Music Engagement in Alzheimer Disease

By

Ashley David Vanstone

A thesis submitted to the Graduate Program in Psychology in conformity with the requirements for the degree of Doctor of Philosophy

Queen’s University

Kingston, Ontario, Canada

September, 2017

Copyright © Ashley David Vanstone, 2017
Abstract

Alzheimer disease (AD) is characterized by progressive memory loss and deterioration of functional abilities, but anecdotal and clinical observations suggest that many individuals with AD continue to respond in meaningful ways to music, sometimes well into the course of the disease. Previous research in the psychology and neuroscience of music has established that some music cognitive and perceptual abilities are less affected by AD than others, but it is unclear what implications these preserved abilities have for how individuals with AD engage with music in their daily lives. The purpose of this dissertation is to explore the relationship between music cognition and engagement. Study 1 examined episodic, implicit, and semantic memory for melodies in participants with AD relative to older adult and younger adult control groups. AD participants showed impaired ability to form new memories for melodies, but their semantic memory for melodies was on par with that of the older and younger control participants. Study 2 addressed the need for an informant-report measure of music engagement. 35 items were created in parallel self-report and informant-report formats. Exploratory factor analysis of data from a large development sample guided the construction of six subscales, each of which showed high internal reliability. A further study showed a high correlation between self-report and informant-report versions in a sample of older adult respondents. Study 3 explored patterns of association between semantic memory for melodies, melody perception, and music engagement in a series of 15 AD cases. No single cognitive or perceptual ability was sufficient to explain cases of high music engagement. Heterogeneity between cases supports the hypothesis that there are multiple pathways by which music engagement may be sustained in those with AD. Individual cases are examined to draw out implications for basic and clinical research on music and AD.
Co-Authorship & Publication

Statement of Co-Authorship

For each of the studies presented in this dissertation, I took primary responsibility for study conception and design, data analysis, interpretation of findings, and manuscript preparation and revision. My co-authors shared their perspectives and expertise at every stage in the process; the form and substance of these manuscripts was shaped and enriched in discussion with them and by their comments on earlier versions of this work. Data were collected either by me or under my supervision by co-authors (Svenja Kotz, Michael O’Grady, Tina Poon, Rosalind Sham, Ritu Sikka, Leila Tangness, and Michael Wolf). Tina Poon and I jointly created the MusEQ scale items (Chapter 3). Michael Wolf made a substantive contribution to developing and refining the rating scale for qualitative interview data (Chapter 3). All of the co-authors understood that this work was to form part of my dissertation, and they have consented to its inclusion here. All of the research presented here was conducted under the supervision of Dr. Lola L. Cuddy.

Declaration of Previous Publication

This dissertation contains three article manuscripts. Chapters 2 and 3 have been published in very similar form in peer reviewed journals. Citation information is listed on the first page of each chapter. Inclusion of previously published material is in compliance with the terms of Author Agreements for University of California Press (Chapter 2) and Taylor and Francis (Chapter 3).
Acknowledgements

It would require an entire volume to properly acknowledge the personal and academic supports that have enabled me to write this dissertation. I am grateful for a thousand kind and helpful gestures, words of counsel and encouragement, and gifts of time and energy.

First, I wish to thank all those who participated in my studies. You gave me your time, shared your experiences, and complied with my bothersome requests such as to draw a clock or to tell me the date. I do hope that my work is a faithful interpretation of your experience.

To my supervisor, Dr. Lola Cuddy: Thank you for your long forebearance during this protracted Ph.D. Your insistence on rigor and clarity (and keen eye for instances when it lacks) have sharpened my thinking. You enriched my academic life by supporting my attendance at conferences, supervision of students, and co-publication of our work. It has been an honour to work under your supervision, and I thank you sincerely for the attention and care you have brought to my training. I am also grateful for the support and comradeship of my labmates in the Music Cognition Lab – what a fantastic bunch you are. You have been fun to work with and so kind in your support of my research.

Thanks, as well, to members of my supervisory committee – Dr. Cella Olmstead (who graciously served as my co-supervisor), Dr. Chris Bowie, and Dr. Angeles Garcia. I appreciate your gracious engagement with my work and your helpful feedback throughout this process. I am very grateful to Dr. Daryl Wilson, who generously agreed to step in when an additional member was needed. A special note of thanks goes to Dr. Garcia, Lisa McAvoy and the rest of the Memory Clinic family; Thursday morning clinics were a highlight of my week.

My colleagues at the Counselling Service and School of Graduate Studies showed a saintly degree of understanding during these past few years. I could not have asked for a more
lovely and supportive group of people to work with. Thanks to Dr. Brenda Brouwer, Dr. Mike Condra, and Dr. Mary Acreman for facilitating time away to write, and to Dr. Kim McAuley for her particularly effective brand of friendly encouragement.

I am grateful to the friends who prompted me to stay musically engaged while I was writing about music engagement – Dr. Breanne Oryschak, Dr. Julia Brook, Charlie Walker, Rev. Elizabeth Macdonald & the SSUC community, and the crew at Kingston School of Music. Thanks as well to Dr. Ana Ortiz de Guinea, Dr. Jo Scholz, Dr. Michelle Bertrand, and Dr. Karen Rudie; these dear friends have navigated the vicissitudes of academic life and helped me find confidence that these ideas were worth pursuing. My sanity at the end of this process comes courtesy of Dr. Zuzana Sramek, who truly has heard (and listened to) it all. Joanne Roston has been a grounding and enriching presence in my daily life and deserves high praise for her crisis intervention skills.

Sincere thanks to my parents, who have endured having a son spend almost half of his natural life expectancy in school. Your support has afforded me the gift of a rewarding intellectual life. And finally, to Manoj, who bore daily witness to the joys and sorrows of this endeavour, pushing me through the stuck spots, all while finishing his own dissertation: my deepest thanks; I wouldn’t have got here without you.
Table of Contents

Abstract...........................................................................................................................................ii
Co-Authorship & Publication..................................................................................................................iii
Acknowledgements..............................................................................................................................iv
Table of Contents..................................................................................................................................vi
List of Tables ........................................................................................................................................vii
Chapter 1: General Introduction..........................................................................................................1
Chapter 2: Episodic and semantic memory for melodies in Alzheimer disease ............................22
Chapter 3: Measuring Engagement With Music: Development of an Informant-Report Questionnaire ....45
Study 1: MusEQ Scale Development ..................................................53
Study 2: Evaluation of the MusEQ ......................................................60
Chapter 4: Music cognition and engagement in Alzheimer disease: a case-comparative analysis ..........82
Appendix 1: MusEQ-Basic questionnaire items .................................................................125
Appendix 2: Fuzzy set membership scores for outcome and conditions .......................................126
Supplemental Material: Comparative analysis of psychological cases: a fuzzy set approach .........127
Chapter 5: Conclusions and General Discussion............................................................................130
Appendix A: Music Engagement Questionnaire (MusEQ) -- Supplemental Information .................139
Appendix B: General Research Ethics Board Approval .................................................................143
List of Tables

2.1. Participant Demographics. 43

2.2. Results for Recognition Memory Test (Explicit and Implicit Memory) and Familiarity Decision Test (FDT). 44

3.1. Study One: Participant Demographics for Both Groups. 77

3.2. MusEQ Subscales: Internal Consistency, Items, and Factor Loadings. 78

3.3 Study Two: Demographics for both participant groups. 80

3.4 Correlations Between MusEQ Scales, Qualitative Interview Ratings, and Demographics for OA and AD Groups. 81

4.1. fsQCA overview 118

4.2. Demographic information for control and AD groups. 119

4.3. AD and control group median scores on ITT, MBEA, and MusEQ. 120

4.4. Coding scheme for outcome and condition fuzzy set membership. 121

4.5. Consistency and coverage of conditions for MusEQ and ~MusEQ 122

4.6. Analysis of conditions for the MUSEq and ~MUSEq outcomes. 123

A.1. MusEQ (Informant Version) Scale Score to Percentile Conversions (All Ages) 140

A.2. MusEQ (Informant Version) Scale Score to Percentile Conversions (Older Adults) 141

A.3 MusEQ Basic Scale Items (Informant Version) 142
Chapter 1: General Introduction

The 2014 Sundance Film Festival Audience Award went to the documentary *Alive Inside*, which “chronicles the astonishing experiences of individuals around the country who have been revitalized through the simple experience of listening to music” (from [www.aliveinside.us](http://www.aliveinside.us)). Prominently featured in this film is an elderly gentleman, Henry, who is living with severe dementia, spending much of his time sitting in a wheelchair, disengaged from the world. Everything changes, though, when headphones are placed on his ears and he is exposed to music from much earlier in his adult years. From withdrawn, non-verbal, with eyes closed, he seemingly awakens, singing along, responding rhythmically, smiling, and even thanking the attendant. How is it that music could have such an effect on a person whose world has become so constrained by the cognitive and functional impairments of dementia?

Such responses raise the question of whether persons with Alzheimer disease (AD) are able to experience music as meaningful and engaging due to their music cognitive abilities being less affected by AD than some other abilities. This is the motivating question behind the series of studies presented in this dissertation. More specifically, I focus on the status of memory for long-familiar melodies in listeners with AD, and on the relationship between memory for melodies and musical experience in daily life.

This introductory chapter provides background information as context for the following studies and to make their motivations and methods more accessible to a general psychology audience. I begin with a brief overview of clinical and neuropsychological issues in AD, followed by an introduction to the literature on music cognition in AD. I conclude by developing
the concept of “music engagement” and its relevance to dementia, and by defining the scope of this dissertation.

**Alzheimer disease: a primer**

AD is the most common form of dementia, with worldwide prevalence of 5 – 7% in individuals 60 and older, making it a substantial contributor to global disease burden (Prince et al., 2013). Its course is progressive, with insidious onset, beginning with anterograde amnesia before expanding to other cognitive domains and resulting in loss of function in daily activities. There is currently no disease modifying treatment, so clinical management is focused on addressing concurrent medical conditions that may compound AD symptoms and on managing behavioural and psychological symptoms.

AD is eponymously named for the physician Alois Alzheimer, who in 1906 described its clinical and neuropathological features based on the case of Auguste D. Descriptions of dementia date back to the classical period, though, and Alzheimer’s work came as an extension of earlier descriptions in the writings of late 19\(^{th}\) century Psychiatry. Conceptions of AD have been driven by advances in neuropathology and neuroimaging, and by the accumulation of clinical observations; present day trends in understanding the biological and clinical basis of AD are extending a long trajectory in the struggle to understand this prevalent and devastating disease (Boller, Bick, & Duychkaerts, 2007).

Neurofibrillary tangles due to tau hyperphosphorilation, first observed by Alzheimer in 1906, are the neuropathological hallmark of AD. They occur alongside neuronal plaques formed by the accumulation of amyloid-B. The distribution of these pathologies serves as the basis for staging AD (Braak, Griffing, Arai, Bohl, & Bratzke, 1999). Structural and functional neural damage follows a predictable sequence, which begins decades prior to the onset of symptoms. It
begins in the (trans-)entorhinal region and progresses to affect a network of brain areas including frontal and sensory association cortices (Schroeter, Stein, Maslowski, & Neumann, 2009).

AD is characterized by progressive impairment in two or more cognitive domains, that cannot be explained by other medical conditions, and that affects functioning in the individual’s typical activities (Mckhann et al., 1984). AD-related memory loss begins insidiously with impairments in encoding new episodic memories; impairment of attention, language, visuospatial ability, and executive function tends to be less pronounced at onset, becoming more significant with disease progression (Weintraub, Wicklund, & Salmon, 2012).

While it has been possible to characterize a prototypical neuropsychological profile of AD, it is also apparent that AD does not present in an entirely homogeneous way across individuals. There is not a clear consensus on the typology of AD subtypes. In a large longitudinal dataset, individuals with diagnoses of probable AD were reliably classified into groups showing greater impairment of semantic knowledge or visuospatial skills, or showing more equivalent levels across these domains (Fisher et al., 1997; Fisher, Rourke, & Bieliauskas, 1999). A more recent cluster analysis of neuropsychological test data, on the other hand, identified 13 subsets of patients, characterized by disproportionately impaired performance on tests of visuospatial skills, executive function, praxis, or language, in addition to those showing the more classic pattern of predominantly amnestic impairment (Stopford, Snowden, Thompson, & Neary, 2008). Some inter-individual variability is accounted for by disease severity – in general, non-amnestic deficits become more pronounced with disease progression – but some variability exists independently of disease severity (Ralph, Patterson, Graham, Dawson, & Hodges, 2003). While it remains valuable to study the prototypical AD syndrome, more recent
efforts to personalize treatment and to develop disease modifying therapies give new relevance
to identifying distinct subtypes (Lam, Masellis, Freedman, Stuss, & Black, 2013).

In addition to cognitive impairment, AD creates functional impairment in activities of
daily living (Gauthier, Gélinas, & Gauthier, 1997). AD also commonly includes behavioural and
psychological symptoms, such as depression, apathy, or agitation (Cerejeira, Lagarto, &
Mukaetova-Ladinska, 2012). Pharmacological interventions for behavioural problems in AD are
frequently used but are associated with disturbing adverse effects and modest efficacy (Sink,
Holden, & Yaffe, 2005). Nonpharmacological therapies offer a safer and more tolerable
approach, although the quality of their empirical support is variable (Ayalon, Gum, Feliciano, &
Areán, 2006; Olazarán et al., 2010).

Music, memory, and AD

Is memory for music somehow spared in AD, in contrast with memory for other types of
information? Given that memory impairment is the central deficit of AD, this question provides a
natural starting place in the larger project of understanding the striking responses to music
observed in some cases of AD. The following comments offer context for how the research has
approached memory for music in AD; memory for melodies, in particular, is addressed in more
detail in Chapters Two and Four.

Case studies have documented preserved musical skills among musicians with AD who
retained the ability to play an instrument and to form memories for new pieces of music (Beatty
et al., 1988; Cowles et al., 2003; Fornazzari et al., 2006; Fornazzari, Mansur, Acuna, Schweizer,
& Fischer, 2017). In each of these cases, preserved musical ability stood in contrast with marked
deficits in other domains. These cases prompted questions about the extent to which music is
“unforgettable” in AD and led to the suggestion that procedural memory is one component of preserved musical ability (Baird & Samson, 2009).

Memory for music takes a variety of forms, not all of which are affected in the same way by AD. However, while music does not represent an untouched “island of preservation” in AD (Baird & Samson, 2015), instances of greater-than-expected memory for music and associated information have been documented in a variety of experimental contexts. Preserved memory for melodies facilitates encoding or retrieval of memory for other types of information; new learning of verbal information can be improved when paired with melodies (Deason, Simmons-Stern, Frustace, Ally, & Budson, 2012; Moussard, Bigand, Belleville, & Peretz, 2012, 2014a; Simmons-Stern, Budson, & Ally, 2010). A similar effect has been observed when melodies are associated with physical gestures (Moussard, Bigand, Belleville, & Peretz, 2014b). Familiar music is also an effective means of evoking spontaneous recollection of associated episodic memories in persons with AD (El Haj, Fasotti, & Allain, 2012; El Haj, Postal, & Allain, 2012), possibly by enhancing the positivity associated with these memories (Cuddy, Sikka, Silveira, Bai, & Vanstone, 2017). Preserved musical memory in AD has been proposed to reflect relatively less severe cortical atrophy and hypometabolism in the caudal anterior cingulate and ventral pre-supplementary motor area – regions crucial to encoding and retrieval of musical memories in young adult listeners (Jacobsen et al., 2015). This relatively robust neural substrate offers a neurobiological rationale for why memory for music, although not spared in all respects or for all individuals, appears to have a favoured status in AD.

While the aforementioned examples involve learning and retrieval of information associated with particular melodies or musical excerpts, presentation of music also improves retrieval of semantic autobiographical memories (conceptual knowledge about one’s life) (Foster...
an effect particularly pronounced with sad music (García et al., 2012). Improvement in category fluency while listening to instrumental music has also been noted in persons with AD, an effect attributed to enhancement of attention (Thompson, Moulin, Hayre, & Jones, 2005). It appears, then, that music is able to enhance memory in AD both through direct association with a musical stimulus and by optimizing ancillary processes linked to emotion, arousal, or attention. Taken together, these findings speak to the promise of research-informed applications of music in AD care.

Music, engagement, and dementia

Although impairment of memory and cognitive ability is the hallmark of AD, functional impairment must also be evident in activities of daily life in order to diagnose AD. The distinction between cognitive and functional impairment is relevant to the musical domain as well, although it has been given little attention in the music cognition literature. This gap in the literature is a central motivation for this dissertation. I adopt the construct of music engagement to provide a framework for delineating and evaluating what it means for an individual to “function,” musically-speaking.

It cannot be assumed that impaired music cognitive abilities have a uniform effect on music activities in daily life, either across activities or across individuals. Many individuals with congenital deficits in music processing nonetheless maintain some appreciation for music (McDonald & Stewart, 2008). During data collection for previous studies on music and AD, I observed informally that participants demonstrated preferences for and aversions to particular forms of music. Their comments seemed to reflect long-held personal tastes and cultural frames of reference more than current music cognitive abilities. This observation suggested that the
relationship between music cognition and function deserved further consideration, and it served as an initial motivation for the research presented in this dissertation.

Our working definition of *engagement* is borrowed from the Comprehensive Process Model, which proposes that engagement is “the act of being occupied or involved with an external stimulus” (Cohen-Mansfield et al., 2011, p. 860). This model conceptualizes engagement by persons with dementia as resulting from joint and reciprocal influences of the *stimulus, person, and environment*. In considering *music* engagement, then, we broaden our focus beyond the cognitive-perceptual processes involved in processing musical stimuli; memory for music (preserved or otherwise) is only one attribute of the person, and music is only one class of stimulus among many types of stimuli with which a person might engage.

Music is ubiquitous in the lives of most individuals; it is present both in music-focused activities, such as playing an instrument or attending concerts, and as an accompaniment to other activities. Listening to music is used to structure activities of daily living (de Nora, 2000), facilitate mood regulation (Saarikallio & Erkkila, 2007), and foster social connection and identity (Hargreaves & North, 1999; North, Hargreaves, & Hargreaves, 2004). Its use tends to be associated with subjective wellbeing (Weinberg & Joseph, 2016). All of these uses involve some level of occupation or involvement with the musical stimulus, whether or not music is the central focus. *Music engagement*, then, is constructed in broad terms and is entwined in multiple facets of daily life.

The capacity to engage with music begins very early in life; infants are able to discriminate many of the tonal and rhythmic features fundamental to music (Trehub, 2003). Throughout childhood and adolescence, these fundamental music perceptual abilities are shaped by culture, giving rise to more sophisticated processing of musical structure and emotion.
(Stalinski & Schellenberg, 2012). During adolescence music acquires heightened importance in the development of emotion regulation, personal mastery, relationships, and identity (Laiho, 2004). Music cognitive development, then, is entwined with evolving individual and social practices, which entrench music in daily life. Forms of music engagement are not static across the lifespan – for example, participants described how their musical tastes and activities were shaped by changes in family circumstances.

Music activities continue to carry significance later in life and with the onset of dementia. Use of music is positively associated with wellbeing for older adults (Laukka, 2007), and regular music activities provide meaningful cognitive, emotional, and social benefits to those living with dementia (Elliott & Gardner, 2016; Särkämö et al., 2014). Shared music making activities are enjoyable and promote interpersonal connectedness not only for persons with dementia but also for their family and professional caregivers (McDermott, Orrell, & Ridder, 2014). Where one member of a couple is living with dementia, group singing activities provide an enjoyable experience in which both members of the couple are able to actively participate, making a positive contribution to the relationship (Unadkat, Camic, & Vella-Burrows, 2016). Music engagement in AD is significant, then, as an avenue for enhancing quality of life through positive and meaningful shared activity – a striking contribution, given that the cognitive and functional impairments of dementia place so many other activities out of reach.

Music therapy is a common feature of dementia care. It could be considered a special case of music engagement, one where engagement is facilitated in a clinical context by a professional with one or more therapeutic objectives. Modes of intervention in music therapy include incorporating music into psychological or physical rehabilitation, group-based music activities for caregivers and persons with dementia, and facilitating individualized listening.
These interventions have been criticized as lacking empirical support on the basis of there being few randomized controlled trials of music therapy in dementia (Vink, Birks, Bruinsma, & Scholten, 2004; van der Steen et al. 2017). If a broader range of evidence is considered, music therapy interventions appear to have a moderate, short-term effect on anxiety in persons with dementia (Ueda, Suzukamo, Sato, & Izumi, 2013). Controversy surrounding the evidence for music therapy speaks to the methodological quality of clinical studies rather than the concerns regarding its safety or tolerability. Better defined, more meaningful theory and outcomes may be critical to refining the research of music therapy and practice (McDermott, Crellin, Ridder & Orrell, 2012). Regardless, it is clear that at least for some individuals with AD, music therapy represents a helpful and meaningful form of music engagement.

This dissertation does not directly address the efficacy of music therapy, but the research presented here is motivated by the need to establish a sound theoretical base for the development and individualization of psychosocial approaches to dementia (c.f. Moniz-Cook, Vernooij-Dassen, Woods, & Orrell, 2011). As with other cognitive domains, there appears to be heterogeneity in dementia-related patterns of hedonic response to music and other auditory stimuli (Fletcher et al., 2015), although a music-cognitive typology specific to AD has not been developed. Understanding the link between engagement and cognition, as well as clarifying individual differences in the mechanisms of music engagement, could inform the refinement of music-based interventions in order to make optimal use of the patient’s residual music cognitive abilities.

**Overview of chapters**

This dissertation addresses the relationship between music cognition and engagement in a series of three papers, which are presented in Chapters Two, Three, and Four.
Chapter Two presents a study contrasting episodic and semantic memory for melodies in listeners with AD. While the focus on melody carries some limitations (which are discussed in the Chapter Five), the use of melodic stimuli offers conceptual and methodological clarity: a melody is often the defining feature of a piece of music; melodies can be presented in short standardized excerpts; and simple melodic stimuli avoid many of the potential confounds associated with more naturalistic musical stimuli. In this study, the AD group was impaired, relative to control participants, in the ability to form new episodic memories for novel melodies. On the other hand, AD participants showed little impairment in recognizing long-familiar melodies. Musical semantic memory, we conclude, is more durable in AD than episodic memory for melodies. This finding raises the question of whether memory for long-familiar tunes, by virtue of being less affected by AD, is relevant to understanding music engagement.

Before addressing this question further, we faced the challenge of defining and measuring the extent of AD participants’ engagement with music. This challenge is the focus of Chapter Three. What leads us to say that someone is musically engaged, to describe a person as having high levels of “occupation or involvement” with music? Music engagement is a broad construct; typically-aging listeners exhibit an array of music-related behaviours and activities, many of which have subjective importance that extends beyond observable behaviour. A number of self-report questionnaires are available to assess music engagement. While they define their constructs in different terms – “use of music” (Chin & Rickard, 2012), “musical reward value” (Mas-Herrero, Marco-Pallares, Lorenzo-Seva, Zatorre, & Rodriguez-Fornells, 2013), or “musical sophistication” (Müllensiefen, Gingras, Stewart, & Musil, 2012), for example – they all speak to the form and intensity of an individual’s occupation or involvement with music. This previous psychometric work informs how we understand the music engagement construct, but to
accurately evaluate the musical lives of individuals with moderate or severe dementia, we need a measurement that can be completed by a third party, since self-reported functional ability declines in accuracy with the progression of cognitive impairment (Farias, Mungas, & Jagust, 2005). The Music Engagement Questionnaire (MusEQ) is a solution to this challenge.

The study reported in Chapter Four explores the convergence between cognition and engagement in listeners with AD. In data collection for previous studies, I had observed informally that certain individuals scored poorly on music cognition tasks but yet responded enthusiastically to music. It seemed that not all music cognitive abilities, as measured with experimental tasks and evaluated relative to control participants, are strictly necessary for engagement with music in daily life. There are many ways in which people engage with music, so perhaps the neurocognitive and psychosocial mechanisms for music engagement vary between individuals, according to preferred modes of engagement and pre-morbid musical experiences. In the case of reduced music perceptual acuity, perhaps the individual is able to draw on other resources to engage in meaningful ways with music.

My methodological approach in Chapter Four was motivated by the possibility that mechanisms for music engagement vary between individuals, as well as by the exploratory nature of the question. I adapt fuzzy-set qualitative comparative analysis (fsQCA; Ragin, 2009) to analysing patterns of music cognition and engagement within a case series of individuals with AD. FsQCA was originally developed in Political Science, and it has not been applied previously to a psychological case series, although use of fsQCA in behavioural research is increasing in the Management disciplines (Rihoux, Alamos-Concha, Bol, Marx, & Rezsohazy, 2013). It is explained alongside the study findings in a way that should be accessible to a Psychology readership. Across the case series, there were multiple consistent patterns of cognitive and
demographic conditions in which high levels of music engagement were observed to occur. A
descriptive and qualitative analysis of these patterns highlights the relevance of memory for
long-familiar melodies to music engagement and raises several substantive and methodological
considerations for future research.
References


https://doi.org/10.3389/fneur.2012.00073

https://doi.org/10.1525/mp.2012.29.4.429


https://doi.org/10.1017/S1041610297004857


https://doi.org/10.1177/0305735699271007


with dementia. *Cochrane Database of Systematic Reviews.*

https://doi.org/10.1002/14651858.CD003477.pub3


https://doi.org/10.1177/0305735616659552


https://doi.org/10.1101/cshperspect.a006171
Chapter 2: Episodic and semantic memory for melodies in Alzheimer disease

A very similar version of this chapter is published as:

Abstract

The present study addressed episodic and semantic memory for melodies in three groups of participants: 35 younger adults, 40 older adults, and 10 individuals with mild to moderate Alzheimer’s disease (AD). To assess episodic memory, a study list of eight novel target melodies was presented three times, followed by a test trial in which target melodies were mixed with foil (previously unheard) melodies. Both explicit and implicit measures were obtained. Explicit memory was assessed by the accuracy of discrimination of the target melodies from the foils. Younger adults were significantly more accurate than older adults, who in turn had significantly higher scores than AD adults. Implicit memory was assessed by examining the difference in pleasantness ratings between target and foil melodies. Younger adults showed significantly greater differences in pleasantness ratings than older adults and AD adults; scores for the two latter groups did not differ. To assess semantic memory, participants were asked to identify traditional melodies within a series of traditional and novel melodies. In contrast to the episodic memory results, all three groups showed very high scores on the semantic memory task with no significant differences among groups. The results support the notion that, though other forms of musical memory may be compromised, semantic memory for melody may be preserved in normal aging and in AD.

Key words: Alzheimer’s disease; episodic memory; implicit memory; semantic memory; melodies
Episodic and Semantic Memory for Melodies in Alzheimer Disease

Research on musical memory in dementia has yielded an apparent puzzle (Cuddy & Duffin, 2005). While certain laboratory studies have reported impaired memory performance for listeners with Alzheimer’s disease (AD), caregiver reports, case studies, and other laboratory studies have reported considerable preservation of musical memory. This discrepancy may be approached by considering the different memory tasks employed in different studies and the consequent demands on proposed memory systems.

When listeners with AD are tested in a conventional recognition memory paradigm, they reveal impaired performance relative to that of healthy age-matched controls (Bartlett, Halpern, & Dowling, 1995, Exp. 1; Ménard & Belleville, 2009). This paradigm involves first playing a list of melodies in the laboratory. These melodies form the study list and the melodies in the list may be either novel or traditional. Typically, listeners are instructed that they will be tested for recognition of melodies in the study list, but in a variant of the procedure, the study list is simply played without instructions about later recall (Halpern & O’Connor, 2000). The study list is followed by a recognition test. In the test, the study melodies, the targets, are randomly mixed with other melodies that were not presented for study, the foils. The task is to differentiate the targets from the foils.

The recognition task thus requires memory for an event (the presentation of the study list) and a location (the study list was presented in the laboratory session). When a melody from the study list appears in the recognition test, the listener must recognize that the melody was played by the experimenter at a certain point in time in the laboratory session. If the melody in question is a traditional melody (e.g., “Silent Night”) it is not sufficient for the listener to have known the melody outside the laboratory. The listener must determine whether “Silent Night” heard on the
recognition test was or was not in the study list. Correctly remembering that the melody was on the study list is an instance of an episodic memory (after Tulving, 1972, 1983, 1985). On the basis that the formation of episodic memories for melodies is impaired in AD, Baird and Samson (2009) have suggested that music memories have been forgotten.

Episodic memory tasks employed in laboratory studies of music memory must be distinguished from the everyday real-world task of remembering cherished melodies that have been learned over a lifetime. Memories for these familiar melodies form the music lexicon and, again following Tulving (1972, 1983, 1985) may be termed musical semantic memories (for a review, see Omar, Hailstone, & Warren, 2012). The experimental task involves playing a sequence of both traditional and unfamiliar melodies and asking the listener to identify which melodies are familiar from life outside the laboratory. Thus the listener is asked to access a generalized form of musical knowledge without reference to a particular context.

In a test of musical semantic memory, persons with AD appear to show little if any impairment in comparison with healthy age-matched controls. Positive results have been reported for a single case study (Cuddy & Duffin, 2005), case series (Vanstone & Cuddy, 2010), and larger laboratory samples (Bartlett, Halpern, & Dowling, 1995, Exp. 1; Cuddy et al., 2012; Hsieh, Hornberger, Piguet, & Hodges, 2011). Moreover, Samson, Baird, Moussard, and Clément (2012) report that, within the same participant sample, persons with AD who were impaired at musical recognition memory relative to age-matched controls nevertheless showed intact familiarity judgments for familiar melodies. The authors suggest that in AD recognition memory processes are dissociated from those involved with retrieval from the musical lexicon. The current study was motivated to find further support for this suggestion.

Before turning to the current study, we would like to clarify that our focus is memory for
music itself— that is, for the pitch, tonal, metric, rhythmic properties, and so forth that constitute melody. Other forms of musical memory may involve associated verbal memories. An associated episodic memory might be the description of a life event triggered by music (e.g., Janata, Tomic, & Rakowski, 2007); an associated semantic memory might be the identification of the composer, title, genre, or theoretical analysis of a piece of music. Such memories are beyond the scope of this study.

Moreover, while the terms episodic and semantic clearly differentiate the tasks that are employed in the current study, it is not known whether the tasks have the cognitive demands similar to others tasks administered for AD. However, the hallmark of AD is progressive loss of the ability to form new episodic memories (Carlesimo & Oscar-Berman, 1992), whereas semantic memories generally, though they may be affected by some degradation of long-term memory storage, are less severely affected than other forms of memory in AD (Hodges & Patterson, 1995). Our notion of dissociation of these processes in AD in musical memory is therefore not inconsistent with previous reports.

To assess episodic memory, part of the current study follows the methods of Halpern and O’Connor (2000) with certain modifications, as described below. Halpern and O’Connor tested three participant groups—young, older, and AD adults—in a standard episodic recognition memory paradigm. The targets were short unfamiliar melodies. During two presentation blocks, participants were given a cover task (rating the speed of the melodies) and were not told that a later recognition memory test would be presented. The blocks were followed by a test trial containing targets and foils. To assess explicit memory, the authors collected decisions whether each melody in the test trial had been heard, or not, in the previous cover task. To assess implicit memory, the authors collected ratings of the pleasantness of each melody in the test trial. Rating
previously heard melodies—those in the cover task—higher in pleasantness than newly presented melodies is considered evidence of implicit memory and is also called the “mere exposure effect” (Zajonc, 1968).

AD performance on both tasks was quite poor with chance performance on the implicit memory task and near chance performance on the explicit memory task. However age-matched controls also performed near chance on the explicit memory task (although their performance level for the implicit memory task was comparable to the younger adults). This poor performance from the age-matched controls on the explicit memory task raises questions about the difficulty of the task itself and whether normal aging effects could account for both AD and control performance on that task.

In one part of the current study we attempted to facilitate performance of older adults on the explicit memory task so that effects of AD could be more clearly revealed. Facilitation was attempted through intentional instructions and an additional study block. Before and between the study blocks, participants were given specific instructions that memory for the melodies would be tested in a later set of trials. Three, rather than two, study blocks were presented before the recognition test. Explicit recognition data were collected as well as pleasantness ratings. Three participant groups were assessed: younger, older, and AD adults. All participants were screened for a report of depressive symptoms since the presence of depression might bias performance on implicit memory tasks that have an emotional connotation (Barry, Naus, & Rehm, 2004).

In the other part of the current study, older and AD adults completed a test of music familiarity as a measure of semantic memory. In support of the hypothesis of dissociation between episodic and semantic memory in AD, we would expect AD adults to perform more poorly than older adults on the episodic task, but not on the semantic task.
Method

Participants

Demographic characteristics of participants are given in Table 1, which reports for each of the three participant groups, means, medians, range of age, and years of general education as well as distribution of gender and years of music training. The mean, median, and range of scores for the Mini-Mental Status Exam (MMSE; Folstein, Folstein, & McHugh, 1975) are shown for the older participants. English was the first language of all participants.

[Insert Table 1 about here.]

We may note that in Table 1, younger participants had more years of music training than the other two older groups. This result is typical of volunteer samples in our present community (Cuddy et al., 2012). Despite similar levels of general education, young adults today report greater opportunities for music training and exposure than older adults. We examine the role of music training later in the data analysis.

Controls. Controls were 35 younger adults (YA) from the undergraduate population at Queen’s University and 40 older adults (OA) from the local community recruited through newspaper advertisements and contact with local seniors’ organizations. YA were screened for depressive symptoms with the Beck Depression Inventory – 2nd edition (BDI-2; Beck, Steer, & Brown, 1996), a widely used measure with high internal consistency (Storch, Roberti, & Roth, 2004) and criterion validity (Sprinkle et al., 2002) in a university student population. OA were screened with the Geriatric Depression Scale (GDS; Sheikh & Yesavage, 1986). The GDS shows high construct validity for an older adult population in that it converges with other measures of depression while having less sensitivity to cognitive impairment (Marty, Pepin, June & Segal,
No participants in either group revealed clinically significant symptoms of depression (as indicated by a score of 20 or greater on the BDI-II for YA or a score greater than 5 on the GDS for OA). Inclusion criteria for OA also included the ability to hear normal conversation (according to self-report) and a score of 28/30 or higher on the MMSE.

*Alzheimer's disease.* Ten participants with mild to moderate Alzheimer's disease (AD) were referred from the memory disorders clinics of two local hospitals and a local support group. Prior to being referred to this study, participants had been evaluated by a geriatrician or geriatric psychiatrist, who assigned a diagnosis of probable AD according to NINCDS-ADRDA criteria (McKhann et al., 1984). Their clinical evaluation had included a clinical interview with patient and caregiver, medical work-up and imaging to rule out other causes of dementia, and neuropsychological testing. At the point of recruitment, then, participants’ diagnoses of probable AD had been established. No further diagnostic evaluation was conducted in the course of this study, although as with the OA group, AD participants were screened for depression with the GDS.

AD participants completed the MMSE for descriptive purposes, to provide a metric of cognitive impairment at the time of their participation. However, assignment to the AD group was based on clinical diagnosis not the MMSE scores. The MMSE scores for two AD participants overlapped the range for the controls – these individuals had mild stage AD, high levels of formal education, and prior experience with the MMSE in a clinical setting, which together likely resulted in the high scores. When these two participants were dropped from the data analysis, the patterns of significance were unchanged. These two participants were retained in the sample.

*Musical Tests*
Recognition memory and pleasantness ratings for studied unfamiliar melodies. The 16 unfamiliar melodies for the present study (Bartlett et al., 1995; Halpern & O’Connor, 2000) were kindly supplied by Andrea Halpern. The melodies had been constructed by rearranging the rhythmic units and pitch intervals of traditional melodies so that the style was retained but the original melodies were not recognizable. Each of the melodies was approximately 5 s long and was recorded in a synthesized piano timbre. Two study lists of melodies were generated: List A contained eight out of the 16 melodies and List B contained the remaining eight.

Participants were randomly assigned to either study List A or study List B. The study list was presented three times as successive blocks with four seconds of silence between each melody. Melodies within each study block were presented in one of three fixed random orders. The order of the three study blocks was randomized for each participant. Instructions to participants were to listen carefully to the melodies in order to recognize them in a later test. Instructions were repeated between blocks and were followed immediately by presentation of the next block.

Following the study blocks, a test trial was presented. In the test trial, the eight study melodies were intermixed with eight foils and all 16 were presented in a random order. The foils were the melodies from the list not studied so for participants who studied List A, the foils were the melodies from List B and vice versa.

Participants were asked to rate the pleasantness of each melody in the test on a scale of “1” (“least pleasant”) to “5” (“most pleasant”). They were also asked to indicate if they had heard each melody previously during the study trials by answering “yes” or “no.”

Familiarity of traditional melodies. The Familiarity Decision Test (FDT; Liégeois-Chauvel, Peretz, Babaï, Laguitton, & Chauvel, 1998) was administered. The FDT contains 10
familiar melodies and 10 novel melodies. The familiar melodies were drawn from the repertoire of melodies popular in North America and the novel melodies were constructed by reversing the sequence of pitches in the familiar melodies and making small adjustments of pitch and duration to achieve a musically acceptable melody (Hébert, Peretz, & Gagnon, 1995). Participants were instructed to listen to a series of melodies that “may or may not be familiar to you” and were asked to indicate their familiarity with each tune by answering “yes” or “no.”.

The use of the FDT permitted comparison with other research on semantic memory for melodies in AD (Cuddy et al., 2012; Vanstone & Cuddy, 2010). The novel melodies in the FDT were all different from those used for recognition of studied unfamiliar melodies, thus eliminating any possibility that the novel melodies in the FDT had in fact been heard earlier in the experimental session.

Procedure

Participants were tested in a quiet room in the University or in the case of AD participants, at their home or retirement residence if preferred. Where testing was conducted at the participant’s place of residence, we ensured that the location was quiet and had minimal distractions. Demographic information was collected first, followed by the MMSE (for AD and OA). Then the FDT (for AD and OA) and the study and test trials for the recognition memory task were administered. The BDI or GDS was administered last. At the conclusion of the session, the purpose of the research was outlined and questions about the research were addressed.

Results

Table 2 shows, for each participant group, the mean, median, maximum and minimum score for each of four response measures: two for recognition memory (explicit memory), one for pleasantness (implicit memory), and one for familiarity (semantic memory). The data
distributions for 5 of the 12 cells in Table 2 did not conform to normality as evaluated by the Shapiro-Wilk test, so nonparametric statistics were applied throughout.

[Insert Table 2 about here.]

Recognition Memory for Studied Unfamiliar Melodies — Explicit Memory

We scored both percent correct recognition and $d'$. For the latter score, we recorded the proportion of trials for which each participant correctly stated that a melody had previously been presented ("hits") and the proportion of trials a melody was incorrectly stated to have been previously presented when in fact it had not been ("false alarms"). The hits and false alarm rates were used to compute $d'$ scores for each participant.

Statistical results for percent correct and $d'$ scores were similar; we present the results for $d'$. The YA, OA and AD groups were significantly different, Kruskal-Wallis(2) = 45.27, $N = 85$, $p < .01$. Post-hoc Mann-Whitney U tests showed that the YA group had higher $d'$ scores than OA participants, $U = 149.5$, $N = 75$, $p < .01$, who in turn had higher scores than the AD group, $U = 103.0$, $N = 50$, $p < .05$). To evaluate whether group differences in $d'$ were driven by differences in hit rates or false alarm rates, we compared the YA and OA groups and the OA and AD groups. The YA group made more hits ($Mdn = 7$) than the OA group ($Mdn = 6$), $U = 222.00$, $p < .01$. YA participants also made significantly fewer false alarms ($Mdn = 0$) than OA participants ($Mdn = 2$), $U = 1126.00$, $p < .01$. OA participants, in turn, made significantly more hits than AD participants ($Mdn = 3.5$), $U = 100.50$, $p < .05$. In contrast, though, there was no significant difference in number of false alarms between the OA ($Mdn = 2$) and AD ($Mdn = 2$) groups, $U = 191.00$, $p = .82$.

Single-sample Wilcoxon signed-rank tests were conducted for each group to determine whether performance was above chance. All three groups performed significantly above chance:
For the YA group, $W = 5.25, N = 35, p < .01$, for the OA group, $W = 5.02, N = 40, p < .01$, and for the AD group, $W = 2.21, N = 10, p < .05$.

**Pleasantness Ratings for Studied Unfamiliar Melodies — Implicit Memory**

We calculated for each participant the difference between the average pleasantness rating of studied melodies from that of the foil melodies. A positive difference score indicates that higher pleasantness ratings were assigned to previously heard melodies. Pleasantness difference scores for the YA, OA and AD groups were significantly different, $\text{Kruskal-Wallace}(2) = 11.76, N = 85, p < .01$. Posthoc Mann-Whitney $U$ tests showed that the YA scored higher than OA, $U = 393.0, N = 75, p < .01$, but that the OA and the AD groups were not significantly different, $U = 211.5, N = 50, p = .78$. Single-sample Wilcoxon signed-rank tests revealed that the YA group median was above the level of chance, $W = 4.75, N = 35, p < .01$. Since the AD and OA group scores did not differ significantly, their scores were combined and compared collectively to the level of chance. The collective group median was significantly greater than the level of chance, $W = 5.40, N = 50, p < .01$.

**Familiarity of Traditional Melodies**

In contrast to the pattern of results above, both AD and OA groups had very high scores, comparable to those obtained in a separate sample (Cuddy et al., 2012). Moreover, there was no significant difference between the AD and OA groups, $U = 194.0, N = 50, p = .88$. As YA were not tested on the FDT in the current study, Cuddy et al. (2012) data for YA are shown for comparison.

**Relations with Music Training**

Spearman correlations between category of years of music training (see Table 1) and test scores ($d'$, pleasantness difference, and FDT) for each participant group yielded only one
significant correlation—for YA and $d'$, $\rho = .35, N = 35, p < .04$. No other correlations were significant, $.17 > p < .80$.

A further inspection of the median $d'$ results was conducted across categories of years of music training. For YA, scores for the lowest and the highest level of training were 2.25 and 2.68, respectively; for OA, scores for the lowest and the highest level of training were 1.68 and 1.07, respectively; and for AD scores for the lowest and the highest level of training were 0.5 and 0.2, respectively. At each level there was a clear differentiation in median scores YA > OA > AD and thus the music training of YA could not alone account for the median $d'$ differences among groups.

**Comparison with Halpern and O’Connor (2000) on the Recognition Memory Test**

Comparisons of the means provided by Halpern and O’Connor (2000, Table 2) and the present means shows that for YA and OA, $d'$ scores were at least 2.5 standard errors higher in the present study than in the study by Halpern and O’Connor (2000) and that for YA the mean pleasantness difference was higher by 1.4 standard error. Some aspect of the experimental procedure – perhaps the intentional instructions and extra block of study trials – appeared to benefit YA, and OA to some extent. AD performance did not appear to benefit from the modification to the paradigm. Though above chance in the present study, AD performance was quite poor relative to YA and OA.

Halpern and O’Connor (2000, Table 2) also reported correlations between $d'$ and pleasantness (Old-New) scores to see if performance on the implicit task could be accounted for by performance on the explicit task. No correlation was significant. In the current study, the correlation was nonsignificant for YA, $\rho = .14, N = 35, p = .42$, thus replicating Halpern and
O'Connor’s results for YA. However, the correlation in the current study was significant for OA, \( \rho = .37, N = 40, p = .02 \), and for AD \( \rho = .78, N = 10, p < .01 \).

*Comparison with Cuddy et al (2012) on the Familiarity Decision Test*

Median scores of 90% correct for each participant group fit well within the range of scores reported for the YA, OA, and mild AD groups reported by Cuddy et al. (2012). Although this test is sensitive to effects of AD (Cuddy et al., 2012; Vanstone & Cuddy, 2010), it is an easy test at the mild stage and remains easy though the stages of AD for many individuals.

*Discussion*

Younger adults, older adults, and individuals with mild to moderate AD differed in ability to form episodic memories for melodies. For explicit recognition memory, the performance of YA participants was significantly higher than the OA group, which in turn had higher scores than the AD group. All three groups performed above the level of chance. On the implicit memory task, the YA group surpassed the OA and AD groups in rating previously heard melodies as more pleasing than those that had not been presented in the study trials. The OC and AD groups did poorly and did not differ significantly on this task. However, their combined performance was above the level of chance.

Both the OA and AD groups showed very strong performance on the recognition of traditional melodies with no significant difference between groups. Their scores were comparable to those observed in YA adults in previous studies.

Thus, in both normal aging and dementia, the data imply strikingly preserved ability to recognize traditional melodies encoded over the lifespan. These memories are semantic insofar as they are accessed without reference to a particular spatiotemporal context. Moreover, the data
imply that memory for musical material may follow a similar trajectory to memory for nonmusical information with dissociation between episodic and semantic memory.

A few further comments on the episodic memory task: (1) We employed a similar paradigm to Halpern and O’Connor (2000) and the results, in general, corresponded to the earlier study. However, the current work employed three study trials rather than two and added instructions that participants should try to remember the melodies for a subsequent recognition trial. As the procedural changes were not manipulated parametrically, we cannot make a definite statement about the relative effects of additional trials on explicit and implicit memory. However, manipulations intended to facilitate performance had little benefit in AD; (2) In the OA and AD groups, there was no significant correlation between music training and the episodic tasks. This finding suggests that music education is not a protective factor against age-related decline in episodic memory for melodies. In fact, a previous review concludes that for musical tasks drawing upon cognitive processes such as those engaged in encoding new memories, age-related declines have a more powerful effect than musical experience (Halpern & Bartlett, 2002); and (3) The implicit memory results in the current study (YA > OA = AD) do not exactly reproduce the results in Halpern and O’Connor (2000, where YA = OA > AD). One further difference is the size of the correlations between d’ and the pleasantness scores for OA and AD – nonsignificant in Halpern and O’Connor but significant in the present study. Possibly in the present study implicit measures were somewhat contaminated by more robust performance on the explicit task. That is, perhaps changes to the explicit memory task (i.e. additional study trials and task instructions) affected how some participants approached the implicit memory task due to their having formed stronger explicit memories. If task changes had a stronger effect for YA than for OA and AD participants, then aging effects would be inflated, leading to the OA-AD
differences we observed. Implicit memory impairment in aging and AD depends heavily on the nature of the particular task (Meiran & Jelicic, 1995) and on the strength of any associated explicit memory (Mitchell & Bruss, 2003). However, the majority of studies on implicit memory in aging and AD have employed word-based priming tasks, raising the question of how well the existing literature would explain a music-based mere exposure effect. We leave the untangling of this issue to future research.

In sum, for music as for many other domains, patterns of performance differ according to particular task demands. In order to properly characterize musical memory in AD, it is important to distinguish between the particular forms of memory being studied. The present findings demonstrate the utility of making careful distinction between memory tasks, given the divergence between the ability of participants with AD to recognize traditional melodies and to form memories for novel melodies. Distinctions such as this one will hopefully be informative as clinical researchers move forward in developing empirically driven interventions to address the disability caused by AD. Anecdotal and clinical observation have highlighted that many persons with AD continue to engage with and derive pleasure from music. The present findings raise the question of whether intact semantic memory for long-familiar tunes may comprise part of the mechanism by which music engagement may be preserved in AD.
Author Note

This research was supported by grants to L. L. Cuddy from the Natural Sciences and Engineering Council of Canada, the GRAMMY foundation®, and the Alzheimer Society of Canada (Dr. Albert Spatz award). We thank Kevin Munhall for the technical help and facilities of the Queen’s Biological Communication Centre, and the reviewers for many helpful comments.

Correspondence concerning this article should be addressed to Lola L. Cuddy, Department of Psychology, Queen’s University, Kingston, ON, K7L 3N6. E-mail: Lola.Cuddy@queensu.ca
References


Table 2.1
*Participant Demographics*

<table>
<thead>
<tr>
<th></th>
<th>YoungerAdults</th>
<th>OlderAdults</th>
<th>AD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>19.7 (18 - 23)</td>
<td>74.8 (65 - 88)</td>
<td>70.7 (58 - 89)</td>
</tr>
<tr>
<td>Mean (range)</td>
<td>20</td>
<td>74</td>
<td>71</td>
</tr>
<tr>
<td>Median</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>10/25</td>
<td>15/25</td>
<td>2/8</td>
</tr>
<tr>
<td><strong>Years of education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (range)</td>
<td>13.7 (12 - 16)</td>
<td>14.3 (10 - 20)</td>
<td>14.1 (12 - 20)</td>
</tr>
<tr>
<td>Median</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td><strong>MMSE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (range)</td>
<td>-</td>
<td>29.6 (28 - 30)</td>
<td>22.78 (16 - 28)</td>
</tr>
<tr>
<td>Median</td>
<td>30</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td><strong>Years of music training</strong> (n)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>4</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>1-3 years</td>
<td>8</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>4-7 years</td>
<td>5</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>7-10 years</td>
<td>12</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>10 years or more</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note:* One member of the AD group did not receive the MMSE as she was familiar with it from her professional life. Her mild stage status was confirmed clinically.
Table 2.2
Results for Recognition Memory Test (Explicit and Implicit Memory) and Familiarity Decision Test (FDT)

<table>
<thead>
<tr>
<th></th>
<th>Younger adults</th>
<th>Older Adults</th>
<th>AD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recognition memory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Percent correct</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>91</td>
<td>71</td>
<td>58</td>
</tr>
<tr>
<td>Median</td>
<td>94</td>
<td>75</td>
<td>56</td>
</tr>
<tr>
<td>Minimum</td>
<td>69</td>
<td>38</td>
<td>50</td>
</tr>
<tr>
<td>Maximum</td>
<td>100</td>
<td>94</td>
<td>75</td>
</tr>
<tr>
<td><strong>Recognition memory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.48</td>
<td>1.20</td>
<td>0.44</td>
</tr>
<tr>
<td>Median</td>
<td>2.68</td>
<td>1.15</td>
<td>0.32</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.99</td>
<td>-0.36</td>
<td>0.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.07</td>
<td>2.68</td>
<td>1.47</td>
</tr>
<tr>
<td><strong>Pleasantness difference (Studied vs Foil)</strong></td>
<td>0.47</td>
<td>0.16</td>
<td>0.17</td>
</tr>
<tr>
<td>Mean</td>
<td>0.50</td>
<td>0.12</td>
<td>0.13</td>
</tr>
<tr>
<td>Median</td>
<td>-0.38</td>
<td>-0.50</td>
<td>-1.00</td>
</tr>
<tr>
<td>Minimum</td>
<td>1.25</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FDT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Percent correct</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>88</td>
<td>88</td>
<td>87</td>
</tr>
<tr>
<td>Median</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Minimum</td>
<td>60</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Maximum</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: FDT data for the younger adult group are presented here for comparison purposes and are taken from Cuddy et al. (2012).
Chapter 3: Measuring Engagement With Music: Development of an Informant-Report Questionnaire


Acknowledgments

The authors wish to thank Dr. Patricia Davis for her valuable comments on an earlier version of the questionnaire. Dr. Angeles Garcia graciously facilitated participant recruitment through the Memory Disorders Clinic at Queen’s University. A number of research assistants helped with the administration of this study. Sean Bai, Sophie Waldman, and Zoe Hodgins meticulously coded the qualitative interviews.
Abstract

Objectives: This study describes the development of the Music Engagement Questionnaire (MusEQ), a 35-item scale to measure engagement with music in daily life. Music has implications for wellbeing and for therapy, notably for individuals living with dementia. A number of excellent scales or questionnaires are now available to measure music engagement. Unlike these scales, the MusEQ may be completed by either the participant or an informant.

Method: Study One drew on a community-based sample of 391 participants. Exploratory factor analysis revealed six interpretable factors, which formed the basis for construction of six subscales. Study Two applied the MusEQ to a group of participants with Alzheimer’s disease (AD; n = 16) as well as a group of older adults having no diagnosis of dementia or other neurocognitive disorder (OA; n = 16). Informants completed the MusEQ, and the OA group also completed the self-report version of the MusEQ. Both groups had an interview in which they described the place music had in their lives. These interviews were scored by three independent raters.

Results: The MusEQ showed excellent internal consistency. Five of the factor-derived subscales showed good or excellent internal consistency. MusEQ scores were moderately correlated with a global rating of ‘musicality’ and with music education. There was strong agreement between self-report and informant-report data. MusEQ scores showed a significant positive relationship to independent ratings of music engagement.

Conclusion: The MusEQ provides a meaningful and reliable option for measuring music engagement among participants who are unable to complete a self-report questionnaire.

Keywords: Music and Arts < Psychosocial Interventions> ; Psychological and Social Aspects <Dementia and Cognitive Disorders> ; Quantitative methods and statistics
Measuring Engagement With Music: Development of an Informant-Report Questionnaire

Music is a universal aspect of the human experience, but individuals vary widely in the extent to which music forms a part of daily life. For some, listening to music may be a pleasant diversion, while for others it may be a life-defining passion. Some devote their energy to mastering the technique of their musical instrument, while others assiduously avoid even singing ‘Happy Birthday’ at a social gathering. Across the lifespan, music may serve as a focus in the formation of social identity and as a means by which self-identity is reinforced (De Nora, 2000; North, Hargreaves, & Hargreaves, 2004), making an individual’s choice of music activities an important part of their self-narrative.

Music activities are important in the lives of many older adults. The use of music is associated with increased wellbeing for older adults, as it fosters social connection and mood regulation (Laukka, 2007). Music is known to evoke autobiographical memories (Janata, Tomic, & Rakowski, 2007), which is an important facet of music-induced emotion (Jäncke, 2008; Juslin & Västfjäll, 2008) and which may encourage reminiscence. Many musical activities have limited physical demands, making them attainable for individuals who are living with mobility impairments or other physical restrictions. At the same time, listening to music supports engagement with physical exercise (Karageorghis & Priest, 2011) and may be a useful tool in motor skill neurorehabilitation (Schneider, Schönle, Altenmüller, & Münte, 2007). Music, then, is an ideal stimulus with which older adults may engage.

Most people do not have difficulty giving examples of the role that music plays in their lives, but it represents a greater challenge to measure music engagement in a standardized manner suitable for inclusion in quantitative research. Research in the psychology of music often has relied upon music education as a proxy for participants’ levels of engagement with and
acculturation to music. Certainly, formal music training has powerful relationships with the basic cognitive (Hannon & Trainor, 2007) and neurological (Schlaug, 2001) mechanisms whereby individuals process and remember music. Yet even without formal training, non-musicians learn to process musical structure in a way that allows for rich musical experience (Koelsch, Gunter, Friederici, & Schroger, 2000). Music education, as a simple proxy of ‘musicality,’ cannot fully capture the resulting individual differences in musical experience.

The task of quantifying individual differences in music engagement is important to both basic and applied research in the psychology of music and music therapy. For example, evidence for the positive effects of music therapy in the management of dementia is emerging (McDermott, Crellin, Ridder, & Orrell, 2013; Vink, Birks, Bruinsma, & Scholten, 2004). If researchers are to maximize the effectiveness of music therapy interventions, they must consider the role of individual differences (Spiro, 2010); no approach to treatment is equally effective for all individuals within a target population. It seems reasonable to posit that, within the context of music-based interventions, participants’ existing levels of music engagement would inform best practices for how such interventions should be deployed. Healthcare interventions concerned with improving quality of life (Frisch, 1998) should not overlook music engagement in the context of the psychology of personal wellbeing (Croom, 2012).

Developing a measure to meet this requirement is complicated by the breadth and complexity of the music engagement construct. Formal music education and the ability to play a musical instrument are important indicators of an individual’s level of music engagement. However, listeners engage with music on an emotional level, which may involve physiological responses (Blood & Zatorre, 2001; Salimpoor et al., 2013), evocation of personal memories (Janata et al., 2007), and regulation of mood (Chin & Rickard, 2013; Saarikallio & Erkkilä,
Listeners also engage with music in and through the social world (Hargreaves & North, 1999); parties, dances, religious gatherings, and sporting events all tend to involve music. In fact, musical tastes and abilities play a prominent role in the formation of social identity (MacDonald, Hargreaves, & Miell, 2002). Music engagement also occurs in the course of daily activities; the right soundtrack can provide a sense of motivation or ambiance in tasks ranging from exercising to washing dishes to studying (De Nora, 2000). A meaningful evaluation of an individual’s musical life, then, needs to encompass the emotional, social, and cognitive aspects of everyday experience as well as music-specific activities such as playing a musical instrument or singing in a choir.

**Existing Measures of Music Engagement**

The earliest, and for a long time the principal, approaches to measuring individual differences in musical experience were geared towards selecting the most promising candidates for formal music education, and they focused on testing perceptual acuity for musical sounds. More recent questionnaire development has allowed researchers to study musical experience outside of the laboratory.

Some questionnaires examining musical experience in daily life take the approach of assessing one particular domain of music experience based on a given field of interest. The Music in Mood Regulation questionnaire (MMR; Saarikallio, 2008) directly assesses the ways in which respondents use music to regulate emotion and mood. Saarikallio and Erkkila (2007) posit that music activities facilitate seven distinct strategies, which serve to regulate the subjective, physiological, and behavioural aspects of mood. The MMR is a 40-item scale with a factor structure consistent with the author’s earlier theoretical model and demonstrating convergent validity with other measures of mood regulation.
While the MMR examines music engagement through the lens of mood regulation, the Barcelona Music Reward Questionnaire (BMRQ; Mas-Herrero, Marco-Pallares, Lorenzo-Seva, Zatorre, & Rodriguez-Fornells, 2013), conceptualizes music as a stimulus that produces the experience of reward. The authors identify five factors that describe the ways in which people experience music as a rewarding stimulus: Music Seeking, Emotion Evocation, Mood Regulation, Social Reward, and Sensory-Motor response. The overall 20-item scale and the factor-derived subscales show excellent internal consistency as well as convergent validity with measures of reward-seeking behaviour. Like the MMR, the BMRQ assesses the emotion and mood effects of music, but other factors on this questionnaire encompass the social and physical aspects of music reward as well as the behaviours involved in seeking out music. Approaching music experience from the perspective of reward / reinforcement provides a unifying theoretical perspective while allowing for breadth in the content of the questions.

Werner, Swope and Heide (2006) adopted a broader approach in developing the Music Experience Questionnaire (MEQ). The 51 items of the MEQ examine six domains of music experience. These domains encompass the emotional and mood-regulatory aspects of music experience, aptitude for performing and improvising, physical responses to music, the inclusion of music in social activities, and the importance assigned to pursuit of musical experiences. The content of the MEQ speaks broadly to two principal factors: one concerns the subjective responses to music, be they physical or mental, and the other concerns active involvement in musical activities.

The Music USE Questionnaire (MUSE; Chin & Rickard, 2012) is a comprehensive instrument measuring both the quantity and the quality of music engagement. The authors conceptualize music engagement as the connection between the individual and the music
activity. Engagement encompasses productive activities, such as performing a musical instrument, as well as receptive activities such as listening to a musical recording. They view engagement as reflecting personal commitment on an emotional or intellectual level and as fulfilling functions in the intellectual, emotional, social, and physical domains. The item content of the MUSE was developed to encompass the wide range of forms and functions that music engagement may take. It is available in 58-item and 32-item versions, yielding scores on four engagement-style subscales: Cognitive and Emotional Regulation; Engaged Production; Social Connection; and Dance and Physical Exercise.

As with the MEQ and the MUSE, the Goldsmiths Musical Sophistication index (Gold-MSI; Müllensiefen, Gingras, Stewart, & Musil, 2012) casts a wide net in assessing everyday musical characteristics. The term ‘sophistication’ is intended to bypass common preconceptions about musical talent or ability (Ollen, 2006), embracing instead a broad construct that includes ‘musical skills, expertise, achievements, and related behaviours across a range of facets’ (p. 2). The Gold-MSI Takes into account the frequency of musical behaviours, the ease and accuracy with which they are performed, as well as the variety within an individual’s pattern of musical behaviours. Musical sophistication may draw upon the benefit of formal musical training, but the construct encompasses a sufficiently broad range of musical behaviours to recognize the skill of musically attuned individuals who have cultivated their musical skill in ways other than through formal musical training.

**Informant-Based Measurement**

The capacity for self-report is often impaired in persons with Alzheimer disease (AD), particularly for questions that relate to their behaviour and personality at the current stage in life. They experience a “failure to update their self-image after disease onset” (Rankin, Baldwin,
Pace-Savitsky, Kramer, & Miller, 2005, p. 632). While persons with AD may report more reliably on immediately felt aspects of their experience, such as depressed mood (Salmon et al., 2008), self-report data regarding current typical behaviour would not be expected to be reliable. Gauging an individual’s level of music engagement requires exactly this type of question.

Informant-based questionnaires are important in the diagnosis and management of dementia, and meta-analysis identifies a clinically meaningful contribution of psychometric instruments to this process (Jorm, 1997). Many informant-based questionnaires are available to measure activities of daily living (ADLs), and they generally show a high degree of accuracy (Lindeboom, Vermeulen, Holman, & De Haan, 2003). No such questionnaire exists for music engagement, though; questionnaires available to measure music engagement require a level of self-awareness that cannot be assumed in individuals with cognitive impairment.

In some contexts, it may be possible for researchers or clinicians to directly observe persons with dementia. Research based on direct observation has documented the importance of music to understanding the neuropsychology (Cuddy & Duffin, 2005) and lived experience (Cohen-Mansfield, Marx, Dakheel-Ali, Regier, & Thein, 2010) of persons living with dementia. A structured observation scale such as the Music in Dementia Assessment Scale (McDermott, Orgeta, Ridder, & Orrell, 2014; McDermott, Orrell, & Ridder, 2014) has been shown to yield reliable and clinically meaningful quantitative ratings of engagement in music therapy sessions. However, the limited time-span of direct observation may not capture the experience of individuals outside of the controlled context in which they are observed, especially for those who do not reside in an institutional setting. For this purpose, it would be necessary to use a questionnaire that could be completed by a caregiver or family member who is able to make observations in a sustained way throughout the typical rhythm of day-to-day life. The current
paper aims to fill the need for an informant-based questionnaire assessing participants’ current levels of music engagement.

**Study 1: MusEQ Scale Development**

In Study One, we present information on the development of an informant-based measure of music engagement, the Music Engagement Questionnaire (MusEQ), which attempts to capture the multifaceted nature of music engagement while working within the conditions of what informants are able to report reliably about the subjective experience of someone close to them. We present results of an exploratory factor analysis, along with the subsequent development of factor-derived subscales that provide measures of six specific content areas within the broader domain of music engagement. Formatted versions of the MusEQ, along with a scoring guide, are available in the supplemental materials for this article.

**Method**

**Participants.** 391 participants completed Study One. They were recruited through word-of-mouth, flyers and outreach to community organizations, and through social media. Older adults were well represented in the sample, although individuals of all ages were welcome to complete the study. Participation in the study was limited only by the ability to complete an English-language questionnaire and by willingness to give consent to participation; there were no formally stated inclusion or exclusion criteria, neither were participants screened for cognitive impairment. As a result, the present sample comprises individuals with a broad range of ages, musical backgrounds, and socio-economic circumstances. Demographics are shown in Table 1. This study received ethics approval through the General Research Ethics Board of Queen’s University.

[Insert Table 1 about here]
Materials.

Music Engagement Questionnaire (MusEQ). Prior to conducting this development study, we had created a set of 35 questions about engagement with music. These questions form the items of the MusEQ used in this study. In developing these items, we began with a review of the literature on music engagement, uses of music in everyday life, and musical functioning in aging and dementia, which is reviewed briefly in the introduction to this paper. Through discussion of this literature within the research team, we identified behavioural responses to music that indicate engagement with music and that can be observed by a third party. We then generated candidate items based on these behaviours and refined the wording through pilot testing and through consultation with an individual diagnosed with early-stage dementia. We endeavored to create a selection of items that would encompass the factors present in existing measures of music engagement, subject to the constraints that they reflect observable behaviours. Participants rated how much each of these statements described the person about whom they were responding (or, in the self-report version, themselves) during the past month (1 = “not at all”; 5 = “very much.”).

Procedure.

Participants chose to complete the study using either a paper form (n = 148, 38%) or an online version (n = 243, 62%). The online and paper formats were identical in content. Regardless of which format they used, participants were randomly assigned to complete either the self-report or the informant-report version of the questionnaire. For the self-report version, participants completed the items to reflect their own experience. For the informant report version, participants were asked to choose someone whom they see on a regular basis and whom
they know very well; participants completed the questionnaire to reflect their observations of that third person.

In the online version, participants first followed a link we provided, where they were presented with a letter of information. After giving consent to participate they were assigned to either the informant or self-report version of the questionnaire according to a computer-generated random sequence. They were first presented with the demographic questions, followed by the 35 items of the MusEQ. Participants who completed the study on paper received an envelope containing the letter of information, consent form, study instructions, and either the informant or the self-report version of the questionnaire. Randomization to self-report or informant version for the paper format was conducted by distributing the envelopes in a random sequence as participants were recruited. Participants returned the completed questionnaire packages by mail in a stamped, addressed envelope provided in the study package.

**Data Analysis.**

Statistical analyses were conducted with IBM SPSS version 20 for Mac. For the 35 variables of the MusEQ, no more than 1.8% of the data was missing for any one item. Of the 391 participants, 61 had at least one missing response from the MusEQ. Of these 61 participants, the median number of missing responses was 1, and the maximum number was 10.

**Exploratory Factor Analysis.** A principal components analysis with Varimax rotation was conducted to reduce the 35 MusEQ items to a smaller number of underlying factors. The self- and informant-report samples were combined for the purposes of factor analysis, resulting in a factor structure that is unified across both versions of the questionnaire. The items refer to observable behaviours, implying that the underlying factor structure should be consistent whether items are answered by an external observer or by the participant. To address the
possibility that missing data may not have been missing at random and would therefore create systematic bias in the analyses, five datasets were generated in which missing values were imputed using the SPSS multiple imputation algorithm. There were no substantial differences in the factor solution across these five data sets, and so analyses from the original dataset are reported here with the 61 participants with missing data excluded, leaving N = 330.

**Scale Construction.** Following principle components analysis, the resulting six factors of interest were used to construct factor-weighted scales. First, items were screened to ensure adequate rating on at least one factor identified in the exploratory factor analysis. Items were then assigned to subscales based on the factors on which they loaded most strongly. The content of these items was then reviewed for their interpretability relative to the other items on their assigned scale, after which it was possible to name and describe each subscale.

Factor-weighted scale scores were computed after the interpretability of each cluster of items had been established. These scores were computed in the following way for each of the six factors:

1) Weighted item scores were calculated by multiplying the raw score of each scale item by its component score coefficient, which had been computed in the factor analysis. This step allowed for items with higher factor loadings to exert a proportionally higher weight in the score.

2) To increase the intuitive meaning of scale scores and to allow comparison of scores between scales, the sum of weighted item scores was divided by the sum of the component score coefficients for that scale. This step ensures that minimum and maximum values of each scale are 1 and 5, corresponding to the Likert scale anchor points of ‘applies not at all’ and ‘applies very much,’ respectively.

**Results**
Factor Structure of the MusEQ. The sample size was adequate for the present analyses, with a Kaiser-Meyer-Olkin measure of .894. Item inter-correlations were large enough to permit a factor analysis, as confirmed by Bartlett’s Test of Sphericity, Chi-Square(595) = 5522.02, p < .01. For the questionnaire as a whole, Cronbach’s alpha = .92.

Eight factors with eigenvalues greater than 1 were initially retained, which accounted for 63.12% of the cumulative variance. The three negatively-worded items (i.e. those on which a higher score indicated less engagement with music) from the original 35 item pool were clustered on the seventh and eighth factors, with no other items weighted most heavily on these factors, so these two factors were removed from further steps in the scale development process. The remaining six factors accounted cumulatively for 56.56% of the variance prior to rotation and 54.20% after rotation.

Scale Construction. After exclusion of the three negatively worded items, the remaining 32 items were assigned to their respective factor scales based on their rotated component loadings; each item was assigned to the factor scale on which it had the highest loading. All but one of the items weighted on at least one factor with a loading greater than or equal to .40. The one item with a lower loading (.34) was, nonetheless, interpretable within its assigned factor and was not detrimental to the internal consistency of that factor scale, so it was retained. After items were assigned to their respective factor scales, an analysis of the item content revealed that each of the six scales contained collections of items that were coherent and interpretable. Internal consistency, scale items, and their factor loadings are presented in Table 2.

[Insert Table 2 about here]

Five items loaded most strongly on the first factor, which we referred to as Music in Daily Life (Daily) because these items were concerned with the role the music plays in the
routine aspects of daily life for the respondents. Specifically, items addressed the use of music during routine or boring tasks as well as the practice of sharing or telling others about music that the respondent enjoys.

The second factor encompassed eight items relating to the emotional and mood regulatory aspects of musical experience, and we labeled this subscale *Emotional Listening Experience* (*Emotion*). Although emotion is an inherently internal experience, the content of these items was restricted to overt behavioural responses indicative of emotional response to music, so as to be suitable for rating by a third-party observer. These behavioural responses included choices about listening to recorded music, such as playing back a song multiple times if the respondent enjoys it, or suspending other activities to stop and listen to music that is playing in the background. The items also included behavioural responses that are more directly characterized as emotional, such as showing overt signs of emotion in response to certain music or listening to music to calm down or to relax. While these items are presumed to access information about the subjects’ internal experience, the items are framed in terms of observable behaviour.

The third factor, which we labeled *Musical Performativity* (*Perform*), includes six items that involve music in social context. The content of this scale includes musical performance in the traditional sense (e.g. playing a musical instrument), but it goes beyond the performance related activities accessible only to those with specialized musical training. Although playing a musical instrument often takes place in private and thus is not, strictly speaking, social in nature, the items on this subscale collectively point to the behaviours that cause an individual to be known to other people as a ‘musical’ person. Insofar as these behaviours involve active
participation, and because they point to an identity, which is constructed in the social realm, subjects can be said to ‘perform’ their musical identity.

The fourth factor includes six items that relate to the consumption of musical experience – *Musical Consumer Behaviour (Consume)*. The items address consumer choice in its typical sense; for example, spending money to buy recordings. They also involve music-seeking behaviour more broadly, as evidenced by actively seeking out opportunities to attend concerts or social activities that involve music. It is the investment of resources in seeking music that delineates the act of consumption here.

The four items that loaded on the fifth factor – *Responsive Music Listening (Response)* – address responses made in synchrony with music that is being heard. These include tapping to the beat of music or humming or singing along with music that is being played.

Finally, the sixth factor, which we termed *Musical Preference (Prefer)*, includes three items questioning the extent to which the subject shows preferences or dislikes for certain styles of music. The breadth of content on this scale was limited, and the internal consistency was lower than that of the other scales, but this scale is included for the purposes of future refinement of the MusEQ.

**Relationship Between MusEQ Scores and Demographic Characteristics.** Since some demographic variables were collected as ordinal data, non-parametric correlations were used to explore the relationships between MusEQ scores and the demographic characteristics. For the self-report data, demographics refer to the respondent, and for the informant-report data, the demographics refer to the individuals about whom the MusEQ was completed, not the informant who completed the questionnaire. MusEQ total score correlated positively with the single-item rating of how ‘musical’ the individual is, rho(389) = .51, p < .01. Among the subscales, this
question was most strongly correlated with Perform, \( \rho(389) = .70, p < .01 \). Age showed weak negative correlations with MusEQ scores; the strongest correlation with Age was on the Daily subscale, \( \rho(368) = -.42, p < .01 \). There was no relationship observed between years of education and total MusEQ scores, \( \rho(383) = -.09, \text{n.s.} \). Music educational level, on the other hand, did show a significant relationship to MusEQ total score, \( \rho(388) = .33, p < .01 \); this relationship was strongest for the Perform scale, \( \rho(388) = .45, p < .01 \).

**Study 2: Evaluation of the MusEQ**

Three objectives are pursued in Study Two. First, we address the question of whether MusEQ informant ratings are an appropriate proxy for an individual’s own responses. Self-report data are vulnerable to biases; respondents generally want to portray themselves in a favorable light. However, describing one’s musical activities is not generally considered a sensitive matter, and so, while MusEQ self-report scores could be subject to some inflation in a positive direction, they should overall show a strong positive relationship to informant-report scores. Furthermore, the relationship between informant and self-report scores is expected to be strong because the MusEQ items were developed with objective behavioural indicators in mind.

Study Two also addresses the question of whether MusEQ scores reflect how participants and their informants understand their musical lives. To address this question, we used holistic ratings of qualitative interview data in which participants were free to describe their music-related experience in a way that seemed most suitable to them. Referencing MusEQ scores to a more global and unstructured measure makes it possible to establish whether the MusEQ is measuring aspects of music engagement that participants deem relevant and important enough to report freely in context of an unstructured interview.
An additional objective of this study was to establish that the MusEQ informant version can be used reliably in a population of individuals who may not be capable of providing a reliable self-report – namely, those living with Alzheimer’s disease (AD). These participants were compared with a group of cognitively typical older adults (OA). While Study One drew on a large community-based sample, including many adults over the age of 65. The present study applies the MusEQ specifically to older participants, with whom the MusEQ may be useful in subsequent research and clinical work.

Methods

Participants. Twenty-two OA participants were recruited from the community by newspaper ads and through posters in spaces frequented by older adults. Prior to inclusion in the study, they were screened to ensure that they had no prior diagnosis of dementia, stroke, or other neurological disorder. They also underwent a cognitive screening test (described below) to rule out presence of an incipient dementia. An additional 16 participants with AD took part in the study along with a family member or caregiver; the severity of their AD symptoms ranged from mild to severe. These participants were recruited in collaboration with a memory disorders clinic, where potential participants were identified and then contacted by the research team to request their participation. All but one of the AD participants were living at home in the community with support from family and/or professional caregivers. The remaining participant lived in a nursing home. Both the AD and OA participants were also taking part in a separate study on music engagement (reported in Chapter 4 of this dissertation), for which they provided data at the same testing sessions as the present study. Demographic characteristics of both participant groups are reported in Table 3.

[Insert Table 3 about here]
Materials.

Qualitative Interview Rating. The qualitative interview allowed participants to clarify or expand upon any relevant comments they had made and to describe the ways in which music is part of their daily lives. The qualitative data were assigned numerical ratings that were then used in the analyses reported here. Participants were also completing another study on music engagement at the same testing sessions, and during the structured parts of the protocol they often commented spontaneously on aspects of, or moments in, their musical lives. For example, when asked about how many years of music lessons they had taken, numerous participants shared a story about their experience of music lessons. These comments served as prompts for the interview in addition to a general invitation to describe the role that music played in their lives. Investigators made notes during the interview, recording the substance of participants’ comments as well as the queries or prompts that were made by the investigator.

Since the qualitative interviews were unstructured, participants discussed a wide range of different experiences; not all participants discussed the same facets of their engagement with music. It was impractical, then, to rate interviews on an inflexible scale that did not take into account the heterogeneity of participants’ lived experiences. We assigned numeric ratings to the interviews in a multi-step procedure, with the goal of capturing an individual’s level of music engagement in a holistic manner.

The investigator who took the primary lead in developing this coding scheme (M.W.) was blind to any information about the participants apart from what was recorded in the interview notes. At no point did he have access to participants’ MusEQ scores, although he was familiar with the literature on music engagement. Adopting an inductive, grounded theory approach (Glaser & Strauss, 1967; Strauss & Corbin, 1994), he began by reading the entire
corpus of interviews to become familiar with the range of content. Following an initial reading, he worked in an iterative fashion to identify the domains of musical experience discussed by participants and then to describe in qualitative terms the gradient of experience levels within each domain. He used these descriptions to form a coding rubric, which then was used as a guide to assign ratings on a 0 – 8 scale to each interview. These ratings were forced to a quasi-normal distribution.

Following initial development of the coding scheme, the interviews were rated again by three independent raters. As during the initial development phase, these raters were blind to any information other than what was contained in the interview notes. The raters, who were undergraduate students in Psychology, were trained how to use this coding scheme; they received specific instruction on the rating scale, and they made practice ratings using hypothetical vignettes. After being trained, they worked independently from one another to rate the interviews. Inter-correlations between each of the three rater’s scores ranged from $r(45) = .69$ to $r(45) = .83$, with a mean correlation of .75. When taking into account the absolute differences between each rater’s scores and comparing the three raters simultaneously, the intra-class correlation coefficient was .90, which indicates a high level of agreement. To derive a final interview score, we averaged the three independent scores for each participant. This averaged score is the qualitative interview rating used in subsequent analyses.

**Cognitive Screening.** All participants completed the Mini-Mental Status Exam (MMSE; Folstein, Folstein, & McHugh, 1975). The MMSE is a brief, widely used test of cognitive status. It comprises 11 different tasks, including simple tests of orientation, immediate memory, delayed recall, calculation, handwriting, and naming. The test is scored out of 30. Prior
to inclusion in this study, any OA participant with an MMSE score of less than 27 had been excluded. For AD participants, the MMSE was included as an index of dementia severity.

The Montreal Cognitive Assessment (MoCA; Ziad et al., 2005) was administered to OA participants in addition to the MMSE, as it is more sensitive to early signs of cognitive decline, allowing us to exclude participants who may have had undiagnosed dementia. It is scored out of 30 and contains tasks screening for problems in visuospatial function, memory, language, abstract thinking, and orientation to place and time. Data from any OA participant with a score less than 26 were excluded from the study.

**Demographics Questionnaire.** Participants completed a questionnaire to gather information on their level of education, music education, age, gender, and broad appraisal of their level of musicianship. The questionnaire was administered orally at the time of study participation; OA participants answered the questions independently, while members of the AD group provided this information in collaboration with a close family member.

**Procedures.** Study data were collected during in-person testing sessions, at which participants also completed musical and neuropsychological tasks for a related study (reported separately, manuscript in preparation). The OA participants attended the sessions in a quiet office, while AD participants had the option of coming to our offices or being tested in their own homes. For OA participants, cognitive screening measures were administered at the beginning of the testing sessions, followed by a battery of music tasks. They completed the self-report version of the MusEQ following the music tasks, and they were given a package containing the informant-report version to take home and have completed independently by someone who knows them well and with whom they have frequent contact. The qualitative interviews were administered following the completion of these tasks. The order of testing was flexible for AD
participants, as it was necessary to take into account factors such as fatigue or participant rapport, especially for those with moderate or severe stage AD. When these factors were not an issue, the testing order for the AD group was: MMSE, followed by the music tasks, followed by the qualitative interview. Informants completed the MusEQ while the participant was completing the music tasks.

Results

**Self-Informant Convergence.** We evaluated the convergence between individuals’ self-report and the ratings made by an informant using data from the 22 OA participants who had an informant-report version completed by someone they knew well in addition to completing the self-report version of the MusEQ. Paired-samples t-tests of the MusEQ total score and each of the subscale scores revealed no significant differences between self and informant ratings, except on the Emotion subscale, where self-ratings ($M = 3.49$, $SD = 0.76$) were higher than informant ratings ($M = 3.04$, $SD = 0.80$); $t(21) = 3.44$, $p < .01$. Correlations between self and informant ratings were significant for MusEQ Total scores, $r(22) = .78$, $p < .01$. Correlations were also significant for subscale scores, ranging from $r(22) = .44$, $p < .05$ to $r(22) = .91$, $p < .01$. Only the Prefer subscale scores did not show a significant correlation between self and informant ratings, $r(22) = .15$, $p = .50$.

**MusEQ and Demographic Characteristics.** In this second study, we examined these relationships separately for the OA and AD groups (see Table 4). Analyses are reported based on informant-report data for both the OA and the AD groups. Non-parametric correlations are reported because some of the demographic variables were gathered as ordinal data. The demographic variables were not strongly associated with MusEQ scores. However, Music Education was positively associated with Perform in the OA group, although not in the AD
group. Conversely, Music Education was associated with Consume in the AD group but not in the OA group. Age was positively correlated with Perform in the OA group but not in the AD group.

[Insert Table 4 about here]

**Qualitative Interview Ratings.**

Informant ratings of the MusEQ were used for both OA and AD participants in the analyses of the relationship between qualitative ratings and the MusEQ. In contrast with the overall weak associations between demographics and MusEQ scores, the relationships between qualitative ratings and MusEQ scores were much stronger. For both the AD and OA groups, there was a significant positive relationship between MusEQ total score and qualitative rating. Correlations between qualitative ratings and the MusEQ subscale scores are presented in Table 4.

**Discussion**

Data from Study One demonstrate that the MusEQ has an interpretable factor structure in which six factors account for just over half of the variance among the 35 items. Of the six resulting sub-scales, five show high levels of internal consistency, as does the scale as a whole. Study Two established, in a sample of older adults and individuals living with AD, that MusEQ scores are positively related to music education and to holistic ratings of musicality. Study Two also showed strong correlations between informant- and self-report data.

Other measures of music engagement, by virtue of being self-report instruments, are able to rely on respondent introspection to assess internal experience of music – emotion, personal meaning, and transcendent experience are all facets of music engagement to which the subject has direct access but that may be inferred only indirectly by a third-party. Herein lies the major challenge in developing an informant-report questionnaire. To conduct the factor analyses
presented in Study One, we pooled the informant and self-report data from the development sample. This decision was based on the assumption of measurement invariance – that both versions of the MusEQ measure the same underlying construct. Confirmatory factor analysis, using new informant and self-report data, would be useful in evaluating whether each version, separately, retains the factor structure that was derived from pooled informant and self-report data (Floyd & Widaman, 1995). This remains an important step in the psychometric validation of the MusEQ.

The organization of the item content within the MusEQ factor structure was distinctive in some respects from existing measures, likely on account of adopting this third person perspective in item development. Despite this challenge, though, the content domains of the subscales overlap with those of other music questionnaires, mirroring themes from the extensive body of quantitative and qualitative literature on music in everyday life. For example, Emotion has its counterparts in the ‘Cognitive and Emotional Regulation’ scale of the MUSE (Chin & Rickard, 2012), the ‘Emotions’ scale of the Gold-MSI (Müllensiefen et al., 2012), the ‘Emotional Evocation’ and ‘Mood Regulation’ scales of the BMRQ (Mas-Herrero et al., 2013), and the ‘Positive Psychotropic Effects’ and ‘Affective Reactions’ scales of the MEQ (Werner et al., 2006). Similar patterns are observed for the Perform and Response scales.

The MusEQ did not contain a factor specifically related to the social dimension, but because items were written in a way that could be evaluated by an observer, there is socially relevant content woven throughout the Daily, Perform, Consume, and Response scales. The substantial positive correlations between qualitative interview ratings and the Perform subscale highlight the continuity between performance of a musical instrument and less explicitly recognized forms of performance – the performing of a musical identity through an enthusiasm
for music. It is on this subscale that ‘People who know her/him describe her/him as a musical person’ loads, and as people describe their musical lives, the acting out of those lives in a social context is an important part of their story.

Comparisons of informant- and self-report data provide additional support to the claim that a proxy respondent can make reliable reports of music engagement. The only scale to show significant difference was *Emotion*. MusEQ self-report *Emotion* scores were on average about half a point higher on a five-point Likert scale, as would be expected if it were measuring an aspect of experience that will never be revealed in full to the outside world. The magnitude of this difference, though, is small enough that it should not impose interpretive challenges in examining informant-report data.

The correlation between the MusEQ and music education was in the predicted direction and modest in magnitude. On average, those with more music training show greater engagement with music in their daily lives, but the modest size of the observed positive correlation highlights that music engagement encompasses much more than merely the activities facilitated by formal training. Music education does play a role in shaping adult musical life, but it does not tell the whole story. People use and enjoy music in a variety of ways and for multiple different purposes.

In contrast with the positive association between MusEQ scores and music education, there was no significant correlation between MusEQ scores and years of education. Although an individual’s patterns of music engagement could be shaped indirectly by formal education, the conceptual link between education and music engagement is much weaker than the link between music education and music engagement. The observation of a smaller correlation with years of education, then, offers preliminary support for the divergent validity of the MusEQ.
If music education serves as a very specific marker of musical experience, then the qualitative interview data were, in contrast, very general – interviews were unstructured, and participants shared with us what they considered relevant to our understanding of their musical lives. When quantified with a flexible and reliable rating scheme, their positive correlations with MusEQ scores indicate that the questionnaire data are measuring, at least in part, the aspects of music engagement our participants feel is important to describing their musical lives.

The MusEQ was developed with a view to studying the musical experience of individuals with AD relative to the general adult population. For this reason, we did not include questions that may be unduly influenced by physical limitations – this decision precluded having questions to do with the use of music in dance or exercise and was a compromise of comprehensiveness in favour of applicability of content to older adults.

In contrast with some instruments (e.g. the MMR and MEQ), the Study One sample was community-based and reflects the responses of adults across the lifespan rather than primarily younger adults. The applicability of the MusEQ to an older adult population was further established in Study Two. Because the scale is designed to capture the normative adult experience, though, there are no items specific to forms of music engagement observed in advanced dementia. For example, caregivers report anecdotes of loved ones with severe dementia becoming dramatically more alert and responsive while listening to favorite pieces of music. These instances are of profound importance to caregivers and family members (Chatterton, 2010), yet cognitively typical older adults do not tend to experience music in this way.

The decision to have items reflect the normative adult experience creates both a strength and a limitation. On one hand, it may be insensitive to the responses to music of those with
severe impairment. These responses, though non-normative, are very relevant to quality of life for persons with AD and their caregivers. Researchers and clinicians interested in capturing such responses to music would be better to use an observational scale such as the MiDAS. On the other hand, if the objective is to study change in behaviour relative to neurological impairment, the normative stance adopted by the MusEQ is essential. How is the music engagement of persons with AD different from that of older adults without AD? The MusEQ can answer this question while setting aside the issue of what aspects of music engagement are most meaningful or significant in the context of a caregiving relationship.

The MusEQ is internally consistent, has a meaningful factor structure, and shows positive relationships with music education and qualitative appraisals. These findings are promising with respect to future research on its psychometric validity, which should address its convergence with other music engagement measures and confirm the factor structure within a large sample of older adults. Clinical research with the MusEQ could include its use in characterizing participants in studies evaluating music-based interventions in AD or other populations with neurological impairment. Would higher levels of music engagement at baseline predict greater response to the intervention? Or perhaps an effective intervention would be one that increased music engagement, bringing with it the benefits known to come from having a rich musical life.
References


Table 3.1.

Study One: Participant Demographics for Both Groups

<table>
<thead>
<tr>
<th></th>
<th>Informant</th>
<th>Self</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 178</td>
<td>N = 213</td>
<td>N = 391</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>82 (46.1%)</td>
<td>55 (26.2%)</td>
<td>137 (35.3%)</td>
</tr>
<tr>
<td>Female</td>
<td>81 (45.5%)</td>
<td>135 (64.3%)</td>
<td>216 (55.7%)</td>
</tr>
<tr>
<td>Not Specified</td>
<td>15 (8.4%)</td>
<td>20 (9.5%)</td>
<td>35 (9.0%)</td>
</tr>
<tr>
<td>Age – Mean (SD)</td>
<td>38 (18)</td>
<td>38 (21)</td>
<td>38 (19)</td>
</tr>
<tr>
<td>Highest Educational Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary School</td>
<td>37 (21.3%)</td>
<td>64 (30.6%)</td>
<td>101 (26.4%)</td>
</tr>
<tr>
<td>College Diploma</td>
<td>27 (15.5%)</td>
<td>17 (8.1%)</td>
<td>44 (11.5%)</td>
</tr>
<tr>
<td>Undergraduate Degree</td>
<td>59 (33.9%)</td>
<td>53 (25.4%)</td>
<td>112 (29.2%)</td>
</tr>
<tr>
<td>Graduate Degree</td>
<td>51 (29.3%)</td>
<td>75 (35.9%)</td>
<td>126 (32.9%)</td>
</tr>
<tr>
<td>Employment Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Time</td>
<td>74 (41.6%)</td>
<td>69 (32.4%)</td>
<td>143 (36.6%)</td>
</tr>
<tr>
<td>Part Time</td>
<td>19 (10.7%)</td>
<td>19 (8.9%)</td>
<td>38 (9.7%)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>11 (6.2%)</td>
<td>8 (3.8%)</td>
<td>19 (4.9%)</td>
</tr>
<tr>
<td>Student</td>
<td>52 (29.2%)</td>
<td>74 (34.7%)</td>
<td>126 (32.2%)</td>
</tr>
<tr>
<td>Retired</td>
<td>21 (11.8%)</td>
<td>40 (18.8%)</td>
<td>61 (15.6%)</td>
</tr>
<tr>
<td>Music Training (Years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 2</td>
<td>101 (57.4%)</td>
<td>80 (37.7%)</td>
<td>181 (46.6%)</td>
</tr>
<tr>
<td>3 – 5</td>
<td>36 (20.5%)</td>
<td>49 (23.1%)</td>
<td>85 (21.9%)</td>
</tr>
<tr>
<td>6 – 8</td>
<td>10 (5.7%)</td>
<td>35 (16.5%)</td>
<td>45 (11.6%)</td>
</tr>
<tr>
<td>≥ 9</td>
<td>29 (16.5%)</td>
<td>48 (22.6%)</td>
<td>77 (19.8%)</td>
</tr>
<tr>
<td>‘Musicality’(^a)</td>
<td>6 (3)</td>
<td>6 (2)</td>
<td>6 (3)</td>
</tr>
</tbody>
</table>

\(^a\)Global rating of the participant’s level of ‘musicality’ on a scale of 0 – 10.
Table 3.2.  
*MusEQ Subscales: Internal Consistency, Items, and Factor Loadings*

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Alpha: Self / Informant</th>
<th>Factor Loading</th>
<th>Item (from the self-report version)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>.79 / .86</td>
<td>.78</td>
<td>I listen to music while I perform chores or boring tasks.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.57</td>
<td>I tell others if I hear a song that I really like.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.53</td>
<td>When I enjoy a certain piece of music, I try to share it with others.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.67</td>
<td>If I am bored I listen to music to pass the time.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.72</td>
<td>I always listen to music when doing certain tasks (e.g. cooking or cleaning).</td>
</tr>
<tr>
<td>Emotion</td>
<td>.78 / .83</td>
<td>.71</td>
<td>I relax when listening to peaceful music.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.70</td>
<td>When I listen to familiar music, I recall events from my past.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.63</td>
<td>I become emotional when I hear certain types of music.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.53</td>
<td>I become cheerful when I listen to music I enjoy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.52</td>
<td>I listen to music to calm down when I’m upset.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.51</td>
<td>I stop what I am doing in order to listen to music that is being played.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.48</td>
<td>I adjust (or request that someone else adjust) the volume on the stereo when I like or dislike the music that is playing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.34</td>
<td>I play a song over and over if I like it.</td>
</tr>
<tr>
<td>Perform</td>
<td>.82 / .87</td>
<td>.78</td>
<td>I play a musical instrument for pleasure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.77</td>
<td>I create my own music (e.g. by making up my own tunes or by changing the words to existing songs).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.76</td>
<td>People who know me describe me as a musical person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.51</td>
<td>I show interest in learning about pieces of music that I enjoy (e.g. finding out more about the particular musician or learning about the style or genre of the song.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.50</td>
<td>I talk with other people about music.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.49</td>
<td>My social activities revolve around music.</td>
</tr>
</tbody>
</table>
Table 2, continued.

| Consume | .80 / .81 | .76  | I spend money to buy recordings or attend concerts. |
|         |          | .66  | I enjoy attending concerts or other live musical performances. |
|         |          | .53  | I go out of my way to hear music. |
|         |          | .48  | I enjoy the same types of music as the people I spend time with. |
|         |          | .45  | I show interest in my collection of musical recordings. |
|         |          | .40  | I am usually excited by the chance to hear the music that I like. |

| Respond | .79 / .84 | .78  | When I am by myself or with close family/friends, I will hum or sing along with music that is being played. |
|         |          | .68  | I sing as I go about my daily activities. |
|         |          | .67  | I move my body to the beat of music that is playing (e.g. tapping my feet or bobbing my head). |
|         |          | .63  | If others are singing, I join in. |

| Prefer  | .65 / .63 | .86  | I show specific preferences for certain types of music. |
|         |          | .79  | I like particular styles of music. |
|         |          | .58  | I dislike certain styles of music. |
Table 3.3.
Study Two: Demographics for both participant groups.

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>OA</td>
<td>AD</td>
</tr>
<tr>
<td>Gender – N (%)</td>
<td>Female</td>
<td>11 (50%)</td>
<td>5 (31.2%)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>11 (50%)</td>
<td>11 (68.8%)</td>
</tr>
<tr>
<td>Age – Mean (SD)</td>
<td></td>
<td>70.36 (6.21)</td>
<td>76.31 (6.71)</td>
</tr>
<tr>
<td>MMSE – Mean (SD)</td>
<td></td>
<td>28.91 (1.06)</td>
<td>19 (7.46)</td>
</tr>
<tr>
<td>MoCA – Mean (SD)</td>
<td></td>
<td>26.91 (1.02)</td>
<td></td>
</tr>
<tr>
<td>Years of Education – Mean (SD)</td>
<td></td>
<td>14.91 (4.94)</td>
<td>13.56 (3.60)</td>
</tr>
<tr>
<td>Music Training – N (%)</td>
<td>Less than 1 year</td>
<td>10 (45.5%)</td>
<td>11 (68.8%)</td>
</tr>
<tr>
<td></td>
<td>1 to 3 years</td>
<td>3 (13.6%)</td>
<td>2 (12.5%)</td>
</tr>
<tr>
<td></td>
<td>4 to 7 years</td>
<td>4 (18.2%)</td>
<td>1 (6.2%)</td>
</tr>
<tr>
<td></td>
<td>8 to 10 years</td>
<td>3 (13.6%)</td>
<td>1 (6.2%)</td>
</tr>
<tr>
<td></td>
<td>10 + years</td>
<td>2 (9.1%)</td>
<td>1 (6.2%)</td>
</tr>
</tbody>
</table>
Table 3.4.
Correlations Between MusEQ Scales, Qualitative Interview Ratings, and Demographics for OA and AD Groups.

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Years of Education</th>
<th>Music Education Level</th>
<th>Qualitative Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OA Group (N = 22)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MusEQ Total</td>
<td>.34</td>
<td>.30</td>
<td>.38</td>
<td>.72**</td>
</tr>
<tr>
<td>Daily</td>
<td>.11</td>
<td>.02</td>
<td>.12</td>
<td>.30</td>
</tr>
<tr>
<td>Emotion</td>
<td>-.02</td>
<td>.12</td>
<td>.05</td>
<td>.50*</td>
</tr>
<tr>
<td>Perform</td>
<td>.48*</td>
<td>.26</td>
<td>.59**</td>
<td>.79**</td>
</tr>
<tr>
<td>Consume</td>
<td>.22</td>
<td>.33</td>
<td>.21</td>
<td>.45*</td>
</tr>
<tr>
<td>Response</td>
<td>.31</td>
<td>.17</td>
<td>.38</td>
<td>.51*</td>
</tr>
<tr>
<td>Prefer</td>
<td>.28</td>
<td>.26</td>
<td>.31</td>
<td>.47*</td>
</tr>
<tr>
<td><strong>AD Group (N = 16)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MusEQ Total</td>
<td>.15</td>
<td>.04</td>
<td>.49</td>
<td>.53*</td>
</tr>
<tr>
<td>Daily</td>
<td>-.25</td>
<td>.20</td>
<td>.38</td>
<td>-.02</td>
</tr>
<tr>
<td>Emotion</td>
<td>.26</td>
<td>.26</td>
<td>.25</td>
<td>.57*</td>
</tr>
<tr>
<td>Perform</td>
<td>.44</td>
<td>.28</td>
<td>.27</td>
<td>.69**</td>
</tr>
<tr>
<td>Consume</td>
<td>.00</td>
<td>-.03</td>
<td>.51*</td>
<td>.46</td>
</tr>
<tr>
<td>Response</td>
<td>.34</td>
<td>-.23</td>
<td>.38</td>
<td>.46</td>
</tr>
<tr>
<td>Prefer</td>
<td>.00</td>
<td>-.12</td>
<td>.14</td>
<td>.52*</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).
Chapter 4: Music cognition and engagement in Alzheimer disease: a case-comparative analysis

Ashley Vanstone, Svenja Kotz, Michael O’Grady, Ritu Sikka, and Lola L. Cuddy

Department of Psychology, Queen’s University at Kingston
Abstract

There is mounting evidence for the therapeutic use of music in Alzheimer disease (AD), and a parallel body of neuroscientific and psychological research has described characteristics of music cognition in persons with AD. Memory for long-familiar melodies, in particular, appears to be relatively less affected by AD than many other cognitive abilities. It remains unclear how music cognitive abilities are related to engagement with music in the daily lives of persons with AD. This study adopts fuzzy-set qualitative comparative analysis to make comparisons across a series of 15 AD cases on measures of music cognition and engagement. Group data from 29 older adult control participants served as a normative reference against which individual AD cases were assessed. Participants completed tests of melodic processing ability, memory for long-familiar melodies, and general cognitive impairment, and they provided questionnaire data on music training background and current levels of engagement in music-related activities. As a group, AD participants performed comparably to control participants and showed similar levels of music engagement. AD cases with high levels of music engagement showed a variety of patterns of music cognitive ability, dementia severity, and music education. Case data support the proposal that memory for long-familiar melodies is relevant to music engagement in AD. These findings have implications for future research on the psychology of music in AD and for the refinement of music-based interventions in dementia care.
Music Cognition and engagement in Alzheimer disease: A case-comparative analysis

What allows individuals affected by Alzheimer disease (AD) to engage with music, despite suffering cognitive impairment in multiple domains and resulting loss of function in daily life? A growing literature on music cognition in AD has characterized the profile of music cognitive abilities that tend to be preserved or spared in AD. It remains unclear, though, how these abilities affect the daily musical lives of those living with AD.

Engagement occurs when an individual is attentive to or occupied with a stimulus (Cohen-Mansfield et al., 2011). Engagement with music takes many forms, whether it be listening to a favorite recording, singing in a choir, or any number of other activities in which music has an integral or supporting role. A person’s music engagement is evidenced by participation in these activities and by the affective or behavioural responses that music often evokes.

Individuals living with dementia often display a lack engagement in their daily lives, to the detriment of their quality of life (Cohen-Mansfield, Dakheel-Ali, & Marx, 2009). Engagement with music activities is associated with increased wellbeing in AD (Särkämö et al., 2014), and music-based interventions show promise for managing the behavioural-affective symptoms of dementia (McDermott, Crellin, Ridder, & Orrell, 2013; Vink, Birks, Bruinsma, & Scholten, 2004). It is clear, then, that music engagement does occur in AD, and that maintaining or facilitating it is an issue of clinical importance.

It is less clear, though, to what extent music engagement in persons with AD is dependent on preserved music cognitive abilities. In this paper we present a comparative analysis of 15 AD cases, through which we explore how processing of and memory for melodies contribute to music engagement in the daily lives of persons with AD. To facilitate comparisons across cases,
we implement fuzzy set qualitative comparative analysis (fsQCA), an approach to case comparative analysis that, to our knowledge, has not yet been presented in the Psychology literature. Our study is motivated by three research questions, which we discuss in turn:

1) Is memory for long-familiar melodies relevant to music engagement in AD?
2) In what ways does music cognitive ability interact with AD severity and premorbid characteristics to influence music engagement?
3) How do the combinations of factors related to music engagement vary between individuals with AD?

**Melody, memory, and engagement in AD**

Music cognitive abilities are not universally immune to AD, although some aspects of music processing are more durable than others (Baird & Samson, 2009, 2015). In order to sustain attention to a stimulus, to engage in a meaningful way, one must be able to perceive and process that stimulus, at least to some extent. If certain music cognitive abilities are preserved in a listener with AD, then it stands to reason that those abilities could form part of that person’s capacity to engage with music.

Memory for long-familiar melodies (MLFM) is relatively robust in the face of AD. Recognition of familiar melodies is often preserved in persons with AD, sometimes even in individuals with severe AD (Cuddy et al., 2012). Many listeners with AD also show preserved ability to sing tunes when prompted by the lyrics. Certain aspects of melodic processing, particularly the ability to detect distortions in melodies, also tend to be preserved in AD participants with mild AD as well as in some whose AD is at the moderate stage (Kerer et al., 2013; Vanstone & Cuddy, 2010). Relative to robustly-encoded memory for long-familiar melodies, explicit memory for newly presented melodies is more likely to be impaired by AD
(Bartlett, Halpern, & Dowling, 1995; Ménard & Belleville, 2009; Vanstone et al., 2012), as is the ability to recall the names of familiar melodies (Kerer et al., 2013). Of the forms of musical memory studied to date, then, MLFM appears most likely to be preserved in AD, which suggests that it has potential to be broadly relevant to music engagement.

It is probable that MLFM is a central component in the mechanism for music engagement in persons with AD because, in addition to being relatively less affected by the disease, it is implicated in a number of the other mechanisms by which music engagement is known to occur. First, listeners tend to have more intense and pleasant emotional responses to familiar music relative to unfamiliar music (Ali & Peynircioğğlu, 2010). To the extent that preserved memory enhances the feeling of familiarity, it would be expected to enhance emotional response. Second, music-evoked autobiographical memories (MEAMS) are more likely to be elicited by familiar music (Janata, Tomic, & Rakowski, 2007). This phenomenon extends to listeners with AD (El Haj, Postal, & Allain, 2012), for whom it tends to be a positive experience (Cuddy, Sikka, Silveira, Bai, & Vanstone, 2017). Long-familiar music, as well, is often part of a repertoire of music that is widely known within a culture, thus creating potential for social connection through shared musical experience. Individuals are able to participate more meaningfully in a group sing-along, for example, if they remember the melodies being sung.

Long-familiar melodies are directly implicated in each of these three processes – music-evoked emotion, MEAMs, and social connection; these in turn would be expected to shape the musical experience of individuals with AD. Through its ability to help modulate emotion, music may calm a person during periods of agitation, or it may provide stimulation during periods of apathy and disengagement. MEAMs evoked by familiar melodies may facilitate reminiscence, helping an individual to retain connection to the personal past and to preserve orientation to the
sense of self. Singing familiar melodies from a shared repertoire of songs may contribute to the wellbeing of the person with AD and the caregiver (Chatterton, Baker, & Morgan, 2010).

Although MLFM is implied in these mechanisms of engagement, the link between preservation of MLFM and engagement with music in the lives of persons with AD remains to be examined directly. It is clear that MLFM plays a role in the social and emotional processes by which listeners respond to music, but it does not follow that the preservation of these memories in individuals with AD is necessary or sufficient for music engagement to occur. In the present study, we take this as our starting place for exploring the role of music cognition in engagement.

**AD progression, premorbid experience, and personal context**

While we have argued for the prediction that preserved MLFM is relevant to how persons with AD use and respond to music, it would be implausible to suggest that it is the sole determining factor. Variation in music engagement within the general adult population exists quite apart from the influence of music cognitive deficits. Music engagement in a person with AD is likely to reflect premorbid musical experience as well as disease-dependent effects, both of which should be considered in conjunction with music cognitive ability. In the present study we examine two aspects of premorbid experience: music education and level of general education.

Formal music training affects the structure and function of the auditory system (Kraus & Chandrasekaran, 2010) as well as the organization of auditory processing in the central nervous system more broadly (Skoe & Kraus, 2012). Learning to read music and to play a musical instrument allows an individual to engage with music in more ways. Ultimately, sustained engagement in music activities, especially at an intensive level, may ameliorate the effects of cognitive aging (Hanna-Pladdy & Gajewski, 2012). Music education is positively correlated
with music engagement in the cognitively healthy population (Vanstone, Wolf, Poon, & Cuddy, 2016). We expect, then, that premorbid music education would help sustain engagement.

We also consider the relevance of formal education to music engagement. Unlike music education, general education is not correlated with engagement in the cognitively healthy population. It does shape premorbid experience in other important ways, though, as a marker of socio-economic status, which may have downstream effects on financial resources and quality of care. It also increases potential for a cognitively stimulating lifestyle, which offers a buffer against cognitive decline through processes of cognitive reserve (Stern, 2009). Low educational attainment is actually a risk factor for dementia (Lindsay et al., 2002). It is possible that education-related effects on music engagement would become evident only after the onset of AD. It is not predicted to have a direct positive effect on engagement, but rather to have protective effects that are relevant to engagement in the presence of other factors.

At the point of AD onset, individuals vary in the forms their music engagement takes and in the determining factors that shaped their engagement across the lifespan. Different music activities make differing cognitive and functional demands on the person – listening to the radio is arguably less demanding than conducting an orchestra, for example. AD is characterized by progressive impairment of both cognitive and functional abilities. As AD-related impairment increases, individuals become restricted in the range of abilities they previously employed in order to carry out music activities. We predict that, as a result, the abilities less affected by AD, particularly MLFM, become more critical to the mechanisms of music engagement.

Of course, the factors described here – education, music education, and AD severity – provide only a very general overview of the factors shaping an individual’s musical life. As participants recounted the stories of their musical lives, they told us about their families,
churches, schools, wars, migrations, hardships, and celebrations. The present analysis does not capture the richness of their accounts. It does, however, acknowledge the reality that any variable proposed to facilitate music engagement has its effect within the context of the individual.

As a result, we expect that within a set of individuals with AD who are musically engaged, we will observe differing combinations of factors that might explain their continued engagement. We are, in other words, assuming the equifinality (c.f. Cicchetti & Rogosch, 1996) of music engagement. The contribution of MLFM is likely to be more meaningfully explained in terms of its interactions with other factors within the context of the individual.

A case comparative approach: implementation of fuzzy set qualitative comparative analysis (fsQCA)

We have proposed working hypotheses (1) that MLFM contributes to music engagement in AD and (2) that its effects occur through interactions among multiple factors, which vary between individual cases. We expect, in other words, qualitative differences in the combinations of factors leading to engagement. We adopt a case series approach as a means of exploring how these factors are configured in individual cases and identifying where MLFM is situated relative to the other factors under consideration.

In this analysis we use fuzzy set qualitative comparative analysis (fsQCA; Ragin, 2009b) to facilitate the process of making comparisons across a series of AD cases. Case series methodology is useful for explaining heterogeneity within patient groups and identifying associations or dissociations between cognitive functions (Schwartz & Dell, 2010). Case series data pose the challenge, though, of making systematic comparisons across multiple cases in a way that identifies commonalities without erasing meaningful differences between cases. This challenge motivates our use of fsQCA in the current study.
This study is, to our knowledge, the first in which fsQCA has been applied to a case series that uses quantitative psychological data, so it will be unfamiliar to many readers. A full presentation of the theory, computations, and assumptions of fsQCA is beyond the scope of this paper. Instead, we provide an overview of the process here, and in the Methods and Results we describe the methodology in parallel to the substantive analysis. Table 1 presents a summary of each stage in the analysis, outlining its objectives and noting how they were implemented in the present study. The supplementary material to this article provides an annotated list of resources to learn more about fsQCA.

[Insert Table 1 about here.]

Fundamentally, fsQCA is an analysis of relationships between sets of cases that belong, or do not belong, to the conceptual categories being investigated – categories reflecting a case’s level of music engagement (the outcome) and the presence of the factors proposed to support music engagement (the conditions). The sets are characterized as fuzzy sets because cases vary in terms of how clearly they belong to the category of interest. For instance, few people show a complete absence of engagement with music, and likewise, there are few for whom music is the central focus of daily activities; some individuals clearly belong or do not belong to the category of “highly musically engaged,” but many individuals show more ambiguous levels of engagement.

Rather than “in” or “out,” a case’s membership in each fuzzy set is labeled with a numerical value (fuzzy set scores) between 0 (full non-membership) and 1 (full membership); 0.5 indicates the point of maximal ambiguity between membership and non-membership. Fuzzy sets are also constructed in their inverse, or negated, forms; full membership in set [A] is equivalent to full non-membership in set [not A], and vice versa. Negated sets strengthen the analysis by
allowing for identification of patterns in which the absence of one condition has different effects on the outcome depending on what other conditions are present.

*Calibration* is the process of defining conceptual categories for the conditions and outcome, specifying criteria (*coding rules*) for how the data are used to evaluate membership in these categories, and calculating fuzzy set scores to describe each case’s membership in the conditions and outcome (Ragin, 2009). Coding rules link quantitative data to their qualitative interpretations by taking into account previous research, prior knowledge regarding the concept and its measurement. We ask, for example, what it means for a case to be “fully in” the set of cases with preserved MLFM. From the music cognition and neuropsychology literatures, we work from the convention of classifying participants’ abilities as “impaired” or “preserved” based on their performance relative to a control group distribution. Performance equal to the control group mean fits unequivocally into the “preserved” category, and often scores falling 2 standard deviations below the mean are classified as “impaired.” By referencing this convention, we assign qualitative meaning to numerical data.

The coding rules specify empirical values corresponding to fuzzy set scores of 0, 0.5, and 1, which serve as the basis for mathematical transformation of case data to fuzzy set scores. Fuzzy set scores in this study reflect the presence or absence of music engagement (which we designate the *outcome*) and of the factors we hypothesize to support music engagement (the *conditions*). FsQCA uses these scores to evaluate the relationships between fuzzy sets. The rationale for these coding rules for each condition is described below in the Methods section, and the values are summarized in Table 4.

Two metrics are used to describe the relationships between fuzzy sets: *consistency* and *coverage* (Ragin, 2006). *Consistency* scores measure the extent to which members in a condition
also show membership in the outcome. They reflect the proportion of fuzzy set scores in a condition (across all cases in the series) that are less than or equal to the corresponding scores in the outcome. Using fuzzy set scores to measure consistency results in a metric that is weighted to take into account that cases provide varying strength of evidence for or against a subset relation. For example, a case with fuzzy set scores of .95 in the outcome and .95 in the condition would provide strong support to the claim of a subset relation, while a case with scores of .95 in the outcome and 0.60 in the condition would lend weaker support. Consistency is calculated with the following formula, where \( X \) represents membership in the condition and \( Y \), membership in the outcome:

\[
\text{Consistency}(X_i \leq Y_i) = \frac{\sum (\min(X_i, Y_i))}{\sum (X_i)}.
\]

Consistency scores measure the proportion of a condition’s membership that also has membership in the outcome, but they do not evaluate the converse relationship – the proportion of the outcome’s total membership that has membership in the condition. This proportion is measured instead in the \textit{coverage} scores, calculated as:

\[
\text{Coverage}(X_i \leq Y_i) = \frac{\sum (\min(X_i, Y_i))}{\sum (Y_i)}.
\]

It is possible for a condition to have high consistency while accounting for only a small proportion of the total membership in the outcome. For example, suppose an outcome of “frequent concert attendance” and a condition of “being employed as a music critic.” It would be expected that music critics attend concerts with very high frequency, but yet music critics make up only a small proportion of those who are frequent concertgoers. In this case, the condition would have high consistency but low coverage of the outcome. Conditions with low coverage may still be informative in that they represent a reliable, although less common, subset of cases.
showing an outcome. Figure 1 is a simple illustration of the concepts of consistency and coverage between sets.

So far we have described fsQCA in terms of relationships between the case sets constructed for individual conditions and for the outcome. The major analytical contribution of fsQCA, though, is in its procedures for evaluating relationships between combinations of conditions, or configurations, and the outcome. Configuration sets are constructed by Boolean addition of individual conditions, such that fuzzy set scores reflect membership in each of the conditions making up the configuration. For example, a case with preserved MLFM and high music education would have membership in the set of cases showing “preserved MLFM and high music education.” A case with preserved MLFM but low music education would not.

Extending this concept to fuzzy sets, a case’s membership in a configuration is defined by its lowest score in the constituent conditions. A case with scores of 0.95 in “preserved MLFM” and 0.75 in “high music education” would have a score of 0.75 in “preserved MLFM and high music education.”

Analysis of configurations begins with generating an exhaustive list of all possible configurations, which is known as the truth table. For each case, fuzzy set scores are computed for membership in each of the configurations, from which consistency and coverage scores are generated. This rather unwieldy table is then subjected to a reduction process in order to yield more interpretable findings. Configurations are deleted if their consistency is less than 0.80 or if they contain no cases with fuzzy set membership greater than 0.5. Using a minimization algorithm implemented in fs/QCA 3.0 software (Ragin & Davey, 2014), the remaining rows are analysed to identify a solution – the combination of configurations that together have optimal consistency with the outcome. The solution is evaluated first for its overall consistency and
coverage of the outcome. Each configuration appearing in the solution is referred to as a solution term, for which the cases are identified that have membership greater than 0.5.

Having generated a solution, the researcher must interpret the findings in order to address the research questions. At this stage in the process, the solution terms are examined in light of what is known about the conditions and their measurement. The interpretation also draws upon knowledge of the individual cases to gain insight into the meanings of the solution terms. For example, the researcher may identify commonalities between cases that are members of the same configuration, drawing upon case data that were not included as conditions in the fsQCA solution. The objective of interpretation is to establish the plausibility of hypotheses and to refine the working hypotheses in light of theory and case data, rather than to reject a null hypothesis. Our working hypotheses lend themselves well to statement in fsQCA terminology. We have predicted that, in a set of AD cases music engagement, we will observe multiple configurations of conditions proposed to support music engagement, and we expect that MLFM will be included in these configurations.

Methods

Participants and case selection

Participants with diagnoses of probable AD were recruited in collaboration with the Queen’s University Memory Disorders Clinic, where patient files were reviewed to identify potentially eligible participants, who were then contacted by telephone with information about the study. Those with neurological or psychiatric co-morbidities including history of stroke or non-AD dementia were excluded from participation. Inclusion criteria also required participants to be aged 65 or older, to have normal hearing or hearing corrected to normal with hearing aids, and to have no history of stroke, other acquired brain injury, or substance dependence. They had
not exceeded recommended alcohol intake guidelines within the past five weeks and, at the time of the study, were not suffering from any psychiatric conditions. In addition, each participant in the AD group was required to have a caregiver who had frequent contact with the participant and was willing to provide information regarding the participant’s background and current functioning.

Fifteen AD participants were selected to ensure variability in the levels of dementia severity, formal education, and music training. This approach to case selection embraces diversity rather than homogeneity, congruent with the qualitative aspects of our analysis – the objective of this study being to identify patterns within cases rather than to make generalizable statements about the AD population.

A sample of older adult control participants (controls) provided a basis for normative comparison on music cognitive and engagement measures. The 29 control participants took part in this study after responding to advertisements in local newspapers or to posters placed in areas commonly frequented by older adults. Control participants underwent cognitive screening to rule out undiagnosed dementia or mild cognitive impairment. They were given the option to have a close friend or family member complete a questionnaire about the participant’s music engagement. Otherwise, they met the same inclusion criteria as participants in the AD sample. Demographic information for each group is provided in Table 2.

[Insert Table 2 about here.]

All participants provided informed consent prior to completing the study procedures. Control participants provided consent independently. AD participants completed the informed consent process with the assistance of a caregiver. Regardless of the participant’s ability to understand the study procedures, testing did not proceed without the assent and cooperation of
the participant. This study received approval by the General Research Ethics Board of Queen’s University.

**Materials**

Neuropsychological screening tests.

The Mini-Mental Status Exam (Folstein, Folstein, & McHugh, 1975) is a brief test commonly used to evaluate global cognitive function or to provide a marker of change in persons with dementia. It comprises 11 tasks assessing orientation, memory, attention, and language. The maximum possible score is 30. The MMSE was administered to both controls and AD participants; in the control group it was used as part of the screening for incipient cognitive impairment, while in the AD group it served as a marker of dementia severity. In addition, control participants were administered the Montreal Cognitive Assessment (Ziad et al., 2005) to provide a more sensitive screening for cognitive impairment. The MoCA provides brief assessment of cognitive status in the domains of memory, visuo-spatial ability, language, attention, and orientation. It has good sensitivity and specificity for abnormal cognitive performance in older adults.

Music listening tasks.

The Instrumental Tunes Test (ITT) contains a series of 50 instrumental melodies, presented in 8.5 second excerpts pre-recorded with a synthesized piano timbre. Half are well known melodies, highly familiar with English-speaking, North American listeners. The other half are novel melodies that were composed by altering the note order of familiar tunes, such that they had similar musical characteristics to the familiar melodies but were unrecognizable to listeners. Familiar and unfamiliar melodies were previously pilot tested to ensure that they had
high levels of familiarity or unfamiliarity (Sikka, Cuddy, Johnsrude, & Vanstone, 2015). After each melody was presented, the participant was requested to indicate whether or not the melody is familiar. They were not required to provide the name or any other details about the melody.

An adapted version of the Montreal Battery for Evaluation of Amusia (MBEA; Peretz, Champod, and Hyde 2003) was included as an ancillary measure to the ITT, to measure the preservation or impairment of the perceptual abilities involved in processing melodic information. (For a review of the theoretical motivation for the MBEA, see Peretz and Coltheart, 2003). The original version of the MBEA has an administration time of approximately two hours, but the version used in this study was shortened – Campanelli and colleagues (2016) found that participants with mild-moderate AD (MMSE range 18-26/30) were able to attend successfully to the full version, but with longer completion time than for healthy controls. For this reason the authors suggested that alternate measures of melodic processing be included for participants with more severe cognitive impairment. The version of the MBEA used here includes four sub-tests, with 20 trials per test. For each trial, participants hear two short melodies in sequence and are requested to identify whether they are the same or different. In half of the trials, the melodies are identical. In the other half, one note in the second melody has been changed. In the first sub-test (Interval), the changed note affects only the size of the musical interval. In the second sub-test (Contour), the altered note changes the over-arching contour of the melody. In the third sub-test (Scale), the altered note is in violation of the melody’s musical scale, and in the fourth (Rhythm), the duration is changed to alter the rhythm of the melody. Scores on these tasks were combined to generate a total score, which was used in subsequent analyses.

Music Engagement Questionnaire (MusEQ).
The Music Engagement Questionnaire (Vanstone et al., 2016) is a 35-item scale that measures an individual’s current degree of engagement with music activities. It is available in a self-report version as well as an informant-report version to be completed by a third party who knows the participant well. The latter was used in this study.

Items are rated on a five-point Likert scale ranging from 1 (“not at all”) to 5 (“very much”), and respondents are asked to make their ratings based on observations from the past month. Item content encompasses a broad range of behavioural responses to music, including patterns of music use in the course of everyday life, emotional responsiveness to music, performance and music-making activities, physical responses to music, and expression of preferences or opinions regarding music. MusEQ scores correlate both with global impressions of “musicality” and with qualitative ratings derived from interview data. The scale items were selected to avoid activities that rely heavily on complex activities of daily living, in order to reduce the influence of general, non-musical functional impairments that result from AD. The inclusion of some items that involve higher-level activities of daily living was necessary (e.g. listening to music while performing household chores), though, in order to encompass as much of the music engagement construct as possible.

The present case series includes participants with widely varying levels of AD severity. To create a “lowest common denominator” measure that would be equally applicable across the AD severity spectrum, we computed an additional score, MusEQ Basic. This score was calculated from 11 items selected from the 35 items of the MusEQ. These items were selected on the basis that they do not require the individual to complete additional, non-musical activities of daily living. The eleven items formed a scale with high internal reliability ($\alpha = .88$). In our dataset (described below), Basic was strongly correlated with the MusEQ Total score, $rs(37) =$
.88, p < .001. However, discrepancies between Basic and full-scale scores became greater as MMSE scores decreased, rs(37) = -.42, p = .009. MusEQ Basic scores were used for the comparative analysis of AD cases. A list of the scale items is provided in Appendix 1.

**Procedures**

Testing sessions for control participants were conducted in a quiet room at the University, and protocols were administered in a fixed order beginning with a short interview to gather demographic information, after which cognitive testing was administered (MMSE and MoCA), followed by music testing (ITT and MBEA). Following the cognitive and music tasks, participants were asked to complete the self-report version of the MusEQ. At the conclusion of the session, they participated in an unstructured interview in which they were invited to provide any additional information that they saw as relevant to the study as well as a narrative description of the role of music in their lives. During the interview, the researcher made notes of the participant’s comments. 22 of the 29 control participants had a close family member complete the informant-report version of the MusEQ, which they returned by mail to the study team. For consistency, both group data comparisons and case comparisons are based on informant-report data.

The testing protocol for AD participants required flexibility in order to accommodate their varied physical and mental capacities. Most chose to be tested in their own homes rather than travelling to our offices. During testing they were encouraged to take breaks as necessary and were given the option to be tested in two or more shorter sessions where fatigue or attention span was an issue. Where possible, the order of testing was consistent with the control group, although flexibility was used where required in order to maintain a participant’s engagement in the session. A caregiver assisted the participant in the informed consent process, took part in the
interview, corroborated the participant’s background information, and completed the informant-report version of the MusEQ.

**Results**

**AD and Control Group Data**

Distributions of AD and control group data on ITT, MBEA tasks, and MusEQ scales were compared using Mann-Whitney U tests. Group medians, test statistic values, and p-values are provided in Table 3. Each participant’s ITT and MBEA responses were scored for their hit (answering “familiar” or “different” on trials where that is the correct answer) and false alarm (answering “familiar or “different” on trials where that is the incorrect answer) rates, from which an index of discriminability (d’) was computed (Stanislaw & Todorov, 1999). Group comparisons and subsequent comparative analyses were made on the basis of d’ values. Raw scores (items correct) for MBEA are also reported for reference.

[Insert Table 3 here]

For the MBEA total score, we did not observe a significant difference in d’ between the AD and control groups; their responses were equivalently sensitive in discriminating between “same” and “different” melodies. For individual MBEA tasks, d’ was not significantly different between groups, except for the Rhythm task, where AD participants showed somewhat poorer discrimination than controls. For the ITT, the median d’ value was marginally lower in the AD group, although group distributions were not significantly different to reliably conclude that AD participants as a group showed less sensitive discrimination of familiar from unfamiliar melodies.
There were no discernable differences between the median scores of AD and control participants on the MusEQ. MusEQ Basic scores were positively correlated with MusEQ Total scores in the control group (rs = .85, p < .01) as well as in the AD group (rs = .91, p < .01). However, discrepancies between Basic and Total scores (Basic minus Total) were somewhat greater in the AD group, U(37) = 239.00, p = .02, and discrepancy values were negatively associated with MMSE, rs(15) = -.57, p = .03; participants with greater cognitive impairment tended to have a MusEQ Basic score that was higher than their Total score.

**Fuzzy Set Analysis of AD Cases**

The purpose of this analysis is to explore the characteristics of AD cases that show high or low levels of music engagement. The mixed methods used here call for some adjustment to the convention of maintaining rigid demarcation between Results and Discussion. Interpreting the configurations identified in the fsQCA involves relating individual case data to the configurations in which they have membership. However, these results are presented such that there should be no confusion between observations and interpretations.

**Calibration.**

The coding rules serve as the basis for generating fuzzy set scores using the calibrate function in the fsQCA 2.5 software package, which uses a log transformation to standardize data into fuzzy set membership scores distributed between 0 and 1, anchored to the criteria specified for full membership and non-membership in each set (Ragin, 2009). Table 4 summarizes the coding rules, the values of each variable that correspond to fuzzy set scores of 1.0, 0.5, and 0.0. The resulting scores for each case are provided in Appendix 2. To distinguish between measures and their corresponding fuzzy sets, the measures are designated using their abbreviations in
regular font and fuzzy sets, in italics. Negated versions of sets (i.e. the absence of a condition or outcome) are prefixed by ∼.

The outcome in our analysis, MusEQ, was defined as occurring when a case is very much engaged in music-related activities, which corresponds to a score of 5 on the MusEQ Likert scale. Full non-membership occurs when a case is not at all engaged in these activities, corresponding to a score of 1. The point of maximal ambiguity between these two points is a score of 3, indicating that the case is somewhat engaged.

For the music tasks (ITT, MBEA), calibration was based on the neuropsychological convention of classifying performance on a task as preserved or impaired, relative to the distribution of control group data. Full membership was assigned to cases having scores greater than or equal to the control group mean. Full non-membership was coded as less than or equal to two standard deviations below the control group mean, with maximal ambiguity occurring at the midpoint, one standard deviation below the control group mean. The conditions ITT and MBEA, then, refer to the sets of cases for whom performance on the ITT or MBEA was classified as preserved.

MMSE scores served as the metric of dementia severity. Full membership in the MMSE set was assigned to cases where AD is in the mild stage, and full non-membership, to those where AD has advanced to cause severe cognitive impairment. The corresponding MMSE scores were derived from literature on MMSE and dementia severity (Perneczky et al., 2006).

Education levels were calibrated such that full membership in EDUC indicates a high level of formal education – specifically, equivalent to four years or more years of university study. Non-membership in EDUC indicates having no post-secondary education. For music education, respondents indicated their years of music training on a five-point ordinal scale, so
these five points were aligned with fuzzy set membership scores. Full membership in MUSED signifies more than 10 years, and full non-membership corresponds to less than one year.

**Individual conditions.**

After calibration, each condition was examined individually for its consistency and coverage relative to the MusEQ outcome and to its negation, ~MusEQ. By convention, a consistency threshold of 0.80 indicates a consistent relationship between sets. No threshold is drawn for coverage values; however, they serve as a guide to the interpretive significance of a condition relative to the outcome. Consistency and coverage values are presented in Table 5.

For MusEQ, coverage scores of most individual conditions were moderate. MUSED was the exception, with a coverage score of 0.92. Those of the other conditions ranged between 0.60 and 0.67. All consistency scores were below 0.80, with values ranging from 0.35 (MUSED) to 0.74 (ITT).

Individual conditions, in their negated sets, were also examined in relation to the absence of music engagement, the ~MusEQ outcome. Coverage scores were modest; values ranged from 0.48 to 0.60. ~MUSED had strong consistency (0.96), while all other values were below 0.80, ranging from 0.48 (~MBEA) to 0.60 (~MMSE).

**Analysis of configurations.**

Following analyses of individual conditions, we proceeded to examine combinations of conditions (configurations) for their consistency with the presence (MusEQ) and absence (~MusEQ) of music engagement. The algorithm for this process is implemented in fs/QCA 3.0 (Ragin & Davey, 2014). In both cases, optimal consistency and coverage were obtained with the intermediate solution, which balances parsimony and complexity in the process of minimizing
the number of solution terms. Configurations were retained for interpretation if they showed consistency greater than 0.80 with the outcome and if they contained at least one case with membership greater than 0.5. The label for a configuration combines the fuzzy set labels comprised by the configuration. For example, “ITT and MMSE,” the set of cases with unimpaired ITT scores and milder cognitive impairment, would be labeled ITT*MMSE.

This model simultaneously considers the relationships of demographic and music perceptual conditions to the outcome of music engagement. The overall MBEA score (MBEA), ITT, MMSE, level of music education (MUSED), and level of general education (EDUC) were included as conditions. Table 6 summarizes fsQCA solutions for the MusEQ and ~MusEQ models. Coverage, consistency, and solution terms are listed for each model. For each solution term, the table lists the coverage and consistency, as well as identifying cases with membership scores greater than 0.5 in that term.

**Outcome: high music engagement (MusEQ).**

The model showed high consistency and good coverage for the MusEQ outcome. Of the nine cases in the series belonging to MusEQ, six had membership greater than 0.5 in at least one of the solution terms. The broad model points to three configurations – types of cases – that are consistent with MusEQ and two that are consistent with ~MusEQ outcome. We consider each of these in turn as distinct types of AD cases showing high music engagement.

**ITT*~MMSE.** Four cases were members of the ITT*~MMSE solution term, indicating normal MLFM and, at the same time, significant cognitive impairment. For these cases, melody recognition cannot be attributed merely to having a mild level of cognitive impairment; memories for these melodies have persisted despite unambiguous cognitive impairment of AD. They were in other respects a diverse group. Three cases had less than one year of formal music
education, while another had more than eight years. Two cases had university degrees, while the other two had eight and 12 years of education.

On MBEA scores, likewise, these cases encompassed a range of music-perceptual abilities – one case showed unambiguous preservation, while the others had overall MBEA scores evidencing marginal or clear impairment on some tasks. All discriminated violations of musical scale at rates comparable to control participants, but each of the remaining cases showed impairment on at least one of the four MBEA subtasks. This impairment, though, did not appear to affect music engagement – the case with the lowest MBEA score had the highest MusEQ score, and conversely, the case with the highest MBEA score reported the most modest level of music engagement. For recognition of familiar melodies, in contrast, the two highest scoring cases were also reported as having the highest levels of music engagement. Taken together, this configuration indicates a type of AD case where preserved MLFM in the presence of more advanced cognitive impairment is consistent with high levels of music engagement.

**MBEA*~MMSE*~EDUC.** Two cases were members of this solution term, characterized by normal ability to identify changes to novel melodic patterns, based on their discrimination of interval, contour, scale or rhythmic features of the melodies. As in the preceding configuration, these cases showed significant cognitive impairment, and in addition did not have high levels of education. Their performance on the MBEA indicates that they have retained the capacity to deploy implicit music perceptual knowledge when they listen to melodies, even those they have not heard before.

This configuration of cases offers further clues as to the significance of recognition memory for familiar melodies. One case, who was also a member of the preceding solution term, showed preservation on the ITT (d1 = 1.66). The other’s ITT score was somewhat weaker (d1 =
1.24), at the lower margin of typical control performance but by no means evidencing a complete absence of discrimination for familiar melodies. The participants in both of these cases, however, had a first language other than English and had immigrated to Canada as young adults. Their inclusion in this study was rationalized on the basis that they would likely have been exposed to these melodies, having lived for decades in the Anglo-Canadian environment. The case data do not speak to the question of whether their low ITT performance was due to degraded MLFM or to another factor, such as lack of previous exposure to the melodies included in the ITT. However, we noted in the interview and testing process that these participants did have memory for a repertoire of music that brought joy and held personal significance.

**MBEA*MMSE*MUSED*EDUC.** One case showed the presence of numerous conditions hypothesized to support engagement with music. She was able to discriminate changes to novel melodies, had a relatively mild degree of cognitive impairment, and benefited from higher levels of education and music training. In this case, the impact of AD is relatively mild. This profile implies that high music engagement was present prior to AD onset, supported by high levels of music training and education, unimpeded by perceptual deficits in melodic processing.

One aspect of this case is harder to explain, though; the participant scored poorly on the ITT, despite robust performance on the MBEA. This deficit could not be explained by obvious differences in musical enculturation, although it would be difficult to rule out whether the participant was in some way limited in her previous exposure to these melodies. We note that this case had a unique profile on the MBEA subtasks, representing the only instance of a low Contour score accompanied by high scores on all of the other subtasks.

**Outcome: Low music engagement (~MusEQ).**
Consistency for the negated outcome solution was equally as high as for the positive outcome solution, but the solution coverage was lower. Two cases had solution term membership greater than 0.5, out of the six cases with membership greater than 0.5 in ~MUSEq outcome. The intermediate solution contains two solution terms: ~ITT*~MUSED*~EDUC*MMSE and ~MBEA*~MUSED*~EDUC*MMSE. Each term included one case with a membership score of greater than 0.5. These cases are characterized by less music education and less formal education. They each have impairment on one of the music tasks but not the other. Both solution terms include milder cognitive impairment (MMSE) as a condition, in contrast with the positive outcome solution, in which five out of six members showed more severe impairment (~MMSE).

Discussion

Group data of AD and older control participants are consistent with a now-familiar finding: listeners with AD show comparatively less impairment in their memory for melodies learned in the distant past, in contrast with their cognitive impairment in other domains. Performance on music tasks varied considerably between individual participants, though, supporting our premise that individual differences are important to understanding the basis for music engagement in AD. Likewise, there was considerable overlap of control and AD MusEQ scores, supporting the decision to analyze engagement in absolute terms rather than considering it as preserved or impaired relative to a control group.

FsQCA of our case series data provides support for the predictions that preserved MLFM is a relevant factor in understanding music engagement in AD, that preserved music cognitive ability shows its positive relationship to engagement in combination with other characteristics of the case, and that these combinations vary between individuals. Analysis of AD cases pointed towards multiple configurations that were consistent with high or low music engagement. For
both high and low music engagement, MLFM was part of the fsQCA solution, where it showed much clearer consistency with engagement when considered in conjunction with other aspects of the cases rather than as an isolated variable.

Severity of cognitive impairment proved to have an important influence on the relationships between music cognition and engagement. Cognitive impairment appeared in every solution term for the analyses of both high and low engagement cases. Impaired MLFM or melodic processing were most consistently related to low music engagement when overall cognitive impairment was less severe. On the other hand, preserved MLFM and melodic processing were most consistent with high music engagement when cognitive impairment was more severe. It appears that the beneficial effects of MLFM for engagement stand out more clearly for individuals whose AD has progressed beyond the mild stage.

Music education emerged as an additional factor that was present in the fsQCA solutions for both high and low music engagement. It was predicted to have a positive relationship with engagement, as it did in the MusEQ scale development sample. As an isolated set, it showed low consistency with the outcome of high music engagement but very high consistency with the outcome of low music engagement. In the analysis of configurations, music education (and lack thereof) showed the consistent relationship to engagement, both high and low, in configuration with milder cognitive impairment. Taken together, these observations point to the influence of music education on participants’ premorbid musical lives, raising the question of whether AD progression obscures some of the positive effect derived from music education.

The findings of this exploratory analysis reflect the patterns observed within the present case series; they demonstrate the utility of fsQCA in addressing a complex and multiply determined psychological phenomenon. It would be incorrect to infer that the present findings
reflect population distributions or that they provide a complete taxonomy of the mechanisms whereby individuals with AD come to engage with music. However, the analysis does clearly establish that multiple configurations exist and that the factors under consideration are relevant to establishing a comprehensive theoretical model of music engagement in AD.

The present findings also suggest a number of directions for future research on music and AD. Of the 15 cases examined, 8 had membership greater than 0.50 in a consistent configuration—this is a promising level of coverage given the complexity of the phenomenon and the relatively simple forms of measurement used. It does suggest, though, that additional configurations remain to be observed, something that could be achieved through refinement of how cases are evaluated and by accumulation of a larger base of cases. Regardless of the actual number of configurations existing in the population, though, the finding of multiple configurations could inform the use of regression analyses in designing future studies. With larger sample sizes, fsQCA and regression offer complementary approaches to analysis through incorporating QCA solutions into regression models, calculating effect sizes and evaluating robustness (Fiss, Sharapov, & Cronqvist, 2013).

The configurations observed here included premorbid factors (levels of formal education and music training) as well as factors based on current performance (MMSE and music cognitive tasks). Longitudinal data would help disambiguate the role of AD severity in shaping the mechanisms of music engagement, allowing researchers to observe the process of how individuals shift between configurations as the disease progresses, remaining engaged with music but doing so through different means. In addition, more detailed neuropsychological and functional profiling of cases could clarify the mechanisms whereby AD might spare or impair
music engagement; some music activities are more reliant on functioning in non-musical activities, while others may be more closely associated with music perceptual mechanisms.

The behaviour-focused approach of the MusEQ is arguably well-suited to understanding the relationship of engagement with music cognitive abilities, which are measured through behavioural performance on music perceptual tasks. This approach allows for standardization of measurement across cases or over time, which permits quantitative analysis and facilitates case comparison. The divergence between MusEQ Basic and Total scales demonstrates the importance of choosing measurements that are appropriate to the cases. Item content in the Basic scale is appropriate to individuals across the AD severity spectrum, while the Total scale taps into a broader range of music-related behaviours and so offers a more nuanced assessment of engagement for participants in the earlier stages of AD. With more advanced dementia, though, the Total scale risks becoming unduly confounded with dementia-related functional impairment.

There remains a role for qualitative inquiry on music engagement in AD to address how the disease affects the meaning and significance of music engagement in the lives of persons with AD and their partners in care. Music has significance to persons with AD and to their caregivers (Chatterton et al., 2010), which may not be reflected in the frequency or variety of behaviours. In a person with end-stage AD, even a very simple response may have tremendous meaning by virtue of its contrast with the typical lack of responsiveness to other stimuli. A low score on a scale such as MusEQ, then, should not be taken as proof that music is unimportant to the person with AD. Rather, it is evidence that the frequency, variety, or intensity of typical music-related behaviours is low. The behaviours and their subjective importance are both relevant to a broader understanding of music engagement.
Understanding individual differences in the mechanisms of music engagement in AD carries clinical significance because it could inform the customization of music-based interventions. Our observations in this analysis reiterate the importance of familiar music while also suggesting that interventions be targeted to AD severity. Moving forward, a comprehensive taxonomy of music engagement pathways in AD, along with clinically appropriate ways of assessing these pathways, would be a resource for case formulation and treatment planning in music therapy – the clinician’s task, after all, is to serve individuals, regardless of how atypical the presentation. For example, if disengagement were explained in one case by impairment of ADLs, then perhaps the clinician would need only to facilitate access to the activity – for example, by adapting the user interface on a music player so it is simpler to operate. On the other hand, if music perceptual mechanisms were compromised, the clinician may need to select musical material with more simple tonal structure or clearer rhythmic patterns.

Apart from clinical application, individual differences in mechanisms of music engagement are important insofar as they provide insight into an important aspect of the personal experience of persons with AD. Engagement with music evolves across the lifespan, reflecting socio-cultural influences and personal attributes. The preponderance of evidence points to beneficial effects of music activities across the lifespan. Naturally, we seek to understand the place of music in the lives of individuals with AD, often with the objective of its application to the clinical management of troubling symptoms such as agitation or apathy. It has been argued, from an ethical standpoint, that dementia care should support and facilitate what remain of a person’s capabilities and alleviate the harm stemming from incapacity (Higgs & Gilleard, 2016). Musical preferences and practices have been described as “a technology of the self” (DeNora, 1999), infused in daily life and shaping personal identity. We have yet to meet anyone who
describes their motivation for music engagement as primarily therapeutic. For most people, then, the capabilities that permit music engagement are no different than the capabilities that permit engagement in other meaningful activities. Dementia care, by extension, should encompass musical wellbeing, including but not limited to its instrumental value towards specific therapeutic ends. Understanding the music cognitive basis for music engagement could be one small tool in service of this objective.

References


https://doi.org/10.1111/nyas.13155

https://doi.org/10.1017/S0954579400007318


https://doi.org/10.1097/JGP.0b013e318202bf5b


https://doi.org/10.1016/S0304-422X(99)00017-0

https://doi.org/10.1080/03601277.2010.515897


https://doi.org/10.1080/09658210701734593


https://doi.org/10.1093/aje/kwf074


https://doi.org/10.1016/j.bandc.2009.03.008


https://doi.org/10.1097/01.JGP.0000192478.82189.a8


**Table 4.1**

*fsQCA Overview*

<table>
<thead>
<tr>
<th>Stage</th>
<th>Objectives</th>
<th>Implementation in current study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case selection</td>
<td>Identify and define a set of cases that illustrate the research question</td>
<td>Recruited 15 AD participants with varying disease severity and music backgrounds</td>
</tr>
<tr>
<td>Data collection</td>
<td>Characterize cases on the dimensions of interest</td>
<td>AD participants tested on cognitive and music tasks; demographics and music engagement data gathered</td>
</tr>
<tr>
<td>Calibration</td>
<td>Develop criteria (coding rules) for full membership and non-membership in each conceptual category; calculate fuzzy set scores</td>
<td>Each AD case assigned fuzzy set scores based on music tasks, degree of cognitive impairment, demographic variables, and music engagement</td>
</tr>
<tr>
<td>Fuzzy set analysis</td>
<td>Evaluate fuzzy sets for consistency and coverage of overlap with the outcome; examine cases for membership in all possible configurations; generate solution to describe the configurations of conditions that overlap best with the outcome</td>
<td>Identified configurations of cognitive and demographic conditions that most consistently describe AD cases with and without high music engagement</td>
</tr>
<tr>
<td>Interpretation</td>
<td>Describe qualities of the configurations that form the solution, in light of case membership in configurations</td>
<td>Described multiple distinct sets of characteristics observed in AD cases with high and low music engagement</td>
</tr>
</tbody>
</table>
Table 4.2

Demographic information for control and AD groups

<table>
<thead>
<tr>
<th></th>
<th>Control (n = 29)</th>
<th>AD (n = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (Female/Male)</td>
<td>17/12 (59/41%)</td>
<td>5/10 (33/67%)</td>
</tr>
<tr>
<td>Age – Years (M (SD))</td>
<td>71.03 (6.04)</td>
<td>76.07 (6.87)</td>
</tr>
<tr>
<td>Education – Years (M (SD))</td>
<td>14.76 (4.82)</td>
<td>13.67 (3.70)</td>
</tr>
<tr>
<td>Music Education (N (%))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 year</td>
<td>15 (52%)</td>
<td>10 (67%)</td>
</tr>
<tr>
<td>1 – 3 years</td>
<td>3 (10%)</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>4 – 7 years</td>
<td>5 (17%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>8 – 10 years</td>
<td>3 (10%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>&gt; 10 years</td>
<td>3 (10%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>MMSE (M (SD))</td>
<td>29.07 (1.00)</td>
<td>20.13 (6.32)</td>
</tr>
</tbody>
</table>
Table 4.3

*AD and control group median scores on ITT, MBEA, and MusEQ*

<table>
<thead>
<tr>
<th></th>
<th>Control  n = 29</th>
<th>AD  n = 15</th>
<th>U</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITT (d’)</td>
<td>1.99</td>
<td>1.73</td>
<td>140.50</td>
<td>.06</td>
</tr>
<tr>
<td>MBEA (d’)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.56</td>
<td>2.28</td>
<td>156.50</td>
<td>.13</td>
</tr>
<tr>
<td>Contour</td>
<td>2.17</td>
<td>1.64</td>
<td>164.50</td>
<td>.19</td>
</tr>
<tr>
<td>Interval</td>
<td>2.12</td>
<td>1.64</td>
<td>173.00</td>
<td>.27</td>
</tr>
<tr>
<td>Scale</td>
<td>2.49</td>
<td>2.56</td>
<td>240.50</td>
<td>.56</td>
</tr>
<tr>
<td>Rhythm</td>
<td>2.49</td>
<td>1.90</td>
<td>124.50</td>
<td>.02</td>
</tr>
<tr>
<td>MBEA (correct responses)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (/80)</td>
<td>70</td>
<td>64</td>
<td>145.50</td>
<td>.07</td>
</tr>
<tr>
<td>Contour (/20)</td>
<td>17</td>
<td>15</td>
<td>155.00</td>
<td>.12</td>
</tr>
<tr>
<td>Interval (/20)</td>
<td>17</td>
<td>15</td>
<td>166.00</td>
<td>.20</td>
</tr>
<tr>
<td>Scale (/20)</td>
<td>18</td>
<td>18</td>
<td>222.00</td>
<td>.91</td>
</tr>
<tr>
<td>Rhythm (/20)</td>
<td>18</td>
<td>16</td>
<td>109.50</td>
<td>.01</td>
</tr>
<tr>
<td>MusEQ (Informant Version)</td>
<td>n = 22</td>
<td>n = 15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.97</td>
<td>2.92</td>
<td>163.00</td>
<td>.96</td>
</tr>
<tr>
<td>Basic</td>
<td>2.91</td>
<td>3.18</td>
<td>192.00</td>
<td>.42</td>
</tr>
</tbody>
</table>
Table 4.4

*Coding scheme for outcome and condition fuzzy set membership*

<table>
<thead>
<tr>
<th>Fuzzy Set</th>
<th>Outcome</th>
<th>Conditions</th>
<th>Music Perception</th>
<th>Education</th>
<th>Cognition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Music Engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>MusEQ</em> (units)</td>
<td><em>ITT</em> (0-5 scale)</td>
<td><em>MBEA</em> (d’</td>
<td><em>CONTOUR</em></td>
<td><em>SCALE</em></td>
</tr>
<tr>
<td>Full membership</td>
<td>5</td>
<td>&gt;= 1.92</td>
<td>&gt;= 2.52</td>
<td>&gt;= 1.97</td>
<td>&gt;= 2.46</td>
</tr>
<tr>
<td>[1.0]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximal ambiguity</td>
<td>3</td>
<td>1.38</td>
<td>1.77</td>
<td>1.37</td>
<td>1.07</td>
</tr>
<tr>
<td>[0.5]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full non-</td>
<td>1</td>
<td>0.84</td>
<td>&lt;= 1.01</td>
<td>&lt;= 0.68</td>
<td>&lt;= 0.18</td>
</tr>
<tr>
<td>membership</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values corresponding to fuzzy set membership scores of 1.0, 0.5, and 0.0 for each variable. *MusEQ*, Music Engagement; *ITT*, Instrumental Tunes Test; *MBEA*, MBEA Total Score; *CONTOUR*, MBEA Contour Test; *INTERVAL*, MBEA Interval Test; *SCALE*, MBEA Scale Test; *RHYTHM*, MBEA Rhythm Test; *EDUC*, years of education; *MUSED*, 5 point ordinal scale calibrated to fuzzy set scores; *MMSE*, Mini-Mental Status Exam.
### Table 4.5

*Consistency and coverage of conditions for MusEQ and ~MusEQ*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Condition</th>
<th>Consistency</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MusEQ</strong></td>
<td>MMSE</td>
<td>0.56</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>EDUC</td>
<td>0.53</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>MUSED</td>
<td>0.35</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>ITT</td>
<td>0.74</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>MBEA</td>
<td>0.69</td>
<td>0.63</td>
</tr>
<tr>
<td><strong>~MusEQ</strong></td>
<td>~MMSE</td>
<td>0.60</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>~EDUC</td>
<td>0.55</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>~MUSED</td>
<td>0.96</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>~ITT</td>
<td>0.50</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>~MBEA</td>
<td>0.48</td>
<td>0.55</td>
</tr>
</tbody>
</table>
Table 4.6

Analysis of conditions for the MusEQ and ~MusEQ outcomes

<table>
<thead>
<tr>
<th>Model</th>
<th>Solution Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MusEQ = f(MBEA, ITT, MUSED, EDUC, MMSE)</strong></td>
<td><strong>ITT*~MMSE</strong> + MBEA <em>~MMSE + MBEA</em> MMSE * MUSED * EDUC**</td>
</tr>
<tr>
<td><strong>coverage:</strong> 0.68; <strong>consistency:</strong> 0.94</td>
<td></td>
</tr>
<tr>
<td><strong>Intermediate solution; assumption: all conditions present</strong></td>
<td></td>
</tr>
<tr>
<td>Raw Coverage</td>
<td>.50</td>
</tr>
<tr>
<td>Unique Coverage</td>
<td>.24</td>
</tr>
<tr>
<td>Consistency</td>
<td>.96</td>
</tr>
<tr>
<td>Cases &gt; .5 membership*</td>
<td>CM (0.84, 0.92)</td>
</tr>
<tr>
<td></td>
<td>GB (0.80, 0.77)</td>
</tr>
<tr>
<td></td>
<td>AM (0.75, 0.57)</td>
</tr>
<tr>
<td></td>
<td>MW (0.66, 0.63)</td>
</tr>
<tr>
<td><strong>~MusEQ = f(MMSE, EDUC, MUSED, ITT, MBEA)</strong></td>
<td><em><em>~ITT</em> ~MUSED</em> + ~EDUC* MMSE + ~MBEA * ~MUSED* ~EDUC* MMSE**</td>
</tr>
<tr>
<td><strong>coverage:</strong> 0.37; <strong>consistency:</strong> 0.95</td>
<td></td>
</tr>
<tr>
<td><strong>Intermediate solution; assumption: all conditions absent</strong></td>
<td></td>
</tr>
<tr>
<td>Raw Coverage</td>
<td>0.24</td>
</tr>
<tr>
<td>Unique Coverage</td>
<td>0.16</td>
</tr>
<tr>
<td>Consistency</td>
<td>0.93</td>
</tr>
<tr>
<td>Cases &gt; .5 membership*</td>
<td>LN (0.73, 0.66)</td>
</tr>
</tbody>
</table>

*Case ID (solution term fuzzy score, outcome fuzzy score)
Figure 4.1

Illustration of subset relations
Appendix 1: MusEQ-Basic questionnaire items

Thinking of the person you described in the previous questionnaire, please indicate how much each of the following statements describes him/her during the past month.

1 = not at all   2 = a little bit   3 = somewhat   4 = quite a bit   5 = very much

1. Moves his/her body to the beat of music that is playing (e.g. tapping my feet or bobbing his/her head).
2. When by him/herself or with close family/friends, (s)he will hum or sing along with music that is being played.
3. Sings as (s)he goes about daily activities
4. Tells others if (s)he hears a song that (s)he really likes.
5. If others are singing, (s)he joins in.
6. His/her social activities revolve around music.
7. Is usually excited by the chance to hear the music that (s)he likes.
8. People who know her/him describe her/him as a musical person.
9. Relaxes when listening to peaceful music.
10. When (s)he listens to familiar music, (s)he recalls events from her/his past.
11. Becomes cheerful when listening to music (s)he enjoys.
## Appendix 2: Fuzzy set membership scores for outcome and conditions

<table>
<thead>
<tr>
<th>Case</th>
<th>Outcome</th>
<th>Music Perception</th>
<th>Education</th>
<th>Cognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>WD</td>
<td>0.9</td>
<td>0.88 1 1 1 1 1 0.99 0.97 0.5 0 0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AV</td>
<td>0.95</td>
<td>0.98 0.93 0.54 0.66 0.97 0.7 0 1 0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td>0.23</td>
<td>0.87 0.98 1 0.99 0.99 0.97 0 0 0.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JB</td>
<td>0.37</td>
<td>1 1 1 1 0.99 1 0.88 0.99 0 0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SR</td>
<td>0.12</td>
<td>0.99 0.29 0.9 0.15 0.99 0.02 0.05 0 0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>0.43</td>
<td>1 0.98 0.81 1 0.96 0.88 1 0.33 0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BF</td>
<td>0.75</td>
<td>0.01 0.94 0.25 1 0.97 0.97 0.95 0.67 0.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN</td>
<td>0.34</td>
<td>0 0.92 0.81 0.96 0.99 0.88 0.05 0 0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JG</td>
<td>0.53</td>
<td>0.01 0.12 0.29 0.05 0.86 0.33 0.95 0 0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>0.57</td>
<td>0.83 0.98 1 1 0.99 0.61 0 0 0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CM</td>
<td>0.92</td>
<td>0.96 0.01 0.01 0 0.83 0.01 1 0 0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GB</td>
<td>0.77</td>
<td>0.96 0.21 0.64 0.43 0.96 0.02 0.05 0 0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW</td>
<td>0.63</td>
<td>0.66 0.29 0.9 0.74 1 0.26 0.95 0.83 0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MD</td>
<td>0.72</td>
<td>0.31 0.93 0.54 0.14 0.86 1 0 0.33 0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS</td>
<td>0.18</td>
<td>0.02 0 0 0 0 0.08 0.95 0 0.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Supplemental Material: Comparative analysis of psychological cases: a fuzzy set approach

Case studies historically have played a vital role in the methodology of cognitive neuropsychology, where phenomena have been studied in single or multiple cases, or by evaluation of trends within series of cases. As sample sizes increase, though, the process of comparison becomes more cumbersome. Fuzzy set qualitative comparative analysis (FsQCA) is used in the present study as a tool to facilitate the comparison across cases.

Application of fsQCA in the Psychology literature is novel, but fortunately there is a wealth of resources available to assist researchers wanting to understand more about the methodology or to apply it in their own work. The resources described here provide detailed discussions of the methodology and its application.

General Overviews

In this chapter, Charles Ragin describes the logic of fsQCA and the main steps in the process:


For an additional helpful and practical overview of fsQCA principles and their application to data analysis in the social sciences, see:

Fuzzy Sets and Subset Relations

This chapter explains the concept of calibration in depth, as well as presenting and explaining the mathematical transformation used to derive fuzzy set scores:


The concepts of consistency and coverage are developed here in detail, with information on how the values are calculated:


Software

A number of software packages have been developed to facilitate fsQCA. An up to date list is maintained at: http://www.compasss.org/software.htm#fsQCA.

In the present study, we used fs/QCA version 3.0:

Other Resources

A wealth of resources are available online at www.compasss.org. COMPASSS (Comparative Methods for Systematic Cross-Case Analysis) is “a worldwide network bringing together scholars and practitioners who share a common interest in theoretical, methodological and practical advancements in a systematic comparative case approach to research which stresses the use of a configurational logic, the existence of multiple causality and the importance of a careful construction of research populations.” (from the website) It provides links to a variety of resources, including software, information about training events, and discussion regarding new methodological developments.

The following book chapter demonstrates the application of fsQCA to a substantive research topic, explaining the methodology and its application in parallel to the results and study design:

Chapter 5: Conclusions and General Discussion

I began this dissertation by posing the case of Henry, a man featured in the documentary *Alive Inside* who showed dramatic engagement with music, despite severe dementia that left him disengaged from his environment most of the time. How might we understand cases like his, where individuals with AD engage with music in ways that stand out relative to their disengagement from other stimuli? Exploring this question prompted two methodological developments: a questionnaire for informant-report measurement of music engagement, and a novel approach to case series analysis. The empirical studies were motivated by the hypothesis that preserved music cognitive abilities form part, but not all, of the explanatory picture. Taken together, findings presented in these papers support the assertion that mechanisms of music engagement in AD vary between individuals, and that among these mechanisms, memory for long-familiar melodies has particular relevance for music activities in daily life.

Engagement – occupation or involvement with a stimulus – is proposed in the Comprehensive Process Model to be jointly determined by attributes of the person, the stimulus, and the environment (Cohen-Mansfield et al., 2011). The findings presented here are consistent with this model and suggest a useful framework to guide future research. Setting aside environmental factors, I have focused in particular on the music cognitive abilities of individuals with AD. These abilities, their preservation or impairment, are attributes of the person, and they reflect the person’s capacity to process musical stimuli. Music cognitive abilities, then, exist at the intersection of person and stimulus characteristics.
What attributes of music make it an engaging stimulus for many individuals living with AD? This dissertation placed particular emphasis on melody, one attribute of musical stimuli. Experimental tasks evaluated processing of and memory for melodies. This focus yields experimental control; findings are not confounded by other musical features (e.g. timbre, polyphony) or extra-musical factors (e.g. lyrics). Processing and memory for these controlled stimuli was shown to be affected by AD (Chapter Two) and relevant to music engagement in daily life (Chapter Four). Data from these tasks speak directly and precisely to a particular instance of music engagement – that is, to engagement with short excerpts of familiar and unfamiliar melodies in a controlled setting where particular forms of response were requested (i.e. making judgments of familiarity or similarity/difference). The resulting account is a profile, more than a portrait, of music cognition in AD.

The elements of music are interdependent, “constantly and permanently interconnected” (Barenboim, 2009, p. 13), though. On a neuropsychological level, their processing is dissociable (Peretz & Coltheart, 2003), so it makes sense to isolate them through experimental control. However, the inherently integrated quality of music poses limits to a modular understanding of music cognition, limits made evident by those participants whose impaired performance on music perceptual tasks stood in contrast with lively responses to preferred music. These individuals showed responses to preferred music (e.g. entrainment to a beat, displays indicating recognition, positive affect) that would not be possible in the case of complete musical apperception. These observations point to a previously-unexplored distinction: music perceptual acuity may be sufficient to permit meaningful engagement with musical sound, even if it is classified as impaired relative to age-typical norms.
The interconnection of musical elements creates redundancies that are present to a much greater extent in real-life music, relative to experimental stimuli. I propose that such redundancies could enable music engagement in persons with compromised music perceptual ability. Consider the differences between a folk melody presented as a single instrumental line (as in our experimental stimuli) and, on the other hand, as a recording by a band and singer. The melody itself has an implied harmonic structure, which is explicitly reinforced by the instrumental accompaniment of the band. Similarly, the melody implies an underlying metric structure, which is typically made more salient by a band’s rhythm section. Furthermore, the harmonic structure has a rhythm of its own, which tends to accord with patterns of strong and weak beats articulated in the metre of the song.

As a theoretical direction for future research, I propose that these redundancies, arising from interconnection of musical elements, could reinforce perception and decrease the level of perceptual acuity required for meaningful engagement with the musical stimulus. Such an effect could result from interactions between processing modules, whereby perception of one musical element enhances perception of another element. Enhanced perception may facilitate implicit musical expectations (c.f. Huron, 2006), evoking emotional experience and reinforcing engagement. The effects of interconnection and redundancy on music processing in AD could be investigated experimentally by systematically combining two or more musical elements in the stimuli. For example, perhaps melody recognition could be enhanced by adding an accompaniment consisting of a rhythm, a chord progression, or both.

Drawing on musical semantic memories is part of many different music activities, and over a lifetime they become associated with autobiographical memories. Through engagement, musical semantic memories are activated, often in vital and emotionally-salient ways, and they
may evoke other memories from the personal past. Autobiographical memories, both episodic and semantic, form a distinct self-memory system (Conway & Pleydell-Pearce, 2000), which is important to maintaining continuity of personal identity across life epochs (Conway, Singer, & Tagini, 2004). Musical semantic memories are able to evoke autobiographical memories in persons with AD (Cuddy, Sikka, Silviera, Bai, & Vanstone, 2017; El Haj, Postal, & Allain, 2012); engaging with music from the past creates possibility to experience continuity of the self during a time of life often marked by disconnection from previous aspects of personal experience. To the extent that musical semantic memories are autobiographical, future research on musical memory might consider whether musical memories behave similarly to other forms of self-relevant memory.

All three studies presented in this dissertation have relied on cross-sectional designs. AD participants showed wide variation in dementia severity, allowing for the inference that preserved musical semantic memory and music engagement may persist well into the course of the disease. These data raise questions regarding how AD affects these and other music-related capacities over time and within the individual. For example, it is unclear if AD participants with low engagement were always similarly disengaged from music, or whether they had become so over the course of their illness. For those with high levels of engagement, we were unable to evaluate whether their means of engaging with music had shifted or whether they retained the same music activities – that is, is there an underlying musical impulse that remains constant while shifting its expression to circumvent the functional limitations of AD? Or do individuals simply continue in their usual music activities until each one in turn becomes impossible? Observing changes in music cognition and in the quality and quantity of music engagement within individuals and over time would help answer these questions. The findings presented here
imply that such longitudinal data would be informative, given that meaningful levels of engagement are observed well into the AD course. They also suggest that longitudinal study design would benefit from including measures of musical semantic memory, given its implication in the fuzzy set solutions presented in Chapter 4.

The studies presented in this dissertation have focused on basic processes and methodological issues, and they have implications for clinical research and application of music to dementia care. Managing behavioural and psychological symptoms of dementia remains an important direction in music therapy research. Music-based intervention holds promise as a safer and more pleasant alternative to pharmacological approaches, although its empirical evidence base is not as well developed as it is for some other psycho-social interventions. Controlled clinical trials have a role to play, but the ultimate clinical task is to translate research evidence into interventions that are effective for specific individuals. The psychotherapy literature – which has accumulated evidence for how individual differences are relevant to adapting treatment for individual patients (Norcross & Wampold, 2011) – provides a template for how music therapy research could refine music-based interventions in dementia.

From the case-comparative perspective offered here, such a development is important; if different music activities have differing cognitive and functional demands, then these demands should be taken into account when clinicians help their patients to engage with music for therapeutic purposes. Given the tendency for music semantic memories to be less affected by AD than some other forms of memory, it is unsurprising that the music activities facilitated in dementia care environments often revolve around familiar songs – group singing being the most common example. It seems that such activities are enjoyed by participants with varying levels of musical and extra-musical ability, but over-reliance on one single mode of music activity (e.g.
group singing sessions) leaves patients at risk of musical disengagement should they lose the requisite functional abilities – it would be hard to sing along having forgotten the lyrics and become unable to read the song sheet, even if the memory for melody remained. Perhaps, in that instance, the facilitator might individualize care by creating an environment in which the individual is free to vocalize with vowel sounds instead of the lyrics or to keep time with a hand drum if not inclined to sing. As knowledge about the musical phenotypes of AD grows, it should inform the ongoing efforts of applied researchers studying music-based interventions. For now, though, the simple fact that there is heterogeneity in the music cognition and engagement of listeners with AD has a clear clinical implication, one likely more relevant to administrators than to front line clinicians: delivery of music-therapy interventions requires the clinician to observe and adapt to the shifting abilities of individual patients. This task requires clinical skill and sensitivity, and volunteer-led or ad hoc music programming should not be equated with music-based care provided by a skilled professional.

Studies on the neuropsychology of music and AD often conclude with some remarks on clinical application. It makes sense that such implications be drawn out, insofar as they contribute to the theoretical motivation for music therapeutic interventions. Generally, though, clinical application is not the primary motivation for this basic research. It is implied, but generally not articulated, that understanding the neuropsychology of music is valuable because music is a valued part of human experience. It matters whether this experience persists or fades in the face of dementia.

Most people do not frame their musical experience in therapeutic terms, even if they do recognize its benefits to physical or emotional wellbeing. In contrast, the discourse on music and dementia tends to highlight the practical uses of music to manage behavioural, emotional, and
cognitive deficits – uses that are undeniably important and deserve scholarly attention. Music is used for problems arising from dementia. Similarly instrumental motivations are implied in research on music education and intelligence (e.g. Schellenberg, 2004). Allocating resources to music is legitimized if it strengthens children’s mathematical ability or makes nursing home residents more compliant at feeding time.

In focusing on music’s clinical use towards specific ends, music-for-dementia, we risk overlooking its aesthetic and social value, its humanizing potential, which prompts me to consider a parallel line of inquiry: music-in-dementia. Starting from scientific observation of how dementia (in its various forms) affects the musical brain and cognition, we might re-imagine the experience of music as encompassed within the experience of dementia. How does the musical self adapt to encroaching neurodegenerative disorder? What is it like to engage with the musical stimulus amidst cognitive and functional pressures of dementia? How could this experience be expressed and experienced in social context?

The perspective of music-in-dementia implies the coming alongside of scientists and artists, in collaboration with persons with dementia, to further understand the functional and neurological mechanisms of engagement and to explore the nascent musical possibilities these mechanisms contain. It invites clinicians to look beyond traditional categories of clinical outcome. Engagement with music-for-dementia may result in beneficial reductions in symptoms such as apathy or agitation. Engagement with music-in-dementia signals adaptation of musical life to the new and often distressing realities of living with a neurodegenerative disorder. It should be facilitated, celebrated, and acknowledged as a legitimate focus of dementia care.


Appendix A: Music Engagement Questionnaire (MusEQ) -- Supplemental Information


The following tables present normative data for the MusEQ and its subscales, listing the percentile equivalents for scale score values. The data provided here are from the scale development dataset collected from informants and reported in the paper, incorporating additional older adult control data collected since we published the initial scale development findings. For these tables, participants with missing data were excluded only for the scales on which they had missing data. N’s vary for each scale as a result, and they are noted in the tables.

The listed values refer to the factor-weighted scale scores, in which response values (on a 1-5 Likert scale) are multiplied by the factor coefficients derived in scale development and then normalized back to a 1-5 scale. We have created an Excel worksheet to calculate factor-weighted scaled scores from raw data, which can be found at: https://www.researchgate.net/publication/274093704_Measuring_engagement_with_music_Development_of_an_informant-report_questionnaire#share.

Also included here are percentile scores for a new scale, MusEQ Basic, which has been developed since we initially reported MusEQ scale development. This scale is intended to provide a shorter measure, focusing on the music activities that rely least on more complex activities of daily living. We believe it is better suited to evaluating individuals with more severe dementia-related impairment, or where a brief measure is important for practical purposes. Table 3 lists the 11 MusEQ Basic scale items. Unlike for the other scores in Table 1, the Basic score is
simply the mean response value of the 11 scale items. Additional information will be available in a forthcoming paper.

Table A.1: MusEQ (Informant Version) Scale Score to Percentile Conversions (All Ages)

Participant age range: 12 – 88 years. Mean age: 41 years (SD = 19)  
Sample N = 200

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Daily (n = 192)</th>
<th>Emotion (n = 189)</th>
<th>Perform (n = 194)</th>
<th>Consume (n = 194)</th>
<th>Respond (n = 195)</th>
<th>Prefer (n = 196)</th>
<th>Total (n = 172)</th>
<th>Basic (n = 200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1.41</td>
<td>1.76</td>
<td>1.07</td>
<td>1.78</td>
<td>1.25</td>
<td>2.61</td>
<td>1.94</td>
<td>1.64</td>
</tr>
<tr>
<td>10</td>
<td>1.82</td>
<td>2.05</td>
<td>1.18</td>
<td>2.01</td>
<td>1.66</td>
<td>3.00</td>
<td>2.20</td>
<td>2.00</td>
</tr>
<tr>
<td>15</td>
<td>2.09</td>
<td>2.21</td>
<td>1.26</td>
<td>2.17</td>
<td>1.81</td>
<td>3.18</td>
<td>2.44</td>
<td>2.20</td>
</tr>
<tr>
<td>20</td>
<td>2.38</td>
<td>2.38</td>
<td>1.44</td>
<td>2.45</td>
<td>2.02</td>
<td>3.45</td>
<td>2.67</td>
<td>2.45</td>
</tr>
<tr>
<td>25</td>
<td>2.68</td>
<td>2.50</td>
<td>1.57</td>
<td>2.57</td>
<td>2.23</td>
<td>3.51</td>
<td>2.85</td>
<td>2.55</td>
</tr>
<tr>
<td>30</td>
<td>2.97</td>
<td>2.58</td>
<td>1.70</td>
<td>2.74</td>
<td>2.47</td>
<td>3.62</td>
<td>2.93</td>
<td>2.66</td>
</tr>
<tr>
<td>35</td>
<td>3.14</td>
<td>2.74</td>
<td>1.83</td>
<td>2.90</td>
<td>2.54</td>
<td>3.73</td>
<td>2.97</td>
<td>2.82</td>
</tr>
<tr>
<td>40</td>
<td>3.30</td>
<td>2.85</td>
<td>1.93</td>
<td>3.11</td>
<td>2.76</td>
<td>3.73</td>
<td>3.04</td>
<td>2.91</td>
</tr>
<tr>
<td>45</td>
<td>3.46</td>
<td>2.95</td>
<td>2.00</td>
<td>3.26</td>
<td>3.00</td>
<td>3.91</td>
<td>3.17</td>
<td>3.04</td>
</tr>
<tr>
<td>50</td>
<td>3.58</td>
<td>3.08</td>
<td>2.28</td>
<td>3.44</td>
<td>3.08</td>
<td>4.00</td>
<td>3.27</td>
<td>3.18</td>
</tr>
<tr>
<td>55</td>
<td>3.72</td>
<td>3.21</td>
<td>2.41</td>
<td>3.52</td>
<td>3.31</td>
<td>4.07</td>
<td>3.35</td>
<td>3.27</td>
</tr>
<tr>
<td>60</td>
<td>3.87</td>
<td>3.33</td>
<td>2.57</td>
<td>3.60</td>
<td>3.54</td>
<td>4.27</td>
<td>3.46</td>
<td>3.45</td>
</tr>
<tr>
<td>65</td>
<td>4.02</td>
<td>3.44</td>
<td>2.75</td>
<td>3.72</td>
<td>3.75</td>
<td>4.27</td>
<td>3.55</td>
<td>3.64</td>
</tr>
<tr>
<td>70</td>
<td>4.11</td>
<td>3.62</td>
<td>2.97</td>
<td>3.81</td>
<td>3.79</td>
<td>4.38</td>
<td>3.65</td>
<td>3.64</td>
</tr>
<tr>
<td>75</td>
<td>4.22</td>
<td>3.84</td>
<td>3.31</td>
<td>3.88</td>
<td>4.00</td>
<td>4.58</td>
<td>3.83</td>
<td>3.73</td>
</tr>
<tr>
<td>80</td>
<td>4.35</td>
<td>3.97</td>
<td>3.59</td>
<td>3.97</td>
<td>4.08</td>
<td>4.65</td>
<td>3.88</td>
<td>3.89</td>
</tr>
<tr>
<td>85</td>
<td>4.53</td>
<td>4.13</td>
<td>3.96</td>
<td>4.08</td>
<td>4.31</td>
<td>4.73</td>
<td>4.02</td>
<td>4.09</td>
</tr>
<tr>
<td>90</td>
<td>4.73</td>
<td>4.27</td>
<td>4.41</td>
<td>4.22</td>
<td>4.75</td>
<td>5.00</td>
<td>4.10</td>
<td>4.27</td>
</tr>
<tr>
<td>95</td>
<td>5.00</td>
<td>4.44</td>
<td>4.74</td>
<td>4.54</td>
<td>5.00</td>
<td>5.00</td>
<td>4.29</td>
<td>4.55</td>
</tr>
</tbody>
</table>
Table A.2: MusEQ (Informant Version) Scale Score to Percentile Conversions (Older Adults)

Participant age range: 65 - 88. Mean age: 71 years (SD = 6)
Sample N = 41

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Daily (n = 39)</th>
<th>Emotion (n = 38)</th>
<th>Perform (n = 39)</th>
<th>Consume (n = 40)</th>
<th>Respond (n = 40)</th>
<th>Prefer (n = 40)</th>
<th>Total (n = 33)</th>
<th>Basic (n = 41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1.00</td>
<td>1.59</td>
<td>1.00</td>
<td>1.83</td>
<td>1.00</td>
<td>2.63</td>
<td>1.61</td>
<td>1.37</td>
</tr>
<tr>
<td>10</td>
<td>1.28</td>
<td>1.68</td>
<td>1.07</td>
<td>2.01</td>
<td>1.02</td>
<td>3.00</td>
<td>1.73</td>
<td>1.64</td>
</tr>
<tr>
<td>15</td>
<td>1.49</td>
<td>2.08</td>
<td>1.18</td>
<td>2.03</td>
<td>1.29</td>
<td>3.02</td>
<td>2.21</td>
<td>1.94</td>
</tr>
<tr>
<td>20</td>
<td>1.81</td>
<td>2.25</td>
<td>1.25</td>
<td>2.23</td>
<td>1.74</td>
<td>3.31</td>
<td>2.33</td>
<td>2.22</td>
</tr>
<tr>
<td>25</td>
<td>1.92</td>
<td>2.45</td>
<td>1.36</td>
<td>2.54</td>
<td>1.84</td>
<td>3.48</td>
<td>2.50</td>
<td>2.48</td>
</tr>
<tr>
<td>30</td>
<td>2.04</td>
<td>2.53</td>
<td>1.45</td>
<td>2.69</td>
<td>2.00</td>
<td>3.55</td>
<td>2.77</td>
<td>2.56</td>
</tr>
<tr>
<td>35</td>
<td>2.28</td>
<td>2.61</td>
<td>1.54</td>
<td>2.75</td>
<td>2.04</td>
<td>3.73</td>
<td>2.85</td>
<td>2.64</td>
</tr>
<tr>
<td>40</td>
<td>2.52</td>
<td>2.72</td>
<td>1.56</td>
<td>2.95</td>
<td>2.13</td>
<td>3.88</td>
<td>2.87</td>
<td>2.78</td>
</tr>
<tr>
<td>45</td>
<td>2.79</td>
<td>2.77</td>
<td>1.67</td>
<td>3.08</td>
<td>2.47</td>
<td>4.00</td>
<td>2.92</td>
<td>2.82</td>
</tr>
<tr>
<td>50</td>
<td>2.98</td>
<td>3.02</td>
<td>1.72</td>
<td>3.35</td>
<td>2.54</td>
<td>4.09</td>
<td>2.98</td>
<td>2.82</td>
</tr>
<tr>
<td>55</td>
<td>3.03</td>
<td>3.12</td>
<td>1.76</td>
<td>3.47</td>
<td>2.75</td>
<td>4.27</td>
<td>3.01</td>
<td>2.83</td>
</tr>
<tr>
<td>60</td>
<td>3.15</td>
<td>3.20</td>
<td>1.84</td>
<td>3.54</td>
<td>3.00</td>
<td>4.27</td>
<td>3.12</td>
<td>2.93</td>
</tr>
<tr>
<td>65</td>
<td>3.29</td>
<td>3.27</td>
<td>2.04</td>
<td>3.64</td>
<td>3.29</td>
<td>4.27</td>
<td>3.32</td>
<td>3.09</td>
</tr>
<tr>
<td>70</td>
<td>3.37</td>
<td>3.42</td>
<td>2.31</td>
<td>3.71</td>
<td>3.52</td>
<td>4.41</td>
<td>3.41</td>
<td>3.29</td>
</tr>
<tr>
<td>75</td>
<td>3.54</td>
<td>3.71</td>
<td>2.58</td>
<td>3.80</td>
<td>3.71</td>
<td>4.65</td>
<td>3.47</td>
<td>3.50</td>
</tr>
<tr>
<td>80</td>
<td>3.63</td>
<td>3.93</td>
<td>2.69</td>
<td>3.86</td>
<td>4.02</td>
<td>4.65</td>
<td>3.54</td>
<td>3.64</td>
</tr>
<tr>
<td>85</td>
<td>3.78</td>
<td>4.10</td>
<td>2.86</td>
<td>4.03</td>
<td>4.22</td>
<td>4.96</td>
<td>3.61</td>
<td>3.79</td>
</tr>
<tr>
<td>90</td>
<td>4.02</td>
<td>4.27</td>
<td>3.37</td>
<td>4.22</td>
<td>4.29</td>
<td>5.00</td>
<td>3.75</td>
<td>3.91</td>
</tr>
<tr>
<td>95</td>
<td>4.59</td>
<td>4.39</td>
<td>4.24</td>
<td>4.85</td>
<td>4.96</td>
<td>5.00</td>
<td>4.10</td>
<td>4.09</td>
</tr>
</tbody>
</table>
Table A.3: MusEQ Basic Scale Items (Informant Version)

Please indicate how much each of the following statements describes _____________ during the past month.

1 = not at all   2 = a little bit   3 = somewhat   4 = quite a bit   5 = very much

1. Moves his/her body to the beat of music that is playing (e.g. tapping my feet or bobbing my head).
2. When by him/herself or with close family/friends, (s)he will hum or sing along with music that is being played.
3. Sings as (s)he goes about daily activities
4. Tells others if (s)he hears a song that (s)he really likes.
5. If others are singing, (s)he joins in.
6. His/her social activities revolve around music.
7. Is usually excited by the chance to hear the music that (s)he likes.
8. People who know her/him describe her/him as a musical person.
9. Relaxes when listening to peaceful music.
10. When (s)he listens to familiar music, (s)he recalls events from her/his past.
11. Becomes cheerful when listening to music (s)he enjoys.
January 06, 2015

Mr. Ashley Vanstone  
Graduate Student  
Department of Psychology  
Queen's University  
Kingston, ON, K7L 3N6

GREB Romeo #: 6005650  
Title: "GPSYC-521-11 A Neuropsychological Model of Music Engagement in Alzheimer’s Disease"

Dear Mr. Vanstone:

The General Research Ethics Board (GREB) has reviewed and approved your request for renewal of ethics clearance for the above-named study. This renewal is valid for one year from January 17, 2015. Prior to the next renewal date you will be sent a reminder memo and the link to ROMEO to renew for another year.

You are reminded of your obligation to advise the GREB of any adverse event(s) that occur during this one year period. An adverse event includes, but is not limited to, a complaint, a change or unexpected event that alters the level of risk for the researcher or participants or situation that requires a substantial change in approach to a participant(s). You are also advised that all adverse events must be reported to the GREB within 48 hours. Report to GREB through either ROMEO Event Report or Adverse Event Report Form at http://www.queensu.ca/ors/researchethics/GeneralREB/forms.html.

You are also reminded that all changes that might affect human participants must be cleared by the GREB. For example you must report changes in study procedures or implementation of new aspects into the study procedures. Your request for protocol changes will be forwarded to the appropriate GREB reviewers and/or the GREB Chair.

Please report changes to GREB through either ROMEO Event Reports or the Ethics Change Form at http://www.queensu.ca/ors/researchethics/GeneralREB/forms.html.

On behalf of the General Research Ethics Board, I wish you continued success in your research.

Yours sincerely,

Joan Stevenson, Ph.D.  
Chair  
General Research Ethics Board

c.: Dr. Lola Cuddy, Co-investigator  
Dr. Stanka Fitneva, Chair, Unit REB  
Ms. Marie Tooley, Dept. Admin.