESM is only a useful methodology when the experiences under examination occur frequently during daily life. As such, an inclusion criterion for the study was that participants should currently experience frequent auditory verbal hallucinations (score of 2 ('at least once a day') or above on the frequency item of the Psychotic Symptoms Rating Scale – Auditory Hallucinations (PSYRATS-AH; Haddock, McCarron, Tarrier, & Faragher, 1999). The PSYRATS is a semi-structured interview measuring psychological dimensions of delusions and hallucinations. The auditory hallucinations (PSYRATS-AH) subscale has 11 items (including frequency, intensity, duration, disruption and beliefs about origin and control) and the delusion subscale (PSYRATS-D) has six items (including conviction, preoccupation, disruption to functioning and distress). All items are rated by the interviewer on a 5-point ordinal scale, with a potential range of scores for the hallucinations subscale of 0–44 and of 0–24 for the delusions subscale. Higher scores indicate greater pathology.

A further decision was made to set an exclusion criterion such that participants should not have previously received 16 sessions or more of NICE-adherent Cognitive Behavioural Therapy for psychosis (CBTp). It was anticipated that receipt of CBTp might change the nature of voice appraisals and responses reported participants, and we were interested in assessing these effects in an 'intervention-naïve' sample.

2.2.8 Maximizing Compliance

Missing data is a near inevitability in ESM research, largely due to participants missing numerous individual ESM signals (Black, Harel, & Matthews, 2012). Whilst a recent study (Hartley, Varese, et al., 2014) demonstrated no significant associations between compliance and clinical or demographic characteristics such as age, gender or mental health symptoms (positive, negative or general), other studies have demonstrated slightly lower rates of compliance in people with a diagnosis of schizophrenia (Johnson & Grondin, 2009; Kimhy et al., 2006). Furthermore, there is some evidence that compliance may decrease over the course of the ESM period (Broderick, Schwartz, Shiffman, Hufford, & Stone, 2003). Special efforts must therefore be made to maximise compliance with the procedure, beginning with the thorough briefing of participants, and extending to regular follow-up throughout the sampling period. Despite this, the chances

of missing data remain high; methods employed to handle missing data within Chapters Four, Five and Seven are discussed in Section 3.4.

2.2.8.1 Participant training

In line with recommendations, the initial assessment session included a 30 minute briefing session, in which participants were trained in the use of the smartphone by providing detailed instructions and practising its usage by going through a practice questionnaire in detail, ensuring that each item, and the associated response scales, were fully understood. This briefing took place on the day prior to the start of the ESM assessment period, in order to facilitate recall of the instructions.

Participants were shown how to use the smartphone, including switching it on and off, and switching the alarm onto silent (vibrate) mode if required. It was emphasised to participants that when answering the questionnaires, they should refer to their experiences in the moment just before they heard the signal. Participants were provided with the researcher's contact details, and asked to contact the researcher immediately if they have any questions or if anything went wrong (e.g. the equipment stops working).

2.2.8.2 Contact during the monitoring period

Participants were contacted twice during the assessment period – typically on the first and fourth day of the study - to provide support and encouragement, assess their adherence to instructions, identify any potential distress associated with the method, and help participants overcome any potential barriers for completing the questionnaire. Prior to the initial contact, data provided by the participant was inspected via the online database (data was automatically uploaded in real-time) to identify any potential compliance issues. Participants were explicitly asked whether there were any questions that they were finding difficult to understand, or anything else to do with the procedure that they were unsure about. Participants were again encouraged to contact the researcher if they experienced any new issues.

2.2.8.3 Debriefing

At the end of the assessment period, participants' reactivity to, and compliance with, the method were examined in a debriefing session. Participants were asked to review a list of ESM questions, and indicate any that they had found unclear or problematic during the study. Furthermore, participants were asked to record whether they had experienced

any technical problems. These debrief forms were reviewed on an individual basis during subsequent data cleaning.

2.3 Analytic Approach

The sections above presented some of the major design considerations when planning an ESM study. ESM data also presents several unique challenges for data analysis, which will be the subject of the remainder of this chapter.

2.3.1 Multilevel data.

Whilst ESM data is rich and informative, this complexity presents unique challenges for analysis. ESM produces 'intensive longitudinal' data; large volumes of repeated measures data across a series of individual participants (Bolger & Laurenceau, 2013).

Such data are known as multilevel, hierarchical, or nested; in other words, data collected on different measurement occasions can be considered as 'nested' within individuals. By convention it is said that that measurement occasions reside at level 1 within the 'multilevel structure', whilst participants lie at level 2 (Rasbash, 2008). This hierarchical data structure is illustrated in Figure 2.2.

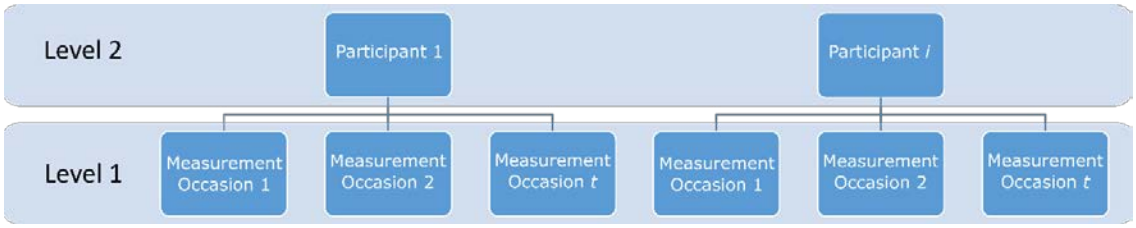

Figure 2.2. Illustration of the multilevel structure of ESM data.

Approaches to the analysis of single-level data, such as multiple linear regression, are based on the assumption that model residuals are independent, or uncorrelated. Multilevel data structures breach this assumption, as repeated measurements are typically correlated within persons (i.e. they are more similar within individuals than they are between individuals). Because the independence assumption is violated for these data structures, multiple linear regression, and other approaches based on correlations, will produce biased tests of effects or latent structures (Hox, 2010a; Reise et al., 2005). As such, the lack of independence due to clustering necessitates different approaches to analysis.

2.3.2 Multilevel statistical approaches

The remaining sections will describe the approaches to analysis utilised in Chapters Four, Five and Seven, including multilevel regression approaches examining both 'momentary' and 'dynamic' (i.e. time-lagged) associations between state variables, and multilevel approaches to mediation analysis. The study presented in Chapter Six utilised more traditional multiple regression approaches, due to its idiographic focus on mechanisms operating within two separate participants (i.e. data was not multilevel). As such, these approaches will not be further discussed here, instead being outlined within Chapter Six.

2.3.2.1 Multilevel regression

2.3.2.1.1 Overview

The primary aim of this thesis is to explore the proximal psychological mechanisms related to the onset of voices and associated distress during daily life. Whilst associations between variables have traditionally been assessed using ordinary least squares (OLS) regression techniques, these methods are inappropriate when data is clustered, as they typically result in the underestimation of standard errors (Steele, 2008). One way to appropriately model such data is to use a multilevel model, also known as a hierarchical linear model or a mixed-effects model.

Multilevel regression approaches allow the examination of associations between variables at both the within- and between-person levels. For example, in considering the (hypothetical) association between two momentary variables, stress and voice intensity, the question at the within-person level is whether, within individuals, voice intensity is higher *in moments* when stress is higher. At the between-person level, on the other hand, the question is whether individuals who report higher levels of stress *on average* also report higher levels of voice intensity. These relationships are independent; within-subject relationships can be negative when between-subject relationships are positive; and vice versa (see earlier example in Section 1.3.4.2). A statistical overview of these concepts (derived from descriptions by Hox, 2010a; Nezlek, 2012b; Schwartz & Stone, 2007) is provided in the following sections, with reference to the procedures utilised in the studies in Chapters Four, Five and Seven.

In the following presentation, we assume that there is an outcome variable, y_{it} (with i indexing persons and t indexing the momentary scores of the i^{th} person), and one moment-level predictor variable (x_{it}). At the 'core' of the model, there is the 'Level 1'

equation (1.1) describing the within-person relationship between two variables measured at the moment-level (y_{it} and x_{it}).

$$\text{Level 1 (within-person):} \qquad y_{it} = \beta_{0i} + \beta_{1i}x_{it} + r_{it} \tag{1.1}$$

Here, when the Level 1 predictor x_{it} is entered un-centred (i.e. raw scores are used), β_{0i} represents the expected value of the outcome variable for person i when the predictor equals zero. β_{1i} represents the relationship between the predictor and the outcome for person i. As with ordinary least squares (OLS) regression, the Level 1 error term, r_{it}, indicates that the relationship between these two variables varies from moment-to-moment within individual i.

These person-specific regression lines are illustrated for two fictional participants in Figure 2.3 (red and blue lines). Examples of time-specific error terms are displayed for both participant 1 (r_{1t}) and 2 (r_{2t}).

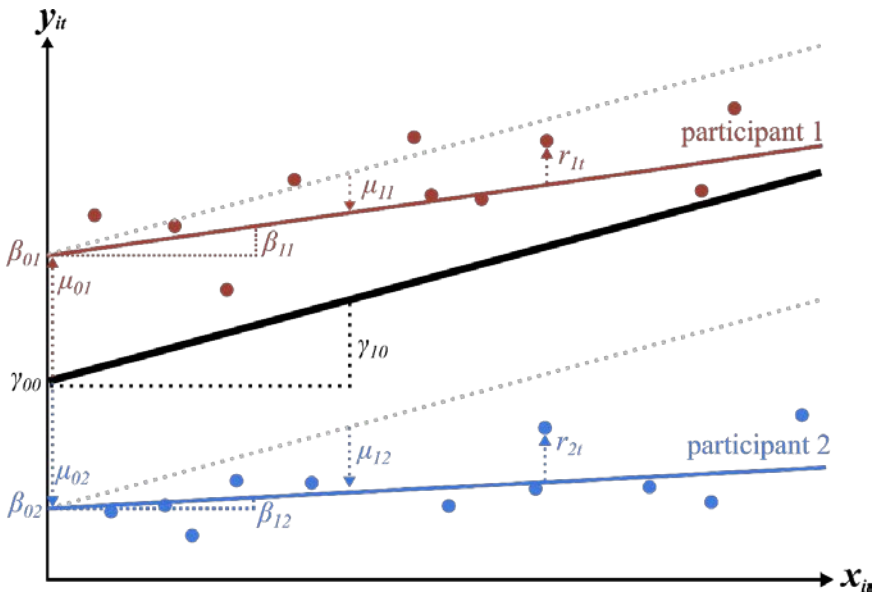

Figure 2.3. Graphical representation of a multilevel model representing the association between two momentary variables, x_{it} and y_{it}. The blue and red lines represent the within-person (Level 1) regression lines between x_{it} and y_{it} for two different (fictional) participants (i = 1,2), each of which is characterised by a person-specific intercept (β_{0i}) and slope (β_{1i}). Deviations of an individual's data points from their person-specific regression line are denoted by r_{it} (where t can represent any measurement occasion from 1-90). The thick black line represents the grand-mean regression line, specified by Level 2 equations for the grand-mean intercept (γ_{00}) and slope (γ_{10}). The deviation of each person-specific intercept from the grand-mean intercept is denoted by μ_{0i}, whilst the deviation of each person-specific slope from the grand-mean slope is denoted by μ_{1i}.

The within-person relationships denoted by equation 1.1 are allowed to vary between people (i.e. they are specified as 'random' effects, as opposed to being fixed across people) by introducing person-specific error terms (μ_{0i} and μ_{1i}) for both the Level 1 intercept and slope in a Level 2 equation:

$$\text{Level 2 (between-person):} \qquad \beta_{0i} = \gamma_{00} + \mu_{0i}$$
$$\beta_{1i} = \gamma_{10} + \mu_{1i} \qquad (1.2)$$

Here, the person-specific intercepts (β_{0i}) and slopes (β_{1i}) from the Level 1 equation are essentially 'brought down' to the Level 2 equations as outcome variables, and modelled as a function of the grand-mean intercept/slope (γ_{00}/γ_{10}) plus a person-specific error term (μ_{0i}/μ_{1i}).

When the Level 1 predictor variable x_{it} is entered un-centred (i.e. raw scores are used), the grand mean intercept (γ_{00}) is interpreted as the *average within-person score* on the outcome variable, y_{it}, when x_{it} is zero. The grand-mean slope (γ_{10}) can be interpreted as the *average within-subject relationship* between the predictor x_{it} and the outcome x_{it}.

The values of γ_{00} and γ_{10} provide the parameters for the grand-mean regression equation, which is illustrated in Figure 2.3 (thick black regression line), alongside the person-specific error terms for participants 1 (μ_{01} and μ_{11}) and 2 (μ_{02} and μ_{12}).

2.3.2.1.2 Centring of Predictor Variables

How predictors are centred is one of the critical aspects of multilevel analyses. These analyses produce unstandardized coefficients, and in such analyses, the intercept is meaningful. Centring is particularly important at Level 1 because centring changes the meaning of the Level 1 intercept and slope, and these parameters are being 'brought up' to Level 2. That is, by changing how predictors are centred at Level 1, one changes what is being analysed at Level 2 (Nezlek, 2011).

As illustrated above, when Level 1 predictors are entered un-centred (using raw scores), the intercept for each person (β_{0i}) represents the expected value of the outcome variable for person i when the predictor equals zero. As such, at Level 2, the grand-mean intercept (γ_{00}) is interpreted as the *average within-person score* on the outcome variable when the predictor equals zero. However, where a predictor is measured on a 1-7 likert scale, as in the present thesis, zero is not a valid value for the predictor.

Two different centring options can be used in order to produce an interpretable intercept in cases where zero is not a valid value for the Level 1 predictor variable (Enders & Tofighi, 2007). Grand mean centring (GMC) of predictor variables refers to the practice of subtracting the *sample mean of the predictor* from each raw predictor score ($x_{it} - \overline{x}$). Person (or group) mean centring (PMC) of predictor variables is conducted by subtracting *a person's mean score on the predictor* from each raw predictor score provided by that same person ($x_{it} - \overline{x}_i$). These two methods have very different implications for the interpretation of regression coefficients

When Level 1 predictors are entered grand-mean centred, the intercept for each person (β_{0i}) represents the expected value of the outcome variable when the Level 1 predictor is at its grand mean *across all individuals in the sample*. This changes the meaning of the grand mean intercept (γ_{00}), which is now interpreted as the average within-person score on the outcome variable when the predictor is *at its grand mean across individuals*. Thus, one of the critical consequences of GMC is that it adjusts the intercept for Level 2 differences in the predictor. Furthermore, the presence of between-person variation in the GMC predictor scores means that the person-specific (β_{1i}) and grand mean regression slopes (γ_{10}) are also an ambiguous mixture of the within- and between-person association between the predictor and the outcome. Raudenbush and Bryk (2002) suggest for this reason that GMC results in an inappropriate estimator for the average within-person effect.

Alternatively, when Level 1 predictors are entered person-mean centred, the intercept for each person (β_{0i}) represents the expected value of the outcome variable when the Level 1 predictor is at its mean *for that particular individual*. This changes the meaning of the grand mean intercept (γ_{00}), which is now interpreted as the average within-person score on the outcome variable when the predictor is *at its pooled within-person mean* (Enders & Tofighi, 2007). In contrast to GMC, PMC removes all between-person variation from the predictor variable and yields person-specific regression slopes (β_{1i}) that are 'pure' estimates of the relationship between the predictor and outcome for each person. This results in a grand mean regression slope coefficient (γ_{10}) that is unambiguously interpreted as the pooled within-person regression of the predictor on the outcome (Enders & Tofighi, 2007).

For these reasons, it has been suggested that PMC is the most appropriate form of centring in situations in which the primary substantive interest involves a Level 1 (i.e., within-person) predictor (Raudenbush & Bryk, 2002). Since the primary focus of this

thesis is in characterising the average momentary within-person relationships between voice related constructs, PMC will be used in all analyses.

2.3.2.1.3 Entry Method

Hox (2010a) recommends a bottom-up analysis strategy, whereby model building begins with a basic, intercept only model (where the intercept is modelled as random, and no explanatory variables are included), and further parameters are systematically added. At each stage, we decide which regression coefficients or (co)variances to keep on the basis of significance tests, the change in model fit, and changes in the variance components (i.e. whether these are reduced). Using Maximum Likelihood (ML) estimation, nested models can be compared using the likelihood ratio test, whilst non-nested models are compared by computing change in Akaike's Information Criterion (AIC; Burnham, Anderson, & Anderson, 2004). Since fixed parameters are typically estimated with more precision than random parameters (Hox, 2010a), it is suggested that each Level 1 predictor should initially be entered fixed (i.e. the variance components of the slopes are fixed at zero). When the contribution of Level 1 predictors has been assessed, Level 2 predictors can be added to the model, in order to examine whether person-level explanatory variables explain between-person variation in the dependent variable.

Once the fixed part of the model has been established, testing for random slope variation is performed on a variable-by-variable basis. Variables with no significant fixed effects should be tested for random slope variation. Once it has been established which slopes have significant variance components, all of the variance components are added simultaneously into the final model, and the fit of this random model compared to the fixed model.

Finally, cross-level interactions between Level 1 and Level 2 predictors can be tested for those Level 1 predictors with significant slope variation. This allows an assessment of moderation of Level 1 (within-person) associations by Level 2 (person-level) variables.

2.3.2.1.4 Controlling for time effects

Intensive longitudinal data not only differ across participants; they are also strictly ordered in time. Because of this time ordering of values, it is possible that concurrent changes in x_{it} and y_{it} are not due to any causal process but may be a consequence of the passage of time itself, or of some third variable that changes linearly with time. As a

result, Bolger and Laurenceau (2013) recommend that in order to rule out time as a source of confounding of within-subject x_{it}-to-y_{it} relationships, time (i.e. measurement occasion) must be included as a covariate in the Level 1 model.

2.3.2.1.5 Assumptions of Multilevel Models

Due to the presence of residuals at multiple levels of analysis, multilevel models entail a number of additional assumptions beyond those of traditional multiple regression approaches (Steele, 2014):

A. Level 1 errors

i. Normality and homoscedasticity

Level 1 errors for different observations within individuals are assumed to be normally distributed with a mean zero and constant variance σ_r^2 (i.e. homoscedasticity of variance across different levels of the predictor; Steele, 2014). The variance-covariance matrix, "$\sum_R$", of the T_i residuals, $\{r_{it}\}$, for person i is sometimes called the "R-matrix". With the just-stated assumptions, the R-matrix has the value σ_r^2 in all diagonal cells and zero in all off-diagonal cells:

$$r_{it} \sim N(0, \sigma_r^2) \quad (1.3)$$

ii. Independence of Level 1 errors

In addition, it is assumed that these Level 1 errors are independent for any pair of occasions t and t' for individual i:

$$\mathrm{cov}(r_{it}, r_{it'}) = 0 \quad (1.4)$$

and that Level 1 errors are independent for any pair of observations for different individuals i and i':

$$\mathrm{cov}(r_{it}, r_{i't'}) = 0 \quad (1.5)$$

The assumption indicated by equation (1.5) will usually be reasonable unless individuals are clustered in some way (Steele, 2014). However, the assumption indicated by equation (1.4) may not hold, particularly in intensive longitudinal research utilising ESM, since due to the close timing of consecutive measurement occasions, the correlation between responses (and their associated errors) at occasions t and t' is

likely to be higher for occasions that are closer together temporally, and smaller the further apart are occasions t and t'. As such, this possibility of serial autocorrelation must be tested and corrected for if necessary (Bolger & Laurenceau, 2013).

There are several possible structures that can be specified for the R-matrix to allow $\text{cov}(r_{it}, r_{it'}) \neq 0$. In intensive longitudinal research, a first-order autoregressive, or AR(1), structure is commonly used (Walls, Höppner, & Goodwin, 2007):

$$r_{it} \sim N(0, \Omega_r), \quad \Omega_r = \sigma_r^2 \begin{pmatrix} 1 & & & & \\ \rho & 1 & & & \\ \rho^2 & \rho & 1 & & \\ \vdots & \vdots & \vdots & \ddots & \\ \rho^{T-1} & \rho^{T-2} & \rho^{T-3} & \cdots & 1 \end{pmatrix} \quad (1.6)$$

Under an AR(1) model, $\text{var}(r_{it}) = \sigma_r^2$ for all occasions *t* and $\text{cov}(r_{it}, r_{it'}) = \sigma_r^2 \rho^{|t-t'|}$, so $\text{corr}(r_{it}, r_{it'}) = \rho^{|t-t'|}$ (Steele, 2014).

With this structure specified, the correlation between the responses at occasions t and t' depends on the length of time between them, and is smaller the further apart are occasions t and t'.

An AR(1) model has just one additional parameter, ρ, to capture the within-individual covariance structure. The covariance matrix given by equation (1.6) implies a constant correlation for a given lag. For example, $\text{corr}(r_{it}, r_{it'}) = \rho$ for any pair of consecutive occasions t and t', and $t' = t + 1$, i.e. $\text{corr}(r_{i1}, r_{i2}) = \text{corr}(r_{i2}, r_{i3}) = \cdots = \text{corr}(r_{i,T-1}, r_{iT}) = \rho$. For this assumption to hold, observations must be equally spaced. In the present thesis (and most ESM research), this is not the case, since measurement occasions are spaced between 30-90 minutes apart. However, serial autocorrelation is tested for by comparing the fit of baseline models to those with an AR(1) structure. This structure was retained in cases where model fit was substantially improved.

iii. Level 1 errors are uncorrelated with Level 1 predictors

Level 1 errors are additionally assumed to be uncorrelated with any Level 1 predictors.

$$\text{cov}(r_{it}, x_{it}) = 0 \quad (1.7)$$

B. Level 2 residual terms

i. Normality and homoscedasticity

Level 2 residual terms μ_{0i} and μ_{1i} are assumed to follow a bivariate normal distribution with zero mean:

$$\begin{pmatrix}\mu_{0i}\\ \mu_{1i}\end{pmatrix} \sim N(0, \Omega_\mu), \quad \Omega_\mu = \begin{pmatrix}\sigma^2_{\mu_0} & \\ \sigma_{\mu_{01}} & \sigma^2_{\mu_1}\end{pmatrix} \tag{1.8}$$

The between-person variance in the grand mean intercept is $\text{var}(\mu_{0i}) = \sigma^2_{\mu_0}$, whilst the between-person variance in the grand mean slope is $\text{var}(\mu_{1i}) = \sigma^2_{\mu_1}$. These variances indicate the degree to which the intercept and the slope vary between individuals.

The covariance between individuals' intercepts and slopes is $\sigma_{\mu_{01}}$. This value can be interpreted in combination with the signs of the intercept and slope of the average line. For example, if both the average intercept ($\gamma_{00} > 0$), and slope are positive ($\gamma_{10} > 0$), a positive intercept-slope covariance ($\sigma_{\mu_{01}} > 0$) indicates that individuals with above-average intercepts ($\beta_{0i} > 0$) tend also to have steeper-than-average slopes ($\beta_{1i} > 0$), whilst individuals with below-average intercepts ($\beta_{0i} < 0$) tend to have shallower-than average slopes ($\beta_{1i} < 0$). Conversely, under these circumstances, a negative intercept-slope covariance ($\sigma_{\mu_{01}} < 0$) implies that individuals with above-average intercepts ($\beta_{0i} > 0$) tend to have shallower-than-average slopes ($\beta_{1i} < 0$), whilst individuals with below-average intercepts ($\beta_{0i} < 0$) tend to have steeper-than average slopes ($\beta_{1i} > 0$).

Variance and covariance parameters are generally not assumed to be zero (zero between-person variance in an intercept or slope indicates that the parameter should be specified as 'fixed' in the Level 2 model), and thus the variance-covariance matrix Ω_μ is usually specified as unstructured (i.e. unconstrained), in order to allow estimation of each variance component.

ii. Level 2 residual terms are uncorrelated for any pair of individuals

We additionally assume that the Level 2 residual terms for any pair of individuals i and i' are uncorrelated:

$$\begin{aligned}\text{cov}(\mu_{0i}, \mu_{0i'}) &= 0\\ \text{cov}(\mu_{1i}, \mu_{1i'}) &= 0\end{aligned} \tag{1.9}$$

This assumption will usually reasonable unless individuals are clustered in some way.

iii. Level 2 residual terms are uncorrelated with Level 1 errors

Random terms at different levels are assumed to be uncorrelated, regardless of whether they refer to the same individual ($i = i'$):

$$\begin{aligned} \text{cov}(\mu_{0i}, r_{i't}) &= 0 \\ \text{cov}(\mu_{1i}, r_{i't}) &= 0 \end{aligned} \quad (1.\ 10)$$

iv. Level 2 residuals are uncorrelated with Level 1 predictors

Level 2 residuals are additionally assumed to be uncorrelated with any Level 1 predictors.

$$\begin{aligned} \text{cov}(\mu_{0i}, x_{it}) &= 0 \\ \text{cov}(\mu_{1i}, x_{it}) &= 0 \end{aligned} \quad (1.\ 11)$$

2.3.2.1.6 Model Diagnostics

Diagnostic checks were carried out for all of the above-stated assumptions for each model, by generating model-predicted Level 1 residuals and Level 2 random effects, and visually inspecting plots of their univariate and bivariate distributions (Rabe-Hesketh & Skrondal, 2008; Snijders & Berkhof, 2007). Where model assumptions were violated, robust standard errors were calculated (Huber, 1967).

A. Outliers and Influential Cases

i. Outliers at Level 1

Bivariate outliers were detected by inspecting standardised Level 1 residuals for values greater than ±4 (Rabe-Hesketh & Skrondal, 2008).

A. Influential cases at Level 2

Influential cases at Level 2 can be particularly problematic in small samples (Van der Meer, Te Grotenhuis, & Pelzer, 2010). DFBETAs are the most direct influence measure of interest to model builders; these measure the difference between a regression coefficient when the *i*th observation is included and excluded, the difference being scaled

by the estimated standard error of the coefficient. Belsley, Kuh, and Welsch (1980) suggest observations with |DFBETAi| $> 2/\sqrt{n}$ as deserving special attention, but it is also common practice to use 1 (Bollen & Jackman, 1990), meaning that the observation shifted the estimate at least one standard error. In the present thesis, DFBETAS were generated using the Stata mltcooksd command within the Multilevel tools (mlt) package.

2.3.2.2 Modelling temporal dynamics

2.3.2.2.1 Overview

The approach described above allows an assessment of the momentary association between two or more measured variables. We may additionally wish to model the temporal dynamics of voice hearing experiences in relation to other contextual variables, in order to examine the temporal sequelae of these experiences. Two main approaches have been described within the ESM literature; voice phase analysis and time-lagged analysis.

2.3.2.2.2 Voice Phase Analysis

This approach was first described by Delespaul, DeVries, and van Os (2002), who determined that voice 'episodes' occurring during daily life (i.e. an uninterrupted series of ESM voice reports) follow a particular temporal course, characterised by a rise and fall in voice intensity through different phases of the episode. In this approach, each ESM report is categorised according to its temporal relationship with the first report of a voice episode (i.e. the first time a voice is reported following a period of low reported voice intensity). ESM reports are categorised as; i) the last report before an episode; ii) the first report in an episode; iii) the last report in an episode; iv) the first report after an episode; v) voice reports in the middle of an episode; vi) reports occurring outside of an episode. Using this approach, it has been demonstrated that that voice intensity typically increases to a peak at moments occurring during an episode, before dropping at the last report of an episode (Delespaul et al., 2002; Oorschot, Lataster, Thewissen, Bentall, et al., 2012).

The approach to categorisation of voice reports is illustrated in Figure 2.4. Within this approach, ESM reports with a score of ≥ 3 on the voice intensity item are classified as occasions when voices were present (indicated in the figure by black circles). This cut-off value has been used within previous descriptions of this method (Oorschot, Lataster, Thewissen, Bentall, et al., 2012), presumably because it allows for the visualisation of (low-level) variation in voice intensity occurring outside of periods where voices are

reported at higher intensities. Referring to the figure, each measurement occasion (T) over the course of the day can be categorised according to its relation with surrounding voice reports. In the upper panel, a voice report occurred at time T (indicated by the black circle at measurement occasion 3), and was both preceded and followed by other voice reports at occasions 2 and 4 respectively. As such, within the coding scheme outlined in Table 2.2, this ESM report is classified as a 'moment during' an episode. In the lower panel, we are seeking to classify an ESM report that occurred later in the day (measurement occasion 7). At this time point, no voices were reported (indicated by the white circle). However, this report was followed by a voice report at measurement occasion 8 and as such, this report is classified as occurring at the 'last moment before' an episode.

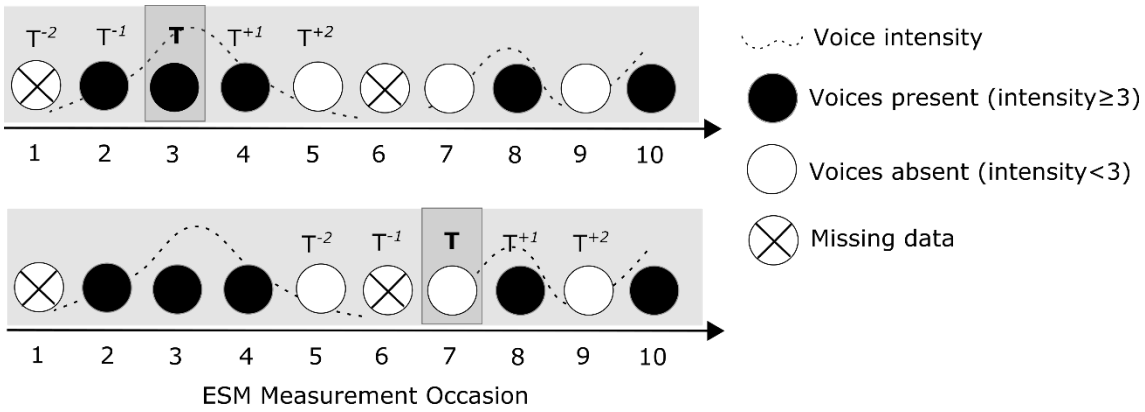

Figure 2.4. Illustration of categorisation of voice reports.

Table 2.2 displays the full coding scheme via which ESM voice reports are classified. Within the table, values of 0 indicate ESM reports with a score of <3 on the item 'I hear voices', whilst values of 1 indicate ESM reports with a score of ≥3 on this item. Values labelled 'x' indicate missing data. Entries in the 'Voice Phase' column indicate the category to which the values in the remaining columns have been classified. This classification is determined according to the values in columns T_{-2} – T_{+2}; column T_{-1} indicates whether or not voices were reported at the previous measurement occasion (and so on for column T_{-2}), whilst column T_{+1} indicates whether voices were reported at the next occasion (and so on for column T_{+2}). A voice episode is defined as sequence of one or more voice reports; a maximum of one missing data point is permitted per episode.

Table 2.2. Coding scheme for classification of voice reports according to phase within an episode

Voice Phase	**T_{-2}**	**T_{-1}**	**T**	**T_{+1}**	**T_{+2}**
Unrelated moment		0	0	0	
Unrelated moment		0	0	x	0
Unrelated moment	0	x	0	0	
Unrelated moment	0	x	0	x	0
Last before an episode			0	1	
Last before an episode			0	x	1
First during episode		0	1		
First during episode	0	x	1		
Moment during episode		1	1	1	
Moment during episode		1	1	x	1
Moment during episode	1	x	1	1	
Moment during episode	1	x	1	x	1
Last during episode			1	0	
Last during episode			1	x	0
First after an episode		1	0		
First after an episode	1	x	0		
First and last during episode		0	1	0	
First and last during episode	0	x	1	0	
First and last during episode		0	1	x	0
First and last during episode	0	x	1	x	0
Last before and first after episode		1	0	1	
Last before and first after episode	1	x	0	1	
Last before and first after episode		1	0	x	1
Last before and first after episode	1	x	0	x	1

Notes: each ESM report is categorised according to its temporal relationship with the first report of a voice episode (i.e. the first time a voice is reported following a period of low reported voice intensity). ESM reports are categorised as; i) the last report before an episode; ii) the first report in an episode; iii) the last report in an episode; iv) the first report after an episode; v) voice reports in the middle of an episode; vi) reports occurring outside of an episode.

Once each ESM report has been classified according to this coding scheme, the five voice phases can be entered as dummy-coded predictor variables in a multilevel model, in order to explore the temporal relationship between voice episodes and hypothesised antecedent variables (Delespaul et al., 2002; Oorschot, Lataster, Thewissen, Bentall, et al., 2012):

$$\begin{aligned} &\text{Level 1:} && y_{it} = \sum_{k=1}^{K} \beta_{ki}\text{VOICE PHASE (k)}_{it} + r_{it} \\ &\text{Level 2:} && \beta_{kli} = \sum_{k=1}^{K} \gamma_{k0} + \mu_{ki} \end{aligned} \tag{1.12}$$

Here, y_{it} represents the reported level of a particular momentary experience (e.g. voice intensity) of person i at time t. The Level 1 model is a no-intercept model where voice phases are entered un-centred as six dummy-coded variables (k). The Level 2 model allows each Level 1 coefficient to vary between participants. The Level 2 coefficients (γ_{k0}) indicate the grand-mean relationship between each Level 1 predictor and the outcome variable.

2.3.2.2.3 Dynamic (Autoregressive) Models

Dynamic models are used when previous responses are believed to exert a causal influence on subsequent responses (Nezlek, 2012a). This pattern of dependency is sometimes referred to as *state dependence* (Steele, 2014). In such analyses, the goal is to determine if the relationship between one variable measured at time *n*-1 is related to another variable at time *n*, or vice versa. Such models (equation 1.13) typically control for levels of the outcome variable at the previous time point, in order to identify the independent contribution of proposed antecedents (Wichers, 2014). Reverse modelling (equation 1.14) allows for an assessment of temporal precedence, a necessary but not sufficient condition for the demonstration of causality (Conner & Lehman, 2012):

Forward Model:

$$\begin{aligned} &\text{Level 1:} && \text{VAR1}_{it} = \beta_{0i} + \beta_{1i}\text{VAR2}_{t-1,i} + \beta_{2i}\text{VAR1}_{t-1,i} + r_{it} \\ &\text{Level 2:} && \beta_{ki} = \sum_{k=1}^{K} \gamma_{k0} + \mu_{ki} \end{aligned} \tag{1.13}$$

Reverse Model:

Level 1: $$\mathrm{VAR2}_{it} = \beta_{0i} + \beta_{1i}\mathrm{VAR1}_{t-1,i} + \beta_{2i}\mathrm{VAR2}_{t-1,i} + r_{it} \quad (1.14)$$

Level 2: $$\beta_{ki} = \sum_{k=1}^{K} \gamma_{k0} + \mu_{ki}$$

It is common in a dynamic model for the residuals r_{it} to be assumed independent. Although it is possible to allow for an additional source of dependence through autocorrelated r_{it}, this is not generally done in practice (Steele, 2014).

The clearest pattern of results for such analyses is when one of these lagged coefficients is significant, whilst the other is not. This provides tentative evidence of causality in one direction, whilst the reverse causal relationship is not viable (Nezlek, 2011).

2.3.2.3 Multilevel Mediation

2.3.2.3.1 Overview

Because the independence assumption is violated for hierarchical data structures, standard approaches to mediation analysis will produce biased tests of the effects in the model.

Furthermore, with hierarchical data, predictors can reside at different levels of the data (e.g., within-person vs. between-person characteristics). Given this, mediation in multilevel models may take several forms (Bolger & Laurenceau, 2013). Upper level mediation exists when the effect of a Level 2 predictor on a Level 1 outcome is mediated by another Level 2 predictor (2 → 2 → 1 mediation). Lower level mediation exists when the mediator is a Level 1 variable. In some cases of lower level mediation, the effect of a Level 2 predictor is mediated (2 → 1 → 1 mediation), and in other cases the effect of a lower level predictor is mediated (1 → 1 → 1 mediation). In the current thesis, the primary interest is in lower level 1 → 1 → 1 mediation.

Bauer, Preacher and Gil (2006) have demonstrated a method for estimating a 1 → 1 → 1 model using conventional multilevel analysis software, using selection (or indicator) variables to formulate the model with a single Level 1 equation (in contrast to previous methods, which required the specification of separate Level 1 equations for the mediator and outcome variable; e.g. Kenny, Korchmaros and Bolger (2003)). This approach entails restructuring ESM data by 'stacking' Y and M for each measurement occasion *t* within individuals *i*, creating a new outcome variable, Z_{it}. This single outcome variable

allows a multivariate model to be fit using univariate multilevel modelling software. Two indicator variables - SY and SM – are created to distinguish the two variables stacked in Z_{it}.The variable SM is set equal to 1 when Z_{it} refers to M and is 0 otherwise. Similarly, the variable SY is set equal to 1 when Z_{it} refers to Y and is 0 otherwise. The variables X and M are retained in the new data set, as they are needed as predictors of Z_{it}. Following this data restructuring, the $1 \rightarrow 1 \rightarrow 1$ multilevel mediation model can be specified as follows:

$$\text{Level 1:} \quad Z_{it} = \beta_{1i}SM_{it} + \beta_{2i}SM_{it}X_{it} + \beta_{3i}SY_{it} + \beta_{4i}SY_{it}M_{it} + \beta_{5i}SY_{it}X_{it} + r_{it} \tag{1.15}$$

$$\text{Level 2:} \quad \beta_{ki} = \sum_{k=1}^{K} \gamma_{k0} + \mu_{ki}$$

When fitting this model, one must specify that a set of distinct residual-error parameters be estimated for each level of SM (Bauer et al., 2006). This represents a form of heteroscedasticity because the residual variance for Z_{it} is then conditional on SM. This can be achieved using the residuals by() option in Stata (StataCorp, 2015a).

Thus, Z_{it} is the value of the outcome Y_{it} or mediator M_{it} for person i at time t, dependent upon the value (0 or 1) of the dummy indicator variables SM and SY, plus the interactions between these indicator variables and the outcome variables y_{it} and M_{it}. In the Level 2 equation, γ_{20} indicates the average within-person effect of X_{it} on M_{it}; γ_{40} indicates the average within-person effect of M_{it} on y_{it}; whilst the average within-person *direct effect* of X_{it} on y_{it} is denoted by γ_{50}. The average indirect and total effects are specified by the formulae:

$$\text{Average indirect effect:} \quad E(\beta_{2i}\beta_{4i}) = \gamma_{20} \times \gamma_{40} + \sigma_{\mu_{24}} \tag{1. 16}$$

$$\text{Average total effect:} \quad E(\beta_{2i}\beta_{4i} + \beta_{5i}) = \gamma_{20} \times \gamma_{40} + \sigma_{\mu_{24}} + \gamma_{50} \tag{1. 17}$$

95% confidence intervals for these effects were calculated using formulae specified by Bauer, Preacher, and Gil (2006).

2.3.3 Statistical Power

Power to detect effects in intensive longitudinal studies employing multilevel analyses is determined by eight factors (Bolger, Stadler, & Laurenceau, 2011); i) the expected effect size for the average participant; ii) the number of participants in the sample; iii) the total number of measurement occasions per participant; iv) the within-person variance in the predictor; v) the between-person variance in the effect; vi) the autocorrelation coefficient between adjacent error terms; vii) the within-person variance in the effect; viii) the selected type 1 error probability (i.e. the chosen α-level).

Given these various sources of variance, which occur at both the within- and between-person levels, power analysis within multilevel analyses is a complex exercise (Hox, 2010b). As a result, various rules of thumb have been proposed to guide researchers in selecting an appropriate sample size at each of these levels, with Kreft's '30/30 rule' (Kreft, 1996) being commonly employed (i.e. 30 participants with at least 30 measurement occasions per participant. Based on a review of simulation studies, (Hox, 2010b) concluded that this sample size is sufficient when the primary focus of investigation is fixed model parameters (i.e. the average effect across participants), as is the case in the present thesis. In line with this suggestion, previous ESM studies have detected significant effects in samples of ~30, with a total of 60 measurement occasions per participant (Hartley et al., 2015; Hartley, Haddock, et al., 2014; So et al., 2013).

Given the focus of the present study on voice hearing experiences, it is critical to base power calculations on the expected total number of ESM voice reports. Assuming a final sample size of 30 participants, and an average ESM compliance rate of 60% across participants (the minimum rate typically observed in ESM studies within schizophrenia populations; Hartley, Varese, et al., 2014), the study is expected to produce between 1620-2700 momentary data reports over the course of the nine day assessment period. Past ESM research has demonstrated that voices are likely to be reported on ~60% of measurement occasions (Peters, Lataster, et al., 2012); thus, final analyses are expected to be based on a minimum of 972 voice reports across 30 participants (32 voice reports on average per person), slightly exceeding the 30/30 sample size recommended by Kreft (1996).

2.4 Chapter Summary

This chapter has presented an overview of important practical issues of design, measurement and analysis in ESM studies, and a rationale for methods employed in Chapters Four, Five and Seven.

3 Chapter Three: ESM Scale Psychometrics

3.1 Chapter Overview

The previous chapter discussed the methodological and analytic considerations inherent in studies employing intensive longitudinal designs, and presented a rational for study design decisions made within the present thesis. The present chapter will provide an overview of preliminary analyses undertaken prior to substantive inferential analyses in Chapters Four, Five and Seven[2]. Approaches to data preparation will be discussed, including a rationale for data exclusion based on participant non-compliance, and clinical and demographic characteristics presented for the final sample included within subsequent analyses. An analysis of missing data will be presented, and approaches to handing missing data discussed. A comprehensive psychometric analysis of ESM measures will be presented, including the assessment of; i) within- and between-person variability; ii) item reliability; iii) item validity; iv) measurement reactivity; v) diagnostic differences in ESM outcomes.

3.2 Analysis software.

Stata 14.0 (StataCorp, 2015b) was employed for all data preparation and analyses, with the exception of the calculation of multilevel correlation matrices (Section 3.5.3), which were obtained using Mplus (version 6.0; Muthén & Muthén, 2010).

3.3 Data preparation.

Given the complexity of the data collected using the ESM, data cleaning and pre-processing is arguably one of the most challenging aspects of conducting an ESM study (McCabe, Mack, & Fleeson, 2012). Whilst using a smartphone to administer the ESM questionnaire limits the labour associated with transcribing the data, other data quality issues may arise due to technical problems, or errors made during the questionnaire coding phase (particularly due to the extensive use of conditional branching).

As such, the first stage of data cleaning involved inspection of univariate and bivariate summary statistics, in order to identify values lying outside of the possible scale range, or coding errors within conditional responses. As part of this process, conditional

[2] The study presented in Chapter Six utilises different approaches to analysis; these are described in the relevant chapter.

responses to voice-related items (e.g. “I felt inferior to the voice”/”I felt inferior to the voices”) were aggregated to form a single variable reflecting the construct of interest. Finally, records completed more than 15 minutes after the prompt (or where the prompt was dismissed by the participant) were recoded as invalid. The number of valid responses per participant was calculated, and participants who provided less than 33% of the 90 possible responses were excluded from further analysis. Four of 35 participants were excluded on this basis. A summary of the demographic and clinical characteristics of the final sample (*N* = 31) is presented in Table 3.1.

Table 3.1. *Demographic and clinical characteristics (N=31)*

Mean age (SD)	41.9 (11.4)
Gender, n (%)	
Male	11 (35.5)
Female	18 (58.1)
Other*	2 (6.5)
Ethnicity, n (%)	
White British	27 (87.1)
Black African	0 (0.0)
Black Carribean	0 (0.0)
Asian	0 (0.0)
White Other	1 (3.2)
Other	3 (9.7)
Place of birth, n (%)	
UK-born	28 (90.3)
Non-UK-born	3 (9.7)
Level of Education, n (%)	
School	7 (22.6)
Further	17 (54.8)
Higher	7 (22.6)
Employment Status, n (%)	
Unemployed	14 (45.2)
Other	17 (54.8)
OPCRIT+ DSM-IV Diagnosis, n (%)	
Schizophrenia	12 (38.7)
Schizoaffective disorder	2 (6.5)
Other psychotic disorder	3 (9.7)
Borderline personality disorder	10 (32.3)
Depression with psychotic features	3 (9.7)
Bipolar Disorder	1 (3.2)
Psychotropic medication, n (%)	
Antipsychotic	28 (90.3)
Atypical	28 (90.3)
Typical	0 (0.0)
Atypical and typical	0 (0.0)
Antidepressant	21 (67.7)
Other	10 (32.3)
None	0 (0.0)

*Two participants reported non-binary gender identification

3.4 Missing data.

The near inevitability of missing data in intensive longitudinal studies has been well documented (Black et al., 2012; Kimhy et al., 2012). Three kinds of naturally arising missing data can be differentiated in studies of this nature. First, item non-response occurs when participants answer only a subset of items at any particular measurement occasion, and do not respond to certain individual items (Schafer & Graham, 2002). This type of non-response is not such a problem when questionnaires are administered via smartphone, since participants are typically required to complete the entire questionnaire. Second, wave non-response occurs when participants do not complete any items for a particular measurement occasion (Jelicić, Phelps, & Lerner, 2009). This typically occurs when participants miss or dismiss the alarm. This is the most common type of missing data in ESM studies. Finally, missing data can occur due to attrition (a special case of wave non-response); where a participant drops out of the study and does not return.

Further to these causes, the decision is often made in ESM studies to exclude measurements that are not completed within a requested time-frame (e.g. within 15 minutes of the prompt); these measurements are typically considered 'invalid', as they may no longer represent ambulant monitoring of experience (Palmier-Claus et al., 2011). In addition, it is often recommended to exclude participants who provide a limited number of valid reports (typically those completing less than a third of assessments over the sampling procedure), since these measurements can no longer be considered a random sample of momentary experiences (Hartley, Varese, et al., 2014; Palmier-Claus et al., 2011).

Analyses of data included in Chapters Four, Five and Seven (N=31) indicated that wave non-response accounted for the vast majority of missing data in this study (939 cases), with invalid responses due to delayed questionnaires being the second most common cause (135 cases). There were no cases of item non-response. Thus, overall, a total of 1071 waves were missing, out of a possible 2790 (i.e. 90 per participant), indicating that 38.4% of data was missing overall (i.e. a compliance rate of 61.6%). This is similar to compliance rates demonstrated in previous ESM studies within schizophrenia populations (Hartley, Varese, et al., 2014).

3.4.1 Determining the mechanism of missingness

Missing data are not inherently problematic; however, threats to the validity of statistical inferences arise when missing data are handled inappropriately (Black et al., 2012). The processes by which missing data occur (known as missing data mechanisms) have important implications for choosing analytic techniques that provide valid statistical inferences (Black et al., 2012).

Three mechanisms of missingness have been described, with respect to the relationship between the probability of missingness and variables in the dataset (Rubin, 1976). In brief, data are considered 'missing at random' (MAR), when the probability of missingness depends on the observed data, but not on the values of missing data. Data are considered 'missing not at random' (MNAR) when missingness is a function of the unobserved values themselves, even after controlling for observed variables. Finally, an important special case of MAR, called missing completely at random (MCAR), occurs when the distribution does not depend on either the observed or unobserved data (Schafer & Graham, 2002). Missingness is considered 'ignorable' (i.e. the processes accounting for missingness do not need to be modelled within the substantive analysis) if the mechanism that created the missing data is either random or it is related to information that is known (i.e. MCAR or MAR; McKnight, McKnight, Sidani, & Figueredo, 2007). Whilst it is not possible to affirm statistically that data are MAR or MNAR, because the unobserved values are not available for such testing, the analyst can test the assumption of MCAR, and consider the plausibility of ignorable missingness (Black et al., 2012).

With respect to determining mechanisms of missingness in ESM data, the assumptions of MCAR can be tested by assessing model-relevant predictors of item- and wave-non-response (Granholm et al., 2008; Hartley, Varese, et al., 2014; Jelicić et al., 2009). In the present study, our exploration of the potential causes of missingness focuses on wave non-response (since there was no evidence of item non-response). Due to our small sample size (N=31), we used a series of simple linear regression analyses to assess the associations between the number of missing waves (i.e. measurement occasions) as the dependent variable, and i) within-person ESM item means; ii) sociodemographic variables (age and gender); ii) clinical variables (PSYRATS-AH total; an indicator of overall voice severity; see Section 2.2.7) as predictors. Significant effects of these predictors on wave non-response would indicate that the pattern of non-response departs significantly from the MCAR assumption (Black et al., 2012). The results of these analyses are displayed in Table 3.2.

Table 3.2. *Results of simple regression analyses with number of missing measurement occasions as dependent variable (N=31). Unstandardized betas are reported.*

Predictor	B	*SE*	*p*
Age	0.15	0.23	0.53
Gender (0 = Male, 1 = Female)	0.85	5.62	0.88
(0 = Male, 1 = 'Other')	-4.59	11.29	0.69
Diagnosis (0 = Psychosis, 1 = Other)	-6.24	5.10	0.23
PSYRATS-AH Total	0.25	0.62	0.69
Mean ESM Voice intensity	1.41	1.40	0.32
Mean ESM Depersonalisation	-0.16	1.32	0.91
Mean ESM Momentary stress	-1.26	2.07	0.55
Mean ESM Negative voice content	0.90	1.93	0.65
Mean ESM Voice dominance	0.42	1.38	0.76
Mean ESM Voice uncontrollability	0.43	1.39	0.76
Mean ESM Voice intrusiveness	1.73	1.98	0.39
Mean ESM Voice resistance	-1.03	1.50	0.50
Mean ESM Voice compliance	1.33	1.90	0.49
Mean ESM Voice-related distress	1.50	1.73	0.39

These results indicate that, similar to the findings of Hartley et al. (2014), there were neither large nor significant differences in the degree of wave non-response according to demographic or clinical characteristics of the sample. Furthermore, missing data were not correlated with any of the ESM variables.

Given indications of fatigue effects in past ESM studies (Broderick et al., 2003) we further explored whether these effects were partially responsible for wave non-response (i.e. whether wave non-response was more likely as the study progressed). A multi-level logistic regression model was estimated using the MELOGIT command, with the dichotomous variable 'missing wave' [1 = wave missing; 0 = wave present] as dependent variable and measurement occasion (1-90) as the independent variable. This analysis demonstrated a significant increase in the likelihood of missing data over the course of the nine days (OR = 1.01, z = 6.64, p < .001, 95% CI [1.00, 1.01]), suggesting the presence of fatigue effects, and thus divergence from the MCAR assumption.

3.4.2 Applying appropriate techniques

Whilst there is no diagnostic procedure that validly differentiates between MAR and MNAR (McKnight et al., 2007), the plausibility of MAR can be increased by including

nonresponse-relevant auxiliary variables in the analytic model (i.e. variables that predict missingness; Collins, Schafer, & Kam, 2001; Little & Rubin, 2002). This increases the likelihood that covariates of missingness are controlled for (such that any remaining variance in missingness is nonsystematic), and reduces the probability of bias in parameter estimation (Black et al., 2012; Graham, 2003). Therefore, all subsequent analyses proceeded under the assumption that missing data, including data that are missing due to attrition, were ignorable, whilst increasing the plausibility of MAR by controlling for linear effects of time (i.e. measurement occasion).

When there is evidence that missing data is statistically ignorable (under the MAR assumption), statistical and empirical evidence has established that principled missing data techniques, including maximum likelihood (ML) estimation algorithms and multiple imputation (MI), provide more accurate and efficient estimates than older *ad hoc* approaches such as complete case analysis or single imputation (Schafer & Graham, 2002). Furthermore, these principled techniques can be applied under less restrictive missing data assumptions than ad hoc approaches; even when MAR is not precisely satisfied, such departures are rarely large enough to effectively invalidate the results (Collins et al., 2001).

Maximum likelihood is the default estimation procedure for multilevel data models (the approach typically employed with ESM data; see section 2.3.2) in many commonly used statistical packages. With these estimation algorithms, the parameters that have the greatest likelihood of producing the observed data, given the specified model, are identified. MLE does not require observations to be balanced; individuals may have differing numbers of observations spaced at different intervals, which makes MLE well suited for intensive longitudinal designs (Black et al., 2012; Schafer & Graham, 2002). All complete and partially observed cases contribute to the MLE of model parameters, and the missing data values are treated as random variables to be averaged across (Collins et al., 2001). Given a properly specified model, ML parameter estimates from incomplete longitudinal data will be unbiased and efficient when missingness is ignorable. As such, all models within this thesis will be estimated using ML estimation methods.

3.5 ESM scale psychometrics

Establishing the psychometric properties of self-reported scales and constructs is critical for the interpretation of analyses based on these scales. Poor scale reliability can attenuate the effects observed in research, as compared with the ‘true’ psychological

effects, reducing the likelihood that an observed effect will reach statistical significance. Furthermore, if a scale's scores have ambiguous or undemonstrated psychological meaning, then research using the scale cannot be interpreted confidently in terms of any particular psychological construct (Furr, 2011).

Assessing scale reliability and validity is particularly challenging with repeated measures data, since variability exists at both the between-person and within-person levels (See Section 2.3.1). That is, the total variance of each item and the covariance/correlation between items is influenced by the variation of item ratings within individuals over time and by the variation between individuals in their average rating (Reise et al., 2005). As such, one can examine the psychometric properties of a scale both across persons as well as within persons over time (Mogle, Almeida, & Stawski, 2014). Assessment of the psychometric qualities of within-person variability require statistical approaches that differ from traditional between-person approaches, since these must take into account the nested structure of the data (Nezlek, 2012a).

3.5.1 Assessing Between- and Within-Person Variation in ESM Items

The first step in assessing the psychometric properties of ESM items and scales is to estimate the between- and within-person variability for each individual item (Mogle et al., 2014). The intraclass correlation (ICC), provides an index of the percentage of between-person variability relative to the total variability, and can thus be used to assess the degree to which items vary between persons, or from moment-to-moment within persons.

In the case of repeated measures data, the ICC estimates the degree to which variance in each item is due to between-individual differences in their average item rating over time: in other words, the amount due to the variation of individual means around the grand mean as opposed to the variation of an individual's ratings around his or her own mean (Reise et al., 2005). When the ICC equals zero, all variation is within individuals. In turn, an ICC of zero indicates that the item is not behaving in a trait-like manner. Most important, an ICC of 1 means that the data are independent, and there is no need for statistical approaches that control for clustering (such as the multilevel approaches described in Section 2.3.2). To the degree that the ICC is greater than zero, item variation is due to between-individual differences in their mean level considered over time. In turn, as the ICC approaches 1, this indicates that the item reflects a more trait-like construct, with little variation within individuals.

For analyses exploring within-person associations, as is the focus of the present thesis, it is critical that items demonstrate a sufficient degree of within-person variation. If this is not the case, such items can be considered more 'trait-like' than 'state-like' (i.e. they are time-invariant). Standard deviations can be calculated at both the within- and between-person levels, providing a further indication of the variation residing at each level of analysis. A summary of item means, ICCs and within- and between-person standard deviations for items assessed in Chapters Four, Five and Seven are displayed in Table 3.3.

Table 3.3. *Means (M), intra-class correlations (ICC), and within- and between-person standard deviations (SD) for all study variables (N=31)*

					SD	
Item		*M*	%*	*ICC*	*Within-person*	*Between-person*
1.	Voice intensity	4.02	63.6	0.49	1.83	1.85
2.	Depersonalisation	3.48	68.3	0.74	1.16	2.00
3.	Momentary stress	3.56	74.4	0.37	1.58	1.27
4.	Negative voice content	5.91	94.3	0.52	1.23	1.37
5.	Voice dominance	3.94	74.6	0.73	1.10	1.91
6.	Voice uncontrollability	4.88	85.5	0.66	1.23	1.90
7.	Voice intrusiveness	4.78	92.7	0.46	1.33	1.32
8.	Voice resistance	4.84	88.2	0.66	1.21	1.75
9.	Voice compliance	2.53	52.1	0.48	1.38	1.38
10.	Voice-related distress	4.32	87.9	0.51	1.30	1.51

*Percentage of measurement occasions (*N*=1719) on which experience was reported with score >1. For voice-related items, this is the percentage of voice reports (*N*=1094) on which experience was reported with score >1.

Across participants, mean levels of negative voice content, voice intensity, voice-related distress, perceived uncontrollability and intrusiveness, and resistance to voices were particularly high, supporting the notion that hearers commonly perceive their voices as problematic during the course of their daily activities. However, ICC values indicate a significant and nontrivial level of clustering for each of the items, indicating substantial between-person variation (i.e. individual differences) in these mean levels. In particular, these analyses indicate high between-person variation in voice intensity and distress, perceived voice dominance and uncontrollability, degree of resistance to voices, and reported levels of depersonalisation, indicating heterogeneity in both the experience of voice hearing, and in the psychological mechanisms underlying these experiences. In

this context, given that nearly one third of the variance on some items is between-person variance, it is necessary to utilise statistical approaches that can control for clustering (described in Section 2.3.2).

The values of within-person standard deviations reveal substantial within-person (i.e. temporal) variation in various constructs related to the experience of distressing voices, including voice characteristics (voice intensity and negative content), voice appraisals (perceived voice dominance, uncontrollability and intrusiveness), voice responses (resistance and compliance), emotional consequences of voices (voice-related distress), and contextual factors (stress and depersonalisation). Of these constructs, depersonalisation and perceived voice dominance demonstrated the least within-person variation, suggesting that these experiences might be somewhat more 'trait-like' in nature, demonstrating greater variation between individuals than within individuals. Variables demonstrating particularly high within-person variability included voice intensity, distress, perceived voice intrusiveness, compliance with voices, and stress.

3.5.2 Assessing ESM Item Reliability

Reliability is most commonly defined as the degree to which observed score variance reflects true score variance (Furr, 2011). Common approaches to assessing reliability in cross sectional research – such as test-retest reliability – are inappropriate for ESM data; since the constructs being measured are expected to fluctuate over time, reliability cannot be assessed through comparison of one measurement to the next (Hektner, Schmidt, & Csikszentmihalyi, 2007). Other traditional approaches, such as the assessment of the internal consistency of multi-item scales, must be modified to account for variability at the within- and between-person levels (Nezlek, 2012a).

In ESM research, the traditional protocol for assessing test-retest reliability is modified (Hektner et al., 2007) so that one set of aggregated responses (typically one half of the sampling period) is tested against a second set of aggregated responses from the same person (the second half of the sampling period). The 'split-week' reliabilities for items assessed in Chapters Four, Five and Seven are displayed in Table 3.4.

Table 3.4. *Split-week reliabilities for ESM items included in Chapters Four, Five and Seven.*

Item		Split-week
1.	Voice intensity	.94***
2.	Depersonalisation	.95***
3.	Momentary stress	.78***
4.	Negative voice content	.93***
5.	Voice dominance	.84***
6.	Voice uncontrollability	.89***
7.	Voice intrusiveness	.67***
8.	Voice resistance	.93***
9.	Voice compliance	.83***
10.	Voice-related distress	.83***

These analyses provide evidence of stability of underlying central tendency for all constructs investigated. In other words, whilst voice hearing experiences tended to fluctuate from moment-to-moment, the mean levels of these constructs within individuals remained relatively stable over time.

3.5.3 Assessing ESM Item Validity

An ESM item is considered to have validity if there is evidence that scores from the measurement procedure display empirical patterns that are consistent with the theoretical construct of interest (Shrout & Lane, 2012). Assessment of validity in ESM research requires consideration of both between-person and within-person variation, with the validity of within-person measures being dependent on the variability of the scores over time and how easily the measurement concept can be interpreted in a daily context.

Convergent and discriminant validity of ESM items can therefore be established by assessing whether different constructs can be distinguished at the between- and within-person levels (Mogle et al., 2014), via the calculation of within- and between-person correlation matrices (Shrout & Lane, 2012). These correlations were produced using the TWOLEVEL BASIC procedure in Mplus (version 6.0; Muthén & Muthén, 2010). Table 3.5 displays the within- and between-person correlations for the ESM variables described in Chapters Four, Five and Seven.

Table 3.5. *Within- and between-person correlations between the main study variables.*

		1	2	3	4	5	6	7	8	9	10
1.	Voice intensity	1.00	0.44	0.05	0.55	0.42	0.40	0.53	0.25	0.37	0.42
2.	Depersonalisation	0.28	1.00	0.48	0.46	0.67	0.59	0.59	0.42	0.53	0.66
3.	Momentary stress	0.25	0.27	1.00	0.23	0.54	0.35	0.17	0.25	0.48	0.41
4.	Negative voice content	0.31	0.23	0.19	1.00	0.46	0.34	0.75	0.54	0.31	0.60
5.	Voice dominance	0.28	0.22	0.25	0.24	1.00	0.58	0.54	0.52	0.56	0.82
6.	Voice uncontrollability	0.38	0.33	0.27	0.26	0.41	1.00	0.36	0.08	0.30	0.50
7.	Voice intrusiveness	0.41	0.27	0.30	0.35	0.40	0.35	1.00	0.51	0.42	0.79
8.	Voice resistance	0.19	0.21	0.12	0.23	0.15	0.24	0.23	1.00	0.18	0.55
9.	Voice compliance	0.15	0.10	0.20	0.08	0.25	0.28	0.17	-0.07	1.00	0.64
10.	Voice-related distress	0.49	0.36	0.39	0.39	0.35	0.44	0.54	0.26	0.19	1.00

Notes. Entries below the diagonal (white) represent within-person correlations; entries above the diagonal (grey) represent between-person correlations. Reported values were calculated based on 1713 observations.

It has been suggested that convergent validity is indicated by a correlation coefficient greater than .70 (Carlson & Herdman, 2012). At the within-person level (below the diagonal in Table 3.5), none of the bivariate correlations reach this threshold; the highest average within-person correlation is between the momentary items capturing voice-related distress and intrusiveness (r = .54), indicating that, as expected, these constructs are related but sufficiently distinct. As such, whilst many of the ESM items demonstrate substantial covariance over time, they are distinguishable within any particular moment, and thus can be assumed to reflect different, but related, aspects of voice hearing experiences. For example, whilst voice characteristics (i.e. voice intensity and negative content) are associated with levels of voice distress at any particular moment in time, it is clear from the values of these correlation coefficients that voice characteristics only explain a proportion of the variance in voice-related distress. Likewise, whilst it has previously been suggested that voice hearing can be conceptualised as a form of dissociative experience (Moskowitz & Corstens, 2008), the observed correlation coefficient (r = .28) suggest that voice intensity and depersonalisation experiences are associated, but distinguishable, at any particular moment in time.

Divergent validity is indicated by low or negative correlations between items designed to capture different constructs; for example, results in Table 3.5 indicate that responses to voices might be more separable at the within-person level; the observed negative within-person correlation between compliance and resistance responses suggests that these responses do not tend to occur contemporaneously (r = -.07).

At the between-person level (above the diagonal in Table 3.5), several bivariate correlations exceed the .70 threshold; for example, there is a strong positive correlation between perceived voice dominance and voice-related distress (r = .82); in other words, in line with past cross-sectional research (Mawson et al., 2010), participants who perceive their voices to be powerful in relation to themselves are more likely to experience distress in relation to their voices. Notably however, this value differs substantially to the observed within-person correlation between these two constructs (r = .35), lending support to the notion that associations observed at the cross-sectional level may not reflect processes operating within individuals (described in Section 1.3.4.2).

3.5.4 Assessing measurement reactivity

A frequent question when using repeated daily life assessments concerns the possibility that repeatedly asking an individual how they think, feel, or behave may change the

intensity or frequency of those variables (Kimhy et al., 2012), an effect known as 'measurement reactivity'. Whilst investigations have found no indication of significant reactivity to mobile assessments in patients with schizophrenia (Johnson & Grondin, 2009), it has been recommended that researchers explore the possibility of measurement reactivity by examining and reporting linear trends in ESM items over time (Barta, Tennen, & Litt, 2011). As such, a series of multilevel regression analyses were performed with ESM items as the outcome variables, and measurement day (1-9) as the predictor variable. Results from these analyses are presented in Table 3.6.

Table 3.6. *Results of multilevel regression analyses with ESM items as outcome variables and measurement day (1-9) as the predictor (N=31). Unstandardized betas are reported.*

	Outcome Variable	*B*	*SE*	*p*
1.	Voice intensity	0.04	0.03	0.21
2.	Depersonalisation	0.00	0.02	0.84
3.	Momentary stress	-0.04	0.02	0.06
4.	Negative voice content	0.01	0.02	0.52
5	Voice dominance	0.00	0.02	0.99
6.	Voice uncontrollability	0.02	0.02	0.22
7.	Voice intrusiveness	-0.01	0.02	0.79
8.	Voice resistance	-0.00	0.02	0.80
9.	Voice compliance	0.01	0.00	0.11
10.	Voice-related distress	0.02	0.02	0.37

No significant associations were found between study day and scores on any of the ESM items, indicating no evidence of measurement reactivity in the present study.

3.5.5 Assessing diagnostic differences in momentary experiences

Given the trans-diagnostic nature of the present sample, we finally explored whether ESM item scores varied according to diagnosis. A series of multilevel regression analyses were performed with ESM items as the outcome variables, and diagnosis (psychosis or non-psychosis), and PSYRATS-AH and PSYRATS-D total scores (measures of overall voice and delusional severity; see Section 2.2.7 for a full description) as predictor variables. Results from these analyses are presented in Table 3.7.

Table 3.7. *Associations between ESM variables and diagnosis and symptom measures.*

Dependent Variable	Diagnosis[a]	PSYRATS-AH	PSYRATS-D
	B (SE)	*B* (SE)	*B* (SE)
Voice intensity	0.11 (0.56)	**0.34 (0.07)*** **	-0.07 (0.40)
Depersonalisation	0.12 (0.68)	**0.29 (0.09)** **	-0.02 (0.05)
Momentary stress	-0.16 (0.51)	0.03 (0.07)	0.03 (0.04)
Negative voice content	-0.79 (0.45)	**0.17 (0.06)** **	-0.05 (0.03)
Voice dominance	-0.49 (0.54)	**0.26 (0.07)*** **	0.04 (0.04)
Voice uncontrollability	0.63 (0.65)	**0.26 (0.09)** **	-0.02 (0.05)
Voice intrusiveness	0.07 (0.50)	**0.15 (0.07)***	-0.01 (0.04)
Voice resistance	-0.73 (0.59)	**0.19 (0.08)***	-0.01 (0.04)
Voice compliance	-0.08 (0.54)	0.11 (0.07)	0.01 (0.04)
Voice-related distress	-0.72 (0.47)	**0.13 (0.06)***	0.06 (0.03)

[a]Psychosis = 1, non-psychosis=0
[b]The *B* is the unstandardized fixed regression coefficient of the predictor in the multi-level model. Robust standard errors are reported for all coefficients.
* $p<.05$, ** $p<.01$, *** $p<.001$ *(significant findings are shown in bold)*

Inspection of the values within the second and fourth columns indicate that there is no evidence for significant differences in ESM item scores according to diagnosis (psychosis vs non-psychosis) or delusional severity. Of course, our small sample, and potential heterogeneity within the 'non-psychosis' group, precludes definitive conclusions from this data; however, these findings are consistent with similarities in the experiences of voice hearers across diagnoses, and potentially in the mechanisms underlying these experiences. As such, these results provide further justification for the use of a trans-diagnostic sample in the studies presented in Chapters Four, Five and Seven.

3.6 Chapter Summary

This chapter presented an overview of the approaches to data preparation and psychometric analysis employed in the studies described in Chapters Four, Five and Seven. Missing data was predicted by time in the study, but not clinical, demographic or ESM variables. All ESM items displayed nontrivial levels of clustering, and significant within-person variation, justifying the use of multilevel approaches to analysis. However, alongside this within-person variation, items displayed acceptable split-week reliabilities, providing evidence of the stability of underlying central tendency. Correlational analysis demonstrated that items were distinguishable at the within-person level, providing evidence of divergent validity. Finally, we found no evidence of changes in item

responses over the course of the study, suggesting that measurement reactivity was limited.

Alongside providing evidence for the psychometric robustness of ESM measures used within these studies, these results present several interesting substantive findings. Findings lend support to the notion that voice hearing experiences are dynamic, multi-faceted phenomena, varying both within and between individuals across a range of dimensions. Whilst voice experiences possess some trait-like characteristics, with the mean reported levels of voice intensity and distress being high, and remaining relatively stable over time, these findings highlight the importance of acknowledging the state-like properties of voices. Whilst no significant differences were found between participants with a psychosis diagnosis compared to those with non-psychosis diagnoses in any of the ESM variables under investigation, findings provided evidence of individual differences in both voice experiences and mechanisms.

4 Chapter Four: Depersonalisation mediates the antecedent effect of everyday stress on voice hearing

4.1 Abstract

Primary objectives: It has been proposed that dissociation plays a trans-diagnostic role in the aetiology of voice hearing experiences, possibly being involved in the onset of specific voice episodes during daily life. The present study investigated the temporal relationship between reports of voices, subjective stress and a specific component of dissociation, namely depersonalisation, in the daily lives of voice hearers with a 'need for care'. It was hypothesized that depersonalisation would mediate the relationship between daily life stress and fluctuations in voice intensity.

Method: Thirty-one psychiatric outpatients reporting frequent voice hearing experiences were studied for nine days using the Experience Sampling Method (ESM), a structured self-assessment diary technique, which included measures of subjective stress, voice intensity, and depersonalisation.

Results: Both stress and depersonalisation demonstrated significant variation over the course of voice episodes, being greatest during moments when voices were reported. High levels of both stress and depersonalisation predicted increases in voice intensity at subsequent measurement occasions, whilst a bi-directional temporal association between stress and depersonalisation was observed. Levels of depersonalisation were found to fully mediate the observed antecedent effects of stress on voice intensity.

Conclusions: These results support the notion of an antecedent and maintenance role of stress in voice hearing, with this relationship being explained by the effect of stress on depersonalisation. This study might inform future investigations into the proximal mechanisms underlying this mediation effect, and further promote the development of intervention approaches targeting stress-induced dissociation in voice hearers.

4.2 Introduction

Voice hearing experiences (or auditory verbal hallucinations) are commonly reported by patients with diagnoses including dissociative identity disorder, schizophrenia and related psychotic disorders, post-traumatic stress disorder, borderline personality disorder; bipolar disorder; and major depression (McCarthy-Jones, 2012), but are also common in the general population, where they are typically not associated with significant distress or need for care (Baumeister et al., 2017; Johns et al., 2014).

Recent research has witnessed a growing interest in dissociative processes as a potential trans-diagnostic mechanism related to voice hearing experiences (Longden, Madill, et al., 2012; Moskowitz & Corstens, 2008; Pilton et al., 2015). Dissociation refers to a ‘‘lack of normal integration of thoughts, feelings and experiences into the stream of consciousness and memory” (Bernstein & Putnam, 1986) and is typified by experiences of depersonalisation/derealisation (i.e., experiencing a sense of unreality, detachment or disconnection in relation to one's body and surroundings; Hunter, Sierra, & David, 2004), absorption (i.e., the experience of losing contact with one's present moment experience and becoming immersed in internal events such as thoughts and imagery; Waller, Putnam, & Carlson, 1996); and dissociative amnesia (i.e., the inability, distinct from ordinary forgetfulness, to consciously retrieve autobiographical, personal information that would ordinarily be readily accessible to recall; Spiegel et al., 2011).

Specific links between dissociation and voice-hearing have been proposed (Moskowitz & Corstens, 2008), with dissociative experiences potentially playing a predisposing role or acting as a preliminary stage in the development of voice hearing experiences (Pérez-Álvarez et al., 2011; Varese et al., 2012). This notion finds support from a recent meta-analysis, which found that the relationship between dissociation and voice hearing is strong and consistent, across diagnoses and non-clinical groups (Pilton et al., 2015). Furthermore, research has indicated strong and specific trans-diagnostic associations between experiences of early adversity and both voice hearing (Hammersley et al., 2003; Read et al., 2003; Shevlin et al., 2007; Whitfield et al., 2005) and dissociation (Holowka et al., 2002; Van Ijzendoorn & Schuengel, 1996), with mounting evidence that dissociation mediates the relationship between voices and childhood trauma (Perona-Garcelán et al., 2014; Perona-Garcelán, Carrascoso-López, et al., 2012).

Whilst presenting a convincing case for a relationship between voice hearing and dissociation, the research discussed has relied exclusively on cross-sectional trait measures, indicating only that voice hearers are also predisposed to dissociate.

Furthermore, some have suggested that this association may have been inflated; the measure most commonly used in these studies (the Dissociative Experiences Scale (DES; Bernstein & Putnam, 1986) includes an item assessing voice hearing, along with other items that may tap into attentional deficits commonly reported by schizophrenia patients, potentially confounding analyses of the dissociation-voices link. However, intriguingly, other research has demonstrated that dissociation is higher in patients reporting current voice hearing experiences, compared to 'remitted' voice hearers (Perona-Garcelán et al., 2008; Perona-Garcelán, García-Montes, Ductor-Recuerda, et al., 2012; Varese et al., 2012), suggesting that further explorations of the 'state' relationship between voice hearing and dissociation are warranted (Varese, Udachina, et al., 2011).

A method that is ideally suited to exploring proximal mechanisms of voice hearing is the Experience Sampling Method (ESM). ESM is a momentary assessment approach in which phenomena are recorded several times per day when prompted by an electronic device (Csikszentmihalyi & Larson, 1987). Momentary assessment holds several advantages over traditionally used measures (see Section 1.3.4.2). For example, it allows for the assessment of experiences within the contexts in which they arise naturally, conferring high ecological validity, and overcoming issues of retrospective recall bias (Palmier-Claus et al., 2011).

ESM has been used to assess the 'momentary' relationship between voices and dissociation, and research has also considered the role of stress in this equation. A body of experimental and self-report studies have suggested a role for stress as an antecedent to voice hearing (Cooklin et al., 1983; Corstens & Longden, 2013; Nayani & David, 1996; Slade, 1972), and ESM research has demonstrated a significant momentary association between stress and both voices (Palmier-Claus, Dunn, et al., 2012) and dissociative states (Stiglmayr et al., 2008). Furthermore, ESM research has demonstrated an association between childhood trauma and psychotic reactivity (including dissociative experiences) to daily life stresses (Lardinois, Lataster, Mengelers, Van Os, & Myin-Germeys, 2011).

To date however, only one study has directly explored the relationship between stress, dissociation and voice hearing during daily life. Varese, Udachina, et al. (2011) demonstrated a significant momentary association between stress, voices and dissociative experiences, finding that voices were significantly more likely to be present in moments where greater dissociation was reported, and that this relationship was strongest during moments of high self-reported stress. Whilst these findings are

suggestive of a proximal role of stress and dissociation in voice hearing experiences, this study was limited by its use of a 'momentary' approach, which whilst based on 'real time' data, is still cross-sectional and thus limited in its ability to assess directionality.

The present study aims to extend this previous work by using a 'temporal' approach to explore the dynamics of voices in relation to stress and dissociation. Two approaches to exploring the temporal dynamics of voice hearing experiences have been described previously in the ESM literature. First, given findings that voice hearing experiences often follow a characteristic time course during daily life, with the intensity of voices increasing to a peak during any one particular 'episode' (i.e. a period of elevated voice intensity), before dropping at the end of an episode (Delespaul et al., 2002; Oorschot, Lataster, Thewissen, Bentall, et al., 2012), studies have explored whether proposed antecedent and maintaining factors demonstrate similar systematic variation across the different phases of voice episodes. An observed correspondence between the time courses of voice episodes and contextual variables are considered to be suggestive of a temporal relationship, a pre-condition for causality (Conner & Lehman, 2012). The strength of this approach is that is allows for the assessment of antecedents to the onset of voice episodes. However, an alternative approach to assessing temporal dynamics is a 'time-lagged' approach, where the aim is to determine if one variable measured at time *n*-1 is related to another variable at time *n*, or vice versa (Hartley et al., 2015; Palmier-Claus et al., 2014). An advantage of this approach is that it makes full use of the 'micro-longitudinal' nature of ESM data, and allows for a preliminary assessment of directionality, and thus the identification of temporal antecedents.

The present study will utilise both of these approaches, first aiming to assess the temporal dynamics of stress and dissociation in relation to the phases of voice episodes, and subsequently exploring the role of these factors as antecedents and/or mediators of voice onset and increases in voice intensity. The study will additionally build on the work of Varese et al by focusing specifically on depersonalisation, rather than dissociation more generally. Previous research has indicated that depersonalisation/derealisation might be a stronger predictor of both voice presence (Kilcommons & Morrison, 2005; Perona-Garcelán et al., 2008; Perona-Garcelán, García-Montes, Ductor-Recuerda, et al., 2012), and current voice hearing status (Perona-Garcelán et al., 2008; Perona-Garcelán, García-Montes, Ductor-Recuerda, et al., 2012), compared to other aspects of dissociation (e.g. absorption and dissociative amnesia). As such, the present study will use a measure of momentary depersonalisation experiences.

This study makes five predictions. First, we predicted that both stress and depersonalisation would demonstrate significant variation over the course of a voice episode. Specifically, following from the findings of Varese, Udachina, et al. (2011), we predicted that levels of reported momentary stress and depersonalisation would be elevated during voice episodes compared to moments unrelated to an episode, and that the increase in stress, specifically, would be evident prior to the onset of voices. Second, given previous evidence of an antecedent role of stress in voice hearing, we predicted that increases in voice intensity would be associated with increased stress levels at the previous measurement occasion. Third, in line with past findings of increased depersonalisation in patients reporting current voice hearing experiences, we predicted that increases in voice intensity would be associated with increased levels of depersonalisation at the previous measurement occasion. Fourth, based on evidence of an antecedent role of stress in dissociative experiences, we predicted that increases in depersonalisation would be associated with increased reported stress at the previous time point. Finally, we predicted that the time-lagged relationship between stress and subsequent voice intensity would be mediated by antecedent levels of depersonalisation.

4.3 Method

4.3.1 Sample

Thirty-five participants were recruited from mental health services across Sussex, UK. Inclusion criteria were: aged 18 or over; currently treated as an outpatient of mental health services; currently experiencing frequent auditory verbal hallucinations (score of 2 (‘at least once a day’) or above on the frequency item of the Psychotic Symptoms Rating Scale – Auditory Hallucinations (PSYRATS-AH; Haddock, McCarron, Tarrier, & Faragher, 1999); adequate command of the English language. Exclusion criteria were: unable to provide fully informed written consent; symptoms precipitated by an organic cause; evidence of primary substance dependence; previously received 16 sessions or more of NICE-adherent Cognitive Behavioural Therapy for psychosis (CBTp). All participants entered the study between November 2014 and December 2015. Full ethical approval was obtained from the Camberwell St Giles National Research Ethics Committee (REC reference: 14/LO/0475).

4.3.2 Data Collection

4.3.2.1 Basic Sample Characteristics*.*

Data on age, gender, ethnicity, level of education, and employment status were collected using a modified version of the Medical Research Council socio-demographic schedule (Mallet, 1997). DSM-IV diagnoses were determined based on structured examination of case records using the OPerational CRITeria+ (OPCRIT+) system (Rucker et al., 2011). Data on medication use were collected using a medication checklist, which was completed based on close examination of clinical documentation, recording the use of all prescribed antipsychotic, antidepressant and other psychotropic medication.

4.3.2.2 ESM Measures.

Data on voice intensity, stress and depersonalisation were collected using the ESM to allow for assessing moment-to-moment variation in these variables prospectively, in the real world and in real time, with high ecological validity. All ESM items were rated on a 7-point Likert scale (1 *not at all* to 7 *very much).*

4.3.2.2.1 Momentary voice intensity

The intensity of voices was assessed with one ESM item; “Right before the beep I could hear a voice or voices that other people couldn’t hear” (Kimhy et al., 2006). During the ESM briefing, we ascertained that the participants understood that this question related to voices and that responses on the Likert scales reflected voice intensity (2 = ‘can barely be heard’ to 7 = ‘disturbingly loud making normal functioning impossible’).

4.3.2.2.2 Voice episodes

A voice episode consisted of one or more consecutive moments with a score of ≥3 on the item I hear voices”. We took a liberal approach to missing data, since this is a naturalistic study, and allowed a maximum of one missing data point per episode. In order to analyse temporal dynamics and relation to stress and depersonalisation, moments were categorized as either the last moment before an episode, the first moment in an episode, a moment during an episode (not first or last moment), the last moment during an episode, the first moment after an episode and unrelated to an episode (i.e., all the other moments). Additional information about this coding scheme can be found in Table 2.2 (see Section 2.3.2.2.2). Within this coding scheme, it is not possible to accurately classify the first and last report of each day; as such, these reports were excluded from the analysis. Furthermore, an important precondition for analysis involving categorical predictors is that categories are mutually exclusive; overlap between

categories will result in invalid parameter estimates (Nezlek, 2011). Therefore, moments that were categorised as both the first after and the last before a voice episode, or as both first and last during a voice episode, were also excluded from analysis.

4.3.2.2.3 Momentary depersonalisation

Momentary depersonalisation was assessed with one ESM item adapted from the Cambridge Depersonalization Scale (CDS; Sierra & Berrios, 2000); “Right before the beep I felt detached or unreal”.

4.3.2.2.4 Momentary stress

Momentary stress was assessed with one ESM item; “Right before the beep I felt stressed” (Vilardaga et al., 2013).

4.3.2.3 ESM Procedure.

All participants were provided with a smartphone pre-loaded with the movisensXS experience sampling app (https://xs.movisens.com/), via which the ESM measure was administered ten times per day. We used a time-based design with stratified random sampling (i.e. with ESM assessments scheduled at random within set blocks of time; Myin-Germeys et al., 2009; Palmier-Claus et al., 2011; Stone, Shiffman, Atienza, & Nebeling, 2007). On each day over an assessment period of 9 consecutive days, the smartphone emitted 10 “beep” signals at semi-random moments within 90 minute blocks of time. Sampling took place between 7:30 A.M. and 10:30 P.M.

During an initial briefing session, we trained participants in the use of the smartphone by providing detailed technical instructions (e.g. switching on/off, use of stylus for answering questions, etc.) and practising its usage by going through a practice questionnaire. In this session, participants were further given instructions about the ESM assessment and asked to stop their activity and respond to the above items each time the device emitted the beep signal as part of a more comprehensive diary questionnaire assessing voice phenomenology, appraisals and responses, and social interactions in daily life.

During the assessment period, which was selected to start at any day of the week at discretion of the participants (to optimize compliance and achieve sufficient spread of week and weekend days in our sample), the ESM questionnaire was available to participants for a duration of 15 minutes after emission of the beep signal. Participants were contacted twice during the assessment period to assess their adherence to instructions, identify any potential distress associated with the method, and help

participants overcome any potential barriers for completing the questionnaire in order to maximise the number of observations per participant.

At the end of the assessment period, participants' reactivity to, and compliance with, the method were examined in a debriefing session. Participants were required to provide valid responses to at least one-third of the emitted beeps to be included in the analysis.

4.3.3 Statistical Analysis

ESM data have a multilevel structure, such that multiple observations (level-1) are nested within participants (level-2). Linear mixed models were therefore used to control for within-subject clustering of multiple observations using the MIXED module (for continuous outcomes) and the MELOGIT command (for dichotomous outcomes) in Stata 14.0 (StataCorp, 2015b). In all models, outcome and dummy-coded predictor variables were entered un-centred, whilst all continuous predictor variables and covariates were entered group (i.e. person) mean centred, in order to control for between-person differences in experience intensity (Nezlek, 2012a).

Intercepts and slopes were modelled as random effects, wherever this resulted in an improved model fit (i.e. indicating significant between-person differences in the parameter). Fixed and random linear effects of time (i.e. measurement occasion) on the dependent variables were explored and controlled for when necessary (Bolger & Laurenceau, 2013). In all mixed models, an independent random-effects covariance matrix was specified to allow for distinct variances of all random effects. Given the possibility of serial autocorrelation between residual errors in ESM data (Bolger & Laurenceau, 2013), in all analyses described we explored whether model fit was improved by modelling the residual error structure using an autoregressive process of order 1 (Walls et al., 2007).

Maximum likelihood estimation of these models allowed for the use of all available data under the relatively unrestrictive assumption that data is missing at random and if all variables associated with missing values are included in the model (Mallinckrodt, Clark, & David, 2001). The improved fit of complex models above baseline models was evaluated using Akaike's and Schwarz's Bayesian information criteria (Burnham et al., 2004). Where model assumptions were violated, standard errors of the final models were estimated using robust maximum likelihood methods. Effect sizes from predictors in the multilevel model were expressed as B, representing the unstandardized fixed regression

coefficient. This can be interpreted in the same way as unstandardized B estimates in single level regression analysis.

4.4 Results

4.4.1 Basic Sample Characteristics and ESM Item Descriptives

A total of 35 participants were assessed with the ESM during the study period. Of these, 31 participants completed ESM assessment (with ≥30 valid responses) and, therefore, a high proportion of those initially assessed were included in the analysis (i.e., 88.5% of 35). Demographic and clinical information for participants included within the final analyses are summarized in Table 3.1 (see Section 3.3).

ESM data were provided on 1,682 occasions, of which voices were reported at 1,094 moments (65% of measurement occasions). All participants (100%) reported ESM-voices, with a mean of 35.3 voice reports (range 2–69) per participant over the nine days. Four hundred and sixty-six (27.7%) ESM reports were unclassifiable according to the voice phase coding scheme, either due to being the first or last report of the day, or due to their position in relation to two or more cases of missing data. A further 174 (10.3%) reports were excluded due to being classified as both the first and last report of a voice episode. As such, it was possible to classify 1,042 reports (62% of data) into the following categories; the last moment before an episode (105 reports); the first moment in an episode (99 reports); a moment during an episode (358 reports), the last moment during an episode (178 reports), the first moment after an episode (108 reports) and unrelated to an episode (194 reports). Descriptive statistics for all other ESM constructs are displayed in Table 4.1.

Table 4.1. *ESM construct descriptive statistics.*

Construct	Mean	Within-person SD	Between-person SD	Split-week reliability (*r*)*
Momentary voice intensity	4.02	1.83	1.85	0.94***
Momentary depersonalisation	3.48	1.16	2.00	0.95***
Momentary stress	3.56	1.58	1.27	0.78***

*The split-week reliability (the ESM equivalent of test-retest reliability) was calculated as the correlation between mean within-person item scores from the first half (days 1-4) and the second half (days 5-9) of the sampling period.

4.4.2 Do levels of stress and depersonalisation vary over the course of a voice episode?

First, a series of multilevel models were specified in order to compare differences in momentary experiences at different phases during a voice episode. In these models, current voice intensity, depersonalisation and stress were entered as dependent variables, and phases of the voice episode (last moment before episode, first moment in episode, moment during episode, last moment during episode and first moment after episode) were entered as dummy-coded independent variables.

In line with our first prediction, the fit of baseline multilevel models predicting mean levels of depersonalisation and stress were substantially improved following inclusion of voice phase as a predictor, suggesting significant variation in both depersonalisation and stress according to voice episode phase. Furthermore, as expected, participants reported significantly higher levels of stress and depersonalisation during a voice episode compared to moments unrelated to an episode (Figure 4.1 and Table 4.2).

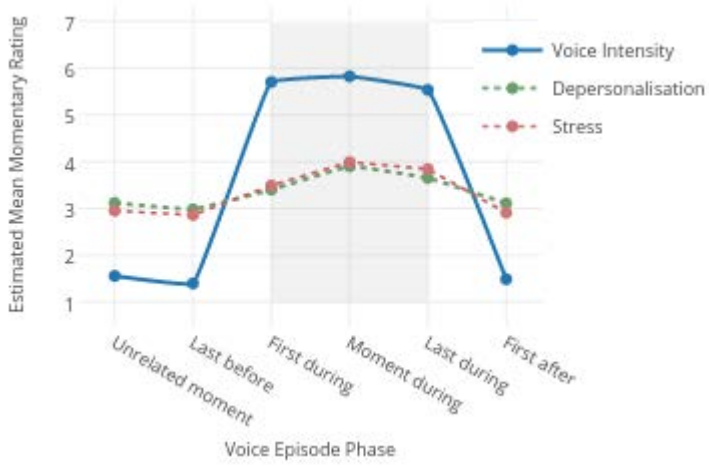

Figure 4.1. Changes in voice intensity, depersonalisation, and stress over voice episodes**.** The lines represent change in the population mean of i) momentary voice intensity (blue) and ii) momentary depersonalisation (green) and momentary stress (red) across each phase of a typical voice episode (moments within the episode are shaded in grey).

However, contrary to our first prediction, there was no evidence of an increase in stress in the last moment before episode onset.

Table 4.2. *Dynamics of voices, stress and depersonalisation*.

	Voice intensity	Stress	Depersonalisation
Unrelated moment (B)	1.56 (.16)	2.95 (.28)	3.12 (.36)
Last before episode (B[a])	-.16 (.12)	-.09 (.22)	-.14 (.16)
First during episode (B[a])	4.14 (.12)***	.54 (.23)*	.28 (.17)
During episode (B[a])	4.26 (.12)***	1.04 (.22)***	.78 (.16)***
Last during episode (B[a])	3.97 (.11)***	.89 (.21)***	.53 (.16)**
First after episode (B[a])	-.07 (.12)2	-.04 (.22)	-.01 (.16)

*p<0.05, **p<0.01, ***p<0.001.

[a]Regression coefficient indicates the difference in intensity of the variables as compared to moments unrelated to voices.

4.4.3 Does stress predict subsequent changes in voice intensity?

We explored whether fluctuations in voice intensity were predicted by preceding stress, regardless of voice episode phase, using a time-lagged multilevel model with voice intensity at time *t* as the dependent variable, and stress at the previous moment (*t*-1) as the independent variable. This model controlled for levels of the voice intensity variable at the previous moment (*t*-1).

The results of this analysis provided support for our second prediction, indicating that increases in voice intensity at time *t* were significantly predicted by increases in reported stress at the previous (*t*-1) measurement occasion (B = .08, z = 2.17, p = .03, 95% CI [0.01, 0.15]). The reverse model (i.e. voice intensity predicting subsequent stress) was not significant (B = .04, z = 1.58, p = .12, 95% CI [-0.01, 0.09]), indicating a uni-directional antecedent effect of stress on subsequent voice intensity.

4.4.4 Does depersonalisation predict subsequent changes in voice intensity?

We next used a time-lagged approach to test our third prediction that increases in voice intensity at time *t* would be associated with increased levels of depersonalisation at the previous measurement occasion (*t*-1). Indeed, this was found to be the case (B = .12, z = 2.49, p = .01, 95% CI [0.03, 0.22]), even after controlling for voice intensity at *t*-1, indicating that a unit increase in depersonalisation was associated with a 0.12 unit increase in voice intensity at the next time point. The reverse model (i.e. voice intensity predicting subsequent depersonalisation) was not significant (B = .02, z = 0.97, p = .33, 95% CI [-0.02, 0.06]).

4.4.5 Does stress predict subsequent changes in depersonalisation?

Further time-lagged multilevel regression analyses indicated that, in support of our fourth prediction, increases in depersonalisation at time *t* were significantly predicted by increases in reported stress at the previous time point (B = .05, *z* = 2.40, *p* = .02, 95% CI [0.01, 0.10]), even after controlling for depersonalisation at the previous measurement occasion. However, the reverse model was also significant (B = .08, *z* = 2.01, *p* = .04, 95% CI [0.01, 0.16]), indicating a bi-directional relationship between stress and depersonalisation over time.

4.4.6 Is the temporal relationship between stress and voice intensity mediated by depersonalisation?

The results above indicate that increases in momentary voice intensity (at time *t*) were predicted by higher levels of stress and depersonalisation reported at the previous time point (*t*-1). Finally, we sought to test whether the observed relationship between stress and voice intensity is mediated by depersonalisation, using a multilevel mediation approach (Bauer et al., 2006). Multilevel mediation is necessary since it is possible that the direct, indirect and total effects might vary between individuals; a multilevel approach provides estimates of the average population effects.

The results of this analysis are summarised in Figure 4.2.

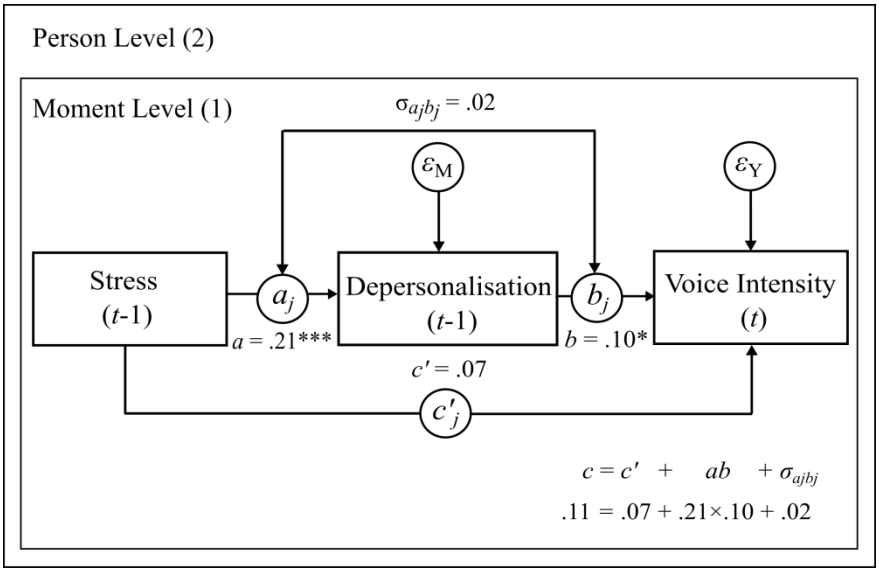

Figure 4.2. Illustration of mediating effect of depersonalisation between antecedent stress and momentary voice intensity.

We found evidence of a significant indirect effect of stress at *t*-1 on subsequent voice intensity through depersonalisation at *t*-1 (*B* = 0.04, *z* = 2.06, *p* = .04, 95% CI [0.01, 0.08]). After adjusting for depersonalisation, the direct effect (*c'*) of stress on voice

intensity at the next time point was reduced and no longer reached significance (*B* = 0.07, *z* = 1.90, *p* = .06, 95% CI [-0.01, 0.14]).

In line with our final prediction, this suggests that the association between stress at time *t*-1 and voice intensity at time *t* is fully mediated by depersonalisation at time *t*-1, with the indirect pathway explaining 36.4% of the total effect *c* (*B* = 0.11, *z* = 2.77, *p* = .006, 95% CI [0.03, 0.19]).

4.5 Discussion

This study sought to clarify the temporal relationships between voice hearing, stress and dissociation, exploring specifically the proposed role of stress as an antecedent to voices, and depersonalisation as a mediator of this effect.

The findings show that, in line with our predictions, both momentary stress and depersonalisation varied significantly across the phases of voice episodes. Consistent with previous findings (Varese, Udachina, et al., 2011), levels of stress and depersonalisation were significantly higher in moments where voices were reported. Furthermore, the time courses of stress and depersonalisation were remarkably similar, suggesting a close momentary association between these two constructs.

Contrary to predictions, we found no evidence of increases in stress at the moment prior to voice episode onset. However, the observed directional time-lagged effects of stress on subsequent voice intensity indicate a more subtle effect of stress on modulating moment-to-moment fluctuations in voices. Similar time-lagged effects were found between depersonalisation and subsequent voice intensity, supporting the notion of an antecedent role of depersonalisation in voice hearing. Furthermore, we found evidence of a bidirectional dynamic relationship between stress and depersonalisation, whereby increases in depersonalisation were predicted by antecedent stress levels, and increases in depersonalisation predicted further subsequent increases in stress. Given these demonstrated time-lagged relationships between stress, depersonalisation and voice intensity, we finally explored whether the relationship between stress and subsequent voice intensity was mediated by antecedent levels of depersonalisation. In line with our prediction, we found that the association between stress and subsequent increases in voice intensity was fully mediated by antecedent levels of depersonalisation.

These results build on the findings of Varese, Udachina, et al. (2011) suggesting a mechanism via which stress may serve to increase voice intensity. This previous study

found that voices were significantly more likely to be present in moments where greater dissociation was reported, and that this relationship was strongest during moments of high self-reported stress. These previous findings, in combination with results from the present study, are consistent with the notion that stress exerts its effect on voice intensity via its role in inducing depersonalisation experiences, whilst depersonalisation in turn appears to be related to the momentary onset and intensification of voice hearing experiences. The demonstrated reciprocal time-lagged association between stress and depersonalisation additionally provides a potential mechanism for the maintenance and escalation of voice intensity 'in-the-moment'; once depersonalisation experiences occur, they may result in further stress, which in turn increases the likelihood of further depersonalisation, and a resultant increase in voice intensity.

A question that is not addressed by this study is the nature of the mechanism via which depersonalisation experiences might lead to the onset or intensification of voices. Cognitive, phenomenological and dialogical models have proposed a central role for threat appraisals and self-focused attention in the maintenance of depersonalisation (Hunter, Phillips, Chalder, Sierra, & David, 2003) and the onset of specific voice episodes (García-Montes, Pérez-Álvarez, & Perona-Garcelán, 2012; Parnas, 2003). Cognitive models of depersonalisation and voice hearing suggest that catastrophic interpretations of depersonalisation experiences (or other anomalous experiences) may elicit safety behaviours such as hypervigilance and self-focused attention (Hunter et al., 2003), in an attempt to understand or protect against perceived threat (Morrison, 1998). Dialogical models propose that this intense focus on inner experience - and in particular, on certain aspects of inner dialogue - results in a loss of metacognitive perspective, and the resulting perceptualization of components of inner speech (Perona-Garcelán, García-Montes, Ductor-Recuerda, et al., 2012; Perona-Garcelán et al., 2015).

In support of this account, a wealth of research has demonstrated high self-focused attention in voice hearers (Allen et al., 2005; Ensum & Morrison, 2003; Morrison & Haddock, 1997b). Whilst later research has demonstrated that it is not a variable that specifically affects people with voices, but rather people with psychoses in general (Perona-Garcelán et al., 2008), research has demonstrated a stronger association between trait levels of self-focused attention and absorption in voice hearers (Perona-Garcelán et al., 2008), leading researchers to suggest that voice hearers may pay more attention to dissociative experiences. Indeed, research has found that the relationship between self-focused attention and voice hearing is not direct, instead being mediated by depersonalisation (Perona-Garcelán et al., 2011). A task for future ESM research will

be to test the ecological validity of this model by exploring the temporal relationships between depersonalisation, voices and self-focused attention/absorption during daily life.

The findings of this study should be interpreted in light of several limitations. First, is important to note that in our mediation analysis, the indirect pathway via depersonalisation explained only 34% of the total effect of stress on voice intensity, and the direct pathway approached significance. As such, it is likely that mechanisms other than depersonalisation contribute to the observed dynamic relationship between stress and voice intensity. Whilst the magnitude of the effects demonstrated in this study were small, it has been suggested that, given the frequency with which these effects are observed during daily life, the cumulative impact of small effects observed in ESM studies may be substantial (Myin-Germeys et al., 2003).

The second caveat to bear in mind is our use of a trans-diagnostic sample of voice hearers. Whilst there is now strong evidence for a role of dissociation in voice hearing regardless of diagnostic or clinical status, our study was underpowered to examine whether diagnosis, or symptoms characteristic of certain disorders, such as paranoia in schizophrenia, moderate the observed effects. It might be expected for example, that the effects we observed would be moderated by trait levels of depersonalisation, which might in turn differ across diagnoses. Indeed, in this study we observed relatively high between-person variation in mean momentary depersonalisation (Table 4.1), suggesting that there may be individual differences in the extent to which this mechanism applies. Whilst preliminary analyses found no evidence for diagnostic differences in mean momentary levels of depersonalisation, or of an association with PSYRATS delusional severity (Table 3.7), future research should seek to establish whether the observed effects of stress and depersonalisation on voice hearing apply across diagnoses.

A final limitation is our use of a single-item measure of momentary depersonalisation. Whilst the use of single-item measures is not uncommon in ESM research (Hartley, Haddock, et al., 2014; Vilardaga et al., 2013), and is unlikely to present a significant risk to reliability due to the repeated administration of items (Hektner et al., 2007), it has recently been recommended that a minimum of three ESM items per construct be used in order to allow assessment of construct reliability at both the within- and between-person levels (Mogle et al., 2014; Shrout & Lane, 2012). Furthermore, whilst the face validity of this item appeared to be respectable, having been adapted from a similar item in the Cambridge Depersonalisation Scale (CDS), the full CDS was not administered within this study, precluding an assessment of convergent validity. However, a multilevel correlation analysis performed on the data (see Section 3.5.3) demonstrated reasonable

divergent validity between our depersonalisation, voice intensity and stress ESM items at the within-person level, indicating that these were assessing different constructs at any single point in time. Future work in this field would be aided by the creation of a fully validated measure (i.e. at the within- and between-person levels) of momentary dissociation, including subscales assessing both depersonalisation/derealisation and absorption.

In conclusion, our results provide ecological validation for a mediating role of depersonalisation experiences in the relationship between everyday stress and fluctuations in voice hearing. In addition to providing support for contemporary psychological models of distressing voices, this is an important step towards identifying potential proximal targets for psychological intervention, which typically aim to reduce voice distress and interference, rather than attempting to eliminate voice hearing experiences. We have provided evidence that both stress and depersonalisation are antecedent factors in the experience of voices during daily life, suggesting that interventions designed to promote stress-management, or the reduction of dissociative tendencies in voice hearers with a need for care (Farrelly, Peters, Azis, David, & Hunter, 2016), might be effective in reducing voice frequency or intensity. Future ESM research should further explore the conditions in which depersonalisation experiences might emerge, and the mechanistic links between depersonalisation experiences and the onset of voices, in order to enrich models of the proximal onset and fluctuation of voice hearing experiences.

5 Chapter Five: Responding to voices during daily life; the maintenance of voice appraisals and associated distress

5.1 Abstract

Primary objectives: Cognitive models propose that behavioural responses to voices – such as compliance and resistance - maintain the distress experienced by some voice hearers, by preventing disconfirmation of beliefs about voice power and uncontrollability. The present study used the Experience Sampling Method (ESM) to investigate the momentary and 'micro-longitudinal' associations between voice-related distress, behavioural responses, and voice appraisals, in order to examine the hypothesized maintenance role of behavioural responses during daily life.

Method: Thirty-one psychiatric outpatients reporting frequent voice hearing experiences completed a smartphone-based ESM questionnaire ten times a day over nine days, assessing voice-related distress; resistance and compliance responses to voices; voice characteristics (intensity and negative content); and appraisals of voice dominance, uncontrollability and intrusiveness. Relationships between variables were analysed using both momentary and time-lagged multilevel regression in order to assess the directionality of temporal effects.

Results: In line with predictions, both resistance and compliance were associated with momentary voice appraisals, but not voice characteristics. Specifically, perceived dominance of voices was a unique predictor of momentary compliance, whilst perceived uncontrollability of voices was associated with both compliance and resistance responses. Contrary to expectations, no relationships were found between intrusiveness appraisals and responses. As expected, greater resistance and compliance were reported in moments of increased voice distress, but these associations did not persist after controlling for concurrent voice appraisals and characteristics. Momentary voice distress was predicted by appraisals of voice dominance, uncontrollability and intrusiveness, but unexpectedly, was also independently predicted by both voice intensity and negative voice content. As predicted, both compliance and resistance responses were related to increases in voice-related distress at subsequent measurement occasions, whilst antecedent voice appraisals and characteristics had no such effect. Antecedent voice distress did not predict behavioural responses, indicating directional effects of responses on subsequent distress. Furthermore, compliance, but not resistance, additionally predicted subsequent increases in appraisals of voice

uncontrollability. Again the reverse model showed no association, indicating directional effects of compliance on uncontrollability appraisals.

Conclusions: These results provide support for the cognitive model by suggesting that both momentary behavioural and affective responses to voices are associated with concurrent negative voice appraisals. Furthermore, findings suggest that behavioural responses may be driven by voice appraisals, rather than directly by distress, and lend support for a role of behavioural responses in the maintenance of voice appraisals and associated distress during the course of daily life. These findings provide further impetus for a therapeutic focus on behaviour change. However, the demonstrated contribution of voice characteristics to momentary distress suggest the importance of a parallel consideration of voice content in therapy.

5.2 Introduction

Voice hearing experiences, or auditory verbal hallucinations, are typically defined in relation to their perceptual characteristics (David, 2004). However, such definitions belie the fact that voice hearers are typically not passive bystanders of these experiences (Beavan, 2011; Nayani & David, 1996). Voices represent an unusually compelling verbal experience, and hearers commonly report being drawn in to reacting or responding to their voices (Thomas et al., 2013), either via direct and reciprocal acts of communication with voices (Hayward et al., 2011), or via the use of actions to mitigate their activation or negative impact (Farhall et al., 2007).

The cognitive model proposes that these behavioural responses are driven primarily by the beliefs a person holds about their voices (Chadwick & Birchwood, 1994). Voices, typically perceived as powerful, intrusive beings with malevolent intent towards the hearer or others, and over whom the hearer has little control or ability to escape, have been suggested to evoke innate evolved subordinate defences of fight, flight or submission, similar to those observed in real-world social interactions (Gilbert et al., 2001), as a means of mitigating perceived threat (Morrison, 1998). In support of this account, a number of studies have demonstrated that efforts to resist voices (by arguing back, avoiding cues that trigger voices, or employing distraction tactics), and attempts to appease the perceived agent of the voices by complying with voice commands, are commonly reported responses to voices (Chaix et al., 2014; Hacker et al., 2008; Howard, Forsyth, Spencer, Young, & Turkington, 2013). Furthermore, both resistance and compliance responses are predicted by perceptions of voice dominance (Birchwood et al., 2004; Gilbert et al., 2001; Hayward et al., 2008; Reynolds & Scragg, 2010) and intrusiveness (Hayward et al., 2008; Mackinnon et al., 2004), whilst resistance (both to command hallucinations, and voices more generally) is additionally associated with perceived voice malevolence (Birchwood et al., 2004; Hayward, 2003; Peters, Williams, et al., 2012; van der Gaag et al., 2003; Vaughan & Fowler, 2004).

Behavioural responses to voices are considered a central target of cognitive behaviour therapy for psychosis (Morrison & Barratt, 2010), due to their potentially immediate distressing or harmful effects. These harmful effects are most evident in the case of compliance with voice commands, which can pose significant risks of danger to self and others, with an estimated 30% of hearers reporting at least partial compliance with harmful voice commands (Shawyer et al., 2003). Cognitive models further suggest that, rather than simply representing a consequence of voice beliefs, behavioural responses in turn play a role in maintaining voices and associated distress and disability (Chadwick

& Birchwood, 1994; Morrison, 1998). In the case of resistance responses, Morrison (1998) suggested that efforts to resist voices may be counterproductive, serving to increase voice frequency in a manner similar to the demonstrated effects of thought-suppression on the frequency of intrusive thoughts (Abramowitz, Tolin, & Street, 2001). Morrison also proposed that resistance and compliance should be conceptualized as 'safety behaviours' (Salkovskis, 1991); compensatory actions that may afford short-term relief, but contribute to the longer-term maintenance of voice distress, by preventing opportunities for disconfirmation of negative voice beliefs (Michail & Birchwood, 2010).

In support of a role of behavioural responses in the maintenance of voice distress, it has been demonstrated that voice hearers typically perceive their responses as being effective in reducing the sense of immediate threat from voices (Hacker et al., 2008), whilst cross-sectionally, there is consistent evidence of a positive association between levels of voice-related distress and resistance or avoidance responses (Farhall & Gehrke, 1997; Hayward et al., 2008; Vaughan & Fowler, 2004), and safety behaviours including resistance and compliance (Hacker et al., 2008). Hacker et al. (2008) demonstrated that the positive association between safety behaviour use and distress is mediated by perceived voice omnipotence, consistent with the notion that safety-seeking behaviours exert their effect on distress by preventing disconfirmation of threat. Furthermore, randomized controlled trials (RCTs) of cognitive therapy for command hallucinations (COMMAND), which aims to change omnipotence beliefs through the use of behavioural experiments to test the consequences of resisting commands (Meaden et al., 2013), have demonstrated reductions in both compliance behaviours, and beliefs about the perceived power of voices (Birchwood et al., 2014; Trower et al., 2004).

However, whilst the initial COMMAND pilot RCT reported reductions in voice related distress (Trower et al., 2004), this finding was not replicated in the full-scale trial (Birchwood et al., 2014), suggesting that other factors are involved in maintaining distress, in addition to behaviours and appraisals. Furthermore, to date, the majority of research exploring this issue has been cross-sectional in nature. Whilst findings are consistent with the interpretation that resistance and compliance responses may contribute to or maintain voice-related distress, the opposite inference cannot be ruled out; distressing voices may lead to the hearer persisting with ineffective responses (Farhall et al., 2007; Hacker et al., 2008). Furthermore, these studies have relied on 'retrospective' accounts of voice hearers, and so it remains unknown how different response styles might impact on voice-related distress during the course of daily life. It is well-established that trait-level associations are not necessarily reflective of the

momentary associations between equivalent ‘state’ variables (Stone et al., 2007), which may be more indicative of the proximal mechanisms underlying voice distress during daily life.

An approach that might shed further light on the role of behavioural responses in maintaining voice distress and associated appraisals, is the Experience Sampling Method (ESM). ESM involves assessing constructs of interest using questions delivered by paper or electronic means at unpredictable intervals during participants’ daily life. This provides a rich, ecologically valid dataset within which to examine the relationships between variables as they fluctuate over time. ESM has previously been used to assess relevant aspects of the cognitive behavioural model of voice hearing; Peters, Lataster, et al. (2012) demonstrated significant associations between momentary levels of voice distress, voice intensity, and concurrent appraisals of voice power and uncontrollability, whilst Hartley, Haddock, Vasconcelos e Sa, Emsley, and Barrowclough (2015) used a ‘micro-longitudinal’ approach to demonstrate that momentary increases in voice intensity and distress are predicted by antecedent attempts to control or suppress thoughts. However, to date, no study has assessed the dynamic relationships between voice appraisals, responses and distress.

The present study aims to build on the work of Peters, Lataster, et al. (2012) by testing the predictions of the cognitive model that; a) both behavioural and affective responses to voices during daily life are driven primarily by beliefs, rather than voice characteristics such as negative content or intensity and b) that behavioural responses serve to maintain or exacerbate negative voice appraisals and distress from moment-to-moment. Specifically, we will assess the momentary and micro-longitudinal relationships between compliance and resistance responses, and momentary appraisals of voice dominance (i.e. voice rank), intrusiveness, and uncontrollability due to their demonstrated cross-sectional and momentary associations with voice distress (Birchwood et al., 2004; Hayward et al., 2008; Mackinnon et al., 2004; Peters, Lataster, et al., 2012; Reynolds & Scragg, 2010). The independent contributions of voice intensity and negative content will be assessed, as a direct test of the proposal that voice appraisals are more influential in predicting behavioural and affective responses to voices than voice characteristics (Chadwick & Birchwood, 1994).

The study makes four predictions. First, we predicted that momentary voice resistance and compliance responses to voices would be more closely associated with concurrent voice appraisals, rather than the content or intensity of voices. Specifically, in line with past cross-sectional research, it is expected that both momentary resistance and

compliance responses will be most closely related to concurrent appraisals of voice dominance and intrusiveness, with uncontrollability uniquely predicting compliance.

Second, we predicted that there would be a positive relationship between momentary voice distress and concurrent resistance and compliance responses (indicating greater use of these behaviours at times of distress), but that these associations would not persist after controlling for the effects of concurrent voice appraisals (i.e. suggesting, in line with the cognitive model, that responses are driven by voice appraisals, rather than by distress).

Third, in line with their hypothesised role as safety behaviours, we predicted that resistance and compliance behaviours would be associated with increases in voice distress from moment-to-moment during daily life.

Finally, based on the suggestion that responses serve to maintain distress by reinforcing negative voice appraisals, we predicted that resistance and compliance behaviours would be associated with moment-to-moment increases in appraisals of voice dominance, intrusiveness and uncontrollability.

5.3 Method

5.3.1 Sample

Thirty-five participants were recruited from mental health services across Sussex, UK. Inclusion criteria were: aged 18 or over; currently treated as an outpatient of mental health services; currently experiencing frequent auditory verbal hallucinations (score of 2 (‘at least once a day’) or above on the frequency item of the Psychotic Symptoms Rating Scale – Auditory Hallucinations (PSYRATS-AH; Haddock et al., 1999); adequate command of the English language. Exclusion criteria were: unable to provide fully informed written consent; symptoms precipitated by an organic cause; evidence of primary substance dependence; previously received 16 sessions or more of NICE-adherent Cognitive Behavioural Therapy for psychosis (CBTp). All participants entered the study between November 2014 and December 2015. Full ethical approval was obtained from the Camberwell St Giles National Research Ethics Committee (REC reference: 14/LO/0475).

5.3.2 Data Collection

5.3.2.1 Basic Sample Characteristics***.***

Data on age, gender, ethnicity, level of education, and employment status were collected using a modified version of the Medical Research Council socio-demographic schedule (Mallet, 1997). DSM-IV diagnoses were determined based on structured examination of case records using the OPerational CRITeria+ (OPCRIT+) system (Rucker et al., 2011). Data on medication use were collected using a medication checklist, which was completed based on close examination of clinical documentation, recording the use of all prescribed antipsychotic, antidepressant and other psychotropic medication.

5.3.2.2 ESM Measures.

Data on voice characteristics, appraisals, responses, and emotional impact were collected using the ESM to allow for assessing moment-to-moment variation in these variables prospectively, in the real world and in real time, with high ecological validity. All ESM items were rated on a 7-point Likert scale (1 *not at all* to 7 *very much).* In moments when participants reported hearing only one voice, voice-related items referred to the 'voice' rather than 'voices'. Furthermore, in moments when no voices were reported, an alternative set of non-voice-related items were presented in order to balance the questionnaire administration time.

5.3.2.2.1 Voice characteristics

Voice intensity: The intensity of voices was assessed with one ESM item; "Right before the beep I could hear a voice or voices that other people couldn't hear" (Kimhy et al., 2006). During the ESM briefing, we ascertained that the participants understood that this question related to voices and that responses on the Likert scales reflected voice intensity (2 = 'can barely be heard' to 7 = 'disturbingly loud making normal functioning impossible').

Negative voice content: Negative voice content was assessed with one ESM item adapted from the Psychotic Symptoms Rating Scale – Auditory Hallucinations (PSYRATS-AH; Haddock et al., 1999); "Right before the beep the voices were saying negative things".

5.3.2.2.2 Voice appraisals

Voice dominance: Perceived social dominance of the voice in relation to the hearer was assessed with one ESM item adapted from the Voice Rank Scale (Birchwood et al., 2000); “Right before the beep I felt inferior to the voices”.

Voice intrusiveness: Perceived voice intrusiveness was assessed using one ESM item adapted from the Voice and You Scale (Hayward et al., 2008); “Right before the beep I felt that the voices were intruding on my personal space”.

Voice uncontrollability: Perceived uncontrollability of voices was assessed using one ESM item; “Right before the beep I felt that the voices were out of my control” (Peters, Lataster, et al., 2012).

5.3.2.2.3 Behavioural responses

Resistance: Resistance towards voices was assessed using one ESM item adapted from the Beliefs about Voices Scale – Revised (BAVQ-R; Chadwick, Lees, & Birchwood, 2000); “Right before the beep I was trying to ignore the voices or stop them from talking”.

Compliance: Compliance with voices was assessed using one ESM item adapted from the Voice Compliance Scale (VCS; Beck-Sander, Birchwood, & Chadwick, 1997); “Right before the beep I was doing what the voices were telling me to do”.

5.3.2.2.4 Voice emotional impact

Voice-related distress: Distress associated with voices was assessed using one ESM item; “Right before the beep the voices were upsetting me” (Peters, Lataster, et al., 2012).

5.3.2.3 ESM Procedure.

Please see Section 4.3.2.3 (page 88) for a description of the ESM procedure utilised in this study.

5.3.3 Statistical Analysis

Please see Section 4.3.3 (page 89) for a description of the statistical analyses utilised in this study.

5.4 Results

5.4.1 Basic Sample Characteristics and ESM Item Descriptives

A total of 35 participants were assessed with the ESM during the study period. Of these, 31 participants completed ESM assessment (with ≥30 valid responses) and, therefore, a high proportion of those initially assessed were included in the analysis (i.e., 88.5% of 35). Demographic and clinical information for participants included within the final analyses are summarized in Table 3.1 (see Section 3.3).

ESM data were provided on 1,682 occasions, of which voices were reported at 1,094 moments (65% of measurement occasions). All participants (100%) reported ESM-voices, with a mean of 35.3 voice reports (range 2–69) per participant. 30 participants (96.8%) reported attempting to resist their voices at least once over the course of the nine-day assessment period. Across these individuals, some degree of resistance (i.e. score >1) was reported on 88.4% of measurement occasions during which voices were experienced. 24 participants (77.4%) reported complying with voice demands at least once. On average, these individuals reported complying with their voices to some degree (score >1) on 58.5% of occasions when voices were reported. There were no significant changes in compliance (*B* = 0.06, *z* = 1.61, *p* = .11, 95% CI [-0.01, 0.01]) or resistance (*B* = -0.01, *z* = -1.35, *p* = .18, 95% CI [-0.01, 0.01]) behaviours over the course of the nine days. Descriptive statistics for all ESM constructs are displayed in Table 5.1.

Table 5.1. *Descriptive statistics for ESM items assessing voice characteristics, appraisals, responses and impact*

	M	*SD* (within-person)	*SD* (between-person)	Split-week reliability (*r*)[b]
Intensity	4.02	1.83	1.85	.94***
Negative content	5.91	1.23	1.37	.93***
Voice dominance	3.94	1.10	1.91	.84***
Uncontrollability	4.88	1.23	1.90	.89***
Intrusiveness	4.78	1.33	1.32	.67***
Resistance	4.85[a]	1.21[a]	1.64[a]	.93***
Compliance	2.71[a]	1.46[a]	1.33[a]	.83***
Distress	4.32	1.30	1.51	.83***

[a]calculated across participants who reported this response (score >1) on at least one occasion
[b]The split-week reliability (the ESM equivalent of test-retest reliability) was calculated as the correlation between mean within-person item scores from the first half (days 1-4) and the second half (days 5-9) of the sampling period

5.4.2 Are behavioural responses to voices best predicted by concurrent voice characteristics or voice appraisals?

We explored predictors of momentary responses to voices using two multilevel models, with resistance and compliance responses as the outcome variables, and voice intensity, negative voice content, voice dominance, voice uncontrollability and voice intrusiveness as predictors. Table 5.2 reports the results of these analyses.

Table 5.2. *Momentary associations between behavioural responses*, *voice characteristics and appraisals*

Outcome Variables[a]	Predictor Variables				
	Voice Characteristics		Voice Appraisals		
	Intensity	Negative content	Dominance	Uncontrollability	Intrusiveness
	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)
Resistance (*N*=30)	-0.01 (0.04)	0.13 (0.07)	-0.03 (0.06)	**0.11** (0.05)*****	0.07 (0.06)
Compliance (*N*=24)	0.03 (0.04)	-0.02 (0.04)	**0.16** (0.08)*	**0.21** (0.06)******	0.03 (0.04)

[a]Includes only participants who reported response with score>1 on at least one occasion; see text for details
[b]The *B* is the unstandardized fixed regression coefficient of the predictor in the multi-level model. Robust standard errors are reported for all coefficients.
* $p<.05$, ** $p<.01$, *** $p<.001$ *(significant findings are shown in bold)*

In line with our predictions, momentary reports of voice resistance and compliance responses were significantly associated with concurrent voice appraisals, but not voice characteristics (although note that the momentary association between negative voice content and resistance responses approached significance; p =.05). Also supporting our predictions, momentary compliance behaviours were associated with appraisals of voice dominance and uncontrollability, with the results indicating that, on average, a unit increase in perceived voice dominance was accompanied by a 0.16-unit increase in voice compliance. A Wald chi-square test indicated that there was no significant difference in the magnitude of the effects of perceived voice dominance and uncontrollability on compliance behaviours (χ^2 (1) = 0.27, p =.60). Unexpectedly, perceived voice uncontrollability was the only significant predictor of momentary resistance to voices, whilst voice intrusiveness was not significantly associated with either compliance or resistance behaviours.

5.4.3 Are behavioural responses related to momentary levels of voice distress?

A multilevel model with voice distress as the outcome variable, and resistance and compliance responses as predictors, indicated that momentary distress was significantly associated with both resistance (B = 0.23, z = 3.55, p <.001, 95% CI [0.10, 0.35]) and compliance (B = 0.18, z = 3.48, p < .001, 95% CI [0.09, 0.29]) responses. However, in

line with our predictions, these effects did not persist once voice characteristics and appraisals were added to the model (Table 5.3), indicating that there is not a direct relationship between distress and resistance/compliance responses.

Table 5.3. *Momentary associations between voice-related distress and behavioural responses, voice characteristics and appraisals*

Outcome Variable[a]	Predictor Variables						
	Behavioural Responses (*t*)		Voice Characteristics (*t*)		Voice Appraisals (*t*)		
	Resistance	Compliance	Intensity	Negative content	Dominance	Uncontrollability	Intrusiveness
	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)
Distress (*t*)	0.04 (0.04)	0.03 (0.02)	**0.18** (0.04)***	**0.08** (0.04)*	**0.09** (0.04)*	**0.17** (0.05)**	**0.31** (0.06)***

[a]Analysis excluded participants who did not report compliance or resistance responses. Thus, this analysis is based on 922 observations from 24 participants.
[b]The *B* is the unstandardized fixed regression coefficient of the predictor in the multi-level model. Robust standard errors are reported for all coefficients.
* $p<.05$, ** $p<.01$, *** $p<.001$ *(significant findings are shown in bold)*

As predicted by the cognitive model, voice distress was significantly associated with appraisals of voice dominance, uncontrollability and intrusiveness. However, unexpectedly, both voice intensity and negative voice content made significant independent contributions to the prediction of momentary voice distress.

5.4.4 Are behavioural responses related to subsequent increases in voice distress?

Next, reports of voice responses at the *previous ESM measurement occasion* (time *t*-1) were entered as predictor variables in a multilevel regression analyses assessing *current* voice distress (time *t*) as the dependent variables. This analysis controlled for the effects of voice appraisals, characteristics and distress at *t*-1. Table 5.4 reports the results of this analysis, including all model covariates.

Table 5.4. *Time-lagged associations between voice-related distress at time t and behavioural responses at time t-1*

Outcome Variable[a]	Predictor Variables		Model Covariates					
	Behavioural Responses (*t*-1)		Voice Characteristics (*t*-1)		Voice Appraisals (*t*-1)			Emotional Impact (*t*-1)
	Resistance	Compliance	Intensity	Negative content	Dominance	Uncontrollability	Intrusiveness	Distress
	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)
Distress (*t*)	**0.10** (0.05)*****	**0.11** (0.03)******	-0.04 (0.05)	-0.05 (0.05)	0.03 (0.05)	-0.06 (0.05)	0.07 (0.05)	**0.27** (0.08)******

[a]Analysis excluded participants who did not report compliance or resistance responses. Thus, this analysis is based on 519 time-lagged observations from 24 participants.
[b]The *B* is the unstandardized fixed regression coefficient of the predictor in the multi-level model. Robust standard errors are reported for all coefficients.
* $p<.05$, ** $p<.01$, *** $p<.001$ *(significant findings are shown in bold)*

In support of the predictions of cognitive models, the results indicate that both resistance and compliance behaviours are associated with increases in voice-related distress at subsequent measurement occasions, even after controlling for antecedent effects of voice characteristics, appraisals and voice-related distress. A unit increase in voice compliance or resistance at time *t*-1 were associated with a 0.1-unit increase in voice–related distress at time *t*, indicating that these responses might serve to maintain or exacerbate voice-related distress. A Wald chi-square test indicated that there was no significant difference in the magnitude of the effects of resistance and compliance on subsequent distress (χ^2 (1) = 0.04, *p* =.85).

Running the reverse models indicated that levels of voice distress reported at *t*-1 did not significantly predict compliance (*B* = 0.07, *z* = 1.15, *p* = .25, 95% CI [-0.05, 0.18]) or resistance (*B* = -0.03, *z* = -0.66, *p* = .51, 95% CI [-0.12, 0.06]) at time *t*, indicating directional effects of these behavioural responses on subsequent distress.

5.4.5 Are behavioural responses related to subsequent increases in negative voice appraisals?

Finally, we performed a series of multilevel analyses in order to determine whether behavioural responses at time *t*-1 predict subsequent increases in voice appraisals. Here, voice dominance, uncontrollability and intrusiveness at time *t* were the outcome variables, whilst voice responses at the previous time point (*t*-1) were the predictor variables. Voice characteristics, appraisals and associated distress at time *t*-1 were controlled for in these analyses. Table 5.5 reports the results of these analyses including all model covariates.

Table 5.5. *Time-lagged associations between voice appraisals at time t and behavioural responses at time t-1.*

Outcome Variable[a]	Predictor Variables		Model Covariates					
	Behavioural Responses (*t*-1)		Voice Characteristics (*t*-1)		Voice Appraisals (*t*-1)			Emotional Impact (*t*-1)
	Resistance	Compliance	Intensity	Negative content	Dominance	Uncontrollability	Intrusiveness	Distress
	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)	B^b (SE)
Dominance (*t*)	0.01 (0.04)	0.03 (0.03)	0.02 (0.05)	-0.06 (0.05)	0.16 (0.08)	0.08 (0.05)	-0.01 (0.04)	0.05 (0.07)
Uncontrollability (*t*)	0.01 (0.05)	**0.08 (0.04)***	0.01 (0.06)	-0.05 (0.06)	0.01 (0.08)	**0.14 (0.07)***	0.08 (0.05)	0.04 (0.08)
Intrusiveness (*t*)	0.10 (0.06)	0.06 (0.04)	-0.09 (0.07)	0.02 (0.07)	0.08 (0.06)	0.01 (0.06)	**0.20 (0.08)****	**0.16 (0.07)***

[a]Analyses excluded participants who did not report compliance or resistance responses. Thus, these analyses are based on 517-639 time-lagged observations from 24 participants.
[b]The *B* is the unstandardized fixed regression coefficient of the predictor in the multi-level models. Robust standard errors are reported for all coefficients.
* $p<.05$, ** $p<.01$, *** $p<.001$ *(significant findings are shown in bold*

Resisting voices at time *t*-1 did not independently predict changes in voice appraisals at time *t*, although the associations between resistance and subsequent increases perceived intrusiveness approached significance (*B* = 0.10, *z* = 1.80, *p* = .07, 95% CI [-0.01, 0.21]).

On the other hand, compliance with voices at time *t*-1 was significantly associated with increases in perceived uncontrollability of voices, at time *t*. Running the reverse model indicated that compliance at time *t* was not significantly predicted by voice uncontrollability (*B* = 0.06, *z* = 0.91, *p* = .36, 95% CI [-0.07, 0.20]) at time *t*-1, suggesting directional effects of compliance on this outcome.

5.5 Discussion

In support of the cognitive model, our findings suggest that both momentary behavioural and affective responses to voices are associated with concurrent negative voice appraisals. Whilst momentary voice distress was associated with both resistance and compliance responses, these effects did not persist after controlling for concurrent voice appraisals, suggesting that these behaviours are not direct responses to (or causes of) momentary voice distress, but to beliefs about voices. Furthermore, in line with the hypothesised role of behavioural responses in the maintenance of voice distress, our 'micro-longitudinal' analyses indicated that both resistance and compliance behaviours were associated with increases in voice-related distress at subsequent measurement occasions, even after controlling for antecedent effects of voice characteristics, appraisals and voice-related distress. Furthermore, compliance was additionally associated with increases in appraisals of voice uncontrollability over time, suggesting a mechanism via which responses may serve to maintain voice distress.

Considering first the results of our momentary analyses, the demonstrated associations between momentary negative voice appraisals and both voice distress and behavioural responses are consistent with the possibility of a mediating role of voice appraisals in both behavioural and affective responses to voices (Chadwick & Birchwood, 1994). In line with past cross-sectional and ESM research, voice distress was associated with concurrent appraisals of voice dominance, uncontrollability and intrusiveness (Beavan & Read, 2010; Birchwood et al., 2000; Hayward et al., 2008; Peters, Lataster, et al., 2012), whilst both compliance and resistance were associated with appraisals of voice uncontrollability, with compliance additionally being associated with appraisals of voice dominance. Further supporting a possible mediating role of voice appraisals in

determining the behavioural consequences of voices is the observation that the associations between voice distress and both resistance and compliance responses did not persist after controlling for concurrent voice appraisals. These findings parallel those of Hacker et al. (2008), who demonstrated that the observed cross-sectional association between safety behaviour use and voice distress is mediated by appraisals of voice omnipotence, suggesting that safety behaviours reflect attempts to mitigate perceived threat, rather than to reduce distress *per se*. Our findings suggest that similar mechanisms may be at play during daily life.

The demonstrated association between compliance and perceived voice dominance is consistent with a wealth of cross-sectional findings implicating perceived voice rank (Reynolds & Scragg, 2010) and omnipotence (Bucci et al., 2013; Fox et al., 2004; Reynolds & Scragg, 2010) as predictors of compliance with voice commands. However, whilst we predicted, based on past cross-sectional research (Birchwood et al., 2004; Gilbert et al., 2001; Hayward et al., 2008), that voice dominance would also be associated with resistance, this was not born out in our findings.

Interestingly, some studies have failed to demonstrate an association between voice omnipotence (a construct closely related to voice dominance) and resistance, after controlling for the perceived malevolent intent of voices (Peters, Williams, et al., 2012; van der Gaag et al., 2003). Indeed, social relating theories (Benjamin, 1989; Hayward et al., 2011; Thomas, McLeod, & Brewin, 2009) propose that voices perceived as dominant will elicit complementary submissive responses, such as compliance, whilst resistance is more likely to be elicited by voices that are perceived as intrusive or hostile. Whilst we found no evidence of an association between voice intrusiveness and resistance responses, our finding that dominance uniquely predicted compliance, and not resistance, are in line with this suggestion. Based on their findings, Peters et al. suggested that voice malevolence might be more critical in eliciting resistance than voice power/dominance (Peters, Williams, et al., 2012). This notion is supported by findings from the command hallucination literature, where resistance to commands is best predicted by perceived voice malevolence, and with compliance being more likely when voices are perceived as powerful (Barrowcliff & Haddock, 2006; Bucci et al., 2013). However, since we did not assess perceived voice malevolence, we were unable to test this possibility.

Our findings additionally highlight the importance of appraisals of voice uncontrollability in both resistance and compliance responses. To our knowledge, this construct has not previously been assessed as a predictor of voice compliance or resistance, but research

has demonstrated cross-sectional associations between voice-related distress and both perceived voice uncontrollability (Beavan & Read, 2010; Peters, Lataster, et al., 2012), and metacognitive beliefs about the uncontrollability of voices and their associated danger (Morrison, Nothard, et al., 2004; Varese et al., 2016). It has been suggested that perceived loss of control may elicit maladaptive attempts to control or suppress voices (Varese et al., 2016), or alternatively, reinforce appraisals of voice power, eliciting submissive responses such as compliance (Benjamin, 1989; Thomas et al., 2009). Whilst our findings are consistent with these suggestions, it is of course equally possible that appraisals of uncontrollability may stem from failed attempts to resist voices or their commands.

We attempted to assess the directionality of these effects using a micro-longitudinal approach. We predicted that in addition to demonstrating momentary associations with appraisals of voice dominance and uncontrollability, resistance and compliance responses would play a role in maintaining or exacerbating voice distress during daily life, being associated with increases in both voice distress and negative appraisals over time. In line with our predictions, our results indicated that both resistance and compliance behaviours are associated with increases in voice-related distress at subsequent measurement occasions, even after controlling for antecedent effects of voice characteristics, appraisals and voice-related distress. Furthermore, these associations appear to be directional; antecedent distress did not predict increases in resistance or compliance responses. Similar findings have previously been demonstrated with regard to the role of attempts to control or suppress thoughts on subsequent voice distress (Hartley et al., 2015); our results suggest that this effect applies to attempts to control or resist voices.

We also found some support for the notion that behavioural responses might maintain distress via their effect on reinforcing and/or preventing disconfirmation of negative voice appraisals (Michail & Birchwood, 2010; Morrison, 1998). Compliance with voices was associated with subsequent increases in appraisals of voice uncontrollability, whilst the time-lagged association between resistance and perceived voice intrusiveness approached significance. This dynamic association between compliance and voice uncontrollability is particularly interesting in light of our findings of momentary associations between uncontrollability appraisals and both voice distress and compliance, suggesting a mechanism via which compliance may serve to exacerbate voice distress, and prompt further compliance, over time, by reinforcing appraisals of voice uncontrollability.

The findings of this study should be interpreted in light of several limitations. First, whilst we suggest that our findings are consistent with a mediating role of voice appraisals in the relationship between behavioural responses and voice distress, both in the moment and over time, it was not possible to perform formal tests of mediation whilst controlling for necessary covariates due to model non-convergence. Future research should use a multilevel mediation approach (Bauer et al., 2006; Bolger & Laurenceau, 2013) within the context of a larger ESM study to test whether; i) the observed momentary association between responses and voice distress are mediated by appraisals of voice dominance and uncontrollability; ii) the observed micro-longitudinal relationship between compliance and subsequent increased in voice distress is mediated by appraisals of voice uncontrollability.

Second, we did not assess or control for the influence of appraisals of voice malevolence. As mentioned previously, voice malevolence is one of the most consistently reported predictors of voice resistance within the voice hearing and compliance hallucination literature (Birchwood et al., 2004; Hayward, 2003; Peters, Williams, et al., 2012; van der Gaag et al., 2003; Vaughan & Fowler, 2004). Whilst we constructed an item to assess voice benevolence for use within the present study, this item was rarely endorsed during daily life, and demonstrated unacceptably low within-person variability for use (in reverse-coded form) within the present analyses. Attempts to assess 'state' models of voice hearing would be greatly aided by the development of psychometrically robust ESM items to assess various aspects of the cognitive model.

Third, the magnitude of the effects demonstrated in the present thesis were generally small, although not negligible. Small effect sizes are not uncommon in ESM studies, but it has been suggested that the cumulative impact of these effects may be substantial given the frequency with which these effects are observed during daily life (Myin-Germeys et al., 2003), and particularly if a certain threshold is reached or the effect of a protective factor is reduced (Myin-Germeys, Delespaul, & van Os, 2005).

Finally, an important caveat to the interpretation of our results is our finding of associations between momentary voice distress and both voice intensity and negative content, even after controlling for voice appraisals. Whilst this lies in contrast to previous cross-sectional research (van der Gaag et al., 2003), similar findings were obtained in a previous ESM study (Peters, Lataster, et al., 2012), suggesting that the influence of voice characteristics on voice-related distress as experienced during daily life may have been underestimated. This finding echoes suggestions that exploration of voice content may be a crucial component of both understanding and reducing the distress experienced by

some in relation to their voices (Beavan & Read, 2010; Longden, Corstens, et al., 2012; Romme & Escher, 2000).

Acknowledging the limitations outlined above, our results provide ecological validation for a role of compliance and resistance responses in the maintenance of voice distress and negative voice appraisals during daily life. In addition to providing support for cognitive models, these findings have implications for psychological interventions for distressing voices, supporting the notion that behaviour change should remain a central goal of therapy. However, the results have particular implications for therapies incorporating behavioural experiments encouraging attempts to resist command hallucinations; our findings highlight the importance of differentiating between resistance to voice commands, and resisting voice experiences more generally. In this respect, interventions incorporating acceptance and mindfulness approaches (Chadwick et al., 2015), or targeting coping behaviours or interpersonal relationships with voices, may offer hearers an alternative way of relating and responding to their voices (Dannahy et al., 2011). Furthermore, whilst our results support the focus of cognitive interventions on reducing appraisals of voice power/dominance and uncontrollability, they highlight the importance of a parallel therapeutic focus on coping with negative voice content.

6 Chapter Six: Delineating Mechanisms of Change in Cognitive Behaviour Therapy for Psychosis: Potential Contributions of Experience Sampling Methodology

6.1 Abstract

Primary objectives: An increased understanding of therapeutic change mechanisms is critical for the development of more efficacious psychological interventions. However, traditional self-report measures are limited in their ability to discern key changes occurring outside of the therapy room. The current article provides a framework for the use of momentary assessment strategies, such as the experience sampling method (ESM), as a research tool for identifying subtle, implicit and dynamic changes occurring over the course of therapy that are currently inaccessible to other research methods.

Method: The potential contributions of ESM towards delineating therapeutic change mechanisms are illustrated using data from two patients who participated in a series of six day ESM assessments over the course of cognitive behavioural therapy for psychosis (CBTp).

Results: A series of within-person regression and dynamic network analyses conducted on this longitudinal ESM data are used to demonstrate changes in three mechanisms proposed to underlie therapeutic gains in CBTp: i) the nature and intensity of voice appraisals; ii) emotional reactivity to environmental stress; iii) the persistence of negative cognitive and emotional states from moment-to-moment. These mechanistic changes occur alongside gains on standardised, retrospective clinical outcome measures.

Conclusions: The findings provide preliminary support for appraisals and emotional reactivity mechanisms potentially underlying therapeutic gains. They also hint at heterogeneity across individuals in terms of change processes. Such idiographic examination of moment-to-moment patterns of experience can provide valuable insights into clinically important real-world changes that might be overlooked by other research methods. Recommendations and suggestions are made for future research adopting longitudinal ESM assessments as a means to investigate mechanisms of therapeutic change both within and between participants.

6.2 Introduction

A growing body of meta-analytic evidence supports the efficacy of Cognitive Behavioural Therapy for Psychosis (CBTp) in the treatment of positive psychotic symptoms (Burns, Erickson, & Brenner, 2014; Turner, van der Gaag, Karyotaki, & Cuijpers, 2014; Van der Gaag et al., 2014), resulting in endorsements by national treatment guidelines in several countries (American Psychiatric Association, 2004; National Collaborating Centre for Mental Health, 2014; Royal Australian and New Zealand College of Psychiatrists, 2005). Critics have noted however that these effect sizes are moderate at best, and are further reduced when CBTp is compared with an active therapy control (Jones, Hacker, & Cormac, 2012; Turner et al., 2014), or after controlling for potential sources of bias (Jauhar et al., 2014). Such findings have sparked debate around whether practice is running ahead of the evidence-base (McKenna & Kingdon, 2014; Wykes, 2014).

Echoing an on-going dialogue within the psychotherapy literature more broadly (Emsley et al., 2010; Hayes et al., 2013; Kazdin, 2009), many researchers have emphasised the importance of systematic attempts to improve both the effectiveness and efficiency of CBTp (Birchwood & Trower, 2006; Freeman, 2011; Jolley & Garety, 2011). These are pressing objectives, as CBTp is a complex intervention requiring a level of resourcing that routine mental health services are currently unable to support (Waller et al., 2013). In the UK, only 10% of those who could benefit currently have access to CBTp (Schizophrenia Commission, 2012), and it has been suggested that this figure might be even lower in the US and Australia (Farhall & Thomas, 2013).

Key to this endeavour is developing our understanding of the psychological mechanisms underlying therapeutic change (Nock, 2007); in other words, investigating how, and for whom, CBTp is effective (Birchwood & Trower, 2006; Steel, 2012; Turkington, Wright, & Tai, 2013). Discriminating active and redundant therapeutic components allows the optimization of interventions; potent elements can be enhanced and ineffective strategies removed from protocols (Nock, 2007). Identifying the factors that predict individual treatment response, and the mechanisms via which these factors operate *within* individuals, will allow for more efficient targeting of interventions. Finally, understanding change mechanisms will allow the development of routine measures to track change more efficiently.

To date, mechanism research within CBTp has largely focused on identifying variables that mediate therapeutic outcomes in Randomised Controlled Trials (RCTs; Garety et al., 2008; Hodgekins & Fowler, 2010; Morrison et al., 2012). However, despite some

recent successes (e.g. Freeman et al., 2015) these have produced mixed results, with the vast majority of putative mediators either demonstrating no change over therapy (Garety et al., 2008), or being unconnected to improvements in therapeutic outcomes. Furthermore, even demonstrated mediators are likely to be global constructs that incorporate multiple distinguishable components (Kazdin, 2007; Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001); additional approaches are required to identify the *specific* processes via which therapy leads to changes in outcome (Kazdin, 2007). Moreover, findings from RCTs mask a large degree of between-person heterogeneity in both treatment response and change mechanisms (Barlow et al., 2013). It has been suggested that an intensive idiographic focus on treatment responders is a more efficient way to generate hypotheses regarding processes underlying individual difference in treatment response (Barlow et al., 2013; Hayes et al., 2013).

An approach that seems ideally suited to this kind of fine-grained, within-subject exploration of therapeutic change mechanisms is the Experience Sampling Method (ESM; Csikszentmihalyi and Larson 1987). ESM is a diary method that allows the 'real-time' quantitative assessment of participants' subjective experiences as they go about their daily lives (Myin-Germeys et al., 2009). Participants are required to carry a digital wristwatch and a set of questionnaires on their person[3] for a number of consecutive days. Several times per day, participants are signalled by a beeping sound from the watch to fill out a questionnaire, which contains items assessing various aspects of the participant's current experience (e.g. thoughts, feelings, psychotic experiences and social context).

The advantages of ESM for studying psychotic experiences (Oorschot, Kwapil, Delespaul, & Myin-Germeys, 2009) and its potential application to clinical assessment (Myin-Germeys, Birchwood, & Kwapil, 2011; Oorschot, Lataster, Thewissen, Wichers, & Myin-Germeys, 2012) are well-documented. In addition, ESM confers advantages over other methodologies with regards to assessing therapeutic change mechanisms. Ambulatory methods allow the assessment of fleeting experiences such as cognitive appraisals, which are central to theories of psychosis (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001), and one of the main targets of CBTp (Morrison & Barratt, 2010), and which unless captured 'in-the-moment' may be quickly forgotten, or prone to retrospective recall biases (Oorschot et al., 2009). ESM also enables assessment of changes occurring outside the treatment setting (e.g. changes in social interaction);

[3] Note that this study was conducted in 2007, prior to the emergence of smartphone-based methodologies; see Page i for a description of author contributions to this paper.

these are perhaps the most important mechanisms to assess, as they indicate how interventions provided during therapy might impact on real-life social and occupational functioning (Nock, 2007). The repeated, simultaneous assessment of both experiential and contextual variables constitutes an excellent tool to study changes in the (potentially implicit) interactions between a person and their environment over the course of therapy (Oorschot, Lataster, Thewissen, Bentall, et al., 2012; Wichers, 2014). Finally, the richness of the data produced by ESM allows the simultaneous assessment of multiple potential change mechanisms, and lends itself well to both idiographic and nomothetic approaches to analysis.

To illustrate the potential contributions of ESM as a research tool for exploring therapeutic change mechanisms, we performed a series of idiographic analyses on data provided by two patients experiencing psychotic symptoms, who completed a series of ESM assessments over the course of CBTp (Peters, Lataster, et al., 2012). The within-person mechanisms occurring alongside changes in distress and intensity of auditory verbal hallucinations (or 'voices'), as the primary presenting problem of both patients, were explored; however, similar approaches could be adopted for other symptoms.

CBTp incorporates a range of different therapeutic methods, all with the aim of reducing distress and improving coping in daily life (Birchwood & Trower, 2006; Morrison & Barratt, 2010). Amongst these approaches, patients are encouraged to explore alternative explanations of experiences that may be more adaptive and less distressing, including an exploration of beliefs about the omniscience and omnipotence of voices (Morrison & Barratt, 2010). By promoting 'decentring' from distressing beliefs about voices and other psychotic experiences (Peters et al., 2010), CBTp additionally aims to help people to break out of vicious cycles of unhelpful appraisals, behaviours and emotions, and reduce stress reactivity by exploring precipitating and perpetuating factors of psychotic symptoms during daily life (Birchwood & Trower, 2006; Morrison & Barratt, 2010). These processes are facilitated via the use of between-session homework tasks, where patients are encouraged to monitor features of their experience, gaining further insight through the data-gathering process (Morrison & Barratt, 2010).

Based on these key methods utilised within CBTp, we explored three putative therapeutic change mechanisms, all of which currently present a challenge for assessment via traditional research methods relying on retrospective self-report:

(1) reductions in momentary appraisals of voice power (Birchwood et al., 2000), and increases in 'decentring' appraisals (i.e. psychological explanations of voice hearing experiences; Garety et al. 2001);

(2) reduced symptomatic reactivity to activity-related and social stress (Myin-Germeys & van Os, 2007);

(3) reduced persistence of negative cognitive and emotional states from moment-to-moment (Wigman et al., 2013).

6.3 Method

6.3.1 Participants

This study was approved by the SLaM/IoP Ethical Committee (Research), Reference 243/03. Participants were recruited from consecutive referrals over an 18-month period to the Psychological Interventions Clinic for Outpatients with Psychosis (PICuP), a specialist service offering CBTp in the South London and Maudsley National Health Service Foundation Trust in the UK. Individuals were asked to participate in a longitudinal study involving ESM assessments over the course of CBTp (Peters et al., 2009; Peters, Lataster, et al., 2012). Twelve agreed to participate [five men and seven women; mean age 36.4 (SD = 5.6) years]. We report data from two participants who demonstrated improvements on standardised clinical outcome measures following CBTp, as well as providing valid data at three comparable stages during therapy (baseline, mid therapy and end of therapy).

Patient 1 is a 34-year old single woman of White/Asian ethnicity. She was referred to the service for assessment of the distressing voices that she had experienced intermittently since the age of 14. She completed 12 sessions of CBTp over a four-month period. Patient 2 is a 37-year old single male of Black Caribbean ethnicity. He was referred for assessment of distressing voices heard continuously for approximately one year. He completed 20 sessions of CBTp over a 6-month period.

6.3.2 ESM Procedure

Following informed consent participants completed a maximum of five six-day ESM assessments, each of which took place at a different stage during therapy; baseline (at referral to the clinic); immediately pre-therapy (following approximately three months of being on a waiting list); mid-therapy (three months into therapy); end of therapy; follow-up (three months after end of therapy). At the beginning of each six-day ESM assessment period, participants received a digital wristwatch and six pocket-sized booklets (one for each day, each containing ten identical ESM self-assessment forms).

Ten times each day, the watch emitted a ‘beep’ at semi-random moments between 7.30 AM and 10.30 PM. After each ‘beep’, participants were asked to fill out one of the ten identical ESM self-assessment forms, which contained items assessing mood, psychopathology, and context. Participants were instructed to complete their reports immediately after the beep and to register the time at which they completed the questionnaire. Reports were assumed valid when participants responded to the beep within 15 minutes, and when participants completed a minimum of 33% of assessments within each assessment phase.

6.3.3 Measures and Materials

6.3.3.1 Standardized interviews and questionnaires.

The Psychotic Symptom Rating Scales – Auditory Hallucinations Subscale (PSYRATS-AH; Haddock et al. 1999*):* This is a semi-structured interview measuring psychological dimensions of auditory hallucinations. The subscale has 11 items (including voice frequency, distress, disruption and beliefs) rated by the interviewer on a 5-point ordinal scale, with a potential range of scores of 0–44. Higher scores indicate greater voice severity.

6.3.3.2 ESM Measures.

The ESM booklets contained items assessing a range of hypothesised targets of CBTp including affect, psychotic symptom dimensions, symptom appraisals and social and occupational engagement (Peters, Lataster, et al., 2012). The following variables are included within the present demonstration as they relate specifically to the mechanisms under investigation. All items were rated on a 7-point likert scale (1 not at all to 7 very much):

Voice intensity. The voice hearing experiences of each individual were elicited at the initial assessment and transcribed in the person’s own words on the front page of the booklet and on each self-assessment form as ‘My first problem is …’. Both patients described their first problem simply as ‘voices’. The momentary intensity of voices was assessed with the item ‘my voices are present’.

Voice appraisals. Voice power appraisals were assessed with the item ‘Right now my voices are powerful’. ‘Decentring’ voice appraisals were assessed with the item ‘Right now I believe my voices are to do with the way my mind works’.

Voice distress. Momentary voice distress was assessed with the item 'my voices are upsetting me'.

Negative Affect. This was assessed using six items, prefaced by the words 'I feel …'. These items consisted of 'low', 'guilty', 'ashamed', 'anxious', 'annoyed' and 'scared'. Principal component analyses (with oblique rotation) within each participant at each therapy stage consistently identified one factor with an eigenvalue greater than 1, consisting of the items 'low', 'anxious' and 'annoyed'. The items 'guilty', 'ashamed' and 'scared' were reported with low frequency and variability, and thus were excluded from the analyses. The resultant 'Negative Affect' factor accounted for an average of 58.6% of total within-subject variance. One factor-based scale with equal weights for each item was created (mean Cronbach's $\alpha = 0.60$ within subjects).

Social and activity-related stress. Social stress was captured with the item 'I am with people I like'. Appraisals of the current activity were assessed using the item 'this is difficult', rated on a bipolar scale from -3 (not at all) to 3 (very). For the purpose of analyses, a variable reflecting activity-related stress was created by recoding this item so that the final variable was rated on a 7-point Likert scale (1=*not at all* to 7=*very*).

6.4 Analyses

To assess changes in mechanisms 1-3 over the course of therapy, data were analysed using the REGRESS module in Stata 14.0 (StataCorp, 2015b). Since ESM measurement occasions are not independent (Kimhy et al., 2012), the effects of time (i.e. beep number) were controlled for within all regression analyses.

In order to quantify changes in mechanism 1, momentary voice power and voice decentring appraisal was regressed against therapy stage (dummy coded with 'baseline' as the reference category) for each participant. Similarly, for mechanism 2, voice intensity was regressed against activity/social stress, therapy stage (dummy coded with 'baseline' as the reference category) and the therapy stage x stress interaction term. Following these regression analyses, Post-hoc Tukey pairwise comparisons were used to assess differences between scores/interactions at each therapy stage.

For mechanism 3, a dynamic 'network approach' was used to assess and visualise changes in the temporal interrelationships between momentary states, using a vector autoregression (VAR) model (Bringmann et al., 2013; Wichers, 2014). VAR is a multivariate extension of an autoregressive (AR) model (Shumway & Stoffer, 2006). An

AR model is typically applied to a repeatedly measured variable obtained from a single participant. In this way, the temporal dynamics within an individual are modelled. An AR model can be considered as a regression model in which a variable at time point *t* is regressed to a lagged (measured at a previous time point, *t*-1) version of that same variable (Walls & Schafer, 2006). In VAR the time dynamics are modelled for multiple variables. Thus, variables are regressed on a lagged version of the same variable and all other variables of the multivariate network (Wichers, 2014). Furthermore, the first measurement of the day is excluded from analysis (Bringmann et al., 2013) in order to avoid using the measurements of yesterday to predict the measurements of today (because a night – a comparatively large time interval - separates the two days).

6.5 Results

6.5.1 Basic Sample Characteristics and ESM Item Descriptives

Patient 1 completed four ESM assessment periods; at baseline, mid therapy, end of therapy and at 3-month follow-up. Across the three ESM phases included in this analysis (baseline, mid-therapy, and end-of-therapy), she recorded an average of 33 valid entries at each phase for the voice presence item (out of a maximum of 60 responses), with the presence of voices being reported on 58.6% of these entries. Over the course of therapy,

Patient 2 completed all five ESM assessment periods. Across the three ESM phases included in this analysis (baseline, mid-therapy, and end-of-therapy) he recorded an average of 53.3 entries at each phase for the voice presence item (out of a maximum of 60 responses), with the presence of voices being reported on 91.3% of these entries.

For the sake of simplicity, the following assessment of change mechanisms focuses on the three equivalent ESM phases completed by both participants before, during, and immediately following therapy. Descriptive statistics for clinical outcomes at each therapy stage are displayed in Table 6.1.

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Table 6.1. *Descriptive statistics for PSYRATS-AH and ESM voice intensity and distress at each therapy stage*

Measure	Patient 1			Patient 2		
	Baseline	*Mid-Therapy*	*Post-therapy*	*Baseline*	*Mid-Therapy*	*Post-therapy*
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
PSYRATS-AH						
Total Score	37 (N/A)	16 (N/A)	15 (N/A)	33 (N/A)	34 (N/A)	25 (N/A)
Distress (Intensity)	3 (N/A)	0 (N/A)	0 (N/A)	3 (N/A)	3 (N/A)	1 (N/A)
ESM						
Voice Intensity	1.98 (0.90)	2.00 (0.48)	1.09 (0.29)	3.17 (1.56)	3.39 (1.64)	2.88 (1.65)
Voice Distress	2.42 (0.83)	1.08 (0.28)	1.00 (0.00)	2.43 (1.98)	3.05 (2.21)	2.52 (2.15)

6.5.2 Mechanism 1: Momentary appraisals of voice power and 'decentring' appraisals

Figure 6.1 displays changes in the mean momentary conviction in voice power and 'decentring' appraisals over the course of therapy for Patients 1 and 2.

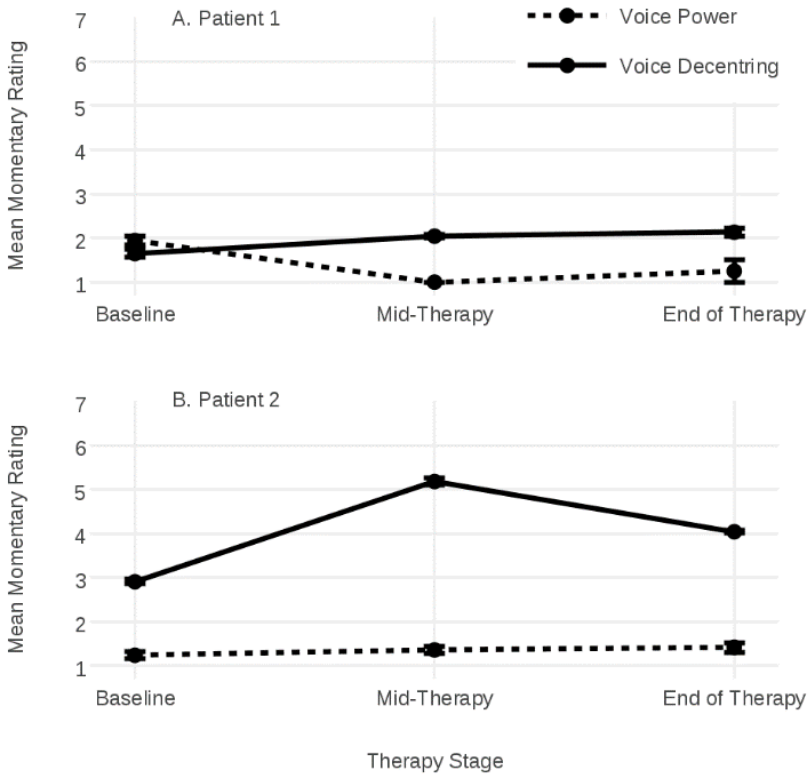

Figure 6.1. Changes in the mean momentary conviction in voice decentring appraisals for Patients 1 (panel a) and 2 (panel b) at baseline, mid-therapy and end of CBTp. Error bars represent ±1 SE.

For Patient 1 (Figure 6.1A), post-hoc Tukey pairwise comparisons indicated that mean momentary voice power decreased significantly from baseline (M = 1.94) to mid therapy (M = 1.00, t(58) = -8.18, p <.001), before rising slightly (but non-significantly) by the end of therapy (M = 1.25, t(58) = 1.08, p =.53). Mean momentary conviction in voice decentring appraisals increased significantly from baseline (M = 1.65) to mid therapy (M = 2.04, t(80) = 4.01, p <.001) and increased further (non-significantly) at the end of therapy (M = 2.13, t(80) = 0.68, p = .78).

For Patient 2 (Figure 6.1B), mean momentary voice power remained relatively stable from pre-therapy (M = 1.24) to mid therapy (M = 1.36, t(157) = 0.93, p =.62), and at the

end of therapy (*M* = 1.42, *t*(157) = 0.49, *p* =.87), suggesting that therapy was not successful at targeting voice power appraisals for this individual. However, the baseline rating of voice power was very low for this individual, limiting the potential for change. On the other hand, mean momentary conviction in voice decentring appraisals increased significantly from baseline (*M* = 2.91) to both mid therapy (*M* = 5.18, *t*(157) = 27.87, *p* <.001) and the end of therapy (*M* = 4.04, *t*(157) = 13.50, *p* <.001), despite a small decrease between the mid and end of therapy (*t*(157) = -13.69, *p* <.001).

6.5.3 Mechanism 2: Symptomatic reactivity to activity-related and social stress

Figure 6.2 displays changes in stress reactivity over the course of CBTp for Patients 1 and 2.

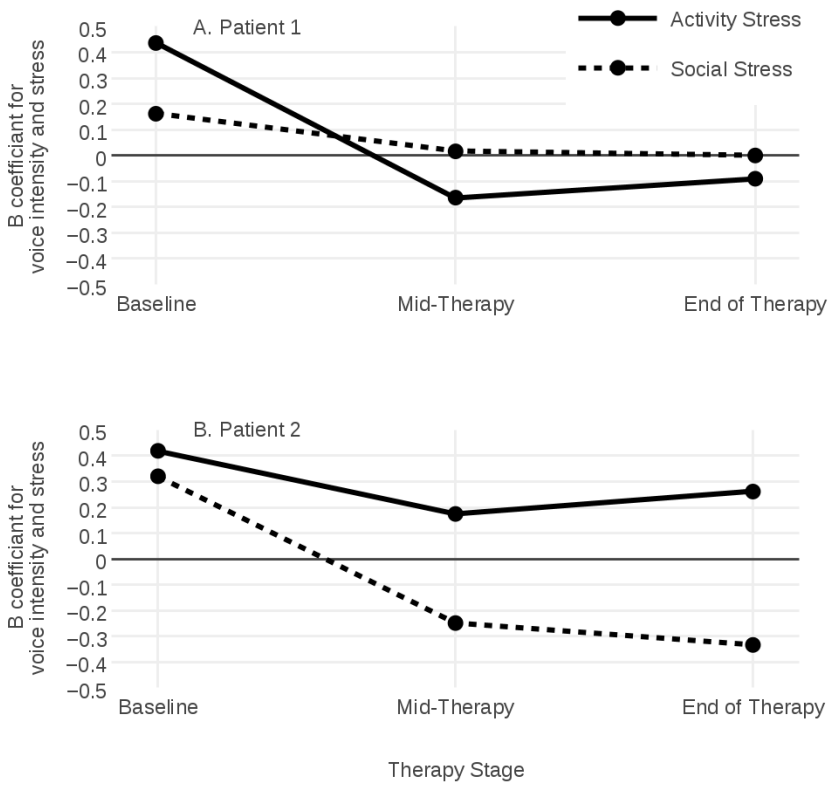

Figure 6.2. Stress-reactivity (i.e. the 'momentary' association (unstandardized beta) between voice intensity and i) activity-related stress; ii) social stress for Patients 1 (panel a) and 2 (panel b) at baseline, mid-therapy and end of therapy. Note that higher beta values reflect greater stress-reactivity.

For Patient 1 (Figure 6.2A) at baseline there was a significant positive momentary association between activity-related stress and voice intensity (B = 0.44, *t*(91) = 2.47, *p* =.002), indicating that a unit increase in activity-related stress was associated with a

0.44-unit increase in voice intensity. Post-hoc Tukey pairwise comparisons indicated that this association weakened over therapy; relative to baseline, the momentary relationship between voice intensity and activity-related stress decreased significantly at mid-therapy (B = -0.16, *t*(91) = -2.51, *p* =.037) before rising slightly (non-significantly) at the end of therapy (B = -0.09, *t*(91) = 0.25, *p* =.97), relative to mid-therapy. A similar, though non-significant trend was observed for the momentary association between voice intensity and social stress, which fell from baseline (B = 0.16, *t*(35) = 0.92, *p* =.36) to mid-therapy (B = 0.00, *t*(35) = -0.74, *p* =.74) and further from mid-therapy to the end of therapy (B = -0.09, *t*(35) = -0.10, *p* =.10). Overall, this indicates a reduction in stress-reactivity for this patient over the course of therapy.

Similar to Patient 1, for Patient 2 (Figure 6.2B) at baseline there was a significant positive momentary association between voice intensity and activity-related stress (B = 0.42, *t*(149) = 2.58, *p* =.011). Post-hoc Tukey pairwise comparisons indicated that this association weakened (non-significantly) over therapy; relative to baseline, the momentary relationship between voice intensity and activity-related stress decreased at mid-therapy (B = 0.17, *t*(149) = -1.22, *p* =.44) before rising slightly at the end of therapy (B = 0.26, *t*(149) = 0.49, *p* =.88), relative to mid-therapy. A similar, though non-significant trend was observed for the momentary association between voice intensity and social stress, which fell from baseline (B = 0.32, *t*(49) = 1.27, *p* =.36) to mid-therapy (B = -0.25, *t*(49) = -1.42, *p* =.34) and further from mid-therapy to the end of therapy (B = -0.33, *t*(49) = -0.15, *p* =.99), relative to mid-therapy.

6.5.4 Mechanism 3: Persistence of negative cognitive and emotional states from moment-to-moment

Three ESM items were reported with sufficient frequency and variability for inclusion within the network analyses: activity-related stress, voice intensity and negative affect. Analyses were exploratory, comprising all possible interrelationships between the three variables. Figure 6.3 shows a series of VAR network models illustrating the dynamic, time-lagged associations between these three momentary states for Patients 1 and 2 at baseline, mid-therapy and end of therapy.

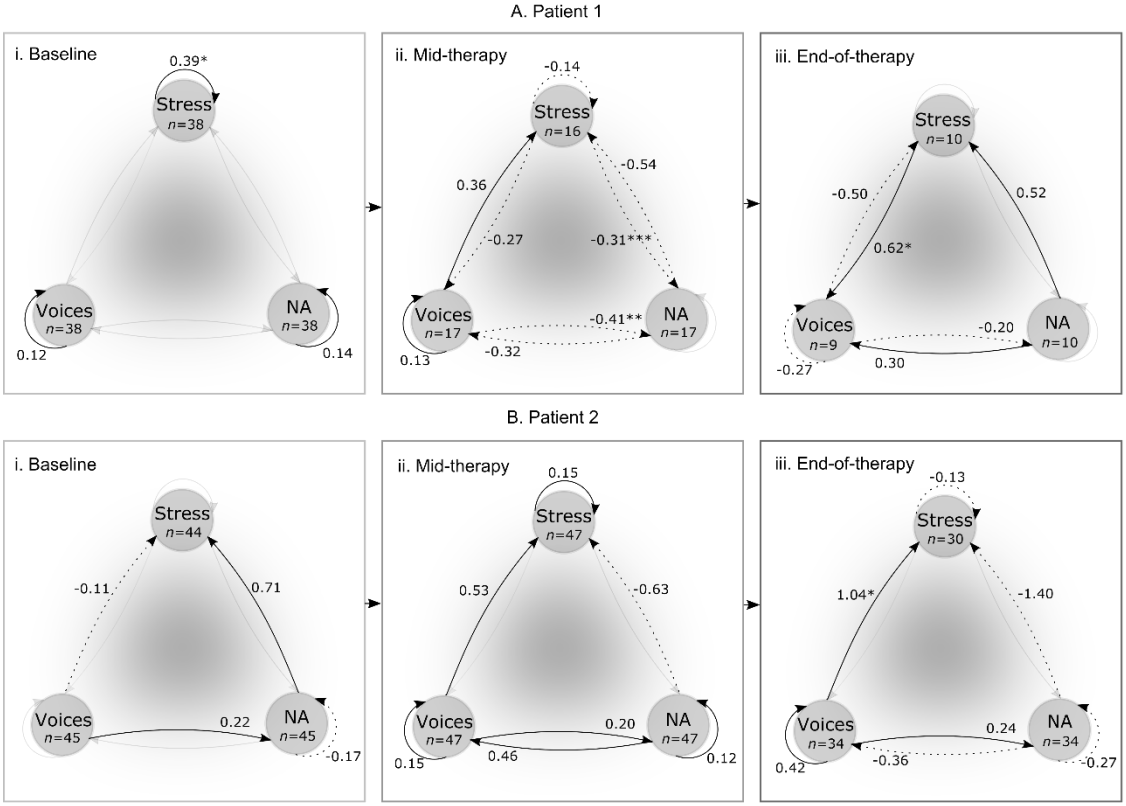

Figure 6.3. Vector Autoregressive Regression (VAR)-based network models illustrating the dynamic associations between activity stress, negative affect and voice intensity for Patient 1 at baseline (panel A(i)); mid-therapy (panel A(ii)); and end of therapy (panel A(iii)); and Patient 2 at baseline (panel B(i)); mid-therapy (panel B(ii)); and end of therapy (panel B(iii)). Each model illustrates the combined results of significant time-lagged associations between these states expressed in a network in which nodes represent the states and the arrows the time-lagged impact of one state on the other. Associations between states were assessed only for the first time lag [moment(t−1) → moment(t)]. B-Coefficients of time-lagged effects with unstandardized effect sizes >0.1 are depicted (* p<.05, ** p<.01, *** p<.001). Continuous lines indicate positive time-lagged associations, whilst dotted lines represent negative time-lagged associations. The number of time-lagged observations on which these analyses were based (i.e. per item, per therapy phase, per individual) is denoted by *n*.

Contrary to our hypotheses, for both patients, voice hearing experiences appeared to be relatively context-independent at baseline (Panels Ai and Bi); fluctuations in voice intensity were not predicted by antecedent levels of stress, and similarly, there was no evidence of time-lagged effects of negative affect on voice intensity for either patient.

Also unexpectedly, these analyses provided evidence of *increases* in the context dependency of voices over the course of therapy in both patients. The nature of these dependencies differed between participants, indicating individual differences in changes occurring over therapy. Whilst improvements were observed in Patient 1 at mid therapy

(Panel Aii), in that *decreases* in voice intensity were observed following reports of high stress or negative affect, these associations had reversed by the end of therapy (Panel Aiii), with antecedent stress and negative affect predicting subsequent increases in voice intensity. This indicates that dynamic symptomatic reactivity to stress actually *increased* over the course of therapy for Patient 1.

Reversals in dynamic associations were also observed in Patient 2; at mid therapy (Panel Bii), voice intensity was associated with antecedent levels of negative affect, whilst at the end of therapy (Panel Biii), improvements were observed, with negative affect predicting subsequent decreases in voice intensity. These findings indicate that the mechanisms underlying voice hearing experiences within individuals may well fluctuate in unexpected ways over the course of therapy, with improvements not necessarily occurring in a linear fashion.

6.6 Discussion

This paper aimed to demonstrate how ESM can contribute to our understanding of the idiographic change mechanisms underlying positive therapeutic change in CBTp. Although the findings are illustrative only, there was preliminary evidence for a range of processes involving appraisals and emotional reactivity potentially underlying therapeutic gains during CBTp.

The results of the first analysis (*Mechanism 1*) illustrate the utility of ESM for understanding the impact of therapy on a person's passing thoughts as they occur during 'real life', outside of the therapy session. Here, a significant increase in the mean momentary conviction in voice decentring appraisals was observed over the course of CBTp for both patients, whilst voice power was only successfully modified in Patient 1 (however, note that baseline reports of voice power were very low for Patient 2). This suggests that cognitive change strategies learned over the course of therapy might be successfully utilised outside of the therapeutic setting when appraising the meaning of psychotic experiences as they arise during the course of daily life, but that power beliefs may not drive distress in all voice hearers.

The repeated, simultaneous assessment of different elements of experience achieved using ESM also provided further insight into more implicit changes occurring over the course of CBTp. The observed trend towards reduced stress reactivity over the course of therapy for Patient 1, and to a lesser extent Patient 2 (*Mechanism 2*), suggest that this

might represent a mechanism underlying gains on global assessments of therapeutic outcome. Possible routes to changes in stress-reactivity include an increase in the utilisation of cognitive reappraisal strategies, but this suggestion requires further empirical investigation.

Contrary to our predictions, the dynamic VAR network analyses of ESM data (*Mechanism 3*) demonstrated increases in the moment-to-moment persistence of negative cognitive and emotional states for both patients, a finding that is particularly interesting given recent suggestions that persistence of mental states from moment to moment may represent vulnerability to psychopathology (Kuppens, Allen, & Sheeber, 2010; van de Leemput et al., 2014; Van Os & Linscott, 2012; Wigman et al., 2013).

However, these results may alternatively suggest an increase in the context-dependency of voices over the course of therapy; at baseline, voice intensity appears to be unrelated to antecedent levels of stress and negative affect, but over the course of therapy, voices may appear more specifically in these contexts. It should be noted that these changes occurred in the context of decreased (Patient 1) or stable (Patient 2) momentary voice-related distress (the intended target of CBTp when applied to distressing voices). These findings in combination suggest that whilst voice intensity may be more closely linked with stress and negative affect as therapy proceeds, this does not have a corresponding impact on voice-related distress. However, this emergence of new and potentially maladaptive dynamic associations suggests a potential use for ESM in guiding the course of therapy (Hartmann et al., 2015). For example, ESM-based feedback might be utilised during therapy to identify targets for intervention that are most likely to work for a particular patient. The demonstrated individual differences in maintenance and change mechanisms further reaffirms the importance of adopting an idiographic approach such as that offered by ESM.

There are three main limitations of the demonstrated approach, which should be addressed in future research. First, in the present demonstration, power to detect significant effects was limited. This is a particular issue when constructing VAR network models, where the analysis of lagged variables necessarily results in a reduction of the number of reports included in analysis (i.e. because only consecutive reports contribute to the model). It has recently been suggested that up to three weeks of ESM data collection might be required to construct a reliable VAR network model, but in the present demonstration data was collected over just six days per therapy stage.

This issue is compounded in longitudinal research such as this, where decreased compliance over the course of therapy further reduces power to detect significant effects at later assessment stages, limiting our ability to compare effects from pre- to post-therapy. Furthermore, differences between participants in terms of compliance with the ESM procedure limits our ability to draw firm conclusions about individual differences in change mechanisms. Whilst we can be reasonably confident in the reliability of networks provided by Patient 1 (since these were based on a minimum of 30 time-lagged reports; i.e. half of the 60 possible ESM reports), the reliability of networks provided by Patient 2 at mid- and post-therapy are less certain (being based on between 9 and 17 lagged data points).

Whilst this presents a problem for the reliability and interpretation of within-person networks in the context of low compliance, it is not such an issue when ESM is conducted in the context of larger-scale RCTs, since power to detect population effects in within-person mechanisms is largely determined by the number of participants, rather than the number of reports provided by each person (Bolger & Laurenceau, 2013). RCTs employing these methods should however perform power calculations based on the expected number of ESM reports provided at the end of therapy.

A second limitation is that the present research design is limited in its ability to determine the timeline of changes (i.e. whether changes in the proposed mechanisms precede change in the therapeutic outcome - a central requirement for the demonstration of mediation; Kazdin 2007), since it may miss changes occurring in the periods between assessments. One potential solution to both the power and timeline limitations is to adapt ESM for continuous use over the course of shorter-term RCTs. Continuous assessment strategies are better able to capture individual differences in the time course of therapeutic change (Nock, 2007), effectively resolving the 'timeline' requirement. Furthermore, such a strategy produces more data points per individual, increasing power to detect significant time-lagged associations and providing richer information about the temporal dynamics of therapeutic change mechanisms. The use of mobile app-based ESM procedures (Johnson & Grondin, 2009; Palmier-Claus, Ainsworth, et al., 2012) is likely to facilitate participant compliance in longitudinal research, further increasing power to detect changes.

A third limitation is that since Patient 1 did not complete the pre-therapy ESM period, we were unable to assess the degree of 'natural' variation occurring within the waiting list period for both patients, in order to compare this to the degree of changes occurring over

the course of therapy. This makes it impossible to determine whether the observed changes occurred as a result of therapy, or due to natural recovery over time. Similarly, it is possible that the changes observed here are due to the process of ESM monitoring itself, rather than indicating specific effects of therapy. Monitoring of daily experiences is encouraged within CBTp (Morrison & Barratt, 2010), since this is assumed to facilitate insight of the links between situations, thoughts, behaviours and emotions, and it is likely that ESM monitoring would serve a similar function. Future studies should aim to maintain participant compliance with the ESM assessments at a minimum of four stages over therapy; baseline, pre-therapy, mid-therapy, and end-of-therapy, in addition to including a control group completing ESM assessments outside of the context of therapy.

Despite some limitations, these findings clearly demonstrate the potential of ESM to furthering our understanding of therapeutic change mechanisms. These results provide preliminary evidence for changes in momentary voice appraisals and symptomatic reactivity to stress over the course of CBTp, occurring in ‘real life’, outside of the therapy room, whilst also highlighting the importance of considering individual differences in change mechanisms within the context of RCTs. ESM may provide a valuable means of advancing understanding of critical therapeutic change mechanisms, and has applications for data-driven, personalised formulation within routine clinical practice.

7 Chapter Seven: An exploration of factors associated with stress-induced depersonalisation in voice hearing

7.1 Abstract

Primary objectives: The role of daily life stress in the moment-to-moment fluctuation of voice hearing experiences is now well established. In Chapter Four, we demonstrated using the Experience Sampling Method (ESM) that this temporal relationship between stress and voice hearing is mediated by depersonalisation experiences, suggesting a potential antecedent role for stress-induced depersonalisation in the modulation of voice intensity. The present study investigated the degree to which this effect is generalizable across participants, and subsequently explored associations between the presence of this mechanism and; i) clinical and diagnostic characteristics; and ii) aspects of voice phenomenology.

Method: An exploratory idiographic approach was employed to compare voice hearers who display evidence of this mechanism to those who do not, using scores from; a) validated clinical assessments capturing constructs such as stress and anxiety, voice and delusional severity, attachment styles and beliefs about voices, self and others; and b) aggregated mean momentary data obtained using ESM, assessing depersonalisation and aspects of voice phenomenology.

Results: The presence of this mechanism was significantly associated with higher trait stress, fewer benevolence beliefs about voices, and lower engagement with voices. Analyses revealed trend-level associations between this mechanism and poorer outcomes across a number of domains, including trends towards higher attachment anxiety, depression and voice severity.

Conclusions: Stress-induced depersonalisation may represent a proximal mechanism of voice hearing for a significant subset of voice hearers, who appear to be characterized by more negative experiences and outcomes. Further research in a larger sample is required to formally test these predictions, but it is possible that intervention approaches targeting stress-induced depersonalisation may be particularly effective for these individuals.

7.2 Introduction

There is now growing evidence that stressful experiences during daily life play an antecedent role in the momentary onset and fluctuation of psychotic experiences, such as voice hearing (auditory verbal hallucinations). Research utilizing the Experience Sampling Method (ESM) - a momentary assessment approach in which phenomena are recorded several times per day when prompted by an electronic device (Csikszentmihalyi & Larson, 1987) - has demonstrated momentary associations between self-reported stress and voice intensity during the course of daily life (Glaser, Van Os, Thewissen, & Myin-Germeys, 2010; Palmier-Claus, Dunn, et al., 2012), echoing findings from a larger body of research indicating that stress-sensitivity may represent an endophenotype for psychosis (Myin-Germeys & van Os, 2007). This research has demonstrated that experiences of trauma in childhood - a demonstrably potent environmental risk-factor for psychotic experiences (Bentall et al., 2014) - are associated with both emotional (Glaser, van Os, Portegijs, & Myin-Germeys, 2006) and psychotic (Lardinois et al., 2011) reactivity to daily life stresses in adulthood, indicating long-lasting and enduring effects of childhood trauma on adult stress-sensitivity.

However, the mechanisms via which daily life stresses may serve to exacerbate voice hearing experiences and other psychotic experiences are less clear. The potential developmental role of dissociative processes in voice hearing specifically has received increasing attention in recent years, following demonstrations that dissociation mediates the relationship between early life trauma and voice hearing (Perona-Garcelán et al., 2014; Perona-Garcelán, Carrascoso-López, et al., 2012; Varese et al., 2012).

Evidence of a more proximal relationship between voice hearing and dissociation comes from studies finding that dissociation is higher in patients reporting current voice hearing experiences, compared to remitted voice hearers (Perona-Garcelán et al., 2008; Perona-Garcelán, García-Montes, Ductor-Recuerda, et al., 2012; Varese et al., 2012). Intriguingly, psychosis patients who report depersonalisation experiences (a specific form of dissociation during which a person may experience a sense of unreality, detachment or disconnection in relation to their body and surroundings) have been found to be both more likely to hear voices, and more sensitive to stress, than patients without these experiences (Maggini, Raballo, & Salvatore, 2002), suggesting a link between stress, dissociation and voice hearing. Indeed, the ‘special relationship’ between dissociative experiences and both anxiety and stress has been well-documented (Hoyer, Braeuer, Crawcour, Klumbies, & Kirschbaum, 2013; Mauricio Sierra, Medford, Wyatt, &

David, 2012), with ESM research finding that, that like psychotic experiences, dissociative states demonstrate momentary associations with self-reported stress during daily life (Stiglmayr et al., 2008).

These findings have led authors to suggest that dissociative processes may play a mediating role in the relationship between stress and voices during daily life (Varese, Udachina, et al., 2011). The presence of a close link between stress, dissociation and voices in daily life has been supported by work by Varese, Udachina, Myin-Germeys, Oorschot and Bentall (2011), who demonstrated using ESM that voices appear to be more likely to occur in moments when dissociative states are reported - an association that is particularly evident during moments of high self-reported stress. In Chapter Four, we assessed the directionality of these effects, using a 'time-lagged' modelling approach to explore the temporal dynamics of voices in relation to stress and depersonalisation experiences. This study provided the most direct evidence to date for a role of dissociative processes in the modulation of voice hearing during daily life, demonstrating that high levels of stress predict increases in voice intensity at subsequent measurement occasions, with this effect being fully mediated by levels of depersonalisation.

However, questions remain unanswered with regard to the generalizability of this effect. Our study observed relatively high between-person variation in mean momentary depersonalisation, suggesting that there may be individual differences in the extent to which this mechanism applies. Furthering our understanding of the factors associated with the presence of this mechanism may have implications for triage and intervention for voice hearers for whom dissociative processes play a particularly prominent role.

The present study will adopt an exploratory idiographic approach to explore; i) the extent to which this stress-depersonalisation-voices mediation effect is generalizable across participants; ii) associations between the presence of this mechanism and diagnostic and clinical characteristics. Specifically, we will compare voice hearers who display evidence of this mechanism to those who do not, using scores from; a) aggregated mean momentary data obtained using the ESM, capturing average 'state' levels of stress, depersonalisation, voice intensity and distress over the course of the assessment period; and b) validated clinical assessments capturing 'trait-level' constructs such as stress and anxiety, voice and delusional severity, attachment styles and beliefs about voices, self and others

We make a number of specific predictions. First, we suggest that this mechanism will be particularly evident in individuals who are especially prone to stress and depersonalisation experiences, both at a trait level, and during daily life. Along similar

lines, it is possible that stress-induced depersonalisation is particularly prevalent within specific diagnoses, such as Borderline Personality Disorder, in which dissociation represents a core diagnostic feature (American Psychiatric Association, 2013). Given our use of a trans-diagnostic sample of voice hearers, we will explore the possibility that diagnosis – or symptoms characteristic of certain disorders, such as delusional beliefs in psychosis - moderate the observed effects.

We will additionally explore the relationship between our demonstrated mediation mechanism and variables drawn from traumagenic attachment models of voice hearing. The cognitive attachment model of voices (CAV; Berry, Varese, & Bucci, 2017) proposes that the propensity to experience dissociative states is driven or exacerbated by specific types of attachment pattern, including insecure-anxious attachment (i.e., an attachment style characterized by beliefs that one needs to rely on other people, negative beliefs about the self and an expectation that other people will let them down). These insecure attachment styles are suggested to arise from adverse childhood experiences such as suboptimal caregiving or more extreme experiences of neglect and abuse. It is suggested that repeated exposure to relational traumas in childhood results in oversensitivity to threat in the context of later stressors, resulting in dissociative experiences. Research has demonstrated links between insecure attachment and both dissociation (Ogawa et al., 1997; Sandberg, 2010) and dimensions of voice hearing (Berry, Barrowclough, & Wearden, 2008; Pilton et al., 2016). Given these previous findings, we predict that the group in which the stress-dissociation mediation mechanism is present will be characterized by; i) higher levels of insecure-anxious attachment; ii) more negative beliefs about others; and iii) more negative beliefs about the self.

Finally, we will explore the relationship between the presence of this mediation effect and the experience of voices, with regard to phenomenology, and beliefs and responses to voices. Our first prediction, based on previous evidence of significant bivariate associations between measures of dissociation and voices (Pilton, Varese, Berry, & Bucci, 2015), is that participants who demonstrate evidence of this mediation pathway will report voices of greater intensity/severity. Similarly, we predict that this mechanism may be associated with higher levels of voice distress, and maladaptive beliefs about and responses to voices. The CAV model makes the prediction that individuals with an insecure-anxious attachment style are more likely to hold beliefs that voices are powerful and malevolent (Berry et al., 2017), and as a result, may be more likely to be distressed by their voices. On the assumption that our stress-dissociation mechanism is more

prevalent in individuals who hold insecure-anxious attachment styles, we would also expect this group to hold more negative beliefs, and display more resistance, towards their voices.

7.3 Method

7.3.1 Sample

Thirty-five participants were recruited from mental health services across Sussex, UK. Inclusion criteria were: aged 18 or over; currently treated as an outpatient of mental health services; currently experiencing frequent auditory verbal hallucinations (score of 2 ('at least once a day') or above on the frequency item of the Psychotic Symptoms Rating Scale – Auditory Hallucinations (PSYRATS-AH; Haddock, McCarron, Tarrier, & Faragher, 1999); adequate command of the English language. Exclusion criteria were: unable to provide fully informed written consent; symptoms precipitated by an organic cause; evidence of primary substance dependence; previously received 16 sessions or more of NICE-adherent Cognitive Behavioural Therapy for psychosis (CBTp). All participants entered the study between November 2014 and December 2015. Full ethical approval was obtained from the Camberwell St Giles National Research Ethics Committee (REC reference: 14/LO/0475).

7.3.2 Data Collection

7.3.2.1 Basic Sample Characteristics*.*

Data on age, gender, ethnicity, level of education, and employment status were collected using a modified version of the Medical Research Council socio-demographic schedule (Mallet, 1997). DSM-IV diagnoses were determined based on structured examination of case records using the OPerational CRITeria+ (OPCRIT+) system (Rucker et al., 2011). Data on medication use were collected using a medication checklist, which was completed based on close examination of clinical documentation, recording the use of all prescribed antipsychotic, antidepressant and other psychotropic medication.

7.3.2.2 ESM Measures.

Data on voice intensity, stress and depersonalisation were collected using the ESM to allow for assessing moment-to-moment variation in these variables prospectively, in the real world and in real time, with high ecological validity. All ESM items were rated on a 7-point Likert scale (1 *not at all* to 7 *very much).*

7.3.2.2.1 Momentary stress

Momentary stress was assessed with one ESM item; "Right before the beep I felt stressed" (Vilardaga et al., 2013).

7.3.2.2.2 Momentary depersonalisation

Momentary depersonalisation was assessed with one ESM item adapted from the Cambridge Depersonalization Scale (CDS; Sierra & Berrios, 2000); “Right before the beep I felt detached or unreal”.

7.3.2.2.3 Momentary voice intensity

The intensity of voices was assessed with one ESM item; “Right before the beep I could hear a voice or voices that other people couldn’t hear” (Kimhy et al., 2006). During the ESM briefing, we ascertained that the participants understood that this question related to voices and that responses on the Likert scales reflected voice intensity (2 = ‘can barely be heard’ to 7 = ‘disturbingly loud making normal functioning impossible’).

7.3.2.2.4 Momentary voice distress

Distress associated with voices was assessed using one ESM item; “Right before the beep the voices were upsetting me” (Peters, Lataster, et al., 2012).

7.3.2.3 Validated Clinical Measures.

7.3.2.3.1 Psychosis Attachment Measure (PAM; Berry, Barrowclough, & Wearden, 2008)

The PAM is a 16-item self-report psychosis attachment measure, which assesses insecure- anxious and insecure-avoidant attachment in the context of current close relationships in adulthood. Items are rated on a four-point ordinal scale from 0 (not at all) to 4 (very much). A factor analytic study (Berry et al., 2008) identified that this measure consists of two subscales; ‘attachment anxiety’ [eight items (e.g. ‘I worry that key people in my life won’t be around in the future’); potential range of scores 0–32]; and ‘attachment avoidance’ [eight items (e.g. ‘I prefer not to let other people know my ‘true’ thoughts and feelings’); potential range of scores 0–32]. Higher scores on these subscales indicate higher levels of anxious and avoidant attachment. Berry et al. (2008) produced evidence of good concurrent validity and internal reliability for both subscales (attachment anxiety =.82; attachment avoidance =.76)

7.3.2.3.2 The Psychotic Symptom Rating Scales (PSYRATS; Haddock et al., 1999)

The PSYRATS is a 17 item semi-structured interview measuring the various psychological dimensions of delusions and hallucinations. All items are rated by the interviewer on a five-point ordinal scale from 0 (absent) to 4 (severe).The PSYRATS

comprises two subscales: the auditory hallucinations subscale (AHS) consists of 11 items (including frequency, intensity, duration, disruption and beliefs about origin and control; potential range of scores 0–44); whilst the delusions subscale (DS) consists of 6 items (including conviction, preoccupation, disruption to functioning and distress; potential range of scores 0–24). Higher scores indicate greater pathology.

A recent factor analytic study (Woodward et al., 2014) identified that the AHS comprises four subscales; 'distress' [five items (amount and degree of negative content; amount and intensity of distress; controllability); potential range of scores 0–20]; 'frequency' [three items (frequency, duration, and disruption); potential range of scores 0–12]; 'attribution' [two items (location and origin of voices); potential range of scores 0–8]; and 'loudness' [one item (loudness item only); potential range of scores 0–4]]. The same study found that the DS comprises two subscales; 'distress' [two items (amount and intensity of distress); potential range of scores 0–8]; and 'frequency' [four items (amount and duration of preoccupation; conviction; disruption); potential range of scores 0–16]. Studies have indicated generally strong interrater reliability of the PSYRATS and adequate test-retest reliability (Drake, Haddock, Tarrier, Bentall, & Lewis, 2007; Gillian Haddock et al., 1999), alongside good internal consistency of the individual subscales (Woodward et al., 2014).

7.3.2.3.3 Depression, Anxiety and Stress Scale-21 (DASS-21)

The DASS-21 is a shortened version of the DASS-42 self-report questionnaire assessing distinct dimensions of psychological distress (Lovibond & Lovibond, 1995). The scale consists of 21 items assessing respondents over the past week, with items being rated on a four-point ordinal scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). This measure comprises three subscales; 'depression' [seven items (e.g. 'I felt that life was meaningless'); potential range of scores 0–21]; 'anxiety' [seven items (e.g. 'I felt scared without any good reason'); potential range of scores 0–21]; and 'stress' [seven items (e.g. 'I tended to over-react to situations'); potential range of scores 0–21]. There is evidence of good reliability for all three subscales and the total scale, with coefficient alphas ranging between 0.79 and 0.94 (Antony, Bieling, Cox, Enns, & Swinson, 1998).

7.3.2.3.4 Brief Core Schema Scales (BCSS; Fowler et al., 2006)

The BCSS is a 24-item self-report questionnaire assessing both negative and positive schemas about self and others. Items are rated on a five-point ordinal scale from 0 (no) to 4 (believe it totally). This measure consists of four subscales; 'negative self-schema' [six items (e.g. 'I am a failure'); potential range of scores 0–24]; 'positive self-schema' [six items (e.g. 'I am good'); potential range of scores 0–24]; 'negative other-schema' [six items (e.g. 'Other people are devious'); potential range of scores 0–24]; and 'positive other-schema' [six items (e.g. 'Other people are trustworthy'); potential range of scores 0–24]. The measure shows good internal consistency, test-retest reliability and validity within a psychotic population (Fowler et al., 2006; Smith et al., 2006).

7.3.2.3.5 Beliefs about Voices Questionnaire-Revised (BAVQ-R; Chadwick, Lees, & Birchwood, 2000)

This 35-item self-report questionnaire measures beliefs about the malevolence, benevolence and omnipotence of voices, alongside behavioural and emotional responses to voices. Each item is rated on a four-point ordinal scale ranging from 0 (disagree) to 3 (strongly agree). A recent factor analytic study (Strauss et al., n.d.) pooling data from 450 participants in eight study centres identified that this measure consists of four subscales; two relating to beliefs, and two relating to responses to voices. The two beliefs subscales identified were 'persecutory beliefs about voices' [twelve items (e.g. 'My voice is persecuting me for no good reason'); potential range of scores 0–36] and 'benevolence beliefs' [six items (e.g. 'My voice wants to help me'); potential range of scores 0–18]. The two responses subscales identified were 'resistance' [nine items (e.g. 'When I hear my voice usually I tell it to leave me alone'); potential range of scores 0–27] and 'engagement' [eight items (e.g. 'When I hear my voice usually I listen to it because I want to'); potential range of scores 0–24]. The measure shows good internal consistency and validity within a psychotic population (Chadwick et al., 2000).

7.3.2.4 ESM Procedure.

All participants were provided with a smartphone pre-loaded with the movisensXS experience sampling app (https://xs.movisens.com/), via which the ESM measure was administered ten times per day. We used a time-based design with stratified random sampling (i.e. with ESM assessments scheduled at random within set blocks of time; Myin-Germeys et al., 2009; Palmier-Claus et al., 2011; Stone, Shiffman, Atienza, &

Nebeling, 2007). On each day over an assessment period of 9 consecutive days, the smartphone emitted 10 “beep” signals at semi-random moments within 90 minute blocks of time. Sampling took place between 7:30 A.M. and 10:30 P.M.

During an initial briefing session, we trained participants in the use of the smartphone by providing detailed technical instructions (e.g. switching on/off, use of stylus for answering questions, etc.) and practising its usage by going through a practice questionnaire. In this session, participants were further given instructions about the ESM assessment and asked to stop their activity and respond to the above items each time the device emitted the beep signal as part of a more comprehensive diary questionnaire assessing voice phenomenology, appraisals and responses, and social interactions in daily life.

During the assessment period, which was selected to start at any day of the week at discretion of the participants (to optimize compliance and achieve sufficient spread of week and weekend days in our sample), the ESM questionnaire was available to participants for a duration of 15 minutes after emission of the beep signal. Participants were contacted twice during the assessment period to assess their adherence to instructions, identify any potential distress associated with the method, and help participants overcome any potential barriers for completing the questionnaire in order to maximise the number of observations per participant.

At the end of the assessment period, participants’ reactivity to, and compliance with, the method were examined in a debriefing session. Participants were required to provide valid responses to at least one-third of the emitted beeps to be included in the analysis.

7.4 Results

7.4.1 Basic Sample Characteristics and ESM Item Descriptives

A total of 35 participants were assessed with the ESM during the study period. Of these, 31 participants completed ESM assessment (with ≥30 valid responses) and, therefore, a high proportion of those initially assessed were included in the analysis (i.e., 88.5% of 35). Demographic and clinical information for participants included within the final analyses are summarized in Table 3.1 (see Section 3.3).

ESM data were provided on 1,682 occasions, of which voices were reported at 1,094 moments (65% of measurement occasions). All participants (100%) reported ESM-voices, with a mean of 35.3 voice reports (range 2–69) per participant over the nine days.

Within-person descriptive statistics for each of the key ESM constructs (stress, voice intensity and depersonalisation) are displayed in Table 7.1.

Table 7.1. *ESM construct descriptive statistics.*

	Stress (X)		Voice Intensity (Y)		Depersonalisation (M)	
Pt	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	3.02	0.89	6.94	0.23	1.59	0.60
2	1.13	0.67	2.91	2.35	1.02	0.14
3	2.20	1.38	4.98	2.01	4.06	1.73
4	3.81	1.49	6.69	1.16	4.00	1.74
5	4.19	1.03	4.22	0.97	3.91	1.06
6	4.66	1.64	5.79	1.67	6.95	0.38
7	3.32	2.09	4.65	2.91	1.60	1.43
8	4.06	1.87	1.76	1.52	6.25	1.21
9	2.84	2.31	6.80	1.10	6.90	0.67
10	1.30	1.14	4.28	2.83	1.00	0.00
11	3.87	0.79	6.22	0.75	6.11	0.61
12	4.46	1.70	3.00	2.38	3.06	1.63
13	5.82	1.49	3.16	2.23	2.45	0.94
14	2.54	1.45	3.98	2.45	3.00	1.26
15	1.25	0.92	3.94	1.59	1.84	1.07
16	4.64	0.94	2.42	1.76	4.83	0.97
17	4.32	1.52	1.82	1.15	2.89	0.95
18	3.83	1.49	1.08	0.39	3.08	1.57
19	3.22	1.43	1.22	0.88	1.27	0.96
20	1.21	0.59	5.53	2.45	1.00	0.00
21	4.20	1.52	3.48	2.26	3.30	1.29
22	4.05	2.07	1.07	0.35	1.05	0.31
23	3.98	2.15	4.68	1.75	2.70	1.54
24	4.85	2.37	7.00	0.00	6.78	1.05
25	3.33	1.84	3.42	2.70	1.36	0.83
26	5.90	2.14	6.41	1.71	6.07	1.78
27	3.13	2.13	6.84	0.41	6.58	0.89
28	4.75	1.38	2.89	2.14	5.48	0.95
29	2.47	1.56	3.69	2.36	2.75	1.78
30	2.33	1.42	2.57	2.31	3.17	1.58
31	4.36	2.26	3.64	2.72	2.50	2.09

Note. Pt = participant; *M* = mean; *SD* = standard deviation.

7.4.2 Is the stress-depersonalisation-voices mediation effect generalizable across participants?

We conducted a series of within-person regression analyses to explore the presence or absence of the stress-depersonalisation-voices mediation effect within individual participants. These analyses tested each of the three direct paths within the mediation model separately, i.e. i) *X*-*Y* (stress (*t*-1) → voice intensity (*t*)); ii) *X*-*M* (stress (*t*) → depersonalisation (*t*)); and iii) *M*-*Y* (depersonalisation (*t*-1) → voice intensity (*t*)) paths). Whilst the mediated effect (*X*-*M*-*Y*) was also tested, statistical power to detect significant within-person effects is limited within a more complex model such as this. As, such, participants who demonstrated raw effect sizes ≥0.05 on all three direct pathways were considered to display evidence of the effect.

These analyses (Table 7.2.) identified 13 participants who demonstrated evidence of this mechanism, whilst 16 did not. Two participants were excluded from further analysis due to limited or zero variation on one or more of the constructs of interest (see Table 7.1)

Table 7.2. *Idiographic mediation analyses*

	X-Y		*X-M*		*M-Y*		*X-M-Y*		
Pt	*B*	*p*	*B*	*p*	*B*	*p*	*B**	*p*	Effect present
1	-0.09	0.08	-	-	-	-	-	-	N
2	-0.36	0.67	-	-	-	-	-	-	N
3	0.43	0.04	0.52	<0.01	0.34	0.03	0.33	0.13	Y
4	0.28	0.05	0.70	<0.01	0.09	0.50	0.35	0.05	Y
5	0.63	<0.01	0.69	<0.01	0.64	<0.01	0.10	0.76	Y
6	0.01	0.95							N
7	0.09	0.66	0.06	0.53	0.40	0.28	0.11	0.58	Y
8	0.20	0.20	0.37	<0.01	0.34	0.20	0.14	0.45	Y
9	0.10	0.24	0.03	0.44	-0.07	0.80	-	-	N
10	-0.34	0.49	-	-	-	-	-	-	N
11	0.25	0.21	0.25	0.06	0.24	0.35	0.22	0.27	Y
12	0.36	0.17	0.27	0.04	-0.04	0.91	-	-	N
13	0.33	0.14	0.05	0.52	0.17	0.62	0.35	0.13	Y
14	0.15	0.70	0.59	<0.00	0.29	0.51	-0.16	0.81	Y
15	0.06	0.75	-0.01	0.93	-	-	-	-	N
16	0.38	0.09	0.26	0.02	-0.06	0.79	-	-	N
17	-0.02	0.86	-	-	-	-	-	-	N
18	-0.04	0.23	-	-	-	-	-	-	N
19	-0.09	0.38	-	-	-	-	-	-	N
20	-0.59	0.43	-	-	-	-	-	-	N
21	0.23	0.26	0.44	<0.01	0.22	0.39	0.19	0.42	Y
22	-	-	-	-	-	-	-	-	Exc[a]
23	0.13	0.52	0.09	0.38	0.22	0.37	0.13	0.52	Y
24	-	-	-	-	-	-	-	-	Exc[b]
25	-0.21	0.33	-	-	-	-	-	-	N
26	0.34	0.05	0.52	<0.01	0.48	0.01	0.17	0.32	Y
27	-0.04	0.21	-	-	-	-	-	-	N
28	-0.30	0.19	-	-	-	-	-	-	N
29	0.27	0.39	0.25	0.20	0.16	0.57	0.25	0.44	Y
30	0.09	0.88	0.24	0.24	0.28	0.53	0.13	0.84	Y
31	0.35	0.30	0.38	0.01	-0.34	0.39	-	-	N

*Effect of stress (*t*-1) on voice intensity (*t*) after controlling for depersonalisation (*t*-1)
[a]Participant excluded from further analysis due to low variance on both M and Y, resulting in model collinearity.
[b]Participant excluded from further analysis due to zero variance on Y.

7.4.3 Are there trait differences between voice hearers for whom this mechanism is present versus absent?

7.4.3.1 Are there diagnostic differences between voice hearers for whom this mechanism is present versus absent?

We first explored the potential association between diagnosis and the presence of the mediation mechanism. Of the 13 participants who displayed evidence of this mechanism, 7 had received a diagnosis of psychosis, whilst 6 had other diagnoses. Of the 16 participants for whom this mechanism was not evident, 10 had received a diagnosis of psychosis, whilst 6 had other diagnoses. There was no significant association between diagnosis (psychosis vs non-psychosis) and the presence of this mechanism (X^2 (1, N = 29) = 0.22, p =0.64).

7.4.3.2 Between-group differences in mean momentary scores

A series of pairwise comparisons of means were conducted to explore differences between the 'mechanism present' and 'mechanism absent' groups on mean momentary ESM scores. The results of these analyses are displayed in Table 7.3.

Table 7.3. Contrasts between group in which mechanism was present versus group in which mechanism was absent

	Mechanism Present		Mechanism			95% CI		*d*
Dependent Variable	*M*	*SD*	*M*	*SD*	MD_{iff}	*LL*	*UL*	
Mean ESM stress	3.74	1.20	3.22	1.34	-0.53	-1.50	0.44	-0.41
Mean ESM depersonalisation	3.80	1.50	3.21	2.22	-0.59	-2.01	0.83	-0.30
Mean ESM voice intensity	4.35	1.48	3.91	1.96	-0.44	-1.75	0.87	-0.25
Mean ESM voice distress	4.33	1.34	4.15	1.63	-0.19	-1.32	0.94	-0.12

Note. MD_{iff} = mean difference; CI= confidence interval; *LL*= lower limit; *UL*= upper limit; *d*= Cohen's *d*.

As anticipated, these analyses revealed trends towards higher mean momentary levels of stress, depersonalisation and voice intensity and distress in the 'mechanism present' group.

7.4.3.3 Between-group differences on validated clinical measures

Finally, a series of pairwise comparisons of means were conducted to explore differences between the ‘mechanism present’ and ‘mechanism absent’ groups on validated clinical measures collected prior to the ESM data collection period. The results of these analyses are displayed in Table 7.4.

Table 7.4. Contrasts between group in which mechanism was present (*N*=13) versus group in which mechanism was absent (*N*=16)

	Mechanism Present		Mechanism Absent			95% CI		*d*
Dependent Variable	*M*	*SD*	*M*	*SD*	MD_{iff}	*LL*	*UL*	
PSYRATS-AH TOT	31.08	3.04	29.31	5.00	-1.76	-4.87	1.34	-0.42
PSYRATS-AH-DIS	15.69	1.25	15.25	2.77	-0.44	-2.05	1.16	-0.20
PSYRATS-AH-FRQ	7.62	1.98	6.81	2.48	-0.80	-2.50	0.90	-0.35
PSYRATS-AH-ATT	4.77	1.54	4.63	1.67	-0.14	-1.37	1.08	-0.09
PSYRATS-AH-	3.00	1.00	2.63	1.15	-0.38	-1.19	0.44	-0.35
PSYRATS-D TOT	12.15	7.40	11.75	1.91	-0.40	-6.17	5.36	-0.05
PSYRATS-D-DIS	4.92	3.07	4.56	3.08	-0.36	-2.72	2.00	-0.12
PSYRATS-D-FRQ	7.23	4.59	7.19	4.79	-0.04	-3.63	3.55	-0.01
DASS-21-DEP	13.85	3.69	10.50	7.32	-3.35	-7.68	0.99	-0.56
DASS-21-ANX	11.38	5.42	9.00	6.24	-2.38	-6.83	2.06	-0.40
DASS-21-STR	15.69	3.54	11.00	5.30	-4.69	-8.08	-1.30	-1.02
PAM-ANX	15.15	6.45	12.62	6.06	-2.53	-7.36	2.30	-0.41
PAM-AVD	15.15	5.44	15.06	3.71	-0.09	-3.78	3.60	-0.02
BCSS-NS	11.62	5.20	11.50	7.60	-0.12	-5.02	4.79	-0.02
BCSS-PS	6.23	5.85	8.50	7.17	2.26	-2.69	7.23	0.34
BCSS-NO	11.08	5.98	8.25	7.80	-2.83	-8.08	2.43	-0.40
BCSS-PO	10.69	4.92	10.88	6.94	0.18	-4.35	4.71	0.03
BAVQ-R-PER	26.46	7.33	20.50	9.37	-5.96	-12.33	0.40	-0.70
BAVQ-R-BEN	0.69	1.25	2.63	2.83	1.93	0.30	3.57	0.85
BAVQ-R-RES	21.23	4.36	19.13	3.01	-2.11	-5.07	0.86	-0.57
BAVQ-R-ENG	1.00	1.29	3.00	3.44	2.00	0.05	3.95	0.74

Note. MD_{iff} = mean difference CI= confidence interval; *LL*= lower limit; *UL*= upper limit; *d*= Cohen's *d*; PSYRATS-AH= Psychotic Symptoms Rating Scale-Auditory Hallucinations (TOT= Total Score; DIS= Distress Subscale; FRQ= Frequency Subscale; ATT= Attribution Subscale; LDN = Loudness Subscale); PSYRATS-D= Psychotic Symptoms Rating Scale-Delusions (TOT= Total Score; DIS= Distress Subscale; FRQ= Frequency Subscale); DASS-21= Depression, Anxiety and Stress Scale-21 Item (DEP= Depression Subscale; ANX= Anxiety Subscale; STR= Stress Subscale); PAM= Psychosis Attachment Measure (ANX= Attachment Anxiety Subscale; AVD= Attachment Avoidance Subscale); BCSS= Brief Core Scheme Scale (NS= Negative Self Schema Subscale; PS= Positive Self Schema Subscale; NO= Negative Other Schema Subscale; PO= Positive Other Schema Subscale); BAVQ-R= The Beliefs About Voices Questionnaire-Revised (PER= Persecutory Voice Beliefs Subscale; BEN= Benevolent Voice Beliefs Subscale; RES= Voice Resistance Subscale; ENG= Voice Engagement Subscale).

As anticipated, these analyses revealed significantly higher trait stress scores (DASS-21-STR) in the ‘mechanism present’ group compared to the ‘mechanism absent’ group. Likewise, analyses additionally indicated a trend towards greater overall voice severity (PSYRATS-AH TOT) in the mechanism present group, which appeared to be driven in particular by higher voice frequency (PSYRATS-AH-FRQ) and loudness (PSYRATS-AH-LDN). Analyses also indicated trends towards higher trait depression (DASS-21-DEP) and anxiety (DASS-21-ANX) scores in the ‘mechanism present’ group, and to a lesser extent, on delusional severity (PSYRATS-D TOT).

These results additionally reveal trends towards higher attachment anxiety (PAM-ANX) in the ‘mechanism present’ group, as well as greater endorsement of negative beliefs about others (BCSS-NO). Similarly, trends were observed for positive beliefs about the self (BCSS-PS), with the ‘mechanism present’ group reporting fewer positive self-beliefs.

Finally, the results indicate evidence for group differences in beliefs about and responses to voices. Voice hearers in the ‘mechanism present’ group were significantly less likely to report benevolence beliefs in relation to their voices (BAVQ-R-BEN), whilst also being significantly less likely to engage with their voices (BAVQ-R-ENG). Similarly, analyses indicated trends towards higher endorsement of persecutory voice beliefs (BAVQ-R-PER), and greater resistance to voices (BAVQ-R-RES), in the ‘mechanism present’ group.

7.5 Discussion

In a previous paper (Chapter Four), we demonstrated that temporal associations between stress and voice intensity appear to be fully mediated by depersonalisation experiences, suggesting a role for stress-induced depersonalisation in the modulation of voices during daily life. This paper aimed to explore the generalisability of this effect, and the factors associated with the presence of this mechanism.

Our idiographic mediation approach demonstrated evidence of this pathway in 13 of 29 participants (44.8%), suggesting that this may represent a proximal mechanism in a significant subset of voice hearers. As anticipated, analyses revealed trends towards higher mean momentary levels of stress, depersonalisation and voice intensity in voice hearers who demonstrated evidence of this mediation mechanism, suggesting that this pathway may be particularly common in voice hearers who are highly prone to stress and/or depersonalization experiences. This notion is reinforced by the finding that individuals who demonstrate evidence of this mechanism had significantly higher trait stress levels.

In line with past findings demonstrating similar levels of stress-reactivity in voice hearers with psychosis and borderline personality disorder (Glaser, Van Os, Thewissen, & Myin-Germeys, 2010), we found no evidence of a significant association between the presence of this mechanism and clinical diagnosis (i.e. psychosis versus non-psychosis). Whilst these findings should be interpreted with some caution, due to the inclusion of voice hearers with a range of diagnoses within the ‘non-psychosis’ group, these results are consistent with evidence of a trans-diagnostic role of dissociative experiences in voice hearing (Pilton, Varese, Berry, & Bucci, 2015).

Interestingly, our results revealed preliminary evidence that the presence of this stress-depersonalisation pathway may be associated with greater voice severity across a number of domains. On average, voice hearers who were prone to stress-induced depersonalisation reported voices that were louder, occurred more frequently, and were perceived as more distressing. These voice hearers were also significantly less likely to report benevolence beliefs in relation to their voices, and were less likely to engage with their voices.

Furthermore, the presence of this stress-depersonalisation mechanism was associated with a range of negative clinical outcomes, including trends towards greater depression,

anxiety, and delusional severity. In line with our predictions, we found evidence of trend-level associations between proneness to stress-induced depersonalisation and higher levels of attachment anxiety, alongside more negative beliefs about others, and fewer positive self-beliefs.

Findings of increased overall voice severity in people presenting with this mechanism provide further support for a role of both stress-sensitivity and dissociative mechanisms in voice hearing, at both proximal and developmental levels. Our findings can be interpreted in the context of evidence for a shared developmental trajectory towards stress-sensitivity and dissociation; both have been consistently linked with both voice proneness (Glaser et al., 2010; Palmier-Claus, Dunn, et al., 2012; Pilton et al., 2015), and to experiences of trauma during childhood (Glaser, van Os, Portegijs, & Myin-Germeys, 2006; Lardinois, Lataster, Mengelers, Van Os, & Myin-Germeys, 2011). Traumagenic models of voice hearing, such as the cognitive attachment model of voices (CAV; Bucci, Emsley, & Berry, 2017), suggest that repeated exposure to relational traumas in childhood results in oversensitivity to threat in the context of later stressors, resulting in dissociative experiences. Our findings present preliminary evidence of this mechanism in action; voice hearers who demonstrated a tendency towards stress-induced depersonalisation also displayed higher levels of attachment anxiety, indicating a potential developmental route towards this mechanism.

A caveat of the present work regards issues in determining the directionality of the demonstrated effects. Our findings suggest that stress-induced depersonalisation is associated with a constellation of negative experiences, including increased depression and anxiety, negative schema in relation to self and others, negative voice beliefs and responses, and increased voice distress. This begs the question; does this litany of effects represent the outcome of stress-induced depersonalisation, or is this constellation indicative of some common underlying developmental factor?

An interesting perspective on this has been presented by the CAV model, which suggests that childhood trauma and insecure or disorganized attachment styles may have a ‘two-hit’ effect on voice hearing, by; i) increasing the tendency towards stress-reactivity and dissociation; and ii) promoting the formation of negative schema about self and other, which in turn influence appraisals of voices and resulting distress. Indeed, previous studies have demonstrated links between childhood abuse and dissociation; depression; and voice malevolence beliefs (Offen, Waller, & Thomas, 2003), providing preliminary evidence for this double hit model. On this basis, it is possible that our

findings represent a constellation of experiences arising from a common underlying factor; relational trauma experienced in childhood. Of course, whilst this is an interesting conjecture, the omission of a validated measure of childhood trauma in the present study precludes formal testing of this hypothesis. Future work should seek to clarify the link between momentary stress-induced depersonalisation and childhood history of relational trauma.

On a more technical level, a second limitation of the present work involves the characterization of our 'mechanism present' and 'mechanism absent' groups. Due to the relatively small number of voice reports per person, statistical power to conduct full within-person mediation analyses was limited. We therefore made the decision to include individuals who demonstrated small effects on all three direct pathways (i.e. stress → voice intensity; stress → depersonalisation *and* depersonalisation → stress). Whilst this represented a 'strong' inclusion criterion, it necessarily excluded some individuals who demonstrated large effects on individual pathways, and who may therefore be considered to display evidence of stress-reactivity. In particular, it is possible that for some individuals, stress has a more direct effect on voice hearing experiences; indeed, in Chapter Four, the direct path between stress and voice intensity approached significance, suggesting that additional mechanisms may be at play.

Despite this, it is worth re-iterating that our findings suggest that this mechanism is far from ubiquitous. Inspection of within-person descriptives indicates a high degree of between-person variation in mean momentary levels of depersonalisation, implying that stress-induced depersonalisation may be a key mechanism for some – but not all – voice hearers. Supporting this point, five of our participants experienced high mean momentary voice intensity (>4 out of 7) in the context of low mean momentary depersonalisation (<3 out of 7)), suggesting that these two experiences do not always go hand-in-hand. However, whilst state depersonalisation may not be necessary for voice hearing experiences to occur, our findings suggest that voices experienced in the context of high levels of stress and depersonalisation may be rated as more severe and distressing.

In conclusion, stress-induced depersonalisation may represent a proximal mechanism of voice hearing for a significant subset of voice hearers, who appear to be characterized by more negative experiences and outcomes. Further research in a larger sample is required to formally test these predictions, via the use of moderated multilevel mediation approaches (Bauer, Preacher, & Gil, 2006). This research should focus in particular on the role of childhood trauma and attachment as a potential risk factor for the development

of this proximal mechanism of voice hearing. In the meantime, it is possible that intervention approaches targeting stress-induced depersonalisation may be particularly effective for individuals who are especially prone to dissociative experiences.

8 Chapter Eight: General Discussion

8.1 Summary of chapters

Voice hearing is a commonly reported experience across a range of psychiatric diagnoses, and is often associated with high levels of distress and disruption to everyday functioning. Many people troubled by voices see little benefit from antipsychotic medication, prompting attempts to understand and target psychological mechanisms underlying both the emergence of voices and associated distress.

Research to date has typically adopted a cross-sectional approach, identifying factors associated with the tendency to hear distressing voices. However, less is known about the 'proximal' mechanisms associated with fluctuations in voices and distress during the daily lives of voice hearers. Psychological therapies for distressing voices have demonstrated limited success in reducing voice-related distress, and it is suggested that a better understanding of the proximal mechanisms underlying voices may facilitate advancements in these interventions.

This thesis presented a series of studies utilizing the Experience Sampling Method (ESM) to investigate voice hearing experiences in the natural contexts in which they are experienced. The aim of this thesis was to contribute to understandings of the within-person mechanisms related to the onset, fluctuation and maintenance of voices and associated distress during daily life, as well as those underlying clinical improvements following psychological intervention.

8.2 Integrated overview of findings

8.2.1 Within- and between-person variability in voice hearing experiences

Psychometric analyses conducted in Chapter Three lent support to the notion that voice hearing experiences are dynamic, multi-faceted phenomena, varying both within and between individuals across a range of dimensions.

Evidence was demonstrated for substantial within-person (i.e. temporal) variation in various constructs related to the experience of distressing voices, including voice characteristics (voice intensity and negative content), voice appraisals (perceived voice dominance, uncontrollability and intrusiveness), voice responses (resistance and compliance), emotional consequences of voices (voice-related distress), and contextual

factors (stress and depersonalisation). Of these constructs, depersonalisation and perceived voice dominance demonstrated the least within-person variation, suggesting that these experiences might be somewhat more 'trait-like' in nature, demonstrating greater variation between individuals than within individuals. Variables demonstrating particularly high within-person variability included voice intensity, distress, perceived voice intrusiveness, compliance with voices, and stress.

Correlational analyses indicated that whilst many of these constructs demonstrate significant covariance over time, they are distinguishable within any particular moment, and thus can be assumed to reflect different, but related, aspects of voice hearing experiences. For example, whilst voice characteristics (i.e. voice intensity and negative content) are associated with levels of voice distress at any particular moment in time, it is clear from the values of these correlation coefficients that voice characteristics only explain a proportion of the variance in voice-related distress. Likewise, whilst it has previously been suggested that voice hearing can be conceptualised as a form of dissociative experience (Moskowitz & Corstens, 2008), the current findings suggest that voice intensity and depersonalisation experiences are associated, but distinguishable, at any particular moment in time. On the other hand, these analyses indicate that responses to voices might be more separable at the within-person level; the observed negative within-person correlation between compliance and resistance responses suggests that these responses do not tend to occur contemporaneously.

Alongside this evidence of within-person variability in voice experiences, split-week reliability analyses provided evidence of stability of underlying central tendency for all constructs investigated. In other words, whilst voice hearing experiences tended to fluctuate from moment-to-moment, the mean levels of these constructs within individuals remained relatively stable over time. Across participants, mean levels of negative voice content, voice intensity, voice-related distress, perceived uncontrollability and intrusiveness, and resistance to voices were particularly high, supporting the notion that hearers commonly perceive their voices as problematic during the course of their daily activities. However, there was also evidence for substantial between-person variation in these means. In particular, psychometric analyses indicated high between-person variation in voice intensity and distress, perceived voice dominance and uncontrollability, degree of resistance to voices, and reported levels of depersonalisation, indicating heterogeneity in both the experience of voice hearing, and in the psychological mechanisms underlying these experiences. No significant differences were found

between participants with a psychosis diagnosis compared to those with non-psychosis diagnoses in any of the ESM variables under investigation, providing justification for the use of a trans-diagnostic sample to explore mechanisms of voice onset and distress during daily life.

8.2.2 Mechanisms associated with momentary voice intensity and distress

Having established the psychometric properties of ESM items, Chapters Four and Five sought to investigate predictors of fluctuations in voice intensity and voice-related distress during the course of daily life. Figure 8.1 provides an illustration of significant momentary associations demonstrated across these two studies. Momentary associations indicate the degree to which variables are independently associated with levels of voice intensity and distress experienced at any particular moment in time.

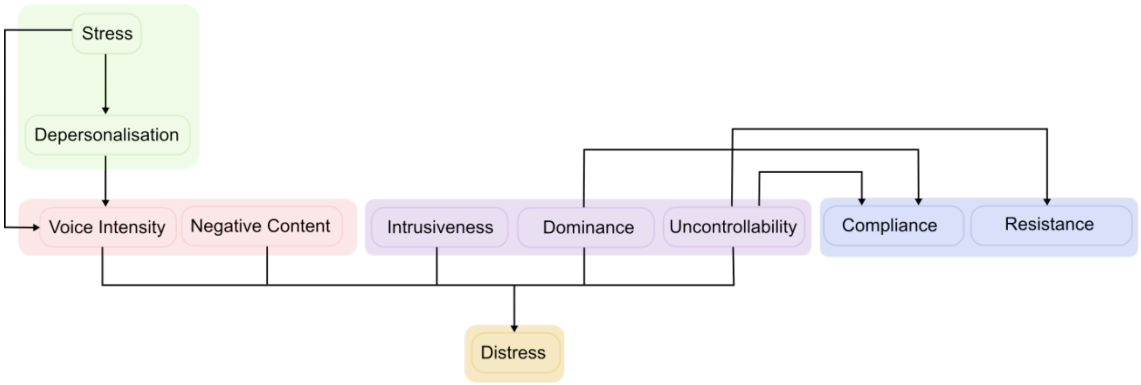

Figure 8.1. Illustration of significant momentary associations demonstrated in the present thesis. Black arrows represent significant effects observed in Chapters Four and Five. Variables have been grouped according to their proposed role within psychological models of voice hearing: contextual factors (green box); voice characteristics (pink box); voice appraisals (purple box); behavioural consequences of voices (blue box); emotional consequences of voices (orange box).

Voice phase analyses conducted in Chapter Four demonstrated that levels of stress and depersonalisation are significantly higher in moments when voices are reported. Furthermore, these analyses demonstrated a very close correspondence between the time courses of stress and depersonalisation in relation to phases of a voice episode, indicating a close momentary association between these two constructs.

The study presented in Chapter Five built on these findings by exploring the momentary factors related to the emotional and behavioural consequences of voices. Levels of momentary voice distress were found to be independently associated with concurrent voice appraisals (perceptions of voice intrusiveness, dominance and uncontrollability),

and structural characteristics of voices (reported voice intensity and negative voice content), whilst behavioural responses to voices were associated with specific voice appraisals, but not voice characteristics. Specifically, momentary compliance with voices was associated with perceived voice dominance and uncontrollability, whilst resistance to voices was associated with perceived uncontrollability of voices. Whilst greater resistance and compliance were reported in moments of increased voice distress, these associations did not persist after controlling for concurrent voice appraisals and characteristics, suggesting that these behaviours are not direct responses to (or causes of) momentary voice distress.

8.2.3 Antecedent and maintenance mechanisms

Whilst such momentary associations are of substantive interest both clinically and theoretically, they do not allow assessment of the directionality of effects. As such, a primary focus of the studies presented in Chapters Four and Five was the assessment of dynamic associations between momentary states, as a means of identifying mechanisms that might serve as antecedent or maintenance factors in voice hearing experiences during daily life. An integrated illustration of significant time-lagged associations demonstrated in these two studies is provided in Figure 8.2. These findings have been overlaid on the results presented in Figure 8.1, in order to aid the visualization of potential maintenance effects.

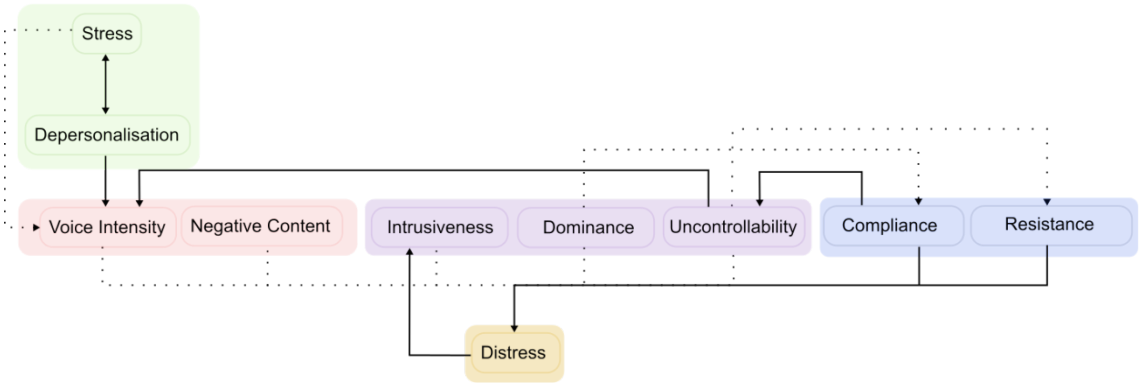

Figure 8.2. Illustration of significant dynamic associations demonstrated in the present thesis (solid black arrows). These findings are overlaid on findings from momentary analyses (dashed black arrows) to aid the visualization of potential maintenance effects.

Findings from Chapter Four provided support for an antecedent and maintenance role of stress in the fluctuation of voice hearing experiences during daily life, with increases in voice intensity being associated with reported stress levels at the previous measurement occasion. However, findings suggested that this association between stress and voice

intensity may not be direct, instead being mediated by depersonalisation experiences. Depersonalisation experiences, like stress, predicted increases in voice intensity at subsequent measurement occasions, and multilevel mediation analysis found that the observed antecedent effects of stress on voice intensity were fully mediated by levels of depersonalisation. Furthermore, findings suggested a bi-directional temporal association between stress and depersonalisation, whereby stress predicted increases in depersonalisation over time, and vice versa. Since stress is closely associated with momentary voice intensity (see underlay in Figure 8.2), this may represent a mechanism via which voice hearing experiences are maintained over time.

Findings from Chapter Five provided support for a similar role of behavioural responses to voices in the maintenance of voice-related distress. Dynamic analyses indicated directional effects of compliance and resistance responses on subsequent voice distress, with both responses predicting an increase in voice-related distress over time. Furthermore, compliance responses were found to predict subsequent increases in appraisals of voice uncontrollability, a variable associated with momentary levels of voice distress (see underlay in Figure 8.2). Whilst it was not possible to perform formal tests of mediation whilst controlling for necessary covariates due to model non-convergence, these findings are consistent with the possibility that compliance responses may serve to maintain voice distress by reinforcing momentary appraisals of voice uncontrollability.

8.2.4 Therapeutic change mechanisms

Whilst Chapters Four and Five assessed psychological mechanisms associated with the experience of voices and related distress, the study presented in Chapter Six sought to extend this by using a similar momentary assessment approach to assess *changes* in voice mechanisms occurring over the course of cognitive behavioural therapy for psychosis (CBTp). Analyses were based on intensive idiographic data from two patients undergoing CBTp for their distressing voices, and findings provided preliminary support for changes in a number of psychological mechanisms over the course of the therapy.

First, findings provided evidence for changes in voice appraisals over the course of therapy. Prior to the onset of therapy, participants rarely endorsed psychological explanations of their voice hearing experiences during the course of day-to-day life. However, significant increases in the degree to which these explanations were endorsed were observed over the course of therapy for both patients, indicating that CBTp may successfully target appraisals proposed to reduce voice distress. On the other hand,

significant changes in appraisals of voice power were only observed for one of the two patients over the course of therapy. However, mean reports of momentary voice power were very low at baseline (compared to levels of voice dominance reported by participants in the study presented in Chapter Five), suggesting a limited role for momentary perceptions of voice power in driving voice-related distress in these two patients.

In line with findings presented in Chapter Four (Figure 8.1), significant positive momentary associations between voice intensity and concurrent ratings of stress were observed for both patients prior to the onset of therapy. Such associations were observed in relation to both social and activity-related stress, providing further support for the role of symptomatic reactivity to stress (or indeed, stress as a reaction to voices) in the experience of voices during daily life. Furthermore, these associations were shown to reduce significantly over the course of therapy for both patients, indicating that CBTp may achieve gains at least in part via targeting stress-reactivity mechanisms.

Findings from dynamic network analyses provided evidence of idiographic differences in the mechanisms associated with dynamic changes in voice intensity over the course of therapy. Contrary to our hypotheses, for both patients, voice hearing experiences appeared to be relatively context-independent at baseline; in contrast to findings from Chapter Four, fluctuations in voice intensity were not predicted by antecedent levels of stress, and similarly, there was no evidence of time-lagged effects of negative affect on voice intensity for either patient. Also unexpectedly, these analyses provided evidence of *increases* in the context dependency of voices over the course of therapy in both patients. The nature of these dependencies differed between participants, indicating individual differences in changes occurring over therapy. Whilst improvements were observed in Patient 1 at mid therapy, in that *decreases* in voice intensity were observed following reports of high stress or negative affect, these associations had reversed by the end of therapy, with antecedent stress and negative affect predicting subsequent increases in voice intensity. This indicates that dynamic symptomatic reactivity to stress actually *increased* over the course of therapy for this patient.

Such reversals were also observed in Patient 2; at mid therapy, voice intensity was associated with antecedent levels of negative affect, whilst at the end of therapy, improvements were observed, with negative affect predicting subsequent decreases in voice intensity. These findings indicate that the mechanisms underlying voice hearing

experiences within individuals may well fluctuate in unexpected ways over the course of therapy, with improvements not necessarily occurring in a linear fashion.

8.3 Main findings; implications and future directions

8.3.1 Within- and between-person variation in voice phenomenology, processes, and therapeutic change mechanisms

The present findings lend support to the notion that voice hearing experiences are dynamic, multi-faceted phenomena, varying both within and between individuals across a range of dimensions. Whilst voice experiences possess some trait-like characteristics, with the mean reported levels of voice intensity and distress being high, and remaining relatively stable over time, these findings highlight the importance of acknowledging the state-like properties of voices. Whilst no significant differences were found between participants with a psychosis diagnosis compared to those with non-psychosis diagnoses in any of the ESM variables under investigation, findings provided evidence of individual differences in both voice experiences and mechanisms.

The development of state models of voice hearing will be advanced by a greater understanding of the aspects of voice hearing experiences that are; a) reported frequently; b) reported at high mean levels; c) demonstrate substantial within-person variability; d) demonstrate substantial between-person variability. However, whilst a number of previous ESM studies have explored contextual predictors of voice hearing, these have rarely reported descriptive statistics pertaining to the degree of within- and between-person variation in the constructs under investigation.

Understanding of the elements of voice hearing experiences that are reported frequently and at high mean levels allows for an increased focus on the aspects of voices that are deemed most problematic to voice hearers in general in their daily lives. For example, within the current sample, negative voice content, perceived voice uncontrollability and intrusiveness, and resistance to voices were reported frequently and at high mean levels, suggesting that these may represent common experiences of voice hearers, which could be more explicitly addressed in research and therapy.

Information about natural variation in voice hearing experiences may prove beneficial in the identification of key individualized targets for psychological therapy, both within research and by front-line clinicians. Researchers from a functional contextual orientation suggest that the development of theoretical models should proceed according

to the pragmatic goals of treatment development, with priority given to processes or variables that can be changed and manipulated directly (Hayes et al., 2013). In this sense, it is possible the elements of voice hearing experiences that demonstrate the greatest natural variation might be most amenable to change in therapy. Our findings suggest that perceived voice intrusiveness, compliance with voices, and stress are targets that are particularly sensitive to influence by contextual variables. Results from Chapter Six provide additional support for the notion that stress may represent a viable target of therapy, with symptomatic reactivity to stress demonstrating significant reductions in both patients over the course of CBTp.

Within the context of therapy, acknowledgement of and discussion around this natural variation in voice hearing experiences may be beneficial. Such an approach has been adopted by coping strategy enhancement protocols, in order to identify the contexts in which voices may be less of a problem, and to facilitate the increased use of natural adaptive coping strategies (Tarrier, 2002). It is possible that an increased awareness of the contextual factors and antecedent conditions related to fluctuations in voice intensity and distress may serve to undermine more stable, global beliefs about the nature of voice hearing experiences. This further suggests a potential application for ESM as a clinical tool (Myin-Germeys et al., 2011). Participants in Chapter Six demonstrated high rates of compliance with the ESM procedure prior to therapy, allowing the construction of reliable within-person dynamic networks. In the future, such networks may provide a useful tool for understanding the mechanisms that drive voices and distress for particular individuals. Indeed, pilot data from a follow-up study exploring the utility of ESM data as a clinical tool (manuscript in preparation) suggests that participants demonstrate even higher rates of compliance when ESM is used within the context of therapy, and that this data can facilitate clinical insight into key voice antecedents and adaptive coping strategies.

Theory and intervention development would further benefit from an increased understanding of the domains in which voice hearing experiences commonly vary between individuals, since this variation may be indicative of different underlying causal mechanisms (Jones, 2010; McCarthy-Jones et al., 2014), and suggest alternative approaches to treatment (Thomas et al., 2014). Our findings of between-person differences in mean levels of perceived voice dominance and uncontrollability, degree of resistance to voices, and reported levels of depersonalisation, indicate that traditional approaches to cognitive intervention, with their focus on modifying beliefs about voice

power, may not be as effective for some individuals. Indeed, participants in study 6 demonstrated very low mean levels of momentary power appraisals prior to the onset of CBTp, suggesting a limited role for momentary perceptions of voice power in driving voice-related distress in these two patients.

8.3.2 Depersonalisation as a mediator of symptomatic reactivity to stress

Current findings additionally provide support for a central role of stress as both an antecedent of and reaction to voices during the course of daily life. Results suggest that the antecedent role of stress in the modulation of voice intensity may be mediated by the effects of stress on inducing depersonalisation experiences. Furthermore, findings indicate a reciprocal, dynamic relationship between stress and depersonalisation, which may represent a mechanism via which voices are maintained or exacerbated during daily life.

These findings are consistent with a body of empirical work demonstrating increases in voice frequency under conditions of stress (Cooklin et al., 1983; Corstens & Longden, 2013; Nayani & David, 1996; Slade, 1972), and with previous ESM research demonstrating momentary associations between stress and voice presence (Palmier-Claus, Dunn, et al., 2012), stress and dissociative states (Stiglmayr et al., 2008) and between stress, dissociation and voice presence (Varese, Udachina, et al., 2011). However, these findings represent an advance on past research, by moving beyond the demonstration of cross-sectional associations, and suggesting a specific mechanism via which stress may serve to modulate voices during daily life.

Clinical implications of these findings include increased impetus for exploring the impact of depersonalisation experiences during therapy. Evidence that both stress and depersonalisation may represent antecedent factors in the experience of voices during daily life suggests that interventions designed to promote stress-management, or the reduction of dissociative tendencies in voice hearers with a need for care, might be effective in reducing voice frequency or intensity. Whilst findings from Chapter Six suggests that stress in reaction to voices may be successfully targeted by CBTp, it is possible that a more specific focus on the factors maintaining depersonalisation experiences may prove beneficial (Farrelly et al., 2016).

A key goal for future research will be to examine the precise nature of the proximal mechanisms via which; i) stress acts to induce depersonalisation experiences; ii) depersonalisation experiences lead to the emergence or intensification of voices. It has

been suggested that stress may act to induce depersonalisation experiences via its activation of the endogenous opioid system (M. Sierra, 2009), which may serve the adaptive function of 'blunting' emotional responses to adverse situations (Bandura, Cioffi, Ban-Taylor, & Brouillard, 1988). In line with this suggestion, research has demonstrated that exposure to selective κ receptor opioid agonists reliably elicits depersonalisation and derealisation symptoms in a dose dependent manner under placebo-controlled conditions (Pfeiffer, Brantl, & Herz, 1985; Walsh, Strain, Abreu, & Bigelow, 2001), whilst administration of opioid antagonists has been shown to result in improvements of dissociative symptoms in patients with PTSD (Glover, 1993) and BPD (Bohus et al., 1999).

In relation to the nature of the mechanism via which depersonalisation might result in the emergence of voices, cognitive, phenomenological and dialogical models have proposed a central role for threat appraisals and self-focused attention in the maintenance of both depersonalisation (Hunter et al., 2003) and the momentary onset and fluctuation of specific voice episodes (García-Montes et al., 2012; Parnas, 2003). Cognitive models of depersonalisation and voice hearing suggest that catastrophic interpretations of depersonalisation experiences (or other anomalous experiences) may elicit safety behaviours such as hypervigilance and self-focused attention (Hunter et al., 2003), in an attempt to understand or protect against perceived threat (Morrison, 1998). Dialogical models propose that this intense focus on inner experience - and in particular, on certain aspects of inner dialogue - results in a loss of metacognitive perspective, and the resulting perceptualization of components of inner speech (Perona-Garcelán, García-Montes, Rodríguez-Testal, et al., 2012; Perona-Garcelán et al., 2015).

Whilst this account has received support from cross-sectional research (Allen et al., 2005; Ensum & Morrison, 2003; Morrison & Haddock, 1997b; Perona-Garcelán et al., 2008, 2011), a task of future ESM research will be to test the ecological validity of this model by exploring the temporal relationships between depersonalisation, threat appraisals, self-focused attention and voice hearing during daily life. Furthermore, given our findings of individual differences in the degree to which stress represents a trigger of voices and in mean levels of depersonalisation, future research should investigate the extent to which these mechanisms are generalizable across voice hearers.

8.3.3 The role of voice appraisals and responses in the modulation of voice-related distress

The present findings further suggest a role of voice appraisals and responses in the modulation of voice-related distress during day-to-day life. In support of cognitive models of voice hearing, our findings indicate that both momentary behavioural and affective responses to voices are associated with concurrent negative voice appraisals. Furthermore, findings suggest that whilst momentary voice distress is associated with both resistance and compliance responses, it is likely that these behaviours are not direct responses to (or causes of) momentary voice distress, but are instead elicited by beliefs about voices. However, in line with the hypothesised role of behavioural responses in the maintenance of voice distress, our 'microlongitudinal' analyses indicated that both resistance and compliance behaviours were associated with increases in voice-related distress at subsequent measurement occasions, providing support for a role of behavioural responses as antecedents to voices. Furthermore, compliance was additionally associated with increases in appraisals of voice uncontrollability over time, suggesting a mechanism via which responses may serve to maintain voice distress.

These findings are consistent with past cross-sectional and ESM research demonstrating associations between voice appraisals and emotional and behavioural consequences of voices (Beavan & Read, 2010; Birchwood et al., 2000; Hayward et al., 2008; Peters, Lataster, et al., 2012), and provide further ecological validation for cognitive models of voice hearing (Chadwick & Birchwood, 1994). However, our finding that voice intensity and content make an independent contribution to momentary distress support the suggestion that cognitive models may have underestimated the role of voice characteristics in determining the emotional consequences of voices (Beavan & Read, 2010).

The demonstrated association between compliance and perceived voice dominance is consistent with a wealth of cross-sectional findings implicating perceived voice rank (Reynolds & Scragg, 2010) and omnipotence (Bucci et al., 2013; Fox et al., 2004; Reynolds & Scragg, 2010) as predictors of compliance with voice commands, and provides the first ecological demonstration of these effects. Our findings additionally highlight the importance of appraisals of voice uncontrollability in both resistance and compliance responses, a relationship that has not previously been explored. The finding that responses to voices predict increases in voice distress over time is consistent with models suggesting that voice responses may function as safety behaviours, employed

to mitigate the sense of threat from voices, but ultimately serving to maintain voice distress (Morrison, 1998). Furthermore, our finding that compliance responses additionally predicted increases in appraisals of voice uncontrollability provides support for the notion that behavioural responses might maintain distress via their effect by reinforcing and/or preventing disconfirmation of negative voice appraisals (Michail & Birchwood, 2010; Morrison, 1998).

These findings have implications for psychological interventions for distressing voices, supporting the notion that behaviour change should remain a central goal of therapy. However, the results have particular implications for therapies incorporating behavioural experiments that encourage attempts to resist command hallucinations; our findings highlight the importance of differentiating between resistance to voice commands or content, and resistance to the voice experience more generally. Whilst experimenting with resisting voice commands may help to challenge appraisals of voice dominance and uncontrollability, our findings suggest that resistance responses such as avoidance of triggering situations, or fighting back with voices, may serve to increase distress in the long run. In this respect, interventions incorporating acceptance and mindfulness approaches (Chadwick et al., 2015), or targeting coping behaviours or interpersonal relationships with voices, may offer hearers an alternative way of relating and responding to their voices (Dannahy et al., 2011). Furthermore, whilst our results support the focus of cognitive interventions on reducing appraisals of voice power/dominance and uncontrollability, they highlight the importance of a parallel therapeutic focus on coping with negative voice content (Longden, Corstens, et al., 2012). This is particularly pertinent given our findings in Chapters Three and Six of individual differences in the strength of beliefs about voice dominance and power.

Future research attempting to develop state models of voice hearing may benefit from a closer consideration of the role of threat appraisals in determining distress and behavioural responses to voices. Whilst our results suggested that behavioural responses to voices are driven primarily by beliefs about voice dominance and controllability, rather than directly by distress, influential cognitive theories of emotion propose that emotional and behavioural responses do not arise directly from beliefs, but are instead activated by momentary appraisals of the personal significance of experiences in terms of their potential harm or benefit to wellbeing (Lazarus & Smith, 1988). Indeed, it has been suggested that the perception of threat or harm is central to the maintenance of emotional and behavioural reactions to voices, with perceived threat

being driven both by beliefs about voice power and malevolence (Hacker et al., 2008), and directly by threatening voice content (Farhall, 2005; Morrison, 1998).

It has been suggested that humans and other animals possess evolved neural mechanisms for detecting and defending against environmental and social threats, and that voices, typically being perceived as powerful, intrusive beings with malevolent intent towards the hearer or others, may serve to activate these systems (Gilbert et al., 2001). Hostile attacks from dominants have been shown to increase cortisol and reduce serotonin levels in subordinates (Sapolsky, 1990), and trigger innate subordinate defences of fight, flight or submission (Dixon, 1998) suggesting a mechanism via which appraisals of voice threat might serve to elicit distress and safety behaviours during daily life. A task of future ESM research will be to test the ecological validity of this model by exploring the temporal relationships between voice appraisals, threat appraisals, safety behaviours and voice-related distress.

8.4 An attempt at integration; a proposed 'state' model of the momentary onset and fluctuation of voices and associated distress

Given the proposed parallel role of threat appraisals and safety behaviours in the maintenance of depersonalisation/derealisation experiences (Hunter et al., 2003), voice appraisals and distress (Farhall, 2005; Hacker et al., 2008; Morrison, 1998) and in the onset of voice episodes (Morrison, 1998; Parnas, 2003; Perona-Garcelán et al., 2015), these theories can be integrated with findings from the current thesis into a proposed state model for the modulation of voice hearing and associated distress during daily life (Figure 8.3).

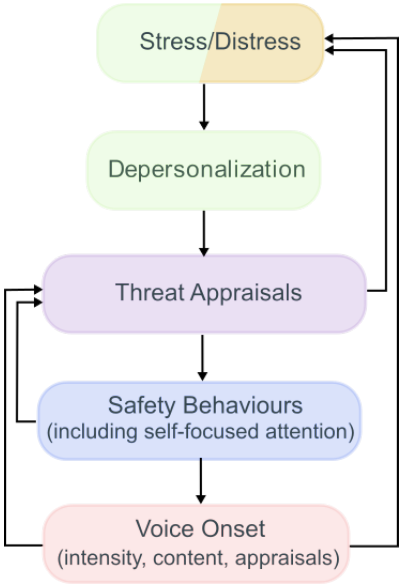

Figure 8.3. An integrated 'state' model for the modulation of voice hearing and associated distress during daily life

This model draws on cognitive, phenomenological and dialogical theories, along with findings from a large body of cross-sectional research, and an emerging ESM literature, including the studies presented in this thesis.

Within this model, stress is proposed to directly induce depersonalisation experiences (Chapter Four) via its effects on the endogenous opioid system (M. Sierra, 2009). Depersonalisation experiences are typically perceived as strange or unsettling, capturing attention (Parnas, 2003), and in some individuals, promoting rumination as to their potential meaning (Hunter et al., 2003; Parnas, 2003). For some individuals, these experiences will be considered to represent a significant threat to their physical or psychological integrity (i.e. "I'm going crazy"; "I'm going to lose control of myself"; "I'm going to do something stupid"), resulting in heightened arousal and further increases in self-focused attention (Garety et al., 2001; Hunter et al., 2003; Morrison, 1998). Increases in arousal may serve to further increase the intensity of depersonalisation/derealisation experiences (Hunter et al., 2003), whilst the intense focus on inner experience is proposed to have two effects. First, it may encourage further rumination, and the exacerbation of threat appraisals (Hunter et al., 2003). Second, it may result in a loss of metacognitive perspective, and the resulting perceptualization of components of inner speech as voices (Perona-Garcelán et al., 2015).

Once voices emerge, critical and abusive voice content may serve to reinforce appraisals about the threat posed by these experiences (Farhall, 2005; Morrison, 1998). Beliefs about the power and malevolent intentions of the agent behind the voice may further

contribute to this sense of threat (Hacker et al., 2008; Morrison, 1998), raising cortisol levels and resulting in the subjective experience of distress (Sapolsky, 1990). Threat appraisals may also activate evolved mechanisms of subordinate defence (Gilbert et al., 2001), resulting in the use of safety behaviours, such as compliance and resistance responses, in an attempt to mitigate perceived threat (Hacker et al., 2008; Morrison, 1998). These responses may in turn serve to promote further increases in distress, by reinforcing appraisals of voice power and uncontrollability (Chapter Five), and preventing the disconfirmation of threat appraisals (Morrison, 1998). Voice intensity and/or content may additionally contribute to increases in voice distress, perhaps via activation of negative self-schema (Close & Garety, 1998; Thomas et al., 2015). Finally, increases in distress may serve to further exacerbate levels of depersonalisation, closing the cognitive behavioural cycle.

Whilst all elements of this model have received support from cross-sectional studies, core components have yet to be assessed in the course of the daily lives of voice hearers. Key research questions for future ESM investigations include;

1. Is the dynamic association between depersonalisation and voice intensity mediated by threat appraisals and/or self-focused attention?
2. Is the momentary association between voice appraisals and voice distress mediated by threat appraisals?
3. Is there a dynamic association between voice appraisals and/or voice content and threat appraisals?
4. Is there a dynamic association between safety behaviours and threat appraisals?
5. Is the momentary association between voice content and distress mediated by negative self-schema?

Investigations should additionally seek to determine the degree of individual differences in each pathway, in order to determine the mechanisms with broadest applicability for intervention.

8.5 Limitations of empirical chapters

8.5.1 Statistical power and accuracy of parameter estimates

8.5.1.1 Statistical power

Formal *a priori* power analyses were not conducted within the present thesis, with sample sizes being selected on the basis of generic statistical guidelines (Hox, 2010b; Kreft, 1996) in combination with expected compliance rates and effect sizes based on the findings of previous ESM research (Section 2.3.3). There are a number of reasons to assume that the studies presented may not have been sufficiently powered to test all hypotheses.

As outlined in Chapter Two, power to detect effects in intensive longitudinal studies is determined by eight factors (Bolger et al., 2011). Three of these factors are of particular relevance within the current thesis. First, since statistical power to detect effects in multilevel models depends on the effect size for the average participant, the small effect sizes observed in the present studies raise the possibility that other small but clinically-relevant effects may have gone undetected. Second, power is negatively influenced by a greater degree of between-person variance in these effects, which was observed to be relatively high for significant effects demonstrated within these studies. Third, power is determined by both the number of participants in the sample, and the total number of measurement occasions per participant. Whilst it has been suggested that the power of significance tests for within-person regression coefficients (such as those explored within the current thesis) are more dependent on the total number of data points than the number of participants (Hox, 2010b), recent power simulations have revealed that, regardless of the specific hypothesis under investigation, power to detect effects is more heavily influenced by the number of participants than the number of sampling points (Bolger & Laurenceau, 2013; Scherbaum & Ferreter, 2011). As such, the large number of measurement occasions within the present study may not have resulted in substantial increases in power to detect within-person effects.

Issues of power are further compounded by the rates of missing data in the present studies. Whilst the degree of observed data loss was similar to that observed in previous ESM studies (Black et al., 2012), this presents a particular problem for research assessing dynamic, time-lagged effects, as was a primary focus of empirical studies presented in Chapters Four, Five and Six. Dynamic analyses require the availability of

consecutive data points, and as such high rates of missing data resulted in a large reduction in data available for these models.

Whilst analyses presented in Chapters Four and Five were based on a minimum of 517 time-lagged data points across all participants, and as such, it is unlikely that missing data represented a particular problem in and of itself for statistical power in these studies, this issue was clearly evident in the within-person dynamic network models presented in Chapter Six. Since these analyses were conducted using a within-person multiple regression approach (as opposed to multilevel regression approaches used in Chapters Four and Five), power is primarily determined by the number of data points provided by a particular participant (alongside the expected effect size, and the degree of variance in the predictor and outcome variables). As such, the problem of missing data for power is compounded in idiographic research, and particularly in the context of research questions involving the use of time-lagged analyses. This idiographic approach was however, merely intended to be illustrative of the potential of ESM for studying change mechanisms in the context of randomised controlled trials. Future studies should employ similar multilevel analytic methods to those used in Chapters Four and Five, and thus power to detect time-lagged effects would be greatly increased. However, given evidence for reductions in compliance across the six-day ESM assessment periods, RCTs employing these methods should perform power calculations based on the expected number of ESM reports provided at the end of therapy. This will ensure that any changes in observed effects can be attributed to therapy, rather than variation in power to detect effects across assessment phases.

8.5.1.2 Accuracy of parameter estimates

Aside from issues of statistical power, the small sample size employed by studies in the current thesis may also have implications for the accuracy of parameter estimates and their standard errors. The maximum likelihood (ML) estimation methods used within the current thesis are based on the assumption of large sample sizes (Hox, 2010b). Since the sample size within the present thesis is relatively small, this prompts questions about the accuracy of estimates (i.e. regression coefficients and variances) and their standard errors. Accuracy of standard errors is important to consider because standard errors that are positively or negatively biased may in turn result in biased significance tests. Whilst simulation studies have indicated that ML estimates for regression coefficients and within- and between-person variances, along with the standard errors of regression coefficients, are generally unbiased in small samples (i.e. N = 30), standard errors for

between-person variances are slightly biased downwards (Maas & Hox, 2005). However, since the focus of this thesis was primarily on tests of regression coefficients, rather than between-person variances, this does not represent a particular issue for interpretation of our main findings.

Future ESM studies should take steps to address these issues. Given the imperative for understanding between-person differences in mechanisms of voice hearing and therapeutic change processes, it has been suggested that the accuracy of standard errors for between-person variances can be optimized using a minimum sample size of 50 participants (Maas & Hox, 2005). However, when considering power, researchers have recently warned against the use of 'rules of thumb' approaches, when selecting a minimum sample size, recommending instead the use of Monte Carlo power simulations based on pilot data (Bolger & Laurenceau, 2013). Pilot data is particularly helpful given that estimates of within- and between-person variance in effects are rarely reported in the psychosis ESM literature, and such estimates are fundamental to multilevel power calculations.

8.5.2 ESM item reliability

Whilst evidence for the reliability of items used within the present thesis was presented in Chapter Three, several limitations to our approach to item design and psychometric assessment bear mentioning.

All studies within the present thesis used single items to assess momentary constructs. This was primarily in the interest of reducing participant burden, and is a common approach in past ESM studies (Vilardaga et al., 2013). Whilst the unreliability of responses to single items has been well documented in traditional cross-sectional research, necessitating the use of multiple item scales, it has been suggested that the use of single items in ESM research does not present a risk to reliability, since repeated measurement serves to 'average out' random measurement error (Bolger & Laurenceau, 2013; Hektner et al., 2007).

However, a disadvantage of the single item approach is that it does not allow assessment of reliability of constructs at both the within- and between-person levels. Between-person reliability indicates the degree to which a measure is able to reliably assess systematic differences between individuals in an underlying construct, whilst within-person reliability indicates the degree to which a measure is able to reliably assess systematic change in

the construct within individuals over time (Mogle et al., 2014). Since the calculation of 'split-week' correlations is based on the mean scores of participants, these merely provide an index of consistency of responses at the between-person level; they do not allow for the partitioning of true and random variation (Nezlek, 2011), and do not provide an indication of within-person reliability. There is increasing recognition of the importance of establishing reliability of within-person variation (Shrout & Lane, 2012), particularly when this variability is the primary focus of research (Mogle et al., 2014). Low reliability can result in a reduction in the size of observed effects, and consequently, on their likelihood of reaching statistical significance (Furr, 2011).

It has been suggested that assessment of within-person variability requires the inclusion of at least three items for each construct under investigation (Nezlek, 2011; Shrout & Lane, 2012). Similar to the use of multi-item scales in cross-sectional research, this approach considers different items within a scale to be replicate measures, which can be averaged to reduce the impact of error variation (Shrout & Lane, 2012). However, traditional approaches to assessing internal consistency, such as Cronbach's alpha, are inappropriate for the assessment of reliability within ESM studies, since they do not allow the separation of within- and between-person variation in responses (Nezlek, 2011). Thus, whilst a number of past ESM studies have utilised multi-item scales (Myin-Germeys et al., 2003; Udachina, Varese, Oorschot, Myin-Germeys, & Bentall, 2012), their use of traditional approaches to reliability analysis preclude the accurate estimation of within-person reliability of the resulting composite scores. A number of alternative approaches to the assessment of multi-item scale reliability have been suggested, including those based on generalisability theory (Mogle et al., 2014), multilevel confirmatory factor analysis (Shrout & Lane, 2012), and multilevel measurement models (Nezlek, 2011). Future ESM research should seek to employ these methods.

8.5.3 Assessment of temporal associations

A number of limitations bear mentioning in relation to the assessment of temporal associations between variables within the present thesis, and in ESM research more generally. Within the present thesis, two approaches to the assessment of temporal relationships were adopted; voice phase analysis and dynamic models.

8.5.3.1 Voice phase models

Whilst the voice phase approach provides an interesting visualisation of the correspondence in time-courses of variables proposed to be related to voices, and has previously been successful in identifying temporal antecedents of voice episodes (Delespaul et al., 2002; Oorschot, Lataster, Thewissen, Bentall, et al., 2012), this method does not provide an optimal fit for voice hearing data obtained using ESM, as demonstrated by the fact that it was only possible to classify 62% of data within the voice phase coding scheme. Within this scheme, it is not possible to classify the first or the last report of the day, or reports that occur in sequence with two or more cases of missing data. As such, the generalisability of findings to the daily life experience of voice hearing can be questioned.

Furthermore, the requirement of mutual exclusivity of categories within dummy coded multilevel regression analyses (Nezlek, 2011) necessitated the exclusion of 10% of data which naturally fell into multiple categories (e.g. moments that were both the first and last report of an episode, or the first after and the last before an episode). Whilst the reported effects persisted when these measurement occasions were included in the analysis, it is worth noting that such data points might be of particular interest clinically, since they may represent critical 'turning points' into or out of a voice episode. Future research should investigate the internal and external contextual factors associated with these turning points, compared to occasions when voices persisted over a series of sampling points.

8.5.3.2 Dynamic models

The dynamic models utilised within the present thesis also entail some limitations. First, the success of these approaches in identifying temporal antecedents depends critically on the correspondence between the interval between measurement occasions and the time course of processes under investigation (Stone et al., 2007). In line with previous research, studies within the present thesis adopted a protocol with an average inter-sample interval of 90 minutes (Oorschot, Lataster, Thewissen, Bentall, et al., 2012; Peters, Lataster, et al., 2012). Whilst significant time-lagged effects were demonstrated using this interval, it is likely that in reality the processes under investigation operate over much shorter time scales. It is possible therefore that the observed effects reflect the tendency of experiences, appraisals and responses to persist over time; for example, if voice hearers are attempting to resist their voices at one measurement occasion, they may continue to engage in these behaviours up until the following sampling point,

inflating the estimates of time-lagged effects. Future research could attempt to capture information about events and experiences occurring in the time since the last measurement occasion (Palmier-Claus et al., 2011). Whilst this suffers to some extent from the same issues of recall bias that befall traditional cross-sectional assessments (Kimhy et al., 2012), given the shorter timeframe of recall required with ESM, and the fact that such reports are averaged over several hundred measurement occasions, this may reliably lead to a clearer picture of the antecedents of voice intensity and distress.

Second, the analytic approach used within the present thesis (first-order autoregressive (AR1) models) are based on the assumption that measurement occasions are equally spaced. However, within the current studies, sampling occurring at semi-random intervals within fixed periods of 90 minutes. Whilst the use of AR1 models in ESM studies utilising semi-random signal-contingent sampling protocols is common (Bringmann et al., 2013; Hartley et al., 2015; Palmier-Claus et al., 2014), and parameter estimates should provide an accurate indication of the average time-lagged effect over a period of 90 minutes (the mean interval between measurement occasions), it remains a possibility that estimates of parameters and/or standard errors may be biased. Analytic methods have been suggested to allow for unequal spacing of measurement occasions within these models (Steele, 2014), and these should be considered in future ESM research.

Third, the dynamic models used within the present thesis disregarded an assumption referred to as the 'initial conditions' problem (Steele, 2014). Put simply, this problem stems from the fact that the value of the lagged response at the first measurement occasion is unknown (because we do not possess data on experiences occurring before participants entered the study). Within these models, the first measurement is treated only as a predictor of responses at following measurement occasions; the potential influence of omitted time-invariant variables (i.e. random error) on this initial value are not accounted for. Since the estimation of time-lagged effects is dependent upon the value of this first measurement, ignoring the initial conditions problem can result in the overestimation of dynamic effects, and the corresponding underestimation of random variance (Steele, 2014).

More sophisticated statistical approaches have been proposed which control for the influence of random variance on responses at the first measurement occasion (Steele, 2014), but these have yet to be utilised within the ESM literature. One previous ESM study has attempted to resolve this issue by excluding the lagged version of the outcome variable as a model covariate (Hartley, Haddock, et al., 2014), but this is not common

practice (Ben-zeev, Frounfelker, Morris, & Corrigan, 2012; Granholm, Ben-Zeev, Fulford, & Swendsen, 2013), and is likely to result in the overestimation of the unique effects of model predictors (Wichers, 2014). Furthermore, it has been noted that the initial conditions problem is less likely to result in biased parameter estimates when the number of repeated measurements is large (i.e. greater than 20) (Steele, 2014). As such, it is unlikely that this creates significant issues for interpretation of results from Chapters Four and Five. However, findings of the within-person network analyses presented in Chapter Six should be interpreted with some caution.

Finally, it is important to emphasise that dynamic analyses only indicate precedence, a necessary but not sufficient condition of causality (Conner & Lehman, 2012). Whilst reverse modelling can provide an indication as to whether one direction of effects can be discounted, these models do not establish causality (Kline, 2011).

8.6 Conclusions

Findings presented in this thesis build on understandings of the proximal psychological mechanisms related to the experience of and therapy for distressing voices. Results lend support to the notion that voice hearing experiences are dynamic, multi-faceted phenomena, varying both within and between individuals across a range of dimensions. Findings additionally suggest antecedent and maintenance roles for stress and depersonalisation in the fluctuation of voices during daily life, and of voice appraisals and responses in the modulation of momentary voice-related distress. Preliminary evidence was obtained for changes in negative voice appraisals and symptomatic reactivity to stress over the course of cognitive behavioural therapy for psychosis, demonstrating the utility of momentary assessment approaches to delineating therapeutic change mechanisms. An integrative ‘state’ model for the modulation of voice hearing and associated distress was presented based on these findings in conjunction with previous theoretical and empirical work, providing a platform for future research. These findings encourage a greater focus of interventions on targeting mechanisms associated with daily life voice hearing and associated distress, including stress-induced dissociation, negative voice appraisals, and maladaptive behavioural responses to voices. They further highlight the importance of acknowledging within- and between-person variability in voice experiences and mechanisms, towards the essential goal of improving the efficacy of interventions for those distressed by voices.

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Appendices

Appendix A: Letter of NHS Research Ethics Committee (REC) Ethical Approval (Chapters Four and Five)

NHS
Health Research Authority

NRES Committee London - Camberwell St Giles
Bristol Research Ethics Centre
Level 3, Block B
Whitefriars
Lewins Mead
Bristol
BS1 2NT

Telephone: 0117 342 1333
Facsimile: 0117 342 0445

23 April 2014

Ms Sarah Fielding Smith
PhD Student
University of Sussex
Pevensey I
University of Sussex
Brighton
BN1 9RH

Dear Ms Fielding Smith

Study title:	**Examining psychological models of voice hearing in the daily lives of hearers with and without a 'need for care': an experience sampling study**
REC reference:	**14/LO/0475**
Protocol number:	**N/A**
IRAS project ID:	**139953**

The Research Ethics Committee reviewed the above application at the meeting held on 11 April 2014. Thank you for attending to discuss the application.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details, unless you expressly withhold permission to do so. Publication will be no earlier than three months from the date of this favourable opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to withhold permission to publish, please contact the REC Manager Mr Thomas Fairman, nrescommittee.london-camberwellstgiles@nhs.net.

Ethical Considerations

Social or scientific value; scientific design and conduct of the study

- The committee noted that the primary novelty of this research is the use of the 'in the moment' technique rather than a retrospective review. They questioned what the researchers considered the advantages of this technique would be.

You clarified that, in your opinion the 'in the moment' technique offers significant advantages over the retrospective review as it could provide much more details on what is happening to participants in their daily life. This would be useful in developing treatments, which are currently based on retrospective research.

You clarified further that, in some areas you expect to find correlation between the results of the 'in the moment' and retrospective research methodologies. However in other areas a significant divergence may be found. This would be particularly valuable in clinical care. You clarified that you have found that patients in clinic report improvements but none are in fact seen in the administered questionnaires. If this research can help to better understand the relevant factors affecting patients and therefore develop more sensitive tools for identifying these issues, then this may help to fill the gap between what is observed and what the current research states should be the case, helping to develop a more granulated picture.

Recruitment arrangements and access to health information, and fair research participant selection

- The committee stated that they understood and were content with the involvement of, and rationale for the involvement of, those who hear voices and receive care. However they questioned the involvement of those who hear voices but do not need care noting that there would be tremendous variety within this group. The committee suggested that it would perhaps be a more valid comparison to only recruit those with a mental disorder, such as psychosis. You could then compare those with a mental disorder, who hear voices and require care, against those with a mental disorder who hear voices and do not require care. You could then look at the environmental and other differences between these groups to ascertain why some individuals are able to effectively manage their experiences while others require care.

You stated that it must be remembered that those who hear voices are on a continuum. You stated that you will be seeking to recruit those as high up the continuum as possible who do not require care. You further clarified that, while you understand that there will be variety in the group who do not require care, there will also be variety in the group that do, indeed in their clinical experience and other research more variety has been found in the group that do require care, rather than those who do not, who form a relatively homogeneous group.

You stated that there has been a definite lack of research in the no care group and that focusing on this group will fill a significant gap in the current literature, whist potentially being of help in current treatment practice. Finally you stated that you considered it would be difficult to recruit those with a mental disorder who are hearing voices but do not need care, as these would be relatively rare.

Favourable risk benefit ratio; anticipated benefits/risks for research participants (present and future)

- Following consideration of the information provided the committee were satisfied with this aspect of the proposed research.

Care and protection of research participants; respect for potential and enrolled research participants' welfare & dignity

- The committee discussed whether the 10 bleeps during the day would be burdensome for participants, particularly in view of the fact that many would be in work during the day. They questioned whether this would be distressing for participants and, if so, how you proposed to manage and mitigate this.

You replied that Ms Fielding Smith had travelled to Maastricht to test the device and found

that she got used to it surprisingly quickly. Furthermore other research has found that participants do not find wearing the device troubling in any way. However they clarified that, should any participant have difficulties, they would be free to withdraw from the study.

- The committee noted that the researches proposed to make two phone calls during the 9 day period of wearing the device. They questioned what the timing and purpose of these was.

You replied that the primary purpose of the phone calls was to assess if any distress was being caused and, if so, to provide support to participants. The first phone call would be at the end of the first day, a time at which any signs of distress were likely to arise. The second would be arranged at the discretion of the participant and more phone calls could be arranged if this was felt to be necessary.

Informed consent process and the adequacy and completeness of research participant information

- The committee noted that the researchers plan to use both morning and evening questionnaires and requested that information about these and the differences between them be included in the PIS.

You agreed to add this information

- The committee noted that there is a study website but that its web address has not been included on the study poster. They requested that this be added.

You agreed to add this information to the study poster.

Suitability of the applicant and supporting staff

- Following consideration of the information provided the committee were satisfied with this aspect of the proposed research.

Independent review

- Following consideration of the information provided the committee were satisfied with this aspect of the proposed research.

Suitability of supporting information

- Following consideration of the information provided the committee were satisfied with this aspect of the proposed research.

Consider and confirm the suitability of the summary of the study

- The committee considered the researchers answer to IRAS A6 -1 and concluded that this was suitable for publication on the NRES website.

Ethical opinion – Favourable Opinion

The members of the Committee present gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database within 6 weeks of recruitment of the first participant (for medical device studies, within the timeline determined by the current registration and publication trees).

There is no requirement to separately notify the REC but you should do so at the ea diest opportunity e.g when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non clinical trials this is not currently mandatory.

If a sponsor wishes to contest the need for registration they should contact Catherine Blewett (catherineblewett@nhs.net), the HRA does not, however, expect exceptions to be made. Guidance on where to register is provided within IRAS.

It is responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Approved documents

The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
Advertisement	1.0	04 March 2014
Evidence of insurance or indemnity		12 July 2013
Other: CV - Ms Sarah Fielding Smith		
Other: CV - Dr Mark Haywood		
Other: CV - Dr Kathryn Greenwood		
Other: CV - Dr Emmanuelle Peters		
Other: CV - Dr Marieke Wichers		
Other: Letter of Invitation, Non need for care gatekeepers	1.0	04 March 2014
Other: Letter to Care Coordinator	1.0	04 March 2014
Participant Consent Form: Need for Care Version	1.0	04 March 2014
Participant Consent Form: Non Need for Care Version	1.0	04 March 2014
Participant Information Sheet: Need for Care Version	1.0	04 March 2014
Participant Information Sheet: Non Need for Care Version	1.0	04 March 2014
Protocol	1.0	
Questionnaire: Experience Sampling Questionnaire Items	1.0	04 March 2014
REC application		04 March 2014

Membership of the Committee

The members of the Ethics Committee who were present at the meeting are listed on the attached sheet.

There were no declarations of interest

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments •
Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

Feedback

You are invited to give your view of the service that you have received from the Na tional Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

Further information is available at National Research Ethics Service website > After Review

14/LO/0475	**Please quote this number on all correspondence**

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

With the Committee's best wishes for the success of this project.

Yours sincerely

p.p. T. Fairman

Mr John Richardson
Chair

Email: nrescommittee.london-camberwellstgiles@nhs.net

Appendix B: Letter of NHS Research Ethics Committee (REC) Ethical Approval (Chapter Six)

Institute of Psychiatry

at The Maudsley

Ethical Committee
(Research)
Research Ethics Co-ordinator
Margaret M Chambers Msc

P006, Room W109
De Crespigny Park
Denmark Hill
London SE5 8AF
Tel 020 7848 0797
Fax 020 7848 0147
Email m.chambers@iop.kcl.ac.uk

KING'S College LONDON
University of London

ETHICAL COMMITTEE (RESEARCH)

2 June 2004

Prof J Scott
Psychological Medicine
PO96
Institute of Psychiatry

Dear Prof Scott

Re: Processes of change in cognitive-behaviour therapy for psychosis (243/03)

The Chair of the Ethical Committee (Research) has taken action to approve this study from an ethical point of view.

Please note that this approval is subject to confirmation by the full Committee when it meets on 18 June 2004. Initial approval is given for one year. This will be extended automatically only on completion of annual progress reports on the study when requested by the EC(R). Please note that as Principal Investigator you are responsible for ensuring these reports are sent to us.

Please note that projects which have not commenced within two years of original approval must be re-submitted to the EC(R).

Any serious adverse events which occur in connection with this study should be reported to the Committee using the attached form.

Please quote Study No. 243/03 in all future correspondence.

Yours sincerely,

pp Adele Duncan

Margaret M Chambers
Research Ethics Coordinator

Appendix C: Experience Sampling Questionnaire

Item #	Item	Branching Item	Scale
1	Right before the beep I felt stressed	n/a	1 (*not at all*) to 7 (*very much*)
2	Right before the beep I felt cheerful	n/a	1 (*not at all*) to 7 (*very much*)
3	Right before the beep I felt anxious	n/a	1 (*not at all*) to 7 (*very much*)
4	Right before the beep I felt satisfied	n/a	1 (*not at all*) to 7 (*very much*)
5	Right before the beep I felt lonely	n/a	1 (*not at all*) to 7 (*very much*)
6	Right before the beep I felt suspicious	n/a	1 (*not at all*) to 7 (*very much*)
7	Right before the beep I felt excited	n/a	1 (*not at all*) to 7 (*very much*)
8	Right before the beep I felt sad	n/a	1 (*not at all*) to 7 (*very much*)
9	Right before the beep I felt detached or 'unreal'	n/a	1 (*not at all*) to 7 (*very much*)
10	Right before the beep I could hear a voice or voices that other people couldn't hear	n/a	1 (*not at all*) to 7 (*very much*)
11	Right before the beep the number of different voices that I could hear was:	n/a	0/1/2/3/4+
12	Right before the beep the voice* was talking to me	Right before the beep I was thinking about the future***	1 (*not at all*) to 7 (*very much*)
13	Right before the beep the voice* was talking about me	Right before the beep I was deep in concentration***	1 (*not at all*) to 7 (*very much*)
14	Right before the beep the voices were talking to each other**	Right before the beep I was feeling restless***	1 (*not at all*) to 7 (*very much*)

Item #	Item	Alternative Item	Scale
15	Right before the beep the voice* was saying positive things	Right before the beep I was thinking about the past***	1 (*not at all*) to 7 (*very much*)
16	Right before the beep the voice* was saying negative things	Right before the beep I was in a quiet environment***	1 (*not at all*) to 7 (*very much*)
17	Right before the beep the voice* was telling me what to do	Right before the beep I was feeling distracted***	1 (*not at all*) to 7 (*very much*)
18	Right before the beep the voice* was upsetting me	Right before the beep I was worrying about something***	1 (*not at all*) to 7 (*very much*)
19	Right before the beep the voice* was interfering with what I was doing	Right before the beep I was daydreaming***	1 (*not at all*) to 7 (*very much*)
20	Right before the beep I felt that the voice* was out of my control	Right before the beep I felt relieved that I could not hear the voice/s***	1 (*not at all*) to 7 (*very much*)
21	Right before the beep I felt that the voice* was on my side	Right before the beep I felt free from the influence of the voice/s***	1 (*not at all*) to 7 (*very much*)
22	Right before the beep I felt inferior to the voice*	Right before the beep I felt deserted by the voice/s***	1 (*not at all*) to 7 (*very much*)
23	Right before the beep I felt that the voice* was intruding on my personal space	Right before the beep I felt lonely without the voice/s***	1 (*not at all*) to 7 (*very much*)
24	Right before the beep I felt that I would be lost without the voice*	Right before the beep I felt lost without the voice/s***	1 (*not at all*) to 7 (*very much*)
25	Right before the beep I felt a sense of closeness to the voice*	Right before the beep I felt worried that the voice/s would come back***	1 (*not at all*) to 7 (*very much*)
26	Right before the beep I was interacting with the voice*	Right before the beep I was in a rush***	1 (*not at all*) to 7 (*very much*)
27	Right before the beep I was treating the voice* like I would a friend	Right before the beep I was busy doing something***	1 (*not at all*) to 7 (*very much*)
28	Right before the beep I was trying to ignore the voice* or stop it from talking	Right before the beep I was making plans***	1 (*not at all*) to 7 (*very much*)
29	Right before the beep I was doing what the voice* was telling me to do	Right before the beep I was trying to solve a problem***	1 (*not at all*) to 7 (*very much*)

Item #	Item	Alternative Item	Scale
30	Right before the beep I was 'giving in' to the voice*	Right before the beep I was waiting for something or someone***	1 (*not at all*) to 7 (*very much*)
31	Right before the beep I was worrying about what the voice* was saying	Right before the beep I was just passing the time***	1 (*not at all*) to 7 (*very much*)
32	Right before the beep I was letting the voice* come and go without reacting	Right before the beep I was avoiding doing something***	1 (*not at all*) to 7 (*very much*)
33	Right before the beep I was doing something meaningful	n/a	1 (*not at all*) to 7 (*very much*)
34	Right before the beep I was doing something enjoyable	n/a	1 (*not at all*) to 7 (*very much*)
35	Right before the beep I was doing something stressful	n/a	1 (*not at all*) to 7 (*very much*)
36	Right before the beep I was doing something active or engaging	n/a	1 (*not at all*) to 7 (*very much*)
37	Right before the beep, where were you?	n/a	Home/Work/College /Public Place/Other
38	Right before the beep, what were you doing?	n/a	Nothing/Work/Leisure/Other
39	Right before the beep, how many people were you with?	n/a	0/1/2/3/4+
40	Right before the beep I was interacting with this person****	Right before the beep I was enjoying my own company*****	1 (*not at all*) to 7 (*very much*)
41	Right before the beep I felt that this person**** was on my side	Right before the beep I felt relieved to be by myself*****	1 (*not at all*) to 7 (*very much*)
42	Right before the beep I felt inferior to this person****	Right before the beep I felt free from the influence of other people*****	1 (*not at all*) to 7 (*very much*)
43	Right before the beep I felt that this person**** was intruding on my personal space	Right before the beep I felt deserted by other people*****	1 (*not at all*) to 7 (*very much*)
44	Right before the beep I felt that I would be lost without this person****	Right before the beep I felt lost without other people around*****	1 (*not at all*) to 7 (*very much*) OR '*unsure*'
45	Right before the beep I felt a sense of closeness to this person****	Right before the beep I felt lonely without other people around*****	1 (*not at all*) to 7

Item #	Item	Alternative Item	Scale
46	Right before the beep I felt good about myself	n/a	1 (*not at all*) to 7 (*very much*)
47	Right before the beep I felt free to be myself and make my own decisions	n/a	1 (*not at all*) to 7 (*very much*)
48	Right before the beep I felt competent and capable	n/a	1 (*not at all*) to 7 (*very much*)
49	Right before the beep I felt like an 'outsider'	n/a	1 (*not at all*) to 7 (*very much*)
50	Since the last beep something stressful has happened	n/a	1 (*not at all*) to 7 (*very much*)
51	Since the last beep I have consumed:	n/a	Medication/Caffeine /Alcohol/Tobacco/Cannabis/Other Illegal Substance

*note: on sampling occasions when more than one voice was reported, all voice-relevant items referred to the 'voices' rather than the 'voice', with appropriate associated grammar (e.g. the voices *were* as opposed to the voice *was; them* as opposed to *it*, etc.).

**note: this item was only presented on sampling occasions when more than one voice was reported.

***note: these items were only presented on sampling occasions when no voices were reported. Some of these items refer to 'voice/s' rather than 'voice' or 'voices' since participants may report different numbers of voices on different sampling occasions.

****note: on sampling occasions when participants reported being in the company of more than one other person, all socially-relevant items referred to 'these people' rather than 'this person'.

*****note: these items were only presented on sampling occasions when participants reported being alone.