Exploring older people's sensory experiences of nature-based wellbeing interventions: A qualitative study

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Abstract

In recent years, nature-based wellbeing interventions have been promoted in UK communities through green social prescribing to improve people's wellbeing. Older people use their senses (i.e., sight, hearing, smell, touch, and taste) to connect with and derive wellbeing benefits from nature. This qualitative study set out to explore older people's full sensory experiences of nature to understand how their sensory connection to nature has been influenced. Semi-structured interviews were conducted with 23 older people aged 50 to 85 years who had participated in nature-based wellbeing interventions in South Yorkshire, UK, and 8 professionals who delivered such interventions within the communities. Participants were selected through purposive and snowball sampling and data were analysed using reflexive thematic analysis. Findings revealed that the visual pathway facilitated more widespread connection with nature while the tactile pathway deepened older people's relationship with it. Multi-sensory engagement increased opportunities for older adults, especially those with sensory deficits, to connect with nature. Non-visual sensory connections to nature among older people were hindered by three factors: safety considerations, a disconnect between how sensory pathways are established and their environments and routines, and a lack of awareness. Various temporal qualities were identified as being linked to older adults' ability to foster and maintain sensory connection with nature. These included the effect of slowing down and spending time engaging with nature on initiating bonds, the significance of seasonal sensory experiences for cultivating ongoing outdoor connections, past experiences tailored to individual circumstances that could promote sensory connections with nature, and indoor sensory engagement as an alternative for sustained interaction with nature in response to life changes such as ageing. This thesis adds to understanding of how older people interact with nature through all their senses. The findings support nature intervention providers in developing activities and environments tailored to older people's diverse needs and encouraging a broader older population to access the wellbeing benefits of nature.

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Declaration of authorship

I, Sin-Rou Fu, declare that the thesis titled 'Exploring older people's sensory experiences of nature-based wellbeing interventions: A qualitative study' is my own work. I confirm that I am aware of the University's Guidance on the Use of Unfair Means. This work has not been previously been presented for an award at this, or any other, university.

Signed: S R Fu

Date: 22 October 2025

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List of abbreviations

UK	United Kingdom
ONS	Office for National Statistics
SP	Social Prescribing
GSP	Green Social Prescribing
WHO	World Health Organisation
NHS	National Health Service
CINAHL	Cumulative Index to Nursing and Allied Health Literature
ASSIA	Applied Social Sciences Index and Abstracts
App	Application

Chapter 1 – Brief summary mapping to the following chapters in the thesis

This thesis (henceforth referred to as the present study) presents a research project which explores older people's experiences of sensory connection with nature and factors that influence this connection, through nature-based wellbeing interventions.

The present study contains nine chapters. The following is a brief overview of each chapter:

Chapter two provides a background for exploring the present research topic and defines key terms and concepts used throughout the thesis.

Chapter three presents a literature review systematically examining existing empirical research regarding sensory connection with nature and older people's wellbeing and identifies a gap in the evidence. The rationale for the present study is demonstrated, followed by presenting research question, aims and objectives of this thesis.

Chapter four outlines the justification for the methodology chosen for the present study and details the methods used throughout the research process. Approaches that have been used to ensure the research quality and ethical considerations for the data collection process are also provided in this chapter.

Chapter five presents details of recruitment and participant characteristics and outlines the themes of the present study findings.

Chapters six, seven, and eight detail the findings of the present study. Among the five senses, visual and tactile pathways were identified as ways to help older people connect with nature differently. The analysis showed that engaging multiple senses could improve opportunities for older people, especially those with sensory challenges, to connect with the natural world. The findings pointed

out several barriers that hindered non-visual experiences of nature, reducing older adults' connections to natural environments. They also discussed the temporal aspects involved in developing and sustaining sensory connections with nature. These included personal time qualities, such as the importance of slowing down and spending time in nature; nature's time, which related to the cycle of seasons; and life course trajectories, which involved past experiences and life changes that affected how older people engaged with nature.

Chapter nine, discussion and conclusion, demonstrates the contribution of the present study findings to the theoretical understanding of sensory engagement with nature. The strengths and weaknesses of the research process are reflected and reported. This chapter concludes by providing practical suggestions for stakeholders on intervention development directions and suggesting ideas for future research to develop sensory nature interventions and improve nature experience for different older populations.

Chapter 2 – Background to the study

2.1 An increase in population ageing

Ageing populations are a world-wide phenomenon. The proportion of people aged over 65 is estimated to rise from 9.3 per cent in 2020 to 16 per cent in 2050 (United Nations, 2020). That is, globally one in six people will be over 65 years old in 2050. This phenomenon will be more advanced in more developed countries due to a general increase in adult life expectancy (United Nations, 2019). In the United Kingdom (UK), Office for National Statistics (2017) projects that by 2030, 1 in 5 people will be 65 years or older (21.8%), of which 10 per cent will be aged 75 and over (ONS, 2017). The growth in the number of older people may bring some positive effects. For example, many economic opportunities arise in response to the needs of older people (Healy, 2004). Also, as they can provide care for children, labour participation may be compensated or promoted (United Nations, 2019). However, the cumulative burden of physical and mental health issues caused by an increasing ageing population have posed challenges for health and social care systems in the UK (Age UK, 2019).

2.2 Influence of ageing process on older people

In ageing, relationships exist between older people's physical and mental health (Steptoe, Deaton and Stone, 2015). Several studies have linked increased physical health problems in older people such as limited mobility and coronary heart disease to their depressive symptoms, negative emotions, and loss of meaning in life (Steptoe, Deaton and Stone, 2015; Lorem *et al.*, 2017; Aravena *et al.*, 2020); mental health problems (e.g., depression, social isolation, and loneliness) potentially leading to negative physical consequences of older people has also been recognised such as diabetes and frailty (Chapman and Perry, 2008; Gale, Westbury and Cooper, 2018).

Increasing social isolation and loneliness are common in the ageing process and related to adverse effects on the physical and mental health of older people

(Luanaigh and Lawlo, 2008; Toepoel, 2013; Gale, Westbury and Cooper, 2018; Smith and Victor, 2019; Cho *et al*., 2019). For example, Gale, Westbury and Cooper (2018) argue that social isolation and loneliness are associated with premature mortality and the decline of functional status in older people, and severe loneliness is a risk factor for increased physical frailty (Gale, Westbury and Cooper, 2018). Cho *et al*. (2019) note that subjective feelings of loneliness show a stronger correlation than objective deprivation of social isolation, although they both have been linked with poor sleep quality, depression or fatigue in older people. These symptoms are more severe when both are present together (Cho *et al*., 2019). Given the health problems they can cause, preventing and treating social isolation and loneliness are considered a high priority during ageing (Luanaigh and Lawlo, 2008; Toepoel, 2013; Gale, Westbury and Cooper, 2018; Smith and Victor, 2019; Cho *et al*., 2019).

Several interventions have been used to alleviate social isolation and loneliness in older people (Dickens *et al*., 2011; Cotterell, Buffel and Phillipson, 2018; Gardiner, Geldenhuys and Got, 2018; Poscia *et al*., 2018). Examples of these include (Dickens *et al*., 2011; Cotterell, Buffel and Phillipson, 2018; Gardiner, Geldenhuys and Got, 2018; Poscia *et al*., 2018):

- Friendship clubs and video networks (gathering people who may feel lonely to build social connections for reciprocity).
- Befriending (involving matching the pair of a person and a professional/a volunteer to form new friendships and facilitate social reconnection).
- Reminiscence group therapy (sharing personal memories to increase mutual understanding and build social connections).
- Cognitive and social support interventions (delivered by therapists or health professionals to reduce isolation and increase satisfaction with life).
- Pet therapy (involving interaction with animals to enhance social companionship).
- Gardening and internet training (seen as recreational activities to decrease loneliness and may offer intellectual stimulation).

In practice, these interventions are often delivered by voluntary and community sector organisations in order to maintain and promote the wellbeing of local residents.

2.2.1 Social prescribing

In the UK, Social Prescribing (SP) links people to community-based interventions to improve their physical, mental, and social wellbeing (Elston *et al.*, 2019; Drinkwater, Wildman and Moffatt, 2019; Hamilton-West, Milne and Hotham, 2020). The process of SP involves referring people to a navigator (known as a link worker/social prescriber) who assists in identifying personal needs and connecting individuals to sources of support. Various support sources are offered through voluntary and community sectors ranging from advice services to physical, social, and cognitive activities (Pescheny, Randhawa and Pappas, 2020; NHS England, 2022a). The navigator and support sources are usually provided for up to 12 weeks, aimed at building the confidence of individuals referred to address their needs. For example, for those referred due to loneliness, the support would focus on helping them feel capable of socialising and finding suitable places or facilities to do so (Foster *et al.*, 2021). SP is thought to have the potential to reduce isolation and promote the health and wellbeing of older people (Wigfield, Alden and Kispeter, 2015; Dayson *et al.*, 2016; Bertotti *et al.*, 2018; Husk, Lovell and Garside, 2018; Elston *et al.*, 2019; Hamilton-West, Milne and Hotham, 2020). Additionally, it can be beneficial for more cost-efficient use of social care resources in an ageing population (Elston *et al.*, 2019). Some evidence has indicated these benefits can be achieved through a number of non-medical interventions, including mental health and bereavement support, lunch clubs, exercise groups, and nature-based activities (Wigfield, Alden and Kispeter, 2015; Dayson *et al.*, 2016; Bertotti *et al.*, 2018; Husk, Lovell and Garside, 2018).

2.2.2 Green social prescribing

Engaging in nature has gained attention since the Covid-19 pandemic elevated the importance of being in outdoor environments to individuals' health (Fixsen and Barrett, 2022). The UK government and multiple partners announced funding

of more than £5.5 million for embedding nature-based activities in communities via Green Social Prescribing (GSP), where people were connected to the activities by referrals (UK Government, 2020). From 2021, the two-year GSP project was implemented in seven test and learn sites within England to expand and sustainably embed GSP into local communities. This initiative aimed to encourage people to be involved in nature, in order to promote their mental health and reduce health inequalities and demand for health services (UK Government, 2021; NHS England, 2022b). The scheme evaluation showed that a wide range of age groups received support through GSP to access nature-based activities, including those under 18, of working age, and older adults; Statistics indicated that participants across the test and learn sites experienced improvements in happiness, life satisfaction, a feeling of life worthwhile, and anxiety after engaging in the activities (Great Britain. Department for Environment, Food and Rural Affairs, 2024).

2.3 Nature interventions for older people

Nature interventions are a range of activities that include natural components, such as gardening, tree planting, floral arrangement, leaf printing, sound mapping, bird watching, and rambling in the outdoor environment (O'Brien, 2018; Gagliardi and Piccinini, 2019; Scott, Masser and Pachana, 2020). Such interventions can be active interaction with nature (e.g., farming) or passive exposure to nature (e.g., sitting in the garden) (Gonzalez and Kirkevold, 2014; Franco, Shanahan and Fuller, 2017; Gagliardi and Piccinini, 2019; Scott, Masser and Pachana, 2020). Nature interventions have been delivered to individuals, communities, and vulnerable groups in a variety of settings including public gardens, hospitals, nursing home, and woodlands (Chen and Ji, 2015; Bragg and Leck, 2017; O'Brien, 2018; Sia *et al.*, 2020). A number of studies have identified nature interventions are associated with the maintenance and/or improvement of older people's physical functional capacity (Han, Park and Ahn, 2018), cognitive function (Sia *et al.*, 2020), quality of life (Milligan, Gatrell and Bingley, 2004; Leaver and Wiseman, 2016), life satisfaction (Tse, 2010), emotion (Milligan, Gatrell and Bingley, 2004; Leaver and Wiseman, 2016), anxiety (Sia *et al.*, 2020), stress (Han, Park and Ahn, 2018),

depression (McCaffrey, Hanson and McCaffrey, 2010; Chen and Ji, 2015), and social isolation and networking (Milligan, Gatrell and Bingley, 2004; Tse, 2010; Chen and Ji, 2015; Leaver and Wiseman, 2016). As multiple impacts on physical, mental, and social aspects of wellbeing have been highlighted, the benefits of nature experiences for older people are believed to be synergistic and holistic (Newton, 2007).

Whilst engagement with nature may be a way to maintain or promote the wellbeing of older people, they may not have many opportunities to be outdoors, because of decreased physical and psychosocial capacity (Kono *et al*., 2004; Orr *et al*., 2016). Kono and colleagues (2004) noted that exposure to the outdoor environment was significantly reduced for older adults who moved from home to care settings (Kono *et al*., 2004). Spaltenstein *et al*. (2020) argue that varying degrees of physical and mental factors can lead to decreased frequency of going outdoors among community-dwelling older people. Therefore, they suggest that nature interventions should align with individual needs (Spaltenstein *et al*., 2020). However, rather than losing their enjoyment in nature, older people adapt to the conditions and connect to the natural environment in a number of new ways. An investigation by Butler and Cohen (2010) found that a 79-year-old woman living in the community used her own unique way to link with nature. She spent most of her day on a chair directed away from the windows due to physical limitations, which made it impossible to see the beautiful natural scenery outside through the windows. She set a mirror on the table to engage with the outdoor environment and enjoyed it via bird watching (Butler and Cohen, 2010). Given this, Orr *et al*. (2016) concluded that older people appeared to not only be keen on nature but have their own avenues to make contact with the natural environment (Orr *et al*., 2016). Likewise, research by Collins *et al*. (2020) demonstrates that experiencing nature can take many forms beyond just ‘going to outdoor environments’. They built the indoor sensory garden (the daily environment placed pot plants) and the simulated outdoor sensory garden (a canopy tent isolating the daily environment, with plants in pots and a window to see natural scenery) to explore the effects of engagement with nature on agitation and quality of life in older people with

dementia. During the interventions, four participants were asked to interact with specific plants using different senses, such as viewing yellow Chrysanthemum, touching Dracaena, smelling Rosemary, listening to the sound of crushing Simpson Elite Lettuce, and tasting Cilantro (Collins, 2019). Although both sensory gardens had a positive impact on the participants' agitation and quality of life, for half of them engaging with plants in the simulated outdoor setting was more effective in decreasing their agitated behaviours; a greater effect on promoting quality of life was found in the indoor sensory garden intervention (Collins *et al.*, 2020).

2.3.1 Sensory experiences in nature

Humans experience the natural world through five sensory pathways, comprising sight, hearing, smell, taste, and touch (Franco, Shanahan and Fuller, 2017). Evidence has suggested that older people receive wellbeing benefits from nature through these senses (Walker and Hiller, 2007; Butler and Cohen, 2010; Bengtsson and Carlsson, 2013; Wang and Glicksman, 2013; Orr *et al.*, 2016). For example, looking at the beauty of nature through windows is beneficial to quality of life (Butler and Cohen, 2010); listening to birdsong from the outdoors reduces a sense of loneliness (Walker and Hiller, 2007); recognising a flower scent related to the past from the surroundings of the nursing home gives a sense of being at home (Bengtsson and Carlsson, 2013); tasting own-grown food through horticultural activities brings a sense of pleasure and safety (Wang and Glicksman, 2013); touching plants and soil while gardening gives a feeling of oneness with nature (Orr *et al.*, 2016). For older people, it may be particularly important to understand how diverse sensory pathways serve as their connection to nature. This is because deterioration or impairments caused by ageing and disease in sensory organs (e.g., hearing loss and blindness) can reinforce their barriers to experiencing the outdoors and nature-based activities (Gibson *et al.*, 2007; Olsson *et al.*, 2013). Research on nature engagement for people with sensory impairments highlights both similarities and differences with those without such disabilities (Burns, Paterson and Watson, 2009; Chan, Shek and Agapito, 2022). A survey by Chan, Shek and Agapito (2022) revealed that hearing-

impaired visitors, using hearing aids, generally experienced similar sensory inputs, including sights, sounds, smells, tastes, and textures, in a wetland park as those without disabilities. Yet, a phenomenon of sensory compensation or substitution was observed, with tactile sensations playing a significant role in their sensory experiences compared to general visitors (Chan, Shek and Agapito, 2022). Burns, Paterson and Watson (2009) pointed out that for people with disabilities, outdoor participation was not solely for rehabilitation; like able-bodied individuals, outdoor activities were vital to their wellbeing (Burns, Paterson and Watson, 2009). Given the variety of ways people engage with nature, subjective assumptions about people with impairment and disability regarding their perspectives on engaging with nature, methods of participation, and potential wellbeing outcomes may not always reflect actual experiences. Challenging the assumption that engaging with nature through hand touch is essential, Macpherson (2009) found that for some visually impaired walkers, hand contact was neither necessary nor desirable. Instead, tactile information received through the feet aided navigation and terrain appreciation, enhancing the walking experience (Macpherson, 2009). Bell and Foley (2021) showed that even visually impaired individuals who strongly value experiencing non-human nature may be unable to engage meaningfully and feasibly at different life stages due to various factors (e.g., lack of facilities and support and psychological burdens). Therefore, caution should be exercised against over-idealising generalised notions of time and frequency of nature exposure as a route to wellbeing. Instead, more inclusive environments should be developed to foster a genuine wellbeing relationship between visually impaired individuals and nature (Bell and Foley, 2021). Burns, Paterson and Watson (2009) stressed the importance of making programmes accessible, that is, ensuring that programme and activity design enables people with diverse disabilities to fully participate in fulfilling outdoor recreational experiences, thereby promoting greater accessibility; this approach should be based on increasing understanding the nature experiences of specific disability groups and the perspectives of their organisations, rather than relying on subjective assumptions (Burns, Paterson and Watson, 2009). However, a review indicates that in the existing evidence, the sensory descriptions of nature

experience are mainly around visual aspects, and those experiences involving other senses are often ignored as ‘self-evident feelings' by older people and scholars (Orr *et al*., 2016).

In fact, humans connect to nature through multiple sensory channels (Franco, Shanahan and Fuller, 2017; Zhang *et al*., 2017; Bell, Hickman and Houghton, 2023). Corazon *et al*. (2019) found that people with mobility disability particularly valued physical and sensory engagement in green spaces, highlighting the importance of providing multi-sensory immersive nature experiences (Corazon *et al*., 2019). One study noted that while both being in nature and viewing a photo-simulated natural environment had an equal effect in relieving stress on participants experiencing stress and/or burnout, they were not satisfied with the lack of specific or overall sensory stimulation in the photo simulation (Kjellgren and Buhrkall, 2010). This result suggests that people may have their own ways of building a connection with nature, rather than relying on a single visual avenue. As recent reviews have highlighted, in order to outline the interdependence between our wellbeing and nature, it is necessary to develop a deeper understanding of which senses we use to obtain the benefits of nature (Franco, Shanahan and Fuller, 2017; Bell, Hickman and Houghton, 2023).

2.4 Definition of terms

This section will define some key terms and concepts which will be used throughout the thesis.

2.4.1 Older people

There are different concepts and measures to define the elderly population. The chronological age of 65 years or over is traditionally used to define older people (WHO, 2008). As the link between socioeconomic characteristics (e.g., health status and productivity) and older people is increasingly recognised, alternative definitions have been developed to provide appropriate insights into the phenomenon of population ageing in different contexts (United Nations, 2019). For example, the WHO has started categorising older people as reaching over

their median life expectancy at birth (WHO, 2015). The guidance by the Department of Health and Social Care in England argues that active and independent people who have completed their careers and/or child raising can be regarded as entering old age, which may range from those over the age of 50 to reaching retirement age (Great Britain. Department of Health and Social Care, 2001). The present study considers that social interventions delivered in community settings often include those people who are at an early old age to sustain their wellbeing and reduce morbidity. Older people in the present study refer to people aged 50 or older.

2.4.2 Nature

Nature is often viewed as separate from humans in many traditional definitions. For example, the Oxford English Dictionary defines nature as 'the phenomena of the physical world collectively; especially plants, animals, and other features and products of the earth itself, as opposed to humans and human creations' (*Oxford English Dictionary*, 2025). Nevertheless, Williams (2010) observed that most natural spaces accessible to us today are physical places that involve human contrivance, and he expanded on the definition of nature that has extensively interacted with human activities: nature is a complex combination of organic and inorganic matter arranged in countless ways; due to this diversity, not everyone experiences it in the same way at any given time or over a period (Williams, 2010, p. 13). In developing a measure of nature connection, Richardson *et al*. (2019) described nature as 'all different types of natural environment and the things that live in them' and regarded human-constructed spaces as part of nature, such as gardens, farmlands, and canals (Richardson *et al*., 2019). Similarly, it seems unlikely that people could be excluded from the exploration of this study, as nature-based interventions are activities organised by facilitators (see definition in Section 2.4.3), and the locations where these activities take place often include community spaces such as garden rooms and allotments. Based on these perspectives, the present study defines nature as including non-human elements, nature involving humans and their activities, and any materials that the study participants subjectively consider to provide a nature experience. The rationale

for this definition is to encompass as many elements of nature as perceived, thereby enabling a better understanding of how older people engage with nature through their senses.

2.4.3 Nature-based interventions

Nature-based interventions consisting of diverse nature-based activities are commonly used to encourage people to engage with nature. The present study defines nature-based interventions as activities that incorporate natural elements and are organised by voluntary and community sector organisations to improve wellbeing of local people (also known as nature-based wellbeing interventions in the present study).

2.4.4 Wellbeing

In the present study, wellbeing covers a wide range of aspects and includes any contributions that maintain or enhance older people's everyday comfort levels: from those aspects commonly used to assess people's wellbeing, including mental wellbeing, social wellbeing, physical wellbeing, spiritual wellbeing, personal circumstances, and activities and functioning (Linton, Dieppe and Medina-Lara, 2016), to more diverse and subtle dimensions, such as certainty/sense of control/security, learning/capability, inspiration/fulfilment of imagination, sense of place, identity/autonomy, and connectedness/belonging (Russell *et al.*, 2013). The present study employed the term 'comfort levels' instead of absolute positive or high-threshold descriptors such as 'happy' and 'prosperous' (*Oxford English Dictionary*, 2024). This choice aimed to broadly capture potential moments of wellbeing for older people in different contexts and to prevent over-idealising the benefits that nature experiences might bring to them under a variety of conditions.

2.4.5 Sense of touch

The sense of touch in the present study includes pressure and temperature processed by skin receptors, such as feeling the texture of a leaf and the warmth of the sun, and the broader 'haptic' sense. Haptic sensation extends beyond skin

contact to encompass aspects of kinaesthesia (the sense of movement), proprioception (the sense of bodily position), and the vestibular system (the sense of balance) (Paterson, 2009). These aspects are regarded as 'whole-body touch' with the environment (Bell, Hickman and Houghton, 2023).

2.5 Summary

As outlined in the background section, nature and outdoor activities have been encouraged in the UK since the Covid-19 pandemic. Through GSP, nature-based interventions are integrated into communities in order to improve people's wellbeing and relieve pressure on healthcare systems. Evidence indicates that these activities can benefit the holistic dimensions of wellbeing amongst older people. Senses (i.e., sight, hearing, smell, touch, and taste) are pathways older people use to connect with and benefit from nature. It is important to understand how they interact with nature through these sensory pathways, as age-related limitations (e.g., mobility problems and sensory deterioration) may particularly challenge their continued engagement with the natural environment. However, few studies have focused on sensory interaction with nature beyond the visual pathway in older people. The present study therefore explores older people's experiences of nature across all sensory pathways, with the aim of optimising their engagement with nature in nature-based interventions.

Chapter 3 – Literature review, aims and objectives

3.1 Background to the literature review

The importance of connection with nature in the lives of older people is growing as evidence mounts about the relationship between nature experiences and wellbeing in older people (Wright and Lund, 2000; Wu *et al*., 2015; Orr *et al*., 2016; Gagliardi and Piccinini, 2019). There are two main ways for people to experience the natural environment and derive benefits from it (Milligan, Gatrell and Bingley, 2004; Freeman *et al*., 2019). Milligan, Gatrell and Bingley (2004), drawing on a reading of Palka (1999), indicate that these benefits can be gained through physical participation (e.g., simply being in the environment) and sensory experiences in nature. Although the two ways are interrelated, sensory experiences are thought to create deeper connections with nature and therefore are particularly important for people to receive its benefits (Milligan, Gatrell and Bingley, 2004; Freeman *et al*., 2019). Some sensory nature experiences have been identified in several studies and demonstrated the contribution of sensory engagement with nature to participants' wellbeing (Milligan, Gatrell and Bingley, 2004; Kjellgren and Buhrkall, 2010). Kjellgren and Buhrkall (2010) indicated a feeling of enjoyment evoked by floral scents and a sense of tranquillity perceived from natural sounds, smells, and light, which facilitates restoration for participants with stress and burnout syndrome (Kjellgren and Buhrkall, 2010). Similarly, Milligan, Gatrell and Bingley (2004) described that older people valued sensory interaction with nature in domestic gardens, such as observing flower colours, listening to birdsong and smelling scents of wood. Sensory experiences were an important environmental factor that contributed to facilitating relaxing and restorative effects in older people's domestic gardens (Milligan, Gatrell and Bingley, 2004).

Yet despite the significance of sensory experiences in establishing nature connection and its attendant wellbeing benefits, existing reviews have primarily examined the benefits of nature-based activities and natural spaces for older

adults (Wang and MacMillan, 2013; Gagliardi and Piccinini, 2019; Magnussen, Alteren and Bondas, 2021; Wang *et al*., 2022); and only Orr *et al*. (2016) have synthesised how older people's sensory engagement with outdoor nature is attended to across qualitative research evidence (Orr *et al*., 2016). The current review thus aims to explore what sensory engagement has served to develop a positive connection with nature for older people in existing empirical studies, covering different research designs and not limited to experiences that occur outdoors. In addition, Orr and colleagues focused specifically on the sensory narratives of each selected study in their review (although some of their findings were not as relevant to sensory descriptions) and found that the authors of their included studies did not further report much on sensory experiences beyond vision (Orr *et al*., 2016). With this in mind, besides sensory-related findings, the current review also seeks to synthesise main findings from the existing evidence in order to better understand the role of sensory engagement in the nature connection literature.

3.2 Search strategy

The search strategy was developed by the researcher and discussed with the supervisory team. The development of search terms came from the core words of the current review topic: 'nature connection', 'sensory experiences', 'health and wellbeing', and 'older people' and the researcher further developed the synonym for these words. Specific terms for nature-based activities that might be relevant to the current review topic were also considered (e.g., sensory garden and horticulture therapy), with the aim of searching a broad range of literature on nature connection. Subject headings identified in each database were included to optimise the balance of search sensitivity and specificity. The final search terms were checked with an information specialist.

The search terms were combined with Boolean operators OR and AND, and performed in the following databases: MEDLINE (Ovid), PsycInfo (Ovid), CINAHL (EBSCO), Cochrane Library, Web of Science, ASSIA (ProQuest), Scopus, Social Care Online, GreenFILE (EBSCO). Database search fields are limited to the concepts of title, abstract and keywords, depending on the available search fields

provided by each database; for example, searching for the title, abstract and key concepts of an article in PsycInfo and the title and abstract of that in CINAHL. Since combining sensory-related search terms with the AND Boolean operator resulted in a large reduction in retrieved records, these terms were only used in Web of Science and ASSIA. Duplicate search results were removed using the automated tool Deduklick and manual checking. The search terms and combinations were summarised in Appendix 1.

The following inclusion criteria were applied to title and abstract screening:

- Studies were written in English and published in a peer-reviewed journal between January 2013 to December 2022.
- Studies used empirical evidence.
- Study participants had nature experiences (those studies that the researcher could not confirm whether participants actually engaged with nature were excluded.)
- Studies involved health and wellbeing effects.
- Study findings were specific to older people.
- Research was conducted in the community.

Studies potentially meeting the above criteria were retrieved full text and further screened by the researcher. Full-text articles were added to Mendeley. A series of sensory terms was used to sub-search, in order to identify articles including content relevant to older people's sensory experiences of nature. All sub-searches were conducted by the search function in Mendeley. Studies that did not involve sensory experiences or lacked independently sensory-related findings were further excluded. The sensory terms used in this phase of screening are as follows:

- Sensory, multisensory, senses
- Visual, sight, view, see, watch, look, vision, photo, image, video
- Auditory, sound, sonic, audio, song, listen, hear, noise, silence, quiet

- Olfactory, smell, odour/odor, scent, fragrance, aroma, perfume, fresh/pure air, air pollution
- Haptic, touch, tactile, tactility, texture, textural, embody, somatic, skin
- Gustatory, taste, drink, flavour/flavor, food, intake, eat, consume

3.3 Data extraction and synthesis

The researcher first extracted the sensory-related findings of an article to ensure that studies had sufficient sensory descriptions and were relevant to health and wellbeing effects, and then extracted information on year of publication, study aims, methods, population, location, intervention or experiences and main findings. Data synthesis was undertaken by repeatedly reading extracted data (and included articles where necessary if not clear from the extracted information). Findings from this synthesis process were integrated into themes.

3.4 Results

The initial searches of the nine databases identified 2349 potentially relevant articles (See Table 1 for the number of records retrieved from each database), of which 1993 remained after deduplication. Screening of title and abstract following the inclusion criteria resulted in the exclusion of a further 1805 articles, leaving 188 potentially eligible studies for which full texts were sought. A total of 167 articles were excluded after full texts were examined. The reasons for exclusion included not nature interventions (n=59), not empirical studies (n=8), findings not specific to older people (n=44), no health-related outcome targeted (n=3), no sensory experiences involved (n=24), lack of independently sensory-related findings (n=8), and research not performed in the community (n=21). Ultimately, twenty-one articles met the inclusion criteria and were included in the current review (See Figure 1 for screening process; the template of flow diagram from Page *et al*. (2021)). The researcher then read and extracted the information from these included studies. The summary of extracted findings can be seen in Table 2.

Table 1 Retrieved records from database searching

Databases	Results retrieved
MEDLINE (Ovid)	190
PsycInfo (Ovid)	36
CINAHL (EBSCO)	370
Cochrane Library	523
Web of Science	191
ASSIA (ProQuest)	966
Scopus	0
Social Care Online	65
GreenFILE (EBSCO)	8

Note: CINAHL= Cumulative Index to Nursing and Allied Health Literature; ASSIA= Applied Social Sciences Index and Abstracts

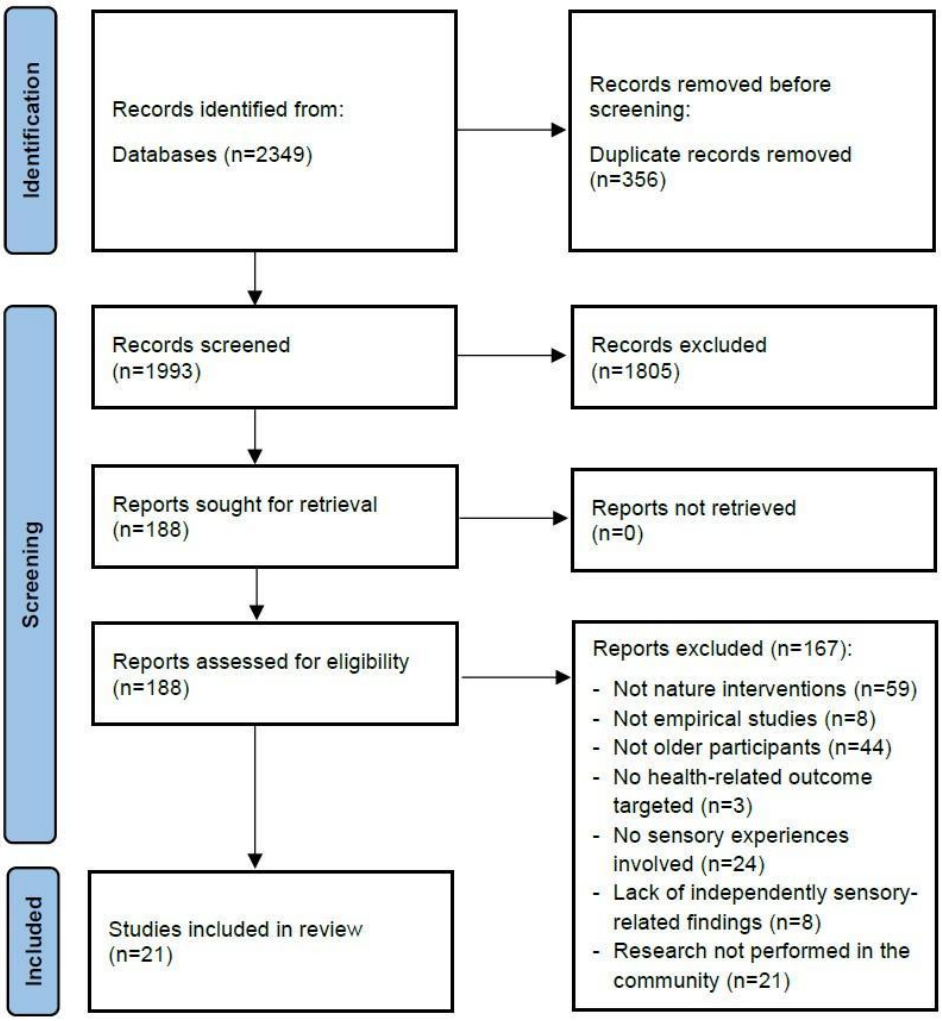


Figure 1 Study selection process

Table 2 Extraction table

Author (Year)	Study aim	Methods	Location/ population	Interventions/ experiences	Sensory-related findings	Main findings
Olsson *et al*. (2013)	To explore the perspectives of people with early-stage dementia on being outdoors.	Qualitative/repeated individual interviews	Sweden/11 community dwellers living with early-stage dementia (52-81 years)	Experiences in outdoor activities	The sensory experiences of being outdoors contributed to a sense of still being able to do something as before and wellbeing for participants.	Being able to engage in outdoor activities independently contributes to the wellbeing and self-worth of people with early-stage dementia.
Boyes (2013)	To explore the ways and integrative benefits of older people engaging in outdoor adventure activities.	Mixed-methods, sequential, exploratory study/semi-structured interviews and a survey	New Zealand/Interviews: 6 community-programme members (63-80 years) and a programme director; Survey: 80 community-programme members (54-83 years)	Experiences in outdoor adventure activities	Multisensory engagement with nature and social, physical, and psychological benefits were found during outdoor adventure activities, but the relationship between sensory experiences and these wellbeing benefits remains unknown.	The benefits of participating in outdoor adventure activities involve physical, social and psychological aspects. Environmental, social, and emotional engagement are more important than the experience of risk and uncertainty in the activities for the older cohort.
Wang and Glicksman (2013)	To explore the benefit of participating in the gardening programme for older people living in low-income housing.	Qualitative/focus groups	USA/20 low-income housing residents (mean age: 71.5)	Growing fruits and vegetables of community gardens	Tasting own grown fruits and vegetables evoked enjoyment and security. Watching fruits and vegetables grow connected participants with living things and made them feel useful. Soil smell evoked a positive feeling.	Benefits of engaging in the gardening programme include promoting physical and mental health, obtaining produce, connecting with the past, living things and others, learning new knowledge, avoiding boredom, and appreciating beauty of nature.

Author (Year)	Study aim	Methods	Location/ population	Interventions/ experiences	Sensory-related findings	Main findings
Dzhambov and Dimitrova (2014)	To examine if awareness of nature experiences is a modifier of the beneficial effects of older people visiting urban green spaces.	Quantitative/questionnaires	Bulgaria/97 older citizens (53-90 years)	Visiting an urban park	The sensory stimulation of birdsong was a predictor of health anxiety: the stronger 'appreciation of bird songs', the lower health anxiety.	'Awareness of nature experiences' is a significant modifier of the beneficial impact of urban green spaces on health anxiety. Actual interaction with urban nature is a key predictor of health anxiety than other confounding factors.
Pleson *et al*. (2014)	To understand usage and perspectives of public park users in a different context to support worldwide active living and participation in physical activity in green spaces for older adults.	Mixed methods, exploratory study/ structured observation and video interviews	Taiwan/Observation: 755 older park users (age 60 and over) and 476 other age group users; Interviews: 19 older park users (age around 60 and older)	Visiting public parks	A desire for fresh air drove a participant to do health-promoting activities in the community green space.	Structured/unstructured activities and strength-training equipment in green spaces are beneficial for the social relationships and physical activity of older park users. Green spaces near residences are important to increase the willingness to use the spaces.
Jonsén, Norberg and Lundman (2015)	To understand the meaning of life for the oldest older adults living in rural northern Sweden.	Qualitative, exploratory, interpretative study/unstructured interviews	Sweden/10 rural dwellers (85-95 years)	Experiences of sense of meaning in life.	Memories of picking berries to provide family food and connecting with nature through the view of windows gave participants a sense of meaning in life.	Meaning in life is usually perceived by memories of life stages and associated with having a mission to be performed. This feeling is achieved through finding beauty and happiness, passing on traditions across generations, and believing in being looked after by faith.

Author (Year)	Study aim	Methods	Location/ population	Interventions/ experiences	Sensory-related findings	Main findings
Coleman and Kearns (2015)	To explore the impact of the island's blue spaces on experiences of place, ageing, and wellbeing in older people.	Qualitative, phenomenological, case study/in-depth interviews, participatory photo-elicitation and associated written journals	New Zealand/11 community dwellers (65-94 years)	Blue space experiences on an island	Watching and listening to the sea helped forget the unpleasant past and focus on the positive experiences of the present. Viewing blue space alongside green space connected participants to the outside world and was a source of daily pleasure and satisfaction.	The blue space of the island is seen as a resource to help maintain the wellbeing of older people's independent lives by providing daily amusement and helping them deal with challenging emotions.
Scott, Masser and Pachana (2015)	To explore the benefits of connecting with nature through home gardens and the impact of ageing on gardening activities.	Mixed methods/online and mailed surveys	Australia/331 gardeners (60-90 years)	Gardening activities	Seeing their own plants grow felt pleasure, meaningful and satisfaction. Tasting homegrown, chemical-free fruits and vegetables provided health benefits. Touching soil evoked a sense of pleasure. Listening to birdsong improved a participant's mood.	Appreciation of the beauty of gardens, connection to nature, sense of accomplishment, and physical and mental activity are the reasons to continue pursuing gardening as participants age. Strategies are developed to overcome physical limitations and maintain gardening activities. Gardening can provide physical, psychological and practical benefits to older gardeners.

Author (Year)	Study aim	Methods	Location/ population	Interventions/ experiences	Sensory-related findings	Main findings
Leaver and Wiseman (2016)	To explore the experiences of visiting other people's gardens and learn about the possibility of making it a hobby in later life.	Qualitative, phenomenological study/Semi-structured individual and group interviews	UK/7 community dwellers (60-81 years)	Visiting domestic gardens which owners open to the public	The sensory engagement of seeing, hearing, smelling, and touching was an embodied sense of well-being. Seeing the plants grow evoked a feeling of pleasure and pride. Watching the growth of plants shared by other gardeners in your own garden built community connections.	Garden visiting as a hobby in later life can establish a meaningful connection with nature and between gardeners. This contributes to individual wellbeing and community bonds.
Strout *et al*. (2017)	To evaluate the feasibility of growing vegetables utilising raised beds for older people in low-income housing and the impact on their health and cognition.	Mixed methods/photos, weekly feedback, a focus group, questionnaires	USA/10 senior housing residents (67-89.5 years)	Growing leafy green vegetables in a raised bed	Eating own grown vegetables derived enjoyment and increased participants' diverse intake and consumption of vegetables. Watching vegetables grow evoked a participant's positive feelings.	With equipment and guidance, participants can grow vegetables themselves and feel the process is enjoyable and meaningful. A positive improvement in social interactions, cognition, and self-reported nutrition and health status is found.

Author (Year)	Study aim	Methods	Location/ population	Interventions/ experiences	Sensory-related findings	Main findings
Finlay (2018)	To explore the impact of snow and ice on older people's perceived wellbeing.	Qualitative, case study/semi-structured interviews and observation	USA/Interviews: 125 community dwellers (55–92 years); Observation: 6 community dwellers (66-78 years)	Everyday experiences of white space	Participants derived enjoyment and satisfaction from viewing white space by windows. A desire to breathe fresh air outside led a participant to overcome mobility limitations during a snowy winter.	White spaces can both improve and reduce older people's physical, mental, and social wellbeing. Whether white space is a therapeutic landscape may depend on the individual and context.
Cassarino, Tuohy and Setti (2019)	To test the effects of nature exposure on attention restoration among older people.	Quantitative, experimental study/a computer-based task	Ireland/75 older community dwellers (60-95 years) and 21 university students (mean age: 21.48)	Viewing images of natural or urban environments on the computer screen	Viewing natural and urban environmental images had no significant and differential effects on older participants' attention.	No effects of environmental exposure on attention restoration are found in older adults.
Robbins and Seibel (2020)	To explore the impact of gardening on the temporal dimension of wellbeing amongst older African Americans in Detroit.	Qualitative, ethnographic study/semi-structured interviews and observation	USA/27 community dwellers (51-89 years)	Experiences of meaningful changes in gardening practices over time	The colours of plants were used to represent a continuous connection with a deceased loved one. Touching plants aroused the interest of youth in gardening and facilitated communication between the generations.	Gardening promotes connections to the past by linking it to deceased loved ones and the future by encouraging interactions with younger generations and the community.

Author (Year)	Study aim	Methods	Location/ population	Interventions/ experiences	Sensory-related findings	Main findings
Irvine *et al*. (2020)	To investigate the feasibility of incorporating the activity tracking technology and self-rated health and wellbeing measure into the group outdoor health walking programme.	Mixed methods, feasibility study/questionnaires, step counts, in-depth interviews, and verbal/written feedback	UK/13 community dwellers (63-81 years) and stakeholders	Group outdoor health walk	Getting fresh air in the outdoor environment helped a participant sleep better, have more positive emotions, and feel energetic.	Activity trackers encourage older walkers to engage with the programme but complicate its delivery. Following the intervention, participants meet the standard of physical activity and report improvement in physical, cognitive, emotional and spiritual wellbeing.
Odzakovic *et al*. (2020)	To understand the meaning of neighbourhood living experiences for people with dementia.	Qualitative, phenomenological study/walking interviews	Sweden/14 community dwellers with dementia (62-87 years)	Lived experiences of neighbourhood	Hearing nature (e.g., wind) and seeing wildlife and the colour change of leaves under different weather conditions improved the participants' wellbeing.	The neighbourhood provides a sense of attachment and freedom of movement for people with dementia. Daily neighbourhood walks sustain social relations and a restorative connection with nature.
van Heezik *et al*. (2020)	To examine factors associated with variation in nature engagement among older people in different residences and the quality of adjacent spaces where the engagement may occur.	Mixed methods/photo taking, semi-structured interviews and questionnaires	New Zealand/72 older adults living in the community or care setting (66-99 years)	Experiences in engagement with nature	Participants enjoyed looking at nature through window views, especially those who lived in family homes and had the views with a high proportion of green and water. Loss of window views had a negative effect on some participants who moved into downsized accommodations.	Participants feel sadness, frustration, and anger because of reduced nature engagement as they age. Living in downsized and rest homes, where gardens have less variability, may result in lower quality nature experience.

Author (Year)	Study aim	Methods	Location/ population	Interventions/ experiences	Sensory-related findings	Main findings
Milligan *et al*. (2021)	To understand the mechanism by which nature affects the perceived wellbeing of people in later life through nature-adventure activities.	Qualitative, exploratory study/semi-structured interviews	UK/12 community dwellers (52-75 years)	Experiences in nature-adventure activities	Sensory stimuli provided by wild space can keep participants away from the stress and anxiety of everyday lives. It seemed to help them approach problems with new perspectives and detachment.	Preferred level of engagement with activities (e.g., security/risk and passive/active), sensory stimuli of wilderness, and individuals' contexts shape the wellbeing impact of nature adventure activity in later life.
Ness and Munkejord (2021)	To explore the perceived wellbeing of older South Sámi adults with a reindeer-herding background.	Qualitative/photovoice, in-depth interviews	Norway/11 South Sámi people (67-84 years)	Experiences about situations, things and persons that perceived wellbeing	Connecting with nature through window views and looking at photos that evoke the memories of being in nature created a sense of wellbeing. The same reindeer sound as in childhood created intense wellbeing. Watching reindeer and tasting reindeer meat benefited participants' wellbeing. Not being able to eat reindeer meat in a care setting was thought to have adverse wellbeing effects.	A sense of wellbeing is found in the experiences of participants connecting with nature, reindeer and family. For promoting individual wellbeing, it is important to consider care receivers' life stories and perspectives of wellbeing.

Author (Year)	Study aim	Methods	Location/ population	Interventions/ experiences	Sensory-related findings	Main findings
Dendle *et al*. (2022)	To explore the significance of pets and wildlife to the everyday lives of older Australians.	Qualitative/online focus groups and typed posts	Australia/103 community dwellers (50-92 years)	Lived experiences of interacting with pets and wildlife	Connection to everyday wildlife and nature by vision and audition increased the quality of life and a sense of belonging.	Developing relationships with pets and wildlife contributes to older adults' wellbeing and life quality. Given the concerns about the cost and commitment of owning a pet expressed, helping them connect with wildlife may be a way to improve their wellbeing.
Ahnesjö, Karlsson and Bergman (2022)	To test the effects of exposure to different natural environments on heart rate and power output during physical activity in older people.	Quantitative, randomized crossover study/a questionnaire, heart rate and power output	Sweden/48 community dwellers (female/male mean age: 70.4/70.7)	Exposure to indoor, simulated outdoor, and outdoor natural environments	The simulated outdoor environment (using visual and auditory simulations) might be too artificial. As a result, participants felt confused and psychologically stressed, which increased their heart rate.	No significant effects are found on the outcomes of heart rate or power output in three different environments.
Lee *et al*. (2022)	To explore what bird characteristics are meaningful to older people and evaluate the psychosocial impact of Bird Tales programme on older people living in residential care.	Mixed methods/focus groups, individual interviews and questionnaires	USA/Focus group: 30 community dwellers (mean age: 68.7) Bird Tales programme: 11 assisted living residents (mean age: 80.5)	Focus group: perceptions and experiences of nature and birds Bird Tales programme: Indoor-based nature activities using birds	Multi-sensory attributes of sound and sight of birds contributed to a positive mood, enjoyment, and a sense of strength.	Multisensory, spiritual, and therapeutic aspects of birds are meaningful to older people. The project promotes positive experiences for them in residential care facilities by cognitively stimulating activities, connections to others and the past, and positive views of birds and nature.

3.4.1 Study characteristics

Of the 21 included studies, six reported on outdoor activities (Olsson *et al*., 2013; Boyes, 2013; Dzhambov and Dimitrova, 2014; Pleson *et al*., 2014; Irvine *et al*., 2020; Milligan *et al*., 2021); five studies were activities involving gardening (Wang and Glicksman, 2013; Scott, Masser and Pachana, 2015; Leaver and Wiseman, 2016; Strout *et al*., 2017; Robbins and Seibel, 2020); two studies were lab-based nature interventions (Cassarino, Tuohy and Setti, 2019; Ahnesjö, Karlsson and Bergman, 2022); three studies were experiences of engagement with natural spaces (Coleman and Kearns, 2015; Finlay, 2018; van Heezik *et al*., 2020); one study reported on community-dwelling older adults' experiences with natural elements and indoor-based nature activities with older people living in residential care (Lee *et al*., 2022); and the remaining four studies did not initially aim to explore nature experiences, but rather found nature-related findings from older people's lived experiences (Jonsén, Norberg and Lundman, 2015; Odzakovic *et al*., 2020; Ness and Munkejord, 2021; Dendle *et al*., 2022).

Eleven of the studies used qualitative approaches (Olsson *et al*., 2013; Wang and Glicksman, 2013; Jonsén, Norberg and Lundman, 2015; Coleman and Kearns, 2015; Leaver and Wiseman, 2016; Finlay, 2018; Robbins and Seibel, 2020; Odzakovic *et al*., 2020; Milligan *et al*., 2021; Ness and Munkejord, 2021; Dendle *et al*., 2022), three studies adopted quantitative approaches (Dzhambov and Dimitrova, 2014; Cassarino, Tuohy and Setti, 2019; Ahnesjö, Karlsson and Bergman, 2022), and seven studies employed mixed methods (Boyes, 2013; Pleson *et al*., 2014; Scott, Masser and Pachana, 2015; Strout *et al*., 2017; Irvine *et al*., 2020; van Heezik *et al*., 2020; Lee *et al*., 2022). Of the 21 studies, two were carried out in Australia (Scott, Masser and Pachana, 2015; Dendle *et al*., 2022), one in Bulgaria (Dzhambov and Dimitrova, 2014), one in Ireland (Cassarino, Tuohy and Setti, 2019), three in New Zealand (Boyes, 2013; Coleman and Kearns, 2015; van Heezik *et al*., 2020), one in Norway (Ness and Munkejord, 2021), four in Sweden (Olsson *et al*., 2013; Jonsén, Norberg and Lundman, 2015; Odzakovic *et al*., 2020; Ahnesjö, Karlsson and Bergman, 2022), one in Taiwan (Pleson *et al*., 2014), three in the UK (Leaver and Wiseman, 2016; Irvine *et al*., 2020; Milligan *et al*., 2021), and five in the United States (Wang and Glicksman, 2013; Strout *et al*., 2017; Finlay, 2018; Lee *et al*., 2022; Robbins and Seibel, 2020). Most of the studies reported only on older populations

living in the community, and two studies included older people living in the community and residential care (van Heezik *et al.*, 2020; Lee *et al.*, 2022). Two of the studies focused on community-dwelling older people diagnosed with dementia (Olsson *et al.*, 2013; Odzakovic *et al.*, 2020).

3.4.2 Narrative synthesis

The following themes were identified through data synthesis:

- Health and wellbeing benefits received through nature connection
  - *Multiple benefits of being in nature for older people*
  - *Factors influencing perceived benefits*
- Barriers to connecting with nature
- Sensory connection with nature
  - *Connecting with nature through the five sensory pathways*
  - *Understudied sensory engagement*

3.4.2.1 Health and wellbeing benefits received through nature connection

Multiple benefits of being in nature for older people

The included studies outlined below illustrate that connection with nature contributes to physical, psychological, social and cognitive benefits for older people (Olsson *et al.*, 2013; Boyes, 2013; Wang and Glicksman, 2013; Dzhambov and Dimitrova, 2014; Pleson *et al.*, 2014; Coleman and Kearns, 2015; Scott, Masser and Pachana, 2015; Leaver and Wiseman, 2016; Strout *et al.*, 2017; Irvine *et al.*, 2020; Robbins and Seibel, 2020). In many of these studies, benefits are obtained by doing varying levels of physical activity in outdoor environments. Olsson *et al* (2013) explored the perspectives of being outdoors among people with early-stage dementia through conducting two repeated interviews with each participant. Continuing to participate in outdoor activities was beneficial for maintaining participants' perceived self-worth and social interaction with others (Olsson *et al*, 2013). A study by Boyes (2013) used interviews and a survey to explore the experiences and benefits of older adults in an outdoor adventure community programme. The results showed that nature, social, and emotional engagement within

adventure activities were more important for the participants, rather than experiencing risk and uncertainty. Such mild adventures improved participants' physical, social, and psychological wellbeing (Boyes, 2013). Various data were used to investigate the feasibility of incorporating a physical activity tracking device and self-rating scale in an outdoor group walking programme (Irvine *et al*., 2020). After 12 weeks, all participants met the British physical activity guideline and reported positive changes in sleep, energy, attention, emotion, and spirit (Irvine *et al*., 2020). A survey by Dzhambov and Dimitrova (2014) indicated 'awareness of nature experiences' was an important modifier of the positive effect of visiting an urban park on health anxiety in older users; actual interaction with nature through sensory stimulation had a better predictive effect on health anxiety (Dzhambov and Dimitrova, 2014). An exploratory study aimed at advocating the global active participation of green space among older people, investigating urban park users' usage and views in Taiwan, as a different context from North America and the United Kingdom (Pleson *et al*., 2014). By short-structured interviews and an observational survey, engaging in structured and unstructured activities (e.g., dance classes and rambling) and physical training equipment in the urban parks were found to promote users' social relationships and physical activity (Pleson *et al*., 2014). Positive associations between various gardening activities and older adults' benefits have been shown in several studies (Wang and Glicksman, 2013; Scott, Masser and Pachana, 2015; Leaver and Wiseman, 2016; Strout *et al*., 2017; Robbins and Seibel, 2020). Leaver and Wiseman (2016) conducted qualitative interviews to understand the experiences of visiting other people's home gardens as a leisure activity. The findings highlighted that through sharing lives and garden designs and objects during garden visits, both participants and the community developed meaningful social relationships (Leaver and Wiseman, 2016). Similarly, a qualitative study by Robbins and Seibel (2020) featured meaningful social connections established in gardening practices. This paper used interviews and observation to explore the influence of gardening experiences on older African Americans' wellbeing in the Detroit context; Gardening is thought to maintain bonds with deceased loved ones through its practices and symbolic plants and facilitate interactions with youth within the family and community. While this study was limited to specific background, the insight from the findings suggests that gardening practices can contribute to the wellbeing of older people in a way that maintained intergenerational

relationships (Robbins and Seibel, 2020). With concern for health inequalities, Wang and Glicksman (2013) and Strout *et al*. (2017) evaluated the benefits of implementing gardening programmes for older people living in low-income housing, using focus groups and mixed methods data collection respectively. These results reported that the benefits of engaging in gardening activities included physical (e.g., self-reported nutrition), psychological (e.g., enjoyment and avoiding boredom), social (e.g., interaction with others), and cognitive (e.g., learning new knowledge) improvements (Wang and Glicksman, 2013; Strout *et al*., 2017). Scott and colleagues carried out a mixed-methods study to investigate domestic gardens in association with older gardeners' health and wellbeing via a survey consisting of closed-and open-ended questions. Most perceived benefits related to physical and psychological aspects, such as maintaining physical activity and giving a feeling of achievement (Scott, Masser and Pachana, 2015).

In addition to being in touch with nature outdoors (Olsson *et al*., 2013; Boyes, 2013; Wang and Glicksman, 2013; Dzhambov and Dimitrova, 2014; Pleson *et al*., 2014; Scott, Masser and Pachana, 2015; Leaver and Wiseman, 2016; Strout *et al*., 2017; Irvine *et al*., 2020; Robbins and Seibel, 2020), there are also positive effects of indoor nature connection. Coleman and Kearns (2015) examined the impact of island blue space (sea and sky) on the ageing-in-place and wellbeing of older people through a variety of qualitative data (i.e., interviews, photos and journals); Connecting surrounding blue space from home provided daily entertainment for participants and helped relieve their emotions due to ageing and unresolved issues from the past. Nonetheless, it is important to note that these benefits of indoor nature engagement were generated in a cohort of older community dwellers with relatively advanced age and restricted mobility (Coleman and Kearns, 2015).

A number of included articles emphasised the impact of nature connection on the psychological and social wellbeing of older adults (Jonsén, Norberg and Lundman, 2015; Odzakovic *et al*., 2020; Dendle *et al*., 2022). Jonsén, Norberg and Lundman (2015) interviewed the oldest older people (85-95 years) in a rural area to learn about experiences that gave them a feeling of meaning in life. Early memories related to nature and the appreciation of nature at the present were found to bring them meaning in life

(Jonsén, Norberg and Lundman, 2015). Odzakovic and colleagues explored neighbourhood lived experiences through walking interviews with the intention of understanding the advantages of ageing-in-place for older people with dementia. Being connected to nature was seen by participants as a constitutive element of their daily walks and had restorative power (Odzakovic *et al.*, 2020). In Australia, a study using online focus groups examined older adults' everyday experiences regarding interacting with pets and wildlife. This paper indicated that interacting with local Australian wildlife seemed conducive to a sense of belonging and quality of life, without the burden of cost and commitment under ownership (Dendle *et al.*, 2022). These qualitative findings drawn from a broad exploration of lived experiences not only suggest the importance of nature in later life, but also imply nature connection may primarily contribute to the psychological and social wellbeing of older people.

Factors influencing perceived benefits

Individual contexts, preferences, and perspectives of wellbeing can be underlying factors influencing older people's perceived benefits of connecting with nature (Finlay, 2018; Milligan *et al.*, 2021; Ness and Munkejord, 2021). According to Finlay's interviews and observation, the influence of white space (i.e., snow and ice) on older people's perceived wellbeing depended largely on the individual and the context. Although white landscapes could provide enjoyment and satisfaction, promote physical activity and create unique social connections such as shovelling snow for others, participants were likely to experience fear of falling and frustration and isolation from movement restrictions. Thus, white space might have both healing and detrimental effects on older people (Finlay, 2018). A photovoice study by Ness and Munkejord (2021) indicated that experiences in relation to connecting with nature, reindeer, and family induced a sense of wellbeing in older Sami people with a herding background. These wellbeing experiences were found to operate across memories over the life course, current situations, and life changes in ageing. For example, one participant felt that the same reindeer sounds from childhood produced a strong sense of wellbeing as life changed over time; based on having reindeer meat as a source of perceived wellbeing, participants believed eating unfamiliar foods due to a future move to a care facility might decrease their wellbeing. As such, Ness and Munkejord suggest that healthcare service

delivery should be informed by care receivers' life stories and perceptions of wellbeing (Ness and Munkejord, 2021). Milligan *et al*. (2021) conducted qualitative interviews, aimed at outlining how therapeutic landscapes contribute to the perceived wellbeing of people in later life. While the interpretation of the findings was limited to specific groups with access to nature adventure activities in the wilderness, the authors suggested that therapeutic effects were formed by various factors. Examples of these factors included individual contexts, preferred environmental qualities, and preference for engagement levels (e.g., preferring an activity to be safer or riskier and more active or passive engagement in an activity). Among the factors, sensory stimulation provided by the wilderness environment connected to each factor and therefore the environment was seen as an integral part of constituting participants' wellbeing (Milligan *et al*., 2021).

However, some limitations and issues with the above studies should be noted. In some studies, understanding their findings requires considering the context of study participants with notable gender imbalance and specific socioeconomic backgrounds (e.g., middle-class backgrounds) (Boyes, 2013; Leaver and Wiseman, 2016; Milligan *et al*., 2021). A limitation of some studies is that their participants seem to be a group of people who are already interested in nature engagement, so they may respond more positively to nature-based activities in which they participate (e.g., Wang and Glicksman (2013), Scott, Masser and Pachana (2015), Leaver and Wiseman, 2016, and Milligan *et al*., 2021). Many qualitative or the qualitative parts of mixed methods studies lack analytic transparency in the process of theme generation (Olsson *et al*., 2013; Boyes, 2013; Wang and Glicksman, 2013; Jonsén, Norberg and Lundman, 2015; Coleman and Kearns, 2015; Leaver and Wiseman, 2016; Strout *et al*., 2017; Finlay, 2018; Robbins and Seibel, 2020; Irvine *et al*., 2020; Milligan *et al*., 2021; Ness and Munkejord, 2021; Dendle *et al*., 2022); only Odzakovic *et al*. (2020) provide a relatively detailed analysis procedure. One study by Scott, Masser and Pachana (2015) claimed that they used a grounded theory approach. However, the authors described their emerging themes as being 'automatically generated' by the Leximancer software (Scott, Masser and Pachana, 2015). This is not compatible with the theoretical framework of grounded theory. Positive effects of nature connection suggested by Dzhambov and Dimitrova (2014) and Irvine *et al*. (2020) may need to be further examined due to the insufficient validity of

measurement tools (Dzhambov and Dimitrova, 2014; Irvine *et al*., 2020). In Dzhambov and Dimitrova (2014), the vague definition of the concept 'awareness of nature experiences' leads to unclear whether older people's attitudes toward nature relate to the psychological effect of their participation in nature. Irvine *et al* (2020) suggest that participants meet the UK physical activity guidelines after a 12-week outdoor walking intervention. Nevertheless, it is not possible to determine from the paper how the study identifies or measures the intensity of participants' physical activity, which is required by the guidelines (Irvine *et al*., 2020).

3.4.2.2 Barriers to connecting with nature

While connection with nature contributes to the health and wellbeing of older people in multiple ways, limitations in relation to ageing can hinder them from continuing to engage with nature. A number of the studies found that mobility limitations, physical impairments (e.g., heart failure and replaced joints), and psychological factors (e.g., loss of confidence) negatively impacted participants' ability on maintaining past and present activities in nature/outdoors (Olsson *et al*., 2013; Finlay, 2018; van Heezik *et al*., 2020; Milligan *et al*., 2021; Ness and Munkejord, 2021). In particular, during harsh winters, older people felt more vulnerable as they aged. Safety concerns and health conditions made them more difficult to be outdoors (Olsson *et al*., 2013; Finlay, 2018). The adverse effects of these age-related limitations on engagement with nature can potentially cause negative emotions. As indicated in the survey by van Heezik *et al*. (2020), participants mostly expressed sadness, frustration, and anger at the negative impact of ageing on their ability to engage with nature (van Heezik *et al*., 2020).

Findings from Scott, Masser and Pachana (2015) and Milligan *et al*. (2021) showed that some participants had developed tangible strategies to accommodate the limitations of their ageing bodies, to sustain participation in their desired gardening and nature-adventure activities (Scott, Masser and Pachana, 2015; Milligan *et al*., 2021). These strategies included changing gardening tools, downsizing garden areas, seeking paid and voluntary assistance, limiting time spent, and adjusting the intensity of activities (Scott, Masser and Pachana, 2015; Milligan *et al*., 2021). However, participants in these studies were considered to have better economic means to manage their preferred activities, so

the results could not be inferred to older people with fewer personal and social resources (Scott, Masser and Pachana, 2015; Milligan *et al*., 2021). Apart from the above adaptation strategies, two studies argued that maintaining visual sensory connection with nature was a way in which older people coped with their age-related limitations and continued engagement with nature, for example, looking at the sea out of the window and the photos which could evoke the memory of nature engagement in the past (Coleman and Kearns, 2015; Ness and Munkejord, 2021); although whether increasing age also has consequences for the senses as a pathway to connect older people with nature was not discussed in these studies.

3.4.2.3 Sensory connection with nature

Connecting with nature through the five sensory pathways

It is clear from the included studies that all five senses could be pathways that connect older people to the benefits of nature (e.g., Wang and Glicksman, 2013, Coleman and Kearns, 2015, Scott, Masser and Pachana, 2015, Strout *et al*., 2017, and Robbins and Seibel, 2020). Engaging with nature through vision was the most evident pathway (Olsson *et al*., 2013; Boyes, 2013; Wang and Glicksman, 2013; Coleman and Kearns, 2015; Scott, Masser and Pachana, 2015; Jonsén, Norberg and Lundman, 2015; Leaver and Wiseman, 2016; Strout *et al*., 2017; Finlay, 2018; Robbins and Seibel, 2020; Odzakovic *et al*., 2020; van Heezik *et al*., 2020; Milligan *et al*., 2021; Ness and Munkejord, 2021; Dendle *et al*., 2022; Lee *et al*., 2022). The benefits of nature have been delivered in different formats across multiple spaces through the visual pathway. For instance, watching own plants grow during gardening activities felt pleasure, satisfaction, meaningful and self-worth (Wang and Glicksman, 2013; Scott, Masser and Pachana, 2015; Strout *et al*., 2017); Seeing plants shared by other gardeners growing in the domestic garden developed social connections within the community (Leaver and Wiseman, 2016); Viewing nature outdoors through windows shifted focus towards the positive present and gave a sense of enjoyment, satisfaction and meaning in life (Jonsén, Norberg and Lundman, 2015; Coleman and Kearns, 2015; Finlay, 2018; van Heezik *et al*., 2020); Looking at photos related to personal experiences in nature evoked a feeling of wellbeing (Ness and Munkejord, 2021). Interestingly, due to the attributes of both 'absence' (of noise and odour) and ‘presence’, the auditory and olfactory pathways were relevant to older

people's nature connection (Olsson *et al.*, 2013; Boyes, 2013; Wang and Glicksman, 2013; Dzhambov and Dimitrova, 2014; Pleson *et al.*, 2014; Coleman and Kearns, 2015; Scott, Masser and Pachana, 2015; Leaver and Wiseman, 2016; Finlay, 2018; Irvine *et al.*, 2020; Odzakovic *et al.*, 2020; Milligan *et al.*, 2021; Ness and Munkejord, 2021; Lee *et al.*, 2022). The longing for quietness and fresh air drove older people into natural environments (Olsson *et al.*, 2013; Boyes, 2013; Pleson *et al.*, 2014; Finlay, 2018; Irvine *et al.*, 2020). Experiences in relation to natural sounds and smells have been found to enhance older people's wellbeing. Examples included the mood improved by the sound of butcherbirds; a good feeling experienced by smelling the earth; profound pleasure brought through the sounds and smells in the garden (Wang and Glicksman, 2013; Scott, Masser and Pachana, 2015; Leaver and Wiseman, 2016). the tactile pathway provided embodied nature experience, such as feeling the heat of the sun, touching leaves, and picking berries (Olsson *et al.*, 2013; Boyes, 2013; Jonsén, Norberg and Lundman, 2015; Scott, Masser and Pachana, 2015; Leaver and Wiseman, 2016; Robbins and Seibel, 2020). Such tangible experience seemed to draw interest in connecting with nature. For instance, a participant in Robbins and Seibel (2020) described that the experience of pulling carrots excited young people, so they were encouraged to participate in the garden's harvest. As a result, social bonds were developed between older people and the youth (Robbins and Seibel, 2020). Sense of taste is a pathway that participants and authors were less aware of (Olsson *et al.*, 2013; Wang and Glicksman, 2013; Scott, Masser and Pachana, 2015; Strout *et al.*, 2017; Ness and Munkejord, 2021). Most taste experiences occurred when consuming the produce of gardening, resulting in a feeling of enjoyment and health benefits such as increased intake of pesticide-free and various vegetables (Wang and Glicksman, 2013; Scott, Masser and Pachana, 2015; Strout *et al.*, 2017). Drawing on the findings above, it appears that sensory pathways could lead to different levels of nature engagement and contribute different functions to nature connection among older people, even though sensory engagement with nature is to some extent an inseparable whole. However, no included studies actively explored all these pathways that have been shown to link older people to the benefits of nature.

Understudied sensory engagement

Many studies lack recognition that the senses could be an influential pathway for older people to connect with nature and these studies focused solely on the relationship between nature and obtained benefits (Boyes, 2013; Wang and Glicksman, 2013; Pleson *et al.*, 2014; Jonsén, Norberg and Lundman, 2015; Scott, Masser and Pachana, 2015; Strout *et al.*, 2017; Finlay, 2018; Robbins and Seibel, 2020; Irvine *et al.*, 2020; Odzakovic *et al.*, 2020; Ness and Munkejord, 2021; Dendle *et al.*, 2022). For example, Boyes investigated environmental sensory stimuli provided during outdoor adventure activities and the benefits of participating in these activities, but did not explore the potential correlation of sensory stimuli with perceived benefits (Boyes, 2013). Psychological benefits arising from connection with natural elements through visual and auditory pathways, such as watching leaf colour change and hearing wind, were generalised as the effects of experiencing nature (Odzakovic *et al.*, 2020; Dendle *et al.*, 2022). Motivation to engage with nature and physical and psychological benefits that were engendered by smell were drawn as a general conclusion about the influence of natural spaces (Pleson *et al.*, 2014; Finlay, 2018; Irvine *et al.*, 2020). Potential contributions of connection with nature through taste and touch were disregarded and attention was paid to practical benefits (e.g., horticultural products and wild berries) gained from gardening activities and natural resource use (Wang and Glicksman, 2013; Jonsén, Norberg and Lundman, 2015; Scott, Masser and Pachana, 2015; Strout *et al.*, 2017; Robbins and Seibel, 2020).

Some included studies did not consider all sensory pathways when exploring nature connection in terms of sensory engagement (Dzhambov and Dimitrova, 2014; Cassarino, Tuohy and Setti, 2019; van Heezik *et al.*, 2020; Ahnesjö, Karlsson and Bergman, 2022). Whilst these studies operationalised the concept of sensory stimuli of nature experiences, vision and audition were presupposed to be the only pathways to deliver nature benefits (Dzhambov and Dimitrova, 2014; Cassarino, Tuohy and Setti, 2019; van Heezik *et al.*, 2020; Ahnesjö, Karlsson and Bergman, 2022). The questionnaire developed by Dzhambov and Dimitrova (2014) simply adopted 'appreciation of vegetation' and 'appreciation of birdsongs' as sensory pathways through which older park users interacted with nature (Dzhambov and Dimitrova, 2014). van Heezik *et al.* (2020) only considered diversity in visual dimensions, such as the size of the garden, the number of

plants and the proportion of green and water of the window views, when measuring the quality of indoor and outdoor natural spaces with which older adults might engage (van Heezik *et al*., 2020). The lab-based studies by Cassarino, Tuohy and Setti (2019) and Ahnesjö, Karlsson and Bergman (2022) indicated that the natural environment had no positive effects on older people's attention restoration and on their heart rate and power output during physical activity (Cassarino, Tuohy and Setti, 2019; Ahnesjö, Karlsson and Bergman, 2022). The former study used viewing images of natural and urban environments on a computer screen as a means of testing the effect of exposure to different environments on the restoration of attention among older people (Cassarino, Tuohy and Setti, 2019). The latter exposed them to a simulated outdoor environment with potted plants, forest-patterned wallpaper, and blackbird sounds during physical activity (Ahnesjö, Karlsson and Bergman, 2022). As explained by the authors, it is possible that the insufficient dose of nature (i.e., length of exposure and type of nature) and the overly artificial simulated environment led to insignificant effects of these studies (Cassarino, Tuohy and Setti, 2019; Ahnesjö, Karlsson and Bergman, 2022). However, from another point of view, the outcomes might imply that visual and auditory sensory engagement was not an adequate representation of older adults' experience in nature.

3.5 Summary and rationale for the present study

A growing body of literature has focused on the link between nature connection and the health and wellbeing of older people living in community settings (Olsson *et al*., 2013; Boyes, 2013; Wang and Glicksman, 2013; Dzhambov and Dimitrova, 2014; Pleson *et al*., 2014; Jonsén, Norberg and Lundman, 2015; Coleman and Kearns, 2015; Scott, Masser and Pachana, 2015; Leaver and Wiseman, 2016; Strout *et al*., 2017; Finlay, 2018; Cassarino, Tuohy and Setti, 2019; Robbins and Seibel, 2020; Irvine *et al*., 2020; Odzakovic *et al*., 2020; van Heezik *et al*., 2020; Milligan *et al*., 2021; Ness and Munkejord, 2021; Dendle *et al*., 2022; Ahnesjö, Karlsson and Bergman, 2022; Lee *et al*., 2022). To date, broad benefits associated with connecting to nature, individual factors influencing perceived benefits, and challenges of ageing in maintaining nature engagement have been discussed. This literature review clearly demonstrates that older people use all five senses to connect with the benefits of nature. Also, engaging with nature through different senses appears to affect their nature experience. However, previous studies

have focused on only one or two specific sensory pathways (i.e., vision or vision and audition). No studies have explored the five senses in terms of experiences of older people in nature; and there remains little evidence discussing the potential impact of individual background and ageing on older people's sensory connection to nature (Olsson *et al.*, 2013). The purpose of the present study is to address this gap.

3.6 Research question and aims

The present study will explore the sensory experiences of older people's engagement with nature through nature-based wellbeing interventions using a qualitative approach. Qualitative methods provide the opportunity not only to capture more detailed descriptions of sensory experiences, but to build a full picture of the influence of individual contexts such as increasing age on older people's sensory engagement with nature.

The primary aim of this study is to gain an in-depth understanding of 1) sensory connection with nature that contributes to older people's wellbeing through nature-based interventions; 2) barriers and facilitators of connecting with nature through the five senses in older people. The secondary aim is to explore the experiences and views of sensory engagement with nature among professionals involved in delivering nature-based interventions to older people. The research question explored in the present study is:

What are older people's sensory experiences of nature-based wellbeing interventions?

3.7 Research objectives

1. Use semi-structured interviews to explore experiences of nature for the five senses in older people participating in nature-based interventions.
2. Use semi-structured interviews to explore the intervention providers' perspectives of sensory engagement with nature for older people.
3. Use reflexive thematic analysis to analyse the interview data to understand how older people engage with nature through their senses and how it has been facilitated

and hindered.

4. Provide recommendations regarding the ways in which older people's sensory connection with nature can be optimised for intervention providers and relevant stakeholders such as social prescribers and community nature advisers.

Chapter 4 – Methods

4.1 Research paradigm

The present study is based on an interpretative paradigm. Interpretivism recognises that factors such as culture, environment, and time influence the development of diverse social realities (Alharahsheh and Pius, 2020). Understanding individuals' subjective perspectives within the studied areas is central to the interpretive paradigm; the core principle is to engage with these personal meanings in the social context, including acknowledging their existence, reconstructing them, and comprehending them without distortion (Goldkuhl, 2012). Given the many characteristics of the interpretative paradigm, qualitative methods are considered most appropriate (Alharahsheh and Pius, 2020), as they enable an in-depth exploration of how people perceive and interpret their experiences, rather than assuming a single truth or uniform way of being.

4.2 Methodology

A qualitative methodology has proven to be a good scientific basis for under-researched areas. It contributes to a better understanding of complex phenomena in real-world settings, as it allows for a more complete description of experiences and views derived from diverse informants (Pope and Mays, 1995). The motivation for using a qualitative methodology in the present study was that there is little evidence of older people's sensory experiences in nature, such as in what settings they feel connected to nature through their sense(s), which natural elements create this connection, and what factors that influence sensory connection with nature and attendant wellbeing benefits. As discussed in chapter three, existing studies that acknowledge sensory engagement with nature are limited to considering that older people develop their connection with nature by seeing and hearing specific natural elements (e.g., listening to birdsong and viewing plants and images of nature) (Dzhambov and Dimitrova, 2014; Cassarino, Tuohy and Setti, 2019; van Heezik *et al.*, 2020; Ahnesjö, Karlsson and Bergman, 2022). Older people's interactions with nature through the five senses may involve many combinations. In some cases, it can be an individual interacting with different elements of the natural environment through a single preferred sensory pathway or integrating

multiple senses to receive stimulation from a natural element. A qualitative methodology helps provide richer descriptions and context for various sensory experience situations.

Qualitative methodology involves a range of methods for gathering data. Semi-structured interviews are the most commonly used data collection method in qualitative research. They allow existing knowledge and hypotheses to be introduced into the data collection process through predetermined questions (Hale, Treharne and Kitas, 2007; Peters and Halcomb, 2015). These pre-prepared questions help the researcher focus the interview on key elements of participants' perspectives. Furthermore, the flexibility of semi-structured interviews provides an openness to the possibilities of outcomes as the research progresses (Milliken, 2010; Morris, 2015). For example, predetermined questions can be iteratively adjusted as the data collection process proceeds. Questions that do not effectively evoke relevant data can be removed, and new questions can be added to be discussed in subsequent interviews to better understand the research topic (Dicicco-Bloom and Crabtree, 2006). In the present study, semi-structured interviews were adopted because they can not only include existing theoretical knowledge surrounding sensory connection with nature, but also allow for unexpected findings to be drawn from participants' own descriptions. Additionally, the individual interview format was chosen rather than a group format to increase older people's willingness to discuss personal factors related to their sensory engagement with nature such as ageing and sensory problems (Dicicco-Bloom and Crabtree, 2006).

4.3 Research design

The present study has a cross-sectional qualitative study design. Semi-structured interviews were conducted to explore the experiences and views of older people and intervention providers on sensory connections with nature through nature-based interventions. All interviews were undertaken by the PhD researcher between August and December 2023. This qualitative study was approved by the University Institutional Review Board from the School of Health and Related Research (ScHARR) Ethics Committee (No. 053561; Appendix 2).

4.4 Sampling and recruitment

The present study participants included older people and intervention providers who design and deliver nature-based interventions. All participants were recruited in South Yorkshire, which is one of the GSP test and learn sites led by the local Integrated Care System. Older people were recruited from five community groups. The eligibility criteria for older people were aged 50 and over and capable of providing informed consent to the interview. Purposive sampling was used to ensure that older people were eligible for the recruitment criteria and were represented in the characteristics of gender, age, reason for participation (referred to through Social Prescribing (SP)/active participation), type of intervention involved, and length/frequency of participation in nature-based interventions.

The researcher approached a gatekeeper at the voluntary and community sector organisations with the information sheet and leaflet (Appendix 3 and 4) by email to ask if they could assist with recruitment by allowing the researcher to attend nature-based interventions they provided to advertise the present study. The researcher presented the research via the leaflet at the beginning or during breaks in the interventions in five community groups. Following this introduction, the researcher approached the group members during the interventions, provided them with the information sheet and asked them if they would be interested in participating in an interview. Prospective participants were asked to leave their contact details (name, phone number and email). The researcher then arranged an interview time and avenue through their preferred contact method, including on the spot, via email and by phone. Depending on the needs of prospective participants, the researcher provided text or telephone interview reminders on the same day or one day in advance.

Intervention providers for the present study involved seven organisations (one worked for two organisations). Purposive sampling was employed to select intervention providers, with the aim of achieving participant diversity across a range of characteristics including gender, age, and type of intervention provided. The researcher sent an invitation email containing the information sheet (Appendix 5) to intervention providers whose contact details were available in the public domain. After receiving positive responses from

potential participants, the researcher further scheduled a time and location for interviews via email or by visiting them at the site where they delivered nature-based interventions. Snowball sampling was also used to recruit intervention providers. This method involved the researcher asking participants to share the research information with others they thought might be interested in participating in the present study. The purpose of using snowball sampling was to reach intervention providers who provided different types of nature-based interventions through their own networks with each other. Participants who had been interviewed and were willing to pass on research information emailed the information sheet to potential participants and copied the researcher on the email. For positive responses, the researcher then took over the contact and arranged an interview time and location via email or in person.

4.5 Data collection

Interview guides for older people and intervention providers were developed independently. Each interview guide was constructed to include background information, opening questions, key questions, and closing questions (Hennink, Hutter and Bailey, 2011; see Appendix 6 and 7). The interview questions and probes were developed from existing evidence of the research topic. The researcher took the following steps to ensure that the interview guides followed a logical order and facilitated the generation of useful data: 1) Both interview guides were reviewed with an experienced qualitative researcher. 2) A discussion was held with key staff from a voluntary and community sector organisation about whether the interview guide for older people was worded in a way that they could understand and respond to. A pilot interview aiming to check the interview guides was arranged with a native English-speaking academic staff member who regularly volunteered at the nature-based activity, but the interview was not successfully conducted due to postponement by the pilot participant. The pilot was not rescheduled as this would have led to a delay in data collection.

All interviews were undertaken in person. Older people were interviewed at public places (e.g., cafes and libraries), the University interview rooms, or their homes. Interviews with intervention providers took place at their workplaces or the University interview rooms. Interview duration ranged from 20 to 90 minutes. An encrypted recording device was

used to record interviews. Field notes were written after the interview, including interview locations, participants' nonverbal behaviours, who was present, and reflection on process and performance of the interview. These notes were used to enrich the contextual information of participants and support data interpretation during the data analysis phase (Phillippi and Lauderdale, 2018). Before the interview began, the researcher explained to each participant the research purpose, the interview process, the time needed, the reason for collecting data through audio recording, data confidentiality and the participants' rights to decide to refuse to be recorded or withdraw from participation. They were given time to read the consent form (Appendix 8) and ask any questions they might have. A signed consent form was obtained from all participants.

4.6 Analysis of data: Reflexive thematic analysis

The present study used reflexive thematic analysis as the data analysis method (Braun and Clarke, 2019). The researcher also considered two other approaches when making this decision, including grounded theory and framework analysis. Grounded theory guides researchers through a systematic process to identify concepts and build an inductively derived theory from qualitative data (Corbin and Strauss 2015). This technique is usually used to explore areas and phenomena that have received little previous research attention or have not been adequately studied (Milliken, 2010), which is potentially suitable for addressing the present research question. It was not chosen because the present study is not directed towards developing a theory (Holloway and Todres, 2003). The key feature of framework analysis is that a data matrix is formed during the analysis process. The matrix is seen to be conducive for analytical transparency and enables researchers to compare information between and within data (Gale *et al*., 2013). However, because of developing a matrix, themes will be formed almost at an early stage of the analysis such as the phase of coding (Gale *et al*., 2013). This may be too restrictive for analysing sensory engagement with nature, which potentially involves complex combinations of the five sensory pathways and various natural elements. Ultimately, reflexive thematic analysis by Braun and Clarke (2019) was chosen as the analytical method, because it can systematically identify patterns within qualitative data and remains flexible enough to evolve analytical concepts from codes to

themes. The present study followed the six-stage process of reflexive thematic analysis developed by Braun and Clarke (2022):

Stage 1: Familiarising yourself with the dataset

I began by immersing myself in transcripts after the interview recordings were transcribed verbatim. Each transcript was read and re-read along with relevant field notes to familiarise myself with the data. Pen and paper were used to note tentative ideas or thoughts.

Stage 2: Coding

At this stage, I first developed a coding frame with the supervisory team. I chose one transcript that the participant had experiences using the five senses to connect with nature during the interview. This transcript was coded separately by my supervisors and myself using Word's Comments feature. After having the three coded documents, I started by going through the main codes and sub-codes of each document. Then, the three documents were examined simultaneously; Whenever I saw the content being coded, I thought about whether the code should be included in the coding frame; If the same content was coded with a different name, I considered which name to adopt or if it needed to be renamed. Ultimately, the three coded documents were combined into a coding frame (See the first and second columns from the left in Appendix 9). Some sub-codes retained two names with similar meanings because I thought the names had similar meanings but slightly different interpretations, which should be clarified as coding progresses. The supervisory team and I discussed the main codes and sub-codes of the combined coding frame and reached a consensus at the meeting. NVivo 14 software programme was utilised to aid in the subsequent coding process (Lumivero, 2023). The coding frame was added to NVivo and all transcripts were uploaded into its database. An auditing approach was adopted to record code generation in each transcript. An example of the audit trail is shown in Appendix 9.

Establishing the coding frame enhanced transparency in the analytic process for the present study. It also allowed the researcher to perform this coding stage more efficiently and assisted in the next 'Generating initial themes' phase by having the researcher to

learn coding techniques from experienced qualitative researchers. For instance, my first coding captured only short sentences or paragraphs of the transcript that referred to the meaning of the code, but not its context. The lack of context for participant statements would have made it difficult for me to understand the full meaning of what participants said through the extracted data alone, which I realised later while performing the next stage.

It should be noted that the coding frame did not result in the themes of the present study being formed at an early stage as in the case of the above framework analysis. Through its use, the segments of data directly relevant to the research question were identified (i.e., data related to sensory experiences, as bold in Appendix 9) and code labels for these segments were noted. These relevant elements were then taken to the next phase.

Stage 3: Generating initial themes

A theme in the reflexive thematic analysis refers to a shared meaning pattern that was united around a core concept (Braun and Clarke, 2022, pp. 77-78). I started identifying patterns across the data. Meaningful codes that helped answer the research question were combined. Patterns that shared the meaning of the combined codes were generated as initial themes. The initial mapping of patterns can be seen in Appendix 10.

Stage 4: Developing and reviewing themes

This stage assessed whether the initial themes could reasonably interpret the combined codes and overall data. To check this, I went back to the overall data. Also, the core concept of each theme and the relationships between themes and between combined codes across themes were reconsidered. The overarching themes, a structure that aids in organising themes, were generated at this stage, in order to clarify the connection between the themes and the aim of the present study (Braun and Clarke, 2022, p. 87).

Stage 5: Refining, defining and naming themes

I again examined the contribution of the core concept conveyed by themes to an overall story that helped address the research question. Each theme was named and a short description of each theme was written. A sub-theme refers to one particular facet under

the theme which needs to be emphasised (Braun and Clarke, 2022, p. 88); I identified a sub-theme under the theme at this stage.

Notably, both stages 4 and 5 involved discarding themes that did apply and re-developing themes.

Stage 6: Writing up

This stage integrated formal and informal writing pieces from the entire analysis process, such as interpretations of themes and reflexive notes. The writing was edited and completed to inform readers how the data answer the research question.

A summary of the above theme development is provided in Appendix 11. The entire analysis process, except for the coding phase, was mainly conducted through pen and paper (See Appendix 12 for an example of performing pen and paper analysis), and digital records were maintained regularly. The process was recursive (or it can be said the stages of analysis somehow overlapped). This means that the researcher proceeded through these stages sequentially, but also returned to earlier stages when necessary, such as revising or developing code labels during the initial theme generation and refining or renaming themes while writing up.

4.7 Ethical considerations

Ethical approval was gained from the School of Health and Related Research (ScHARR) research ethics committee before undertaking the data collection process. The researcher demonstrated the research aims, protocols and the rights to anonymity and withdrawal to all participants through the information sheet. They were allowed time to ask questions and read the consent form before the interview commenced. A signed copy of the consent form was obtained from all participants.

Apart from the ethical approval, potential issues and the actions that the researcher used to cope with ethical issues are discussed as below:

1. The capacity of some older people (e.g., those referred by SP) to participate in the interview may require additional assessment.

2. Participants may feel uncomfortable due to potential health issues during the interview.

The following actions were taken to deal with these issues:

1. After receiving positive responses from the gatekeepers of the community groups, the researcher asked if they had any group members who might not be able to engage comfortably in an interview for up to an hour, so that the researcher could avoid approaching these members when recruiting participants. Additionally, the researcher considered the possibility that members who were incapable of participating in the interview would still express interest in participation during the recruitment. For this situation, the researcher decided that if it happened, time would still be arranged to have a brief conversation with the members so as not to make them feel left out or disappointed.
2. The researcher informed all participants at the beginning of the interview that they could ask for a break or stop the interview at any time. The health status of potentially vulnerable groups (i.e., older adult participants) was given additional concern. Information about advice and support services such as local Age UKs, Samaritans etc. was offered to participants who had challenging emotions and feelings during the interview. If participants' safety and wellbeing was of immediate concern, the researcher provided appropriate support and follow-up.

4.8 Ensuring research quality

4.8.1 Trustworthiness

Guba and Lincoln argue that reliability and validity standards in quantitative research, which are premised on the feasibility of a single truth, are incongruent with the nature of qualitative research that accepts there may be multiple interpretations for a social phenomenon; They suggest alternative ways of evaluating the quality of qualitative research through trustworthiness and authenticity (Lincoln and Guba, 1985 and Guba and Lincoln, 1994, cited in Bryman, 2012, p. 390). The present study used trustworthiness to ensure research quality, which consisted of the following four assessment criteria:

Credibility involves confirming that the researcher's interpretations correctly represent the information conveyed by participants (Bryman, 2012). The present study employed triangulation to ensure credibility. Using field notes added another source of information to clarify participants' statements during the analysis phase. The researcher met with the supervisory team to discuss decisions regarding theme development. This provided different perspectives on the findings and ensured that the researcher's interpretation of participants' statements was acceptable to others.

Transferability involves providing sufficient contextual information in the study for readers to judge whether or to what extent the findings can be transferred to use in their contexts or settings (Braun and Clarke, 2022). To enhance the potential for transferability while preserving participants' confidentiality, the present study has provided the characteristics of participants and settings that can be made transparent in 5.1 Recruitment and participant characteristics. These include sample size, participants demographics, and types of nature-based interventions. Additionally, the present study included exploring the influence of individual contexts on older people's sensory engagement with nature, so the context in relation to the findings was described in detail in the findings chapters six, seven, and eight.

Dependability involves detailing records of the research process through an auditing approach and having them examined by auditors (Lincoln and Guba, 1985, cited in Bryman, 2012, p. 392). The present study was overseen by the supervisory team to ensure that proper procedures have been followed throughout the research process. Elements relevant to the analytic process were carefully documented, including interview transcripts, field notes, participant characteristics, coding process, theme development, and the strength of each theme, and were accessible to the team.

While recognising the inevitable subjectivity contained in qualitative research, researchers need to be able to act in a manner that does not allow their values and preferences, whether personal or theoretical, to influence research execution and findings overtly; Confirmability involves the evaluation of this aspect (Bryman, 2012). The present study ensured confirmability through the researcher being reflexive throughout

the data collection and analysis process. These reflections are demonstrated in the subsequent section 'Reflexivity'.

4.8.2 Reflexivity

Reflexivity involves researchers' self-reflection on whether their methods, beliefs, biases, and decisions have influenced the research process (Bryman, 2012). Being able to reflect on these factors openly helps to enhance research transparency, thus contributing to the quality of qualitative research and the construction of trustworthy knowledge (Yardley, 2000). Below I will explain my background in relation to the present study and describe the reflections I had on the data collection and analysis process.

I came from landscape architecture, which is a discipline in Taiwan where students usually have to choose between academic or practical graduation requirements during their studies. For example, undergraduates must decide to do a student research programme or intern at a landscape architecture firm during their third to fourth year. Given my interest in the academic route, I have around 6 years of experience focusing on research topics in therapeutic landscapes and environmental psychology from my first degree, master's degree and working as a research assistant. During the data analysis process, I did find that my interdisciplinary background and knowledge affected the way I saw participants' interactions with nature. For instance, the term 'nature connection' to me does not simply represent contact with nature, but also involves different levels of people's attitudes and behaviours towards the environment. I have found that the former meaning is more commonly used in the nature intervention literature in the health area and the latter is more common in the field of environmental psychology.

Another reflection during the analysis was the relevance of early nature experiences to the present study. I intended to explore the research topic regarding reminiscence and natural smells when I first started my PhD. Unfortunately, I did not have the opportunity to complete the exploration of this topic. This led me to consider more when the concept sharing a similar meaning was actively brought up by participants and subsequently generated in the analysis, as I was concerned about whether it involved potential bias by myself, such as whether it was compensation for my inability to successfully explore my initial topic. This concern had me holding on to the development of this theme until more

data that shared the same meaning were seen, and until the following reflections were made. I first confirmed that I had no intention for it to appear or not appear in the present study. Then I considered whether this concept was in the evidence base of nature interventions. That is, as far as I know, the term 'reminiscence' is used more often in the reminiscence therapy literature. I thus thought carefully: does this concept still exist when my position is on nature interventions? The answer was yes, because early nature experiences and a similar concept 'primal landscapes (environments of childhood)' were embedded in my background in relation to nature interventions. I have known about them longer than the concept of reminiscence therapy. Therefore, I acknowledge that my theoretical perspective and knowledge from my background shaped the data analysis to some extent. Nevertheless, they did not lead me to make any assumptions about the results of the present study. I stayed open and excited about unknown outcomes. Even, in the early stages of data analysis, I felt worried because I could not imagine what findings might be possible, other than having a clear idea of my research question and aims,

Carrying out interviews was a challenge for me. English is not my first language, which worried me before starting data collection; I wondered if it was possible that I could not fully understand what the interviewee was saying during the interview, thus not being able to form a good conversation and obtain rich data. In my first interview, I used the way of briefly summarising the participant's statements at the end of each interview question topic to make sure I understood them correctly. This experience relieved me of my worries before commencing data collection. After the first few experiences, I began to feel more comfortable about conducting interviews. Another challenge was responding to participants during the interview. I was mindful to avoid asking questions or giving responses that would lead to participants' answers, such as asking leading questions or responding too much with my agreement or disagreement to the experiences and views expressed by participants. At the same time, I considered whether I might make participants uncomfortable if I were too cold, especially when they sought approval for their perspectives. Given these considerations, I tried to provide some brief consent at the end of one topic of interview questions if applicable and follow up with the next topic, or actively expressed interest in participants' narratives after

turning off the recording. In addition, I found that the examples I provided for participants to help explain the questions, if they involved other people, such as 'Some people may think...', seemed to affect their subsequent responses. After noticing this, I instead provided two opposing or multiple different views when giving examples.

Of the five community groups where I recruited older people, I already knew the participants in one of them from volunteering there. Having an established relationship made the recruiting process less challenging in this community group. Several older participants seemed to make more of an effort to share their nature experiences because of this relationship. However, I do not think this significantly affected the richness of the sensory experiences they shared, mainly because the present study only focused on nature experiences involving the five senses, and those nature experiences not involving the senses were excluded from the analysis. A few older participants seemed to believe that the interview involved an evaluation of the nature-based interventions they participated in and therefore either praised their interventions particularly or were concerned that what they said during the interview might negatively affect their groups. In one sense, this meant that the interventions were important and had a positive impact on them. However, this situation made me reflect that if my research topic was an evaluation of nature-based interventions, using a single interview source as a data collection tool might over-represent positive experiences and make it difficult to identify internal factors that might need improvement. I also looked at how these participants described sensory nature experiences and found that they seemed to be doing so in a more neutral way. This may be because the interview questions involving the senses focused on participants' interactions with nature. Their focus on how they explored nature diverted from their sense of being a loyal member of the community groups or that they needed continued support from the interventions. A known intervention provider brought to my attention the possibility that data could be affected by the researcher-participant relationship when I first asked the question about smell in the interview. This participant raised the tone of the voice by saying that smell was important, which made me immediately think that this emphasis seemed to come from knowing that I was focusing on smell alone before. The participant might respond by thinking I had a preference for smell or misunderstood that I had a specific intention in asking the

question about smell. I had no additional reaction to this in the interview, other than to go on to discuss touch and taste in the hope that the participant would understand that all senses would be asked. This situation was recorded in the field note and this participant's statements were examined additionally during data analysis. The overall description was not particularly weighted by smell.

4.9 Chapter summary

This chapter outlines the rationale for selecting a qualitative methodology and its associated data collection and analysis methods for the present study. Strategies for carrying out sampling, recruitment and data collection were described and analysis of data was reported with supporting evidence and examples to demonstrate rigour and transparency. Ethical considerations related to data collection were presented with reflections on addressing potential ethical issues. This chapter concluded by showing how the quality of the present study was maintained and the next chapter will provide an overview of the participants' demographics and the findings of the present study.

Chapter 5 – Participant characteristics and overview of the findings

5.1 Recruitment and participant characteristics

Thirty-five respondents agreed to participate in an interview. Three interviewees withdrew from the study prior to the interview, as they found the scheduled interview conflicted with travel plans or they were concerned about performing poorly at the interview. The researcher undertook thirty interviews with thirty-two interviewees. One interviewee preferred to have a friend present during the interview. Data for this interviewee was removed after the interview. Reason for exclusion was that many responses were interfered with by the accompanying friend.

A total of twenty-nine interviews with thirty-one participants were included in the present study. Twenty-seven interview recordings were transcribed by the researcher and two by a transcriber. Of these participants, twenty were female, ten were male, and one was non-binary. Participants' demographics are detailed in Table 3. Pseudonyms are used throughout reporting of the findings to ensure confidentiality.

Table 3 Demographic information by participants' age, reason for participating in the intervention and role in the present study

Pseudonym	Self-reported age	Role	Reasons for intervention participation
Kate	65	Intervention provider	n/a
Tom	36	Intervention provider	n/a
Ivy	50	Older adult	SP referral
Mavis	57	Older adult	SP referral
June	66	Older adult	Active participation
Ada	77	Older adult	SP referral
Grace	58	Older adult	SP referral
Nelly	65	Older adult	Active participation

Susan	66	Older adult	SP referral
Fred	83	Older adult	SP referral
May	72	Older adult	Active participation
Bert	85	Older adult	Covid-19 pandemic situation
Rachel	65	Older adult	Active participation
Emma	68	Older adult	Active participation
Fiona	52	Intervention provider	n/a
Karen	55	Older adult	Covid-19 pandemic situation
Tony	56	Older adult	Covid-19 pandemic situation
Pat	61	Older adult	SP referral
Clare	42	Intervention provider	n/a
Abi	29	Intervention provider	n/a
Piers	60	Older adult	SP referral
Emily	75	Older adult	Active participation
Linda	75	Older adult	Active participation
Ted	76	Older adult	Active participation
Ivor	61	Older adult	Active participation
Helen	42	Intervention provider	n/a
Joan	68	Older adult	Active participation
Simon	64	Intervention provider	n/a
Gary	63	Older adult	Active participation
Jerry	71	Older adult	Active participation
Laura	43	Intervention provider	n/a

Note: SP = Social Prescribing; the column 'Reasons for intervention participation' is used to indicate the reasons why older participants began participating in nature-based interventions and does not apply to professional participants.

5.2 Overview of findings

Through reflexive thematic analysis, ten themes and one sub-theme were identified; three overarching themes were constructed to organise the themes. Table 4 below summarises the overarching themes, themes, and sub-themes of the present study findings.

Table 4 Summary of overarching themes, themes, and sub-themes

Overarching themes	Themes	Sub-themes
Understanding sensory pathways to connect with nature	Multiple contributions of vision on nature connection	-
	Establishment of deeper connection with nature through touch	-
	Completion and compensation: multi-sensory connection with nature	How multiple sensory experiences with nature can be increased
Barriers to sensory connection with nature in older people	Safety considerations when engaging with nature through touch and taste	-
	Challenges to establishing auditory and olfactory pathways with nature	-
	Unawareness of connection with nature beyond vision	-
A temporal perspective: the connection between time, older people, and nature	Impact of time on becoming connected with nature	
	Influence of previous experiences on sensory connection with nature	-
	Changes and adaptation: managing challenges through indoor sensory connection with nature	-
	Nature's time: building a continuous sensory connection with outdoor nature through the seasonal cycle	-

5.3 Chapter summary

This chapter outlines participants' demographics to add contextual information to their narratives in the present study findings. Following a findings overview in this chapter, the next three chapters will report this study findings in full through overarching themes. Each theme will be described in detail with supporting quotations from the interviews.

Chapter 6 – Understanding sensory pathways to connect with nature

6.1 Multiple contributions of vision on nature connection

This first theme illustrates that the sense of sight facilitated participants' connection with nature in different aspects. Engaging with nature through the visual pathway was mentioned across all participants who were not visually impaired. In a few participants' accounts, it was seen as a fundamental pathway to lead them into the natural world and further discover elements within it. As Mavis stated:

> *[...] That's where the first sense started. [...] You just look for things, don't you? [...] I use one sense first and then increase more and more. [Now] as soon as I go out, I automatically look and listen to things and smell things [...].'* (Mavis, 57)

A few participants' responses demonstrate that vision could influence the use of their other sensory pathways when engaging with nature. Using the sense of sight seemed to come naturally to these participants. They had a habit of 'looking' before taking any further action. Therefore, their connection to nature through senses of hearing, smell, touch or taste was determined after engagement with it by vision. For example, Emma described that her connection with nature through the sense of taste was initiated by seeing natural elements.

> *'When I see something, I think "Oh, that's interesting or useful", I will take some. Maybe first time pick one to taste it and try to find out what it's for.'* (Emma, 68)

In addition, nature connection is more widely available due to the visual pathway. On the one hand, it enables some participants to receive the benefits of nature in various ways. One of the ways is that the participants could connect with nature through their sense of sight from a distance. Even without significant movement, they could engage with nature by looking at remote natural scenes, such as the sky, clouds and trees. This provides easy access to nature and its benefits. As Rachel explained why she did not encounter any challenges in connecting with nature:

‘I don’t think I've got challenges connecting with nature. I know I can look out of my window and I'll see nature.’ (Rachel, 65)

Fred’s experiences showed that visually connecting with nature without being physically present helped him experience the sea he was afraid to approach.

'[...] Like the sea, I always respect the sea. [...] I suppose in a way it scares me a bit because I know what power the sea got. [...] I would feel a lot more secure not being nearby.' (Fred, 83)

Looking at photos of the sea and watching it through the window on the train provided him with a way to engage with the sea while feeling safe.

'[...] In other cases, the sea looks lovely, like the sea at sunset and some marvellous pictures of nature that you see on television. [...] like we did a train journey in Scotland. [...] You could see the sea. It looked calm. It looked beautiful. It gives you a boost when you see something like that [...].' (Fred, 83)

Other ways can be attributed to commonly developed visual-related products and technologies. It allows the participants to make a visual connection with nature in a way that is more unrestricted by location and time. For example, reading nature books provided Mavis with another option to connect with nature besides going to the outdoor environment.

‘[...] If I'm having a rough time I will talk to nature, whether it’s outside or just look at my books with nature in [...].’ (Mavis, 57)

For Ivy, it was a joyful experience to see a real deer that she had only seen on television. Photo-taking helped her record the image of deer. She could reconnect this nature experience and the enjoyment it brought in another place and time by looking at the photo.

'I take the picture and I keep it. When I want to watch it, I watch it. When I see it, the joy that is in me. I don't think anybody experiences that kind of happiness that I've seen a deer. I've never seen a live deer except on TV. I watched Geographic about

animals, animal kingdoms, and I saw all these things. So for me, to see a live one in the park, in the field, I feel joy.' (Ivy, 50)

The above descriptions demonstrate that 1) the visual pathway allows participants to experience nature with fewer physical distance constraints; and 2) the development of visual technologies and products (e.g., pictures and books) provides the participants with opportunities to connect with nature in multiple forms across space and time. Therefore, the participants can obtain the benefits of nature in many ways.

Another contribution is that the visual pathway enables participants to communicate nature experiences easily. Many participants' accounts conveyed that when they wanted to share their experiences of nature with others, visible natural elements were the more common choices. May was able to help others by sharing her visual experiences during the nature-based intervention:

'I was just talking to her, reassuring and saying 'Look at this. This is lovely.', and she was obviously thinking of nature rather than her worries.' (May, 72)

Mavis's description below reflects that delivering visible elements of nature also seems to be the first choice for professionals who provide nature-based interventions. When she thought back to the earliest nature sessions, she stated:

'It started off from the point of view of what you're looking at. They said like ''Oh, look at the tree or draw the tree.'' [...]. (Mavis, 57)

June's observation in the nature-based intervention provides a possible explanation for why the participants were more likely to choose to share visual nature experiences. She found that those group members who used to not speak much had become more communicative and interactive during the intervention. In this regard, she believed this was because visible natural elements created a more obvious focus to get them talking.

'[...] When I first started coming to the group, some of the people were fairly timid and quiet. I have noticed some of them have become more open and maybe it's

because there is a focus there for them to express what they're seeing and experiencing [...].' (June, 66)

As mentioned above, developed visual technology makes it possible for the participants to receive the benefits of nature across places and time. Likewise, the participants can easily communicate their visual experiences with nature to others through digital products. For example, during the interview, Ivy shared with the researcher the photos she took in the natural environment.

'This one I took a picture because I was feeding them and I had only one hand. I just took a picture and later I made the video. This is my face. It was so sunny. Even here, there was another swan. You see the environment. I just took pictures. I took a lot. This is [place name]. Yeah, good day. I walked for like two miles. That is what I've been doing to help myself.' (Ivy, 50)

6.2 Establishment of deeper connection with nature through touch

Analysis of data from the theme demonstrates that participants interacting with nature through the sense of touch are more likely to develop a deeper connection with nature through tangible contact with natural elements.

'[...] Unless you experience the touch of things you don't know, like something's rough or smooth or cold or warm. [...].' (Nelly, 65)

Interestingly, Nelly's description above appears to distinguish engaging with nature through touch from engaging through the sense of sight, providing a clearer explanation of why tactile connection offers a more concrete experience. It is akin to visually capturing the image of a rough-textured natural element, such as the bark of an elder tree; we might think 'it looks rough'. However, we don't truly know what it feels like until we touch it. The thought of 'it looks rough' transforms into a physical experience of roughness that we can feel tangibly.

A few participants found experiences gained through touch more meaningful than other sensory experiences. This can be attributed to the fact that nature-based activities

involving touch often have a specific purpose or produce tangible results. As Gary noted his preference for sensory connection with nature:

> *'Hands on, doing physical work. […] I'm happier working, doing stuff to improve nature, than just wandering around looking at it. […].'* (Gary, 63)

Physical sensations experienced through the sense of touch inspired a few participants to relate what was happening in the natural world to their personal lives. This suggests that the boundary between humans and nature becomes blurred. For example, tangible contact with the soil caused Karen to reconsider the lifestyle choices she had carried with her since working in a retail environment. She realised that similar tasks, which aimed at increasing yields (sales/profits in retail and produce in gardening), could be performed using a different way of thinking and behaving than in the environment she was accustomed to.

> *'[…] Getting your hands dirty, actually digging into the soil, putting something in, and then having to wait in a culture where everything is rushed and busy and pressured to be able to like [have a result]. Planting things and then waiting for them to grow, not knowing whether they will and not everything being productive […].'* (Karen, 55)

The deeper connection is also reflected in how participants thought about nature and the way they interacted with plants and animals. Many people still see themselves in a separate relationship with the natural world. In a sense, this situation can be reflected in the differences between their interactions with the living elements of non-human nature and with other humans; some may not even consider these elements to be living beings but rather objects. The deeper connection here is that a few participants came to understand nature as alive and developed human-like relationships with them. As Tony explained, interestingly, he used the stinging sensation the plant gave him while gardening:

> *'[…] When you're stung, [the participant showed where he was stung] this is all stung this morning from nettles, it hurts. But it reminds me that actually certain*

plants, don't touch them, because they will sting, and it brings plants alive.' (Tony, 56)

Since Ada faced the Covid-19 pandemic alone, as her husband had passed away before the outbreak, the oak tree has been her encouragement. By hugging the tree, she established the connection with it. This bond helped her through the difficult time in her life.

'[...] You have to see if there's anybody else walking down the path, and I hug that tree, touch its bark, because I think if you've survived all that, getting chopped and messed about and you're still here, then I can do it.' (Ada, 77)

The above examples illustrate the emerging awareness of nature as alive among the participants as a result of developing a connection with it through the sense of touch. Also, they demonstrate a closer relationship with nature. Their shift to a more intimate relationship can be seen in their use of anthropomorphic terms and behaviours when interacting with nature. To clarify, what the sense of touch represents in this theme is that it seems to facilitate a connection with nature on a deep level. However, there are barriers against sensory connection with nature via touch. As seen in the example of Ada above, the phrase *'[...] you have to see if there's anybody else walking down the path'* indicates whether the current situation allows her to hug the tree. She was concerned about what others would think of her when it came to a human-like interaction with the tree. Additionally, a few participants did provide experiences related to touch and nature in the interviews. However, the described experiences were part of a continuous motion including touching natural elements. The action was for other purposes, such as picking (touching) fruit in order to eat it further. It was not a conscious decision made by the participants to explore nature by using the sense of touch. These barriers will be discussed in more detail in the themes 'Safety considerations when engaging with nature through touch and taste' and 'Unawareness of connection with nature beyond vision' in the subsequent chapter 'Barriers to sensory connection with nature in older people'.

6.3 Completion and compensation: multi-sensory connection with nature

This theme illustrates that multi-sensory nature experiences are seen as creating a more holistic connection to nature and enabling older people with age-related sensory decline, sensory impairments and sensory processing differences to benefit from nature. The sub-theme discusses how to increase such experiences. Many older participants had sensory experiences involving connecting with nature through two or more sensory pathways at the same time. As Grace described her experience:

> *'[place name] is my big haunt when I go down on the pond. You've got all the wildlife there and all the noise [...]. I just like to see them come in and out. That's my thing and you can smell the salt in the sea. I love that.'* (Grace, 58)

For some, being able to connect with nature through more of their senses represents a more complete connection to nature.

> *'[...] Because where I was before, even five years ago, nature, it's there. It's nice, lovely views [...], but I was not connected fully until I came to the allotment. Because [before] you just walk on grass, you notice it, but [you are connected fully] until in a way you use all your senses. You touch, you smell, you eat [...].'* (Tony, 56)

This difference may arise from the view that each sense acts as one avenue to connect with nature. With more avenues available, older people tend to perceive a more holistic connection.

> *'[...] It's nice for some of these people to focus on something in nature to connect them to what they're doing, because if it's all like just going out for a walk and you don't really know where are you going or what are you doing and you're just sort of out for the reason, what is this? It [sensory experience] is a really 'back to basics' way to connect to nature.'* (Abi, 29; intervention provider)

Such variation is also reflected in the wellbeing benefits older participants gained from nature. The benefits of connecting with nature through a single sense appear to be short-lived and one-dimensional, whereas multi-sensory connection can last longer and promote overall wellbeing.

‘[…] There is like an instant enjoyment of smelling something or tasting something or hearing something. […] I think if you choose just to sit somewhere and take it all in, there's a real taste of a feeling of wellbeing and that for me involves all of the senses […].’ (June, 66)

Additionally, engaging with nature through multiple senses provides older participants with different sensory needs with more opportunities to connect with the natural world. By having access to diverse sensory experiences, the reduction or loss of specific experiences is compensated for to some extent. Therefore, despite age-related sensory decline and differences in sensory processing, they still enjoy nature in their daily lives. As May's response to whether her sensory function had changed because of ageing during the interview:

'My sight is not as good as it was, but my hearing is very good. When you go into the garden it's lovely because obviously robins are singing. If it’s very quiet, I like to listen and see if there's anything about a little whisper or grumble there. Quite often robins come and hum a little to me. It's the most unusual sound. It's very tiny. It's just humming and I was thinking ‘’Oh, that’s great.’’ […]' (May, 72)

Another example comes from a participant who had difficulty noticing the information through her sense of touch.

‘It's just something that I've always had, no feeling really. […] Touching things, I don't get that much response back […].’ (Mavis, 57)

Mavis had been participating in the nature-based intervention for about seven years. When she first started taking part in the intervention, she could only interact with nature by watching it. While she became more involved in the intervention, she realised there was more than one pathway which could be used to connect with nature. She began to use other sensory pathways to receive information from nature (e.g., smelling the scent of soil and leaves and listening to birdsong and crunch of frost) rather than simply seeing it. By doing so, sensory processing differences in touch did not reduce Mavis’ enjoyment of engaging with nature.

'I think maybe I'm more aware of other things [nature experiences received from her other senses]. I think other things compensate for it.' (Mavis, 57)

Similarly, many professional participants emphasised that the multiple ways of interacting with nature that the senses created made nature-based interventions more accessible.

'It [using all senses] just gives people different ways to join in, doesn't it? [...] I think that just caters for everyone's different needs or preferences about how they engage.' (Helen, 42; intervention provider)

Experiencing nature through the sense of touch as a substitute for visual experience was commonly discussed by them, which helped older people with visual impairments participate in the interventions. For example, Tom described the adjustment he and other team members made when considering whether the activity of searching for specific colours in nature might limit the engagement of blind activity participants.

'[...] We hand out different cards with different colours on it and it's about people finding colours out in nature. That's obviously limited to people who got their sight, so that's where we might want to broaden that to not just be about colours and what they can see, but add in another sense like touch. [...].' (Tom, 36; intervention provider)

This idea was also echoed by older participants who lived with sight loss and who had contact with visually impaired people. As Nelly indicated:

'[...] If you can bring nature into your life and connect with nature, it gives you so much. I think it is especially true for some who do this challenge with blindness because they have to depend so much on their other senses. That's why I think 'touch' is good because they can feel how big something is or how rough or smooth something is [...].' (Nelly, 65)

Interestingly, the above phrase *'That's why I think 'touch' is good because they can feel how big something is or how rough or smooth something is [...].'* seems to explain why the tactile pathway can be used as an alternative to the visual pathway to support visually

impaired older people's connection with nature. Among the other four senses, only the sense of touch has a similar function to vision in providing information about the size and texture of natural elements. This commonality between touch and sight is also found in the experience of one participant who had difficulty receiving tactile messages. Although Mavis was unable to feel the moment when the ice particles on the crocus went from solid to melting, by looking at this scene she could picture what people might feel if they were able to receive this tactile information.

> *'[...] It's amazing to see the particles of ice all round the top of the bud of the crocus. [...] You could feel them I would imagine. It did melt, but you could feel them as well, that crispness of solid ice melting through a second. I haven't got much feeling in my fingers, that's another story, but I would imagine other people can.'* (Mavis, 57)

Another often discussed alternative was to support the loss of auditory nature experience through visual experience; when nature-based interventions involved activities regarding the sense of hearing, providing corresponding texts, pictures and other visual information helped hearing-impaired participants to engage.

> *'[...] Someone might not be able to hear something. [...] This is why I think it's sometimes important to be able to print things out within a group as well. So if someone has struggled to absorb some information that we've said with the group, they might be able to take the information and leaflet on and take their own time to read it in a bit more and then understand it [...].'* (Tom, 36; intervention provider)

It is important to recognise that this alternative pertains to visual information designed to aid hearing-impaired older people. Since visual nature experiences are common in nature-based interventions, and hearing loss is a less visible impairment, the reduction or loss of auditory experiences may be overlooked or assumed to be already compensated for. Kate called for raising awareness of the needs of older people with hearing impairment in intervention participation:

> *'[...] Deafness is something that actually not so much attention has been paid for older people. [...] I think it definitely is one of those hidden disabilities. If you see*

someone, you don't know if they're deaf or not. If you see a blind person, you can tell that they can't see, or they have a guide dog, or they wear very thick glasses […].' (Kate, 65; intervention provider)

6.3.1 How multiple sensory experiences with nature can be increased

Two approaches can be useful ways to enhance multi-sensory connections with nature. While engaging with nature through multiple senses can benefit older people's nature experience, some professional participants found that they needed more guidance to gain multi-sensory experiences in the space.

'[…] I suppose it won't be easy to just ask anybody to go out and do that on the road. If it comes forward with building their confidence up to be able to find that experience on the road, know what to look for and what to listen to.' (Abi, 29; intervention provider)

The participants' experiences demonstrate that increasing older people's awareness of different sensory pathways available for engaging with their surroundings can facilitate their use of more senses to experience nature in their everyday lives. Two ideas are raised based on the views and experiences of the participants, for example, guiding older people to explore natural elements that emit fragrances and give different haptic sensations in nearby parks and gardens. Several scent-producing natural elements common to these spaces are noted, including wildflowers, lime trees, lilac trees, roses, and water features.

'[…] by taking people out into the park…and connecting with things that we know are going to provide a good smell […]. Texture is important if you think about walking and what you're walking on. […] So walking on grass, walking on sand, that feels really nice under your feet. […] There are many plants that feel nice in your hands. […].' (Kate, 65; intervention provider)

A wide variety of natural elements are believed to offer haptic experiences, ranging from parts of plants (e.g., touching a tree's bark and running hands through grass) to natural building materials (e.g., feeling the porous surface on a wall and the punchy sensation of walking on a gravel path). Among these experiences, stroking the soft, furry leaves of

plants such as lamb's ears is often liked or considered as therapeutic as petting an animal. While both hands and feet have been suggested as ways for older people to gain tactile input, some professional participants indicated that barefoot experiences might make them hesitant to participate. Abi recognised this situation and made adjustments to her barefoot walking activity:

> *'[…] you can take your shoes off and walk through it with different sensory feelings on your feet. We've also had little pots, so if you can't get up and walk through it or you just don't want to, and the pots are there, on the side of it, so you can still have that experience, but with your hands rather than your feet. […].'* (Abi, 29; intervention provider)

Raising awareness of multi-sensory experiences amongst older people can also be achieved in one location without the need to move. This can be done by encouraging them to record/feel information received through various senses in the space, through activities such as drawing or describing their surroundings, or simply quietly practising breathing exercises and experiencing them.

> *'[…] Drawing or writing, like I'm here sitting, describing, makes me engage in nature more because I notice things. I can then smell. As I'm drawing or writing, ''What am I smelling? Nothing.''. Actually, sometimes we have fire over there or sounds. I can hear sheep. I can hear birds […].'* (Tony, 56)

Another approach to enhance multi-sensory connections is by incorporating natural elements that stimulate different senses in nature-based activities and environmental design. Aromatic plants are commonly used by the participants to enrich their nature experience. These plants can engage more than just the sense of smell. For example, some aromatic plants also have ornamental value (e.g., sweet peas and lavender), and many herbs are not only edible but also need to be touched to release their scent (e.g., sage and rosemary), creating a tactile experience. Scented plants often attract bees and butterflies, providing additional visual and auditory sensory dimensions.

> *'My garden is particularly set out with lots of fragrance, such as flowers, bushes, and things like that. I do enjoy smell. I enjoy touching things and then if it's left to*

smell on my fingers, I really enjoy that. But I also enjoy…because they are fragranced, the sound of bees, the bees in the garden […].' (June, 66)

Specialised sessions and environment design appear to be more effective in enhancing the taste experiences of older people. Although many edible plants were thought to be present in outdoor environments, some professional participants expressed difficulties in encouraging tasting in non-dedicated activities and spaces. For instance, activity participants might lack the ability to recognise edible plants, which could lead them to mistakenly consume inedible plants in areas where edible and inedible plants coexist; improvising foraging behaviour and the need to double-check their collections for safety reasons might also disrupt the flow of the activity.

'That's the first one we struggle with at the minute. We do have some herbs around the gardens that you can pick a bit and try some […], but it's not always easy to get into the places for just the reason of…we don't want to put anything out there, somebody then has another reaction there. We don't want to put berries out in case they try to eat something that shouldn't. […]' (Abi, 29; intervention provider)

A few professional participants reflected on how the physical environment had influenced the multi-sensory experiences of older people and what adaptations were helpful. The adaptations included using raised beds and plants of different heights to enhance the tactile and olfactory experiences of activity participants with mobility limitations, and employing more structured planting methods (e.g., using string or grids to guide planting distances) to support visually impaired participants in gardening activities.

'[…] a raised sensory garden so that you can sit on the edge and just read everything and be able to touch everything. There are lots of smells and textures. […] We use string lines so that we can make sure it's in a straight line in the beds. That's really beneficial for her [a blind activity participant] to be able to do everything that everybody else is doing. She planted all the squash for us in the garden […].' (Laura, 43; intervention provider)

These reflections highlight that when incorporating natural elements that stimulate different senses, it is also important to consider whether older people with different needs can access certain sensory experiences that often require physical or close contact with natural elements to perceive and make adjustments.

6.4 Chapter summary

This chapter examined the role of sensory pathways in older people's nature connection. Various ways of visual engagement with nature fostered numerous connections between older people and the natural environment. Tangible experiences of nature enabled older people to relate more closely to nature, thereby facilitating the development of a deeper nature connection. Multi-sensory engagement contributed to a more comprehensive sense of connection to nature and wellbeing compared with single-sensory engagement, and supported older people in maintaining their connection with nature, especially those experiencing age-related sensory decline, sensory processing differences, and sensory impairments.

Chapter 7 – Barriers to sensory connection with nature in older people

7.1 Safety considerations when engaging with nature through touch and taste

This theme discusses safety considerations that affected participants' sensory connection with nature. During the interviews, when asked about their experiences connecting with nature through the senses of taste and touch, participants commonly expressed concerns that tasting and touching natural elements, such as fungi and plants, could be harmful to their health. This health influence included poisoning and cuts. Thus, they had been cautious or avoided using these two sensory pathways to engage with nature. For example, after describing her connection to nature through each her other senses, Mavis stated:

> *'I mean I'm not saying you should taste all things [...] when you are foraging, you've got to be careful what you taste because you don't want to poison yourself.'* (Mavis, 57)

Since May didn't like the stinging sensation caused by certain plants, she did not have many tactile experiences of nature. She was usually shielded by wearing shoes and gloves when physical contact with natural elements was needed.

> *'Not so much although I do like walking on the grass with bare feet, but I think because of bites something like that if I'm close. I do appreciate all the different prickly leaves, holly leaves, that sort of thing, but I don't tend to touch them so much. Well, I do, but with gloves on, so obviously it's not such an instant feeling.'* (May, 72)

While Nelly described her taste experience with nature, her description also conveyed her safety concerns involving the sense of touch. The thorny features of blackberries could harm foragers, although she thought that they were relatively easy to identify as edible fruit in the wild.

> *'[...] There are ones if you know which ones to pick, [...] like to eat blackberries, you have to use your hands to touch them and make sure you don't get cut because its thorn is really sharp.'* (Nelly, 65)

One professional participant echoes the situation that edible plants with tactile safety concerns could also influence participants' taste experiences of nature. Kate described a lack of activities related to the sense of taste in the nature-based intervention she provided and noted the barriers to this. She talked about a session in which she unsuccessfully led the group to pick blackberries in the park, and explained:

> *'[...] There used to be some in [park name], so maybe the park keepers cut them down because they are really sharp, sharp prickles, sharp thorns.'* (Kate, 65; intervention provider)

Kate went on to describe another factor in her experience that affected activity participants' connection with nature through the sense of taste, which echoes the above older participants' concerns about the poisonous features of plants.

> *'It can be because of fear. They're afraid that they might eat something poisonous. I did see some poisonous berries in [place name].'* (Kate, 65; intervention provider)

The above experiences and views illustrate that participants were often concerned about the harm that physical characteristics of natural elements (e.g., poisonous fruits and spiky leaves) could cause, therefore decreasing their connection to nature through the senses of taste and touch.

A few participants' safety concerns about engaging with nature through touch and taste involved psychological factors regarding fear of potential risks. For example, Karen described that her taste experience of nature was different from that of some people she knew:

> *'I'm not somebody that can go around foraging and picking berries or whatever, but I love to gather them and then I'll go home and bake with them. I love baking, so I'll bake with the vegetables here [the allotment]. I love like getting loads and loads of plums going home and making plum jam, making it plum crumble or whatever, so I kind of forage then cook with it rather than just eat it straight off there. [...] I think for me there's something about knowing that they're clean [...].'* (Karen, 55)

Karen also expressed concerns about potential risks that prevented her from trying out touch experience she wanted:

> *'I've got a friend who's really into barefoot walking. Quite often when she's going on a walk, she'd take off her shoes and socks and just walk through nature. […] Most of the places we walked, I wouldn't walk barefoot, because I'm not sure what would be on the ground. I've often wondered how it would feel to be barefoot in nature, whereas I think we're kind of often shielded from nature. We always got shoes on and stuff like that.'* (Karen, 55)

It seems to be understandable that the participants had these psychological safety worries about using their senses of taste and touch to connect with nature. Engagement with nature through these sensory pathways often involves closer physical distance and even invasive experience. For instance, fruits eaten by participants will then be absorbed into the body. In addition, regardless of physical or psychological safety concerns, in some activities that inevitably required tangible contact with nature (e.g., gardening), participants chose to wear protection (e.g., gloves) to reduce the risk of possible harm. This can broadly prevent them from engaging with nature through the sense of touch.

On the other hand, psychological safety considerations can relate to whether participants feel comfortable using their senses to connect with nature in space. A few participants' narratives reflect concerns about what other people would think about their behaviour when they wanted to use the sense of touch to engage with nature, as Ada described:

> *'[…] You have to see if there's anybody else walking down the path, and I hug that tree, touch its bark, because I think if you've survived all that […] then I can do it.'* (Ada, 77)

In the case of Ada, she instead experienced the rain in the domestic garden and hugged the tree after confirming that no one was around. Her actions suggest whether a space feels psychologically safe for participants can affect sensory connection with nature through the sense of touch.

7.2 Challenges to establishing auditory and olfactory pathways with nature

The next theme explores how the senses of hearing and smell can operate in nature and how this affected participants' connection to nature through auditory and olfactory pathways. Establishment of the auditory pathway in nature connection relies on participants being able to receive the sounds of nature in environments. Such operation can be demonstrated in the experiences of many participants; they described having a greater connection with the sounds of nature when there was less noise in the space. As Tony compared his engagement with natural sounds during and after the Covid-19 lockdown:

> *'[…] In the lockdown, we couldn't hear any cars. Because there were no cars, we could hear birds, we could hear all. It was just amazing. But then after the lockdown, we couldn't hear the birds, because cars were [the participant imitated the car sound]. All you could hear were cars. […]'* (Tony, 56)

When other sounds around a space are louder than those produced by natural elements (e.g., birdsong and rustling leaves), it can prevent participants from connecting with nature through their auditory pathway. This situation seems to be particularly limiting for participants living with sensory disabilities and having special sensory needs. During the interviews, three participants with sensory impairments (e.g., blindness and deafness) and two with sensory processing differences (e.g., over-sensitive or more tolerant to specific sensory experience) highlighted how other environmental sounds could negatively impact their engagement with natural sounds. For instance, for Susan, the sense of hearing has been the most important sensory pathway to connect with nature. After she began to live with moderate hearing loss, she became especially grateful for the opportunity to experience the sounds of nature.

> *'Probably hearing. I may not operate too much on that. Maybe because I'm losing my hearing to nature. I maybe try to appreciate it more now. But I've never been one for picking berries, blackberries or anything like that. […] And smell, I nearly think because of thoughts within me, usually about memory. And Taste, I don't get a lot of pleasure throughout food. […] I never have good eyesight, but hearing is a lot more important to me than looking at a decent bunch of flowers. It sounds terribly*

depressing. A bunch of flowers will die. Flowers will die within a couple of days, but for the time being at least birdsong is constant.' (Susan, 66)

In the interview, she noted how artificial noise in the environment hindered her connection with nature through the sense of hearing.

'The day I went to [place name] […] one sound was like mechanical. I think it was a lawnmower or hedge trimmer. The other was [name] playing. I thought 'Oh, you have no chance to hear birds around here'. (Susan, 66)

Grace stated that due to her autism spectrum conditions, she might experience auditory sensory overload while there was too much noise in a space. She usually coped with this sensory overload by 'turning off' ambient sounds herself.

'I tend to get overloaded with noise, so I have got a habit of blocking out noise I don't want to hear. I can totally switch off.' (Grace, 58)

Although this strategy helped her manage the overload of sounds in her daily life, she indicated the influence it could have on her experience of hearing in the nature-based intervention.

'When I was up there [a place that the community group visited for the nature-based intervention], the building work was going off. There was too much repetitive noise that I couldn't cope with. […] So I was trying to sort the noise out, but then I couldn't hear the conversation.' (Grace, 58)

June was visually impaired. She described the experience of sitting alone in her garden and establishing a connection with natural sounds.

'[…] Mainly the sounds, the sound of nature. I love hearing about animals and different birds. I don't necessarily know what the birds are, but I do love to hear that. […] If I could see to go to other places and do that on my own, I would do it, but as more often it's not, I will do that in my garden. I am fortunate really because I'm living in a fairly quiet area […].' (June, 66)

In the above description, despite June's limited mobility, her connection with natural sounds was not hindered because she had a space that was less disturbed by the surrounding environment at home. However, the phrase *'If I could see to go to other places and do that on my own, I would do it, but as more often it's not, I will do that in my garden.'* reflects the potential impact of her limited mobility caused by visual impairment on engaging with nature through the sense of hearing. Her description suggests that visually impaired participants are not able to travel to places where they can better connect with the sounds of nature as freely as those who can see. Therefore, when the spaces accessible to them are not quiet enough for natural sounds to be heard, their opportunities to connect with natural sounds are more likely to be hindered.

Regarding the sense of smell, people usually passively receive stronger smells rather than actively smell things in environments; we do not get close to everything in a space to pick up its smells, whereas we notice when a scent or odour comes to us, although sometimes we make a conscious decision to smell something that we want to know about. This common way of receiving smells is reflected in some participants' smell experiences, such as the experience Pat described:

> *'Sometimes when it rains it smells a bit different. I think especially about moisture, I love the smell of moisture. […] I love to sit around the fire and love the smell of burning wood. That's great. When you're walking around, there's a smell that is kind of waft, especially in springtime, when you get the blossom […]. This one particular tree is really pungent. It's got a really pungent smell. That's really nice.'* (Pat, 61)

During the interview, Fred did not describe any more experiences with smells except for listing several common scented plants. He noted:

> *'There's nothing to smell. I suppose you can smell the lavender. You can smell the mint, the roses. No, I can't think of it. […] I can't see where the smell comes into it a lot unless a flower or something gives off a strong scent.'* (Fred, 83)

His statement again illustrates that passive exposure to strong scents is a common way for participants to gain olfactory nature experience. It also reflects on the challenges they may face in connecting to nature through the sense of smell if they are unable to

recognise scented natural elements. Indeed, in a natural setting, many smells produced by natural elements (e.g., scents of flowers and herbs) do not deliver strong scents that participants can receive from a distance. Establishment of an olfactory pathway in nature often requires them to identify scented natural elements, and then actively approach or even physically contact them (e.g., close to flowers and rubbing leaves of herbs) to obtain the scents. This process was echoed by Rachel who described various smell experiences of nature in the interview.

> *'[...] You can smell those wild rosemary and wild sage, so if you recognise them, you can smell them. [...] I love herbs, especially thyme, rosemary and lavender. You just get to touch them and the smell is wonderful.'* (Rachel, 65)

However, the way the olfactory pathway operates in nature may result in participants having fewer opportunities to experience natural smells, since they are not always aware of which natural elements have smells and do not actively smell them extensively.

7.3 Unawareness of connection with nature beyond vision

The concept of this theme is to illustrate the lack of awareness among some participants that all senses could be used to connect with nature. To this end, the theme explores situations where participants interacted with natural elements through their senses but were not fully aware of their connection with nature (i.e., did not perceive the relationship between themselves and the natural world). Some participants' sensory experiences did not represent being connected to nature. These experiences seem to result from a situation in which the participants were unfamiliar with using specific sensory pathways to engage with nature, but still sought to share experiences related to these senses and nature. Pat's statement below provides an example of this situation:

> *'I don't think I've ever really thought about using touch as a way of... [connecting with nature]. [...] I do like wood. I don't like metal. Metal is cold and wood is a natural material. I like the feel of wood. [...] But when we do physical activities...for instance, the clearing of the Beech trees. We used the sense of touch then, but I think I wasn't focusing on that sensation.'* (Pat, 61)

During the interviews, some participants were not as explicit as Pat in stating their experience of not being connected to nature through specific senses. Such unawareness of connection with nature often occurs while they described experiences relating to hearing, smell, taste, and touch. These data are presented as follows:

When a few participants were asked about their hearing experiences of nature, they seemed to be thinking about and naming those visible natural elements with sounds. The sound of nature seems to be just background sounds in the participants' experiences; it is embedded as an integral part of natural elements, but is only incidental to their visual experience. For example, Ivy responded to the question by pausing to think, giving a brief answer, and then moving on to another topic:

> *'My hearing of nature…maybe hearing of the thunderstorms and maybe the rain. I love the rain because I need the rain to water my garden.'* (Ivy, 50)

In a few instances, the use of smell only served as a warning. It was used to identify harmful, wanted-to-avoid, or unknown natural elements. As Susan used it to avoid tasting the seasonal soup in the nature-based intervention:

> *'I didn't have any soup because it smelled too much like garlic and I can't cope with garlic.'* (Susan, 66)

Experiences with the sense of taste were linked to foods in participants' daily lives in many interviews. Some of the participants accessed food sources through the natural environment, including gardening and foraging. They were aware of their connection with nature when they ate the produce. A feeling of wellbeing was gained through enjoying tasting food and feeling rewarded for their hard work in growing and gathering produce. Nonetheless, for a few participants, when they linked their taste experiences to foods, the foods were simply products that they knew could be considered part of nature, such as potatoes growing in the ground and apples on the tree. They did not seem to be connected to the natural world through these experiences. One possible reason is that store shopping has become the primary way people obtain food ingredients. A few participants who had multiple experiences of connecting with nature through taste also believed that it is a challenge for people today to establish a connection between nature

and taste. The changes in food purchasing have made people connect to stores instead of the natural environment while eating. Furthermore, with this change, obtaining food from nature is no longer part of people's daily lives during childhood. As a result, the lack of awareness of a connection with nature through taste could become more pronounced in younger populations than those currently studied.

> *'[...], maybe a lot of people nowadays don't get the benefit of tasting natural things. I mean I do know quite a few people who have allotments, grow their own foods, make their produce from that food, and thoroughly enjoy that, but I think possibly nowadays they will be in the minority. [...] We seem to have lost that connection. Even as a child, [...] I do remember doing things like growing, planting seeds to grow vegetables and things like that, so we were out in nature. Then as we got older, we would cook things [...].'* (June, 66)

A few participants only used the sense of touch as one of the actions needed to achieve other purposes. When they were asked about their experiences with touch in nature, they responded to those in which they had the opportunity to have physical contact with natural elements.

> *'Yeah, I touch them, because when I'm picking the plants, I use my hand in picking them, and then I smell the leaves and plants.'* (Ivy, 50)

In these tactile experiences, the participants focus on their end purposes, such as releasing the scent of herbs and gathering produce, rather than feeling the texture of natural elements. However, experiencing the textures is a way to connect with nature and enhance multi-sensory experiences. This has been demonstrated in the theme 'Completion and compensation: multi-sensory connection with nature' in the previous chapter 'Understanding sensory pathways to connect with nature'.

7.4 Chapter summary

Three barriers to older people's sensory connection with nature were illustrated in this chapter. When older people's nature engagement involved touch and taste, careful considerations were given to both physical and psychological safety. Older people faced challenges in establishing auditory and olfactory pathways with nature since their

environments and habits were incongruent with the conditions for developing these sensory pathways. Feeling connected to nature involved behavioural changes and wellbeing benefits. Lack of awareness of establishing nature connection using non-visual sensory pathways influenced older people's opportunity to benefit from it.

Chapter 8 – A temporal perspective: the connection between time, older people, and nature

8.1 Impact of time on becoming connected with nature

The data that form this theme demonstrate the influence of temporal qualities on participants perceiving nature connection. Perceiving connection with nature means that participants are aware of their relationship with nature and have a feeling of being connected to it when they interact with natural elements through their senses. Such a state was described by the participants as *'tuning in to the environment'* (Helen, 42; intervention provider), *'switched on'* (Mavis, 57) and *'your senses open'* (Ivor, 61). Seven older participants, who had only recently (re)connected with nature due to their participation in nature-based interventions and during the situations of the Covid-19 pandemic, in particular expressed their awareness of entering this state, and the differences in engaging with nature after they were in the state. Below, the theme will first discuss participants' experiences as they began to perceive a connection with nature, and then explore how different temporal qualities and their associated behaviours affected this connection.

All seven participants noted that becoming connected to nature involved starting to actively notice nature using their senses. As illustrated in Fred's experience below, although he had been exposed to some natural spaces, being able to consciously observe natural elements in the environment was the beginning of his feeling a connection to nature.

> *'[…] it [the nature-based intervention he has participated in] certainly opens my eyes to a lot of nature, which I've not seen before. Before I just walked through the park, not looking at anything and connecting with nature, but now I walk and I'm looking at the things. I enjoy it. I think it helps me as well.'* (Fred, 83)

Actively noticing nature also appears to be associated with a shift in mentality, rather than simply using (or not using) the senses, which was reflected in Mavis's statement. She only reconnected with nature after participating in the nature-based intervention

offered by her local wildlife trust. Of the period of time when she didn't feel connected to nature, she explained:

> *'I think I was so busy. I was watching squirrels, but I think it was a case of dashing to work, watching squirrels again, dashing back to work. I was there. I was watching bits of nature and I was watching nature on the telly, but I don't think I was actually taking it in enough to get any benefit from it. Where is it now? […] My head is actually feeling the benefit of it.'* (Mavis, 57)

Mavis's description shows that the change in mentality brought about by retirement enabled her to truly connect with nature. Noticing nature became meaningful, whereby she began to gain the benefits of engaging with nature. Another difference in becoming connected to nature that some participants mentioned was that they began exploring nature on their own, outside of nature-based interventions:

> *'I will find the time to do that, go for a walk to look for something. I am more interested in it like my hobby and spend my time.'* (Emma, 68)

This makes perceived connection to nature an important factor to be developed in nature-based interventions, especially those funded through social prescribing routes, as it may foster participants' motivation to extend nature engagement into their daily lives. As described in Section 2.2.1, social prescribing supports referred individuals to participate in an intervention for a limited period of time (usually up to 12 weeks), with the intention that they will be able to use the gains made during this time to tackle their needs. This intention is not always easy to achieve when interventions simply deliver activities without cultivating their independent subsequent engagement. Such a mechanism could potentially have negative consequences (e.g., triggering participants' negative emotions when they had to leave or feeling their needs were unmet because the time was too short), as raised by a few professionals and older participants in their interviews.

> *'In lots of commissioned activities, people get a place for 12 weeks and then they have to move on to something else. […] Although it is a nice way to do a funding*

model, it's not very helpful for the actual person who you're inviting to come to the session.' (Clare, 42; intervention provider)

'When I thought I might not be able to go again because my social prescribing time was coming to an end, and that made me…I was really upset.' (Ada, 77)

The impact of temporal qualities on perceiving connection with nature was demonstrated in the narratives of some of the participants. One is the influence of physical time (i.e., time measured with a clock). Unlike 'having time' due to retirement, children growing up, or less time spent on fitting in society, which was commonly given by many older participants as a reason they increased exposure to nature, the experiences of participants who were new to nature reflected that becoming connected with nature is a process that takes time to develop.

'As time went on, I found it was getting easier to concentrate and easier to focus. I wasn't just looking at things. I found I was actually hearing things as well at the same time. […] Then, you start to find things. […] Like when it's autumn, you can somehow smell autumn in the air. The soil or the leaves on the floor…there's a different smell with autumn. […]' (Mavis, 57)

Another time-quality influence involves a behavioural change: slowing down. Some participants described slowing down as an act of being able to notice natural elements in the environment and therefore closely related to their 'becoming connected with nature'. In a few cases, it was simply attributed by the participants to changing the speed of action. For instance, Pat provided a specific description of the differences in their behaviour after beginning to connect with nature. Walking in the same space, slowing down was thought to be an important change in increasing their nature awareness.

'When I had a dog, I did enjoy walking my dog in the woods. But I never really connected as much as I have done recently with nature. It was more concentrated on keeping an eye on the dog or meeting dog walkers, so I was in that place, but I was never really as connected to it as I've got older. […] I think I'm just more aware. I think I taught myself to stop, whereas before, […], I was walking quickly.' (Pat, 61)

Yet for some participants, it appears to be more of a behavioural manifestation involving a change in mentality, related to ‘shifting attention to nature’ or ‘attitudes and emotions while engaging with nature’.

> *'[…] If I'm trying to get something done, it's not being able to take time and pause and you kind of notice stuff, because I'm busy doing so there's something about being able to come to [name of the intervention] or go for a walk which is slower and therefore engaging in all the senses in a way that I don't have time to do when I'm busy trying to get work done.'* (Karen, 55)

Several participants’ descriptions highlight how the circumstances of nature-based interventions could both facilitate and hinder slowing down involving a shift in mentality and further influence them to notice nature through their senses. For example, Tony used an example where the facilitator made an adjustment for the intervention delivery after she realised that carrying out gardening tasks caused activity participants to focus too much on the physical activity itself, affecting their awareness of the natural environment around the allotment.

> *'[…] Normally, I'm busy doing. When I stop having a cup of tea or chatting, I think ‘oh, that sound’, then I notice the sound. […] I think there's something about finding ways to slow down. Because in here [location where the nature-based intervention took place], it gives me the job, I want to do the job rather than enjoy the space, which is why in two weeks she [facilitator] said no jobs, we just gonna have a fire, food and chat. Let's enjoy this space, which I think it’s good.'* (Tony, 56)

On the other hand, Ivor noted that the nature-based intervention could provide conditions that negatively impacted nature engagement. Ivor was a participant who reconnected with nature while working from home during the Covid-19 pandemic. He then joined his wife in the intervention. Although interacting with like-minded people was indeed one of the factors that attracted many participants to engage in the nature interventions, Ivor expressed that a lack of balance between socialising and nature engagement provision during the intervention did not meet his needs; especially in winter, intervention attendees were more reluctant to go outdoors, and the facilitators

also shortened outdoor activity time and chose to arrange the indoor craft-making activities that had little connection to nature rather than relevant ones.

> *'[Intervention name] in the winter apart from a short walk does not incorporate much to do with nature. […] Maybe [intervention name] is more of a social group to some people. Some people go for the company, the chat and a cup of tea. […] There are people who want to learn more about nature in the group. […] I am okay if you just want to sit and chat with friends. It's a social setting, but it's not [intervention name] [the name was used directly by the participant here probably because it conveyed that the intervention was nature-focused].'* (Ivor, 61)

Importantly, this circumstance affected Ivor to turn his mindset toward nature, so his sensory connection with nature occurred:

> *'[…] After [intervention name], we walk across the park to the other side and when you set off from [intervention name] which is being noisy, people chatting, everything going off and you're going to the park. […] Your senses pick things up. You hear the leaves rustling, which at first you don't, but your senses start to pick things up. You will hear the wind in the trees. You will hear the birds calling. You will see the birds and the squirrel is in the trees as you're walking through. You will smell the freshly cut grass. You will pick up on all these things. […] '* (Ivor, 61)

In the interview, Ivor likened such unbalanced intervention situations to his experiences in the town and city:

> *'Your body reacts differently to it. […] When you're in [city name] city centre, you are prepared or alert for anything that could happen. You may have to step back quickly if you're crossing the road if you're seeing the car. […] Your senses are holding on man-made things when you're in the city centre. Your senses are not listening to any other birds or seeing any animals. […]'* (Ivor, 61)

Drawing on his statement, nature-based interventions that deviate from nature engagement can drain participants' attention, making it difficult for them to shift their mentality and body to be able to notice natural elements in the environment, which is an important factor in becoming connected with nature.

8.2 Influence of previous experiences on sensory connection with nature

This theme discusses participants' experiences where illustrating sensory connection with nature was influenced by previous experiences. For some participants, previous sensory experience of nature laid down a template for how they would go on to connect with nature in later life. Previous experiences for this theme are defined as participants' experiences before older age, ranging from childhood to adulthood, while childhood experiences were more commonly mentioned by these participants in the interviews. The participants actively talked about their sensory experiences of nature in childhood. Some experiences were simply shared, while others were used to explain why they now engaged with nature in a certain way. The quotations below provide examples of how previous experiences contributed to the participants' sensory connection with nature across all sensory pathways:

In one interview, May described the importance to her of connecting with nature through vision. She particularly enjoyed observing colours in natural environments and incorporating her favourite natural hues into her living spaces, such as her domestic garden and home, through plantings. This habit stemmed from her childhood.

> *'We lived in [place name] when I was about 8 or 9 and I used to love that all the trees would be golden. That's probably another reason why I like autumn. [...] We have a lot of roses with hips and haws and the squirrels would come. The trees were fabulous. They were all golden and yellow. I think that's another thing...you know, memories sort of give you a lot of pleasure when you think of things like that.'* (May, 72)

Ada associated many sensory experiences of nature with her previous experiences. As shown below, she actively sought connections with nature through hearing and smell in her daily life; these were inspired by her childhood experiences:

> *'[...] kicking leaves up in the autumn. The noise is fantastic. The crunch under your feet is good. [...] So kicking the leaves up like a child...I have been caught once or twice by another adult saying ''Oh, you are back to your childhood''. Yeah, I never left it.'* (Ada, 77)

'In summer, when the pavements are hot and the rain hits them. […] The smell comes up from the hot pavement and that's a real smell of childhood, and even now when it rains, the smell is fabulous, isn't it?' (Ada, 77)

For June, who had a visual impairment, feeling the texture of natural elements (e.g., fuzzy leaves and rough tree bark) was her primary way to engage with nature during the nature-based intervention. She noted that her experiences with natural elements in school played a role in shaping this.

'When I was very young, we used to have things like sand pits in the classroom. We had like big trays with sand and water. All sorts of things that I suppose because we were children that couldn't see. There were things we could feel. They were tactile. […] I think there is a big connection between what you've done as a child, what you've experienced as a child and what you go on to do and experience and appreciate when you're an adult.' (June, 66)

The taste of a certain type of potato could trigger Rachel's memories of home in her childhood. She thus still sought this flavour in her life, which encouraged her to connect with nature through the sense of taste.

'I was brought up by potatoes and mashed potatoes. […] I like certain types of potatoes. They got the flavour. It's really lovely and reminds me of home, reminds me of our lives that I have those types of potatoes […].' (Rachel, 65)

A few professional participants also suggested that older people's previous experiences might contribute to sensory connection with nature in nature-based interventions. From their perspectives, older people did not always make the connection between their present sensory connection with nature and their previous experiences. These experiences needed to be recalled such as through group discussions.

'[…] I think sometimes they might be quite forgetful about those things that they've done in the past. Sometimes it's about reminding them of things and helping them remember times in their life where they enjoyed doing certain things […].' (Tom, 36; intervention provider)

Reminding older people how they previously engaged with nature through their senses could help them realise their lifelong relationship with nature and then deepen their connection. In addition, recognising that there have been nature experiences or knowledge in the past could boost older people's confidence in sharing their experiences, thereby encouraging interaction among activity participants.

> *'[…] but also you can ask that person: ''Oh, do you remember seeing these when you were growing up?'', ''Did you ever see these birds in your garden?'', […] I think people begin to realise they also have a store of knowledge that they can tap into. It might be deeply hidden from their childhood. […] Then, they: ''Oh yeah, I know that. I remember that.', and then they can pass that knowledge on to the next participant.'* (Kate, 65; intervention provider)

Similarly, older people might have been away from activities they once enjoyed for a long time due to conditions such as ageing or disability. If the development of nature-based interventions could incorporate these activities, their participation might be encouraged. As noted by Tom:

> *'[…] They might have had a hobby or an interest that they did as a kid and then they've never done it since. I've thought about whether through different things you're able to get them to engage with that activity again and now it's helping them with their difficulties.'* (Tom, 36; intervention provider)

The experience of an older participant who had been taking part in the nature-based intervention for six months echoes the above perspectives. Susan described during her first involvement in the intervention, she was unsure whether the group would meet her needs. She felt that *'No, I'm not one for hugging trees. I'm not an outdoor person.'* (Susan, 66), and that such a large group seemed too noisy for her. Susan changed her mind when she visited the group garden, which reminded her of previous experiences.

> *'But once I got into [garden name], there were a little bit of plants just beginning in our little part [the area of the garden]. I love that even if I didn't touch more as most of them do. […] just stood and looked at them and felt them. It's enough.'* (Susan, 66)

Watching the plants growing in the garden brought back memories of a good time in her life, between her children growing up and her health deteriorating. This became the main reason for her to join the intervention.

> *'The quiet in the evening, when I came back from work, when I disappeared into the garden and went away from the TV or phone or whatever. I got gardening in the evening when it was quiet. That was my time. This has rolled me back into that.'* (Susan, 66)

Susan's description reflects that older people may indeed not have clear memories of nature experiences in their early life. Linking to similar activities via sensory pathways, such as Susan's through her vision, is likely to recall memories associated with those experiences. This can encourage development of nature connection and facilitate participation in nature-based interventions. However, it should be noted that memories of previous experiences can be unintentionally recalled through interacting with nature. Therefore, it is possible to trigger negative memories. In Susan's case, the smell of a certain flower reminded her of the moment when her health began to fail and evoked negative memories and emotions. In her life, she deliberately avoided having contact with this flower.

> *'[...] certain flowers, I won't go near because it takes me back to a time. It was maybe a bad memory. The particular smell from that particular perfume ... flower reminds me of something I don't want to remember ever again. [...] When I was first in the hospital, there was a bouquet of [plant name] and lily. I can't smell it now because of that emotional attachment that you want away from.'* (Susan, 66)

Another factor to consider is that previous experiences related to nature may vary across generations, so whether such experiences promote sensory connection with nature may depend on how each generation engages with nature. For example, early nature experiences influenced June and her friends of the same generation to enjoy connecting with nature through the sense of taste. She commented that the extent to which people experience nature through taste could be shaped by their upbringing in relation to nature.

'I think there are a lot of generational effects because if I think of my friends, all of whom are of a similar age [...]. All of those people have an interest in growing their own stuff and eating fresh foods. I'm not saying they're eating fresh food constantly and they don't succumb to convenience foods, but they are more likely to [have an interest in growing foods themselves and eating them]. I thoroughly enjoy using fresh food. So I think it's something that we carry with us from childhood.' (June, 66)

This view in a sense reflects when a generation no longer has the experience of engaging with nature through specific senses in early life, previous experiences may not facilitate sensory connection with nature, in terms of specific sensory pathways. A few professional participants were also aware of this generational effect. While Kate used a significant generational difference as an example (i.e., the 65-year-old herself, her grandparents, and the current children), she noted how sensory connection with nature in childhood varied between generations:

'[...] I think we learn about nature in a different way. I think when I was growing up, [...] we actually spent quite a lot of time outdoors as children [...]. If I think like my grandparents, they would know all the flowers. They knew which berries were okay to eat and which ones were poisonous. [...] Nowadays, I think that children learn a lot about nature from watching TV, from different apps or nature games on their computer [...].' (Kate, 65; intervention provider)

Today's children mostly interact with nature indoors through online material, which connects them to nature primarily through the senses of sight and hearing. This contrasts with the generations of Kate and her grandparents, who experienced many outdoor activities in childhood and had more opportunities to connect with nature using more senses. Again, this difference may influence whether previous experiences can facilitate sensory connection with nature across all sensory pathways.

8.3 Changes and adaptation: managing challenges through indoor sensory connection with nature

This theme demonstrates that for older people facing age-related health issues, mental health challenges, and accessibility issues relating to inclement weather, indoor sensory engagement with nature can serve as an alternative way of sustaining nature connection. The participants commonly indicated that ageing and its concomitant decline in health had an impact on engaging with nature. In terms of sensory decline, both older and professional participants perceived mobility problems as more detrimental to participation in nature-based activities than other sensory issues, such as sight and hearing impairments.

> *'When you get older, it might be more difficult to go for a walk. You can't walk that far. You can't. That's true. Ageing is one of the challenges as well.'* (Emma, 68)

In response to the consequences of age-related health decline, some older participants noted that they had turned their sensory engagement with nature to through (or adjacent to) indoor spaces. This change alleviated the challenges and difficulties they would have in outdoor environments, such as mobility limitation and frequent urination, and maintained their connection with nature.

> *'As a kid, I had a habit of walking out at night because I liked the smell of the dew forming at night. I love that. I used to sit there waiting for the dew to form on the fence because I like that smell. I don't do it so much now because I can't sit in the cold and wait for that to happen. It goes straight into my back and then I'm in agony. I have a lot of very sleepless nights and I now just tend to watch wildlife programmes because going out and listening to birds and the early morning chorus, I just can't do it because it is too cold. [...] I have got lots of houseplants. I bring that nature into the house now. So I still get it but not the connection I used to get as a kid [...].'* (Grace, 58)

Coupled with unpleasant weather, they expressed further concerns about exposure to outdoor environments: *'I don't go out much in winter, I might not come [to the nature-based intervention] as much in winter because I'm afraid of falling. I've fallen a few times*

[…]. Summertime, if it's too hot, I don't go out, so sometimes the weather keeps me in […].' (Nelly, 65), and preferred to connect with nature indoors, including through their homes, public spaces, and indoor nature-based activities.

> *'I do [enjoy nature], but not the cold weather. […], the path is difficult to walk, wet and damp. […] Sometimes in the winter, I walk around [name of public glasshouse] because you can see the plants like outdoors, then you feel warm. You do not feel cold in there.'* (Emma, 68)

Engaging with nature outdoors requires confidence building, as noted by several professional participants, especially for older people with age-related health problems, mental health challenges, and those who have not often participated in nature-based activities before.

> *'[…] I would love to be able to build up their confidence being outside in the garden, and then move to being able to take them outside in a nature reserve and still have confidence to be there, because I think a lot of people find nature reserves to be too open. Unfortunately, people just got so separated from nature, so the sensory side of the garden is all about building up people's confidence in being outside. Some people don't feel safe because they were attacked or abused in the past as well. Again, being in a confined space allows them to build that sense of safety. […].'* (Laura, 43; intervention provider)

Outdoor environments where individuals face various situations (e.g., different weather, terrain, and people) can cause discomfort and insecurity. Importantly, nature-based interventions that lack appropriate support and trigger these feelings can reinforce the belief that being outdoors is unfavourable. Consequently, several professional participants suggested that including indoor nature-based activities as part of the intervention could not only give older people who were hesitant to go outdoors the opportunity to connect with nature but also help build their confidence to engage more in outdoor nature.

> *'[…] I do like a bit of a dyadic approach. So for people who haven't had much experience of being outside generally, and be comfortable in that space, then*

maybe that's a good way in, to do a bit of indoor-outdoor activity to…build your confidence and then we go on to doing everything outside […].' (Helen, 43; intervention provider)

These indoor nature-based activities also need to take into account that older people are sometimes unable to reach intervention sites due to disabilities or inclement weather, rather than because they are not interested in engaging with nature. Providing sensory nature experiences that can be enjoyed at home can help them stay connected to nature. As Tom's observations to his activity participants and suggestions:

'[…] People might not feel comfortable going outside, they might feel isolated, they might feel like their disabilities restrict them from going outside or the park might be 10 minutes away, but they can only walk 5 minutes. So I think it's about making things closer to home or bringing it inside your home. That doesn't have to be anything expensive. That could be just downloading the videos. […] So they might listen to our natural sounds in their home or they might bring in some plants or some flowers that they can look after…it gives people something nice to look at or something nice to smell […].' (Tom, 36; intervention provider)

It is essential to consider that not all older population groups consider current forms of indoor nature engagement to be adequate substitutes for outdoor nature experiences. For example, those who primarily connect to nature through outdoor activities seem to have anticipated that mobility issues caused by ageing would eventually prevent them from going outside and see this as the end of their connection with nature.

'[…] My worry is what I'm gonna be like when I'm not able to do now, if I'm not physically capable of doing it. […] That frustrates me as I'm getting older.' (Jerry, 71)

Pat were on the autism spectrum. Due to differences in sensory processing, sound, especially artificial noise, posed challenges to their daily life. Natural environments surrounded by fewer people were where they escaped from the noise and felt at peace. Their comments on indoor nature engagement were:

'We have a [name of public glasshouse]. Unfortunately, it is full of people. I'd love to walk around there on my own if I'm honest. It'd be nice to just sit there quietly around all that lovely foliage. It's difficult because anything indoors would involve more people. I mean you can bring the outdoors into your home [...]. Obviously, it's not as nice as being in the woods because I live on a road that's quite...is not too busy but busy enough to hear the background noise. So it is not the same experience [...]' (Pat, 61)

Taken together, developing indoor activities and spaces suitable for older people with different needs to connect with nature requires more attention. Mobility issues that are shown to be a major challenge to outdoor nature engagement are a natural concomitant of old age, and indoor sensory connection with nature can also act as a transitional step for those who have not yet adapted to outdoor participation in nature-based interventions.

8.4 Nature's time: building a continuous sensory connection with outdoor nature through the seasonal cycle

This theme discusses how seasons contribute to participants' continuous (sensory) experience of the outdoor natural environment and wellbeing, and thus the seasonal cycle can be a useful framework to develop within nature-based interventions. Two professional participants highlighted the perspectives of offering seasonal nature-based interventions to encourage older people to engage with outdoor nature on a sustained basis. Older people may think that some weather conditions are not suitable for being outdoors. Different seasons are accompanied by distinct weather changes. Providing appropriate seasonal outdoor experiences can foster older people's sense of connection to nature year-round.

'[...] I think that's important for people to experience all the seasons and know that actually you can get outside in all the weather [...]. (Helen, 42; intervention provider)

The cyclical nature of seasons means that understanding how to connect with nature through them often remains relevant for subsequent years (although climate change may

require an ongoing update of our understanding of seasons, rather than viewing them as permanent).

> *'The good thing about the seasonal year is that you know they will repeat, and it might be the same. You help people engage with the seasons, so then they could anticipate and look forward to and celebrate [...].'* (Clare, 42; intervention provider)

Drawing on this perspective, the seasonal structure may cultivate older people to extend engagement with outdoor nature themselves beyond the nature-based interventions. This may be particularly important for those who are limited by the time-limited availability of the interventions, such as social prescribing funding for a restricted time period, and as Ivy noted:

> *'We've been seeing the environment and I kind of like it, but the timing...it's a short time, like an hour or two. I will go out, but I need to do more. I need to see more for myself. [...] Because of health reasons, I couldn't come for some time, so I chose to explore myself by taking a step to go out and feed the ducks.'* (Ivy, 50)

A few older participants also emphasised the influence of seasons on their perspectives of nature and wellbeing. For instance, the change of seasons is often accompanied by the alternation of plant growth and death. Noticing this life cycle appears to reinforce a participant's perception that nature is alive. As Karen stated:

> *'[...] you're far more aware of the seasons. So sitting here and there's the dead vine...because that is the summer thing, that is dying, but then alongside there're things they are growing because they thrive in the cold, and just that kind of feeling really connected into the rhythm of life [...].'* (Karen, 55)

Viewing seasons as time in the natural world, the natural elements associated with the seasons can create a form of 'present moment'. Seasonal nature experience provided Karen with a focus for her meditation and contributed to her mental wellbeing.

> *'I meditate quite a lot and one of the ways I meditate is by first focusing on the sounds [...] to come up here and quite often in the summer you'll hear the birds is wonderful and sounds like again being outside means that you hear sounds like the*

wind in the trees or the rainfall which is just really grounding. Again, kind of the seasonal things, what time of year it is.' (Karen, 55)

A few participants conveyed that the change of seasons represents a new starting point with positive meaning to look forward to.

'[...] I suppose you are always preparing for next season. It keeps you focused.' (Nelly, 65)

The above descriptions demonstrate the potential importance of incorporating seasonal elements into nature-based interventions. Similarly, this view was foregrounded by Clare, who had delivered the nature-based intervention for eight years at the time of her interview, in response to the design of activities in her intervention:

'[...] I think senses are so important because they're...for whatever senses that person has available to them, we can find a way to engage with nature and each other. [...] So we plan the seasonal programme and then we plan the seasonal sessions and then we plan the content of the sessions...often trying to, at that point, bringing different senses [...].' (Clare, 42; intervention provider)

Between seasons and sensory interactions with nature, the seasonal cycle can serve as an overall framework for developing nature-based interventions, and sensory nature experiences associated with seasons can be further used in seasonal activities to increase the inclusiveness of older people's interactions with nature. Indeed, sensory nature connections involving seasons were commonly discussed by older participants during the interviews. They described considerably more experiences in spring and summer, followed by autumn. Several natural elements contributed primarily to the participants' visual, auditory, and olfactory nature experiences during these seasons, including trees, birds, wildflowers, bees and butterflies. In terms of trees, they watched tree leaves change and flowers, listened to *'the rustling of leaves'* (Rachel, 65) and smelled *'the smell of blossoms'* (Pat, 61) in spring and summer, and heard *'the crunch underfoot*' (Ada, 77) while walking in autumn as dry leaves fell to the ground.

'[...] Watching that [tree] either the unfurling or the real blossoming in the summer, or then as it starts to go and fade in the colours of the leaves [...].' (Emily, 75)

The participants tended to birdwatch in spring and autumn, when birds migrate and have active breeding behaviour, while in summer they enjoyed abundant bird songs.

'I like bird watching. We do it twice a year here. […].' (Gary, 63)

'[…] quite often in the summer you'll hear the birds are wonderful […]' (Karen, 55)

Different wildflowers from spring to summer offered the participants visual and olfactory experiences of nature, such as Rachel's statement:

'My walking experience was really good. This summer we found a path and as each month went along, a different set of wildflowers came into blossom […]. These smells were different. […].' (Rachel, 65)

Especially during summer, the mutual relationship between wildflowers and pollinators attracted bees and butterflies, creating a multi-sensory experience for them:

'[…] being summer I might be in my garden. All the plants in my garden are for bees and butterflies. I don't have any ornamental plants. […] That's my way of relaxing. I will sit down with a cup of tea, watching bees and butterflies on flowers…just sit and enjoy, I'll listen to bees and butterflies.' (Gary, 63)

Seasonal haptic and taste nature experiences were mainly discussed by older participants who took part in nature-based interventions focused on gardening and who had domestic gardens. Gardening offered them year-round haptic engagement with nature through touching natural elements and engaging in physical activity, whether they were growing ornamental plants or vegetables and fruits. As Piers described the process of planting in his own garden:

'…bedding plants, these are planted in the summer. They don't last the winter, so they die off and you take them out and you place some autumn bedding plants […] I fetch my tender plants in for the winter, […] because otherwise they'll get frosted […] I'll have to water them, giving them a bit of water over the winter, and then next year I'll put them in bigger pots and feed them once they have exhausted the food from the compost.' (Piers, 60)

Although vegetable and fruit gardening enhanced the participants' seasonal taste experiences, it seems less accessible due to the ongoing effort needed to cultivate edible produce. This was reflected in the responses of a few older participants and a few professionals who did not provide nature-based interventions centred on gardening. Instead, such interventions used seasonal fruits and vegetables, either purchased or foraged by the intervention providers, to increase older people's taste experiences of nature. These experiences took the form of eating directly or facilitating them to prepare seasonal food together.

> *'[…] We would bring something with us, so we might bring a basket with some seasonal snacks. For example, now it might be an elderberry cordial or something and we'll bring that with us, and we'll have a little sharing of refreshments in a natural space […].'* (Clare, 42; intervention provider)

> *'I really enjoyed the sessions we do here when we make seasonal soups and cordials and things like that, out of things that have grown during that season, then we bring it all together to make something that we can taste. […].'* (June, 66)

However, in winter, the outdoor sensory experiences mentioned were few and considered monotonous. These included seeing the shimmering frost, hearing the crunching sound of walking on it, and trying to look after wild birds by feeding them. In this context, one participant's comment offers a potential explanation:

> *'[…] As long as it's not raining or snowing, we still connect with nature, but more for health reasons. A walk can be an exercise. There is not much nature because some of the birds have migrated, some have hibernated, and the rest are less mobile due to the cold weather. They huddle up together or…there's just not as much nature going off in the winter.'* (Ivor, 61)

Ivor's case shows that for older people who still go out in the winter, having fewer sensory experiences of nature may be due to the lack of natural elements with which they can interact, as the natural elements that they are familiar with from spring to autumn are less active or less present during the season.

8.5 Chapter summary

This chapter explored how temporal qualities in individuals and the natural world influence older people's sensory connection with nature. Temporal qualities of slowing down that involved changes in mentality and behaviour, as well as physical time, were important for older people to perceive a connection with nature. Previous nature experiences, tailored to individual circumstances, could foster older people's sensory connection with nature. Biographical disruptions such as ageing and disability interfered with older people's outdoor activities, making indoor sensory engagement with nature an alternative for staying connected. In terms of nature's temporal quality, seasonal sensory experiences could facilitate older people in maintaining a lasting connection with outdoor nature.

Chapter 9 – Discussion and conclusion

9.1 Key findings and contribution to knowledge

This is the first study to explore how older people engage with nature interventions using all five senses. The overall aim of this study was to gain an in-depth understanding of factors influencing older people's sensory connection with nature. To achieve this, the following research question was explored: what are older people's sensory experiences of nature-based wellbeing interventions?

Using a qualitative research design allowed for the exploration of rich sensory experiences whereby various interactions between older people and nature were examined in the present study findings. Existing literature has yet to focus on the sensory issues of older people in nature interventions. Findings from the present study revealed that multi-sensory engagement with nature contributed to a more holistic connection to nature and improvement in wellbeing for older people, and supported their nature engagement, particularly when they had sensory deficits.

Much of the literature on nature interventions has focused on the wellbeing benefits of engaging with nature for older people. The five senses are the established pathways we use to interact with nature, but how to better develop these sensory pathways to nature to help older people access to its attendant wellbeing potential has not been discussed. The present study findings showed that both physical and psychological safety were important considerations when older people used touch and taste to interact with nature. They also revealed a disconnect between the ways to establish auditory and olfactory pathways with nature and the practical realities of older people's surroundings and routines compromising their nature experience of sounds and smells. Beyond these barriers, findings highlighted the need to raise awareness among older adults about how their senses of hearing, smell, touch, and taste could serve as pathways to connect with nature. Combining the findings across sensory pathways, this study yielded insights into each pathway of connecting to nature (see Table 5 in 9.4.1). These insights can help nature intervention providers develop more supportive activities and environments to enable older people to better experience and benefit from the interventions.

Due to directing attention to individual contexts on older people's sensory experiences, the present study identified two important changes involving how older people engage with nature. First, this study population included older people who were new to nature or reconnected with it due to Social Prescribing (SP) and during the Covid-19 pandemic. They described the moment they began to connect with nature and the impact this had on their experience. As confirmed by existing evidence, 'slowing down' is a key step for older people to start noticing environmental cues and building connectedness with nature. Second, the present study showed that indoor sensory engagement activities with nature could serve as a suitable alternative to going outdoors when health issues or external factors such as poor weather prevented this. The existing literature primarily highlights cases where older people have successfully continued their original nature interventions. However, it does not address the experiences of those who have had to stop their usual activities due to ageing or other constraints. The current findings present a new coping strategy that could help support nature engagement for a broader range of older adults.

Another key finding from the present study is that sensory nature interventions based on reminiscence need to consider that negative, as well as positive, memories may be evoked, and mitigate to support this. Prior to this study, connections to the past appeared to be purely beneficial for older people in the literature examining the relationship between nature interventions and wellbeing. This finding therefore assists in understanding the role of reminiscence when it comes to being an element for developing nature interventions.

As shown by the literature, the theoretical concept of nature connectedness links to individuals' perceived wellbeing and the time they spend in nature. Cultivating a sense of nature connectedness may positively impact older adults' wellbeing gains from nature and encourage them to engage more with it. However, it has not yet been prioritised in nature-based interventions that involve social prescription referrals. The present study identified a range of temporal dimensions of sensory nature engagement associated with older adults' connectedness to nature. These can guide nature intervention providers on fostering and maintaining older people's sense of nature connectedness within their programmes (see Figure 2 in 9.4.2).

Overall, the present study contributes to theoretical knowledge by adding evidence to our understanding of older people's comprehensive sensory engagement with nature. Therefore, the findings can help to focus on the development of nature interventions for older people, particularly those with health and disability needs when engaging with nature, in a context where a large body of literature demonstrates only the link between nature and wellbeing in older people.

9.2 Discussion of the findings alongside the existing literature

This section will discuss the present study findings in detail within the context of the literature identified in chapter three and introduce further literature and theoretical concepts to provide more context and understanding of the findings.

9.2.1 Engaging with nature beyond the visual pathway

Findings from the present study indicated that older people faced challenges in engaging with nature through the senses beyond vision due to the following factors:

1) safety concerns when using touch and taste,

2) a disconnect exists between the development of auditory and olfactory pathways in nature and the realities of older people's environments and habits, and

3) insufficient awareness of non-visual sensory connection.

The impact of safety considerations on older people's participation in nature-based activities and perceived wellbeing was noted in Boyes (2013) and Milligan *et al*. (2021). Boyes (2013) described how older people avoided engaging in unmanageable risks and uncertainties that potentially threaten their safety, such as going to wilderness on a snowy day, in the outdoor adventure programme (Boyes, 2013). Milligan *et al*. (2021) found that preferred level of risk and safety affected the perceived wellbeing of older adults in nature adventure activities (Milligan *et al*., 2021). Although the above research and this study share a commonality that older people have safety concerns when engaging with nature, the present findings illustrated that this barrier existed for different activity types and study populations. Evaluated nature-based activities by Boyes (2013)

and Milligan *et al*. (2021) were wilderness-adventure focused. Their study population aimed to engage in activities providing mental and physical challenges and had adequate health and financial support. In the present study, nature-based interventions involved creative activities, gardening, and gentle outdoor experience in local environments. The present study findings were generated from many participants who had health needs and disabilities to cope with when engaging with nature. Against this background, the present study found that participants' safety concerns were mainly due to potential health risk. It prevented some participants from engaging with nature through the senses of touch and taste. For example, they expressed fear about the risk involved in walking barefoot on unfamiliar ground and picking wild fruits and vegetables for eating even though they wanted to have these experiences. Participants in this study expressed concerns that are similar to those of individuals with mobility disabilities (Corazon *et al*., 2019). They voiced worries about personal safety stemming from an inability to navigate unpredictable and inaccessible environments. The researchers identified these limitations as closely related to structural constraints, such as insufficient information and poor spatial planning. To address these issues, they suggested implementing structural modifications (Corazon *et al*., 2019).

Although only voiced by a few participants, they raised the issue of psychological safety when engaging with nature through the sense of touch; a fear of being seen was evoked as they wanted to connect with nature in a way that they felt different from most people, such as hugging a tree. A similar expression appeared in the quote of Wang and Glicksman (2013). After describing the enjoyment of the earthy smell after rain in a focus group, one participant expressed fear of being seen as 'crazy' given that other people might not like the smell (Wang and Glicksman, 2013). These reactions suggest that how most people interact with nature may contribute to and somewhat limit the way older people engage with nature through their senses. Yet perhaps because Wang and Glicksman's study focused only on the benefits of a gardening programme for low-income older people, the influence of psychological safety on nature engagement was not noted by the authors (Wang and Glicksman, 2013). Psychological safety concerns might be reduced through promoted group activities. Knudsen *et al*. (2024) found that for people with arthritis, the collective aspect of nature-based exercise validated activities

that might appear unconventional or challenging to accomplish alone (e.g., running around and pushing a tree). Group practice acted as a catalyst for fostering courage, motivation, and pride among participants (Knudsen *et al*., 2024).

Several studies have reported the contribution of connection to nature through the sense of hearing on the wellbeing of older people, including lower anxiety (Dzhambov and Dimitrova, 2014), diverted attention from unwanted life experiences (Coleman and Kearns, 2015; Milligan *et al*., 2021), increased mood and strength (Lee *et al*., 2022), a sense of belonging (Dendle *et al*., 2022), and subjective overall wellbeing (Leaver and Wiseman, 2016; Odzakovic *et al*., 2020; Ness and Munkejord, 2021). However, no prior studies have discussed the circumstances under which this connection may be better established to enable older people to obtain wellbeing benefits. The present study found that in some cases, the environmental conditions did not adequately support participants' ability to hear natural sounds. This study's participants compared their experiences with greater exposure to natural sounds in situations with less ambient noise such as being alone in the garden. Their experience was diminished or they were unable to connect with nature through hearing due to excessive artificial sounds in the space (e.g., traffic noise and music). This hampered participants from establishing auditory connections with nature and receiving its wellbeing potential. Importantly, this was particularly the case in participants with sensory impairments and sensory processing differences.

The findings of the present study are consistent with existing studies regarding the experiences of natural smells; most older participants in existing research stated the smells that could be passively received, including fresh air and the earth after rain, rather than those that required active smelling (Olsson *et al*., 2013; Boyes, 2013; Wang and Glicksman, 2013; Pleson *et al*., 2014; Finlay, 2018; Irvine *et al*., 2020). Leaver and Wiseman used 'by stopping to smell a flower' to describe older people's engagement with nature through the sense of smell in the garden (Leaver and Wiseman, 2016). Whilst this seems to reflect the authors' attention to cases where older people actively interacted with nature through smell, the results by Leaver and Wiseman (2016) focused on demonstrating how sensory engagement could contribute to wellbeing in older people. How the olfactory pathway operated to link this benefit was not further described.

Understanding how using the sense of smell connects to nature is important because it can provide older people with greater opportunities to benefit from its potential for wellbeing. The present study found that participants faced challenges in engaging with nature through smell because the way to experience more scents in nature was incongruent with their habits. That is, the acquisition of natural smells usually relies on active smelling, as opposed to the way humans typically receive smells passively. Within this incongruence, participants' experiences reflected a lack of ability to identify scented natural elements and a lack of clarity on how to interact with them to obtain fragrance. As a result, their opportunities of receiving wellbeing benefits from natural smells were compromised.

Although Milligan *et al*. (2021) did not further discuss how to enhance older people's awareness of sensory connection with nature, they emphasised the importance of developing this connection during nature-based activities to gain the benefits of nature (Milligan *et al*., 2021). Leaver and Wiseman (2016) described how a participant slowly observed natural elements in the garden and engaged all the senses to illustrate sensory connection with nature in relation to embodied wellbeing (Leaver and Wiseman, 2016). The findings of Section 6.3 of this study showed that access to multi-sensory nature experiences fostered a more comprehensive sense of nature connection and wellbeing, and supported older adults with sensory decline, processing differences, and impairments to remain engaged with nature. Research by Milligan *et al*. (2021), Leaver and Wiseman (2016), and the present findings all demonstrate the importance of engaging with nature through multiple sensory pathways for older adults. However, the present study also revealed that some participants did not fully recognise that the senses of hearing, smell, taste, and touch are pathways to connect with nature. This lack of awareness can hinder them from receiving the benefits that may arise from connecting with nature through some or all of their senses.

9.2.2 Multi-sensory engagement with nature

Evidence for the association between multi-sensory engagement with nature and wellbeing as described by Leaver and Wiseman (2016) and Milligan *et al*. (2021) was also found in the present study. Van Heezik *et al*. (2020) suggested that high levels of nature

connectedness motivated older people to engage with nature outdoors and enjoy the wellbeing benefits of such engagement. This study findings indicated that participants perceived a more holistic connection to nature when engaging with nature through multiple senses than through a single sense. This may be particularly the case when the sense of touch was included in the engagement; as highlighted in chapter six, tangible experience deepened participants' nature connection. However, the Nature Relatedness Scale (Nisbet *et al*., 2009), used to assess the level of nature connectedness by van Heezik *et al*. (2020), did not consider nature experience in terms of the five senses. While a few elements in the scale relate to sensory experiences (i.e., taking notice of wildlife and getting dirt on the hands), in the present study most participants engaged with nature through multiple senses. There may be different combinations (e.g., sight and smell or hearing, taste and touch, etc.) but all five senses were potentially involved. Participants in the present study also demonstrated interactions with various natural elements (e.g., looking at the sea, hearing birdsong, smelling herbs, touching stones and tasting wild berries). These findings suggest that older people's level of connectedness to nature cannot be solely measured by their experience of interacting with a specific natural element in a particular way. Furthermore, people with sensory deficits may reconfigure their sensory engagement as a result of impairments and disabilities, and therefore differ from those without these impacts (Macpherson, 2009; Chan, Shek and Agapito, 2022). This may result in certain sensory experiences not fully reflecting their connectedness to nature, and should be considered when constructing a more comprehensive dimension of nature experience to assess the level of nature connectedness.

The impact of sensory issues on people’s engagement with nature has mainly been studied within the broader literature on nature engagement, sensory impairment and disability (Burns, Paterson and Watson, 2009; Macpherson, 2009; Bell and Foley, 2021; Chan, Shek and Agapito, 2022), but has not been specifically explored in older adults. Although Olsson *et al*. (2013) mentioned that eye problems limited participants' ability to be outdoors, the researchers focused primarily on how symptoms of dementia affected older people's participation in outdoor activities. The present study explored the views and experiences of engagement with nature among older people experiencing age-

related sensory deterioration, sensory processing differences, and sensory impairments; findings indicated that engaging with nature through multiple senses was viewed as a compensatory or alternative way to meet this group's need to connect with nature. A few studies have suggested that individuals with sensory impairments use other, unimpaired senses to compensate for or substitute experiences (Macpherson, 2009; Chan, Shek and Agapito, 2022). Consistent with this study's findings, Macpherson (2009) observed that while people with partial visual impairment or blindness do not fully compensate for their vision deficits, they inevitably develop distinct ways of using and adapting their sense of touch compared to sighted individuals. For those who are born blind, touch can become a means of creating visual impressions or imagery (Macpherson, 2009). Similar to the present findings, Chan, Shek and Agapito (2022) noted that hearing-impaired visitors relied on visual stimuli to enrich their experiences in a wetland park. However, participants in Chan, Shek and Agapito (2022) also reported stronger visual, olfactory, and tactile experiences, with tactile sensations contributing substantially to their overall sensory engagement compared to those without disabilities (Chan, Shek and Agapito, 2022).

Among the five senses, the contributions of vision to older people's connection with nature were acknowledged in the present study. The findings indicated that the visual aspect of nature enabled participants' widespread involvement in nature connection and its wellbeing benefits, as it could be conveyed in various forms across space and time and could be easily used to communicate with other people. These characteristics appear to explain why the association between visual nature experiences and older people's wellbeing are more common in existing literature. For example, many older people share primarily visual experiences of nature in studies using qualitative approaches (Olsson *et al.*, 2013; Boyes, 2013; Wang and Glicksman, 2013; Jonsén, Norberg and Lundman, 2015; Coleman and Kearns, 2015; Scott, Masser and Pachana, 2015; Leaver and Wiseman, 2016; Strout *et al.*, 2017; Finlay, 2018; Robbins and Seibel, 2020; Odzakovic *et al.*, 2020; Milligan *et al.*, 2021; Ness and Munkejord, 2021; Dendle *et al.*, 2022; Lee *et al.*, 2022). Researchers often choose to use visual nature interventions in quantitative research methods as nature scenes can be easily captured and presented through images (Cassarino, Tuohy and Setti, 2019; van Heezik *et al.*, 2020; Ahnesjö,

Karlsson and Bergman, 2022). Importantly, while acknowledging the contributions of vision to older people's connection with nature, given the findings on multi-sensory engagement with nature, the present study calls for greater attention in both qualitative and quantitative research to evaluate the correlation between nature experiences and wellbeing in terms of full sensory experience in older adults.

9.2.3 Temporality and sensory connection with nature

9.2.3.1 Personal temporal qualities

The present findings demonstrated changes in how participants transitioned from unawareness to perception of sensory connection with nature and the influence of temporal qualities (including slowing down and physical time) on this state transition. As illustrated in Section 8.1, the concept of perceived connection with nature refers to participants' awareness of their relationship with nature and feeling connected to nature when engaging with natural elements through their senses. Findings from this study indicated that perceiving a connection with nature involved participants beginning to actively notice natural elements, gain the benefits of nature, and spend more time in natural settings than they had before. Perceived nature connection discussed in the present study aligns with the theoretical concept of nature connectedness, which refers to the closeness of the relationship between people and nature (Lengieza, Aviste and Richardson, 2023). Recognising that higher levels of connectedness to nature can promote greater personal wellbeing and pro-environmental behaviours, there is increasing agreement that fostering a sense of nature connectedness can be a way to enhance both human and environmental wellbeing (Richardson *et al.*, 2022). Consistent with this study's findings, nature connectedness has been linked to individuals' perceived wellbeing benefits from nature (Zelenski and Nisbet, 2014; Berto *et al.*, 2018) and the time spent in natural environments (van Heezik *et al.*, 2020), while intentionally engaging with nature through the senses can account for more levels of nature connectedness than simply being in nature (Richardson *et al.*, 2022).

Since 'having time' was already common among many older participants, the temporal aspects influencing the development of connectedness with nature identified in the present study are in a sense reinforced. Beyond the simplistic idea that having time

enables connectedness to nature, participants reflected that establishing a sense of nature connectedness through the senses was not immediate but rather required a period of engagement with nature. Furthermore, it required 'slowing down' during the experience. Actively noticing nature promotes meaningful engagement and is considered essential for developing nature connectedness (Lengieza and Aviste, 2025). Slowing down and noticing environmental cues through the senses seem to be closely linked actions during interaction with nature. For example, in Leaver and Wiseman (2016), one participant described noticing nature as requiring slowing down and engaging all senses (Leaver and Wiseman, 2016). Building on the findings from McEwan *et al*. (2019), a group of researchers working on nature connectedness co-created 'Stop – Look – Listen and Enjoy Nature' as a green care code to encourage widespread noticing of surrounding environments (The Green Care Code, 2021). The present study's analysis demonstrated that participants slowed down by adopting a gentler pace in nature and/or as a behavioural sign of a mental shift, emphasising the influence of shifting attention to nature and the emotions and attitudes involved in engaging with it. This view is supported by Grant *et al*. (2017), who note that walking speed affects environmental awareness, and the depth of environmental experience is often associated with slower walking or environments conducive to sensory reset (Grant *et al*., 2017), and by Lengieza, Richardson and Aviste (2025), who suggest that negative emotions such as irritation or distraction caused by upcoming commitments can act as significant barriers to experiencing connectedness with nature (Lengieza, Richardson and Aviste, 2025).

Fostering a sense of connectedness to nature seems to have received insufficient attention in nature-based interventions. This is evident in the national evaluation of the GSP programme, which reported that two of seven test and learn sites attempted to measure users' change in connectedness to nature after participating in the interventions. However, due to measurement errors among data providers from voluntary, community and social enterprise organisations, the researchers were unable to provide statistical interpretations (Great Britain. Department for Environment, Food and Rural Affairs, 2024). The present study highlighted the importance of cultivating a connection to nature in such interventions, especially as it might motivate participants to engage with nature more outside of the interventions, thereby supporting independent

nature engagement for socially prescribed participants after up to 12 weeks of supported entry. The findings also indicated that the settings of nature-based interventions could either positively or negatively influence participants' ability to slow down and focus on sensory elements of nature. As noted by Lengieza, Richardson and Aviste (2025), minimising distracted engagement with nature is important, as such disengagement can hinder the development of a meaningful connection (Lengieza, Richardson and Aviste, 2025). Nature-based interventions should place greater emphasis on creating supportive environments that foster sensory connectedness to nature for older people.

9.2.3.2 Nature's time

Seasonality frequently featured in older participants' accounts of sensory nature experiences in the present study. Findings demonstrated how seasons could influence older people's continuous sensory engagement with outdoor nature, sense of connectedness to nature, and wellbeing. This study indicates that seasons can act as a helpful framework; including seasonal sensory elements of nature in nature-based interventions may support maintaining and developing older people's sensory connection to the outdoor environment. The cyclical pattern of the seasons, with each driven by a new set of weather elements, is an integral part of outdoor experiences (De Vet, 2017; Bell, Leyshon and Phoenix, 2019). Providing appropriate seasonal nature activities helps older people explore the ways to engage with outdoor environments across varying weather conditions, and this understanding can be carried forward over the years, fostering a continuous sensory bond with nature. Several studies have highlighted the link between seasons, sensory engagement with nature, and wellbeing. For example, the transition from one season to another, particularly the onset of spring, symbolised hope and evoked feelings of enjoyment, uplift, and refreshment in older adults and people with sight loss (Leaver and Wiseman, 2016; Bell, Leyshon and Phoenix, 2019; Odzakovic *et al.*, 2020). Robbins and Seibel (2020) described how symbolic plants appear, disappear, and reappear with the changing seasons, contributing materially and imaginatively to the social wellbeing of older people, helping them feel connected to loved ones through gardening activities rather than feeling isolated (Robbins and Seibel, 2020). The changing seasons underscore natural transformations such as growth and decay, making nature's 'living' qualities more perceptible and encouraging a focus on the

present moment during older people's engagement with the outdoors (Leaver and Wiseman, 2016). Noticing nature and prompting mindfulness are often considered prerequisites for developing nature connectedness (Lengieza and Aviste, 2025). Recognising nature as composed of 'living things' influences how we relate it to ourselves, thereby affecting our level of connectedness to the natural world (Nisbet, Zelenski and Murphy, 2009).

While seasonal sensory nature activities can help foster sustained sensory connection with outdoor nature, it cannot be ignored that seasonal weather conditions can have both positive and negative impacts on outdoor activities and wellbeing for older adults, people with impairment or disability, and those unfamiliar with specific weather conditions (Finlay, 2018; Bell, Leyshon and Phoenix, 2019; Rishbeth and Birch, 2021). It is crucial to consider the potential impact of seasonal weather on older people's participation in nature-based interventions and to provide the necessary support and flexibility to facilitate sensory nature experiences that adapt to the weather rather than work against it (Bell, Leyshon and Phoenix, 2019). Additionally, the challenges that winter presents for older people's sensory engagement with outdoor nature are reflected in various parts of the present findings (see Sections 8.1, 8.3, and 8.4) and in earlier research (Olsson *et al*., 2013; Finlay, 2018). While this study mainly demonstrated that older participants spent less time outdoors in winter, and it appeared that facilitators also reduced their provision of outdoor activities during nature-based interventions, it is notable that the findings also indicated a considerable decrease in reported sensory experiences of outdoor nature in winter compared to other seasons; as one participant commented, this may be due to a reduction in activity and the presence of some natural elements, such as trees, birds, wildflowers, bees and butterflies. Therefore, for older people who still seek outdoor experiences during winter, their sensory connection to nature may weaken as they lack a clear concept of how to engage with the winter outdoors through their senses. Older people may be more active in winter than we think. As noted by Meijering *et al*. (2024), although they found that older people participated in more outdoor activities, such as walking and cycling, during summer compared to autumn and winter, their findings, based on GPS monitoring and qualitative data, also showed that older adults' activity spaces were larger in autumn and winter (Meijering *et*

al., 2024). Common expectations about mobility issues for older people in winter may overlook their needs and the more nuanced challenges of interacting with the winter landscape through their senses. Additional research is needed to understand better the enablers and barriers to sensory connection with outdoor nature among older people in various winter weather conditions, in order to enhance the maintenance of outdoor sensory nature connectedness during this season.

Findings from the present study showed that early experiences could encourage participants to connect with nature across all senses, initiate their involvement in nature-based interventions, and facilitate the sharing of experiences during the interventions. These findings are in line with Milligan *et al*. (2021) who found that nature experiences in childhood and adolescence were a factor in motivating older people's participation in nature adventure activities and Lee *et al*. (2022) who described early nature experiences encouraging interactions among assisted living residents in an indoor-based nature programme. Although current and previous research shows that early nature experience has many positive aspects that contribute to older people's engagement with nature-based activities, this study also found that it might trigger negative memories.

9.2.3.3 Previous nature experiences

The present study explored how past experiences with nature inform older adults' current sensory interactions with it. Findings indicated that these experiences could foster sensory engagement with nature, facilitate interactions with others during nature-based interventions, and enhance their sense of connection with nature. People seem to seek out previous nature experiences that evoke positive feelings, as reflected in accounts from some research participants; for example, one older participant intentionally waited for the first snowfall to feel like a child on Christmas morning again (Finlay, 2018, p. 81); and a visually impaired participant used memory and imagination to access the multisensory experience of swimming in the sea while medically restricted in her mobility (Bell and Foley, 2021, p. 6). Although relatively understudied, Lengieza, Richardson and Aviste (2025) suggested that nostalgia might influence nature connectedness and merit further exploration (Lengieza, Richardson and Aviste, 2025).

Lee *et al*. (2022) noted that older adults in assisted living actively shared their previous experiences and knowledge about birds in an indoor-based nature intervention, creating a positive social and learning environment. In such an atmosphere, they could benefit from directly participating in conversations or indirectly observing others' interactions (Lee *et al*., 2022).

Notably, previous nature experiences are often single-dimensionally reported with positive outcomes in the nature and outdoor experience literature. For example, some studies have reported the wellbeing benefits of exposure to nature in older adults due to its association with past experiences (Olsson *et al*., 2013; Wang and Glicksman, 2013; Jonsén, Norberg and Lundman, 2015; Scott, Masser and Pachana, 2015; Robbins and Seibel, 2020; Ness and Munkejord, 2021; Lee *et al*., 2022). This seems uncontroversial when these studies broadly investigated older people's nature or outdoor experiences, and previous experience was experiences that participants consciously decided to share. However, the present study focused on understanding the factors influencing sensory connection with nature, aiming to optimise nature-based interventions. Findings suggested could be actively included as an element in these interventions to help older people connect with nature through their senses. It is important to recognise potential issues with adding this element. Firstly, the findings of this study showed that sensory nature experiences might also trigger negative memories and emotions, which can negatively affect the sense of connectedness with nature (Lengieza, Richardson and Aviste, 2025). Another factor was generational differences. The present study indicated there might be differences in how older people from different generations engage with nature through their senses early in life. For example, for younger generations, previous experiences might only foster sensory connection with nature in some senses (e.g., sight and hearing, due to increased engagement via online material) but not in all senses. This aligns with data mentioned by Milligan *et al*. (2021), who described that today, children who did not engage with nature early in life might feel fearful of natural landscapes such as wild spaces, even though early nature experiences were seen as a factor in their study population's initiation into nature adventure activities (Milligan *et al*., 2021). Due to these factors, the present study highlights the importance of considering individual differences to achieve results that promote sensory connection with nature and to prevent potential

negative outcomes. Therefore, findings from this study indicate that the implementation of incorporating previous nature experiences into nature-based interventions requires careful attention to individual contexts.

9.2.3.4 Life changes and indoor sensory connection with nature

A number of studies have shown that indoor sensory engagement with nature has a positive impact on older people's wellbeing (Jonsén, Norberg and Lundman, 2015; Coleman and Kearns,2015; Finlay, 2018; Robbins and Seibel, 2020; van Heezik *et al*., 2020; Ness and Munkejord, 2021; Lee *et al*., 2022). For people with mental health issues, accessing nature indoors can be an option for staying connected to nature; for example findings from Bell and Foley (2021) showed that when being outdoors became a mental challenge, people with sight loss maintained sensory connection with nature through digital nature (e.g., nature CDs and radio programmes) and imagination (Bell and Foley, 2021). Impairment and disability can limit the ability of older people to maintain past and current outdoor activities (Olsson *et al*., 2013). Adverse weather conditions, such as high temperature, strong winds, rain, and snowfall, can exacerbate mobility difficulties for older adults and people with impairment and disability (Finlay, 2018; Bell, Leyshon and Phoenix, 2019; Meijering *et al*., 2024). A few studies have reported strategies developed by older people themselves to cope with physical limitations in participating in nature-based activities (Scott, Masser and Pachana, 2015; Milligan *et al*., 2021). Scott, Masser and Pachana (2015) stated that older people maintained participation in gardening activities by switching to a more manageable garden size, shortening the duration of each engagement, using modified gardening tools, and seeking paid and volunteer assistance from family and friends. Milligan *et al*. (2021) described how older adults instead engaged in new nature adventure activities that their ageing bodies could adapt to but still offered the same mental and physical challenges they sought. Since Scott, Masser and Pachana (2015) and Milligan *et al*. (2021) examined certain types of nature-based activities (i.e., gardening and nature adventure activities), they only presented cases where older people successfully found ways to live with their age-related physical limitations to continue engaging in the same type of activities. The views of those who were compelled to stop these activities or switch to other pursuits due to the limitations were not included. Additionally, the strategies mentioned above seem to require more

financial and social support, such as starting new adventure activities and asking family and friends for help with gardening tasks. These strategies may not be accessible to older people with fewer personal resources. Although Finlay (2018) noted that older people adapted to mobility issues and adverse weather conditions to stay engaged with outdoor nature during winter, the author did not discuss strategies in detail; only one participant was described as changing walking patterns and using cane support as strategies. This may be because the researcher primarily focused on exploring how white space (snow and ice) impacts on the perceived wellbeing of older people.

By exploring the impact of individual contexts on engaging with nature through the senses, the present study presented changes in older people's engagement with nature over the life course. The findings of this study indicated that when age-related health problems prevented older people from engaging with nature as before, indoor sensory access to nature became a strategy for them to sustain their connection with nature. This adaptation was particularly evident during inclement weather. Indoor sensory connection to nature could also be a transitional step to build confidence in interacting with the outdoors for older adults with mental health issues and those newcomers to nature-based activities. Turning to sensory connection with nature indoors can be understood through the concept of biographical disruption. Age-related frailty and chronic illness can trigger biographical disruption, which leads to changes in pre-existing routines and relationships, potentially prompting people to seek new ways to live well (Bell, Tyrrell and Phoenix, 2016; Cluley et al., 2021). In addition, older people who actively continue their nature engagement despite facing age-related problems appear to have a higher sense of nature connectedness (van Heezik *et al.*, 2020).

This study suggests that indoor sensory connection with nature can be offered as another option to enhance the inclusiveness and accessibility of nature-based intervention participation. Some people seem to think that being outdoors is the only way to connect with nature. For instance, a few older participants in the present study viewed their inability to go outside, a consequence of ageing, as a loss of their connection to nature. Olsson *et al*. (2013) noted that older adults with early-stage dementia either stayed indoors during winter due to a fear of falling, leading to feelings of missing the outdoors, or bravely ventured outside despite the risks (Olsson *et al.*, 2013). For people with

impairment and disability, access to the outdoors can be inevitably challenging during severe weather conditions (e.g., snow and strong winds); additional flexibility and support provided by service providers is important in helping these individuals maintain or adjust their routines and activities (Bell, Leyshon and Phoenix, 2019). The findings of this study indicated that further research is needed on indoor sensory connections to nature that are suitable for diverse groups of older adults. Being unable to go outside and stay at home can lead to boredom, stress, and feelings of isolation (Finlay, 2018). For outdoor enthusiasts who face mobility limitations, what types of indoor sensory interventions could serve as effective alternatives? Indoor public spaces can foster social wellbeing for those unable to go outdoors, providing opportunities to build social connections or simply enjoy the atmosphere of a crowd (Finlay, 2018). Yet, for older autistic individuals who prefer solitude, what kinds of indoor nature interventions would be more suitable? Existing studies almost exclusively discuss indoor nature engagement through vision, such as looking at natural views from windows and nature photographs in indoor spaces (Jonsén, Norberg and Lundman, 2015; Coleman and Kearns, 2015; Finlay, 2018; van Heezik *et al*., 2020; Ness and Munkejord, 2021). Similar to the present study, participants' indoor sensory experiences were primarily visual (e.g., the colours of house plants), even though a few described those involving other senses (e.g., watching wildlife programmes with a soundtrack and the fragrance of indoor plants). Cassarino, Tuohy and Setti (2019) reported that viewing natural images through computers had no significant effects on older people's attention restoration. Lee *et al*. (2022) learned through focus groups that the multi-sensory feature of birds was meaningful to older people, and then included it to develop an indoor-based nature programme. Results showed that the programme improved positive experiences for older people living in residential care facilities. The findings of these studies appear to reflect that indoor nature engagement through multiple senses is more likely to promote the wellbeing of older adults than through a single visual sense (Cassarino, Tuohy and Setti, 2019; Lee *et al*., 2022). The benefits of multi-sensory connection with nature were also mentioned in the current research findings in Section 6.3. However, participants in this study and Zhang *et al*.'s (2017) review of nature engagement by people with mobility impairments indicated that multi-sensory nature experiences mostly occurred in outdoor spaces.

Indoor sensory engagement with nature still requires more attention in terms of multi-sensory aspects.

9.3 Strengths and limitations

A number of strengths and weaknesses were identified in the present study and these are discussed in detail below:

This exploratory study adds a unique contribution to the sensory engagement with nature evidence base by being the first to review literature on which connections between the senses and nature have been found to contribute to older people's wellbeing in existing empirical studies spanning all study designs and natural settings. It also generates and explores qualitative data on the full sensory experiences of nature in older people. A qualitative approach enabled the researcher to capture complexities of older people's sensory experiences with individual contexts. The use of field notes throughout data collection aided interpretation and reflection on data during the analysis process and thus maintained the quality of this study. As this study population was recruited from multiple types of nature-based interventions containing many different activities, the present study provides insights into sensory engagement with nature derived from diverse nature experiences.

Alongside these strengths, a number of limitations need to be acknowledged. Only a small number of intervention providers were included in this study (a total of 8 intervention providers and 23 older people), and there was a gender imbalance in both study participant groups (intervention providers: 6 females and 2 males; older adults: 14 females, 8 males, and 1 non-binary individual). All participants voluntarily took part in the present study. The possibility of self-selection bias may have resulted in only those interested in the research topic being voiced, thereby underrepresenting the entire population of older adults participating in nature-based interventions. Another limitation of the present study concerns the recruitment of ethnic minorities. Most community groups willing to support recruitment for the present study had few ethnic minorities. Difficulties were found in recruiting older people capable and willing to participate in interviews in community groups composed primarily of ethnic minorities. This may be

because the present study only considered collecting data through English interviews and they were not fluent English speakers, or they needed more time to develop rapport with a stranger (the researcher) to feel comfortable engaging in an interview. Being limited to recruitment, the experiences and views of ethnic minority groups are limited in this study.

9.4 Recommendations for practice

9.4.1 Increase the use of multi-sensory engagement

It is evident from the present study that the ability to connect with nature through multiple sensory pathways aids older people's nature engagement especially when they have sensory deficits. To make nature interventions more inclusive, it is important to provide opportunities for multi-sensory engagement within a nature activity (e.g., developing an activity that involves both visual and tactile engagement) and to incorporate elements which relate to all senses into a range of nature activities. In this regard, two directions that can promote older people's multi-sensory connection with nature are identified in the present study:

- Help older people become more aware of various sensory pathways they can use to engage with their environment. This can be done by: 1) guiding them to explore environmental cues related to all senses in the local area; and 2) encouraging them to experience the information gathered by all senses in the space, such as through drawing surrounding activity or breathing exercises with sensing environmental information.

- Make more use of natural elements that create multi-sensory experiences in activities and space design, such as plants that are both ornamental and fragrant.

In addition to the broader principles of enhancing multi-sensory experiences outlined above, this study observed that different sensory pathways for engaging with nature have distinct characteristics, facilitators, and barriers. These are summarised in Table 5 below. Leveraging the features and facilitators of these pathways and addressing the barriers

can create more enabling sensory, physical, and even social environments for older people participating in nature interventions.

Table 5 Insights into sensory pathways generated from the present study

Sensory pathways	Insights
Sight	Visual pathway allows older people to experience nature with fewer physical distance restrictions. The development of visual technologies and products offers older people opportunities to connect with nature in various forms across space and time. Visual natural elements (both material and digital) support sharing nature experiences among them. Providing hearing-impaired older adults with visual information for auditory activities can help them participate.
Hearing	Ambient noise can interfere with older people's connection to nature through the auditory pathway, especially those with sensory deficits. Creating nature-based intervention settings that support, rather than hinder, the development of the auditory pathway is important, such as having quiet moments to listen to natural sounds. When natural views and sounds coexist, views tend to become the main way for older adults to connect with nature, while sounds fade into the background, highlighting the importance of raising awareness of sounds in nature.
Smell	Unaware of which plants have scents and how to access them (e.g., approaching or rubbing the plants) can prevent older adults' olfactory pathways from connecting with nature. Assisting older people to engage with scented natural elements around them (e.g., trees and water features in local parks) can foster their connection and olfactory experiences. Cultivating aromatic plants can improve olfactory encounters and even provide a multi-sensory experience. Creating a physical environment that encourages interaction with scented natural elements for older people is important (e.g., by positioning scented plants that require minimal bending).
Touch	Sense of touch helps older people develop a deeper connection with nature, owing to the concrete sensations it provides and the sense of meaningfulness often evoked by tactile-related activities. Older people are concerned about whether tactile interactions with nature might cause harm or how their behaviour is perceived by others. Various elements (e.g., plant parts and natural building materials) and methods (including texture sensation through skin contact and whole-body tactile experiences) can offer touch experiences. Providing older adults with guided and diverse ways to participate (e.g., prompting to use their hands as well as feet) can encourage connection with nature through touch. When designing environments, considering older adults' mobility limitations in accessing plants can create more tactile-friendly spaces (e.g., planting at different heights). Tactile experience can serve as an alternative experience for older people with visual impairments to participate in nature activities. Structured planting techniques that aid distance judgment (e.g., using strings and grids) can help visually impaired older people participate in gardening activities.

Taste	Safety concerns can limit older adults from connecting with nature through the sense of taste. Specialised activities and environmental design (e.g., designating edible plant zones in gardens) can alleviate safety worries and boost taste experiences. The shift from growing one's own food to purchasing it has separated the taste pathway from connection with nature, emphasising the importance of linking ingredients with nature when experiencing food.

9.4.2 Develop a sense of nature connectedness

This study emphasised the importance of fostering a sense of connectedness to nature for the wellbeing of older adults and for boosting motivation for nature engagement beyond the time-limited, socially prescribed interventions. Findings from the present study showed the relationship between temporality and older adults' sensory connection with nature, encompassing personal temporal qualities, the timing of nature, and life course trajectories. It is recommended that nature intervention providers develop and deliver activities focused on these temporal aspects (see Figure 2 for details) to help older adults nurture and maintain a sense of connectedness to nature during such interventions.

Regarding indoor sensory nature engagement alternatives, the findings highlighted that older people might sometimes be unable to access nature intervention sites due to disabilities. In addition to offering indoor options during the interventions, providing extra tools for independent indoor sensory engagement, such as take-home kits, can support varying conditions that may prevent them from connecting with nature.

When integrating reminiscence elements into nature activities, intervention providers should be attentive to the need for tailoring these activities to individual preferences. This could involve group discussions to gather ideas about past experiences with nature that older people might wish to revisit. Such approaches can maximise the benefits of reminiscence for sensory connection with nature while reducing potential risks.

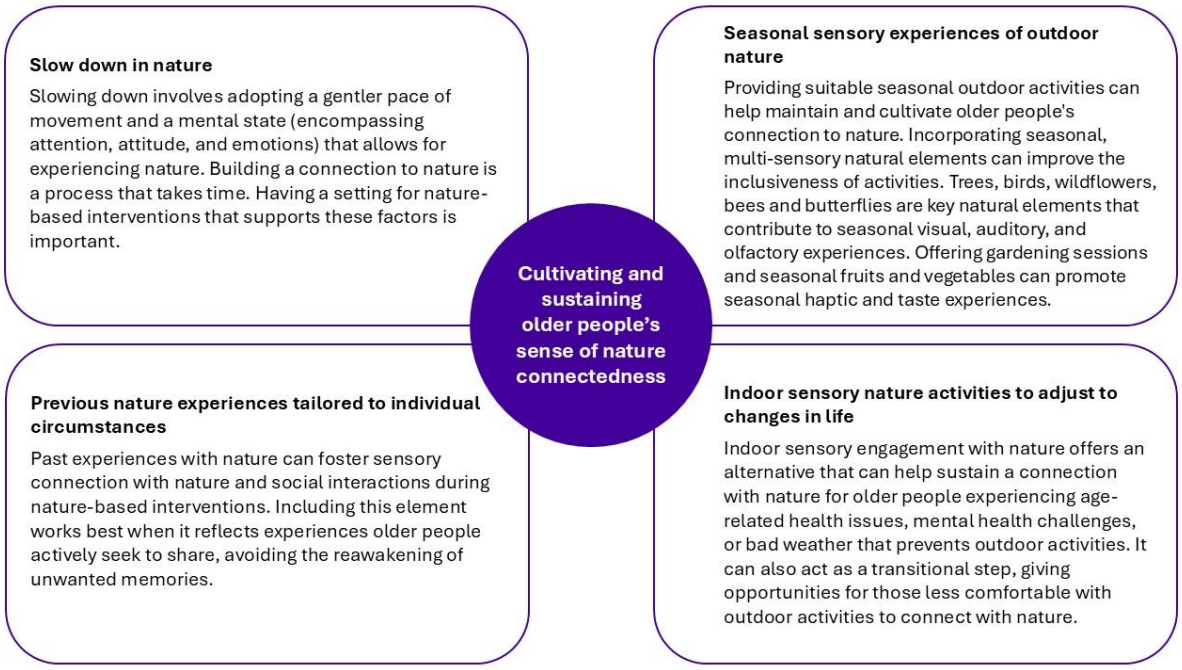


Figure 2 Temporal dimensions associated with older people's sense of connectedness to nature

9.5 Directions for future research

9.5.1 Development and evaluation of multi-sensory nature interventions

Participants in the present study described how engaging with nature through multiple senses contributed to their wellbeing and level of connection with nature compared to through a single sense. Additionally, of the five senses, touch was particularly relevant for older participants to develop a deeper connection with nature. In light of existing literature, high levels of nature connection motivate older people to engage in nature and promote access to its wellbeing benefits; sensory experiences are not adequately considered when assessing levels of nature connection. Further research could focus on developing interventions based on multi-sensory engagement with nature and examining the association between multi-sensory experiences, wellbeing, and levels of connection to nature in older people. A mixed methods research design is suggested so that interventions can be evaluated to produce measurable outcomes while taking into account the complexity of nature experiences involving multiple senses. Research should consider engaging with stakeholders to support the development of such

interventions in order to increase the likelihood that they can integrate into practice settings.

9.5.2 Exploring the needs of older populations with neurodiversity

The experiences and views of neurodiverse older adults appear to be understudied in the nature intervention literature. Neurodiverse participants in the present study demonstrated differing challenges in engaging with nature due to their sensory processing differences and neurodivergent traits. Thus, it is suggested that future research focuses on specifically target populations with neurodiversity to explore how their processing of sensory information in relation to nature differs and how their traits influence participation in nature interventions. Notably, different types of neurodiversity have their own characteristics. Research should consider the differences that exist between them, in order to better meet the needs of neurodiverse populations for nature interventions.

9.6 Conclusion

The older population is increasing globally. Using social prescribing to connect older people with nature to support their wellbeing has been advocated in the UK. Organisations which deliver nature interventions are providing an important service to improve the wellbeing of older people. This thesis has explored how sensory elements of nature interventions can support older people's wellbeing and examined how these elements are experienced in their interactions with nature. Findings identified will assist nature intervention providers in developing more inclusive services which facilitate the provision of a range of nature activities to suit broader older population groups.

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Appendix 1: A summary of literature search terms and combinations

Terms for nature connection		Terms for health and wellbeing		Terms for older people		Terms for sensory engagement	Database subject headings
Combined with 'OR' Boolean operator: ''natur* connection'' ''natur* connectedness'' ''natur* engagement'' ''natur* interaction'' ''natur* intervention'' ''natur*-based activit*''	Combined with 'AND' Boolean operator	Combined with 'OR' Boolean operator: ''wellbeing'' ''well-being'' ''health''	Combined with 'AND' Boolean operator	Combined with 'OR' Boolean operator: ''older people'' ''older adult'' ''elderly'' ''senior''	Combined with 'AND' Boolean operator	Combined with 'OR' Boolean operator: ''sensory'' ''sense'' ''multisensory'' (These terms were searched in Web of Science and ASSIA only)	In MEDLINE: ''Nature, ''Horticultural Therapy'', ''Health'', ''Aged''. In PsycInfo: ''Nature (Environment)'', ''Wilderness Experience'', ''Horticulture Therapy'', ''Well Being'', ''Older Adulthood''. In CINAHL:

‘‘natur* experience’’ ‘‘outdoor activit*’’ ‘‘green care’’ ‘‘horticultur* therapy’’ ‘‘therapeutic horticulture’’ ‘‘therapeutic landscape’’ ‘‘sensory garden’’							‘‘Natural Environment’’, ‘‘Natural and Biologically Based Therapies’’, ‘‘Health’’, ‘‘Aged’’. In Cochrane Library: ‘‘Horticultural Therapy’’, ‘‘Health’’, ‘‘Aged’’. In ASSIA: ‘‘Natural landscapes’’, ‘‘Outdoor activities’’, ‘‘Wellbeing’’, ‘‘Older people’’.

Appendix 2: Letter of ethical approval



Downloaded: 01/08/2023
Approved: 27/07/2023

Sin-Rou Fu
Registration number: 200222149
School of Health and Related Research
Programme: N/A

Dear Sin-Rou

PROJECT TITLE: Exploring older people's sensory experiences of nature-based wellbeing interventions: A qualitative study
APPLICATION: Reference Number 053561

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 27/07/2023 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 053561 (form submission date: 17/07/2023); (expected project end date: 06/12/2024).
- Participant information sheet 1126698 version 1 (17/07/2023).
- Participant information sheet 1123951 version 2 (17/07/2023).
- Participant information sheet 1123953 version 2 (17/07/2023).
- Participant consent form 1123955 version 2 (17/07/2023).
- Participant consent form 1123956 version 2 (17/07/2023).
- Participant consent form 1123958 version 2 (17/07/2023).

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Your responsibilities in delivering this research project are set out at the end of this letter.

Yours sincerely

Anju Keetharuth
Ethics Administrator
School of Health and Related Research

Please note the following responsibilities of the researcher in delivering the research project:

- The project must abide by the University's Research Ethics Policy: https://www.sheffield.ac.uk/research-services/ethics-integrity/policy
- The project must abide by the University's Good Research & Innovation Practices Policy: https://www.sheffield.ac.uk/polopoly_fs/1.671066!/file/GRIPPolicy.pdf
- The researcher must inform their supervisor (in the case of a student) or Ethics Administrator (in the case of a member of staff) of any significant changes to the project or the approved documentation.
- The researcher must comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
- The researcher is responsible for effectively managing the data collected both during and after the end of the project in line with best practice, and any relevant legislative, regulatory or contractual requirements.

Appendix 3: Participant information sheet for older people

University of Sheffield

Participant Information Sheet

Exploring sensory experiences of nature activities in people aged 50 years and over

You are being invited to take part in a research project. Before you decide whether or not to participate, it is important for you to understand why the project is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

1. What is the purpose of the research?

This study aims to understand the sensory experiences of nature activities from different viewpoints. The project is being undertaken as a PhD study at the University of Sheffield. I will use interviews to explore the experiences and views of people aged 50 and above on connecting with nature through sensory experience, and professionals who provide nature activities. The sensory experience means you use your senses (sight, hearing, smell, touch, and taste) to interact with nature, for example, watching leaves change colour with the seasons, listening to birdsong, smelling the fragrance of flowers, touching the soil in gardening activities, and tasting home-grown herbs. The findings from the study will help to inform recommendations for activity providers and future nature interventions.

2. Why have I been chosen?

You have been invited because you a) are aged 50 and over and b) have participated in at least one nature activity.

3. Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep, and be asked to sign a consent form. You are free to withdraw at any point either before or while participating in the interview without affecting any service provided to you. You do not have to give a reason. However, you can only withdraw your interview response until two weeks after the interview, as your response has been anonymised and started analysing. It will not be possible to separate your response from the overall results.

4. What will happen to me if I take part?

If you do decide to take part in the research, it will involve speaking to the researcher for up to an hour. We will be asking out about your sensory experiences in nature activities. The interview can take place at a location that is convenient for you. The interview will be recorded with your permission.

5. What are the possible disadvantages and risks of taking part?

There are no anticipated disadvantages to participating in this research. However, it may cause feeling distressed or upset by a particular question or topic related to your personal experiences. If this happens, you can pause and take a break before returning back to the interview, or stop the interview at any time.

University of Sheffield

6. What are the possible benefits of taking part?

Whilst there are no immediate benefits to you, it is hoped that this work will help to understand how people (50 and over) can connect with nature through sensory interactions. Hopefully, it will help inform future interventions to improve the people's wellbeing.

7. Will my taking part in this project be kept confidential?

Any information that we collect about you during the course of the research will be kept strictly confidential. You will be anonymised by an ID number. This means you will only be identifiable by the research team. You will not be identified in any reports arising from the project. Your interview recording and personal data will be destroyed after they have been transcribed. No other use will be made of the transcripts or data without your written permission, and no one outside the project will be allowed access to the original recordings.

8. What will happen to the results of the research project?

The results of this project will form part of the researcher's PhD thesis, and we will further pursue journal and conference publication of this study.

9. Who is organising and funding the research?

The research is organised by the PhD researcher at ScHARR, University of Sheffield.

10. Who is the Data Controller?

The University of Sheffield will act as the Data Controller for this study. This means that the University is responsible for looking after your information and using it properly.

11. Who has ethically reviewed the project?

This research project has been ethically approved by the ScHARR Research Ethics Committee.

12. What if something goes wrong?

If you have any cause to complain about any aspect of your experience while you are taking part in the project, please contact Dr Sarah Barnes, Supervisor and Designated Safeguarding Contact (0114 222 0727). For issues that remain unresolved, please contact Professor Mark Strong, Dean of ScHARR (0114 222 0812) or Lindsay Unwin, University's Research Ethics & Integrity Manager (l.v.unwin@sheffield.ac.uk).

13. What do I need to do now?

If you are interested in taking part, please tell the researcher who gave you this information sheet. The researcher will then contact you, and tell you more about the project and answer any queries you have (you can change your mind about participating at this stage).

Contact for further information

If you have any queries about this project, please feel free to call us:

Sin-Rou Fu, Principal Investigator Phone: 07762 730486 Email: sfu9@sheffield.ac.uk

Thank you for reading this and for considering taking part in the research.

Appendix 4: Recruitment leaflet for older people

Could you offer up to an hour to help us understand sensory experiences in nature?

A research project to find out whether connecting with nature through the five senses (sight, hearing, smell, touch, taste) could contribute to people's wellbeing.



You may be able to participate in the research, if you:

- Have participated in a nature-based activity
- Are aged 50 years and over
- Can engage in an individual interview (up to an hour)

Other detailed criteria must be met to qualify, which the researcher will discuss with you.

Contact us

Principal investigator: Sin-Rou Fu

Phone: 07762 730486

Email: sfu9@sheffield.ac.uk

University of Sheffield | School of Medicine & Population Health



Appendix 5: Participant information sheet for intervention providers

University of Sheffield

Participant Information Sheet

Exploring sensory experiences of nature activities in people aged 50 years and over

You are being invited to take part in a research project. Before you decide whether or not to participate, it is important for you to understand why the project is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

1. What is the purpose of the research?

This study aims to understand the sensory experiences of nature activities from different viewpoints. The project is being undertaken as a PhD study at the University of Sheffield. I will use interviews to explore the experiences and views of professionals who provide nature activities on connecting with nature through sensory experience, and people (50 and over) who take part in the activities. The sensory experience means people use their senses (sight, hearing, smell, touch, and taste) to interact with nature, for example, watching leaves change colour with the seasons, listening to birdsong, smelling the fragrance of flowers, touching the soil in gardening activities, and tasting home-grown herbs. The findings from the study will help to inform recommendations for activity providers and future nature interventions.

2. Why have I been chosen?

You have been invited because you are a professional who offers nature activities in a community organisation.

3. Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep, and be asked to sign a consent form. You are free to withdraw at any point either before or while participating in the interview without any negative consequences. You do not have to give a reason. However, you can only withdraw your interview response until two weeks after the interview, as your response has been anonymised and started analysing. It will not be possible to separate your response from the overall results.

4. What will happen to me if I take part?

You will be invited to take part in a one-to-one interview with the researcher. This will occur at a time and location which are convenient to you, and will involve you responding to questions about your experiences and views of connecting with nature through the five senses among people aged 50 and over. The interview will be recorded with your permission and will last up to an hour.

5. What are the possible disadvantages and risks of taking part?

There are no anticipated disadvantages or risks as a result of participating in this research.

6. What are the possible benefits of taking part?

Whilst there are no immediate benefits to you, it is hoped that this work will help to understand how people (50 and over) can connect with nature through sensory interactions. The outcome of this research will be used to make recommendations to activity providers and participants, as well as relevant health professionals. Hopefully, it will help inform future interventions to improve the people's wellbeing.

University of Sheffield

7. Will my taking part in this project be kept confidential?

Any information that we collect about you during the course of the research will be kept strictly confidential. You will be anonymised by an ID number. This means you will only be identifiable by the research team. You will not be identified in any reports arising from the project. Your interview recording and personal data will be destroyed after they have been transcribed. No other use will be made of the transcripts or data without your written permission, and no one outside the project will be allowed access to the original recordings.

8. What will happen to the results of the research project?

The results of this project will form part of the researcher's PhD thesis, and we will further pursue journal and conference publication of the study.

9. Who is organising and funding the research?

The research is organised by the PhD researcher at ScHARR, University of Sheffield.

10. Who is the Data Controller?

The University of Sheffield will act as the Data Controller for this study. This means that the University is responsible for looking after your information and using it properly.

11. Who has ethically reviewed the project?

This research project has been ethically approved by the ScHARR Research Ethics Committee.

12. What if something goes wrong and I wish to complain about the research or report a concern or incident?

If you have any cause to complain about any aspect of your experience while you are taking part in the project, please contact Dr Sarah Barnes, Supervisor and Designated Safeguarding Contact (0114 222 0727). For issues that remain unresolved, please contact Professor Mark Strong, Dean of ScHARR (0114 222 0812) or Lindsay Unwin, University's Research Ethics & Integrity Manager (l.v.unwin@sheffield.ac.uk).

13. What do I need to do now?

If you do decide to take part in the research, please complete the short survey via Google Form link or return the reply slip to the researcher. The researcher will then contact you through your preferred contact method to confirm the time and place of the interview.

Contact for further information

If you require further information about this research project, please do not hesitate to contact:

Sin-Rou Fu, Principal Investigator
Phone: 07762 730486, Email sfu9@sheffield.ac.uk
School of Health and Related Research
University of Sheffield
Regent Court, 30 Regent Street
Sheffield, S1 4DA

Thank you for reading this and for considering taking part in the research.

Appendix 6: Interview guide for older people

University of Sheffield

Exploring sensory experiences of nature-based wellbeing interventions

Interview guide

Introduction

Check preferred name.

Ask if they've seen a copy of the information sheet – give another if necessary.

Sign consent form together (agree to send by post if appropriate).

Everything that we discuss today is confidential. The information that we collect from the interview will be made anonymous. With your permission I would like to record the interview. This will help me to focus on the important things that you say and I won't have to make any notes during our discussion. However, if you would prefer for me not to record the interview then let me know and I can take notes.

The interview will usually take us around 30 to 45 minutes to complete.

Could I confirm you are willing for me to record this interview?

Check recording started.

Ask 'Is there anything I have missed or anything else from you?'

Thank them for their participation.

University of Sheffield

Phase 2: Activity participant

Background information

Age:

Gender:

Role in the activities: [Participants, volunteers, professionals, etc.]

Opening question

1. Can you tell me how you first heard about [Wild at Heart or other nature-based activities] and how you came to attend the activities?
   Probe: were you referred to
2. What activities related to nature have you participated in?
   Probe: When, how often, how long, why
3. What do you think about these nature-based activities you have joined?
   Probe: Did changes occur in your life

Experiences of engaging with nature through the five sensory pathways

4. Can you tell me what sensory experiences you have found in these nature-based activities?
   Probe: When, where, how
5. Can you tell me what senses you usually use to experience nature?
   Probe: Important/not important, preference, why, other senses
6. Has your experience with nature changed over time?
   Probe: Senses, patterns (e.g., walk/sit, outdoor/indoor), why, how to respond

Closing questions

7. What other sensory experience would you like to feature in your activities?
   Probe: Why

Appendix 7: Interview guide for intervention providers

University of Sheffield

Exploring sensory experiences of nature-based wellbeing interventions

Interview guide

Introduction

Check preferred name.

Ask if they've seen a copy of the information sheet – give another if necessary.

Sign consent form together (agree to send by post if appropriate).

Everything that we discuss today is confidential. The information that we collect from the interview will be made anonymous. With your permission I would like to record the interview. This will help me to focus on the important things that you say and I won't have to make any notes during our discussion. However, if you would prefer for me not to record the interview then let me know and I can take notes.

The interview will usually take us around 30 to 45 minutes to complete.

Could I confirm you are willing for me to record this interview?

Check recording started.

Ask 'Is there anything I have missed or anything else from you?'

Thank them for their participation.

University of Sheffield

Phase 1: Intervention providers

Background information

Work location:

Job position:

Opening question

1. Can you tell me about your role in your job?
   Probe: How long employed, how long providing nature interventions
2. What groups of people you have provided for nature activities?
   Probe: What activities, where

Perspectives of developing nature-based wellbeing activities

3. Can you tell me through your considerations/thinking when developing the activities for these groups?
   Probe: cohort of people, nature connection, inclusion, why

Barriers and facilitators to engaging with nature by the five senses

4. Do you think there is a relationship between people's characteristics and the way they connect to nature?
   Probe: Referred by SP/joined themselves, health, senses, patterns, why
5. What challenges older people may have when experiencing nature?
   Probe: Why, how to improve, any sensory deterioration noticed
6. What do you think about encouraging sensory engagement in the activities for older people?
   Probe: Disadvantages/advantages, important/not important, why, how

Closing questions

7. What are your hopes or ideas for nature activities in the future?
   Probe: Challenges, what can be better

Appendix 8: Consent form

University of Sheffield

Exploring sensory experiences of nature activities in people aged 50 years and over

Consent Form

Please tick the appropriate boxes	Yes	No
I have read the information sheet that explains the research project, and I have had the opportunity to ask questions.		
I understand that my participation is voluntary and that I can withdraw at any time either before or while participating in the interview. I do not have to give any reasons and there will be no negative consequences. However, my interview response can only be withdrawn until two weeks after the interview, as it has been anonymised and started analysing.		
I understand that taking part in the project will include being interviewed and audio recorded and that if I do not wish to answer any particular interview questions, I am free to decline.		
I understand my interview responses and personal details (name, phone number, address and email address) will be kept strictly confidential.		
I understand that my words may be used in reports and other outputs. I understand that my name will not be linked with the project materials, and I will not be identified in these outputs relating to the project.		
I give permission for my data to be deposited at The University of Sheffield so it can be used legally by the researchers.		
I agree to take part in the above project.		

Name of participant [printed] Signature Date

Name of Researcher [printed] Signature Date

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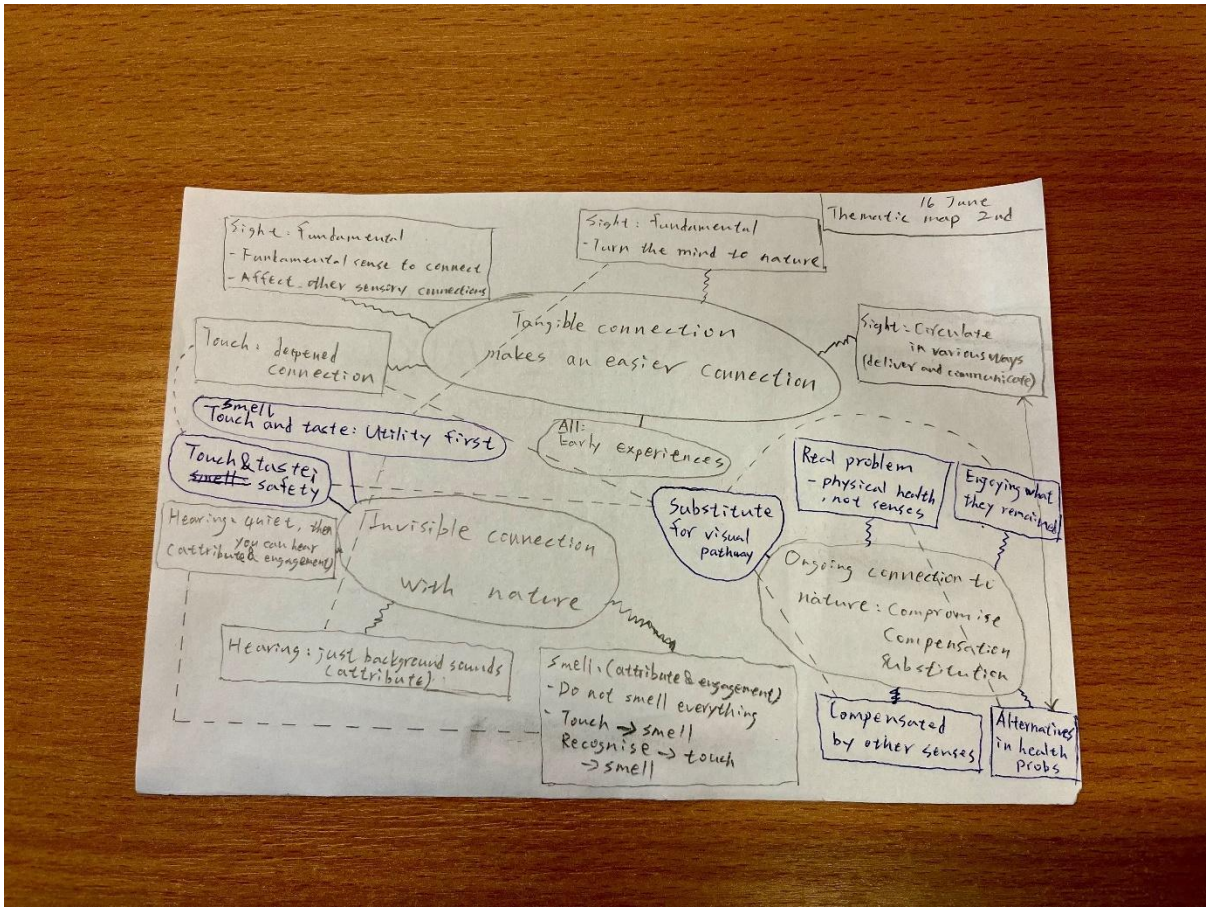
Dr Chris Blackmore, Supervisor Email: C.M.Blackmore@sheffield.ac.uk

Appendix 9: Coding frame and example of the audit trail for the coding process

Coding frame: codes identified from the first transcript		Codes after nine transcripts coded		Codes after eighteen transcripts coded	
Main codes	Sub-codes	Main codes	Sub-codes	Main codes	Sub-codes
Barriers to connecting with nature	**Sensory connection** Daylight	**Barriers to connecting with nature**	**Sensory connection** Daylight Difficulty in accessing Group size and setting Illness Lack of support Mobility Unable to understand further Unawareness	**Barriers to connecting with nature**	**Sensory connection** Daylight Difficulty in accessing Group size and setting Illness Lack of support Mobility Unable to understand further Unawareness
Benefits of nature on wellbeing	Achievable_no harm in not achieving Clearing mind_diverting attention Continuation of social relations Giving purpose in retirement_maintaining lifestyle Link with childhood Making a contribution Reducing loneliness Relaxation Sharing knowledge and experiences Socialising_making friends	Benefits of nature on wellbeing	Achievable_no harm in not achieving Building confidence Clearing mind_diverting attention Continuation of social relations Freedom Getting active Giving purpose in retirement_maintaining lifestyle Improving concentration Link with childhood or previous experience Making a contribution Mood lifts Physical health Reducing loneliness Relaxation and calmness Sharing knowledge and experiences Socialising_making friends	Benefits of nature on wellbeing	Achievable_no harm in not achieving Building confidence Clearing mind_diverting attention Continuation of social relations Freedom Getting active Giving purpose in retirement_maintaining lifestyle Improving concentration Life quality Link with childhood or previous experience Link with religious faith Making a contribution Mood lifts Oneness with nature Physical health Problem solving Reducing loneliness Relaxation and calmness Sharing knowledge and experiences Socialising_making friends
Facilitators of connecting with nature	**Sensory connection** Bonding with groups Inclusive space Like-minded people Making a contribution Social needs	**Facilitators of connecting with nature**	**Sensory connection** Bonding with groups Easy access Encouragement from others Health boost_being active Like-minded people Link with childhood or past experience	**Facilitators of connecting with nature**	**Sensory connection** Bonding with groups Clear purpose Easy access Encouragement from others Health boost_being active Knowledge sharing Like-minded people

			Making a contribution Safe and inclusive space Social needs Utility		Link with childhood or past experience Making a contribution Public advertising_online resources Religion Safe and inclusive space Social needs Utility
Factors affecting nature connection	Childhood Mobility Time Weather	Factors affecting nature connection	Childhood Environment and resources Mindset Mobility Time Weather Work type and load	Factors affecting nature connection	Activity type and load Childhood Environment and resources Mindset Mobility Time Weather
Potential negative impact	Death of nature Unsuccessful care of plants	Potential negative impact	Allergy Death of nature Evoking negative memories Injury and illness Limited provision from a social prescribing referral Unsuccessful care of plants	Potential negative impact	Allergy Death of nature Evoking negative memories Injury and illness Limited provision from a social prescribing referral Unsuccessful care of plants
Sensory experiences	**Hearing** **Impairment** **Multiple senses** **Sight** **Smell** **Taste** **Touch**	**Sensory experiences**	**Hearing** **Impairment** **Multiple senses** **Sight** **Smell** **Taste** **Touch**	**Sensory experiences**	**Hearing** **Impairment** **Multiple senses** **Sight** **Smell** **Taste** **Touch**
Suggestions for nature activities	**Sensory connection** Experts Mixed age groups	**Suggestions for nature activities**	**Sensory connection** Activities in childhood Crafts Existing groups Experts Grouping people with similarities Guidance for starters Mixed age groups	**Suggestions for nature activities**	**Sensory connection** Activities in childhood Crafts Embedding in different cultures Embedding in life Embedding in the health system Existing groups Experts Grouping people with similarities Guidance for starters Mixed age groups One-to-one nature sessions Volunteer development and training
Types of nature activities	Community Personal	Types of nature activities	Community Personal	Types of nature activities	Community Personal

Appendix 10: Initial mapping of patterns for the data analysis



Appendix 11: Summary of theme development

1 – Combined codes/Facets within the theme		2 – Theme: a shared meaning pattern	3 – Overarching theme: a structure that aids in organising themes	4 – Sub-theme: One particular facet under the theme which needs to be emphasised
First sense to use	Fundamental pathway	Multiple contributions of vision on nature connection	Understanding sensory pathways to connect with nature	-
Influencing use of other senses				-
Receiving nature benefits in various ways	Easy circulation			-
Easy for participants to deliver nature experiences				-
Feeling what you see	Sense of tangible contact with nature	Establishment of deeper connection with nature through touch		-
Sense of meaningfulness				-
Nature and self: linking to lives and reflecting				-
Perspectives on nature: living nature				-
Multi-sensory nature experiences	Situations of multi-sensory connection with nature	Completion and compensation: multi-sensory connection with nature		-
Holistic connection and wellbeing				-
Sensory deterioration and processing differences: using multiple (other) senses to enjoy nature in daily lives				-
Professionals: senses create multiple ways to interact with nature	Sensory impairments: using multiple (other) senses to engage in nature-based interventions			-
Substitution for blindness: touch				-
Substitution for deafness: sight				-
Increasing awareness of different sensory experiences that can be gained in a space	*How multiple sensory experiences with nature can be increased*			How multiple sensory experiences with nature can be increased
Incorporating natural elements which can create multiple sensory experiences				
Taste: poisoning	Plant characteristics (physical)	Safety considerations when engaging with nature through touch and taste	Barriers to sensory connection with nature in older people	-
Taste ← Touch: cuts				-
Touch: cuts				-
Taste and touch: cleanliness	Psychological factors			-
Touch: unknown consequences				-
Touch: other people				-
Greater engagement in less noisy spaces	Hearing: Need of quietness	Challenges to establishing auditory and olfactory pathways with nature		-
Engagement (is more likely to be) prevented				-

Usually passively receiving smells	Smell: Need of actively smelling			-
Process of obtaining natural smells				-
Example of giving experiences but not making a connection	Experiences of not perception of connecting with nature	Unawareness of connection with nature beyond vision		-
Hearing: it's background sounds				-
Smell: it's warning				-
Taste: it's food				-
Touch: it's for purposes of something else				-
Related to noticing, receiving benefits, and spending more time	Situations of connecting or not	Impact of time on becoming connected with nature	A temporal perspective: the connection between time, older people, and nature	-
Limited time for nature interventions				-
Physical time: having time	Need for time			-
Physical time: length of time to progress				-
Slowing down: speed and/or mentality change				-
Circumstances of nature interventions (facilitation/hindrance)	Factors to note			-
Mapping participants onto connecting with nature across all the sensory pathways		Influence of previous experiences on sensory connection with nature		-
Hidden elements that promote connection to nature and intervention participation				-
Evoking negative memory	Factors to note			-
There may be differences between generations				-
Mobility issues had a greater impact than other decreased sensory functions		Changes and adaptation: managing challenges through indoor sensory connection with nature		-
Older people: managing ageing and health conditions	Sustaining engagement with nature via indoor sensory connection			-
Older people: managing bad weather (by homes, public spaces and indoor nature-based activities)				-
Professionals: outdoor nature engagement requires confidence building (by bringing nature closer or indoors): dyadic approach/take-home kit				-
Outdoor enthusiasts: lack of access to the outdoors = less or no (sensory) nature experience	Factors to note: different indoor nature engagement needs			-

Autistic older people: indoor space involves more people and noise				-
Influence of seasons on continuous (sensory) nature experience, nature connection, and wellbeing		Nature's time: building a continuous sensory connection with outdoor nature through the seasonal cycle		-
Number of experiences in different seasons	Seasonal sensory connections with nature			-
Important natural elements from spring to autumn (trees, birds, wildflowers, bees and butterflies)				-
Gardening offers seasonal haptic and taste experiences				-
Vegetable and fruit gardening enhances seasonal taste experiences but is less accessible				-
Bringing in seasonal fruits and vegetables can be a useful way				-
Fewer sensory experiences of outdoor nature in winter				-

Note: Numbers 1 to 4 represent the sequence of concept formation during the theme development.

Appendix 12: Example of performing pen and paper analysis

