Safe and Sound

Soundscape research in special needs care

Kirsten van den Bosch

This dissertation has been supported by The Netherlands Organization for Health Research and Development under Grant 94308003(1), and the Research School of Behavioral and Cognitive Neurosciences in Groningen.

Safe and Sound
Soundscape research in special needs care

ISBN: 978-90-367-8144-2
ISBN: 978-90-367-8143-5 (electronic version)
NUR: 848

Cover design by David Oldenburger and Arryon Tijsma
Printed by GVO Drukkers en Vormgevers B.V.

rijksuniversiteit
groningen

Safe and Sound

Soundscape research in special needs care

Proefschrift

ter verkrijging van de graad van doctor aan de
Rijksuniversiteit Groningen
op gezag van de
rector magnificus prof. dr. E. Sterken
en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op

donderdag 29 oktober 2015 om 14.30 uur

door

Kirsten Anna-Marie van den Bosch

geboren op 8 februari 1988
te Rotterdam

Promotores
Prof. dr. C. Vlaskamp
Prof. dr. A.J.J.M. Ruijssenaars
Prof. dr. D. Başkent

Copromotor
Dr. T.C. Andringa

Beoordelingscommissie
Prof. dr. D. Botteldooren
Prof. dr. P.J.C.M. Embregts
Prof. dr. H.J.M. Janssen

Contents

"Unnecessary noise, then, is the most cruel absence of care which can be inflicted either on sick or well."

- Florence Nightingale, 1860 -

Chapter One

Introduction

In her seminal work '*Notes on Nursing: What it is and What it is Not*', Florence Nightingale already understood and emphasized the deleterious effects of noise on both sick or well individuals. However, with a strong focus on the visual domain in research, architecture, and healthcare, the focus on sound in research on quality of life, despite Nightingale's conclusions, seems to have diminished. Although there is a well-established body of research on the acute effects of noise, there is little knowledge about the effects of sound in long-term healthcare settings, which holds in particular for special needs care. This dissertation explores this issue, namely the role of sound in residential facilities and day care services for people with severe or profound intellectual and multiple disabilities. It provides a theoretical framework that allows for better understanding of soundscape and sound annoyance research, guidelines on how to apply the theoretical framework and developed tools to this specific population, and as such it substantiates Florence Nightingale's insights.

Severe or profound intellectual and multiple disabilities

In the DSM-5 (American Psychiatric Association, 2013), intellectual disabilities are defined as neurodevelopmental disorders "*with onset during the developmental period that includes both intellectual and adaptive functioning deficits in conceptual, social, and practical domains.*" This entails prominent deficiencies in intellectual functions such as learning (from experience and instruction), reasoning, judgment, and problem solving, as well as deficits in adaptive functioning limiting independence, such as communication and social participation. The severity of the intellectual disability is categorized based on adaptive functioning, determining the level of support needed. Previously, this categorization was based on IQ scores and a severe intellectual disability was associated with an IQ in the range of 40-25, and a profound intellectual disability was characterized by an IQ not exceeding 25 points. However, IQ measures are difficult to assess within this target group and the validity of these measures drops towards the lower end of the IQ range (APA, 2013). Therefore, the APA adopted a classification similar to that of the American Association on Intellectual and Developmental Disabilities (AAIDD), which is based on the intensity of support needed. According to the APA, people with severe intellectual disabilities require support for all daily activities and constant supervision, and people with profound intellectual disabilities are dependent on others for all aspects of daily physical care, health, and safety (APA, 2013). The AAIDD makes a distinction between extensive support, which is often associated with a severe intellectual disability, and pervasive support, associated with profound intellectual disabilities (Schalock et al., 2010).

An intellectual disability as extensive as described above is predominantly caused by genetic, congenital or acquired biological factors, leading to encephalopathies (disorders of the brain) with implications for the entire central nervous system (Arvio & Sillanpää, 2003). This explains the high comorbidity with other (motor, sensory, and psychiatric) disabilities, characteristic for this target group. Most people with severe or profound intellectual disabilities suffer from motor disabilities such as spastic quadriplegia, but also a high prevalence of seizure disorders like epilepsy diminishes their freedom of movement and daily functioning (Arvio & Sillanpää, 2003; Nakken & Vlaskamp, 2007). This group is described as people with profound intellectual and multiple disabilities (PIMD), and is distinguished by two defining key characteristics: a profound intellectual disability in combination with a profound motor disability. These disabilities are often accompanied by additional severe or profound secondary disabilities or impairments (Nakken & Vlaskamp, 2007).

Speech deficits are among the most prevalent related impairments (Arvio & Sillanpää, 2003) and most people with severe or profound intellectual disabilities function at the preverbal stage of communication, indicating their spoken language is limited, and they can only understand some simple instructions and gestures (APA, 2013; Goldbart, 1997). Sensory impairments in all modalities are also common among these people. This includes malfunctioning olfaction (smell) and gustation (taste) (Doty et al., 2002) and impaired tactile and coetaneous senses (touch, pressure, temperature, and pain) (Oberlander, Gilbert, Chambers, O'Donnell, & Craig, 1999). These sensory impairments are however often overlooked and the assessment of these dysfunctions is extremely difficult, due to the limited cognitive and communicative abilities of people with severe or profound intellectual disabilities.

More obvious and notable sensory impairments include auditory and visual disabilities. The prevalence of visual disabilities increases with the severity of the intellectual disability, with an estimate of 70-85% of people with a profound intellectual disability experiencing visual disorders, in most cases caused by impaired development of the visual cortex in the occipital lobe (cortical blindness) (Evenhuis, Theunissen, Denkers, Verschuure, & Kemme, 2001; Van Splunder, Stilma, Bernsen, & Evenhuis, 2006; Warburg, 2001; Woodhouse, Griffiths, & Gedling, 2000). Auditory problems, although common, appear to be less prevalent, with estimates between 30-80%, in people with PIMD (Evenhuis et al., 2001; Meuwese-Jongejeugd et al., 2006).

The lower prevalence of hearing deficits compared to visual deficits in people with severe or profound intellectual disabilities can be explained by a more prominent role of (preserved) subcortical areas in hearing than in vision (Andringa & Lanser, 2013). Although visual and auditory impairments seem hard to miss, they are still an "*unnoticed, undiagnosed and untreated problem*" (Newsam, Walley, & McKie, 2010). Some studies estimate that up to 85% of ocular disorders and 63% of hearing loss remain unnoticed in people with intellectual disabilities (Kerr et al., 2003; McCullough, Sludden, McKeown, & Kerr, 1996). Reasons for this clinical failure include diminished communicative opportunities, assessment difficulties, and diagnostic overshadowing, where behavioral manifestations indicative of sensory impairments are misattributed to the intellectual disability (Carvill, 2001; Evenhuis, Mul, Lemaire, & de Wijs, 1997; Lennox, Diggens, & Ugoni, 1997).

The combination of intellectual and visual disabilities can cause the individual to be more vulnerable to develop behavioral problems and psychiatric illnesses (Carvill, 2001) and not surprisingly, sensory problems are associated with the onset of challenging behavior (Poppes, Van der Putten, & Vlaskamp, 2010). Challenging behavior is a common problem among people with an intellectual disability. The prevalence of psychiatric and behavioral problems in this population is estimated at 30-50% (Došen, 2005), with an even higher prevalence among people with PIMD (Poppes et al., 2010). Challenging behavior is defined by Emerson et al. (2001) as culturally abnormal behavior of such intensity, frequency, and duration that the physical safety of the person or others is endangered, or behavior that is likely to lead to restrictions in the use of, or the denial of access to, communal facilities. In literature, challenging behaviors are commonly divided into self-injurious behavior, stereotypical behavior, and aggressive / destructive behavior (Rojahn, Matson, Lott, Esbensen, & Smalls, 2001). In addition to the above types of challenging behavior, some authors stress that withdrawn behavior may also be regarded as challenging behavior, given its consequences. Withdrawn behavior is described as behavior in which the person fails to make contact with the environment, which is especially frequent among people with PIMD (Poppes et al., 2010).

All these different types of challenging behavior have a range of negative consequences for the person involved. Examples are limited independence in general and integration into the community, possible stigma's, negative effects on learning and personal development, and reduced participation in social activities (Lundqvist, 2013; Matson et al., 2011). People with an intellectual disability who display challenging behavior are also more at risk to be abused and neglected by their caretakers (Lowe et al., 2007). Challenging behavior is thus a major problem for many people with an intellectual disability, not only because these individuals literally damage themselves, but also because it limits opportunities to participate in activities and to build or maintain relationships with others (Poppes et al., 2010).

Taken together, the combination and severity of their disabilities entails that people with severe or profound intellectual disabilities make up an incredibly heterogeneous group, characterized by a high degree of vulnerability and lack of autonomy, with a great dependence on others for the gratification of their daily needs (Nakken & Vlaskamp, 2007). The participating individuals with intellectual disabilities included in this dissertation, all have in common that they are in need of pervasive support. They all are diagnosed with either a severe or profound intellectual disability (according to the old classification of the DSM-IV-TR [APA, 2000]), and suffer from severe visual impairments or display grave challenging behavior, by which intensive supervision is required.

The effects of noise on well-being

Since there is hardly any information available on the effects of noise on people with severe or profound intellectual disabilities, we will examine literature concerning people without disabilities as a starting point of our investigation. Research on the effects of noise on the well-being of non-disabled people indicates that the sound in our environment plays an important role in physical and psychological well-being. Noise is commonly defined as loud or unwanted sound that causes disturbance. Recently, the World Health Organization (2011) published a report, quantifying the amount of healthy life years lost to the effects of environmental noise (in Europe). They studied the detrimental effects of noise in five categories: cardiovascular disease, sleep disturbance, tinnitus, cognitive impairment in children, and annoyance. All in all, it was calculated that every year at least 1 million healthy life years are lost in Western Europe, due to traffic-related noise alone.

Cardiovascular diseases are one of the most studied adverse effects of noise exposure and include, amongst others, hypertension, high blood pressure, ischaemic heart disease, and myocardial infarction. Reviews of these studies (Ising & Kruppa, 2004; WHO, 2011) show that most of these effects are conform to the noise-stress hypothesis, which states that noise is a nonspecific stressor that activates the autonomic nervous system and endocrine system. This stress response elicits changes in stress hormones such as cortisol and (nor)epinephrine, affecting the individuals' metabolism, and increasing the risk for cardiovascular diseases. These effects seem to occur above noise levels around 65 dB(A) (Babisch, 2002; Ising & Kruppa, 2004). Forasmuch as intellectual and related disabilities are caused by a damaged or underdeveloped cortex, it could be assumed that the autonomic nervous system is essentially still functional. Therefore, there is no reason to believe that these noise induced and stress related symptoms would not occur in people with severe or profound intellectual disabilities.

Sound has the power to wake us up when we sleep, and therefore it can contribute to sleep disturbances. Ample undisturbed sleep is fundamental in maintaining and restoring good health, performance, and well-being (Banks & Dinges, 2007; Colten & Altevogt, 2006). Consequently, noise can have a full array of short- to long-term effects on sleep, ranging from awakening during the night, sleepiness during the day, to chronic insomnia (WHO, 2011). Sound can wake us up because it is partly processed subcortically. The first and fastest signal detection is mediated by the amygdala, which induces the release of stress hormones when a sound is categorized as potentially dangerous (Ising & Kruppa, 2004). It is therefore no surprise that disrupted sleep is associated with heart rate elevations, increased risk of cardiovascular and coronary diseases, and impaired immune function (Buxton et al., 2012).

Even at relatively low sound levels, elevated levels of stress hormones can be measured (Evans, Bullinger, & Hygge, 1998), and long-term exposure to noise during the night could lead to permanently increased cortisol levels (Mashke, Harder, Ising, Hecht, & Thierfelder, 2002). From research on sleep disruptions in hospitals it became clear that the probability of disruptions in sleep increases when the sounds one is exposed to become louder, that electronic sounds are more alarming than other sounds, and that continuous sounds induce less arousal than non-continuous sounds. However, conversations amongst the personnel were also found to be highly alerting (Buxton et al., 2012). For people with severe or profound intellectual disabilities, who often experience trouble sleeping and therefore take naps during the day, it could mean that their sleep is considerably disturbed by all the sounds in their environment, with all kinds of detrimental health effects as a result.

Tinnitus is the experience of hearing sound, when there is no actual external stimulus, and is often described as ringing in the ears. Tinnitus is known to induce stress, sometimes leading to sleep problems, depression, anxiety, and many more adverse effects. There is a strong relation between noise exposure and tinnitus, with 50-90% of patients who experience chronic noise trauma reporting tinnitus (WHO, 2011), and noise-induced hearing loss is thus one of the most common causes of tinnitus (Han, Lee, Kim, Lim, & Shin, 2009). This gives reason to believe that people with severe or profound intellectual disabilities could also suffer from tinnitus. However, since tinnitus is only diagnosable via self-report, it is extremely difficult to reliably assess within this target group.

Cognitive impairment in children relates to the extent to which noise hinders their cognitive capacities. It seems that noise has a greater impact on children than adults (Klatte, Hellbrück, Seidel, & Leistner, 2010) and considering that people with intellectual disabilities are often described as functioning on a premature level, it could be valuable to look at research on non-disabled children as opposed to adults. Children need better listening conditions, or better signal-to-noise ratios, to recognize speech (Fallon, Trehub, & Schneider, 2000). This is probably caused by the fact that they have less knowledge to generate proper signal expectations to compensate for the degraded speech signal (Saija, Akyürek, Andringa, & Başkent, 2014) and they have greater difficulty focusing attention. Especially working memory seems to be sensitive to distractions caused by sound (Beaman, 2005). These effects count even more for children with special educational needs (Klatte et al., 2010).

Unfavorable listening conditions are often the result of bad acoustic conditions, such as long reverberation times. Reverberation is the persistence, through minimally attenuating reflections, of a sound after it is produced. Because of the long reverberation, unwanted sounds remain audible longer, they increase the noise level, and reduce speech intelligibility effectively. This causes people to raise their voices to make themselves heard, causing even more noise, a phenomenon known as the Lombard or café effect (Klatte et al., 2010; Lubman & Sutherland, 2002; Whitlock & Dodd, 2008).

Even when speech is fully intelligible, bad acoustics require more cognitive resources to decode the degraded signal, leading to an increased listening effort. In classrooms this could lead to stress, fatigue, and annoyance, with a worsened atmosphere (Evans & Hygge, 2007) and less positive social relations between teachers and students as a result (Klatte et al., 2010). Teachers in classrooms that have a long reverberation time are also known to report in sick more often than colleagues teaching in classrooms with good acoustics (MacKenzie & Airey, 1999).

Research indicates that prolonged noise in classrooms can even have adverse effects on language acquisition and pre-reading skills (Maxwell & Evans, 2000), and on the development of phonological working memory, which is essential for a child's cognitive development (Klatte et al., 2010). Studies on the effects of environmental (road traffic and aircraft) noise on the performance of young children (7-11 years) also show deficits in long-term memory and reading comprehension, recognition memory, and intentional and incidental memory (Hygge, Evans, & Bullinger, 2002; Lercher, Evans, & Meis, 2003 Stansfeld et al., 2005). Fortunately, the study by Hygge et al. (2002) gives reason to believe that these effects can be reversed after the exposure ceases, with the cognitive capacities of the participants returning to normal within 18 months. However, these results should be interpreted with caution, since it is conceivable that a child who has been exposed to noise for years on end could suffer from a permanent delay in development.

Considering that people with severe or profound intellectual disabilities already have less cognitive capacity as defined by their intellectual disability and often experience sensory impairments, it could very well be that the above described effects of noise on cognitive functioning are exaggerated in these people. Especially when the amplified effects of noise on the functioning of children as compared to adults are considered. Together with the increased risk of cardiovascular diseases due to stress, and the role of noise in sleep disturbances, it could be that noise serves as an important harmful factor in the well-being of people with severe or profound intellectual disabilities.

Soundscape research

Annoyance is the last category of detrimental effects of noise that is addressed in the report from the World Health Organization (2011). The WHO reports that people who experience sound annoyance suffer from various consequences, such as helplessness, depression, anger, anxiety, agitation, dissatisfaction or disappointment (Fields et al., 2001; Job, 1993). These adverse effects indicate a qualitative difference compared to the physiological effects such as cardiovascular disease or sleep disturbance. Annoyance seems to be a psychological, or emotional, response to sound.

Sounds can evoke all kinds of emotional reactions, from positive to negative (Bradley & Lang, 1999). These reactions depend mainly on the meaning people give to the sounds, and less so on the acoustical characteristics of the sound. This meaning arises from the interactions between the listener, the sound source, and the context of the situation (Tajadura-Jiménez, 2008). Traditionally, research on noise was focused on acoustic parameters such as loudness in decibels, dB(A), or reverberation time, as discussed above. However, it appears that merely one third of noise disturbance can be accounted for by acoustics alone (Guski, 2001), and a growing body of research indicates that it is not the physical properties of sound, but the message conveyed within the sound (the meaning people attribute to the sound) that has the largest effect on health effects caused by noise (Ising & Kruppa, 2004). Some experimental studies endorse the hypothesis that sounds are unpleasant due to their intrinsic characteristics, or psychoacoustic properties, as opposed to their intensity, or loudness (Neumann, Waters, & Westbury, 2008). It is even demonstrated that qualitative unpleasant sounds can be experienced as more displeasing than electric shocks or loud tones (Neumann & Waters, 2006) and that emotional sounds elicit greater physiological responses (e.g. startle reflex, skin conductance) than neutral sounds of similar loudness (Bradley & Lang, 2000). In real world settings it appears that an unwanted sound obscuring more pleasant (safety-indicating) sounds is enough for it to be experienced as an annoying intrusion (Andringa & Lanser, 2013). Similarly, the mere reduction of noise levels does not always lead to more positive perceptions of that environment (Adams, Cox, Moore, Croxford, Refaee, & Sharples, 2006; Dubois, Guastavino, & Raimbault, 2006); on the contrary, it can even lead to anxiety (Stockfelt, 1991).

In this dissertation we will use the terms auditory environment and soundscape. An auditory environment is the audible part of a sonic environment of a listener or group. Unlike the sonic environment, the auditory environment implies a perceiver. The field of science that considers the whole of the auditory environment, as it is appraised, is called soundscape research. Essentially soundscape researchers acknowledge both positive and negative effects of sound on the perceiver, and in doing so, the soundscape approach acknowledges a central role for non-acoustic properties of sound. Soundscapes therefore represent more than just the sound signal, but instead refer to *"an environment of sound (sonic environment) with emphasis on the way it is perceived and understood by the individual, or by a society. It thus depends on the relationship between the individual and any such environment"* (Schafer, 1977). Schafer introduced two classes of soundscapes, high and low quality ones. A soundscape of high quality (hi-fi) contains hardly any (constant) loud sounds and few mechanical sounds. Because of this, there is little overlap between the foreground sounds, and the sounds from the wider surroundings that can be heard. This allows for a distant sonic horizon and a high signal-to-noise, or foreground-to-background, ratio. Low quality soundscapes (lo-fi) are associated with an industrial, mechanized world and have sonic horizons that are much closer

(Schafer, 1977). High quality soundscapes thus contain many meaningful sounds that often match the nature of the environment.

Soundscape research goes beyond the focus on noise and its adverse effects on health, but takes a more holistic approach, focusing on the (subjective and attributed) meaning in sound (Botteldooren, De Coensel, & De Mur, 2006; Cain, Jennings, & Poxon, 2013; Schulte-Fortkamp, 2002). The variance in emotional meaning appears to be largely explained by two main factors, namely, pleasantness and arousal (Bradley & Lang, 2000). Similar components have been found by Axelsson, Nilsson, and Berglund (2010) who studied how people appraise auditory environments, and who developed a model to measure the quality of soundscapes that we will use in this dissertation. The results of their study suggest that soundscape perception can be described in terms of two main basic components: pleasantness and eventfulness. Additionally, research by Cain, Jennings, and Poxon (2013) identified calmness and vibrancy as two independent emotional dimensions of soundscapes and their appraisal. These factors relate to the pleasantness and informational content of a soundscape. For non-disabled people, an exciting soundscape is described as a combination of pleasant and eventful, and oppositely a lifeless soundscape is unpleasant and uneventful. These associations observed within groups may vary depending on the individual and may vary even more for people with intellectual disabilities.

In general, it is argued by soundscape researchers that understanding the acoustical properties of a certain place is far less important than understanding how that place influences a person emotionally. This entails that the properties of soundscapes should describe the affective experiences from the listener, as opposed to describing the physical properties of the sound itself (Cain et al., 2013). Since people with severe or profound intellectual disabilities have more difficulty in processing and understanding the world around them, it is fair to assume that they experience difficulties in attributing meaning to certain sounds. This increases the probability of them appraising soundscapes as unpleasant, as compared to the non-disabled population.

Core Affect

There is an essential connection between how people feel and how they appraise the state of the auditory world surrounding them. Feelings of individuals are addressed by numerous concepts, definitions, and approaches within scientific research. Concepts such as emotions, moods, and (core) affect till date have yet to be ascribed with clear and concise definitions. This has led to what Gross (2010) called, in his review and outlook on the future of emotion research, a jumble of conceptual confusion. He also justly points to the importance of clarity in definitions of the concepts used, so that there is no confusion at the reader's end.

In this dissertation 'core affect' will be a key concept in the theoretical framework we present. Russell (2003) describes core affect as the heart of all affective experiences. Core affect is a non-reflective, omnipresent, consciously accessible state, although not always salient. Core affect does not have one specific stimulus (unlike emotions). Instead, it changes gradually over time, and is shaped by many different influences (Thayer, 1989; Watson, Wiese, Vaidya, & Tellegen, 1999), some of which are beyond human awareness, such as environmental changes or subliminal stimuli (Russell, 2005).

Most importantly, core affect is a varying integral blend of the dimensions pleasantness and arousal. This entails that core affect ranges from utmost ecstasy to excruciating agony, and from drowsiness and sleep to a crisp alertness (Russell, 2003). However, a person always has some sort of core affect state, even when feeling neutral (Diener & Iran-Nejad, 1986; Diener, Sandvik, & Pavot, 1991). Core affect defines simple affective feelings that are always present (and reportable in every waking state), and therefore it is the basic component of moods and emotions, which are described below.

Russell and Barrett describe emotions as 'prototypical emotional episodes' (1999). Emotions are short-lived and associated with objects or events that are perceived as relevant (Levenson, 1999). Emotions are thus responses to specific situations and prepare individuals for a certain event to ensure that he or she can cope with that event in a particular way. Frijda (1986) calls this action readiness, because emotions activate specific action tendencies and prepare the individual for a particular coping strategy. Basically, emotions activate and merge physical and psychological functioning to ensure survival in possibly dangerous situations (Tooby & Cosmides, 1990).

Perceptual processes can directly activate some of these emotions, which are called basic emotions (Izard, 2007). Izard (2007) distinguishes six basic emotions that, combined with the action readiness of Frijda (1986), form a number of general coping strategies that are directly elicited when perceiving objects and events. If an emotion is not appropriate for a given situation, it has to be regulated. Emotion regulation is an individual's deliberate or automatic attempt to influence which emotions he or she has, when he or she has them and how these emotions are experienced or expressed (Mauss, Bunge, & Gross, 2007). For people with severe or profound intellectual disabilities it can be assumed that it is more difficult or perhaps even impossible to regulate their emotions, since their disabilities cause difficulties in analyzing their environment and choosing optimal behavior (Evenhuis, Theunissen, Denkers, Verschuure, & Kemme, 2001).

Moods are defined as prolonged periods of core affect and have, unlike emotions, no specific provoking object as incentive (Russell & Barrett, 1999). Moods often have a lower intensity than emotions and a slow response synchronism; they may emerge without a clear cause and can last for days (Scherer, 2005). Where emotions primarily influence actions, moods seem to be related to a degree of perceived control (over one's life) and have a stronger influence on cognition (Siemer, 2005). Whereas core affect only consists of two dimensions, moods can consist of more than just pleasantness and arousal, and mood is thus a much richer concept. However, considering practical applicability, we sometimes address moods in terms of core affect, and these terms will be used interchangeably in the remainder of this dissertation.

The concept of core affect allows for a more principled understanding of human perception of soundscapes. The dimensions of core affect, pleasantness and arousal, closely resemble the dimensions of soundscape appraisal, pleasantness and eventfulness. Furthermore, Russell's (2003) model shows that interactions with the environment can change a person's core affect, which is supported by in vivo research showing that peoples' appraisal of their environments reflects their mood, and vice versa (Kuppens, Champagne, & Tuerlinckx, 2012). It is, for example, difficult or impossible to relax in an unpleasant environment and therefore people actively seek a quiet and pleasant environment to recover from stress (Kaplan, 1995). So it seems that the way people describe their inner state is coupled to the way they describe the state of their surrounding world.

Focusing on core affect might also be beneficial in research addressing the affective lives of people with severe or profound intellectual disabilities. Research indicates that these people have deficits in the communication (and recognition) of emotional expressions, and show more subtle or atypical facial expression, even when they experience extreme states such as pain or anxiety. This makes it extremely hard for the supporting professionals to react appropriately (Adams & Oliver, 2011). Furthermore, focusing on emotions means focusing on only a part of their continual affective lives. The concept of core affect seems to have great potential to serve as an insightful contribution to both soundscape research as research on the affective lives of people with severe or profound intellectual disabilities.

The research project

In 2009 a consortium was formed between the departments of Special Needs Care and Artificial Intelligence of the University of Groningen and four organizations in The Netherlands that provide care for people with intellectual disabilities, namely: Talant (part of care group Alliade), Royal Dutch Visio, Bartiméus en 's Heeren Loo Zorggroep. Starting in March 2012, for a period of three years, research was conducted regarding the role of sound in residential facilities for people with severe or profound intellectual and multiple disabilities, partially financed by ZonMW. The main goal of the project was to study the role of the auditory environment for people with severe or profound intellectual and multiple disabilities in residential facilities and day care services, and to provide practical guidelines for the direct support professionals to improve these auditory environments.

The two main research questions were:

1. What is the role of sound for people with severe or profound intellectual and multiple disabilities in residential facilities and day care services?

2. How can the auditory environment be analyzed, documented and improved in a way that will enable concrete intervention-oriented measures to be taken?

Dissertation structure

Since there is no existing basis of research on the impact of sound on the physical and psychological well-being of people with severe or profound intellectual disabilities, we build this dissertation on emotion and soundscape research, also drawing from approaches from Artificial Intelligence regarding the modeling of human sound perception derived from people without disabilities. By combining knowledge regarding the influence of sound on disabled and nondisabled populations, we gain a richer understanding of the role of sound in the lives of people with a severe or profound intellectual disability, which we apply in the (residential) care practice for people with severe or profound intellectual disabilities.

We adopt an applied exploratory research approach, including qualitative and quantitative methods, starting with the formulation and validation of a theoretical framework (part one), followed by the development and implementation of an assessment procedure (part two), resulting in an attempt to create controlled positive and safe auditory environments for people with severe or profound intellectual disabilities (part three).

Chapter Two

In the first part of this dissertation we will present a theoretical framework on the role of sound in residential facilities, based on techniques from soundscape and emotion research. We propose a taxonomy of soundscapes based on the dynamic interplay between how people appraise their auditory environment and how they describe their mood, or core affect, and the concept of audible safety.

Chapter Three

To test the validity of the proposed theoretical framework, we conduct a focus group study with 34 healthcare professionals working with people with PIMD. By eliciting their latent knowledge regarding this subject, we examine whether it complies with our theoretical framework.

Chapter Four

In the second part, we present staff observations of the auditory environments and core affect of 36 people with profound intellectual and visual disabilities residing in these environments. For this purpose, we have developed and tested a score sheet (*Assessment Auditory Environment*). We combine the appraisals of soundscape and core affect dimensions and analyze the results by means of multilevel linear regression.

Chapter Five

To investigate the hypothesis that low quality auditory environments contribute to the display of challenging behavior, we conduct an observational study. For this purpose, we have digitized the *Assessment Auditory Environment* as a smartphone application, called MoSART (*Mobile Soundscape Appraisal & Recording Technology*), and implemented it by the direct support professionals during a period of four weeks. These measurements are accompanied by pre- and posttest measurements of the moods (MIPQ) and challenging behavior (LGP-PIMD) of 15 participants with a severe or profound intellectual disability.

Chapter Six

In the third and last part of this dissertation we describe a more controlled attempt at studying the effects of five different auditory environments (Beach, Forest, Urban, Music, & Silence) on the core affect of people with severe or profound intellectual disabilities and their challenging behavior. Thirteen participants were presented with these soundscapes in a dedicated room, together with their direct support professionals, who conducted pre- and posttest core affect observations.

Chapter Seven

In the last and concluding chapter of this dissertation we present a summary of, and contemplate on the meaning and significance of the discussed findings. Empirical implications for soundscape research and clinical implications for the daily practice in residential facilities for people with severe or profound intellectual disabilities are presented. Furthermore, we will discuss limitations of the present study and suggestions for further research.

Chapter Two

The role of sound for people with severe or profound intellectual and multiple disabilities

This chapter is based on: Van den Bosch, K., Andringa, T., Başkent, D., & Vlaskamp, C. (2015). The role of sound in residential facilities for people with profound intellectual and multiple disabilities. *Journal of Policy and Practice in Intellectual Disabilities.* Paper accepted for publication.

Abstract

Introduction: We propose that an important role of audition is to establish audible safety. Individuals with profound intellectual and multiple disabilities heavily rely on sound to make sense of the world around them. Therefore, when a soundscape does not provide positive indications of safety, these people will not feel at ease, which may contribute to challenging behavior. **Methods:** By combining soundscape research addressing how people appraise auditory environments, and emotion research on core affect, we conclude that our moods can be viewed as attitudes towards the world. The main dimensions underlying the appraisal of our inner state (core affect) as well as the outside world appear to be very similar, namely: pleasantness and activation or eventfulness. **Results:** The result is a proposed qualitative classification of soundscapes in terms of their pleasantness and eventfulness, and complexity of action selection and audible affordances, namely: Lively, Calm, Boring and Chaotic. **Conclusion**: The simplest safety-relevant meaning attributable to the soundscape is key in understanding soundscape quality, and allows for effective soundscape-design for quality of life. **Implications for practitioners:** These ideas particularly apply to people with profound intellectual and multiple disabilities and therefore, we believe that they will benefit from an environment that is reassuring by providing meaningful audible safety.

Introduction

Research on people with severe or profound intellectual and multiple disabilities (PIMD) has covered a wide range of topics, including the development and evaluation of interventions with a strong focus on sensory stimulation. However, there has been minimal attention to the auditory environment per se and its potential (positive or negative) effects on individuals with PIMD (Kingma, 2005). This paper proposes a theoretical framework regarding the role of sound in homes for people with PIMD.

The minimal attention directed at the auditory environment is remarkable considering the high prevalence of visual impairments amongst people with intellectual disabilities compared to the non-disabled population (Warburg, 2001), especially considering that this prevalence grows with the severity of the intellectual disability (Evenhuis, Theunissen, Denkers, Verschuure, & Kemme, 2001; Woodhouse, Griffiths & Gedling, 2000). According to studies in the Netherlands (Van Splunder, Stilma, Bernsen, & Evenhuis, 2005), nearly 70% of individuals with severe intellectual disabilities are visually impaired, which in most cases is caused by impaired development of the visual cortex in the occipital lobe (cortical blindness). Such cerebral visual impairment (CVI) does not show a consistent pattern among PIMD individuals. Each individual is impaired in a unique way by CVI and even within individuals the condition may vary depending on environmental factors and time. A complicating factor is that in individuals with severe intellectual disabilities a visual impairment often remains unnoticed (Vlaskamp, 2005). This is due to the fact that people with PIMD have greatly diminished capabilities to express themselves: they do not have the verbal capacity to speak and even their body language can be greatly distorted. As a result, they may be unable to complain about a loss of vision or symptoms of visual impairment.

With the (partial) loss of one of the senses, people become more dependent on the remaining ones (Occelli, Spence, & Zampini, 2013). For example, in the case of visual impairments, auditory input becomes more important, compensating the negative effects of degraded eyesight with auditory information (Dufour, Després, & Candas, 2005). Thus, it is likely that many individuals with visual impairments heavily rely on auditory information to make sense of the world surrounding them. If so, the auditory environment could substantially affect their psychological well-being. One of the assumptions of this paper is that this auditory compensation applies equally to people with PIMD, since they seem less often affected by hearing problems than by visual impairment (Evenhuis, et al., 2001). The lower prevalence of hearing deficits compared to visual deficits in these populations with PIMD can be explained by a more prominent role of subcortical areas in hearing than in vision (Andringa & Lanser, 2013). Important auditory processing is, to a large extent subconsciously, performed in the midbrain. For example hearing direction, separating and grouping the signal into separate components, auditory scene analysis (Winkler, Denham, & Nelken, 2009), and probably auditory gist processing (Harding, Cooke, & König, 2007), are midbrain processes that generally seem to be preserved in these populations.

Therefore, due to the presumable high reliance on sounds, supportive auditory environments are likely to be crucial for well-being in this population. It is important that the effects of auditory environments on people with PIMD are well understood so that they can be optimized by caregivers to promote overall well-being and quality of life.

In this paper, we present a theoretical framework using techniques from soundscape and emotion research that can quantify such effects, like core affect, and present a taxonomy of four types of auditory environments, or soundscapes, in which the concept of audible safety plays an important role. Our ultimate goal is to assess soundscape quality and contribute to guidelines for policies to optimize living environments (or habitats) for people with PIMD to enhance psychological well-being and quality of life and to minimize the prevalence of behavioral problems.

Theoretical framework

Audible Safety

The capacity to hear and listen – audition – has an evolutionary history of millions of years (Hester, 2005). One important function of audition, from an evolutionary perspective, is to "warn". If the safety of an environment can be estimated (heard) it allows an individual to relax or attend to other matters instead of being vigilant. Audible safety indications do not so much indicate safety, as well as normalness. In fact, the most pleasant sounds are also profoundly "normal" (Guastavino, 2006; De Coensel & Botteldooren, 2006). Humans tend to like the songs of birds, the soft sounds of domesticated animals, children playing, the neighbour cleaning their house, the murmur of a quiet conversation on the street, and their child singing in the room. These are all sounds that match activities that one is typically engaged in in safety. Consequently we use the judgment of other individuals (including individuals of other species) to inform us about the safety of the environment (Andringa & Lanser, 2013).

We argue that auditory information normally contributes to forming a 'sense of place', which provides clarity about the current location and situation and as such allows an individual to generate expectations (Morgan, 2010; Tuan, 1975). Following the dual pathway model of auditory signal processing (Wang, Wu, & Li, 2008), which suggests two auditory streams of cortical processing, namely a ventral "What" and a dorsal "Where" pathway, we propose that this sense of place arises from the answers to two questions: "Where am I?" and "What is happening?" Based on this sense of place, one can form expectations and anticipate what is to come. An absent, confused, or unstable sense of place can lead to uncertainty and a sense of insecurity because it becomes difficult or impossible to generate situationally appropriate behavior. We hypothesize that for people with PIMD, the process of forming a sense of place relies more on recognition of certain situations than for people without PIMD, due to reduced cognitive capabilities. Therefore, we propose that for people with PIMD, the main question answered by audition is "Am I in a safe place?" This question consists of two components: (1) "Do I know this place?" and (2) "Is this place safe in its current state?"

Only very recently in evolution (less than a few million years) has audition been used for speech and even more recently for non-natural sounds (Andringa & Van den Bosch, 2013). Non-natural sources, like ventilator, traffic, or other machine sounds, act as distractors that make it more difficult for people to establish audible safety and they contribute, for that reason, to sound annoyance. For sound annoyance to occur, it is not necessary that the sound source has particularly annoying acoustic properties. The simple fact that a machine sound obscures more pleasant (safety-indicating) sounds is enough to be experienced as an annoying intrusion (Andringa & Lanser, 2013). For example, the sound of traffic is often not particularly unpleasant; it may even resemble the sound of the ocean, which people typically like to hear. But traffic sounds can also mask subtle environmental sounds indicative of normality and safety. As a result, the main effect of the blanket of non-natural sounds that covers our daily living environments is to further disconnect individuals from their (natural) environment. Unfortunately, this means that, in such situations, it may be even more difficult to determine whether everything is normal and safe. The predictable result is that people become more vigilant, alert, and aroused. Consequently, they are less likely to relax and/or be engaged in an undisturbed activity, and perhaps more likely to be fatigued in the long run (Andringa & Lanser, 2013).

For people with intellectual disabilities in a long-term care situation, such as in a residential facility, these consequences may be amplified. For example: if you are unable to ignore a sound and cannot escape it (e.g., because cannot leave the corresponding environment because you are wheelchair-bound), you will evaluate the sound as annoying, become more stressed, and appraise the overall situation as unpleasant. This is even more likely for people with minimal or no opportunities to influence their (auditory) environment, such as people with PIMD. According to Kahneman (1973) human cognitive resources are limited, and when processing load for one task increases (e.g. for establishing audible safety) this will reduce the amount of resources available for other concurrent tasks. For people with PIMD, who already have reduced cognitive functioning as defined by their intellectual disability, the constant process of determining audible safety in complex auditory environments and the accompanying arousal could dominate or even exceed their cognitive resources. Therefore, if not paid particular attention, the living environments of people with PIMD could – effectively – be structurally deprived of useful positive indications of safety. The resulting (prolonged) stress and arousal may affect their overall psychological well-being and quality of life negatively (Petry, Maes, & Vlaskamp, 2005), also perhaps contributing to behavioral problems.

Assuming audible safety is indeed of such great importance for people with PIMD, we can design for optimized audible indications of safety. These indications should either be relaxing and reassuring, or encouraging activation. This could be achieved, for example, through providing auditory environments that are pleasant to be in with individual sounds that are fun, casual, and interesting for people with PIMD, such as the sounds of animals or toys. In a safe environment, people with PIMD will become motivated to engage in activities and social interactions. This can prevent boredom for these people, encouraging them to explore their environments more and thus learn to master the possibilities and limitations of their environment.

Soundscapes

Research focusing on the psychological aspects of auditory perception is conducted in terms of soundscapes. A soundscape is defined as an environment of sound, with an emphasis on how it is perceived by an individual or society (Schafer, 1977). Research shows that suboptimal soundscapes can induce a wide range of detrimental effects on the welfare of people (CALM, 2004). When a soundscape is perceived as unpleasant, people experience annoyance, and the adverse effects may range from relatively harmless problems with concentration to serious problems related to general health, well-being, and quality of life (WHO, 2000). These negative effects on individuals are not only detrimental for the listeners themselves, but eventually contribute to greater social and economic costs to society (Grahn & Stigsdotter, 2003). To reduce the negative impact of unpleasant soundscapes on the welfare of people we need to gain more insight in which soundscape characteristics elicit these unwanted effects.

The concept "core affect" allows better understanding of human perception of soundscapes. Core affect originates from emotion theory and refers to mood (Russell, 2003) as relation between the individual and the world (Kuppens, Champagne, & Tuerlinckx, 2012). While emotions often are short-lived and not always present, one can always describe in what kind of mood one is. This always-present feeling is called core affect and can be mainly described by the combination of two features: pleasantness and activation (Figure 1a). To give an example: the corresponding core affect for playful enjoyment can be described as pleasant and active. Vice versa, gloominess can be described as unpleasant and passive.

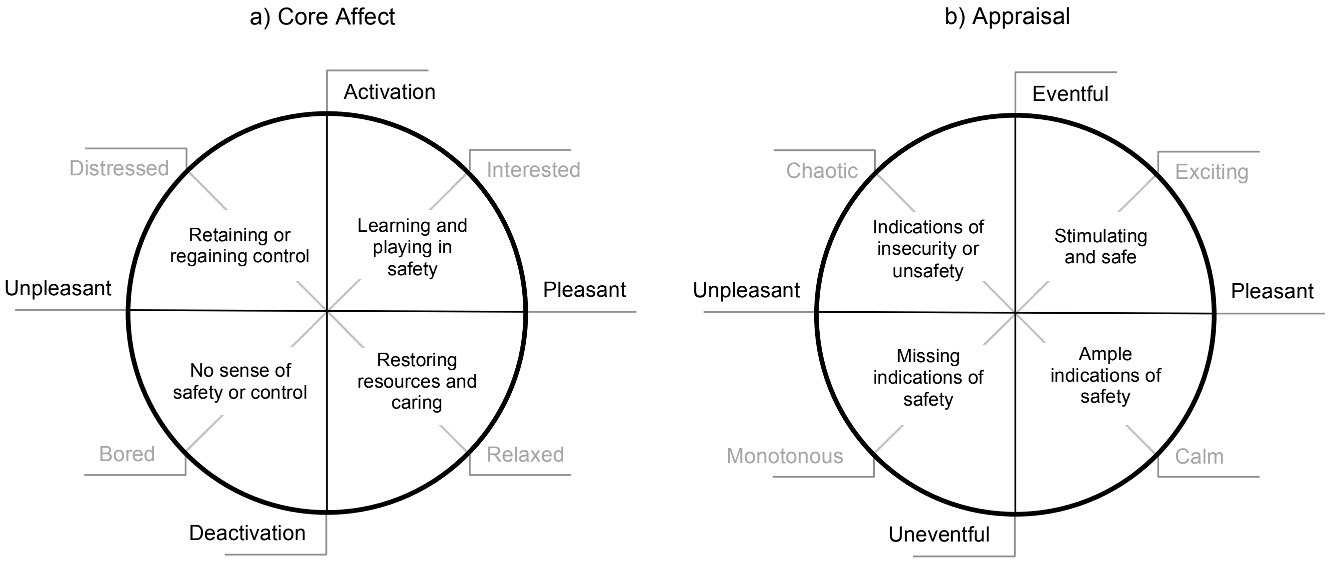


Figure 1. Core affect and appraisal of auditory environments (adapted from Andringa & Lanser, 2013).

Axelsson, Nilsson and Berglund (2010) have studied how people appraise auditory environments and showed that such appraisal is commonly based on the pleasantness and eventfulness of the auditory environment (Figure 1b). Therefore, it seems that the way individuals describe their inner state, or mood, is coupled to the way they describe the state of the surrounding world. This idea is supported by research showing that there is a strong, mutual, and continual relationship between moods and how people appraise their surroundings (Kuppens, et al., 2012; Andringa & Lanser, 2013).

Taxonomy of soundscapes

Based on the similarity between how one feels (core affect) and how one appraises their environment, in combination with the assumption of audible safety, researchers proposed (Andringa & Lanser, 2013) to define soundscapes in four categories: Lively, Calm, Boring and Chaotic (Figure 2).

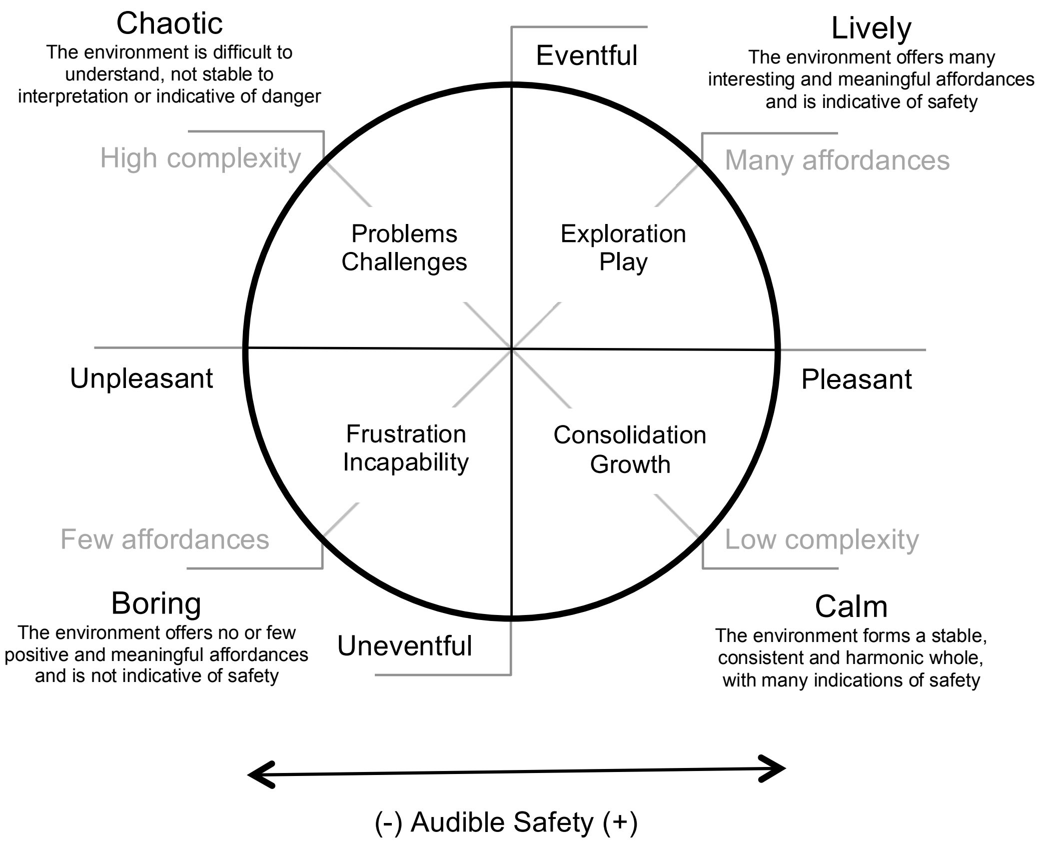


Figure 2. Four types of soundscapes (Lively, Calm, Boring and Chaotic) and their basic dimensions (Eventfulness vs. Pleasantness, or Affordances vs. Complexity) (adapted from Andringa, Van den Bosch, & Vlaskamp, 2013).

These types of soundscapes can be classified according to their pleasantness and eventfulness, or complexity and affordances (Andringa & Van den Bosch, 2013). Figure 2 shows these types, with the degree of pleasantness on the horizontal axis and degree of eventfulness on the vertical axis. In contrast to Figure 1, there are two diagonal axes included: bottom left to top right represents increasing affordances and bottom right to top left represents increasing complexity. Affordances indicate the extent to which the environment offers (pleasant) options for self-selected behavior. The complexity of an environment indicates how difficult it is to choose situationally appropriate behavior. Some situations offer rich possibilities for behavioral options while other, potentially dangerous, situations leave few appropriate choices.

On the pleasant side, a *lively* soundscape represents many affordances that offer interesting options to attract attention and is indicative of safety. It is a stimulating and safe environment, characterized by the presence of pleasant foreground sounds. Exploration (of the environment) is behavior typically seen in lively soundscapes (upper-right quadrant). A lively soundscape offers many affordances representing interesting options to engage in. In an interesting, fascinating environment, one's curiosity is stimulated, encouraging the person to explore and learn. It is a stimulating and safe environment, characterized by the presence of pleasant foreground sounds.

Calm soundscapes provide sufficient indications of safety and allow full flexibility to relax and recover after challenges or stress. They are characterized by pleasant background sounds (such as a forest) and few foreground sounds. Relaxation is behavior associated with a calm soundscape (Booi & van den Berg, 2012; Botteldooren & De Coensel, 2006; Shepherd, Welch, Dirks & McBride, 2013). People look for a park or beach when they want to relax, and people with PIMD do just the same, for example, when they are enjoying a rich garden environment in the company of a trusted care giver.

Boring soundscapes contain little meaningful audible affordances and do not necessarily guarantee safety. Unpleasant background noise and the absence of indications of safety are characteristics of such environments (e.g. a loud air conditioning). Submission (to environmental influences) is behavior that fits a boring and impoverished soundscape (lower left quadrant). It is neither pleasant nor active, because the environment has nothing interesting to offer. It is a monotonous, dull environment that offers little reassuring. People in this quadrant have no sense of security or control over their environment because they do not have the appropriate behavioral repertoire act. This situation endures as long as the person remains stuck in the impoverished environment. Because of the lack of interesting stimuli that are new and safe, familiar behaviors (often stereotypical ones) will be activated to for self-protection and to prevent further deterioration. However, this stereotypical behavior does not help to structurally improve the situation.

Lastly, *chaotic* soundscapes can be difficult to interpret (e.g. by an abundance of sound-producing activities) or might be indicative of unsafety. This is often caused by the presence of unpleasant sounds in the foreground (for example, construction work next to a busy street). It is important to realize that the quality of soundscapes and associated behavior are strongly related: it is difficult to stay calm in a chaotic situation. Therefore, a chaotic soundscape makes people feel distressed (upper-left quadrant, Figure 1a).

Discussion

We propose that the quality of soundscapes is best understood in terms of how we appraise these soundscapes with regard to safety and pleasantness (and not in terms of acoustic properties, such as loudness). The framework we propose may explain why certain loud sounds may not necessarily lead to experiencing discomfort, when one consciously chooses to be exposed to those sounds, such as attending a concert or a party. It may also explain why the subtle sound of a mosquito at night can be greatly irritating, despite being a very soft one. Further research is needed, experimental or observational, to test the claims of this framework, and its usefulness for people with PIMD.

In today's industrial society, it is difficult to prevent the environment becoming filled with unwanted sounds. The monotonous 'blanket' of unnatural sounds promotes people to stay alert and therefore they may not be able to properly relax. However, a potential solution is to create enough diversity in soundscapes so that an escape from these unnatural sounds is possible. When there are enough opportunities to experience pleasant environments, with calm or lively soundscapes, people with or without PIMD can relax and escape from the hectic soundscapes. A bad mood, a negative core affect, reflects a negative evaluation of the person about his or her environment (and the challenges and opportunities it provides). Especially for people with PIMD living in a residential facility, chances are that low quality auditory environments lead to structural challenging behavior (unintended, as support staff would not deliberately promoted such a negative core affect). This behavior should be seen as a sign of active resistance against an unsafe or otherwise sub-optimal living environment.

As described in previous sections, indicating safety is an important role of sounds in the environment. A high quality soundscape helps to continually confirm audible safety. It therefore needs to meet the basic requirements of offering ubiquitous indications of safety and providing ample affordance (ideally the living environment should always provide indications of safety). If the overall situation is clearly indicative of safety through audible activities, even quiet distinctive and unpleasant sounds may not be so disturbing because they occur in a reassuring environment. But if there are few indications of safety (e.g., through masking sounds of air conditioning systems), or if there are indications of unsafety (e.g., the sounds of anxious people or loud machines), then everyone (PIMD or not) is forced to be alert and pay attention to (the negative aspects of) the soundscape. To acknowledge the role of audible safety and translating – on the basis of experience and common sense – one 's own relation to good and bad soundscapes towards the needs and wishes of people with PIMD, will be a first and important step towards offering audible safety to them. We can close our eyes but not our ears. Therefore, we must pay close attention to the design and maintenance of positive soundscapes to ensure highest quality of life for individuals with PIMD.

Chapter Three

What healthcare professionals know: Validating the theoretical framework

This chapter is based on: Van den Bosch, K.A., Andringa, T.C., & Vlaskamp, C. (2013). *The role of sound and audible safety in special needs care.* Paper presented at INTER-NOISE 2013, the 42nd International Congress and Exposition on Noise Control Engineering, Innsbruck (pp. 2267-2272). Innsbruck: INCE.

Abstract

Soundscape research applicable to residential facilities for people with profound intellectual and multiple disabilities (PIMD) is scarce. The aim of this study is to determine the role of sound for persons with PIMD, because we expect it provides insight into the role of audition for them. We hypothesize that sound is important in developing a sense of a safe place: when the auditory environment does not provide positive indications of safety, individuals within this environment will not feel safe. Feelings of unsafety and insecurity are likely to play a major role in the onset of problem behavior and thus reduce the quality of life for people with PIMD. To test the validity of this claim, we organized focus groups for PIMD professionals, where we examined whether their latent knowledge corresponded to our theoretical framework. In total 34 professionals attended. Results showed a strong consistency between the knowledge and experience of the professionals and our theoretical framework, indicating that, for people with PIMD, the auditory environment is crucial in determining the answer to the question "Am I in a safe place?" We conclude that the (re)introduction of positive indications of safety and soundmarks associated with daily structure, in the environment of people with PIMD are likely to improve their quality of life.

Introduction

Particular sounds can be stressful for everyone and they might be even more stressful for people with an intellectual disability. The response of people with profound intellectual and multiple disabilities (PIMD) might teach us something about the more fundamental aspects of noise perception, because their response is minimally filtered or modified by higher cognitive (and culturally biased) processing. Individuals with PIMD can be characterized as having a profound intellectual disability and a profound motor disability, which is accompanied by additional severe or profound secondary disabilities or impairments (Nakken & Vlaskamp, 2007).

Currently, the concept of Quality of Life (QoL) is used as a guide in the treatment, support, and care for people with PIMD. The goal of assessing the QoL of people with PIMD is to preserve and optimize the aspects that are most meaningful in life and improve the things that negatively affect the quality of life (Maes, Vlaskamp, & Penne, 2011). According to the Quality of Life Model (Buntinx & Schalock, 2010) it is a key issue to ensure that people with PIMD experience a maximum sense of basic safety. A diminished sense of basic safety, caused by not (properly) understanding and mastering the structure of the (auditory) environment, can cause a variety of behavioral problems (Maes, Vlaskamp, & Penne, 2011). It is therefore remarkable that research regarding people with PIMD has, until now, hardly focused on contextual settings. Research on the auditory environment within residential facilities for people with PIMD is especially scarce. When considered that people with PIMD have a very high prevalence of visual impairments (Evenhuis, Theunissen, Denkers, Verschuure, & Kemme, 2001; Woodhouse, Griffiths, & Gedling, 2000) research on this topic seems highly relevant.

This paper aims to address the role of sound and audible safety in the living environments of people with PIMD. We hypothesize that sound is crucial in developing a sense of place: when the auditory environment does not provide positive indications of safety, persons within this environment will not feel safe (unless non-auditory safety indications are present). First, we will address the concept 'sense of place' and its relation to auditory environments in a short theoretical introduction. Next, the latent knowledge of 34 healthcare professionals was elicited with a focus group study, to examine whether it complied with our theoretical framework. Our ultimate goal is to assess soundscape quality, contribute to guidelines for policies to optimize living environments for people with PIMD to enhance psychological well-being and quality of life, and through this to minimize the prevalence of behavioral problems.

Sense of place

People with visual disabilities use the sound in their environment to compensate for the loss of visual information. When the visual impairment is combined with a severe cognitive impairment, the auditory information in the surroundings can easily become too complex to comprehend in real-time. We argue that auditory information normally contributes in developing a 'sense of place', which allows one to generate expectations for the location and situation someone is in (Morgan, 2010; Tuan, 1975). The first key question answered by audition is "Where am I?" On the basis of this question it is possible to generate a sense of what is happening and expectations for what might happen (the last one being important to guide knowledge driven perception). So the second key question to be answered by audition is "What is happening?" Together the answers to these questions form a sense of place. Lack of it can lead to uncertainty and a sense of insecurity because one is not able to generate situational appropriate behavior.

Andringa and Lanser (2013) argue that the subtle background sounds of an auditory environment, which are always present, are important to answer the 'where' question. It is the overall auditory "atmosphere", or ambiance, that makes you realize whether you are indoors or outdoors, in a large or small space, safe or not, etc. In addition, the striking foreground sounds, which are striking because they demand attention, predominantly answer the 'what' question. Unpleasant foreground and background sounds arouse and force you to be alert. In contrast, a combination of pleasant fore- and background sounds allows the freedom of mind to address needs proactively. In an environment with sufficient positive indications of safety and the absence of indications of insecurity, people are not forced to be alert.

We hypothesize that the main role of sound, especially for people with severe intellectual disabilities, is to answer the question: "Am I in a safe place?", which consists of two components, namely: 1) "Do I know this place?" And 2) "Is this place in its current state safe?" (Van den Bosch, Andringa, Başkent, & Vlaskamp, 2015). We expect that these are core questions for audition since its evolutionary inception. For humans, who managed to create living environments that are inherently safe and as such do not require constant vigilance, the safety role of sound has become less prominent. Yet the observation that audible safety has become less important in human cultures is indicative of its importance: otherwise the creation of inherently safe environments would not have been a priority. However, for people with severe intellectual disabilities this inherent safety might be less meaningful because they do not understand the larger cultural guarantees for safety.

With this research we hope to improve the living environments of people with severe or profound intellectual disabilities (and visual impairments) by first gaining more insight in the role of sound, and in particular audible safety, in so far known and experienced by care givers. We therefore organized a focus group study in which we tested if the latent knowledge of 34 healthcare professionals regarding the role of sound for people with PIMD complied with our hypothesis. We did this because, for obvious reasons, the clients themselves cannot provide us with an assessment of their auditory environments, and administering physiological measurements is too invasive and impractical for this target group. Moreover, our goal is to increase awareness with regard to the importance of the auditory environments and that, in this case, cannot be established by means of physiological measurements. In addition, we need to know what caregivers know about the role of the auditory environment and what they expect of its role, so that we can translate our scientific knowledge and insights to the daily practice of working with intellectually disabled individuals.

Method

Participants and sampling

Focus groups (Acocella, 2011; Fern, 1982) were used to maximize the collection of high quality information. Participants were recruited from five organizations, from predominantly the Northern part of the Netherlands, that provide residential accommodation to clients with severe or profound intellectual and visual disabilities. Purposive sampling was employed in initial recruitment to enable specific targeting of information rich cases (Patton, 2002). The number of participants was not predetermined; rather, participation ended when the full range of professional experiences about auditory environment was captured. Both excessively homo- and heterogeneous grouping was avoided as was hierarchical positioning to prevent inhibition during the discussions (Acocella, 2011). A total of 34 healthcare professionals voluntarily participated in this study.

Procedure

Data-gathering procedure started with a presentation explaining the goal of the meeting: namely to acquire the diversity of latent knowledge of these professionals regarding the auditory environment in the homes of people with PIMD. In this presentation, the scope of the research was discussed and the theoretical framework of the study was clarified. This part focused on the mutual influencing of mood (core affect) and the appraisal of the (auditory) environment (Andringa & Lanser, 2013; Kuppens, Champagne, & Tuerlinckx, 2012). Consecutively, guidelines for the discussion in the focus groups were given. This phase took about 30 minutes.

Hereafter, the participants were divided into 5 focus groups. The participants were first divided into three levels based on their role in the organization; 'executive' including direct support professionals (DSP) (N = 12), 'context providing' representing behavioral scientists (N = 14), and 'strategic' including the management and policy functions (N = 8). This resulted in two executive level groups with six participants, two groups of seven participants at the context providing level and one strategic level group of eight participants.

The groups were presented with the following question: "*What is the role of sound in homes of people with PIMD as seen from your expertise?*" They were given 75 minutes to brainstorm and orientate on the question. Three skilled moderators were present to facilitate the focus groups. After a lunch (45 minutes) in which the topic was still discussed actively, the focus groups were given another 60 minutes to converge on what they have discussed before and to write down the answers to the question on flip charts. It was mentioned multiple times during the day that the aim was not to reach consensus within the groups, but to provide a diversity of possible answers covering all available expertise and experience.

Finally, the groups were asked to present their results on flipcharts. Each group had five minutes to do so. These presentations led to a lively session in which many groups discovered important commonalities and, quite often, relevant additions to their own results. This session ensured that an initial consensus among the participants was formed, in which the groups were strengthened in the way they had approached the topic. However this did not influence the information on the flipcharts that had already been compiled and finalized. Only the information on the flipcharts was used for further analysis.

During the whole day, audio recordings were made and field notes were taken to note narrative summaries and relevant non-verbal data. These were not used for this study. The analysis below is based on the information as written by the participants on the flipcharts.

Analysis

The workshop leaders (and authors of this paper) gathered the next day to analyze the collected data on the flipcharts. First, the responses of the participants were written down per group and clarified when needed. The authors discussed the answers given by the five groups in general. Following deliberation, corresponding terms were rephrased in uniform terms and the workshop leaders addressed the frequency, similarities, and diversity in the responses.

The text written on the flip charts was digitized and sent to the members of the respective focus group with the request to check for accuracy and completeness. The feedback obtained clarified some examples given and did not affect the analysis.

Results

As Table 1 shows, the most frequent mentioned roles of sound in homes of people with PIMD were Influencing Behavior (N = 6) and Atmosphere (N = 4). The participants mentioned all answers under Atmosphere literally, and Influencing Behavior refers to answers suggesting that sounds can have a relaxing or activating effect on behavior. In addition, Clarity (N = 3), Structure (N = 3) and Safety (N = 3) were mentioned. These answers refer to the predictability of the structure of the day and the role of sound in determining whether a situation is safe or not. Finally Recognition (N = 2) was mentioned as a role of the auditory environment, which involves the recognition of personnel.

Table 2 shows that the groups on the executive level generated most answers (10, on average 5 per group), the context providing groups generated nine answers (on average 4.5 per group) and the group on the strategic level generated fewest and least diverse answers (2).

Table 1 - The given answers and corresponding categories per focus group.

		Organizational level				
Answers	**Category**	E1	E2	C1	C2	S1
Masking (of unwanted sounds)	Influencing behavior		X			
Disruptive (disturbing current focus / activities)	Influencing behavior	X				
Relaxing - Activating	Influencing behavior			X		
Influencing behavior and mood	Influencing behavior				X	
Calm	Influencing behavior		X			
Unrest	Influencing behavior			X		
Atmosphere (role of background sounds)	Atmosphere	X	X	X	X	
Clarity (of activities, people)	Clarity	X	X			
Predictability (of activities, people)	Clarity					X
Structure (sounds indicative of daily structure)	Structure		X	X		
Rituals (sounds indicative of daily structure)	Structure		X			
Safety (direct reference to role of safety)	Safety		X	X		
Unsafely (direct reference to role of safety)	Safety			X		
Recognition (of caretakers)	Recognition				X	X

Table 2 – The answers per category, per organizational level.

Organizational level	**Category**					
	Influencing behavior	Atmosphere	Clarity	Structure	Safety	Recognition
Executive	3	2	2	2	1	
Context providing	3	2		1	2	1
Strategic			1			1

Conclusions

It appears that, according to health care professionals, Influencing Behavior is the most prominent role of sound in homes for people with PIMD (N=6, 28,6%). Influencing Behavior entails that sounds can have activating or relaxing effects on the behavior of persons with PIMD. This supports the claim that the auditory environment could affect the behavior of people with PIMD and as such, should be considered more carefully.

The participating professionals also state that sounds, partially, determine the atmosphere (Atmosphere, N=4, 19%). In the introduction it was mentioned that the atmosphere, carried by the subtle background sounds, helps to answer the where-question on a continual basis and therefore is crucial in forming and maintain a sense of place. In addition, responses in the categories of Clarity, Structure, and Recognition were mentioned as part of the role of sound. Sounds can indicate for example which activities follow or which DSP are present. This might refer more to the foreground sounds, which help to answer the what-question as discussed in the introduction. Lastly, Safety was mentioned, as such, in 14,3% of the cases (N=3), which implies a clear safety aspect in the role of sound for people with PIMD.

Combined, the categories Atmosphere, Clarity, Structure and Recognition form a majority of the answers provided (N= 12, 57,1%). This result provides support for our hypothesis that the auditory environment is indeed crucial in determining a sense of place based on the question "Am I in a safe place?". This implies that the first role of sound is that of an indication of safety, it is not so much the location, but the safety of the situation. The second role of sound would be to clarify the situation. "What is happening here? What can I expect?" Expectations make it easier to handle the complex world around us. Deviations from expectations in the form of unknown or unexpected noises reduce predictability and elicit a sense of unease. Overall, results showed a strong consistency between the knowledge of the professionals and our theoretical framework.

Looking at the differences in the answers across the organizational levels, the most remarkable result is that the Strategic level had fewest and least spread answers. It is also striking that the Strategic level was the only level that mentioned Clarity as the role of sound. The second answer given by the Strategic level was Recognition, which is closely related to Clarity. The Strategic level group was also the only group not to mention Safety, Atmosphere, Structure and Influencing behavior as direct roles of sound within the homes of people with PIMD. This might be suggestive of the Strategic level having a less rich understanding of the role of sound in the daily care, which entails that communication about the role of sound for management and for those involved in daily care should not be the same.

Discussion

There are several limitations to this study. First, we cannot guarantee that our sample was representative. Considering that the participants registered voluntarily, thus showing an interest in the topic, and the diversity of the professions in the group, it is likely that they have a comprehensive insight in the topic. Secondly, using focus groups creates a social situation in which certain participants might feel inhibited from fully participating. They may provide socially desirable answers or no answers at all. We tried to minimize this by emphasizing that we were not looking for consensus, rather for the full range of possible answers. In addition we observed very lively interactions where everyone seemed to participate in.

People with (severe) intellectual and visual disabilities could offer us a unique window on basic human sound processing due to a reduced influence of higher cognitive (culturally biased) processing. The information provided by the DSP support our conviction that the main role of audition (throughout evolution) is to provide and maintain a sense of place. Insufficient indications of safety arouse and motivate individuals to restore a sense of basic (audible) safety.

Our main recommendation therefore is to increase awareness about the role of sound in our environment amongst the staff of organizations caring for people with PIMD. When reflecting on the environment, and keeping the effects of a stressful auditory environment in mind, staff will cope better with the everyday sounds that fill the soundscapes of people with PIMD. In future work we hope to provide guidelines on how (audible) safety can be enhanced and how this can be observed from the behavior of the clients. Increased awareness, not only among the direct support staff, but in all layers of the organization, seems to be the necessary first step to structurally improve the soundscapes of people with PIMD and with that improve their quality of life. We should be aware of the fact that people with PIMD are less autonomous. They often cannot ask if the radio can be turned down, or leave when a soundscape is unpleasant. It is the task of the daily support professionals to recognize what is good for their clients and to act appropriately, and it is the task of the management to promote this. Yet the focus study suggests that, in particular, the management may not be fully aware of the role and importance of sound in the day-to-day-care.

Chapter Four

The relationship between soundscape quality and core affect

This chapter is based on: Van den Bosch, K., Vlaskamp, C., Andringa. T., Post, W., & Ruijssenaars, A. (2014). Examining relationships between staff attributions of soundscapes and core affect in people with severe or profound intellectual and visual disabilities. *Journal of Intellectual & Developmental Disability.* Paper accepted for publication.

Abstract

Background: People with profound intellectual disabilities experience a high prevalence of visual disabilities, making them more dependent on sound. However, research addressing the influence of the auditory environment is scarce. **Method**: Observations of the auditory environments (soundscapes) and moods of people with profound intellectual and visual disabilities, in terms of core affect, were conducted in residential facilities by direct support professionals. Appraisals of soundscape and core affect dimensions were combined and analyzed by means of multilevel linear regression. **Results**: Findings endorse a positive relationship between the observed pleasantness and eventfulness of soundscapes and core affect of people with profound intellectual and visual disabilities. **Conclusion**: This study suggests a relationship between soundscapes and moods of people with profound intellectual and visual disabilities, as judged by staff members engaged in their environments. These findings give reason to believe that improved soundscapes could ameliorate the moods of the residents.

Introduction

People with intellectual disabilities often experience visual disabilities. The prevalence of these visual disabilities increases with the severity of the intellectual disability, with an estimated 78% of people with a profound intellectual disability experiencing visual disorders (Van Splunder, Stilma, Bernsen, & Evenhuis, 2006; Warburg, 2001). Auditory problems although common, appear to be less prevalent (Evenhuis, Theunissen, Denkers, Verschuure, & Kemme, 2001). As a result, many people with profound intellectual disabilities may depend more on sound to interpret their surroundings than people without intellectual disabilities, which is supported by research indicating that people with a visual disability alone compensate for their visual deficit by relying more on auditory information (Dufour, Desprès, & Candas, 2005). It is however not yet clear to what extent this auditory compensation holds for people with severe or profound intellectual disabilities.

Despite the situation described above, research addressing the influence of the auditory environment on the well-being of people with intellectual and visual disabilities is limited (Kingma, 2005). Because people with an intellectual and visual disability will probably rely more on audition, it is important to know the role of sound for them. Normally sound informs people what is going on around them because particular sound sources produce particular sounds (Gaver, 1993; Plomp, 2002). Non-disabled people can reason about where the sounds came from and to what event they related to, so that they might not need to feel unease. Also, they can detect and recognize a known sound source quickly and because of that they can interpret and act on events in their environment (Andringa & Pals, 2010). Andringa and Pals (2010) conducted an experiment to study sound detection and recognition. They found that people use prior knowledge and expectations to analyze and interpret what they hear, but it also works the other way around: what people hear can be used to generate hypotheses about their environment (Winkler, Denham, & Nelken, 2009). Van den Bosch, Andringa and Vlaskamp (2013) suggest that this also holds for people with profound intellectual disabilities, however their disabilities cause difficulties in analyzing their environment and choosing optimal behavior and, therefore, in regulating emotions and moods (Evenhuis et al., 2001).

The highly increased risk of having visual disabilities in people with severe or profound intellectual disabilities, as compared with the general population, has important implications for their living environment (Evenhuis et al., 2001). Many residential facilities, either small scale or large scale, for people with intellectual disabilities have unfavorable acoustic conditions and due to the lack of research and therefore knowledge regarding the influence of auditory environments, these seem to have not been sufficiently taken into account. Consequently it can be assumed that these auditory environments are not explicitly adapted to the needs of people with profound intellectual and visual disabilities. For these people, who already have reduced cognitive functioning as defined by their intellectual disability, the constant processing of auditory information in unfavorable conditions and accompanying arousal may dominate their cognitive resources (Van den Bosch, Andringa, Başkent, & Vlaskamp, 2015). The resulting (prolonged) stress and arousal may deteriorate their overall psychological well-being and quality of life (Petry et al., 2005).

One way of approaching auditory environments and the effect thereof on people is the soundscape approach. Soundscapes are defined as *"an environment of sound (sonic environment) with emphasis on the way it is perceived and understood by the individual, or by a society. It thus depends on the relationship between the individual and any such environment"* (Schafer, 1977). Soundscapes therefore represent more than just a sound signal and include the auditory environment as perceived and understood by people in a specific context. Axelsson, Nilsson, and Berglund (2010), developed a model to measure the quality of soundscapes. The results of their study suggest that soundscape perception can be described in terms of two main basic components: pleasantness and eventfulness. For (non-disabled) people, an exciting soundscape is pleasant and eventful, a calm soundscape is pleasant and uneventful, a chaotic soundscape is unpleasant and eventful, and a monotonous soundscape is unpleasant and uneventful. These associations observed with groups may vary depending on the individual, and may vary even more for people with intellectual disabilities. Research further shows that suboptimal soundscapes can induce a wide range of detrimental effects on the welfare of people (CALM, 2004; Andringa, & Lanser, 2013). When a soundscape is perceived as unpleasant, people experience annoyance, and the adverse effects may range from relatively harmless problems with concentration to serious problems related to general health, well-being, and quality of life (WHO, 2000).

It thus seems that there is a connection between how people feel and the state of the auditory world surrounding them. One important concept concerning how people feel is 'core affect' (Russell, 2003). Core affect concerns basic moods and consists of two dimensions; pleasantness and activation or arousal. These resemble the dimensions of soundscape appraisal. Pleasantness is, in this context, more than just "niceness": it depends also on the degree of perceived control people have over their environment. Russell's (2003) model shows that interactions with the environment can change a person's mood, which is supported by in vivo research showing that peoples' appraisal of their environments reflects their mood, and vice versa (Kuppens, Champagne, & Tuerlinckx, 2012). It is e.g. difficult or impossible to relax in an unpleasant and unsafe environment and therefore people actively seek a quiet and pleasant environment to recover from stress (Kaplan, 1995).

People with severe or profound intellectual disabilities require support to meet their needs and therefore to maintain their quality of life (Petry, Maes, & Vlaskamp, 2005). They have limited control over their own situation and have few opportunities to make adaptive choices regarding everyday activities and major life events (Maes, Lambrechts, Hostyn, & Petry, 2007). This entails, according to the model of Russell (2003), that people with profound intellectual disabilities could experience structurally less positive moods in terms of core affect, kindled by unfavorable and non-adapted soundscapes.

Therefore, the aim of this exploratory study is to provide a first examination of the relation between staff attributions of the quality of soundscapes and staff attributions of the moods of people with severe to profound intellectual and visual disabilities in terms of core affect. As a first step, the method of Axelsson et al. (2010), is used to describe the auditory environment of people with severe or profound intellectual and visual disabilities. As a next step core affect is used to describe how they are influenced by the environments (Kuppens et al., 2012). If we know how people with profound intellectual and visual disabilities are influenced by different auditory environments, we can eventually determine how to improve their (auditory) living environment and to increase their quality of life.

Method

Participants

This study was conducted within a consortium consisting of the University of Groningen and four healthcare organizations in the Netherlands. The healthcare institutions informed parents and legal representatives about the aim of the study. For all participants informed written consent was obtained. The organizations selected participants, based on the following inclusion criteria:

1. A developmental age not exceeding 36 months.
2. A severe visual disability.
3. No significant hearing loss.

All further information regarding age, intellectual and sensory disabilities was obtained from personal files. In total 36 participants were included, comprising 11 women and 25 men. The mean chronological age of the participants was 49.7 years (SD = 12.2), with ages ranging from 20 to 70 years. A specification of the intellectual disability in terms of developmental age was provided from file information, it was however not always specified how this measurement was obtained. Following the classification of the DSM-IV-TR (APA, 2000), 14 participants were reported to have a severe intellectual disability (39%), and 19 participants to have a profound intellectual disability (53%). File information revealed that for three participants there was no up-to-date assessment with regard to the level of intellectual disability, however, special education experts on site appraised them as meeting the inclusion criteria. The mean reported developmental age of the participants was 24.3 months (SD = 16.3).

According to the personal files, all participants were reported to have a severe visual disability, with visual acuity < 0.3 Log-MAR (or so-called 20-40 vision, based on the criteria of the World Health Organization, 2007). The degree of reported visual disability can be divided into six categories: 13 participants (39%) were at least functionally blind or had only light perception; 5 participants (14%) had visual acuity up to 0.1; 6 participants (17%) had visual acuity from 0.1 to 0.2; 7 participants (19%) had visual acuity from 0.2 to 0.3, and 3 participants (8%) had other visual disabilities (e.g., nystagmus). For two participants, there was no current assessment with regard to the degree of visual disability specified in the file; they were included nonetheless based on reports from the direct support professionals indicating these participants met the inclusion criteria. All participants clearly reacted to sound, and there was no significant hearing loss, as evidenced by the reports of specialized audiology centers and evaluations from members of the direct support personnel.

The participants were residing in residential facilities operated by four organizations, dispersed over six locations throughout the Netherlands. Five of these locations, operated by three organizations (OID1[1,2,3], OID2, and OID3), specialize in care for people with an intellectual disability. The other location, operated by the fourth organization, focuses primarily on care for people with a visual disability (OVD1). Although these facilities differ in their primary focus with regard to intellectual or visual disabilities, they are comparable in terms of organization, provided care (residential and day-service), group size, ratio, and daily structure.

The participants were observed by their attending direct support personnel (N=41). Considering people with profound intellectual disabilities have highly diminished communication options, and may only communicate via (distorted) facial expressions, sounds, movements, body posture or muscle tension (Vos, de Cock, Petry, van den Noortgate, & Maes, 2010), observers were chosen who could interpret these subtle signs the best, based on their long experience with these clients (Vlaskamp & Cuppen-Fonteine, 2007). Data-collection days were selected randomly across the days of the week, but in such an order to ensure that only observers who had been familiar with them for at least six months rated the core affect of participants. The participants were observed an entire day, they therefore were observed by multiple members of the direct support professionals due to working hours.

Ethical procedures have been followed and for all of the participants, written consent was obtained from their legal representatives, after they had been informed about the study via written information. All members of the consortium gave verbal and written consent to conduct research at specified locations. Formal ethical approval to conduct this study was obtained by the institutional review board from the University of Groningen.

Instruments

As demonstrated by Axelsson et al. (2010), people (without disabilities) assess soundscapes according to the dimensions of pleasantness and eventfulness. In emotion theory, Russell (2003) defines core affect as an integrated mix of the similar dimensions pleasantness and activation. The combined interpretation of the dimensions of core affect and the appraisal of soundscapes yields four qualitatively different perceptual quadrants, which can be considered four different types of core affect and/or soundscapes: Lively, Calm, Boring, and Chaotic (Andringa & Lanser, 2013; Van den Bosch et al., 2015). As depicted in Figure 3, these perceptual quadrants can be classified according to their relative pleasantness and eventfulness, as well as according to the complexity of action selection and the content of audible affordances.

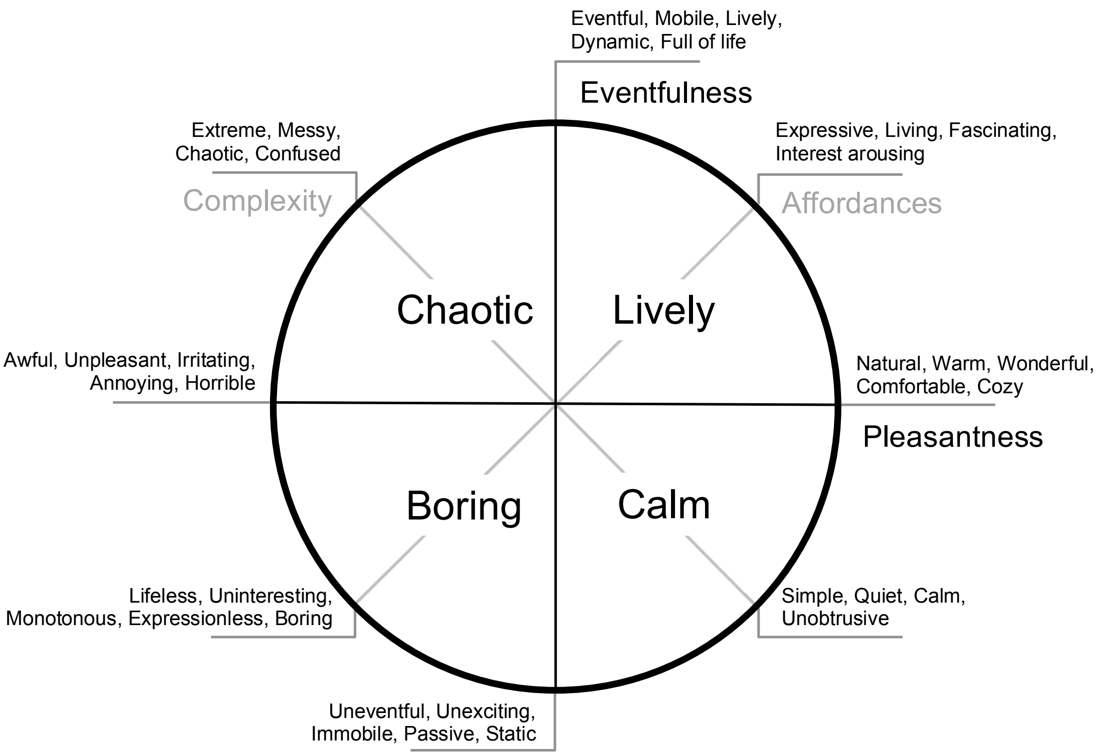


Figure 3: Four perceptual quadrants (Lively, Calm, Boring, and Chaotic) and their basic dimensions (Eventfulness vs. Pleasantness or Affordances vs. Complexity). In the figure, each of these words is positioned at the end of an axis corresponding to a high value on the particular dimension. The other side of the axis corresponds to a low value. This figure also depicts the relative positions of the eight descriptions used on the score sheet.

A score sheet was developed for this study to assess the observed soundscapes and core affect (*Assessment Auditory Environment*: Van den Bosch, Vlaskamp, Andringa, Başkent, & Ruijssenaars, 2014; see Appendix I). The score sheet is based on the Soundscape-Quality Protocol by Axelsson et al. (2010), a reliable tool to assess a person's appraisal of soundscapes. The score sheet includes eight descriptions (D1–D8, see Table 3) consisting of terms that, according to the study by Axelsson and colleagues (2010), correspond to the positions at the ends of the horizontal, vertical, and diagonal axes of soundscape appraisal and core affect (see Figure 3 and Table 3).

Table 3: Eight descriptions (D1–D8), as used on the score sheet for assessing the quality of soundscapes and behavior.

	Description
D1.	Extreme, Messy, Chaotic, Confused
D2.	Awful, Unpleasant, Irritating, Annoying, Horrible
D3.	Lifeless, Uninteresting, Monotonous, Expressionless, Boring
D4.	Uneventful, Unexciting, Immobile, Passive, Static
D5.	Simple, Quiet, Calm, Unobtrusive
D6.	Natural, Warm, Wonderful, Comfortable, Cozy
D7.	Expressive, Living, Fascinating, Interest arousing
D8.	Eventful, Mobile, Lively, Dynamic, Full of life

Using eight Likert scales, observers indicated the extent to which these descriptions suited the observed soundscapes and the observed core affect. A score of zero was interpreted as not applicable and a score of 100 as entirely appropriate. A result form was used to convert the scores on the individual scales of the score sheets to a single point for the observed core affect and a single point for the soundscapes. First, the scores were standardized, after which the scores on the two scales representing opposite ends of each axis were added together, and then divided by two (e.g., (D1+D5)/2). This yielded a single result for each of the four axes, which could then be drawn into a figure on the sheet. Averaging these four points yielded the final score, which could be attributed to one of the four quadrants (Figure 3). This procedure was performed twice, once for the core affect and once for the soundscape.

Behavioral and auditory observations were conducted concurrently, in order to assess the soundscapes as appraised by the direct support professionals themselves, and core affect of the participants. This enabled us to investigate possible relationships between these two variables.

To obtain a representative sampling of the course of a day, the observation days were divided into seven intervals of characteristic activities, as depicted in Table 4 (Zijlstra & Vlaskamp, 2005). This daily structure is reflected in all four organizations, thus making the data comparable across organizations. The aim was to observe each of the participants during each of these intervals, for 10 (randomly chosen) consecutive minutes. Therefore, efforts were made to follow participants during a single whole day, thus involving observations in the residential locations as well as in the day services setting. All participants received day-services at the same healthcare organizations as where they received residential support.

Table 4: Daily structure divided into seven intervals.

Interval	Name	Description
1.	Morning	(from the moment of getting up to leaving for day service)
2.	Morning Activity	(from arrival at day care until lunch)
3.	Lunch	
4.	Afternoon Activity	(from lunch until time of departure)
5.	Afternoon	(from arrival at home until dinner)
6.	Dinner	
7.	Evening	(from dinner until bedtime)

Procedure

A researcher visited each location for one day of data collection (5 days for 5 locations), on which all participants from that location were observed. The researcher gave the observers a short briefing on the research and an instruction on how to use the score sheet during the observations. These briefings and instructions took about 30 minutes per location, per shift. It was explained to the observers that the goal of the observations was to rate the mood (or core affect) of the participants, instead of focusing on specific behaviors and to observe or appraise the soundscapes as the direct support professionals themselves experienced these. Each observation lasted exactly 10 minutes.

At the first locations (OVD1, OID1^{1}, and OID1^{2}) 18 participants were observed. After this round of data collection, the observers evaluated the period of data collection and the score sheet through an unstructured interview with open questions regarding the usability. These evaluations showed that the score sheet was relatively clear and simple to use. Although it took more time than expected to complete the form (up to five minutes per participant), the observers considered that to fall within practical limits.

After this evaluation, data were collected from OID2 and OID1^{3}. Following the data collection, the score sheet was evaluated with the observers. Feedback concerned the difficulty of the instructions and minor errors in the layout of the form. The final version of the result form was corrected in order to improve readability and layout.

The observations at the last location, or OID1^{3,} were performed twice. During the first observation period, the observers had not been properly informed about the observations, thereby resulting in a considerable amount of missing data on this day. After consultation, it was decided to conduct these observations again and to exclude the data from the first day of data collection from the analysis.

Finally, data were collected from OID3. The observations were conducted in the same way as with the other organizations.

Analysis

In the first step, an exploratory analysis was performed on the staff attributions of the soundscapes and the observed core affect, using SPSS 21. Two variables were used to express the appraisal of the soundscapes: *pSound* and *eSound*. The variable *pSound* is a continuous, standardized variable representing the pleasantness component (see the horizontal axis in

Figure 3), and the variable *eSound* represents the eventfulness component (see the vertical axis in Figure 3). Corresponding variables were used to express the observed core affect in the participants: *pBehavior* and *eBehavior*. Differences in the relationship between core affect and soundscapes between the organizations that focus primarily on caring for people with an intellectual disability and the organization that focuses primarily on caring for people with a visual disability were also analyzed. These exploratory analyses provided input for multilevel analysis.

To investigate the relationship between the staff attributions of the soundscapes and observed core affect, a multilevel linear regression model was used, with individual participants at the highest level and repeated measurements for each participant at the lowest level, thus considering the dependent observations within each participant, where some were observed by multiple members of the direct support professionals. Multilevel linear regression analysis, also called random effects model, was selected since this gives valid results in case of missing data at random (Little & Rubin, 1987). The dependent variables reflected staff attributions of the observed core affect (*pBehavior* and *eBehavior*). The independent variables included staff attributions of the soundscapes according to the average (*pSound* and *eSound*) and time of day (*Interval*). To determine whether the observed core affect differed between the two types of organizations, these types were included as explanatory variables (*Organization*), as well as interactions between type of organization and perceived soundscape (both *pSound* and *eSound*). Differences in deviance were used to test the significance of the contributions of several nested models. Four models were formulated for the variables *pBehavior* and *eBehavior*: the Empty model (no explanatory variables), the Interval model (time of day, defined by the aforementioned intervals, as an explanatory variable), the Sound model (various aspects of sound), and the Sound and Organization model (sound and type of organization as explanatory variables). Both fixed and random effects were examined. Observed P-values less than 0.05, were considered significant. The analyses were performed in MLwin 2.23, software specifically designed to carry out multilevel linear regression analyses.

Results

In all, 149 behavioral observations were registered. On average, four observations were made for each participant, with only three participants having less than three observations. The number of observations in each interval is displayed in Table 5 and displays the missing data in especially the morning and evening intervals.

Table 5: Number of observations per interval.

Interval	Name	Number of observations	Number of observational minutes
1.	Morning	14	140
2.	Morning Activity	28	280
3.	Lunch	25	250
4.	Afternoon Activity	26	260
5.	Afternoon	20	200
6.	Dinner	18	180
7.	Evening	18	180
	Total	149	1490

Exploratory analysis

Figure 4 presents the staff attributions of the soundscapes, as observed by direct support professionals. The horizontal axis shows the variable *pSound* (M=0.36, SD=0.33), and the vertical axis represents the variable *eSound* (M=0.28, SD=0.41).

Figure 5 presents the staff attributions of core affect, as observed by direct support professionals. The horizontal axis shows the variable *pBehavior* (M=0.36, SD=0.39), and the vertical axis represents the variable *eBehavior* (M=0.16, SD=0.46).

Figures 4 and 5 also indicate the differences between organizations focused primarily on care for people with an intellectual disability (OID1-3, □) and those focused primarily on care for people with a visual disability (OVD1, +). The averages of the variables for both types of organizations are shown in Table 6.

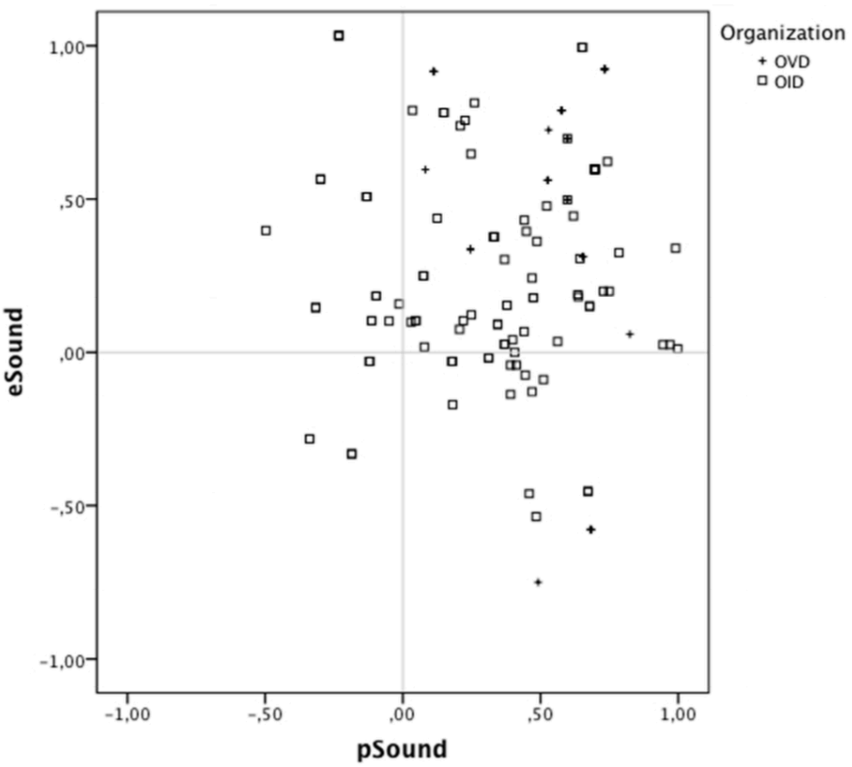


Figure 4: Quality of the observed soundscapes in terms of pleasantness and eventfulness.

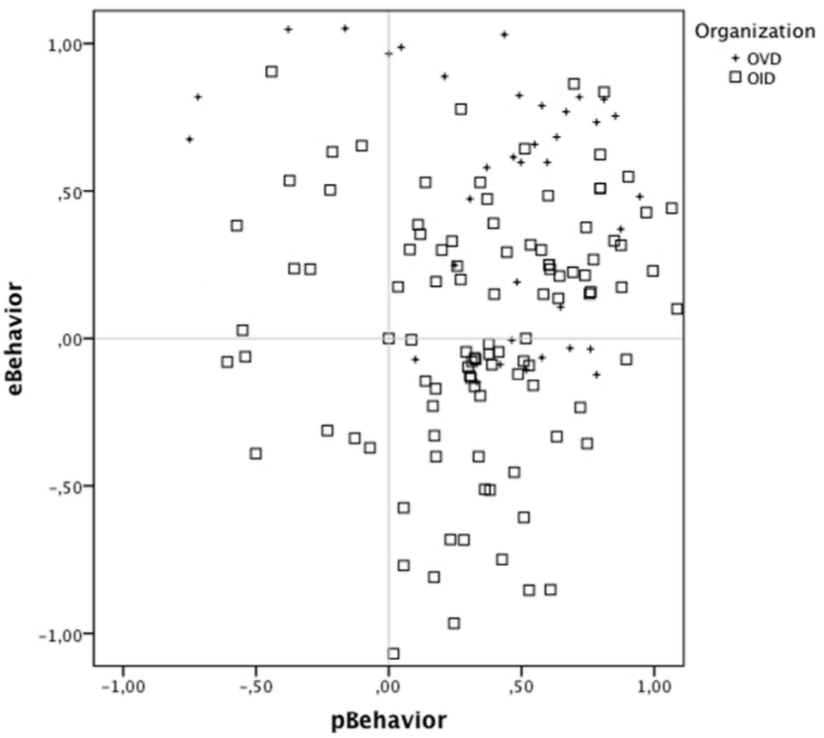


Figure 5: Quality of the observed behavior in terms of pleasantness and eventfulness.

Table 6: Means and standard deviations for the variables pBehavior, eBehavior, pSound, and eSound, by type of organization (primary focus on care for people with an intellectual –OID- or visual disability -OVD-).

	OID1-3		**OVD1**		**Total**	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
pBehavior	0.35	0.39	0.41	0.41	0.36	0.39
eBehavior	0.04	0.42	0.50	0.40	0.16	0.46
pSound	0.30	0.35	0.52	0.22	0.36	0.33
eSound	0.23	0.35	0.44	0.52	0.28	0.41

As suggested by the figures in the table, the results were predominantly positive, and higher scores were assigned for all variables in the organizational type focusing primarily on visual disabilities. This is particularly true for the eventfulness of the observed core affect (*eBehavior*).

Multilevel analysis

The results of the multilevel analysis of the four models for the variable *pBehavior* are displayed in Table 7. First it was examined whether the time of day, specified in intervals, affected the degree of attributed pleasantness of the observed core affect (*pBehavior)* in the Interval model. The results indicate that time of day does not significantly predict staff attributions of the pleasantness of the observed core affect in the participating clients.

Second, analysis of the predictors *pSound* and *eSound* on *pBehavior* revealed a significant effect (*pSound*: estimated regression coefficient = 0.569 [SE = 0.086]*, *eSound*: estimated regression coefficient = 0.172 [0.066]*) in the Sound model. This result identifies the staff attributed pleasantness and eventfulness of a soundscape as significant predictors of the observed pleasantness of core affect in the participating clients (*pBehavior*).

Finally, the type of organization (primary focus on care for people with a intellectual or visual disability) was assessed as an explanatory variable in the Organization model. In this model, *Organization* was not a significant predictor (estimated regression coefficient = 0.080 [SE = 0.079]).

The best-fitting model was thus the Sound model, in which both sound variables (staff attributed pleasantness and eventfulness of the soundscapes) together provided the largest difference in deviance compared to the empty model.

Table 7: Results of multilevel analysis for pBehavior

		Empty model	Interval model	Sound model	Sound and Organization model
			Estimation (se)		
Fixed Effects					
	Intercept	0.361 (0.045)*	0.210 (0.104)*	0.353 (0.034)*	0.294 (0.067)*
Interval					
	Morning[1]		-		
	Morning activity		0.076 (0.118)		
	Lunch		0.152 (0.122)		
	Afternoon activity		0.215 (0.118)		
	Afternoon		0.188 (0.123)		
	Diner		0.247 (0.132)		
	Evening		0.152 (0.126)		
Sound					
	pSound[2]			0.569 (0.086)*	0.593 (0.089)*
	eSound[2]			0.172 (0.066)*	0.184 (0.067)*
Organization					
	Visual[12]				-
	Intellectual				0.080 (0.079)
Random effects					
	Between variance	0.043 (0.017)	0.043 (0.017)	0.017 (0.010	0.015 (0.010)
	Residual variance	0.110 (0.015)	0.104 (0.014)	0.089 (0.012)	0.089 (0.013)
Goodness-of-fit					
	Deviance	120.299	114.193	76.039	75.065

* $p < .05$
[1] Reference category
[2] Compared to the mean

The results of the multilevel analysis for the variable *eBehavior* are displayed in Table 8, using the same four models described above for the variable *pBehavior*. The first model concerns the repeated measurements and the extent to which the time of day (*Interval*) affected the degree of attributed pleasantness of the observed core affect (*pBehavior)*. As with *eBehavior*, no significant effect was found in the Interval model.

Analysis of the Sound model reveals that only the variable *pSound* is a significant predictor for *eBehavior*. This result indicates that the staff attributed pleasantness of a soundscape is predictive of the rated eventfulness of core affect (*eBehavior*: estimated regression coefficient = 0.396 [se = 0.113]*). The predictive value of *eSound* on *eBehavior* is not significant (estimated regression coefficient = 0.165 [se = 0.086]). Considering that the effect is in the expected direction with a P-value of < 0.10, and in order to maintain the comparability of the models for *pBehavior* and *eBehavior*, the model with both sound variables is presented.

In contrast to the results for *pBehavior*, type of organization is a significant explanatory variable for *eBehavior* (estimated regression coefficient = -0380 [se = 0.097]*). The results indicate that the core affect of the participants was rated as more eventful in the organization that focused primarily on caring for people with visual disabilities. This suggests the Sound and Organization Model to be the best predictive model for the variable *eBehavior*.

Table 8: Results of multilevel analysis for eBehavior

		Empty model	Interval model	Sound model	Sound and Organization model
			Estimation (se)		
Fixed Effects					
	Intercept	0.164 (0.054)*	0.128 (0.123)*	0.158 (0.048)*	0.435 (0.082)*
Interval					
	Morning[1]		-		
	Morning activity		0.002 (0.139)		
	Lunch		-0.012 (0.143)		
	Afternoon activity		0.059 (0.139)		
	Afternoon		0.023 (0.145)		
	Diner		0.095 (0.155)		
	Evening		0.120 (0.147)		
Sound					
	pSound[2]			0.396 (0.113)*	0.317 (0.110)*
	eSound[2]			0.165 (0.086)	0.126 (0.084)
Organization					
	Visual[12]				-
	Intellectual				-0.380 (0.097)*
Randomeffects[1]					
	Between variance	0.066 (0.025)	0.066 (0.025)	0.040 (0.019)	0.021 (0.014)
	Residual variance	0.145 (0.020)	0.143 (0.020)	0.146 (0.020)	0.141(0.020)
Goodness-of-fit					
	Deviance	162.905	161.077	148.618	135.009

* $p < .05$
[1] Reference category
[2] Compared to the mean

Discussion

The descriptive analysis of staff attributions of the observed pleasantness and eventfulness of soundscapes and moods in terms of core affect displayed by people with profound intellectual and visual disabilities shows that the averages of all four variables (*pBehavior, eBehavior, pSound, eSound*) fall into the upper-right quadrant. This means that, in general, the observers described both soundscapes and core affect as pleasant and eventful. However, considering the explorative nature of this study, these and the following results, should be interpreted with caution. With regard to the eventfulness of core affect (*eBehavior*), the average was higher at the organization focused primarily on caring for people with a visual disability. The multilevel linear regression analysis findings endorse a relationship between reported soundscape and reported behavior observations, which we expected on the basis of the research by Axelsson et al. (2010) in combination with Kuppens et al. (2012). The combination of the pleasantness and the eventfulness of the soundscapes seem to have significant predictive value for both of these elements of core affect. This combination of pleasantness and eventfulness can be described as the "liveliness" of the soundscape.

In addition to the characteristics of the soundscapes, type of organization appears to be a significant explanatory variable for the eventfulness of core affect (*eBehavior*). These results suggest that the core affect of the participants was rated as more eventful in the organization that focused primarily on the care of people with a visual disability, consistent with the results of the descriptive analysis. This model, a combination of the explanatory variables *pSound*, *eSound,* and *Organization*, is the best predictive model for *eBehavior*. One possible explanation for this difference is that it is conceivable that environmental noise is dealt with differently in these two different types of organizations. In facilities with a primary focus on people with a visual disability there is more attention for acoustic aspects than in facilities that primarily focus on people with intellectual disabilities, e.g. in meeting certain acoustic standards (Van den Wildenberg, Van Welbergen, & Van der Burg, 2002). Facilities with unfavorable acoustical properties may inhibit normal conversation, promote undesirable vocalizations, or create an aversive ambient environment (Egli, Roper, Feurer, & Thompson, 1999). This might cause a less pleasant or eventful core affect in the clients residing in organizations with a primary focus on people with intellectual disabilities.

The results also indicate that time of day is not a significant predictor of staff attributions of core affect. It could be due to trends in the staff attributions, as opposed to actual core affect in the participants. For example, staff might change their expectations throughout the day and rate core affect after lunch as eventful as before lunch, even though there were less actual indications. Also, the bias towards positive ratings, given the seemingly positive overall ratings, can be due to an inadequacy of the staff in reliably assessing core affect as suggested by research from Hogg, Reeves, Roberts, and Mudford (2001). The participants were observed an entire day, and therefore they were observed by multiple members of the direct support professionals due to working hours. This variation is accounted for by including time as a predictor variable in our analysis. However, the uneven number of observations throughout the day challenges the validity of the assertion of time of day not having a relationship with core affect. Further research into the relationship between the time of day and staff attributions of core affect is recommended.

This is a newly developed assessment procedure, and an exploratory (or pilot) study, in which refinement of the assessment procedure played an important role. Consequently there is no information regarding the psychometrics of this assessment procedure yet. The results however, seem to comply with previous research on soundscapes and the effects thereof on (the moods, behavior and health of) people without disabilities (Andringa & Lanser, 2013; CALM, 2004; Kaplan, 1995; Kuppens et al., 2012; WHO, 2000). Also, the procedure was based on the Soundscape Quality Protocol by Axelsson et al. (2010), a reliable tool to investigate the subjective appraisal of soundscapes, however now applied for the first time in healthcare settings for people with profound intellectual disabilities. The validity of this research (partly) stems from the consistency with previous literature, but further research is needed to confirm this

This study is subject to several limitations, such as the choice not to control for individual differences (e.g. level of intellectual or of visual disability) in making the statistical comparisons. This choice was based on the nature of the target group and the facilities in which they reside. In these residential facilities a number of people with profound intellectual and visual disabilities are placed together, forming heterogeneous groups. The aim of this study was to make a first assessment of the staff attributions of soundscapes in these groups and so to ultimately optimize these soundscapes to improve the quality of life of heterogeneous groups of people with profound intellectual and visual disabilities. In future studies, individual differences need to be included in the study design. Also, follow-up study involving simultaneous observations by two members of the direct support professionals, or other groups of observers such as researchers or family members, could allow analysis regarding inter-rater reliability and further psychometric analysis to validate the assessment procedure introduced in this paper. The amount of missing data does not necessarily have to be considered a limitation of this study, since the missing data arose due to logistic reasons, such as a higher workload for the observers in the mornings and evenings. Because the missing data did not arose due to factors related to the dependent variables, and can be considered missing at random, the results from the multilevel analysis are expected to be valid (Little & Rubin, 1987).

One important question that remains is how people with profound intellectual and visual disabilities actually experience soundscapes. Given their profound disabilities, it is likely that they process sound in a different way than people without disabilities. That is the main reason why the DSP in this study were asked to observe and appraise the soundscapes as they themselves experienced these environments. At this point, it is unfeasible to make correct judgments on how people with profound intellectual and visual disabilities experience soundscapes. For example, people without intellectual and visual disabilities can distinguish the importance of sounds but people with these disabilities might be able do this poorly, more slowly, or not at all. All sounds may appear equally important to them, because prioritizing might be difficult and they may have difficulties in attending to the sources optimally. Also, our data does not allow any conclusions regarding the rotation of axes representing core affect, pleasantness and eventfulness, for people with profound intellectual disabilities. For example, people without disabilities might perceive a particular environment as lively, while those with profound disabilities might perceive it as chaotic and overwhelming. If this is the case, the axis should be rotated in a counter clockwise direction. Only by researching how people with profound intellectual and visual disabilities react to different kind of soundscapes, will we be able to unravel the actual perceptual processes of people with profound intellectual and visual disabilities.

The ability of people with disabilities to interact with their environments depends in part upon the sounds within these environments, and people with such disabilities might not have the cognitive capacity to comprehend many contemporary soundscapes (Van den Bosch et al, 2015). It is therefore important to investigate how the auditory environment can be optimized for people with both intellectual and visual disabilities in order to make these people feel safer and more comfortable in their living environment. Because these people cannot adapt optimally to their environment, they need well-tuned conditions to flourish. This may already be accomplished by investigating how people with intellectual and visual disabilities react to sounds and by making simple changes to their environment like adding pleasant background noise and using acoustically damping materials. As a result the interactions between people with intellectual and visual disabilities and their direct caregivers will be more efficient and effective because there will be less miscommunication and negative attention, increasing the probability of people with these disabilities experiencing positive moods.

Chapter Five

The relationship between soundscapes and challenging behavior

This chapter is based on: Van den Bosch, K., Andringa. T., Post, W., Ruijssenaars, A., & Vlaskamp, C., (submitted). The relation between the auditory environment and challenging behavior in people with a severe or profound intellectual disability.

Abstract

This article focuses on the relation between the auditory environment and mood and (challenging) behavior in people with severe or profound intellectual and multiple disabilities (PIMD). Given the high prevalence of visual disabilities in this target group, a high quality auditory environment is important. We describe a pilot study, in which 13 direct support professionals used the smartphone application *MoSART* to appraise the auditory environment during a period of four weeks. Pre- and post-test measurements were administered of the moods (MIPQ) and challenging behaviors (LGP-PIMD) of 15 participants with a severe or profound intellectual disability. Results showed that the implementation of *MoSART* was accompanied by an increase of 'lively' appraised auditory environments, and significant decreases of negative moods and severity of stereotypical behavior of the participants.

Introduction

Challenging behavior is common among people with an intellectual disability. The prevalence of psychiatric and behavioral problems in this population is estimated at 30-50% (Došen, 2005), entailing a three to five times higher risk of suffering from these problems compared to the general population, with an even higher prevalence among people with profound intellectual and multiple disabilities (Poppes, Van der Putten, & Vlaskamp, 2010). Challenging behavior is defined by Emerson et al. (2001) as culturally abnormal behavior of such intensity, frequency and duration that the physical safety of the person or others is endangered, or behavior that is likely to lead to restrictions in the use of, or the denial of access to, communal facilities.

In literature, challenging behaviors are commonly divided into self-injurious behavior, stereotypical behavior, and aggressive / destructive behavior (Rojahn, Matson, Lott, Esbensen, & Smalls, 2001). Self-injurious behavior is defined as behavior that may cause harm to a person's own body (Matson, Cooper, Malone, & Moskow, 2008). Examples are beating, biting or scratching oneself. Stereotypical behavior is described as repeated body movements or postures that are not part of a purposeful act, such as swaying back and forth, smelling objects, yelling and screaming. The definition of aggressive / destructive behavior is an offensive action aimed at people or objects like hitting, kicking, pushing or scratching of other people (Rojahn et al., 2001). In addition to the above types of challenging behavior, some authors stress that withdrawn behavior may also be regarded as challenging behavior, giving its consequences (Poppes et al., 2010). Withdrawn behavior is described as behavior in which the person fails to make contact with the environment. This includes warding off physical contact, avoiding eye contact, being apathetic and having a closed posture. This type of challenging behavior is especially frequent among persons with profound intellectual and multiple disabilities (Poppes et al, 2010).

All these different types of challenging behavior have a range of negative consequences for the person involved. Examples are limited independence and integration into the community, limitations in the way these people are seen by others, negative effects on learning, personal development, and reduced participation in social activities (Matson et al., 2011; Lundqvist, 2013). People with an intellectual disability who display challenging behavior are also more at risk to be abused and neglected (Lowe et al., 2007). Challenging behavior is thus a major problem for many people with an intellectual disability, not only because the person literally damages itself, but also because it limits opportunities to participate in activities and to build or maintain relationships with others (Poppes et al, 2010).

Direct support professionals (DSP) often report anecdotal evidence that highlights the importance of the auditory environment in relation to challenging behavior. Yet they also report that this is neither addressed in their education nor in their team-meetings. Research confirms that the auditory environment of people with PIMD in most cases is insufficiently adapted to the capabilities and limitations of these individuals. Healthcare professionals such as DSP, often do not possess the necessary knowledge about the importance of the auditory environment (Evenhuis, Theunissen, Denkers, Verschuure, & Kemme, 2001; Kingma, 2005;. Meuwese-Jongejeugd et al., 2005; Van den Bosch, Andringa & Vlaskamp, 2013). One consequence is that little attention is paid to the effects of e.g., sounds from radio and television, or unexpected and unfamiliar sounds.

Good attunement between the personal characteristics of people with PIMD and the auditory environment is important because of the dynamic relation between the appraised quality of auditory environments and the listeners' mood (Kuppens, Champagne, & Tuerlinckx, 2012; Andringa & Lanser, 2013). A positive mood improves the appraisal of the auditory environment as positive and vice versa, a bad auditory environment worsens someone's mood. Research by Van den Bosch, Vlaskamp, Andringa, Post and Ruijssenaars (2014) indicates this relationship between the quality of auditory environments and moods of the people within them also exists in people with a profound intellectual disability.

Furthermore, research using the Mood, Interest and Pleasure Questionnaire (MIPQ), showed that people with a severe or profound intellectual disability had lower subjective well-being scores than people with a mild intellectual disability (Vos, De Cock, Petry, Van den Noortgate, & Maes, 2010). In turn, Adams and Oliver (2011) showed that people with lower subjective well-being more often express challenging behavior than people with higher subjective well-being, and Ross and Oliver (2002) found significantly lower moods in people showing challenging behavior. Hayes, McGuire, O'Neill, Oliver, and Morrison (2011) also investigated the relationship between low mood and challenging behavior in people with a severe or profound intellectual disability, but controlled for the presence of potentially confounding variables, such as autism. They found that people with a severe or profound intellectual disability show clear and measurable signs of low mood and that low mood was associated with a higher frequency and greater severity of challenging behavior. These studies suggest that people with a severe or profound intellectual disability more often experience a low subjective well-being, and demonstrate the importance of finding ways to improve the subjective well-being of these people to avoid or diminish the occurrence of challenging behavior.

The relationship between moods, challenging behavior, and the auditory environment could stem from the evolutionary function of sound to warn us for dangerous situations (Andringa & van den Bosch 2013). However, people with a severe or profound intellectual disability have more difficulty understanding their environment and as a result, it is less likely that they will understand the indications of safety provided in their current environments (Van den Bosch, Andringa, Başkent, & Vlaskamp, 2015). For example, unexpected sounds like a loud bang of a closing door are annoying for everyone. People with a severe or profound intellectual disability, however, often do not understand what these sounds mean or where they come from. As a result, they might feel more anxious and unsafe. These feelings can lead to stress, and in turn this stress can give rise to challenging behavior (Van den Bosch et al., 2015).

The capacity of people with a severe or profound intellectual disability to understand the world around them is even more diminished due to the high prevalence of visual impairments amongst these people, even up to the point that some authors state that they may be considered visually impaired until proven otherwise (Van Splunder, Stilma, Bernsen, & Evenhuis, 2006). An intellectual disability impairs daily functioning, and visual impairment diminishes daily functioning even more (Evenhuis, Sjoukes, Koot, & Kooijman, 2009). For example, a severe or profound intellectual disability impairs activities of daily life, linguistic skills, social skills and independent living skills. Visual impairment from childhood delays motor development, attachment, language, motor and learning skills. The combination of intellectual and visual disabilities can cause the individual to be more vulnerable for developing behavioral problems and psychiatric illness (Carvill, 2001) and not surprisingly, sensory problems are indeed associated with the onset of challenging behavior (Poppes et al., 2010). Since auditory information can partially compensate a loss of visual information (Occelli, Spence, & Zampini, 2013; Dufour, Després, & Candas, 2005), people with a severe or profound intellectual disability may be relatively more dependent on the auditory environment.

In addition, people with a severe or profound intellectual disability often have limitations in their communicative abilities, such as verbal or facial expression. These communicative limitations are known to lead to challenging behavior (Lundqvist, 2013; Poppes et al, 2010). Poor auditory environments (e.g., loud music, shouting people, or poor acoustics) make communication even more difficult; therefore reinforcing the communicative limitations of people with a severe or profound intellectual disability and strengthening potential challenging behavior. This makes a high quality auditory environment even more important. It seems that the DSP are often not consciously aware of the impact that sound has on the behavior of people with an intellectual disability and do not take it into account in their daily practice (Van den Bosch, Andringa, & Vlaskamp, 2013). This should be considered alarming, since it is the DSP that control the auditory environment for these people, who are often not able to influence the environment themselves or express their preferences. Therefore it is important to identify the actual role of sound in relation to the behavior of people with a severe or profound intellectual disability and to clearly identify the properties of sound that have a potential impact on the behavior of these people, so it can be made part of daily practice and policies.

Despite the evidence of the importance of the auditory environment for people with PIMD, there is little research on this topic. Therefore, the current pilot study has two main objectives. First, a new assessment method was used to explore the usefulness of this method for practice and research. Second, it was examined whether increased awareness about the role of the auditory environment contributes to a better (perceived) quality of these environments, and subsequently to more positive moods and less challenging behavior in people with PIMD. We investigated this by the implementation of an assessment procedure in the form of a smartphone application, called MoSART (*Mobile Soundscape Appraisal & Recording Technology*, soundscapes are defined as an environment of sound, with an emphasis on how it is perceived by an individual or society; Schafer, 1977).

Method

Participants

Direct support professionals.

The participating DSP (N=13) were employed at a Dutch organization offering day care for people with a severe or profound intellectual disability, at a location specialized in Intensive Support Groups (ISG). This group consisted of two male and 11 female participants with a mean age of 36,4 years (SD = 9,96, range = 22 to 53 years). All DSP received vocational training, were long familiar with the clients and all volunteered to participate in this study.

Clients.

The group of participating clients consisted of 15 people (8 men, 7 women) with a mean age of 44,4 years (SD = 13.29, range = 18 to 55 years). Following the classification of the DSM-IV-TR (APA, 2000), 13 participants were reported to have a severe intellectual disability and two participants were reported to have a profound intellectual disability. Based on the personal files, four participants were reported to have a severe visual disability, with visual acuity < 0.3 Log-MAR (or so-called 20-40 vision, based on the criteria of the World Health Organization, 2007). Six participants reportedly had a moderate visual disability (< 0.5 Log-Mar), and five participants were reported to have no visual disability. Ten participants did not have the ability to speak, the other five participants were reported to display some form of verbal communication. According to personal files, common challenging behaviors within this group were self-injury, (verbal) aggressive/destructive behavior, stereotypical behavior and withdrawn behavior.

Ethical procedures have been followed and for all of the participants, written consent was obtained from their legal representatives, after they had been informed about the study via written information. Formal ethical approval to conduct this study was obtained by the institutional review board from the University of Groningen.

Design

A quasi-experimental in situ design was applied, with pre- and post-test measurements. During a period of four weeks, the smartphone application MoSART was used by DSP. Halfway through this period a meeting took place with the aim to further increase awareness of the auditory environment among the DSP, through a group discussion in which experiences, ideas, and insights were shared. This increased awareness served as the independent variable in this study. The dependent variables were the quality of the auditory environment (measured with MoSART), and the mood (MIPQ) and behavior (LGP-PIMD) of the participants with PIMD.

Procedure

Prior to the beginning of the study, the participating DSP completed the LGP-PIMD and MIPQ for the participating clients, serving as pre-test measurements. Thereafter, the researcher (first author) joined a team meeting to inform the DSP about the study and the use of MoSART. MoSART can be considered as an experience sampling method, which entails that the user is prompted on three random moments during the day to indicate how he or she experiences the auditory environment at that moment (in situ), through on a short questionnaire. In the two weeks following, the DSP worked with MoSART on a daily basis. Following this period, a meeting was organized in which the content and conduct of the study was discussed. This meeting started the second period of two weeks in which the DSP used MoSART. Finally, the LGP-PIMD and MIPQ were administered again, serving as post-test measurements.

Instruments

MoSART.

MoSART is an assessment procedure to measure the appraised quality of auditory environments (soundscapes). It is a version of the *Assessment Auditory Environment* (Van den Bosch et al., 2014), which was digitized to a smartphone application[1] for Android especially for this study, and includes some additional functions (see Appendix II). MoSART sends push notifications three times a day to the user (DSP), at random moments during working hours, with the request to make a measurement. A snooze function is included to refuse or

[1] Thanks to Stefan Bussemaker, student Artificial Intelligence, University of Groningen.

postpone the measurement when it is prompted at an inconvenient moment. The measurement consists of two parts: the recording an audio clip of 30 seconds (not used for this study) and a questionnaire regarding the appraisal of the environment.

In accordance with the *Assessment Auditory Environment*, MoSART asks the user to appraise the auditory environment in terms of pleasantness and eventfulness, using four Likert scales. Furthermore, it asks the user to assess the audibility of different classes of sound sources (Traffic, Mechanical, Human, Natural, and Other) and the overall quality of the respective auditory and visual environment. All these questions are rated on a 0-100 scale. The remaining questions regard the appropriateness and changeability of the auditory environment (answered with yes or no), the current location, the number of staff and the number of clients present in the group, and additional comments. The final result of the measurement of the quality of the auditory environment is shown in five possible outcomes: Lively, Calm, Boring, Chaotic, and Neutral, which is in accordance with the proposed taxonomy of soundscape quality by Van den Bosch et al. (2015) and Andringa and Lanser (2013), with the Neutral outcome as a new addition (Figure 6). Lively and Calm auditory environments are viewed as positive because they contain ample indications of audible safety. Chaotic, Boring and Neutral auditory environments are less desirable because they are hard to interpret or not reassuring. A Neutral environment is however to be preferred over Chaotic and Boring environments.

There are no psychometric qualities of MoSART known yet. However, it is based on the Soundscape Quality protocol by Axelsson et al (2010) and the *Assessment Auditory Environment* (Van den Bosch et al., 2014). The latter has been used successfully before to assess the quality of auditory environments in residential facilities for people with profound intellectual and multiple disabilities (Van den Bosch et al., 2014). Research by Mydlarz (2013) indicates that mobile techniques have proven their suitability for use in research into auditory environments. The use of mobile technologies could potentially give a representative impression of the auditory environment of a person and their ratings of these environments (Mydlarz, 2013).

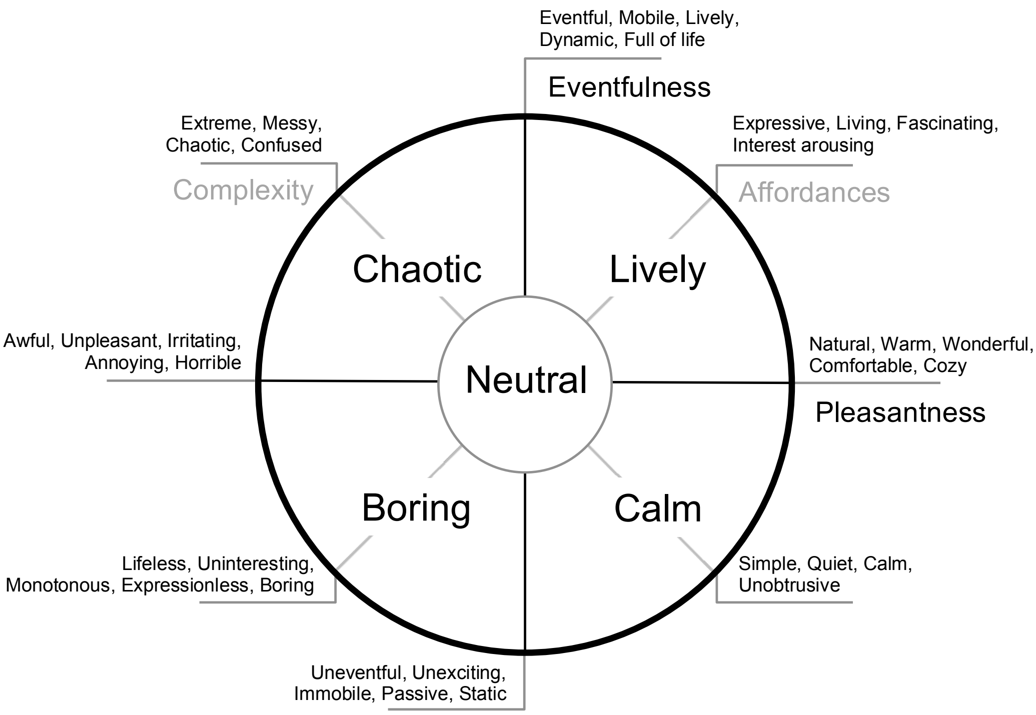


Figure 6. Taxonomy of soundscapes

Mood, Interest and Pleasure Questionnaire (MIPQ).

A Dutch translation of the Mood, Interest and Pleasure Questionnaire (MIPQ) (Petry, Kuppens, Vos, & Maes, 2010; Ross and Oliver, 2003) was used to measure the mood of the participating clients. This version of the MIPQ consists of 25 items divided into three subscales (positive mood, negative mood, and interest) to measure the affect of adults with a severe intellectual disability. The items are scored on a 5-point Likert scale (4 = always, 3 = often, 2 = half the time, 1 = sometimes, 0 = never). Higher scores indicate a better mood, and higher levels of interest and pleasure. An increase in the score on the scale negative mood reflects a decrease in the frequency of this behavior (and is thus also positive), since this scale is reversed in the calculation of the total score. The original MIPQ showed good reliability for all subscales and total score, with high internal consistency (α ≥ .94), high inter-rater (r ≥ .76) and high test–retest reliability (r ≥ .87) for the total scores. Research by Petry et al. (2010) also showed good psychometric qualities for the Dutch translation of the MIPQ, with high internal consistency (α ≥ .80), high inter-rater (r ≥ .69) and high test–retest reliability (r ≥ .86).

Behavior Problem Inventory (LGP-PIMD).

Data regarding the severity and frequency of the challenging behavior of the clients were gathered with the Dutch translation of the Behavior Problem Inventory (BPI-01) (Lambrechts, Kuppens, & Maes, 2009; Rojahn, Matson, Lott, Esbensen, & Smalls, 2001), including extra items to measure withdrawn behavior (LGP-PIMD: Poppes, Van der Putten, Post, & Vlaskamp, 2015). The LGP-PIMD is a behavioral assessment tool consisting of 58 items for self-injurious, stereotypic, aggressive / destructive and withdrawn behavior in people with an intellectual disability and other developmental disabilities. The items are scored on frequency (never, 1 = monthly, 2 = weekly, 3 = daily, 4 = every hour) and severity (1 = limited impact; 2 = moderate impact, 3 = severe impact). Research showed that the original BPI, as the Dutch translation (BPI-01) and the LGP-PIMD are valid and reliable instruments (Lambrechts et al., 2009; Poppes et al., 2015; Rojahn et al., 2001).

Analysis

Considering the explorative nature of this study, the first-time use of MoSART, and the small sample size, an explorative analysis was chosen. Data analysis concerned descriptive statistics of the staff attributions of the quality and characteristics of the auditory environments as gathered by the use of MoSART. The first and second period are compared with each other, to measure the possible effects of increased awareness of the role of the auditory environment amongst the DSP. In order to assess the effects of the use of MoSART on the behavior of the participating clients, paired samples t-tests were performed to analyze any differences in de pre- and post-test measurements of the MIPQ and LGP-PIMD.

Results

MoSART

A total of 170 measurements were made with MoSART by the 13 DSP, of which 74 in the first period and 96 in the second period. The participating DSP rated the auditory environments in the first period with an average grade of 5,5 (*sd* = 1,3) on a 0-10 scale. In the second period, the average grade was rated a 6,3 (*sd* = 2,0).

The results in Table 9 show the final results of the measurements made by the participating DSP with the use of MoSART in terms of the five different types of auditory environments. The results show that during the first period Neutral (36,5%) and Calm (33,8%) appraised auditory environments were most frequent. During the second period Lively auditory environments were most frequent (52,1%), indicating an important increase in Lively and a decrease of the other types of auditory environments. The prevalence of Boring and Neutral auditory environments seems to have decreased the most. The uneven numbers of measurements per participant were not taken into account in these results, since reporting only the average result (or mode) per DSP, would reduce the richness of the results.

Table 9. Frequency table of the number of observations per scored affect category

		Affect					
		Lively	*Calm*	*Boring*	*Chaotic*	*Neutral*	**Total**
Period	*First*	9 (12,2%)	25 (33,8%)	6 (8,1%)	7 (9,5%)	27 (36,5%)	74
	Second	50 (52,1%)	21 (21,9%)	2 (2,1%)	8 (8,3%)	15 (15,6%)	96
Total		59	46	8	15	42	170

Table 10. Mean level of reported sound sources per category, scores run from 0-100

		Sound Source category				
		Traffic	*Mechanical*	*Human*	*Natural*	*Other*
Period	*First*	14,53 (sd 21,91)	16,57 (sd 24,21)	59,51 (sd 20,63)	31,77 (sd 24,89)	38,85 (sd 29,91)
	Second	12,21 (sd 19,21)	21,97 (sd 23,94)	67,85 (sd 18,83)	25,81 (sd 23,65)	46,15 (sd 29,08)

The results in Table 10 indicate the presence of different types of sound sources. A slight decrease in Traffic (e.g. cars passing) and Natural sounds (e.g. song of birds), seems to have made place for a slight increase in Mechanical (e.g. household appliances), Human (e.g. speech) and Other sound sources. The most frequent Other sound source was music or television.

Table 11 shows the results of the questions "*Do you deem the soundscape appropriate for the clients?*" and "*Are you able the change something about the soundscape?*" The results suggest an increase of the number of times these questions were answered positively.

Table 11. Frequency table indicating whether DSP deemed the auditory environment appropriate for the time and place, and changeable.

		Appropriate		Changeable	
		Yes	*No*	*Yes*	*No*
Period	*First*	65 (87,8%)	3 (4,1%)	30 (40,5%)	37 (50%)
	Second	87 (90,6%)	9 (9,4%)	57 (59,4%)	39 (40,6%)

Mood, Interest and Pleasure Questionnaire

A paired samples t-test was conducted to compare the results of the MIPQ, before and after the use of MoSART by the participating DSP. Although there was an increase in the mean scores on all scales, a significant difference was only found between the pre- (*M* = 19.50, *SD* = 2,79) and post-test (*M* = 21.79, *SD* = 3,59) measurements of negative moods, $t(14) = 2,56$, $p = .024$ (see Table 12). These results suggest that the use of MoSART led to a decrease of negative moods in clients with a severe or profound intellectual disability.

Table 12. Outcomes of the dependent samples t-test for the MIPQ.

(sub)Scales	Pretest	Posttest	**Paired Samples Statistics**				
			M	*SE*	*t*	*df*	*p*
Total	50,29 (17,44)	56,64 (15,46)	6,36	3,83	1,66	14	,121
Positive mood	17,60 (8,28)	20,00 (6,70)	2,40	1,58	1,51	14	,152
Interest	13,64 (5,60)	15,29 (5,93)	1,64	1,30	1,27	14	,227
Negative mood	19,50 (2,79)	21,79 (3,59)	2,29	0,89	2,56	14	,024*

* Significant $p < .05$

Behavior Problem Inventory

To compare the frequency and severity of the challenging behavior of the participating clients before and after the use of MoSART by the participating DSP, a paired samples t-test was conducted (see Table 13). A significant difference was found between the pre- (*M* = 0.39, *SD* = 0.14) and post-test (*M* = 0.27, *SD* = 0.19) measurements of the severity of stereotypical behavior, $t(14) = -2,23$, $p = .042$. These results suggest a decrease of the severity of stereotypical behavior in clients with a severe or profound intellectual disability

.

Table 13. Outcomes of the dependent samples t-test for the LGP-PIMD of the frequency and severity for the subscales Self-injurious behavior (SI), Stereotypical behavior (ST), Withdrawn behavior (WD), Aggressive-Destructive behavior (AD) and for the total frequency and severity.

					Paired Samples Statistics		
(sub)Scales	*Pretest*	*Posttest*	*M*	*SE*	*t*	*df*	*p*
Frequency SI	,39 (,28)	,46 (,28)	,07	,06	1,29	14	,219
Severity SI	,29 (,23)	,25 (,16)	-,04	,04	-,94	14	,364
Frequency ST	,87 (,45)	,78 (,58)	-,09	,16	-,57	14	,575
Severity ST	,39 (,14)	,27 (,19)	-,12	,06	-2,23	14	,042*
Frequency WD	1,12 (,66)	1,39 (,62)	,27	,17	1,57	14	,140
Severity WD	,60 (,27)	,59 (,29)	-,01	,07	-,21	14	,837
Frequency AD	,63(,53)	,68 (,50)	,06	,08	,69	14	,503
Severity AD	,38 (,31)	,46 (,37)	,08	,09	,90	14	,383
Frequency Total	,71 (,28)	,73 (,32)	-,02	,09	,27	14	,789
Severity Total	,39 (,14)	,34 (,16)	-,05	,03	-1,45	14	,168

* Significant $p < .05$

Discussion

This study aimed to evaluate the role of the auditory environment in moods and the display of challenging behavior in people with a severe or profound intellectual disability. The results suggest that the use of MoSART amongst the DSP seems to have improved the quality of the auditory environments, with an increase of Lively appraised auditory environments. In addition, a significant decrease of negative moods and severity of stereotypical behavior among the participants with PIMD was reported. Raised awareness about the importance of the auditory environment could be a mediating factor in this effect, but further research is needed to investigate this. However, results from MoSART indicate that the DSP did felt more empowered to change these environments after using MoSART for a couple of weeks. The fact that these changes occurred within a short period of time, demonstrates the immediate effects of the auditory environment on the moods and behavior of people with a severe or profound intellectual disability, and plausibility of success of sound related interventions.

The pilot study appears to be successful, both with regard to the usability of assessment method as the results of the behavioral questionnaires. However, the generalizability of these results is subject to certain methodological limitations. First of all it was the first time MoSART was used in practice, and should therefore be considered a pilot study, also considering the study was not set up as an experiment with a control group. Empirical research to validate this tool as a reliable assessment procedure seems like a logical and necessary next step. Another limitation to this pilot study is that the number of participating DSP and clients was relatively small, and the group of participated clients highly heterogeneous, making statistical analyses ill-advised. These limitations mean that study findings need to be interpreted cautiously as only indicative. Lastly, one important shortcoming that should be considered is the fact that the DSP were asked to appraise the quality of the auditory environment, instead of having the participating clients appraise these environments themselves, which is challenging due to obvious reasons (cognitive impairment, diminished verbal capacities). It cannot be guaranteed that the appraisal of the DSP is in accordance with the way the clients perceive these auditory environments. However, the results of this study, showing an increase of Lively auditory environments and a significant decrease of negative moods and the severity of stereotypical behavior indicate that most people, intellectual disability or not, may perceive auditory environments in a similar way, consistent with literature on soundscape research (Van den Bosch et al., 2014; Axelsson, Nilsson, & Berglund, 2010).

The empirical literature examining the auditory environments (Kingma, 2005) and moods of people with a severe or profound intellectual disability is limited (Ross & Oliver, 2003). As a result of methodological difficulties, there exists a lack of knowledge about the way individuals with a severe or profound intellectual disability express their feelings and preferences (Petry & Maes, 2006). The staff working in facilities for people with an intellectual disability gradually builds up practical knowledge in recognizing and interpreting subtle behavioral signals. One difficulty is that this knowledge remains intuitive, fragmented, and sometimes unused, and is lost when people who know the clients disappear from their lives (e.g., because of staff turnover) (Petry, Maes, & Vlaskamp, 2009). This is why the needs and preferences of people with a severe and profound intellectual disability often remain insufficiently known to those who are providing direct support, contributing to their already limited ability to communicate. An ability to assess mood in people with a severe or profound intellectual disability reliably and validly might be beneficial, since mood could serve as a useful outcome measure of well-being. More information on the influence of the auditory environment on the moods of people with a severe or profound intellectual disability would help to establish a greater degree of accuracy on this matter. Behavioral correlates of affect and physiological measures, which are objectively observable phenomena, might offer insight into the subjective experiences and auditory perception of individuals with a severe or profound intellectual disability, which ultimately could decrease the prevalence of challenging behavior and improve their overall well-being.

Chapter Six

Soundscape sessions

This chapter is based on: Van den Bosch, K., Andringa, T., Peterson, W., Başkent, D., Ruijssenaars, A., & Vlaskamp, C. (submitted). Soundscape sessions for people with severe or profound intellectual disabilities.

Abstract

Background: Previous research indicates a relationship between the auditory environment and core affect of people with severe or profound intellectual disabilities. To further explore this relationship we conducted a more controlled study. **Method:** Thirteen participants with severe or profound intellectual disabilities and challenging behavior were offered five different soundscapes (Beach, Forest, Urban, Music, & Silence), in a dedicated room. Direct support professionals administered core affect observations before and after each session. **Results:** Results show an increase of Relaxed core affect observations after the sessions in all conditions, which was strongest in the Beach and Silent conditions. However, the Silent condition was also accompanied by the biggest increase of Bored and decrease of Interested core affect observations. **Conclusion:** This pilot study could serve an important role in raising awareness and stimulating further research regarding the auditory environments of people with a severe and profound intellectual disability.

Introduction

Noise (defined as loud or unwanted sound that causes disturbance) plays an important role in physical and psychological well-being (WHO, 2011). This is substantiated by research showing a dynamic relationship between how (non-disabled) people appraise their auditory surroundings and how they describe their mood, or core affect (Kuppens, Champagne, & Tuerlinckx, 2012; Russell, 2003). It is for example, difficult or sometimes even impossible to relax in an unpleasant auditory environment and consequently people actively seek quiet and pleasant environments to recover from stress (Kaplan, 1995). Research that focuses on the evaluation of soundscapes (defined as appraised auditory environments; Schafer, 1977) reveals two main underlying dimensions, namely pleasantness and eventfulness (Axelsson, Nilson, & Berglund, 2010; Bradley & Lang, 2000; Cain, Jennings, & Poxon, 2013). These closely resemble the dimensions of core affect (pleasantness and arousal: Russell, 2003), reflecting the close relation between the two.

The pleasantness of a soundscape is not so much determined by its acoustic properties, but by the meaning of the sounds that comprises it (Booi & van den Berg, 2012; Neumann, Waters, & Westbury, 2008). This is reflected by the fact that the mere reduction of noise levels does not always lead to more positive perceptions of that environment (Adams, Cox, Moore, Croxford, Refaee, & Sharples, 2006; Dubois, Guastavino, & Raimbault, 2006), it can even lead to anxiety (Stockfelt, 1991). Also when unwanted sounds obscure more pleasant sounds they can be experienced as annoying (Andringa & Lanser, 2013). This explains why pleasant auditory environments are often associated with natural sounds, and unpleasant ones with mechanical sounds (Andringa & Lanser, 2013; Kaplan, 1995; Shafer, 1977).

Despite the strong relation between soundscape quality and well-being, research on soundscapes within special needs care is limited. One in situ study by Van den Bosch, Vlaskamp, Andringa, Post and Ruijssenaars (2014) indicates that the relationship between soundscapes and core affect also exists in people with severe or profound intellectual disabilities. It might even be more pronounced for them due to their cognitive limitations, high prevalence of visual impairments (Warburg, 2001), and challenging behavior (Poppes, Van der Putten, & Vlaskamp, 2010). In this pilot study we aim to explore this relationship in a more controlled way, to study which soundscape characteristics are desirable for this population. We did this by presenting 25 participants with severe or profound intellectual disabilities with five different soundscapes. As outcome measure we used observations of core affect at the beginning and end of each session, as rated by their direct support professionals (DSP). We expect that calm, natural soundscapes have a relaxing effect on the participants, that lively, man-made, soundscapes elicit an interested core affect, and that a silent soundscape is perceived as unpleasant by the participants.

Method

Participants

Legal representatives were contacted of 35 persons with severe or profound intellectual and multiple disabilities attending a day service centre in The Netherlands specialised in intensive support groups. The participants attended this particular day service centre, because they had a long history of showing serious challenging behavior and therefore required intensive support. This location was chosen because it was expected that the intervention would yield relatively large effects within this specific group of participants. Informed consent was obtained for 25 of these 35 persons, from this group 12 were excluded due to a milder form of intellectual disability, missing of essential file information, or not wanting to enter or stay in the room with the soundscape setup for longer than one minute.

Ultimately, thirteen participants were included. The group consisted of five female and eight male participants, with an average age of 43,2 years (range: 18-56, sd: 13,25). Based on personal files, eleven participants were reported to have a severe intellectual disability, and two participants were reported to have a profound intellectual disability, following the classification of the DSM-IV-TR (APA, 2000). Based on the criteria of the World Health Organization (2007), five participants were reported to have a moderate visual impairment (< 0.5 Log-Mar), three participants were reported to have a severe visual impairment (< 0.3 Log-Mar), and five participants reportedly had no visual impairment. None of the participants were reported to have an auditory impairment. Eight participants had no expressive verbal communication abilities, the other five participants were reported to display some form of (limited) verbal communication.

According to the personal files of the participants, the challenging behaviors included aggressive /destructive behavior (N=10), stereotypical movements (N=4), self-injury (N=7), withdrawal (N=3), and inappropriate sexual behavior (N=1). Multiple challenging behaviors were shown by all participants, resulting in N > 13 in this list.

Materials

Sounds.

Five different conditions were used this study with three recordings recreating real world environments (forest, beach and an urban environment), a computer generated ambient music piece, and a silent condition (simply not playing any sound). The sounds were chosen to be either calm or lively (Andringa & Lanser, 2013; Van den Bosch, Andringa, Başkent, & Vlaskamp, 2015). The forest recording consisted mainly of birds and the sound of wind in the trees. The beach recording predominantly contained the sound of waves crashing on a beach. Both recordings were kept deliberately sparse to create calm environments. The urban recording contained sounds from different parts of the city of Groningen, The Netherlands. This recording varied more in its content (e.g. traffic, market square, and children playing) leading to a livelier environment. The ambient music piece was a calm and slow tonal composition. It was designed to be tranquil and calm just like the two natural recordings, but unlike the forest and beach sounds it had no natural source characteristics. All recordings were designed and created by a professional composer[2].

Room.

For the study a dedicated room was equipped with a six-speaker layout. The day service centre gave permission to redesign a (never used) time-out room. Bookshelves filled with insulating material were placed against the walls of the room, and the speakers and other electronics were placed inside the shelves and covered with an acoustically transparent, but visibly opaque cloth. Additionally two chairs and a matching table were placed to create a welcoming environment, and allowing the participant and DSP to sit comfortably during the sessions.

[2] Renger Koning, composer for audiovisual productions. http://www.soundbase.nl

Core affect appraisal.

Reports on the core affect, or moods, of the participants were obtained with a simplified version of the *Assessment Auditory Environment* (*AAE*; Van den Bosch et al., 2014). In the original version of the *AAE*, consisting of Likert scales, DSP appraised core affect by means of eight descriptions. The scores than had to be standardized, averaged and drawn into a graph. For this study, we choose to let the DSP draw their observations directly into the graph representing core affect (see Figure 7), making this assessment more user-friendly and efficient. An additional section was added to account for neutral moods. DSP were asked to indicate which of the nine sections of the graph (Figure 7) best described the mood of the participant at the beginning and end of each soundscape session. When DSP, against instructions, indicated more than one section of the graph, the researcher would explicitly ask which section fitted best. This ensured that one answer was selected each time.

The DSP (N=33) conducting the core affect observations all volunteered to participate in this study. The group consisted of 11 male and 22 female participants with a mean age of 40 years (sd: 11,43, range: 23-61, 6 missing). All participants received vocational training and were familiar with the participants.

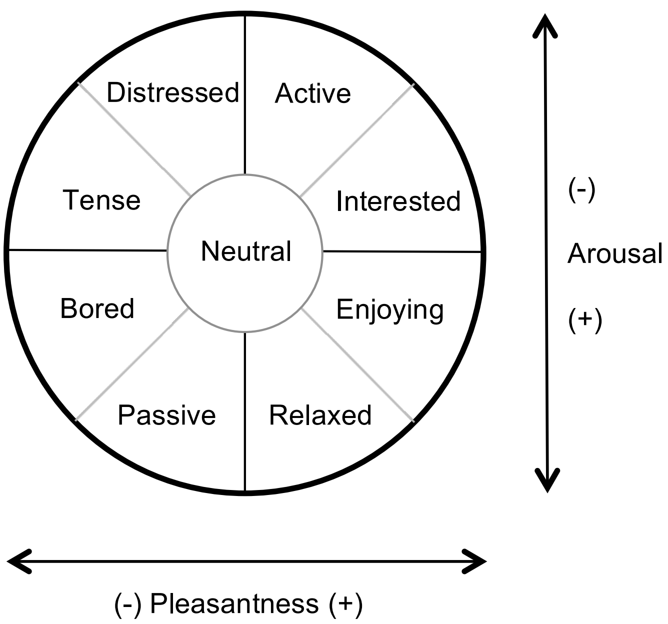


Figure 7. Representation of core affect as used in the assessment form.

Procedure

A typical soundscape session started with the participant and DSP being retrieved from their group in the day service centre and entering the room together. Each participant took part in ten soundscape sessions, twice for each of the five conditions, over the course of nine weeks. The sessions were planned at random moments, dependent on the presence and availability of the participants, DSP, and the researcher. The order in which the participants received the conditions was randomized for each participant. Sessions lasted until the participant indicated wanting to leave (to avoid coercion), with a maximum of 20 minutes. During this time participants were free to move around the room and to behave as they chose, without being occupied with a different task. The DSP were instructed not to initiate interaction, but were allowed to reactively interact with the participants. Furthermore the DSP were instructed to observe the behavior of the participants during the session and report on their core affect at the start (directly after entering) and at the end (before leaving or directly after, depending on the state of the participant) of the session. Upon entering, it was ensured that one of the five recordings (or conditions) was already audible inside the room and continued playing until after the participants left the room.

Analysis

Considering the explorative nature of this study and the chosen methods, a qualitative analysis was performed. Data analysis concerned descriptive statistics of the staff attributions of the core affect of the participants. For this analysis, the nine sections of the core affect graph used were merged in to five categories: Interested (Active + Interested), Relaxed (Enjoying + Relaxed), Bored (Passive + Bored), Distressed (Tense + Distressed) and Neutral. This way it was possible to perform a McNemar-Bowker test, using SPPS 21, to determine whether the differences in core affect between the start and end of the soundscape sessions were significant.

Results

Table 14 shows the results of the staff attributed core affect observations of the participants, at the start and end of the soundscape sessions, divided over the five different conditions (total of 13 participants * 5 conditions * 2 = 130 sessions).

Table 14. Frequency table of core affect ratings, before and after each condition.

	Interested		Relaxed		Bored		Distressed		Neutral	
	Before	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*
Forest	8 (30,8%)	4 (15,4%)	7 (26,9%)	17 (65,4%)	-	1 (3,8%)	7 (26,9%)	3 (11,5%)	4 (15,4%)	1 (3,8%)
Beach	11 (42,3%)	3 (11,5%)	4 (15,4%)	15 (57,7%)	-	2 (7,7%)	6 (23,1%)	2 (7,7%)	5 (19,2%)	4 (15,4%)
Urban	9 (34,6%)	6 (23,1%)	8 (30,8%)	14 (53,8%)	1 (3,8%)	3 (11,5%)	6 (23,1%)	3 (11,5%)	2 (7,7%)	-
Music	8 (30,8%)	5 (19,2%)	4 (15,4%)	14 (53,8%)	-	2 (7,7%)	13 (50%)	3 (11,5%)	1 (3,8%)	2 (7,7%)
Silent	11 (42,3%)	2 (7,7%)	7 (26,9%)	18 (69,2%)	-	3 (11,5%)	4 (15,4%)	2 (7,7%)	4 (15,4%)	1 (3,8%)
Total	47 (36,2%)	20 (15,4%)	30 (23,1%)	78 (60%)	1 (0,8%)	11 (8,5%)	36 (27,7%)	13 (10%)	16 (12,3%)	8 (6,2%)

The results show a pronounced increase of Relaxed core affect observations in all conditions (39,6%). This increase was largest for the Beach and Silent conditions (42,3%) and smallest for the Urban condition (23%). For all conditions, there was a decrease of Interested core affect observations. This decrease was smallest for the Urban (11,5%) and Music (11,6%) conditions, and largest for the Silent condition (34,6%). An increase in Bored core affect observations was found in all conditions, which was largest for the Silent condition (11,5%) and smallest for the Forest condition (3,8%). There is a decrease visible in the number of times participants left the soundscape sessions in a Distressed state, which is largest for the Music condition (38,5%) and smallest for the Silent condition (7,7%). Lastly, for the Neutral core affect observations, a decrease was found for all but the Music condition (+3,8%). An McNemar-Bowker test determined that this movement, or difference, in all the core affect observations represents a significant change, $p < 0.000$.

Concerns were raised that participants might have needed quite some time to adjust to the room and the new elements involved, leading to confounds between the first and latter soundscape sessions. To test this, comparisons were made on the core affect observations between the first four and last five weeks of the study, but no significant changes were found. Also, no significant differences were found in the length of the soundscape sessions (mean duration: 15.25 minutes, sd: 5.64, range 3-20) between the different conditions.

Discussion

Results showed an increase of relaxed core affect observations in all conditions. At first sight, it appeared that the specific condition did not matter, since this effect even arose in the Silent condition. However, a closer look revealed that the Silent condition was accompanied by the largest increase of Bored core affect observations and decrease of Interested core affect observations during the soundscape sessions.

Even though the results are not entirely in line with the expectations as stated in the introduction, it became apparent that it is possible to create pleasant soundscapes that allow people with a severe or profound intellectual disability and challenging behavior to reach a pleasant state of being, in terms of core affect. Even the Silent condition, which was expected to be the least preferable (Adams et al., 2006; Dubois et al., 2006; Stockfelt, 1991), seems to have provided a pleasant soundscape in which the participants were able to relax. This effect could be attributed to the one-on-one attention the participants got from the DSP during these soundscape session, which is a question that is often raised when it comes to the effectiveness of music therapy (Duffy & Fuller, 2000). However, it could also be an indication that the Silent condition was already an improvement over the normal daily auditory environments.

This study has several limitations. First of all, the fact we used staff attributions of core affect, which is necessary since it was not possible to ask the participants themselves, could lower the validity of the observations. Since the core affect of an individual influences its appraisals (Kuppens et al., 2012), it could be that the staff attributions were influenced by the core affect of the DSP. Also, some research indicated that DSP have difficulty to reliably assess the affect of individuals with profound intellectual disabilities (Hogg, Reeves, Roberts, & Mudford, 2001). Considering this limitation combined with the explorative nature of this pilot-study, results should be interpreted with caution and should serve a role in raising awareness and stimulating further research, rather than being interpreted as rigorous scientific findings.

Furthermore, the room with the soundscape setup originally was a time-out room. Even though it had not been used for its intended purpose in this particular day service centre, all rooms of this type look alike. This could have led to feelings of unease in the participants possibly influencing the responses to the soundscapes, as indicated by the participants who did not want to enter the room and were excluded from the study. However, this limitation could also be viewed in the light of the success of the study. With limited resources, we were able to turn a room that elicited negative associations, into a pleasant room where the participants enjoyed themselves and even were able to peacefully fall asleep.

Sounds appear to be an important part of life for people with severe or profound intellectual disabilities, considering the high prevalence of visual disorders. Moreover, audio-visual media, like watching TV or listening to music, is one of the most frequent offered activities to this group (Zijlstra & Vlaskamp, 2005). However, these activities are often offered without careful consideration, creating potentially chaotic environments. Egli, Roper, Fuerer and Thompson (1999) noted "*the extent to which a setting is perceived to be representative of culturally defined norms can influence judgments about whether behavior in the settings conforms to expected standards*". This entails that when the DSP are unaware of the effects of poor auditory environments on the disabled residents, this could lead to detrimental consequences for their health and well-being. Therefore it is important to pay more attention to the auditory environments of vulnerable individuals, such as people with severe or profound intellectual disabilities.

Our intervention was not meant as a kind of multisensory environment used for education, therapy, or leisure provisions (Hogg, Cavet, Lambre, & Smeddle, 2001), but rather as a scientific study to gain more insight in the effects of certain soundscape characteristics on people with severe or profound intellectual disabilities. Our aim is to pro-actively improve the quality of the auditory environments within residential facilities, to reduce the occurrence of low moods and challenging behavior. The findings of this study should provide a basis on which to continue soundscape research and improve design and policies regarding the auditory environments of people with a severe and profound intellectual disability.

"Unnecessary noise, or noise that creates an expectation in the mind, is that which hurts a patient. It is rarely the loudness of the noise, the effect upon the organ of the ear itself, which appears to affect the sick."

- Florence Nightingale, 1860 -

Chapter Seven

Discussion

This dissertation results from a unique, and perhaps unlikely, collaboration between the departments of Special Needs Education & Youth Care and Artificial Intelligence of the University of Groningen. We did not aim for multidisciplinarity only, which simply draws on the knowledge of different disciplines, but for true interdisciplinarity by integrating perspectives, knowledge, and methods from different disciplines. We have demonstrated the complementary connectivity between emotion research, soundscape research, and pedagogics, in a synthesis that blurred the boundaries of these disciplines (Choi & Pak, 2006). This synthesis allowed us to generate new methodologies, knowledge, and insights, regarding the role of sound in residential facilities and day care services for people with severe or profound intellectual (and multiple) disabilities, a hitherto neglected topic. And it has also enriched our understanding of the role of sound and audition on core affect, and vice versa. In this discussion we will summarize and substantiate our findings.

Main findings

We started our research by formulating a theoretical framework (Chapter Two). Here, we argue that the quality of auditory environments is best understood in terms of how people appraise these environments with regard to audible safety, and the combination of pleasantness and eventfulness, as opposed to acoustic parameters, such as loudness. Soundscape and emotion research point out that there is a dynamic interaction between our environment and our moods, and we propose to integrate these to define a taxonomy of soundscapes. By combining the main properties of soundscape appraisal and affective experiences (pleasantness and eventfulness), four qualitatively different types of soundscapes arise: Lively, Calm, Boring, and Chaotic.

Sounds inform us about our surroundings, and we proposed they help us forming a sense of place (Where am I? and What is going on?). Audible safety is an important component of auditory environments, because sounds serve a crucial role in warning us for potential danger. If an auditory environment is not indicative of safety people become more vigilant and alert, which results in stress and appraised unpleasantness. People with severe or profound intellectual disabilities often suffer from visual impairments, making them more dependent on the sound in their environment. As a result, it is likely that the consequences of the quality of auditory environments on their moods are amplified. The constant process of determining audible safety in complex auditory environments and the accompanying arousal might dominate their (limited) cognitive resources. Therefore, if not paid particular attention, the living environments of people with severe or profound intellectual disabilities might be structurally deprived of useful indications of safety. The resulting stress and arousal will affect their overall psychological well-being and quality of life, and possibly contribute to challenging behaviors.

To test the validity of this framework, we organized a focus group study for healthcare professionals working with people with severe or profound intellectual disabilities (Chapter Three). We included 34 professionals from three different organizational levels (executive, context providing, and strategic). The latent knowledge of these professionals regarding the role of sound for people with severe or profound intellectual disabilities was consistent with our theoretical framework, and affirmed the hypotheses that sound is important in establishing a sense of place and influences the behavior of people with severe or profound intellectual disabilities. The results from the focus group study emphasized that raising awareness among the staff (in all layers of the organization) about the role of sound in the homes for people with severe or profound intellectual disabilities is a necessary first step in improving the auditory environments of these people. With this validation of our theoretical framework, we answered the first research question as formulated in the introduction. The role of sound for people with severe or profound intellectual (and multiple) disabilities is to inform them about their surroundings (in other words: form a sense of place), and to provide them a basic sense of safety.

In the second part of this dissertation, we developed an assessment procedure (*Assessment Auditory Environment*, Chapter Four) to explore and test the relationship between the auditory environments and moods of 36 people with severe or profound intellectual disabilities. With this assessment procedure we conducted an observational study, carried out by DSP. Results endorsed a positive relationship between the quality of the auditory environment and the moods of people with severe or profound intellectual disabilities, indicating that improved auditory environments ameliorate the moods of these people.

Subsequently, we digitized this assessment procedure as a smartphone application (*MoSART*, Chapter Five). Results of the DSP using this application showed an improvement of the quality of the auditory environment, with an increase of lively appraised soundscapes.

In turn, this improvement was accompanied by a significant decrease of negative moods and severity of stereotypical behavior of 15 people with severe or profound intellectual disabilities, as predicted by the theoretical framework. These results demonstrate the immediate and strong effects of the auditory environment on moods, and the plausibility of success of sound related interventions. The results also suggest that working with this assessment procedure empowered the DSP to implement improvements in the auditory environment.

In the third and last part of this dissertation (Chapter Six) we describe the effects of a more controlled study on the effect of different soundscapes on the core affect of 13 people with severe or profound intellectual disabilities. We presented the participating individuals, together with their DSP, with five different auditory environments (Beach, Forest, Urban, Music, and Silence), in a dedicated sound-insulated room. Results show an increase of Relaxed core affect observations after the sessions in all conditions, which was strongest in the Beach and Silent conditions. However, the Silent condition was also accompanied by the biggest increase of Bored and decrease of Interested core affect observations.

These last three studies answered the second research question. Our (digitized) assessment procedure, based on the proposed taxonomy of soundscapes, proved to be a useful, efficient, and easy-to-use way of analyzing and documenting (indoor) auditory environments, and the results provide indications on how to improve these environments.

Methodological reflections

Research has reached a point at which an abundance of knowledge has been gathered, yet every field has become highly specialized. Unfortunately, this leads to fragmentation of knowledge, which is characteristic of many fields of science (e.g. Newell, 1973). Our current Western society "*favors a narrow focus over the broader picture, specialists over generalists, fragmentation over unification*" (Andringa, Van den Bosch, & Wijermans, 2015), which goes at the expense of the coalescence and unification of knowledge needed for a true understanding of the complexity of the world.

For example, in psychology research often focuses on the effects of 'something' on the well-being of people. Within psychology well-being is typically approached in terms of emotion. Emotions however are specific to situations: they are fairly rare, short in duration, and have a specific incentive. However, we can always describe some affective state of mind. That state is called core affect: our most foundational affective state defined by the combination of pleasure and arousal. Since we study something as ubiquitous as the auditory environment, we choose to focus on a concept (core affect) that is just as pervasive.

Furthermore, in the public health domain well-being is often approached in terms of physical health, and the effects of noise are studied in terms of acoustical parameters (WHO, 2011). And yes, if the sound level from for example a highway exceeds certain thresholds, blood pressure (on average) rises. But why is that? The acoustic approach to sound is, similar to the emotion approach to behavior, mostly too narrowly focused. Because if we lower an annoying sound slightly in loudness, or change its pitch, it will not necessarily become less annoying. This is because humans are not just objective sound detectors: we appraise our environment, we give meaning to it, and this meaning is personal, situational, and social. We adopted the soundscape approach in this dissertation, because it focuses on how we appraise (or give meaning to) our auditory environment. Since we appraise our environments in a congruent way to how we describe our core affect, joining these seemed like the natural thing to do.

One could say that our moods serve as attitudes towards the world (Andringa & Van den Bosch, 2013). If we feel good we engage in an open way with the world, but if we do not, we focus on ways to make us feel better (Andringa, Van den Bosch, & Vlaskamp, 2013). For example if we feel annoyed, it is less likely we let that old lady skip the line in a supermarket.

But if we are in a good mood, we might even volunteer to pack her groceries. There is a constant interplay between our inner state of being and how we perceive the state of our environment (Kuppens et al., 2012). The one cannot be studied without the other, and therefore we should focus on their relation to improve our understanding of each. That is why we followed an interdisciplinary approach in this research. This approach fits the field of special needs education very well, which has a strong focus on assessments and interventions. As such, it constantly evaluates many aspects involving the well-being of its clients, and the context is always taken into account.

Next to the interdisciplinary nature of our work, we adopted applied exploratory research methods on the grounds that this is the first time the role of sound in residential care for people with severe or profound intellectual disabilities is seriously addressed. Exploratory research is essential when the research question or problem is in its preliminary, initial, and unstructured stages. This requires certain flexibility, but also entails that the research results in explicit plans or actions (Shields & Rangarajan, 2013). These plans and actions will be discussed hereafter in this discussion.

The goal of our research was to understand the role of sound in special needs care, more specifically for people with severe or profound intellectual disabilities, and to develop an intervention-oriented assessment procedure. We realized this through formulating a theoretical framework that synthesized existing research, and we adopted an exploratory approach to construct and refine an assessment procedure. Consequently there is no information available regarding the psychometrics of this assessment procedure yet. However, an assessment or intervention procedure must be developed before its effectiveness can be measured. We have applied the most appropriate existing techniques (Soundscape Quality Protocol by Axelsson et al., 2010) as the basis of our assessment procedure (*Assessment Auditory Environment* and later MoSART). We believe validity of our research (partly) stems from the consistency with existing literature, however further research is needed to confirm this.

While the explorative nature of this study is one of its strengths, it could also be considered a limitation. Since it was the first time our assessment procedures were used in practice and were not set up as experiments in traditional form with control groups, our studies should be considered as pilot studies. While this limits the generalizability and direct applicability of the results in particular care settings, significant insight is gained nonetheless.

Empirical research to validate our tools as reliable assessment procedures in a range of care settings seems like a logical and necessary next step.

Another limitation is the fact that we used convenience samples, which is often the case in working with people with severe or profound intellectual disabilities. The abilities and needs of this target group, and those of the care providers, needed to be taken into account. Relatively small sample sizes and highly heterogeneous groups of participants are common when conducting research with this target group. Therefore caution should be taken not to overestimate the value of the statistical techniques used in this dissertation, and their outcomes.

Furthermore, one important (yet unavoidable) confound to consider is the fact that the DSP were asked to appraise the quality of the auditory environment and moods of the clients, instead of having the participating clients appraise these variables themselves (which is challenging due to obvious reasons). It cannot be guaranteed that the appraisal of the DSP is in accordance with the actual experiences of the participating clients, which potentially lowers the validity of the observations. Since the core affect of an individual influences its appraisals (Kuppens et al., 2012), it could also be that the staff attributions were influenced by the core affect of the DSP themselves. Additionally, some research indicated that DSP have difficulty to reliably assess the affect of individuals with profound intellectual disabilities (Hogg et al., 2001). Despite these limitations, behavioral observations are still the standard in research regarding individuals with severe or profound intellectual disabilities, simply because they have limited capacity for self-report.

Theoretical reflections

In this dissertation we propose a theoretical framework and taxonomy of soundscapes, based on the concept of audible safety, and on their pleasantness and eventfulness. The definition of soundscapes emphasizes how such environments are perceived by individuals, as opposed to giving a mere description of acoustic properties of an auditory environment (Schafer, 1977). This entails that the properties of soundscapes should connect to the affective experiences of the listener, as opposed to simply describing the sound itself (Cain et al., 2013), which creates a need for more qualitative (semantic) descriptors of the characteristics of soundscapes (Rychtarikova, Vermeir, & Domecka, 2008). The field of soundscape research is an interdisciplinary branch of science of increasing prominence. Its researchers endeavor to find an answer to the question of how we, humans, perceive the auditory environment, and how we attribute meaning to it (Botteldooren, De Coensel, & De Mur, 2006; Cain, Jennings, & Poxon, 2013; Schulte-Fortkamp, 2002). Fortunately, it seems that the individual findings do not contradict each other; on the contrary, they complement each other.

We advocate that the simplest safety-relevant meaning attributable to the soundscape is of central importance in understanding human perception of soundscapes, and that moods, which serve as attitudes towards the world, are closely associated. We believe this reciprocity between the appraisal of audible safety in one's surroundings and one's moods also holds for people with severe or profound intellectual disabilities, and might even be amplified. Below we will provide a solid scientific basis to our findings, following the dimensions and core components of the proposed taxonomy as shown in Chapter Two (Figure 2).

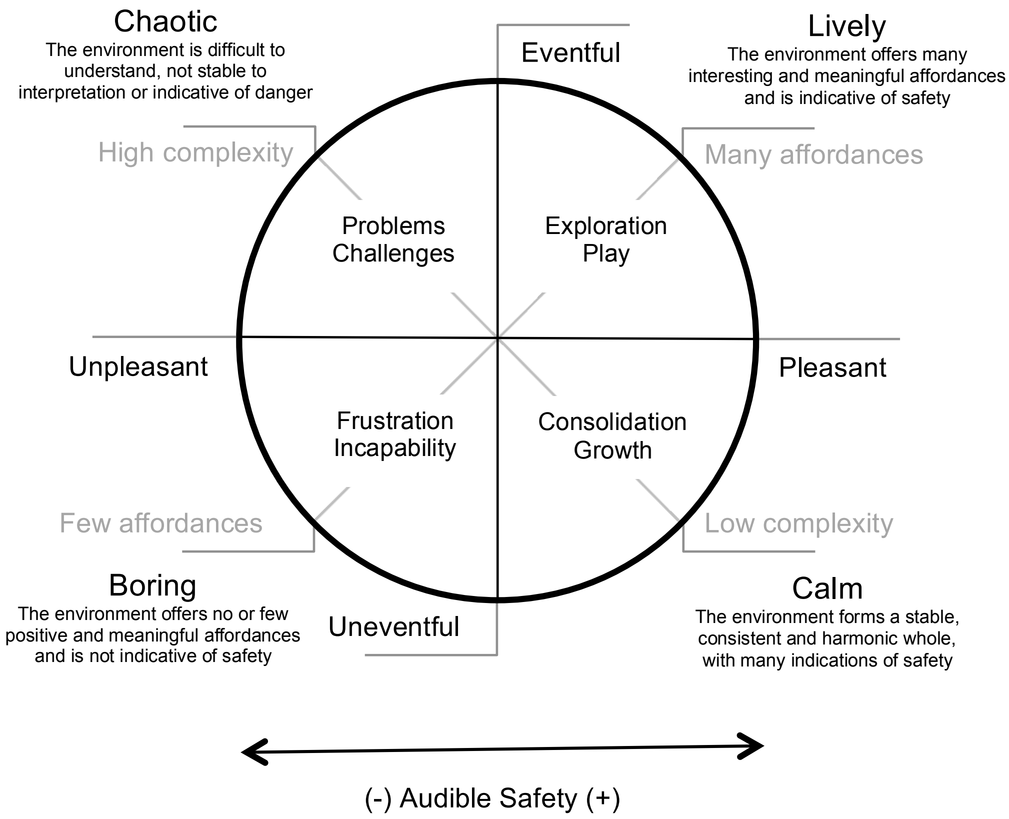


Figure 2. Four types of soundscapes (Lively, Calm, Boring, and Chaotic) and their basic dimensions (Eventfulness vs. Pleasantness, or Affordances vs. Complexity) (adapted from Andringa, Van den Bosch, & Vlaskamp, 2013).

Core affect vs. Appraisal

Sounds help us form a sense of place, an understanding about the current location and situation one is in, which allows individuals to generate expectations and choose situationally appropriate behavior (Morgan, 2010; Tuan, 1975; Van den Bosch et al, 2015). Our surroundings constantly regulate our perception, cognition and emotions, even when we are not aware of it (Bitner, 1992), to promote our survival. Therefore, perception (appraisal: shown in Figure 2, outside the circle) and the affective responses it elicits (core affect: shown in Figure 2, inside the circle) should not be considered separately, they are intertwined with another (Kuppens et al., 2012). Perception impels our basic emotions (Izard, 2007) and our emotions serve to establish our position in our environment; they attract us towards particular places, situations, and people, and they push us away from others (Levenson, 1999).

This push and pull, attraction and rejection, evaluation in terms of positive and negative, beautiful and ugly, good and bad, is a central part of our lives, a cross-cultural phenomenon (Osgood, 1975), and important for survival. It is ubiquitous, embedded in everything we do, and therefore also in how we perceive the world. Wundt (1897) referred to this as affect, and he argued that these subjective experiences, or impressions of the world, in terms of good or bad (valence) are the most pervasive aspect of human perception.

We believe this also holds for people with severe or profound intellectual disabilities, and they might even rely more on these intuitive and unconscious valance-based impressions of the world than people without disabilities, due to their cognitive limitations. Auditory perception, or audition, is defined as: "*The capacity for, or act of sound-based processing in which the existence of something or someone becomes mentally available (in the case of awareness), this availability can be used in a reasoning process to discover the consequences of what has been perceived (in the case of consciousness)*" (Andringa, 2010). Hidden in this definition there is a distinction between hearing and listening. Hearing is defined as *"the bottom-up, gist activation stage of audition aimed at discovering the existence of sound sources and their possible behavioral significance"* (such as audible safety), and listening is defined as *"the top-down, task and knowledge specific detailed analysis of sound and sound sources"* (Andringa, 2010).

Following these definitions, we argue that people with severe or profound intellectual disabilities rely relatively more on hearing than on listening because their top-down processing capacities are limited. This assumption is supported by research showing that young children (7-9 months old) do not listen selectively, i.e., based on expectation, as opposed to adults (Bargones & Werner, 1994); they have yet to develop a top-down filter. This assumption may also apply to some people with profound intellectual disabilities, who function on a developmental level < 24 months.

Moreover, people with severe or profound intellectual disabilities have difficulties in regulating their moods and emotions. These difficulties partially arise from problems with analyzing their environment and choosing optimal behavior (Evenhuis et al., 2001), contributing to the high prevalence of challenging behavior (Poppes et al., 2010). Taking this into account, it suggests that the perception or appraisal of the environment has a more pronounced (or less inhibited) effect on the affective responses of these people, as opposed to the non-disabled population.

Pleasantness vs. Eventfulness

We propose to classify different types of soundscapes based on their pleasantness and eventfulness. Cain et al. (2013) summarize several studies that have found similar dimensions, or core components, of soundscape appraisal, aiding for this classification. Kawai, Kojima, Hirate and Yasuoka (2004) found three dimensions, namely: preference, activity, and sense of life. Kang and Zhang (2010) extracted four factors: relaxation, communication, spatiality, and dynamics. Berglund, Eriksen and Nilsson (2001) also identified four dimensions: adverse, reposing, affective, and expressionless. Additionally, Axelsson, Nilsson and Berglund (2010) described pleasantness and eventfulness as the two main components of soundscape appraisal. All these factors are fairly similar and have in common that they highly relate to the pleasantness, or valance or affect, and informational content of a soundscape. In fact Davies and Murphy (2012) conclude, conform Axelsson, Nilsson and Berglund (2010), "*the weight of evidence in the literature is now sufficient for the first two dimensions of calmness/pleasantness and activity/eventfulness to be regarded as a 'standard model' for the perceptual dimensions of soundscapes.*"

The motivational approach to emotion as described by Cacioppo and Gardner (1999) gives a possible explanation as to why these two components are so pervasive and reoccurring in soundscape research. They describe an affect system underlying emotion or affective judgment and state that two separate channels (or systems) in the brain process positive and negative (or threat related) information. This is supported by fMRI studies demonstrating differences in brain activation across positive, negative, and neutral appraised (visual and auditory) stimuli (Chikazoe, Lee, Kriegeskorte, & Anderson, 2014; Davies et al., 2009). Similarly, Bradley and Lang (2000) found that the principal variance in emotional meaning people give to sounds, can be explained by two factors, namely pleasure and arousal, which are similar to the dimensions of core affect (Russell, 2003). They argue that this is related to two (appetitive and defensive) motivational systems that underlie affective judgment; valence indicates which system is active, and the level of arousal indicates the intensity of activation of these systems, which brings us to the two main dimensions of our taxonomy of soundscapes: pleasantness and eventfulness.

Furthermore, our taxonomy of soundscapes seems to satisfy two needs that are described by Cain et al. (2013). First, it describes soundscape based on two dimensions, which is preferable due to practicality and usability for e.g. urban planners. Secondly, it decomposes soundscapes into dimensions that are related to our emotional appraisals of these environments (Cain et al., 2013), since we have coupled it directly to core affect, the heart of all affective experiences. The dimensions of core affect, pleasantness and arousal, closely resemble the dimensions of soundscape appraisal, pleasantness and eventfulness. Furthermore, Russell's (2003) model shows that interactions with the environment can change a person's core affect, which is supported by in vivo research showing that peoples' appraisal of their environments reflects their mood, and vice versa (Kuppens et al., 2012). Therefore, the concept of core affect allows for a more principled understanding of human perception of soundscapes, it demonstrates that our moods serve as attitudes towards the world, and seems as such particularly appropriate for describing the quality of soundscapes.

Additionally, focusing on core affect appears to be valuable in research on the affective lives of people with severe or profound intellectual disabilities. Their cognitive disabilities entail limitations in emotional expression and communication (Adams & Oliver, 2011), making it difficult for the DSP to recognize their emotions correctly. In turn, this impedes (observational) research on the relationship between the environment and feelings of people with severe or profound intellectual disabilities. Focusing on core affect as a way to describe foundational affective states might be beneficial in this matter, since it is less specific and more holistic than emotions. It thus seems that the concept of core affect has great potential to serve as an insightful contribution to both soundscape research as to research on the affective lives of people with severe or profound intellectual disabilities.

Complexity vs. Affordances

In addition to the two main (horizontal and vertical) dimensions of soundscape appraisal, we introduced two accompanying diagonal dimensions: affordances and complexity, which relate to the vibrancy and calmness dimensions reported by Cain et al. (2013). We proposed that affordances indicate the extent to which the environment offers (pleasant) options for self-selected behavior, and the complexity of an environment indicates how difficult it is to choose situationally appropriate behavior. This notion is consistent with the work of Ulrich (1983) who hypothesized that natural environments are (visually) analyzed based on their structural aspects such as complexity, depth, threats, and the presence of environmental classes like water, which elicit affective responses mediating adaptive behavior and functioning, and as such promote survival. Work from Greene and Oliva (2009) corroborates this, demonstrating that basic affordances in visual stimuli (naturalness, navigability, concealment) are detected quicker than basic object classes (mountains, deserts, lakes).

The prospect refuge theory by Appleton (1975) proposes that landscapes that appear to satisfy survival needs elicit more pleasurable responses. In the light of evolution, humans prefer environments that have many useful affordances and promote exploration, thus open landscapes. However, more enclosed environments are sometimes preferred since they offer safety and make it easier to preserve resources (Appleton, 1975). Smaller spaces also promote interpersonal relationships between people who have a strong and positive emotional bond; in fact we like to keep those people close (Wohlwill, 1976).

Although the prospect refuge hypothesis was originally formulated for landscapes, soundscapes help us just as much in characterizing different environments (Pheasant, Fisher, Watts, Whitaker, & Horoshenkov, 2010) and determining survival needs (e.g., hearing a river when one cannot see it). Recent research affirms the ideas of Appleton and showed that small rooms are overall perceived as safer and more pleasant than big rooms while listening to different sounds (Tajadura-Jiménez, Larsson, Väljamäe, Västfjäll, & Kleiner, 2010a). However, this effect did not hold when the participants were presented with alarming sounds, supporting the notion that pleasant and unpleasant, or safe and alarming, sounds are processed differently (Tajadura-Jiménez et al., 2010a). Interestingly, these effects were stronger for natural sounds as opposed to artificial sounds and the authors speculate that human audition might be tuned to natural sound sources.

The abovementioned findings suggest that (auditory) environments are processed based on characteristics that are beneficial for survival. People without disabilities do this subconsciously, but for people with severe or profound intellectual disabilities, who per definition rely less on cortical processing of information, it might be a more eminent component of their entire perceptual processing.

Furthermore, it is likely that the (artificial, man-made) soundscapes people with severe or profound intellectual disabilities reside in, are too complex for them. Research by Munde, Vlaskamp, Maes, and Ruijssenaars (2014) showed that people with profound intellectual and multiple disabilities can only remain alert for short periods of time around 20 seconds, followed by periods of no or limited alertness. Alertness thus occurs in waves. This entails that people with these disabilities will not be able to deal with complex stimuli for long, and many soundscapes are complex to say the least. It is likely that the processing of low-quality, complex, soundscapes dominates the already limited cognitive resources of people with severe or profound intellectual disabilities, going at the expense of their already fragile alertness (Kahneman, 1973). Interestingly, the research by Munde et al. (2014) found no effects of auditory stimuli like (soft) music or the voices of DSP, i.e., they did not attract any attention. In the line of our research this can be explained by acknowledging the value of audible safety within these stimuli, and as we predict, they indeed do not demand (or attract) attention; they just confirm audible safety.

Audible safety

As we stated throughout this dissertation, we claim audible safety is the central element in the perception of our auditory environments and determines our appraisal of soundscapes. If we take into account the evolutionary, or biological, function of our perceptual systems, it seems rather conspicuous that audible safety plays such an important role. Audition has an evolutionary history of millions of years (Hester, 2005) and its most important function could be to estimate danger and safety (Andringa & Van den Bosch, 2013; Juslin & Västfjäll, 2008). Audition might even be more important than vision in warning us, simply because, unlike vision, sound is perceived omnidirectionally and independent of day- or nighttime. Schafer's (1977) definitions of high and low quality soundscapes, respectively characteristic of natural vs. non-natural/mechanical worlds and with far vs. near sonic horizons, was already suggestive of this function. For example, research indicates that humans have an attentional bias for sounds outside one's visual field (Tajadura-Jiménez, Väljamäe, Kitagawa, & Ho, 2010) and sounds heard behind us, compared to in front of us, elicit more arousal and larger physiological responses, which holds especially for natural sounds (Tajadura-Jiménez et al., 2010a).

Additionally, the fact that humans seem to have faster reaction times to auditory than to visual stimuli, about 50-60 milliseconds faster (Jáskowski, Jaroszyk, &Hojan-Jezierska, 1990), supports the claim that the auditory system has a crucial warning function. These fast reaction times are due to a subcortical processing of auditory streams by the cochlear nucleus, which can account for several features of perceptual organization (Shamma & Micheyl, 2010), and it seems that the fastest signal detection is mediated by the amygdala, also a subcortical area in the brain known to be involved in the coupling of perception and emotions (Ising & Kruppa, 2004; Spreng 2000). Therefore, even during sleep, certain sounds can be interpreted as dangerous, inducing the release of stress hormones and trigger protective reactions (fight, flight or defeat: Henry, 1992; Ising & Kruppa, 2004). For this, the information disclosed in sound seems more relevant than the acoustic characteristics of the sound (Ising & Kruppa, 2004).

We believe that our current day appraisals of soundscapes are still very much based on old evolutionary and survival driven strategies, and we propose that the first (subconscious) decision made in the processing of auditory information is an assignment of safety by subcortical processes. Only after a situation has been deemed safe, can additional resources be allocated for higher complexity processing.

This is of particular importance to people with severe or profound intellectual disabilities. Since there is a more prominent role of subcortical areas in hearing than in vision (Andringa & Lanser, 2013), explaining the lower prevalence of auditory impairments as opposed to visual impairment in these people (Evenhuis et al., 2001), we believe that the basic processing of audible safety is still more or less intact in people with severe or profound intellectual disabilities. However, the constant process of determining audible safety in complex auditory environments could exceed their limited cognitive resources (Kahneman, 1973). Since they have reduced (higher) cognitive functioning, they also might not able to learn and reason about the larger cultural guarantees for safety. This is likely to result in stress and arousal, affecting their overall psychological well-being and quality of life (Petry, Maes & Vlaskamp, 2005).

Quietness

Just recently has audition been used for speech and non-natural sounds (Andringa & Van den Bosch, 2013), which seems to make it harder for humans to establish audible safety (and even more so in people with severe or profound intellectual disabilities). And even though survival is not a pressing need for most people nowadays, some authors state that this remnant primitive reaction must still be an important factor in our appraisal of environments, by fulfilling a restorative need for well-being in tranquil environments (Pheasant et al., 2010). And indeed, in our current day, busy and chaotic environments, there is a strong need for quietness (Booi & van den Berg, 2012).

Quietness (here defined as a tranquil state of mind, and not a direct acoustic descriptor of silence) is a universal need, and its perception is not related to personal characteristics. Most people have the need to recover in quietness, and everybody perceives the same (audible safe) places as quiet (Booi & van den Berg, 2012). This need for quietness can be explained by the Attention Restoration Theory of Kaplan (1995), which states that prolonged periods of (subconscious) directed attention lead to attentional fatigue, and this needs to be recovered in restorative environments. This gains support from findings that restorative environments offering relief from sustained directed attention are known to reduce stress and increase well-being (Hartig, Kaiser, & Bowler, 1997). Also, according to

Kahneman (1973), cognitive resources are limited, which explains why there is an even higher need for quietness among people with bad health or older age (Booi & van den Berg, 2012), making it even more important for people with severe or profound intellectual disabilities.

For restoration we need an alternate mode of attention, one that benefits recovery: fascination. It is proposed that natural environments are ideally suited for fascination because they are tranquil, leave a harmonic impression (Booi & van den Berg, 2012), and are rich, yet do not demand directed attention (Kaplan, 1995). We believe this is due to the high redundancy of easy to process indications of audible safety in natural environments. This is supported by findings indicating that mechanical sounds decrease perceived tranquility, and natural sounds enhance it (Pheasant et al., 2010). Furthermore, findings by Darner (1966) demonstrated that mechanical sounds elicited unpleasant and alert feelings (as opposed to the sound of birds), and more recently Buxton et al. (2012) found that electronic sounds are more arousing than other sounds of similar loudness. Especially for people with severe or profound intellectual disabilities, this entails that mechanical or electronics sounds should not dominate their (supposedly restorative) living environments.

Kaplan (1995) proposes that this need for restoration from directed attention fatigue might be a recent problem, since we are now exposed to so many stimuli that we have to make the distinction between what is important and what is interesting. Our current living environments claim a lot of directed attention. We engage in many interpersonal interactions, need to pay attention to traffic when we are outside, get constantly distracted by email, messages and phone calls, advertisements etcetera. We are constantly exposed to numerous and various stimuli that require or demand our attention. This cognitive overload requires a lot of effort, making us susceptible to fatigue and distraction.

We are less and less in control of our auditory environments, and they have become more diverse, less harmonious, and less predictable, leading to more negative appraisals of the (urban) soundscapes we live in (Davies et al., 2009). Therefore, our environments should offer more diversity, especially in busy cities, so that people have access to quiet (and audible safe) soundscapes where they can recover from our cacophonous living environments (Booi & Van den Berg, 2012), which especially applies to the auditory environments in residential facilities and day service settings for people with severe or profound intellectual disabilities.

Conclusion

Summarizing the above, it seems that our auditory system functions as an (if not the most) important warning system, and people appraise their (auditory) environments based on the meaning they attribute to it (which is a central aspect in the soundscape approach). Our appraisals of soundscapes are based on two main components, namely: pleasantness and eventfulness. These dimensions reflect old motivational and affective systems, attracting us towards certain situations and withholding us from others, to enhance our chances for survival.

We hypothesize that our current day, manmade and mechanized, living environments are not adapted to our, evolutionary old, (subcortical) auditory system, and that we consequently have difficulty establishing audible safety. This leads to more negative and aroused states of core affect, with stress related symptoms as a result. This holds true in particular for people with severe or profound intellectual disabilities, who usually live in unfitting auditory environments and (have to) rely more on subcortical processing of auditory information.

Our findings provide a scientific basis for Florence Nightingale observations, as an explanation of why humans have a growing need for quietness (as a state of mind), and why the noise-stress hypothesis (as explained in the introduction) functions in the way it does. Strikingly, the noise-stress hypothesis is commonly used in research regarding the adverse effects of noise, which focuses on acoustic parameters such as loudness. However, the definition of noise, namely: unwanted sound, already directly implies a core role for a process estimating the wanted- or unwantedness of (the) sound, i.e. meaning giving on the axis of unpleasant-pleasant, while this meaning is often forgotten (or ignored) in acoustically focused research.

The research set out in this dissertation has features that are of interest to and could benefit soundscape research in general. Not only does our theoretical framework demonstrate why acoustical research is not adequate by itself to explain the effects of unfavorable auditory environments, but also why the taxonomy of soundscapes we propose, with the well-founded connection to psychology, can serve as a standard measure of the quality of soundscapes. But most importantly, it demonstrates the importance of the quality of soundscapes in residential facilities for people with severe or profound intellectual disabilities to ensure them a high quality of life.

Implications for the care practice

As described above, we argue that the role of sound for people with severe or profound intellectual (and multiple) disabilities, like any other hearing human, is to inform them about their surroundings (Where am I? and What is going on?), and to provide a basic sense of safety. Below we will provide general recommendations, implications and practical suggestions on how to improve the auditory environment in the care practice with regard to audible safety. We discuss the application of our results for specific situations, namely social interactions and audio-visual media as a leisure option, and the role of good acoustics. We end this part with some notions on how to raise awareness on the topic of audible safety in residential facilities and day care services for people with severe or profound intellectual disabilities.

Audible safety

The most important recommendation we make is to provide ample indications of audible safety in the living environments of people with severe or profound intellectual disabilities. Audible safety may prevent prolonged periods of stress, reduce low moods and/or challenging behavior, and as such contribute to a better quality of life for these people. If the overall situation is clearly indicative of safety through audible activities, even quiet distinctive and unpleasant sounds may not be so disturbing because they occur in a reassuring environment. Audible safety indications are profoundly normal and pleasant sounds, which should either be relaxing and reassuring, or encouraging activation if desired.

Relaxation can be achieved in calm soundscapes, for example, through providing individual background sounds that are pleasant and casual for people with severe or profound intellectual disabilities, such as the sounds of nature or relaxed animals. If possible, one could for example open a window or patio door to let outdoor sounds in, like the song of birds or wind rustling through the leaves. These sounds can also be simulated electronically by the use of cd's or other media, however the manner in which the sound is presented may be of central importance (Guastavino, Katz, Polack, Levitin, & Dubois, 2005). Lively, stimulating, soundscapes represent many affordances that offer interesting options to attract attention and thus promote interest and playful behavior. They consist of pleasant, fun, and appealing foreground sounds, like the sound of music or toys.

Non-natural sources, like ventilator, traffic, or other machine sounds, mask pleasant (and safe) sounds, and act as distractors that make it more difficult to establish audible safety, and as such should be avoided. Utter silence on the other hand is also not preferable, since it does not offer audible safety. Therefore, a pleasant and reassuring (soft) background sound should always be present. This does not always have to consist of natural sounds or music, but can also include the sound of DSP being close by and, for example, preparing a meal. The sounds of (reoccurring) activities and DSP can help to provide people with severe or profound intellectual disabilities with a sense of recognition of certain persons, places, or activities. For example, certain sounds might be consistently used as sound marks that indicate daily structure and as such offer predictability of what's to come.

One sound that is often found in residential facilities for people with severe or profound intellectual disabilities is the vocalization of (anxious) residents. These sounds are clearly not indicative of safety, but unfortunately are mostly inevitable. Some residents might be more sensitive to the vocalizations of group members than others, which should be taken into account in the composition of groups.

Resistant or withdrawn challenging behavior could be seen as an indication of unsafe or otherwise sub-optimal soundscapes, and should encourage DSP to improve the environment. Unpleasant (or unsafe) foreground (chaotic) or background (boring) sounds should be avoided, as well as an abundance of mechanical, man-made, sound-producing activities (like appliances). One potential solution is to create enough diversity in auditory environments in residential facilities so that an escape from unfavorable soundscapes is possible, by offering quiet (not silent) rooms or moments throughout the day. When there are enough opportunities to experience pleasant soundscapes, either calm or lively depending on the current preference, people with severe or profound intellectual disabilities can relax or explore and recover from the hectic soundscapes.

Soundscapes and social interactions

Social interaction is one of the core dimensions of quality of life (Petry et al., 2005), and of great importance to the well-being (Emerson & McVilly, 2004) of people with severe or profound intellectual disabilities. Social interactions take place at every developmental level, but the nature of these social interactions varies due to the specific disabilities and barriers that are encountered in such interactions. People with severe or profound intellectual disabilities are, however, able to understand the social behaviors of an affective and familiar interaction partner during interactions in a familiar, and probably safe, context. Affect attunement (Stern, 1985) is one of the few ways in which people with such limited ways of communication share their internal affective state, by the (emphasized) recasting of their emotional-behavioral states by DSP. Research however shows that the occurrences of affect attunement between DSP and people with profound intellectual disabilities are rare, short, and subtle (Forster & Iacono, 2014).

Unfavorable auditory environments might substantiate this lack of interaction, since research indicates that bad acoustics decrease social interactions (Klatte et al., 2010; Spreat, Lamina, Jefferys, Axelrod, Murphy, & McGuffin, 1990). This could be mediated by noise induced stress and fatigue (Evans & Hygge, 2007) in people with severe or profound intellectual disabilities as well as in the DSP. On the other hand, research has shown that moderate levels of ambient noise (pleasant background sounds) can enhance creative cognition (Mehta, Zhu, & Cheema, 2012), which could promote participation in (playful) activities and engagement in social interactions by the DSP. We believe that positive soundscapes kindle positive emotions, in people with severe or profound intellectual disabilities as well as their DSP, and therefore promote higher quality social interactions and improved quality of life (Fredrickson, 2001; Fredrickson & Branigan, 2005)

Audio-Visual media as leisure options

Access to leisure options is another important aspect of the quality of life of people with severe or profound intellectual disabilities (Sivan, 2000), and freedom of choice is an essential part in the definition of leisure (Hogg, 1995). Currently, the most frequent offered leisure activity to this group of people is audio-visual media, like watching TV or listening to music (Zijlstra & Vlaskamp, 2005). However, this is often done in an improvident and crude way, and freedom of choice is generally minimal. Furthermore, considering the high valence of sensory impairments and seizure disorders, the appropriateness of such activities is questionable (Zijlstra & Vlaskamp, 2005).

In a positive soundscape, proper music can help to relax people and it can even have healing effects (Feder & Feder, 1981; Mazer, 2005). But in an unpleasant soundscape, we predict that music contributes to the chaos (Van den Bosch & Andringa, 2014). Therefore, DSP should be more meticulous in maintaining a high-quality auditory environment and should realize that while (loud) music can be used to mask negative sounds, it also masks the necessary reassuring positive sounds. As such, DSP should prevent that music is audible the entire day, just for the sake of 'having the radio on'. One could also think of creating dedicated rooms, or investing in high-quality headphones, so that the residents with severe or profound intellectual disabilities can each enjoy their own music on desirable moments without bothering other residents.

Acoustics

Even though we stated earlier that acoustic measurements are not sufficient to measure the quality of soundscapes, they are still important. For example, acoustical measurements of reverberation time are related to perceived homelikeness, which in turn is tied to challenging behavior (Egli et al., 1999). Moreover, studies seem to indicate that there is a threshold of noise level around 65 dB(A) during the daytime at which the risk of cardiovascular disease arises (Babisch, 2002; Ising & Kruppa, 2004). Examples of sounds that have a loudness around 65 db(A) are an air-conditioning system or a washing machine, a normal conversation, or the sound of a television. Considering these sounds are all fairly common in residential facilities for people with severe or profound intellectual disabilities (and probably other long term healthcare settings), and often occur simultaneously, this entails that there is an increased risk of cardiovascular diseases (and other adverse effects of noise) for the residents as well as the personnel.

Therefore, care must be taken that not too many (loud) sound sources are audible simultaneously, and definitely not for prolonged periods of time. For pleasant appraised sounds, usually no limits need to be imposed on sound level or duration. For unpleasant sounds, there is a distinction between continuous and non-continuous sound sources: continuous sounds (like constant music or appliances) generally become more annoying the louder they become, and non-continuous sounds (such as people entering, doors closing loudly) get more intrusive the more often and longer they occur (Booi & van den Berg, 2012). Also, non-reassuring sounds coming from behind should be avoided, as they may elicit more arousal (Tajadura-Jiménez et al., 2010a).

Suggestions on how to improve the acoustics in residential facilities and day care services for people with severe or profound intellectual disabilities can be drawn from research on noise in hospitals (Herman Miller, 2009). For example, the building materials of the walls, floors, and ceilings, make up for most of the (unfavorable) acoustical properties of hospital rooms. One study showed that by replacing the ceiling with acoustical tiles, and applying sound-absorbing carpet on the floor, the overall loudness of the auditory environment reduced and quality of sleep of the patients improved, without sacrificing the hygiene of the environment (Dubbs, 2004). Also by simply lubricating the moving parts of (heavy) rolling equipment, can the noise levels be decreased significantly (Mazer, 2002). These interventions can also be applied in the living environments of people with severe or profound intellectual disabilities, and should already be taken into account when designing and building such facilities. One extreme example found in the practice was a bedroom that was placed next to a laundry room where laundry machines frequently were on during the nights. This came at the expense of the quality of sleep of the resident, which easily could have been avoided.

Raising awareness

One important requirement for all recommendations and improvements is to raise awareness of the role of sound in residential facilities and day care services for people with severe or profound intellectual disabilities. Despite some studies on noise-abatement strategies in hospitals, which suggest that design interventions lead to better results than organizational or behavioral interventions (Zimring, Joseph, & Choudhary, 2004), we believe that raising awareness is the essential first step. For as long as the DSP are unaware of the quality of the auditory environment and the effects of poor auditory environments, those environments will endure (Egli, Roper, Fuerer & Thompson, 1999; Keizer, Linderberg, & Steg, 2008), and might lead to detrimental consequences for the health and well-being of the residents that live in such environments.

To acknowledge the role of audible safety and translating (on the basis of experience and common sense) one 's own relation to good and bad soundscapes towards the needs and wishes of people with severe or profound intellectual disabilities will be a first and important step towards offering audible safety. The results in Chapter Five demonstrate that the use of MoSART, without further instructions on how to improve the auditory environments, lead to an improvement of the quality of these environments. These results endorse that raised awareness alone can have significant beneficial effects, and that MoSART is an efficient tool to achieve this.

It is the task of the DSP to recognize what is good for their clients and to act appropriately, and it is the task of the management to promote this. Yet the results from Chapter Three suggest that, in particular, the management may be unaware of the role and importance of sound in the day-to-day-care. Therefore we advise to acknowledge the importance of the auditory environment throughout the entire organization, and emphasize and include it in daily policies and practices. The auditory environment should become part of the responsibilities of interdisciplinary teams containing, amongst others, physicians, occupational therapists, and behavioral scientists. Sensitivity and preference for certain sounds should become part of personal files, more effort should be made to diagnose and treat sensory impairments correctly, and DSP should be trained to understand and effectuate high quality soundscapes. Music therapists are particularly prone for the purpose of raising awareness. These professionals are used to work with sound and are trained in specific methods to observe and assess the effects of different sounds on their clients. We believe it would be highly beneficial to extend their skills and knowledge to the entire auditory environment, instead of being confined to sparse therapeutic moments.

Recommendations for future research

This dissertation focused on the development and refinement of an intervention-oriented assessment procedure to analyze and document the auditory environment of people with severe or profound intellectual disabilities. Since this is a newly developed assessment procedure, and the dissertation mainly consists of exploratory (or pilot) studies, there is no information regarding the psychometric qualities of this procedure yet. Follow-up studies with control groups and simultaneous observations by (at least) two members of the DSP, or other observers such as researchers or family members, are needed to analyze inter-rater reliability and further psychometrics to validate the assessment procedure. We are, currently, already in the process of doing this, since MoSART is being implemented at two healthcare organizations in the Netherlands, offering residential care and education to people with intellectual and visual disabilities. The results from these studies will provide more information regarding validity and reliability.

Even though research indicates that people appraise soundscapes in a fairly consistent manner, Cain et al. (2013) noted that possible nuances between different demographic groups should be studied more. This especially holds for the highly heterogeneous group of people with severe or profound intellectual disabilities. Our choice not to focus on, and control for, individual differences (e.g. level of intellectual or visual disability) in the statistical analyses, was based on the nature of the target group and the facilities in which they reside. In these residential facilities a number of people with severe or profound intellectual disabilities are placed together and share one auditory environment that influences them all simultaneously. Therefore, the priority was to study and improve these environments as a whole, so that many residents could benefit from these improvements, as opposed to focusing on individual based interventions. Future research could focus more on individual differences, however a larger number of participants is needed to achieve sufficient statistical power in subgroups to conduct a more detailed analysis.

One important question that remains to be solved is how people with severe or profound intellectual disabilities actually perceive soundscapes. Given their profound disability, it is likely that they process and interpret sound in a different way than people without disabilities. People without intellectual disabilities are likely to rely more on knowledge driven (top-down) processing and can, for example, distinguish the importance of sounds. People with severe or profound intellectual disabilities might do this poorly, more slowly, or not at all. Individual sounds may appear equally important to them, because prioritizing might be difficult and they may have difficulties in attending to different sound sources effectively.

This notion gives rise to a need for potentially rotating the axes of the soundscape taxonomy (pleasantness and eventfulness), for people with severe or profound intellectual disabilities. For instance, people without disabilities might perceive a particular environment as lively, while those with severe or profound intellectual disabilities might perceive it as chaotic and overwhelming. Also the proposed role of audible safety should be examined further. Questions like which sounds guarantee audible safety and the actual effects of these indications of safety deserve further research attention.

Only by researching, in a controlled way, how people with severe or profound intellectual disabilities react to different kinds of soundscapes, will we be able to unravel the actual perceptual processes of these people. Behavioral correlates of soundscape quality, affect, and physiological measures, which are objectively observable phenomena, might offer insight into the subjective experiences and auditory processing of these individuals. The work of Vos, De Cock, Munde, Petry, Van Den Noortgate, and Maes (2012) may serve as a basis for such research. The perceptual processes of people with severe or profound intellectual disabilities could be of interest to soundscape research in general, since they might inform us of the fundamental aspects of sound perception, because their (subcortical) responses are less filtered or modified by higher cognitive (and culturally biased) processing.

Currently, it is not feasible to make correct judgments on how people with severe or profound intellectual disabilities experience soundscapes. That is the main reason why in this dissertation the DSP were asked to observe and appraise the soundscapes as they themselves experienced these environments. Until we have assessment procedures that reliably and validly measure how people with severe or profound intellectual disabilities appraise soundscapes, automated soundscape appraisal can be a way to diminish the indispensable confounding variables of staff attributions. In the future we hope to use machine-learning algorithms to automatically determine soundscape quality and provide the users, whether it be DSP or researchers, with a standardized result.

Lastly, soundscape research has a strong focus on outdoor settings, and the fact that we have studied indoor environments is unusual. Most people have control over their living environments, and therefore it can be assumed that these indoor soundscapes fit the need and preferences of its residents. However, people with severe or profound intellectual (and multiple) disabilities often do not have this autonomy over their living environment and dependent on the attentiveness, and the knowledge and skills of the DSP, as they will make the choices for them. This applies to other long-term healthcare settings as well, like retirement homes or long stay hospitals. For its vulnerable residents, these healthcare settings are their living environments, so they should be able to feel at home there. Furthermore, the main objective in these settings is to provide the best possible care to maintain and improve the well-being of its residents. As long as the auditory environment continuous to be overlooked, this objective will not be realized, because the auditory environment has a significant influence on their (physical and psychological) well-being (as set out in this dissertation). Therefore we should invest more in research on this topic and take careful notice of the auditory environment in long-term healthcare settings to ensure it is of the best possible quality. In fact, the auditory environment should be safe and sound.

"The fidget of silk and of crinoline, the rattling of keys, the creaking of stays and of shoes, will do a patient more harm than all the medicines in the world will do him good."

- Florence Nightingale, 1860 -

References

Acocella, I., (2011). The focus groups in social research: advantages and disadvantages. *Quality & Quantity, 46*(4), 1125-1136. doi: 10.1007/s11135-011-9600-4

Adams, M., Cox, T., Moore, G., Croxford, B., Refaee, M., & Sharples, S. (2006). Sustainable soundscapes: Noise policy and the urban experience. *Urban Studies*, *43*(13), 2385-2398. doi:10.1080/00420980600972504

Adams, D., & Oliver, C. (2011). The expression and assessment of emotions and internal states in individuals with severe or profound intellectual disabilities. *Clinical psychology review*, *31*(3), 293-306.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed). Arlington, VA: American Psychiatric Association.

Andringa, T. C. (2010). Audition: From sound to sounds. *Machine Audition: Principles, Algorithms and Systems*, 80-145.

Andringa, T. C., & Lanser, J. J. L. (2013). How Pleasant Sounds Promote and Annoying Sounds Impede Health: A Cognitive Approach. *International Journal of Environmental Research and Public Health*, *10*(4), 1439-1461. doi:10.3390/ijerph10041439

Andringa, T. C., & Pals, C. (2010). Detection and recognition threshold of sound sources in noise. Proceedings of CogSci 2009: *Annual meeting of the Cognitive Science Society for basic and applied cognitive science research.*

Andringa, T. C., & van den Bosch, K. A. (2013). *Core affect and soundscape assessment: fore- and background soundscape design for quality of life.* Paper presented at INTER-NOISE 2013, the 42nd International Congress and Exposition on Noise Control Engineering, Innsbruck (pp. 1-10). Innsbruck: INCE.

Andringa, T.C., van den Bosch, K.A., & Vlaskamp, C. (2013). Learning autonomy in two or three steps: linking open-ended development, authority, and agency to motivation. *Frontiers in Psychology*, *18* , 766.

Andringa, T.C., van den Bosch, K.A., & Wijermans, N. (2015). Cognition from life: the two modes of cognition that underlie human behavior. *Frontiers in Psychology.*

Appleton, J. (1975). The experience of landscape. London: Wiley.

Arvio, M., & Sillanpää, M. (2003). Prevalence, aetiology and comorbidity of severe and profound intellectual disability in Finland. *Journal of Intellectual Disability Research*, *47*(2), 108-112.

Axelsson, Ö., Nilsson, M. E., & Berglund, B. (2010). A principal components model of soundscape perception. *The Journal of the Acoustical Society of America*, *128*, 2836. doi:10.1121/1.3493436

Babisch, W. (2002). The noise/stress concept, risk assessment and research needs. *Noise and health*, *4*(16), 1.

Banks, S, & Dinges, D. F. (2007). Behavioral and physiological consequences of sleep restriction. *Journal of Clinical Sleep Medicine*, 3:519–528.

Bargones, J. Y., & Werner, L. A. (1994). Adults listen selectively; infants do not. *Psychological Science*, *5*(3), 170-174.

Beaman, C. P. (2005). Auditory distraction from low-intensity noise: A review of the consequences for learning and workplace environments. *Applied Cognitive Psychology, 19*, 1041-1064.

Berglund, B., Eriksen, C. A., & Nilsson, M. E. (2001). Perceptual characterization of soundscapes in residential areas. In *Proceedings of the 17th International Congress on Acoustics (ICA)*.

Bitner, M. J. (1992). Servicescapes: the impact of physical surroundings on customers and employees. *The Journal of Marketing*, 57-71.

Booi, H., & van den Berg, F. (2012). Quiet Areas and the Need for Quietness in Amsterdam. *International Journal of Environmental Research and Public Health*, *9*(4), 1030–1050. doi:10.3390/ijerph9041030

Botteldooren, D., & De Coensel, B. (2006). Quality assessment of quiet areas: a multi-criteria approach (pp. 1–6). Presented at the Euronoise 2006, Tampere.

Botteldooren, D., De Coensel, B., & De Muer, T. (2006). The temporal structure of urban soundscapes. *Journal of Sound and Vibration*, *292*(1), 105-123.

Bradley, M., & Lang, P. J. (1999). *The International affective digitized sounds (IADS)[: stimuli, instruction manual and affective ratings*. NIMH Center for the Study of Emotion and Attention.

Bradley, M. M., & Lang, P. J. (2000). Affective reactions to acoustic stimuli. *Psychophysiology*, *37*(02), 204-215.

Buntinx, W. H., & Schalock, R. L. (2010). Models of disability, quality of life, and individualized supports: implications for professional practice in intellectual disability. *Journal of Policy and Practice in Intellectual Disabilities*, *7*(4), 283-294.

Buxton, O. M., Ellenbogen, J. M., Wang, W., Carballeira, A., O'Connor, S., Cooper, D., ... Solet, J. M. (2012). Sleep disruption due to hospital noises: a prospective evaluation. *Annals of internal medicine*, *157*(3), 170-179.

Cacioppo, J. T., & Gardner, W. L. (1999). Emotion. *Annual review of psychology*, *50*(1), 191-214.

Cain, R., Jennings, P., & Poxon, J. (2013). The development and application of the emotional dimensions of a soundscape. *Applied Acoustics*, *74*(2), 232-239. doi:10.1016/j.apacoust.2011.11.006

CALM. (2004). *Research for a quieter Europe in 2020*. European Commission Research Directorate–General.

Carvill, S. (2001). Sensory impairments, intellectual disability and psychiatry. *Journal of Intellectual Disability Research*, *45*(6), 467-483.

Chikazoe, J., Lee, D. H., Kriegeskorte, N., & Anderson, A. K. (2014). Population coding of affect across stimuli, modalities and individuals. *Nature neuroscience*, *17*(8), 1114-1122.

Choi, B. C., & Pak, A. W. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clinical and investigative medicine. Medecine clinique et experimentale*, *29*(6), 351-364.

Colten, H. R. & Altevogt, B. M., (Eds.). (2006). *Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem*. National Academies Press.

Darner, C. L. (1966). Sound pulses and the heart. *The Journal of the Acoustical Society of America*, *39*(2), 414-416.

Davies, W. J., Adams, M. D., Bruce, N. S., Marselle, M., Cain, R., Jennings, P., ... & Plack, C. J. (2009). The positive soundscape project: A synthesis of results from many disciplines.

Davies, W. J., & Murphy, J. (2012). Reproducibility of soundscape dimensions (pp. 1–7). Presented at the Internoise 2012, New York: International Institute of Noise Control Engineering.

De Coensel, B., & Botteldooren, D. (2006). The quiet rural soundscape and how to characterize it. *Acta Acustica united with Acustica*, *92*(6), 887-897.

Diener, E.. & Iran-Nejad, A. (1986). The relationship in experience between various types of affect. *Journal of Personality and Social Psychology. 50,* 1031-1038.

Diener, E.. Sandvik, E., & Pavot. W . (1991). Happiness is the frequency, not the intensity, of positive versus negative affect. In F. Strack & M. Argyle (Eds.), *Subjective well-being: An interdisciplinary perspective.* (Vol. 21, pp. 119-139). Oxford, England: Pergamon Press.

Doŝen, A. (2005). *Psychische stoornissen, gedragsproblemen en verstandelijke handicap; een integratieve benadering bij kinderen en volwassenen* [Psychiatric disorders, behavioral problems and mental disability; an integrative approach in children and adults]. Assen: Van Gorcum.

Doty, R.L., Bromley, S.M., Morland, A., Kennard, C., Zee, D.S., Leigh, R.J., Ceranic, B., Luxon, L.M., & Brandt, T. (2002). Part IV. Disorders of the special senses. In J.C. McArthur (Ed.), *Diseases of the nervous system: Clinical neuroscience and therapeutic principles (3rd ed.) vol. 1&2* (pp. 595-691). New York, NY, USA: Cambridge University Press.

Dubbs, D. (2004). Sound effects: design and operations solutions to hospital noise. *Health facilities management*, *17*(9), 14-18.

Dubois, D., & David, S. (1999). A cognitive approach of urban soundscapes. *The Journal of the Acoustical Society of America*, *105*(2), 1281-1281.

Dubois, D., Guastavino, C., & Raimbault, M. (2006). A cognitive approach to urban soundscapes: Using verbal data to access everyday life auditory categories. *Acta acustica united with acustica*, *92*(6), 865-874.

Duffy, B., & Fuller, R. (2000). Role of music therapy in social skills development in children with moderate intellectual disability. *Journal of Applied Research in Intellectual Disabilities*, *13*(2), 77-89. doi:10.1046/j.1468-3148.2000.00011.x

Dufour, A., Després, O., & Candas, V. (2005). Enhanced sensitivity to echo cues in blind subjects. Experimental brain research, 165(4), 515-519.

Egli, M., Roper, T., Feurer, I., & Thompson, T. (1999). Architectural acoustics in residences for adults with mental retardation and its relation to perceived homelikeness. *American Journal on Mental Retardation*, 104 (1), 53 –66.

Emerson, E., Kiernan, C., Alborz, A., Reeves, D., Mason, H., Swarbrick, R., Mason, L., & Hatton, C. (2001). The prevalence of challenging behaviors: A total population study. *Research in Developmental Disabilities, 22*, 77-93. doi: 10.1016/S0891-4222(00)00061-5

Emerson, E., & McVilly, K. (2004). Friendship activities of adults with intellectual disabilities in supported accommodation in Northern England. Journal of Applied Research in Intellec- tual Disabilities, 17, 191–197.

Evans, G. W., Bullinger, M., Hygge, S. (1998) Chronic noise exposure and physiological response: A prospective study of children living under environmental stress. *American Psychological Soc.,* Vol.9: 75-77

Evans, G., & Hygge, S. (2007). Noise and cognitive performance in children and adults. In L. M. Luxon, & D. Prasher (Eds.), *Noise and its effects* (pp. 549-566). New York: John Wiley.

Evans, G. W., Hygge, S., & Bullinger, M. (1995). Chronic noise and psychological stress. *Psychological Science, 6*, 333-338.

Evenhuis, H. M., Mul, M., Lemaire, E. K. G., & de Wijs, J. P. M. (1997). Diagnosis of sensory impairment in people with intellectual disability in general practice. *Journal of Intellectual Disability Research*, *41*, 422–429.

Evenhuis, H. M., Sjoukes, L., Koot, H. M., & Kooijman, A. C. (2009). Does visual impairment lead to additional disability in adults with intellectual disabilities?. *Journal of Intellectual Disability Research*, *53*(1), 19-28.

Evenhuis, H. M., Theunissen, M., Denkers, I., Verschuure, H., & Kemme, H. (2001). Prevalence of visual and hearing impairment in a Dutch institutionalized population with intellectual disability. *Journal of Intellectual Disability Research*, *45*(5), 457-464. doi: 10.1046/j.1365-2788.2001.00350.x

Fallon, M., Trehub, S. E., & Schneider, B. A. (2000). Children's perception of speech in multitalker babble. *Journal of the Acoustical Society of America*, 108, 3023-3029.

Feder E. & Feder B. (1981) *The `Expressive' Arts Therapies: Art, Music and Dance as Psychotherapy*. Prentice-Hall, Englewood Cliffs, NJ.

Fern, E. (1982). The use of focus groups for idea generation: the effects of group size, acquaintanceship, and moderator on response quantity and quality. *Journal of Marketing Research*, 19 (February), 1–13.

Fields, J.M., De Jong, R.G., Gjestland, T., Flindell, I.H., Job, R.F.S., Kurra, S., … Schumer, R. (2001). Standardized general-purpose noise reaction questions for community noise surveys: Research and a recommendation. *Journal of sound and vibration*, *242*(4), 641-679.

Forster, S., & Iacono, T. (2014). The nature of affect attunement used by disability support workers interacting with adults with profound intellectual and multiple disabilities. *Journal of Intellectual Disability Research*, *58*(12), 1105-1120.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American psychologist*, *56*(3), 218.

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition & emotion*, *19*(3), 313-332.

Frijda, N. H. (1986). *The emotions*. Cambridge University Press.

Gaver, W. (1993). What in the World Do We Hear?: An Ecological Approach to Auditory Event Perception. *Ecological Psychology*, *5*(1), 1–29.

Goldbart, J. (1997). Opening the communication curriculum to students with PMLDs. In J. Ware (Ed.), *Educating children with profound and multiple learning difficulties* (pp. 15–63). London: David Fulton Publishers.

Grahn, P. & Stigsdotter, U.A. (2003). Landscape Planning and Stress. *Urban Forestry & Urban Greening*, **2** (1), 1-18.

Greene, M., & Oliva, A. (2009). Recognition of natural scenes from global properties: Seeing the forest without representing the trees. *Cognitive Psychology*, *58*(2), 137–176. doi:10.1016/j.cogpsych.2008.06.001

Gross, J. J. (2010). The future's so bright, I gotta wear shades. *Emotion Review*, *2*(3), 212-216.

Guastavino, C. (2006). The ideal urban soundscape: Investigating the sound quality of French cities. *Acta Acustica United with Acustica*, *92*(6), 945-951.

Guastavino, C., Katz, B. F., Polack, J. D., Levitin, D. J., & Dubois, D. (2005). Ecological validity of soundscape reproduction. *Acta Acustica united with Acustica*, *91*(2), 333-341.

Guski, R. (2001). Moderatoren der Lärmwirkung. *Wichmann, Schlipköter, Fülgraff (eds): Handbuch der Umweltmedizin. Kapitel VII-1 Lärm, Erg. Lfg*, 7(01).

Han, B. I., Lee, H. W., Kim, T. Y., Lim, J. S., & Shin, K. S. (2009). Tinnitus: characteristics, causes, mechanisms, and treatments. *Journal of Clinical Neurology*, 5(1), 11-19.

Harding, S., Cooke, M., & König, P. (2007). Auditory gist perception: an alternative to attentional selection of auditory streams?. In *Attention in Cognitive Systems. Theories and Systems from an Interdisciplinary Viewpoint* (pp. 399-416). Springer Berlin Heidelberg.

Hartig, T., Kaiser, F. G., & Bowler, P. A. (1997). Further development of a measure of perceived environmental restorativeness. *Institute of Housing Research, Working paper*, (5).

Hayes, S., McGuire, B., O'Neill, M., Oliver, C., & Morrison, T. (2011). Low mood and challenging behavior in people with severe and profound intellectual disabilities. *Journal of Intellectual Disability Research*, *55*(2), 182-189.

Henry, J.P. (1992) Biological basis of the stress response. *Integrative Physiological and Behavioral Science 27:* 66-83

Herman Miller. (2009). *Sound Practices: Noise Control in the Healthcare Environment.* Retrieved from: http://www.hermanmiller.com/MarketFacingTech/hmc/research_summaries/pdfs/wp_Sound_Practices.pdf

Hester, E. (2005). The evolution of the auditory system: A tutorial. *Contemporary Issues in Communication Science and Disorders*, *32*, 5-10.

Hogg J. (1995) The ecology of leisure provision: contexts and engagement. In: *Making Leisure Provision for People with Profound Learning and Multiple Disabilities* (eds J. Hogg & J. Cavet), pp. 36-47. Chapman & Hall, London.

Hogg, J., Cavet, J., Lambe, L., & Smeddle, M. (2001). The use of 'Snoezelen' as multisensory stimulation with people with intellectual disabilities: a review of the research. *Research in Developmental Disabilities*, *22*(5), 353-372. doi:10.1016/S0891-4222(01)00077-4

Hogg, J., Reeves, D., Roberts, J., & Mudford, O. C. (2001). Consistency, context and confidence in judgements of affective communication in adults with profound intellectual and multiple disabilities. *Journal of Intellectual Disability Research*, *45*(1), 18-29. doi:10.1111/j.1365-2788.2001.00289.x

Hygge S, Evans G.W., Bullinger M. (2002). A prospective study of some effects of aircraft noise on cognitive performance in school children. *Psychological Science*, 13:469–474.

Ising, H., & Babisch, W. (1983). *Stressreaktionen und Gesundheitsrisiko bei Verkehrslärmbelastung: Methodenvergleich zwischen Feld-und Laboruntersuchungen*. D. Reimer.

Ising, H., & Kruppa, B. (2004). Health effects caused by noise: evidence in the literature from the past 25 years. *Noise and Health*, *6*(22), 5.

Izard, C. E. (2007). Basic emotions, natural kinds, emotion schemas, and a new paradigm. *Perspectives on psychological science*, *2*(3), 260-280.

Jaśkowski, P., Jaroszyk, F., & Hojan-Jezierska, D. (1990). Temporal-order judgments and reaction time for stimuli of different modalities. *Psychological Research*, *52*(1), 35-38.

Job, R. F. S. (1993). The role of psychological factors in community reaction to noise. *Noise as a public health problem*, *3,* 47-79. Arcueil Cedex: INRETS.

Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *Behavioral and brain sciences*, *31*(05), 559-575.

Kahneman, D. (1973). *Attention and effort*. Englewood Cliffs, NJ: Prentice-Hall.

Kang, J., & Zhang, M. (2010). Semantic differential analysis of the soundscape in urban open public spaces. *Building and environment*, *45*(1), 150-157.

Kaplan, S. (1995). The restorative benefits of nature - toward an integrative framework. *Journal of Environmental Psychology*, 15(3), 169 – 182. doi:10.1016/0272-4944(95)90001-2

Kawai, K., Kojima, T., Hirate, K., & Yasuoka, M. (2004). Personal evaluation structure of environmental sounds: experiments of subjective evaluation using subjects' own terms. *Journal of sound and vibration*, *277*(3), 523-533.

Kerr, A. M., McCulloch, D., Oliver, K., McLean, B., Coleman, E., Law, T., et al. (2003). Medical needs of people with intellectual disability require regular reassessment, and the provision of client- and carer-held reports. *Journal of Intellectual Disability Research*, *47*, 134-145.

Keizer, K., Lindenberg, S., & Steg, L. (2008). The spreading of disorder. *Science*, *322*(5908), 1681-1685.

Kingma, J. (2005). Gehoorverlies bij mensen met een (visuele- en) verstandelijke beperking. Resultaten van screening van het gehoor en audiometrie bij 344 personen. Logopedie en Foniatrie, 9, 272-276.

Klatte, M., Hellbrück, J., Seidel, J., & Leistner, P. (2010). Effects of classroom acoustics on performance and well-being in elementary school children: A field study. *Environment and Behavior*, *42*(5), 659-692.

Kuppens, P., Champagne, D., & Tuerlinckx, F. (2012). The dynamic interplay between appraisal and core affect in daily life. *Frontiers in psychology*, *3:380*. doi:10.3389/fpsyg.2012.00380

Lambrechts, G., Kuppens, S., & Maes, B. (2009). Staff variables associated with the challenging behavior of clients with severe or profound intellectual disabilities. *Journal of Intellectual Disability Research*, *53*(7), 620-632.

Lennox, N. G., Diggens, J. N., & Ugoni, A. M. (1997). The general practice care of people with intellectual disability: Barriers and solutions. *Journal of Intellectual Disability Research*, *41*, 380–390.

Lercher, P., Evans, G.W., Meis, M. (2003). Ambient noise and cognitive processes among primary school- children. *Environment and Behavior,* 35:725–735.

Levenson, R. W. (1999). The intrapersonal functions of emotion. *Cognition & Emotion*, *13*, 481–504.

Little, R.J.A., & Rubin, D.B. (1987). *Statistical Analysis with Missing Data*. New York: John Wiley & Sons.

Lowe, K., Allen, D., Jones, E., Brophy, S., Moore, K., & James, W. (2007). Challenging behaviors: Prevalence and topographies. *Journal of Intellectual Disability Research, 51*(8), 625-636. doi: 10.1111/j.1365-2788.2006.00948.x

Lubman, D., & Sutherland, L. (2002). Role of soundscape in children's learning. Proceedings of first Pan-American/Iberian Meeting on Acoustics; Cancun, Mexico.

Lundqvist, L. (2013). Prevalence and risk markers of behavior problems among adults with intellectual disabilities: A total population study in Orebro county, Sweden. *Research in Developmental Disabilities, 34*, 1346-1356. doi: 10.1016/j.ridd.2013.01.010

MacKenzie, D. J., & Airey, S. (1999). Classroom acoustics. *A research project. Summery report. Edinburgh: Heriot-Watt-University (Dept. of Building Engineering and Surveying).*

Maes, B., Lambrechts, G., Hostyn, I., & Petry, K. (2007). Quality-enhancing interventions for people with profound intellectual and multiple disabilities: a review of the empirical research literature. *Journal of Intellectual and Developmental Disability*, 32(3), 163 –178.

Meas, B., Vlaskamp, C., & Penne, A. (2011). *Ondersteuning van mensen met ernstige meervoudige beperkingen. Handvatten voor een kwaliteitsvol leven*. Leuven/ Den Haag: Acco.

Maschke, C., Harder, J., Ising, H., Hecht, K., Thierfelder W. (2002) Stress hormone changes in persons under simulated night noise exposure. *Noise & Health 5*(17): 35-45

Matson, J. L., Cooper, C., Malone, C. J., & Moskow, S. L. (2008). The relationship of self-injurious behavior and other maladaptive behaviors among individuals with severe and profound intellectual disability. *Research in Developmental Disabilities, 29*, 141-148. doi:10.1016/j.ridd.2007.02.001

Matson, J. L., Kozlowski, A. M., Worley, J. A., Shoemaker, M. E., Sipes, M. & Horovitz, M. (2011). What is the evidence for environmental causes of challenging behaviors in persons with intellectual disabilities and autism spectrum disorders? *Research in Developmental Disabilities, 32*, 693-698. doi:10.1016/j.ridd.2010.11.012

Mauss, I. B., Bunge, S. A., & Gross, J. J. (2007). Automatic emotion regulation. *Social and Personality Psychology Compass*, *1*(1), 146-167.

Maxwell, L., & Evans, G. (2000). The effects of noise on pre-school children's pre-reading skills. *Journal of Environmental Psychology, 20*, 91-97.

Mazer, S. E. (2005). Stop the noise: reduce errors by creating a quieter hospital environment. *Patient Safety & Quality Healthcare*, 1-4.

McCulloch, D. L., Sludden, P. A., McKeown, K., & Kerr, A. (1996). Vision care requirements among intellectually disabled adults: A residence- based pilot study. *Journal of Intellectual Disability Research*, *40*, 140– 150.

Mehta, R., Zhu, R. J., & Cheema, A. (2012). Is noise always bad? Exploring the effects of ambient noise on creative cognition. *Journal of Consumer Research*, *39*(4), 784-799.

Meuwese-Jongejeugd, A., Vink, M., van Zanten, B., Verschuure, H., Eichhorn, E., Koopman, D., Bernsen, R., & Evenhuis, H. (2006). Prevalence of hearing loss in 1598 adults with an intellectual disability: Cross-sectional population based study: Prevalencia de impedimentos auditivos en 1598 adultos con discapacidad intelectual: Estudio transversal de base poblacional. *International journal of audiology*, *45*(11), 660-669.

Morgan, P. (2010). Towards a developmental theory of place attachment. *Journal of Environmental Psychology*, *30*(1), 11-22.

Munde, V. S., Vlaskamp, C., Maes, B., & Ruijssenaars, A. J. J. M. (2014). Catch the wave! Time-window sequential analysis of alertness stimulation in individuals with profound intellectual and multiple disabilities. *Child: care, health and development*, *40*(1), 95-105.

Mydlarz, C. (2013). *Application of mobile and internet technologies for the investigation of human relationships with soundscapes.* Unpublished Ph.D., University of Salford, Salford. Retrieved from http://usir.salford.ac.uk/29411/1/Master.pdf

Nakken, H., & Vlaskamp, C. (2007). A need for a taxonomy for profound intellectual and multiple disabilities. *Journal of Policy and Practice in intellectual Disabilities*, *4*(2), 83-87.

Neumann, D. L., Waters, A. M., & Westbury, H. R. (2008). The use of an unpleasant sound as the unconditional stimulus in aversive Pavlovian conditioning experiments that involve children and adolescent participants. *Behavior research methods*, *40*(2), 622-625. doi: 10.3758/BRM.40.2.622

Newell, A. (1973). You can't play 20 questions with nature and win: Projective comments on the papers of this symposium. In W. G. Chasé, *Visual Information Processing* (pp. 283– 308). New York: Academic Press.

Newsam, H., Walley, R. M., & McKie, K. (2010). Sensory impairment in adults with intellectual disabilities—an exploration of the awareness and practices of social care providers. *Journal of Policy and Practice in Intellectual Disabilities*, *7*(3), 211-220.

Nightingale, F. (1860). *Notes on Nursing: What it is, and what it is not*. First American Edition, D. Appleton and Company. Retrieved from http://digital.library.upenn.edu/women/nightingale/ nursing/nursing.html#IV

Oberlander, T.F., Gilbert, C.A., Chambers, C.T., O'Donnell, M.E., & Craig, K.D. (1999). Biobehavioral responses to acute pain in adolescents with a significant neurologic impairment. The Clinical Journal of Pain, 15(3), 201-209.

Occelli, V., Spence, C., & Zampini, M. (2010). Assessing the effect of sound complexity on the audiotactile cross-modal dynamic capture task. *The Quarterly Journal of Experimental Psychology*, *63*(4), 694-704.

Osgood, C. E. (1975). *Cross-cultural universals of affective meaning*. University of Illinois Press.

Patton, M.Q. (2002). *Qualitative Research and Evaluation Methods* (3d Edition). Thousand Oaks, CA: Sage Publications.

Petry, K., Kuppens, S., Vos, P., & Maes, B. (2010). Psychometric evaluation of the Dutch version of the Mood. Interest & Pleasure Questionnaire (MIPQ). *Research in Developmental Disabilities, 31,* 1652–1658.

Petry, K., & Maes, B. (2006). Identifying expressions of pleasure and displeasure by persons with profound and multiple disabilities. *Journal of intellectual and developmental disability*, *31*(1), 28-38.

Petry, K., Maes, B., & Vlaskamp, C. (2005). Domains of quality of life of people with profound multiple disabilities: The perspective of parents and direct support staff. Journal of Applied Research in Intellectual Disabilities, 18(1), 35-46.

Pheasant, R. J., Fisher, M. N., Watts, G. R., Whitaker, D. J., & Horoshenkov, K. V. (2010). The importance of auditory-visual interaction in the construction of 'tranquil space'. *Journal of Environmental Psychology*, *30*(4), 501-509.

Plomp, R. (2002). *The intelligent ear: On the nature of sound perception*. Lawrence Erlbaum Associates Publishers.

Poppes, P., Van der Putten, A. J. J. van der, & Vlaskamp, C. (2010). Frequency and severity of challenging behavior in people with profound intellectual and multiple disabilities. *Research in Developmental Disabilities, 31*, 1269-1275. doi:10.1016/j.ridd.2010.07.017

Poppes, P., Van der Putten, A. J. J. van der., Post, W.J., & Vlaskamp, C. (2015). *Risk markers of challenging behavior in people with profound intellectual and multiple disabilities.* Manuscript submitted for publication.

Rojahn, J., Matson, J. L., Lott, D., Esbensen, A. J., & Smalls, Y. (2001). The behavior problems inventory: An instrument for the assessment of self-injury, stereotyped behavior, and aggression /Destruction in individuals with developmental disabilities. *Journal of Autism and Developmental Disorders, 31*(6), 577-588. doi: 10.1023/A:1013299028321

Ross, E., & Oliver, C. (2002). The relationship between levels of mood, interest and pleasure and 'challenging behavior' in adults with severe and profound intellectual disability. *Journal of Intellectual Disability Research*, *46*(3), 191-197.

Ross, E., & Oliver, C. (2003). Preliminary analysis of the psychometric properties of the Mood, Interest & Pleasure Questionnaire (MIPQ) for adults with severe and profound learning disabilities. *British Journal of Clinical Psychology*, *42*(1), 81-93.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological review*, *110*(1), 145. doi: 10.1037/0033-295X.110.1.145

Russell, J. A. (2005). Emotion in human consciousness is built on core affect. *Journal of consciousness studies*, *12*(8-10), 26-42.

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: dissecting the elephant. *Journal of personality and social psychology*, *76*(5), 805.

Rychtarikova, M., Vermeir, G., & Domecka, M. (2008). The application of the soundscape approach in the evaluation of the urban public spaces. *Journal of the Acoustical Society of America*, *123*(5), 3810.

Saija, J. D., Akyürek, E. G., Andringa, T. C., & Başkent, D. (2014). Perceptual restoration of degraded speech is preserved with advancing age. *Journal of the Association for Research in Otolaryngology*, *15*(1), 139-148.

Schafer, R. M. (1977). The tuning of the world: Toward a theory of soundscape design. New York: Knopf.

Schalock, R. L., Borthwick-Duffy, S. A., Bradley, V. J., Buntinx, W. H., Coulter, D. L., Craig, E. M., ... & Yeager, M. H. (2010). *Intellectual disability: Definition, classification, and systems of supports*. American Association on Intellectual and Developmental Disabilities. 444 North Capitol Street NW Suite 846, Washington, DC 20001.

Scherer, K. R. (2005). What are emotions? And how can they be measured?. *Social science information*, *44*(4), 695-729.

Schulte-Fortkamp, B. (2002). The meaning of annoyance in relation to the quality of acoustic environments. *Noise and Health*, *4*(15), 13.

Shamma, S. A., & Micheyl, C. (2010). Behind the scenes of auditory perception. *Current opinion in neurobiology*, *20*(3), 361-366.

Shepherd, D., Welch, D., Dirks, K., & McBride, D. (2013). Do Quiet Areas Afford Greater Health-Related Quality of Life than Noisy Areas? *International Journal of Environmental Research and Public Health*, *10*(4), 1284–1303. doi:10.3390/ijerph10041284

Shields, P. M., & Rangarajan, N. (2013). *A playbook for research methods: integrating conceptual frameworks and project management*. New Forums Press.

Siemer, M. (2005). Mood-congruent cognitions constitute mood experience. *Emotion*, *5*, 296–308.

Sivan A. (2000) Leisure education, quality of life and populations with special needs. In: *Leisure Education, Community, Development and Populations with Special Needs* (eds A. Sivan & H. Ruskin), pp. 109–17. CABI publishing, Wellingford.

Spreat, S., Lamina, J., Jefferys, J., Axelrod, S., Murphy, B. J., & McGuffin, P. (1990). The impact of environmental noise on mealtime social interactions in a residential facility for persons with mental retardation. *Behavioral Interventions*, *5*(1), 1-13.

Spreng, M. (2000) Possible health effects of noise induced cortisol increase. *Noise & Health 7:* 59-63

Stansfeld, S. A., Berglund, B., Clark, C., Lopez-Barrio, I., Fischer, P., Öhrström, E., ... Berry, B.F. (2005). Aircraft and road traffic noise and children's cognition and health: a cross-national study. *The Lancet*, *365*(9475), 1942-1949.

Stern D. (1985) *The Interpersonal World of the Infant: A View from Psychoanalysis and Developmental Psychology*. Basic Books, New York, NY.

Stockfelt, T. (1991). Sound as an existential necessity. *Journal of Sound and Vibration*, *151*(3), 367-370. doi:10.1016/0022-460X(91)90533-P

Tajadura-Jiménez, A. (2008). *Embodied psychoacoustics: Spatial and multisensory determinants of auditory-induced emotion*. Chalmers University of Technology.

Tajadura-Jiménez, A., Larsson, P., Väljamäe, A., Västfjäll, D., & Kleiner, M. (2010a). When room size matters: acoustic influences on emotional responses to sounds. *Emotion*, *10*(3), 416.

Tajadura-Jiménez, A., Väljamäe, A., Kitagawa, N., & Ho, H. N. (2010). Whole-body vibration influences on sound localization in the median plane. *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering*, *224*(10), 1311-1320.

Thayer, R. E. (1989). *The biopsychology of mood and activation.* New York: Oxford University Press.

Tooby, J., & Cosmides, L. (1990). The past explains the present: Emotional adaptations and the structure of ancestral environments. *Ethology and sociobiology*, *11*(4), 375-424.

Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In *Behavior and the natural environment* (pp. 85-125). Springer US.

Van den Bosch, K.A., & Andringa, T. (2014). *The effect of sound sources on soundscape appraisal.* Paper presented at ICBEN 2014, 11th International Congress on Noise as a Public Health Problem, Nara.

Van den Bosch, K.A., Andringa, T.C., Başkent, D., & Vlaskamp, C. (submitted). The role of sound in residential facilities for people with profound intellectual and multiple disabilities.

Van den Bosch, K.A., Andringa, T.C., & Vlaskamp, C. (2013). *The role of sound and audible safety in special needs care.* Paper presented at INTER-NOISE 2013, the 42nd International Congress and Exposition on Noise Control Engineering, Innsbruck (pp. 2267-2272). Innsbruck: INCE.

Van den Bosch, K.A., Vlaskamp, C., Andringa, T.C., Başkent. D & Ruijssenaars, A.J.J.M. (2014). *Veilige auditieve omgevingen voor mensen met visuele en verstandelijke beperkingen*. Groningen: Stichting Kinderstudies.

Van den Bosch, K.A., Vlaskamp, C., Andringa, T.C., Post, W., & Ruijssenaars, A.J.J.M. (accepted). Examining relationships between staff attributions of soundscapes and core affect in people with severe of profound intellectual and visual disabilities. *Journal of Intellectual & Developmental Disability*.

Van den Wildenberg, M., Van Welbergen, M., & Van der Burg, C. (2002). *Bewust bouwen voor mensen met een visuele en verstandelijke beperking*. Bartiméus Doorn, Nederland.

Van Splunder, J., Stilma, J. S., Bernsen, R. M. D., & Evenhuis, H. M. (2006). Prevalence of visual impairment in adults with intellectual disabilities in the Netherlands: cross-sectional study. *Eye, 20,* 1004 – 1010.

Vlaskamp, C. (2005). Assessing people with profound intellectual and multiple disabilities. In J. Hogg & A. Langa (Eds.), *Assessing adults with intellectual disability: A service provider's guide* (pp. 39–51). Oxford, England: Blackwell.

Vlaskamp, C., & Cuppen-Fonteine, H. (2007). Reliability of assessing the sensory perception of children with profound intellectual and multiple disabilities: a case study. *Child: care, health and development*, *33*(5), 547-551

Vos, P., De Cock, P., Munde, V., Petry, K., Van Den Noortgate, W., & Maes, B. (2012). The tell-tale: What do heart rate; skin temperature and skin conductance reveal about emotions of people with severe and profound intellectual disabilities?. *Research in developmental disabilities*, *33*(4), 1117-1127.

Vos, P., de Cock, P., Petry, K., van den Noortgate, W., & Maes, B. (2010). What makes them feel like they do? Investigating the subjective well-being in people with severe and profound disabilities. *Research in Developmental Disabilities*, 31(6), 1623–1632.

Wang, W. J., Wu, X. H., & Li, L. (2008). The dual-pathway model of auditory signal processing. *Neuroscience bulletin*, *24*(3), 173-182.

Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary consider- ations, and psychobiological evidence. *Journal of Personality and Social Psychology, 76,* 820–838.

Warburg, M. (2001). Visual impairment in adult people with intellectual disability: literature review. *Journal of Intellectual Disability Research*, *45*(5), 424-438. doi: 10.1046/j.1365-2788.2001.00348.x

Winkler, I., Denham, S. L., & Nelken, I. (2009). Modeling the auditory scene: predictive regularity representations and perceptual objects. *Trends in Cognitive Sciences*, 13(12), 532–540.

Whitlock, J.A., & Dodd, G. (2008). Speech intelligibility in classrooms: Specific acoustical needs for primary school children. *Building Acoustics, 15*, 35-47.

Wohlwill, J. F. (1976). Environmental aesthetics: The environment as a source of affect. In *Human behavior and environment* (pp. 37-86). Springer US.

Woodhouse, J. M., Griffiths, C., & Gedling, A. (2000). The prevalence of ocular defects and the provision of eye care in adults with learning disabilities living in the community. *Ophthalmic and Physiological Optics*, *20*(2), 79-89.

World Health Organization. (2000). *Guidelines for community noise*. Berglund, B., Lindvall, T., & Schwela, D.H. (Eds.). Geneva: WHO.

World Health Organization. (2007). *Vision 2020: The right to sight*. Waddell, A. & Heseltine, E. (Eds.). Geneva: WHO

World Health Organization. (2011). *Burden of disease from environmental noise*. Theakston, F. (Eds.). Geneva: WHO

Wundt, W. *Grundriss der Psychologie, von Wilhelm Wundt* (W. Engelmann, Leipzig, 1897).

Tuan, Y. F. (1975). Place: an experiential perspective. *Geographical Review*, 151-165.

Zijlstra, H. P., & Vlaskamp, C. (2005). The Impact of Medical Conditions on the Support of Children with Profound Intellectual and Multiple Disabilities. *Journal of Applied Research in Intellectual Disabilities*, *18*(2), 151–161. doi:10.1111/j.1468-3148.2005.00244.x

Zimring, C., Joseph, A., & Choudhary, R. (2004). The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity. *Concord, CA: The Center for Health Design*.

Summary

Despite the well-established body of research on the acute effects of noise, little is known about the effects of sound in long-term healthcare settings. This is especially true for special needs care. Using an interdisciplinary approach, this dissertation explores two research questions:

1. What is the role of sound for people with severe or profound intellectual and multiple disabilities in residential facilities and day care services?
2. How can the auditory environment be analyzed, documented and improved in a way that will enable concrete interventions to be taken?

To answer these questions, we adopted an applied exploratory research approach, including qualitative and quantitative methods. We started with the formulation and validation of a theoretical framework (part one), followed by the development and implementation of an assessment procedure (part two), which we subsequently used to create controlled positive and safe auditory environments for people with severe or profound intellectual disabilities (part three).

Chapter One

In Chapter One we provide a general introduction of the key concepts of this dissertation. These concepts include severe or profound intellectual disability, effects of noise on well-being, soundscape research, and core affect.

We illustrate that, due to the combination and severity of their disabilities, people with severe or profound intellectual and multiple disabilities make up an incredibly heterogeneous group. They are characterized by a high degree of vulnerability and lack of autonomy, with a great dependence on others for the gratification of their daily needs. Due to a high prevalence of visual impairments among these individuals, they depend relatively more on the sounds in their environment than non-disabled people to make sense of the world surrounding them.

Research on noise (defined as unwanted sound) shows that it can have detrimental effects, such as cardiovascular disease, sleep disturbance, tinnitus, cognitive impairment in children, and annoyance. Considering that people with severe or profound intellectual disabilities already have reduced cognitive capacity as defined by their intellectual disability

and that they often experience visual impairments, we argue that the effects of noise are likely exaggerated in these people.

Traditional research on sound (and noise) has a strong focus on the acoustical properties of sound. In contrast to the traditional research, we focus on the soundscape approach, which emphasizes how auditory environments are understood by the perceiver. Soundscape research goes beyond the focus on noise and its adverse effects on health, but takes a more holistic approach, focusing on the (subjective and attributed) meaning in sound. In general, soundscape researchers argue that the acoustical properties of a certain place are far less important than understanding how that place influences a person emotionally.

The concept of core affect allows for a more principled understanding of human responses to soundscapes. Core affect is described as the heart of all affective experiences (such as moods and emotions) and consists of two components: pleasantness and arousal. The concept of core affect shows great potential to serve as an insightful contribution to both soundscape research, as well as research on the affective lives of people with severe or profound intellectual disabilities.

Chapter Two

In the first part of this dissertation we present a theoretical framework on the role of sound in residential facilities, based on insights from soundscape and emotion research. We propose that sounds inform us about our surroundings, and help us form a sense of place ("Where am I?" and "What is going on?"). Furthermore, we define a taxonomy of soundscapes based on the dynamic interplay between how people appraise their auditory environment and how they describe their mood, or core affect, and the concept of audible safety. By combining the main properties of soundscape appraisal and affective experiences (pleasantness and eventfulness), a taxonomy of four qualitatively different types of soundscapes arises: Lively, Calm, Boring, and Chaotic.

Audible safety is an important component of auditory environments, because sounds serve a crucial role in warning for potential danger. If an auditory environment is not indicative of safety, people become more vigilant and alert, which results in stress and appraised unpleasantness. For people with severe or profound intellectual disabilities in a long-term care situation, such as in residential facilities, these consequences may be amplified due to their reduced cognitive functioning and presumably high reliance on sounds. The constant process of determining audible safety in complex auditory environments and the accompanying arousal could dominate or even exceed their cognitive resources. If not paid particular attention, the living environments of these people might be structurally deprived of (for them) meaningful indications of safety. The resulting stress and arousal affects their overall psychological well-being and quality of life, and possibly contribute to challenging behaviors. Ideally, the living environment should always provide ample indications of safety. If the overall situation is abundantly indicative of safety through audible activities, even distinctive and unpleasant sounds may not be so disturbing because they occur in a reassuring environment.

Chapter Three

To test the validity of this framework, we designed a focus group study for healthcare professionals working with people with severe or profound intellectual disabilities. We included 34 professionals from three different organizational levels (executive, context providing, and strategic). The latent knowledge of these professionals regarding the role of sound for people with severe or profound intellectual disabilities was consistent with our theoretical framework, and affirmed the hypotheses that sound is important in establishing a sense of place and that indeed sound influences the behavior of people with severe or profound intellectual disabilities. The results emphasized that raising awareness among the staff (in all layers of the organization) about the role of sound in the homes for people with severe or profound intellectual disabilities is a necessary first step in improving the auditory environments of these people.

Chapter Four

In the second part of this dissertation, we developed an assessment procedure (*Assessment Auditory Environment*) to explore and test the relationship between the auditory environments and moods (in terms of core affect) in a target group of 36 people with severe or profound intellectual and visual disabilities. The participants resided in four healthcare facilities in The Netherlands and were each observed by their direct support professionals at multiple moments throughout the entire day. A total of 149 observations of 10 minutes were included in a multilevel regression analysis. The results endorsed a positive relationship between the observed pleasantness and eventfulness of the auditory environment and the moods of people with severe or profound intellectual disabilities. Time of day did not appear to be an explanatory variable for the core affect of the participants, however the type of organization (focused primarily on intellectual or visual disabilities) did. The results indicate that improved auditory environments could ameliorate the moods of people with severe or profound intellectual and visual disabilities.

Chapter Five

Subsequently, we implemented the abovementioned assessment procedure as a smartphone application MoSART (*Mobile Soundscape Appraisal and Recording Technology*), to make it easier to use by the direct support professionals and more efficient for research purposes. During a period of four weeks, this application yielded 170 measurements by direct support professionals. Exploratory analysis revealed an improvement of the quality of the auditory environment, with an increase of lively appraised soundscapes. In turn, paired sample t-tests showed this improvement was accompanied by a significant decrease of negative moods (MIPQ) and also of the severity of stereotypical behavior (LGP-PIMD) of 15 people with severe or profound intellectual disabilities who displayed challenging behavior. These observations are in line with the predictions by the theoretical framework. The results showed that working with this assessment procedure empowered the direct support professionals in improving in the auditory environment, in which raised awareness might serve as a mediating factor. Moreover, the results demonstrate the immediate and strong effects of the auditory environment on moods and challenging behavior, and the plausibility of success of sound-related interventions.

Chapter Six

In the third and last part of this dissertation we studied the effects of different soundscapes on the core affect of on another target group of 13 people with severe or profound intellectual disabilities and challenging behavior in a more controlled way. We presented the participating individuals, together with their direct support professionals, with one of five different auditory environments (Beach, Forest, Urban, Music, and Silence), in a dedicated sound-insulated room. Results showed an increase of relaxed core affect observations in all conditions. At first sight, it appeared that the specific condition did not matter, since this effect even arose in the Silent condition. However, a closer look revealed that the Silent condition was accompanied by the largest increase of Bored core affect observations and decrease of Interested core affect observations during the soundscape sessions. Since the participants mostly moved to a more positive core affect state (relaxed or interested) in all presented soundscapes, it entails that these were an improvement over their normal daily auditory environments, indicating that the daily environments do not necessarily provide a positive soundscape to these people.

Chapter Seven

In the last and concluding chapter of this dissertation we present a summary of the main findings, and with that we provide answers on the two research questions of the study. Subsequently, we reflect on methodological issues and contemplate on our interdisciplinary and explorative approach, indicating its importance.

Furthermore we provide theoretical reflections on our soundscape research based on the key concepts of appraisal and core affect, pleasantness vs. eventfulness, complexity vs. affordances, audible safety, and quietness. Not only does our theoretical framework demonstrate why investigating acoustical properties of sound is not adequate by itself to explain the effects of unfavorable auditory environments, it also demonstrates why the taxonomy of soundscapes we propose, with the well-founded connection to psychology, can serve as a standard measure of the perceived quality of soundscapes. But most importantly, it demonstrates the importance of the role of the auditory environment in residential facilities for people with severe or profound intellectual disabilities in providing them with a high quality of life. To promote this, we outline implications for care practice with regard to awareness of the role of sound, soundscape quality, social interactions, leisure options, and acoustics. Lastly, we describe recommendations for future research.

The main objective in long-term healthcare settings (such as residential facilities for people with severe or profound intellectual disabilities) is to provide the best possible care to maintain and improve the well-being of its residents. As long as the auditory environment continues to be overlooked, this objective will not be realized, because of the significant influence of the auditory environment on physical and psychological well-being. We should invest more in research on this topic to ensure the best possible soundscape quality in long-term healthcare settings. In fact, these should be safe and sound.

Samenvatting

In het algemeen geldt voor elk individu dat de kwaliteit van de auditieve omgeving een sterke invloed heeft op zijn of haar welzijn en gemoedstoestand. Het is dan ook des te opvallender, dat er een gebrek aan kennis is over de auditieve omgeving in de langdurige zorg. Dit proefschrift tracht te voorzien in deze ontbrekende kennis omtrent een specifieke categorie personen in de langdurige zorg, namelijk personen met (zeer) ernstige verstandelijke (en meervoudige) beperkingen. De frequent voorkomende visuele beperkingen bij deze personen en hun verminderde cognitieve vermogens, maken hen in het bijzonder afhankelijk van geluid bij het begrijpen van de wereld om hen heen. Toch is, ondanks het grote belang van auditieve informatie, onderzoek naar de invloed van de auditieve omgeving op hun welbevinden beperkt. Met behulp van een interdisciplinaire aanpak speelt dit proefschrift in op dit tekort aan de hand van twee onderzoeksvragen:

1. Wat is de rol van geluid in residentiële zorginstellingen en dagopvang voor personen met een ernstige of zeer ernstige verstandelijke en meervoudige beperking?
2. Hoe kan de auditieve omgeving geanalyseerd, gedocumenteerd en verbeterd worden om concrete interventie-georiënteerde maatregelen mogelijk te maken?

Voor de beantwoording van deze vragen hebben we gebruik gemaakt van een toegepaste en explorative onderzoeks-aanpak, met behulp van kwalitatieve en kwantitatieve methoden. We zijn gestart met de formulering en validatie van een theoretisch kader (Hoofdstukken Twee en Drie), gevolgd door de ontwikkeling en implementatie van een assessment procedure (Hoofdstukken Vier en Vijf). Dit heeft geresulteerd in een gecontroleerde studie waarbij positieve en veilige auditieve omgevingen zijn ontworpen voor en aangeboden aan personen met (zeer) ernstige verstandelijke beperkingen (Hoofdstuk Zes).

Hoofdstuk Eén

In Hoofdstuk Eén geven we een algemene inleiding op de belangrijkste begrippen die ten grondslag liggen aan dit proefschrift. Het hoofdstuk begint met een beschrijving van ernstige of zeer ernstige verstandelijke (en meervoudige) beperkingen. Als gevolg van de combinatie en de ernst van hun verstandelijke en bijkomende (motorische en sensorische) beperkingen, vormen personen met een (zeer) ernstige verstandelijke beperking een bijzonder heterogene groep. Kenmerkend is hun hoge mate van kwetsbaarheid en gebrek aan autonomie, resulterend in een grote afhankelijkheid van anderen om hun wensen en behoeften in het dagelijks leven te kunnen vervullen. Omdat deze personen naast een sterk verminderde cognitieve capaciteit en motorische beperkingen vaak ook visuele beperkingen hebben, veronderstellen wij dat in deze populatie de nadelige effecten van ongewenst geluid opvallend sterk zullen zijn.

Onderzoek naar ongewenst geluid (*noise*) bij personen zonder beperkingen laat zien, dat dit geluid nadelige gevolgen voor het welzijn kan hebben, zoals een verhoogd risico op hart- en vaatziekten, slaapstoornissen, oorsuizen en concentratieproblemen. Tot nu toe heeft dit type onderzoek zich vooral gericht op de akoestiek, zoals de luidheid (in decibellen) of nagalmtijd van het geluid. Wij richten ons echter op de *soundscape* aanpak, die benadrukt hoe auditieve omgevingen worden begrepen en ervaren door de luisteraar. *Soundscape* onderzoek gaat verder dan de focus op akoestiek en de nadelige effecten op de gezondheid, maar volgt een meer holistische benadering, gericht op de (subjectieve en toegeschreven) betekenis van geluid. In dit onderzoek geldt de aanname dat het meten van de akoestische eigenschappen van een bepaalde omgeving minder belangrijk is dan het begrijpen van hoe die omgeving een persoon emotioneel beïnvloedt.

Het concept *core affect* is bruikbaar bij het onderzoeken en begrijpen van de menselijke (emotionele) reacties op soundscapes. *Core affect* wordt beschreven als de kern van alle affectieve ervaringen (zoals stemmingen en emoties) en bestaat uit twee componenten: valentie (positief vs. negatief) en mate van arousal. Deze componenten komen overeen met de basisdimensies waarop mensen de auditieve wereld om hen heen beoordelen, namelijk *pleasantness* (de mate waarin de *soundscape* aangenaam is) en *eventfulness* (de mate waarin de *soundscape* voldoende betekenisvolle gebeurtenissen bevat). Deze overeenkomst tussen de beoordeling van *soundscapes en core affect* is indicatief voor de wederzijdse beïnvloeding van de manier waarop mensen de auditieve wereld om hen heen waarnemen en hun gemoedstoestand.

Hoofdstuk Twee

In het tweede hoofdstuk van dit proefschrift beschrijven we een theoretisch kader gericht op de rol van geluid in residentiële zorginstellingen voor personen met (zeer) ernstige verstandelijke beperkingen, gebaseerd op inzichten uit het hierboven genoemde *soundscape* en emotie-onderzoek. Geluid beïnvloed stemming en het ontlokt soms ook emoties.

Sommige geluiden, in sommige situaties, hebben een positieve invloed op mensen en andere een negatieve invloed. Op basis van de dynamische wisselwerking tussen de beoordeling van *soundscapes* en de gemoedstoestand (of *core affect*) van mensen, definiëren we vervolgens een taxonomie van soundscapes. Door de belangrijkste eigenschappen van *soundscapes* en *core affect* te combineren (*pleasantness* en *eventfulness* of arousal), ontstaat een classificatie van vier kwalitatief verschillende soorten soundscapes, namelijk: Levendig, Kalm, Saai en Chaotisch.
Verder veronderstellen wij dat geluid ons informeert over onze omgeving en helpt met het vormen van een *sense of place* (Waar ben ik? en Wat gebeurt er?). Personen met (zeer) ernstige verstandelijke (en vaak visuele) beperkingen beschikken niet over de voorwaarden voor een goede informatieverwerking en het vermogen om complexe betekenissen te construeren. In de residentiële zorg is de auditieve omgeving bovendien vaak onvoorspelbaar en ongecontroleerd, omdat de leden van de woongroep geluiden maken en soms emotioneel zijn, personeel met elkaar overlegt en er achtergrondgeluiden aanwezig zijn, zoals bijvoorbeeld van een radio, cd-speler of televisie. Daarnaast is er vaak een harde akoestiek, waardoor al deze geluiden als nog onprettiger worden ervaren, omdat ze langer doorgalmen. Het wordt dan moeilijker om een *sense of place* te krijgen of te onderhouden. Op basis van een *sense of place* kunnen mensen normaliter een verwachtingspatroon vormen en anticiperen op wat gaat komen. Verwachtingspatronen maken het makkelijker de complexe wereld om ons heen te hanteren. Afwijkingen hiervan in de vorm van onbekende of onverwachte geluiden leiden tot een lage voorspelbaarheid en een gevoel van onbehagen en onveiligheid. Het concept ‘hoorbare veiligheid’ speelt ook een essentiële rol bij de beoordeling van *soundscapes* en het vormen van een *sense of place*. De belangrijkste evolutionaire functie van auditie, het vermogen om te horen en te luisteren, is namelijk de waarschuwingsfunctie: ‘Is het hier veilig’? Als de veiligheid van een omgeving kan worden geschat (gehoord) stelt dit een individu in staat om te ontspannen of zich tot andere zaken te richten in plaats van waakzaam te zijn in (potentieel) gevaarlijke situaties. Het constante proces van het bepalen van hoorbare veiligheid in complexe auditieve omgevingen en de bijbehorende arousal, kan de cognitieve vermogens van mensen met (zeer) ernstige verstandelijke beperkingen te boven gaan. Indien er onvoldoende aandacht wordt besteed aan de auditieve leefomgeving, zou deze structureel te weinig (voor hen) betekenisvolle aanwijzingen voor veiligheid kunnen bevatten. De spanning en opwinding die daar uit voort vloeit, beïnvloedt het algemeen welbevinden en de kwaliteit van bestaan van iedereen negatief en zeker ook personen met ernstige of zeer

ernstige verstandelijke beperkingen. Het zou eveneens kunnen bijdragen aan het ontstaan en/of in stand houden van probleemgedrag.

Een goede auditieve omgeving helpt om probleemloos een *sense of place* te vormen. Het voldoet aan de basisvoorwaarde van hoorbare veiligheid en biedt voldoende gedragsmogelijkheden. Dit houdt in dat de omgeving niet te complex is, maar wel rijk aan positieve indicatoren van veiligheid. Wanneer de algehele situatie duidelijk hoorbaar veilig is, zullen zelfs onverwachte en onaangename geluiden niet echt storend zijn, omdat ze zich voordoen in een geruststellende omgeving.

Hoofdstuk Drie

Om de validiteit en toepasbaarheid van het theoretisch kader te testen, hebben we een focusgroep-studie georganiseerd voor professionals die werkzaam zijn in de langdurige zorg voor personen met een ernstige of zeer ernstige verstandelijke beperking. In totaal namen 34 professionals, die actief zijn op drie verschillende organisatieniveaus (uitvoerend, voorwaardenscheppend en strategisch), deel aan deze studie. De impliciete kennis van deze professionals met betrekking tot de rol van geluid voor personen met een ernstige of zeer ernstige verstandelijke beperking gaf steun aan ons theoretisch kader. Zo bevestigden de resultaten de hypothese dat geluid belangrijk is bij het vaststellen van een *sense of place* en inderdaad het gedrag van personen met een ernstige of zeer ernstige verstandelijke beperking kan beïnvloeden. Tot slot wezen de resultaten op het belang van de bewustwording onder het personeel (in alle lagen van de organisatie) over de rol van geluid in de woningen en dagbestedingscentra voor personen met een (zeer) ernstige verstandelijke beperking. Wij zien een verhoogde bewustwording onder het personeel dan ook als een noodzakelijke eerste stap om deze auditieve omgevingen te optimaliseren.

Hoofdstuk Vier

In het vierde hoofdstuk van dit proefschrift beschrijven we een studie waarin de relatie is getoetst tussen de auditieve omgeving en de gemoedstoestand (in termen van *core affect*) van 36 personen met een ernstige of zeer ernstige verstandelijke en visuele beperking. De participanten woonden in vier verschillende zorginstellingen in Nederland, waarvan er drie primair gericht zijn op de zorg voor personen met een verstandelijke beperking en één primair op de zorg voor personen met een visuele beperking. Voor dit deel van het onderzoek is een interventie-georiënteerde assessment procedure ontwikkeld: de *Assessment Auditieve Omgeving*. Observaties werden uitgevoerd door hun persoonlijk begeleiders, op meerdere momenten gedurende een hele dag. Met behulp van scoreformulieren werd zowel het *core affect* van de participanten als de kwaliteit van de auditieve omgeving in kaart gebracht. Dit gebeurde aan de hand van een achttal Likert schalen die betrekking hadden op de *pleasantness* en *eventfulness* van het geobserveerde gedrag en geluid. In totaal betrokken we 149 observaties van ieder 10 minuten in een multilevel regressie analyse. De resultaten toonden een positieve relatie aan tussen de waargenomen mate van *pleasantness* en *eventfulness* van de auditieve omgeving en de gemoedstoestand van personen met een ernstige of zeer ernstige verstandelijke beperking. Het tijdstip op de dag bleek geen verklarende variabele voor het *core affect* van de participanten te zijn, maar de aard van de organisatie (primair gericht op verstandelijke of visuele beperking) wel. Mogelijk wijst dit op een kwalitatief betere auditieve omgeving in zorgvoorzieningen die zich primair richten op personen met visuele beperkingen. Concluderend ondersteunen de resultaten de aanname dat een verbeterde auditieve omgeving ook de gemoedstoestand van personen met een ernstige of zeer ernstige verstandelijke en visuele beperking verbetert.

Hoofdstuk Vijf

Om de oorspronkelijke (papieren) versie van de *Assessment Auditieve Omgeving* eenvoudiger in gebruik te maken voor persoonlijk begeleiders en efficiënter te maken voor onderzoeksdoeleinden, is deze gedigitaliseerd als een smartphone-applicatie MoSART (*Mobile Soundscape Appraisal and Recording Technology*). In het vijfde hoofdstuk van dit proefschrift beschrijven we een studie waarbij deze applicatie gedurende een periode van vier weken werd geïmplementeerd door 13 persoonlijk begeleiders. Er vonden 170 metingen plaats van de kwaliteit van auditieve omgevingen binnen een dagbestedingscentrum voor personen met een (zeer) ernstige verstandelijke beperking, gespecialiseerd in probleemgedrag. Exploratieve analyses lieten een verbetering van de kwaliteit van de auditieve omgeving zien, met een toename van levendig beoordeelde *soundscapes*. Toetsing toonde vervolgens aan dat deze verbetering gepaard ging met een significante afname van negatieve stemmingen (MIPQ) en van de ernst van stereotype gedrag (LGP-PIMD) bij 15 participanten. De resultaten ondersteunen het theoretisch kader en tonen aan dat het werken met deze assessment procedure tot gevolg had dat persoonlijk begeleiders zich meer in staat voelen om verbeteringen in de auditieve omgeving door te voeren. Een toegenomen bewustwording over de rol van geluid speelt hierbij mogelijk een mediërende rol. Bovendien toonden de resultaten de onmiddellijke en sterke effecten van de auditieve omgeving op de gemoedstoestand en probleemgedrag aan. Ze bieden daarmee ondersteuning voor het mogelijke succes van op geluid gebaseerde interventies.

Hoofdstuk Zes

In het zesde hoofdstuk van dit proefschrift onderzochten we op een meer gecontroleerde manier de effecten van verschillende auditieve omgevingen op het *core affect* van 13 participanten met een (zeer) ernstige verstandelijke beperking en probleemgedrag. We boden de participanten, samen met hun persoonlijk begeleiders, één van vijf verschillende auditieve omgevingen aan (Strand, Bos, Stedelijk, Muziek, en Stilte), in een speciale geluidsgeïsoleerde kamer. De persoonlijk begeleiders observeerden bij binnenkomst en na afloop van de soundscape sessies het *core affect* van de participanten. Een eerste analyze van deze observaties toonde aan dat de participanten in alle condities, zelfs in de Stilte-conditie, een positievere, meestal ontspannen gemoedstoestand lieten zien. Uit verdere analyses bleek echter dat de Stilte-conditie ook gepaard ging met de grootste toename in observaties van een verveeld *core affect* en afname van een geïnteresseerd *core affect*. Omdat de participanten in alle aangeboden *soundscapes* een meer positief *core affect* (ontspannen) lieten zien, valt dit te interpreteren als een verbetering ten opzichte van hun normale dagelijkse auditieve omgeving.

Hoofdstuk Zeven

In het laatste en concluderende hoofdstuk van dit proefschrift geven we een samenvatting van de belangrijkste bevindingen en beantwoorden we de twee onderzoeksvragen. Vervolgens reflecteren we op methodologische vraagstukken, gaan we in op onze interdisciplinaire en exploratieve benadering en benadrukken we het belang ervan. Verder bieden we een theoretische beschouwing over het *soundscape* onderzoek op basis van de belangrijkste componenten van *soundscapes,* namelijk: *pleasantness* vs. *eventfulness* en complexiteit vs. gedragsmogelijkheden. Daarnaast gaan we in op *core affect,* hoorbare veiligheid en stilte of rust. Ons theoretisch kader toont niet alleen aan waarom akoestisch onderzoek alleen onvoldoende is om de effecten van ongunstige auditieve omgevingen te verklaren, maar ook waarom de taxonomie van *soundscapes* die we hebben ontworpen kan dienen als een standaardmaat voor de kwaliteit van *soundscapes*.

Het voornaamste resultaat van dit proefschrift is echter de bevestiging van het belang van de kwaliteit van de auditieve omgeving in residentiële voorzieningen voor personen met een (zeer) ernstige verstandelijke beperking voor het verbeteren van hun kwaliteit van leven. In dat kader gaan we in op de implicaties voor de zorgpraktijk met betrekking tot hoorbare veiligheid, sociale interacties, audiovisuele media als vrijetijdsbesteding, akoestiek en het vergroten van het bewustzijn in de gehele organisatie. Tot slot geven we aanbevelingen voor toekomstig onderzoek. Het is namelijk belangrijk om onderzoek te blijven doen naar de wijze waarop de auditieve omgeving kan worden geoptimaliseerd voor personen met (zeer) ernstige verstandelijke beperkingen, zodat deze personen zich veiliger en comfortabeler in hun leefomgeving kunnen voelen. Gebaseerd op het theoretisch kader is geconcludeerd dat de hoorbare veiligheid het belangrijkste aspect van geluid is. Door auditieve omgevingen te creëren waarin het gevoel van basisveiligheid centraal staat, kunnen de gebruikers van deze omgevingen optimaal ontspannen en (on)bewust aandacht richten op een onderwerp naar keuze. Juist voor personen met een (zeer) ernstige verstandelijke beperking, die extra moeilijkheden hebben met de verwerking van een wereld die waarschijnlijk veel complexer voor hen lijkt dan voor ons, is deze hoorbare veiligheid van groot belang. Er moeten omgevingen gecreëerd worden die minimaal complex zijn, maar voldoende positieve indicatoren van veiligheid en genoeg gedragsmogelijkheden bevatten.

In termen van *core affect* kan gezegd worden dat, afhankelijk van het doel, levendige en kalme *soundscapes* het meest wenselijk zijn. Chaotische en saaie *soundscapes* moeten zo veel mogelijk vermeden worden. Het is daarbij van belang om te realiseren dat gedrag en geluid elkaar altijd beïnvloeden. Het is immers moeilijk om kalm te blijven in een chaotische situatie. Om positief gedrag en een positieve gemoedstoestand mogelijk te maken is het dus van belang de auditieve omgeving hierop af te stemmen. Er zal dus altijd vanuit een holistisch oogpunt naar de samenhang tussen gedrag en geluid gekeken moeten worden: het ene aspect is oninterpreteerbaar zonder het andere.

Concluderend stellen wij dat het optimaliseren van de auditieve (leef)omgeving in de langdurige zorg (zoals residentiële voorzieningen voor personen met een (zeer) ernstige verstandelijke [en meervoudige] beperking) belangrijk is om de best mogelijke zorg te kunnen bieden en zo het welzijn van de bewoners te bevorderen. Zolang de kwaliteit van de auditieve omgeving over het hoofd wordt gezien, zal de suboptimale auditieve omgeving een belangrijke negatieve invloed hebben op het fysiek en psychisch welzijn van de bewoners. De belangrijkste aanbeveling die wij hierbij naar voren brengen is het vergroten van het bewustzijn over de rol van geluid in de leefomgeving van personen met een (zeer) ernstige verstandelijke beperking, niet alleen bij direct ondersteunend personeel, maar in de gehele organisatie. Wanneer men nadenkt over de geluidsomgeving, en zo vaker stilstaat bij de gevolgen van een stressvolle auditieve omgeving, zal men beter omgaan met de alledaagse geluiden die de auditieve omgevingen van personen met een (zeer) ernstige verstandelijke beperking vullen. Er moet stil gestaan worden bij het feit dat deze personen minder autonoom zijn. Ze kunnen vaak niet vragen of de radio wat zachter mag, of weglopen wanneer het geluid te veel wordt. Het is de taak aan de dagelijks begeleiders om te herkennen wat goed is voor de cliënten, en het is de taak aan het management om dit mogelijk te maken. Onze ogen kunnen we sluiten, maar onze oren niet. Daarom moeten we gehoor geven aan de auditieve omgeving.

Appendices

Appendix I

Assessment Auditory Environment

(in Dutch)

De Assessment Auditieve Omgeving

Testonderdelen

De Assessment Auditieve Omgeving bestaat uit een *Handleiding*, welke u nu voor u heeft, een scoreformulier *Geluid*, een scoreformulier *Gedrag* en een *Resultatenformulier*.

Handleiding

Deze handleiding omvat specifieke instructies voor de afname, de berekening van de scores en uitleg over de interpretatie van de uitkomsten.

Scoreformulier Geluid

Het scoreformulier Geluid bestaat uit een achttal schalen die representatief zijn voor acht sfeeromschrijvingen. Op een schaal van 0 (helemaal niet van toepassing) tot 100 (helemaal van toepassing) kan aangegeven worden in welke mate de genoemde sfeeromschrijving van toepassing is op de geobserveerde auditieve omgeving. Hiermee wordt al het hoorbare geluid binnen de observatieperiode bedoeld.

Scoreformulier Gedrag

Het scoreformulier Gedrag bestaat uit dezelfde achttal schalen die representatief zijn voor acht sfeeromschrijvingen. Op een schaal van 0 (helemaal niet van toepassing) tot 100 (helemaal van toepassing) kan aangegeven worden in welke mate de genoemde sfeeromschrijving van toepassing is op het gedrag wat de geobserveerde cliënt(en) hebben laten zien. Hiermee wordt vooral de globale stemming van de cliënt(en) binnen de observatieperiode bedoeld.

Resultatenformulier

Met behulp van het resultatenformulier kunnen de scores van de beide scoreformulieren in zeven stappen omgezet worden tot kwadrantscores. De kwadrantscores zijn representatief voor de stemming van het geobserveerde geluid en gedrag.

Handleiding

Invultijd

Na een observatie van 10 minuten kunnen de scoreformulieren binnen vijf minuten ingevuld worden. Het is van belang dit direct na de observaties te doen. Met behulp van het resultatenformulier kunnen de scores op de acht schalen van de scoreformulieren binnen enkele minuten omgezet worden tot kwadrant scores.

Benodigdheden voor invullen

Bij het invullen is naast de vragenlijst zelf een pen, liniaal en rekenmachine nodig voor de berekening van de scores. Het gebruik van opnameapparatuur (zowel beeld als geluid) kan gunstig zijn om de observaties later terug te zien. Hierdoor kan op specifieke situaties teruggekeken worden en op specifieke details gelet worden om tot een betere interventie te komen.

Gebruikerskenmerken

De Assessment Auditieve Omgeving kan afgenomen worden door personen uit verschillende beroepsgroepen. Op basis van onderzoeksresultaten wordt echter aangeraden de procedure uit te laten voeren door het direct ondersteunend personeel, omdat zij een grotere empathische betrokkenheid vertonen.

Clientkenmerken

De Assessment Auditieve Omgeving is in eerste instantie ontwikkeld om de huidige kwaliteit van de auditieve omgeving en het gedrag hierin van personen met ernstig visuele en verstandelijke beperkingen te beoordelen. Er zijn geen aanwijzingen gevonden om deze assessment procedure te beperken tot alleen deze doelgroep. Gebruik van de lijst bij ander doelgroepen is experimenteel, onderzoek is nodig om de toepasbaarheid voor andere doelgroepen te bepalen.

Classificatiesysteem

De scores kunnen in vier kwadranten geclassificeerd worden afhankelijk van de scores op de twee kerncomponenten, mate van Plezier en mate van Activering. De Plezier-as (horizontaal, x-as) en de Activatie-as (verticaal, y-as) lopen beide van -1 tot 1. Scores van 0 tot 1 duiden op de Plezier-as op een positief affect en scores van 0 tot -1 op een negatief affect. Scores tussen de 0 en 1 op de Activatie-as duiden op een actieve staat en scores tussen de 0 en -1 op een passieve staat. Hierdoor ontstaan er vier kwadranten: Levendig, Kalm, Saai en Chaotisch.

Afnameprocedure en berekening scores

Algemene afwegingen
Het is van belang om eerst kennis te nemen van de volledige *Handleiding*, *Score- en Resultatenformulieren* voordat u de Assessment Auditieve Omgeving gaat gebruiken. Door alvorens bekend te raken met het doel van de assessment, de items en verschillende kwadranten van Gedrag en Geluid kunt u goed voorbereid aan de slag met de Assessment Auditieve Omgeving. Dit heeft als voordeel dat de afname- en scoreprocedures zo goed mogelijk gevolgd kunnen worden, wat nodig is voor de garantie van de betrouwbaarheid van het onderzoek en de juiste interpretatie van de resultaten.

Bij de ontwikkeling van deze assessment procedure is ernaar gestreefd om deze eenvoudig toepasbaar te maken voor de praktijk. De Assessment Auditieve Omgeving is daarom afgestemd op gebruik voor en door het direct ondersteunend personeel en dient dan ook door deze werknemers afgenomen te worden. Daarnaast kan de Assessment Auditieve Omgeving informatief zijn voor gedragsspecialisten zoals orthopedagogen.

Specifieke afnameprocedure
Wanneer er kennis is genomen van de Handleiding en de in te vullen formulieren kan de Assessment Auditieve Omgeving uitgevoerd worden aan de hand van de volgende stappen:

1. Allereerst dient op het voorblad de naam en geboortedatum van de betreffende cliënt ingevuld te worden. Daarnaast is de informatie over het tijdstip, de ruimte en de activiteit waarop geobserveerd wordt van belang om later uitspraken te kunnen doen over welke situaties geoptimaliseerd dienen te worden.

2. Neem voor de observaties plaats in de ruimte waar de te observeren cliënt zich bevind en probeer hierbij de activiteiten niet te verstoren. Elke observatie duurt 10 minuten. Observeer gedurende deze tijd het gedrag van de cliënt en al het geluid wat u kunt horen. Het is de bedoeling een gevoel van de stemming, de sfeer, te krijgen en hierbij niet te veel focussen op details. Probeer de beoordeling van het geluid, zo objectief mogelijk, vanuit uw perspectief te doen en zich juist niet te verplaatsen in de cliënt.

3. De keuze voor de tijden, activiteiten en frequenties van de observaties staat in principe vrij. Uit analyse is gebleken dat het tijdstip, of soort activiteit, van de dag geen invloed heeft op de invloed van geluid op gedrag. Er kan bijvoorbeeld gekozen worden om specifieke situaties te observeren die vermoedelijk stress met zich mee brengen voor de cliënt. Wel wordt aangeraden de observaties enkele malen te herhalen voor een betrouwbaarder resultaat.

4. Na de observatie dienen de scoreformulieren direct ingevuld te worden. De scoreformulieren voor geluid en gedrag zijn gelijk, maar worden onderscheiden door de tekst rechtsonder op het formulier. Geef van elk van de acht sfeeromschrijvingen (de groep woorden samengenomen vormt een sfeeromschrijving) aan in hoeverre u deze van toepassing vind op wat u heeft geobserveerd door dit punt te markeren op de schaal (0 helemaal niet van toepassing – 100 helemaal van toepassing). Het is belangrijk alle schalen in te vullen, anders kunnen er geen scores berekend worden.

Scores berekenen

De scores kunt u met de hand uitrekenen met behulp van het *Resultatenformulier*. Op dit formulier staat in zeven stappen helder uitgelegd wat u moet doen. Volg deze instructies nauwkeurig op.

rijksuniversiteit groningen
faculteit gedrags- en maatschappijwetenschappen
orthopedagogiek

Geef van de onderstaande sfeeromschrijvingen aan in hoeverre u deze van toepassing vind op het geobserveerde geluid in de omgeving.

1. Extreem, Rommelig, Onthutst, Chaotisch, Verward

(0) Helemaal niet van toepassing ____________________ Helemaal van toepassing (100)

2. Verschrikkelijk, Onaangenaam, Irriterend, Vervelend, Afschrikwekkend

(0) Helemaal niet van toepassing ____________________ Helemaal van toepassing (100)

3. Levenloos, Oninteressant, Monotoon, Expressieloos, Saai

(0) Helemaal niet van toepassing ____________________ Helemaal van toepassing (100)

4. Onbewogen, Onveranderlijk, Immobiel, Passief, Stilstaand

(0) Helemaal niet van toepassing ____________________ Helemaal van toepassing (100)

5. Simpel, Stil, Kalm, Bedaard, Onopvallend

(0) Helemaal niet van toepassing ____________________ Helemaal van toepassing (100)

6. Natuurlijk, Warm, Prachtig, Comfortabel, Gezellig

(0) Helemaal niet van toepassing ____________________ Helemaal van toepassing (100)

7. Expressief, Levend, Prikkelend, Fascinerend, Interesse-opwekkend

(0) Helemaal niet van toepassing ____________________ Helemaal van toepassing (100)

8. Actief, Druk, Levendig, Dynamisch, Veelbewogen

(0) Helemaal niet van toepassing ____________________ Helemaal van toepassing (100)

Opmerkingen:

II

Assessment Auditieve Omgeving GELUID

rijksuniversiteit groningen / faculteit gedrags- en maatschappijwetenschappen / orthopedagogiek

Assessment Auditieve Omgeving GEDRAG

Geef van de onderstaande sfeeromschrijvingen aan in hoeverre u deze van toepassing vind op het geobserveerde gedrag van de client.

1. Extreem, Rommelig, Onthutst, Chaotisch, Verward

(0) Helemaal niet van toepassing — Helemaal van toepassing (100)

2. Verschrikkelijk, Onaangenaam, Irriterend, Vervelend, Afschrikwekkend

(0) Helemaal niet van toepassing — Helemaal van toepassing (100)

3. Levenloos, Oninteressant, Monotoon, Expressieloos, Saai

(0) Helemaal niet van toepassing — Helemaal van toepassing (100)

4. Onbewogen, Onveranderlijk, Immobiel, Passief, Stilstaand

(0) Helemaal niet van toepassing — Helemaal van toepassing (100)

5. Simpel, Stil, Kalm, Bedaard, Onopvallend

(0) Helemaal niet van toepassing — Helemaal van toepassing (100)

6. Natuurlijk, Warm, Prachtig, Comfortabel, Gezellig

(0) Helemaal niet van toepassing — Helemaal van toepassing (100)

7. Expressief, Levend, Prikkelend, Fascinerend, Interesse-opwekkend

(0) Helemaal niet van toepassing — Helemaal van toepassing (100)

8. Actief, Druk, Levendig, Dynamisch, Veelbewogen

(0) Helemaal niet van toepassing — Helemaal van toepassing (100)

Opmerkingen:

III

rijksuniversiteit groningen / faculteit gedrags- en maatschappijwetenschappen / orthopedagogiek

Scoreformulier

1. Om de scores te bereken dient u eerst te meten waar u uw kruisje op elke schaal heeft gezet. De schalen zijn 10 cm lang. Met behulp van een liniaal kunt u bepalen waar uw kruisje staat.
   - Schrijf de scores achter de schalen

2. Vervolgens moeten de scores gestandaardiseerd worden. Vul hiervoor onderstaand schema in (vul de betreffende scores op de stippellijnen):

Schaal:	GELUID	Schaal:	GEDRAG
1	(50 - ....) / 50 =	1	(50 - ....) / 50 =
2	(50 - ....) / 50 =	2	(50 - ....) / 50 =
3	(50 - ....) / 50 =	3	(50 - ....) / 50 =
4	(50 - ....) / 50 =	4	(50 - ....) / 50 =
5	(.... - 50) / 50 =	5	(.... - 50) / 50 =
6	(.... - 50) / 50 =	6	(.... - 50) / 50 =
7	(.... - 50) / 50 =	7	(.... - 50) / 50 =
8	(.... - 50) / 50 =	8	(.... - 50) / 50 =

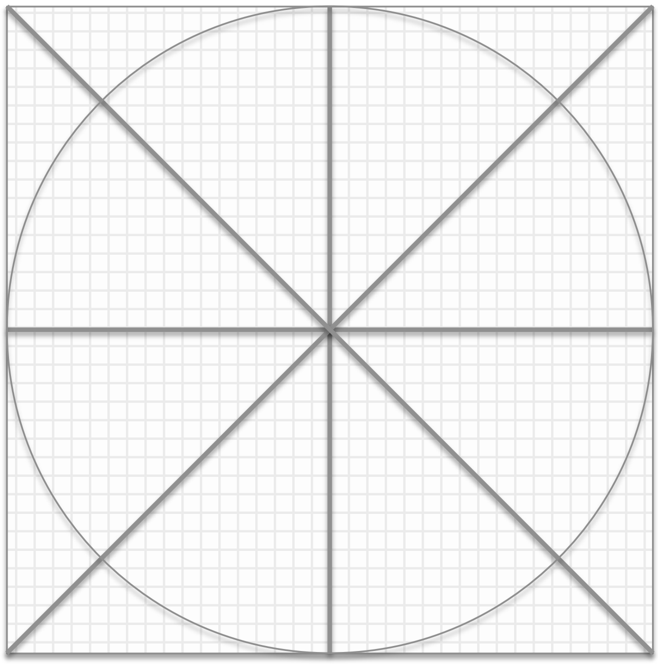
3. Tel nu de score van de eerste schaal op bij de score van de vijfde schaal en deel dit getal door twee, ga zo door. Vul hiervoor onderstaand schema in:

	GELUID	GEDRAG
As 1	(S1 + S5) / 2 =	(S1 + S5) / 2 =
As 2	(S2 + S6) / 2 =	(S2 + S6) / 2 =
As 3	(S3 + S7) / 2 =	(S3 + S7) / 2 =
As 4	(S4 + S8) / 2 =	(S4 + S8) / 2 =

IV

rijksuniversiteit groningen
faculteit gedrags- en maatschappijwetenschappen
orthopedagogiek

4. Teken de scores berekend bij punt 3 voor GELUID in de volgende figuur:



Het vierkant is 10 x 10 cm, alle assen zijn hierdoor ook 10 cm.
Teken met behulp van een liniaal een kruisje op elke as. De assen lopen van -1 tot 1. Het midden staat gelijk aan 0.

As 1 is de Ontspannen as
As 2 is de Plezierig as
As 3 is de Interesse as
As 4 is de Levendig as

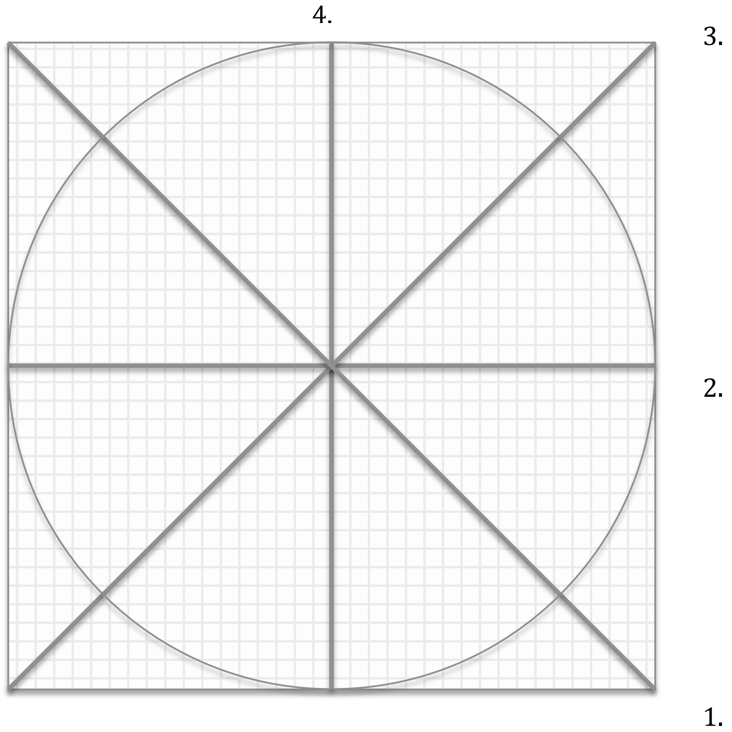
5. Verbind nu de punten van As 1 en As 3 door middel van een lijn en teken in het midden van deze lijn een kruis.
Doe dit ook voor de punten van As 2 en As 4.

Verbind nu de laatste twee getekende kruizen door middel van een lijn en teken in het midden een stip.

In dit kwadrant valt de door u geobserveerde kwaliteit van het geluid.

rijksuniversiteit groningen / faculteit gedrags- en maatschappijwetenschappen / orthopedagogiek

6. Teken de scores berekend bij punt 3 voor GEDRAG in de volgende figuur:



Het vierkant is 10 x 10 cm, alle assen zijn hierdoor ook 10 cm.
Teken met behulp van een liniaal een kruisje op elke as. De assen lopen van -1 tot 1. Het midden staat gelijk aan 0.

As 1 is de Ontspannen as
As 2 is de Plezierig as
As 3 is de Interesse as
As 4 is de Levendig as

7. Verbind nu de punten van As 1 en As 3 door middel van een lijn en teken in het midden van deze lijn een kruis.
Doe dit ook voor de punten van As 2 en As 4.

Verbind nu de laatste twee getekende kruizen door middel van een lijn en teken in het midden een stip.

In dit kwadrant valt de door u geobserveerde kwaliteit van het gedrag.

Appendix II

MoSART

MoSART

MoSART is an acronym for *Mobile Soundscape Appraisal and Recording Technology*. It is a smartphone application developed specifically for this research, enabling in situ experience sampling. MoSART is a digitized version of the *Assessment Auditory Environments* (Van den Bosch et al., accepted) including some additional functions, based on the based on the *Soundscape-Quality Protocol* by Axelsson et al. (2010).

The first version of MoSART was used in the study described in Chapter Five on the relation between the quality of soundscapes on challenging behavior in people with severe or profound intellectual and multiple disabilities. Ad interim, based on previous results and user feedback, the development of MoSART continued and currently a version 2.0 is available. This new version is currently being implemented at three healthcare organizations and will be described below.

Functionality

MoSART sends push notification three times a day, on random moments between working hours, with the request to make a measurement. The measurement consists of two parts: the recording an audio clip of 30 seconds (not used in this dissertation) and a questionnaire with 14 questions regarding the appraisal of the environment.

First, MoSART asks the user to appraise the auditory environment according to the horizontal, vertical and diagonal axis of the soundscape taxonomy, namely: pleasant-unpleasant, eventful-uneventful, calm-chaotic, and lively-boring. Furthermore, it asks the user to assess the audibility of different classes of sound sources (Human, Natural, Music-TV-Radio, Machines-Devices, Traffic, and Other), and the overall quality of the respective auditory and visual environment. All these questions are rated on a 0-100 scale. The remaining questions regard the appropriateness and changeability of the auditory environment (answered with yes or no).

The final result of the measurement of the quality of the auditory environment is based on the results from the questionnaire, and is shown in five possible outcomes: Lively, Calm, Boring, Chaotic, and Neutral (in Dutch: Levendig, Kalm, Saai, Chaotisch, en Neutraal).

Technical specifications

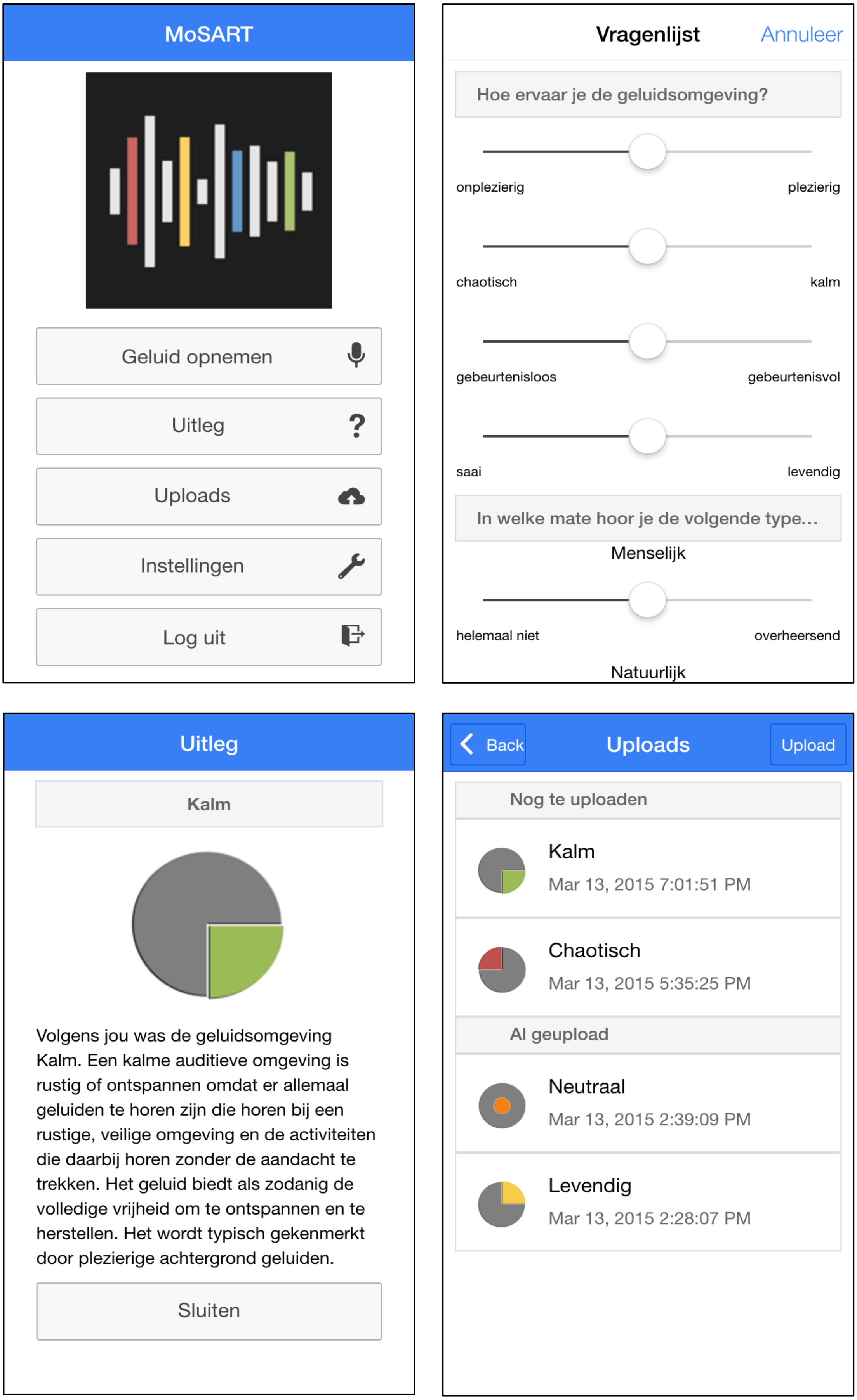
MoSART is a hybrid application, which means it is essentially a mobile website (HTML5) running locally in a native app shell. We choose a hybrid approach to enable multiplatform (Android and iOS) support. Currently, MoSART is only available in Dutch, but an English version is in preparation.

MoSART is build using the front-end UI Ionic mobile development framework in combination with Apache Cordova™. Apache Cordova™ is a set of device APIs that allow a mobile app developer to access native device function such as the microphone from JavaScript.

The audio-recordings are 30 seconds in length, and are saved as WAV files with a 16 kHz sample rate. The recordings and results from the questionnaire are send to, and securely stored on a server hosted by the University of Groningen.

In the future we hope to use machine-learning algorithms, by combining the gathered recordings and appraisal data from the questionnaires, to automatically determine soundscape quality and to provide users with a standardized result.

Screenshots



Publications

English

Andringa, T.C., & van den Bosch, K.A. (2013). *Core effect and soundscape assessment: Fore- and background soundscape design for quality of life.* Paper presented at INTER-NOISE 2013, the 42nd International Congress and Exposition on Noise Control Engineering, Innsbruck (pp. 2273-2282). Innsbruck: INCE.

Andringa, T.C., van den Bosch, K.A., & Vlaskamp, C. (2013). Learning autonomy in two or three steps: linking open-ended development, authority, and agency to motivation. *Frontiers in Psychology*, **4**:766. doi: 10.3389/fpsyg.2013.00766

Andringa, T.C., van den Bosch, K.A., & Wijermans, N. (2015). Cognition from life: the two modes of cognition that underlie human behavior. *Frontiers in Psychology,* **6**:362. doi: 10.3389/fpsyg.2015.00362

Van den Bosch, K.A. (2015). *The role of the auditory environment for people with profound intellectual disabilities.* Paper presented at the Symposium Wissenschaf(f)t Teilhabe, Berlin (pp. 63-71). Berlin: Stiftung Rehabilitationszentrum Berlin-Ost.

Van den Bosch, K.A., & Andringa, T.C. (2014). *The effect of sound sources on soundscape appraisal.* Paper presented at ICBEN 2014, 11th International Congress on Noise as a Public Health Problem, Nara.

Van den Bosch, K.A., Andringa, T.C., Başkent, D., & Vlaskamp, C. (2015). The role of sound in residential facilities for people with profound intellectual and multiple disabilities. *Journal of Policy and Practice in Intellectual Disabilities.* Paper accepted for publication.

Van den Bosch, K.A., Andringa, T.C., Peterson, W., Başkent, D., Ruijssenaars, A.J.J.M., & Vlaskamp, C. (submitted). Soundscape sessions for people with severe or profound intellectual disabilities.

Van den Bosch, K.A., Andringa. T.C., Post, W., Ruijssenaars, A.J.J.M., & Vlaskamp, C., (submitted). The relation between the auditory environment and challenging behavior in people with a severe or profound intellectual disability.

Van den Bosch, K.A., Andringa, T.C., & Vlaskamp, C. (2013). *The role of sound and audible safety in special needs care.* Paper presented at INTER-NOISE 2013, the 42nd International Congress and Exposition on Noise Control Engineering, Innsbruck (pp. 2267-2272). Innsbruck: INCE.

Van den Bosch, K.A., Vlaskamp, C., Andringa. T.C., Post, W., & Ruijssenaars, A.J.J.M. (2014). Examining relationships between staff attributions of soundscapes and core affect in people with severe or profound intellectual and visual disabilities. *Journal of Intellectual & Developmental Disability.* Paper accepted for publication.

Dutch

Van den Bosch, K.A., & Andringa, T.C. (2014). Hoorbare veiligheid voor personen met visuele en verstandelijke beperkingen. In *Sporen van de reiziger.* (pp. 221-236). Garant Publishers.

Van den Bosch, K. A., Andringa, T.C., Post, W.J., Ruijssenaars, A.J.J.M. & Vlaskamp, C. (2015). De relatie tussen de auditieve omgeving en stemming en gedrag van personen met (zeer) ernstige verstandelijke en meervoudige beperkingen. *Nederlands Tijdschrift voor de Zorg aan mensen met verstandelijke beperkingen.*

Van den Bosch, K.A., Andringa, T.C., & Vlaskamp, C. (2014). Luisteren naar het groeien van het gras. *Geluid, 2,* 8-10.

Van den Bosch, K.A., Vlaskamp, C., Andringa, T.C., Başkent, D., & Ruijssenaars, A.J.J.M. (2014). *Veilige auditieve omgevingen voor mensen met visuele en verstandelijke beperkingen: Onderzoeksrapportage ten behoeve van de praktijk.* Stichting Kinderstudies.

Van den Bosch, K.A., Vlaskamp, C., Ruijssenaars, A.J.J.M., & Andringa, T.C. (2014). Het belang van de auditieve omgeving bij personen met visuele en verstandelijke beperkingen. *Orthopedagogiek: Onderzoek en Praktijk* , *53* (7-8), 377-386.

About the author

Kirsten Anna-Marie van den Bosch was born on February 8, 1988 in Rotterdam. She graduated in 2010 from the Erasmus University Rotterdam, where she obtained a Bachelor degree in Psychology and a Master degree in Biological and Cognitive Psychology. In her third and fourth year of education at the Erasmus University, she worked as a research assistant. During her years as a student, she volunteered during the summers at a camp offering equestrian holidays to people with physical, developmental, and intellectual disabilities. After she graduated, she moved to Groningen and in the beginning of 2012, she started her PhD at the department of Special Needs Education and Youth Care from the University of Groningen, in collaboration with the department of Artificial Intelligence (AI). Next to her research activities, she supervised multiple students during their internships, bachelor and master thesis's, and she gave Perception and Sound Recognition courses at the department of AI, where she successfully implemented problem-based learning. In the first year of her doctoral research, she won a price from the Stichting Sinnige Fonds, as an incentive to pursue her line of research. Later on, in 2014, she obtained a dissemination and implementation grant, to implement her assessment procedure MoSART, at three organizations in The Netherlands. In that same year she was selected as one of the *Faces of Science*, a project by the Royal Netherlands Academy of Arts and Sciences. Next to various international conferences, she was asked to give lectures during the Noorderzon Performing Arts Festival and the Night of Art and Science in Groningen, and the Discovery Festival in Amsterdam. One of her latest ventures includes participating in the start-up of a company, SoundAppraisal, with colleagues and students from AI. Currently, she continues her line of research at the department of Special Needs Education and Youth Care at the University of Groningen.

Acknowledgements

This dissertation would not have been possible without the help of the healthcare organizations and professionals that participated, my supervisors, colleagues, researchers such as: psychologists, special need experts, acousticians, biologists, and physicists. But also daily caretakers, medical personnel, programmers, students, people with and without disabilities, designers and architects, artists and performers, people who are really sound annoyed and people who are infatuated by it. Hereby, I want to thank everyone who has contributed to the realization of this dissertation. I feel honored that I have worked together with you all in this project where we build bridges between two disciplines that seemed so far apart: Special Needs Care and Artificial Intelligence. When we embarked on this adventure, I did not expect that its impact would be so large and the support would be so overwhelming.

My gratitude goes to ZonMW for granting the subsidies that made this research possible, and the healthcare organizations that participated (Talant, Koninklijke Visio, Vanboeijen en 's Heerenloo Zorggroep). Without the intensive cooperation with the practice, this project would not have been successful. Special thanks go to Bart Schoppers (Talant) and Roel Menke (Visio). Both have been a recurring theme in this project and a source of inspiration and motivation. Sometimes I still refer to you as the godfathers of my research. Also, I want to acknowledge Ruud Tap (Talant) and Bas Bijl ('s Heerenloo) for their commitment and efforts in making sure that our projects were successful.

Furthermore, I want to thank the members of the reading committee (Prof. dr. D. Botteldooren, Prof. dr. P.J.C.M. Embregts and Prof. dr. H.J.M. Janssen) for reviewing (and approving) my dissertation.

Most importantly, my appreciation goes to my supervisors: prof. dr. Carla Vlaskamp, dr. Tjeerd Andringa, prof. dr. Wied Ruijssenaars, and prof. dr. Deniz Başkent. You all have undoubtedly been the most influential in my success as a PhD student. Without you, I would not have been able to carry out this research, let alone in the limited time we had (writing a dissertation in three years proved to be quite a challenge, but certainly not insurmountable). Carla and Tjeerd, you have played the most important roles as my daily supervisors. I could not have imagined two people to be more different, but yet to come together as a perfectly balanced team. It's like you represent my left and right hemisphere.

Carla, I realize I probably wasn't the easiest PhD student to manage, with my liberal views on office hours, and locations for that matter. Nonetheless, you gave me the freedom to roam (even though I sometimes detected slight concerns), but also you gave me the support and guidance that I needed. You have taught me that in writing one must kill its darlings (despite my sometimes stubborn persistence), and how to take off my 'zevenmijlslaarzen' (met grote stappen snel thuis). Also, you have been a great guide into the world of special needs care. My roots do not lie within this discipline, and I had a lot to learn when I started working on this project (still do). I discovered quickly that dropping the name Vlaskamp had the universal reaction of recognition and respect. For me that reflects your commitment to this very special group of people (with PIMD), and the big impact you had on this field.

Tjeerd, the most difficult thing in working together with you, is learning how to say no. It seemed as if every week you would come up with new ideas, new possibilities, new methods or new platforms. The one more intriguing than the last, and often it were those exciting little 'side projects' that kept me going. More than once I jokingly said that you have indoctrinated me well, but in fact you have taught me well. I remember our first conversation in which you told me that I should forget everything that I had learned during my education, and to that I owe my now broad and holistic views on the world and science in particular. Also, I want to thank you and Merlijn for your hospitality and allowing me to retreat to your home to write. Those weeks have been unprecedentedly important in finishing this dissertation.

Deniz and Wied, having four supervisors turned out to be a luxury and an administrative hassle at the same time. Sometimes it seemed impossible to get all four of you in the same room at the same time. That resulted in less physical contact hours with you, but you have played an important role in my dissertation nonetheless. Deniz, you were always able to improve our manuscripts language-wise, but more importantly: you have a great vision for structure, which manifested itself by asking critical questions and pointing out discrepancies or gaps in my reasoning. Luckily, you did not limit this fine quality to paper, but you also demonstrated its usefulness during those meetings in which we actually did manage to gather altogether. Wied, I want to thank you for your patience, trust and enduring positivity. Your support has been remarkable and very much appreciated. I admire your charm, witty humor, and your powers of persuasion. You are a true gentleman.

Next to my supervisors, other colleagues deserve my gratitude. Hans (prof. dr. Grietens), even though we haven't worked together closely I want to thank you for your commitment to making sure that I was able to continue my research after my position as a PhD student. Wendy (dr. Post), you are an amazing person and a statistical genius. I have always enjoyed our meetings tremendously, and experienced them as energizing and uplifting. Where others might have left your office with tears in their eyes from confusion and despair, I left your office with tears from laughter.

Of course the EMB-club deserves to be mentioned here: Jorien, Annet and Annette, Vera, Aafke, Suzanne J and Suzanne H, Eleonora, Anouk, Leontien, Anne, Linda, and last but definitely not least Petra. Sometimes it was hard for me to keep up with the baby boom that went on (I really worried whether it would be contagious at one point), but it has been a pleasure to work with you all. Also, Marlies, it's been very chocolonely since you've been gone.

Additionally, I would like to mention the code monkeys from Sound Appraisal: Arryon, Stefan, Damian, Henk, and Ronald. Guys, it is a blast working with you, much wow. Stefan, you deserve a big thanks for developing MoSART and turning my technical dreams into reality.

There are also a few people that deserve credit for their creative contributions: David Oldenburger and Arryon Tijsma for their share in the beautiful cover of this dissertation, Annemiek Hospers for making my first ever conference poster and photographs depicting the four quadrants, and Renger Koning for composing the soundscapes we used in our last study.

That leaves me with the most personal acknowledgements. First, I want to thank my two paranymphs and best friends. Kim and Anne, what else can I say? You guys are bananas. Whether it's rushing to the ER, doing my dishes at 3 o'clock at night, or standing by my side during my defense, I know I can always count on you. You two are amazing friends.

Mom and Dad, zonder jullie was dit allemaal niet mogelijk geweest. Dankjewel voor jullie onvoorwaardelijke liefde en steun waar dat nodig was, de hulp rondom mijn verhuizing naar Groningen, de bezoekjes en telefoongesprekken erna. Ook bij jullie kan ik altijd terecht.

Dear Taco, as I experienced certain sensory input patterns, my mental pathways became accustomed to them. The inputs eventually got anticipated and even missed when absent. So could you please continue the petty bickering? I find it most intriguing. *"Non si pasce di cibo mortale, chi si pasce di cibo celeste / He who dines on heavenly food has no need of mortal sustenance"*. Except for sugar of course…

Live long and prosper