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A scoping review: Sensory interventions for older adults living with dementia

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Abstract

This scoping review focused on the existing scholarly literature exploring sensory interventions and immersive environments developed for, and used by, older adults living with dementia. The purpose of the scoping review is 1) to understand the various sensory interventions that have been developed, used, and have provided data to show how such interventions are expected to impact the lives of individuals living with dementia; and 2) to understand how the field is moving forward. We chose to map the literature to understand the types of interventions, the types of outcomes measured, and the contexts of their implementation. Our search was constrained to references from 1990 to 1 June 2019 in the following databases: Academic Search Complete, CINAHL Complete, MEDLINE, PsycINFO databases, and Summon Search discovery layer. We screened 2305 articles based on their titles and abstracts, and 465 were sent to full text review, of which 170 were included in our full text extraction. Once the data were extracted, we created emic categories, which emerged from the data, for data that were amenable to categorization (e.g., study setting, intervention type, and outcome type). We developed ten different categories of interventions: art, aromatics, light, multi-component interventions, multisensory rooms, multi-sensory, music, nature, touch, and taste. Sensory interventions are a standard psychosocial approach to managing the personal expressions commonly experienced by people living with dementia. Our findings can help providers, caregivers, and researchers better design interventions for those living with dementia, to help them selectively choose interventions for particular outcomes and settings. Two areas emerging in the field are nature interventions (replacing traditional “multisensory rooms” with natural environments that are inherently multisensory and engaging) and multi-component interventions (where cognitive training programs are enhanced by adding sensory components).

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Keywords

sensory intervention, nature therapy, multisensory room, aromatherapy, touch therapy, multisensory therapy, light therapy, music therapy

Introduction

The purpose of this scoping review is to investigate how sensory interventions are used for older individuals living with dementia. The diagnosis of dementia is growing in prevalence globally (WHO, 2020a). There are approximately 50 million persons currently living with dementia and this is expected to rise to 82 million by 2030 (WHO, 2020a). Sensory interventions, focusing on engaging the five senses in various ways, have been shown to help those living with dementia (Alzheimer Society of Canada, 2017). While these interventions have gained popularity in dementia care since the 1990s (Alzheimer Society of Canada, 2017), they are currently applied in unsystematic but hopeful ways to improve the lives of people living with dementia (especially for those with late-stage dementia). We undertook this scoping review to understand what types of sensory interventions are being used, and how, in order to inform future application of these approaches.

We chose to conduct a scoping review because we were interested in mapping the literature, rather than determining what types of interventions “work,” which may be the goal of a systematic review (Munn et al., 2018). Sensory interventions are very difficult to compare, it is challenging to measure “how much” of an intervention participants are exposed to, especially when they are exposed to multiple stimuli. In addition, typical small sample sizes and heterogeneous samples (for example, studies typically are conducted on a convenience sample of persons living with dementia and do not exclude or include based on type of severity) make it difficult to compare across interventions.

Our goal was to map out the literature on sensory interventions for people living with dementia with the goal to understand what types of interventions were being undertaken, in what context, and for what populations. At the time that we began our review, we were not able to identify a scoping review of this literature available in the scientific literature. As such, we felt that such a review would help our team, and others guide the development of future multisensory interventions.

Background

Dementia is an umbrella term used to describe a category of degenerative diseases (which includes Alzheimer’s disease, Lewy body dementia, vascular dementia, and other types of dementia) that are commonly associated with a number of cognitive changes, including memory loss, judgment and reasoning problems, and mood changes (Public Health Agency of Canada, 2017). There is no cure for dementia and pharmacologic therapies have limited effectiveness (Cotelli et al., 2012). Psychosocial interventions include approaches such as reminiscence therapy, a structured intervention that uses photographs, newspaper stories, and objects to evoke long-term feelings and memories, and reality orientation therapy (where caregivers reinforce time, day, season, names, and locations) to support mood, behavior, and memory in persons living with dementia (Abraham et al., 2017; Vilela et al., 2017). Many psychosocial approaches include sensory environmental modifications such as aromatics (Oliveira et al., 2015), music (Cotelli et al., 2012), Snoezelen rooms (rooms that contain objects such as fiber optic lights and bubble tubes which aim to engage and calm the senses) (Vilela et al., 2017), and tactile stimulation such as touch (Abraham et al., 2017). Sensory environmental modifications that stimulate senses have become popular treatments for people living with dementia because their environments often have insufficient stimulation or excess stimulation (Minner et al.,

2004; Sakamoto et al., 2013), and because it is theorized that exposure to positive environments elicits a positive psychological and physiological response (Scott et al., 2014). In addition, sensory environment therapies often do not require language skills, making them appropriate for those with moderate to severe forms of dementia. These interventions are intended to induce pleasure and not demand performance (which can lead to elevated anxiety levels) from those living with dementia (Bera, 2008).

Method

Our scoping review methods were guided by the approach outlined by Joanna Briggs Institute (2015) and informed by Arksey and O'Malley (2005) and Levac and colleagues (2010). Our scoping review fits into what Arksey and O'Malley (2005) describe as the third purpose for a scoping review—to summarize and disseminate research findings.

Search strategy

We kept our search strategy and terms broad to identify the maximum number of studies that were eligible for inclusion. The search strategy was developed to identify all studies relevant to sensory interventions and dementia. Search terms included: Dementia, Alzheimer* Disease, Sensory, Sensory Intervention, Sensory Therapy, Multisensory, Older Adult*, Elderly, and Senior*. Search terms were further narrowed with the addition of words that reflected the setting of interventions, including: Residential Care, Long-term Care Home, and Home. Terms were added to reflect the type of intervention, including: Snoezelen, Light Therapy, Music Therapy, Aromatherapy, Aromatics, Nature, Touch, and Taste.

The search was conducted without a study design filter to retrieve studies using all methodologies, including systematic reviews, qualitative studies, quantitative studies, case studies, and references to news stories. We included dissertations, but we did not include gray literature. The databases searched included: MEDLINE, PubMed, Academic Search Complete, CINAHL Complete, PsycInfo, and Summon Search discovery layer. The search was initially conducted in June 2018 and updated January 2019. In addition to the database searches, reference lists were checked for relevant studies. We then checked the bibliographies of those studies for other relevant papers. Our search only included English studies.

Inclusion and exclusion criteria

Our search inclusion and exclusion criteria are listed below. We used the following inclusion criteria:

- Articles that described sensory (or multisensory) interventions
- Articles where the intervention was targeted to people living with dementia (any type)
- Articles that reported outcomes related to people living with dementia

We excluded the following types of articles:

- Articles where the intervention was not targeted to people living with dementia (and instead targeted caregivers)
- Articles that focused solely on caregiver outcomes
- Articles that focused solely on feasibility outcomes

- Systematic reviews

However, systematic reviews were flagged, and their bibliographies extracted to ensure that any additional articles that they reviewed were also included in our review. We did not screen for level of evidence, as our goal was to map the literature, not to determine which interventions were most effective.

It was challenging to delineate the difference between a sensory intervention and a non-sensory intervention, because the world is mediated through our senses and most interventions (even pharmacological interventions) have a sensory component. We decided to restrict ourselves to interventions where the intervention is intended to work by stimulating one or more senses, thus providing improved sleep, mood, quality of life, or any other patient-related outcome. Thus, we did not include massage, because massage is not theorized to work simply through the benefit of touch, but by strategically stretching particular muscles and tendons, and moving lymphatic fluid. Massage (versus therapeutic touch) is based on kinesiological theories of the body and its mechanics. Likewise, acupressure was not included because that is not theorized to work through touch stimulation only, but by stimulating specific meridians in the body. We also did not include doll therapy or pet therapy, although these both have considerable sensory components. Doll therapy is primarily a form of reminiscence therapy and psychosocial therapy. Pet therapy, we felt, is a non-human form of psychosocial therapy. We understand that determining what is included and not included as a sensory intervention is challenging and our approach was to look at the mechanism of action and determine whether we felt that it was primarily through sensory intervention. Since not all mechanisms of action are known (we often know whether an intervention works without knowing why), this was often a judgment call, but we took pains to reach consensus as a group before excluding any studies or types of interventions.

Study selection

We conducted two levels of review—an initial title and abstract review, and a full text review to determine which sources would be included. Both of these reviews were conducted using the help of Covidence. Covidence is a web-based platform to help researchers conduct and organize literature reviews. Prior to undertaking each level of review, we conducted a “calibration exercise” to ensure consistent interpretation of the inclusion and exclusion criteria. All members of the team reviewed the same 10 articles and determined whether they would be included or excluded and why. Then, we met as a group to review our answers and determine whether there was consistency, and if not, where the differences were, and make any necessary clarifications to the process. The “Level 1” review (title and abstract) was conducted in duplicate. Those titles where consensus was not achieved were reviewed by the team during team meetings (usually every week or two). The “Level 2” review (full text) was also conducted in duplicate, and again, discrepancies were discussed and resolved by the team during team meetings. We found that these discussions to resolve discrepancies were helpful and took advantage of our interdisciplinary team. The interdisciplinary approach and duplicate review are both recommended by Levac and associates (2010).

Data extraction

Once the study selection was complete, we extracted the following data from each source into a spreadsheet: authors, year, journal, country, type of article (e.g., experimental, observational, and commentary), type of

experiment (if an experimental article), name of intervention, description of intervention, whether the intervention was targeted to individuals, groups, or both, profession administering intervention, comparator (if any), setting, senses stimulated, outcomes measured, results, number of participants, age of participants, type of dementia of participants, gender of participants, and hypothesized mechanism of action. Since this was a scoping review and not a systematic review, we did not extract outcomes, but rather outcomes measured. To ensure consistent understanding of the data extraction process, all members extracted data from the same 10 articles, and we compared results. This was our “calibration” exercise. This exercise allowed us to update the spreadsheet, as per Levac and associates’ recommendations (2010). Once the calibration exercise was complete, team members were assigned full text articles to extract. Once those were complete, an auditor (another team member) was assigned to each article, as a type of quality assurance and review. The auditor would review the extraction completed by the other team member and flag anything that they did not agree with. Any feedback/issues were brought up at our team meetings and the extraction sheet was updated to provide additional clarification. This iterative process aligns with the recommendations described in Levac and associates (2010).

Data analysis

After the primary data were extracted, we identified groupings of data from the following data fields: type of intervention, setting of intervention, study design, outcome. We developed the sub-categories of each data field through iterative development and testing, until we developed a final set of sub-categories which were comprehensive as a whole and each specific and non-overlapping with the other sub-categories. All data categorization and attribution were conducted by one team member and audited by another. The auditor reviewed the work done by another team member and flagged anything they did not agree with, for discussion with the larger group. Any changes were made through discussion and consensus. We categorized the interventions into the following categories: art, aromatics, light, multi-component interventions, multisensory rooms, multisensory, music, nature, touch, and taste. We categorized the outcome measures into the following categories: behavior (aggression, agitation, wandering, etc.), carer–patient relationship, cognition (memory, language, etc.), feasibility/cost (some interventions also collected this data), movement/mobility (balance, falls, etc.), other (e.g., qualitative description), overall (quality of life and wellbeing), physical (heart rate, pain scores, etc.), psychological/mood (depression, anxiety, etc.), sleep (hours of sleep per day, etc.), and unspecified. Regarding the setting, we categorized the setting that the intervention took place into the following categories: assisted living (including long-term care and retirement), day center, community, own home, specialized care, multiple locations, and unspecified. Specialized care includes dementia wards in hospitals and other acute-level care environments designed for people living with dementia.

Results

Below, we present our results, first describing the main characteristics of included studies, then describing each intervention type, and finally mapping the data to describe patterns in the literature. Together, 7634 studies were imported into Covidence ([Covidence.org](https://www.covidence.org)), and 5329 duplicates were removed. We conducted title and abstract screening of 2305 studies in duplicate, and 465 relevant studies were reviewed in full to be assessed for eligibility. 170 of those studies were included in the final analysis. The PRISMA diagram, detailing the review is below (Figure 1).

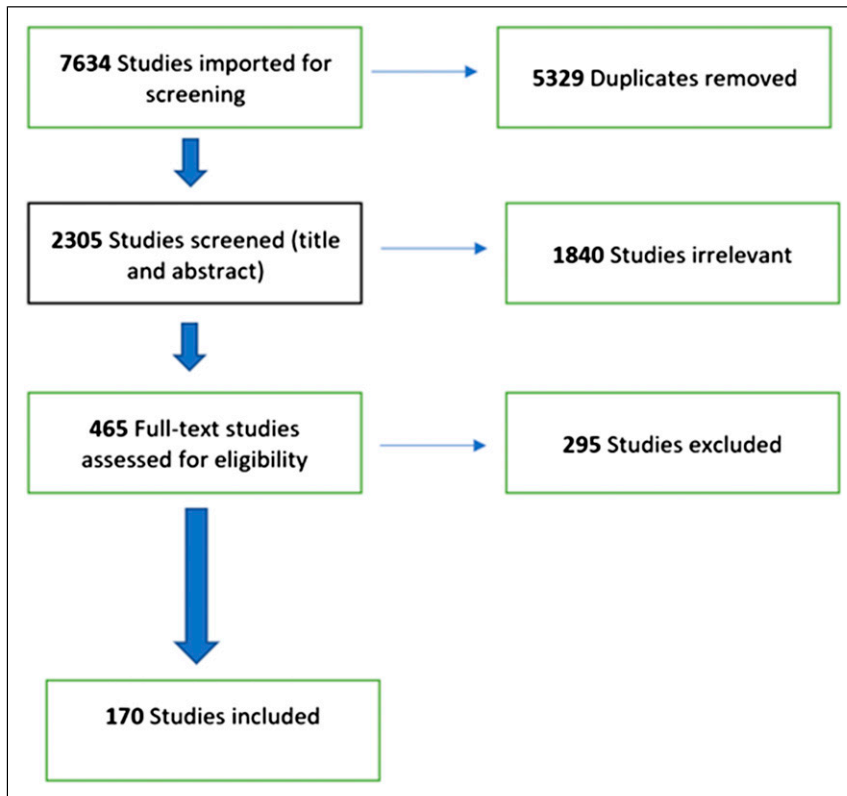


Figure 1. PRISMA diagram of scoping review.

Main characteristics of included studies

In terms of the *location of the studies*, the articles ($n = 170$) were from (in descending order): USA ($n = 57$), the United Kingdom ($n = 27$) and Australia ($n = 15$), Taiwan ($n = 10$), Canada ($n = 8$), Japan ($n = 8$), Spain ($n = 6$), Italy ($n = 4$), Portugal ($n = 4$), Netherlands ($n = 3$), France ($n = 2$), Korea ($n = 2$), Germany ($n = 1$), Hong Kong ($n = 1$), New Zealand ($n = 1$), Norway ($n = 1$), Switzerland ($n = 1$), Turkey ($n = 1$), multiple countries ($n = 1$), and unspecified ($n = 6$). The literature has grown in recent decades; of our included literature, eight articles were published in the 1990s, 56 articles published in the 2000s, and 106 articles published from 2010 to 1 June 2019.

We recorded what *types of dementia* were targeted for the intervention. Eighty-four articles identified what type of dementia the participants were living with. The types included were: Alzheimer's disease (and Alzheimer's-related disease), Lewy Body dementia, vascular dementia, mixed dementia, alcohol-related dementia, and fronto-temporal dementia. Forty-five of the 84 interventions (54%) indicated that participants were living with Alzheimer's disease, 25 (30%) indicated that participants lived with Alzheimer's disease and other types of dementia, and 14 interventions (17%) indicated that participants lived with other types of dementia. There were no differences between the intervention types targeted towards those with Alzheimer's and those with other forms of dementia that we could determine from the data.

The number of participants ranged from 4 to 190, with an average size of 30 individuals in each study. The average age of the population was recorded in 80 studies. The mean *average age* was 82.2, with a range of 72.3–90 years. The *sex distribution* of the study population was recorded in 106 studies. On average, 66% of the population were women, with a range of 0–100%. Four studies were conducted with an all-male veteran population.

Types of interventions

We developed 10 different categories of interventions: art, aromatics, light, multi-component interventions, multisensory rooms, multisensory, music, nature, touch, and taste. Multisensory rooms are environments such as Snoezelen rooms which have multiple objects for sensory interaction. Multisensory involves bringing multisensory objects and stimuli to users. This could range from a portable Snoezelen room, to providing touch interventions with aromatic ones. Multi-component interventions combine sensory interventions (or multisensory interventions) with other interventions such as exercise, cognitive therapy, and orientation therapy. These types of interventions are described below, and the articles for each intervention are summarized in Table 1.

Music ($n = 40$) was the most common type of sensory intervention. It was primarily group-based, although some individual-level programs existed. This is likely due to the well documented improvements in mood and memory that music interventions have demonstrated (Thomas et al., 2017) and the economic feasibility of group music programs (Hsu et al., 2015). One of the theorized mechanisms by which music acts on the physical and emotional body is that by impacting physical parameters, such as the autonomic nervous system (measured by proxy via heart rate), this exerts a positive effect on psychological behaviors and symptoms (such as agitation; Vink et al., 2013). Music is also theorized to improve both emotional state and cognition (Suzuki et al., 2004). Finally, music is thought to stimulate the immune system (Takahashi & Matsushita, 2006).

Of the 40 music interventions, 25 were group based, or individual and group based. The group-based nature of music interventions is unique, it is the only intervention type where more than 35% of the interventions were group based. Thus, their popularity may be due to their feasibility. Music interventions often also benefit from a social element and are more conducive to group-based delivery. Matthews (Matthews, 2015) argues that group-based music enhances wellbeing by enabling participants to shift from being a patient to a participant, by co-creating a social narrative with others. Group singing is hypothesized to improve social skills and enhance social behavior (van der Steen et al., 2018). With regards to who administered the intervention, only 12/40 of the interventions (30%) were delivered by a musical therapist, the others delivered by a range of professionals, from study researchers, research assistants, caregiving staff, musicians, and nurses. Those interventions led by musical therapists were unique in that they most often (7 out of nine total occurrences) measured physical outcomes (such as blood pressure, heart failure events, and salivary cortisol). This does not mean that they were more effective at impacting physical outcomes, but that they more often measured these outcomes (and thus expected them). Music interventions were primarily conducted in assisted living environments ($n = 19$) and specialized care units ($n = 8$) or in an unspecified location ($n = 6$). Many of the articles ($n = 29$) described experimental or quasi-experimental studies, 10 of which were randomized controlled trials, nine of which were non-randomized controlled design, and four of which used a pre-post design. The others were observational studies ($n = 7$) or commentary articles ($n = 4$).

Multisensory rooms ($n = 32$), such as Snoezelen rooms, were first developed in the 1970s and have declined in popularity in the literature. A recent systematic review (Vilela et al., 2017) found that they showed great potential when first developed in the 1970s, but their results have fallen short.

Table 1. Sensory-based interventions for people living with dementia, by intervention type.

Intervention type	Publication
Art	(Bennett et al., 2019; Chauhan, 2018; Johnson et al., 2017; Kinney & Rentz, 2005; Luyten et al., 2018; Martin, 2011; Rouch et al., 2018; Schneider, 2018; Tyack et al., 2017)
Aromatic	(Gray & Clair, 2002; Jimbo et al., 2009; Johannessen, 2013; Snow et al., 2004; Turten Kaymaz & Ozdemir, 2017; Vance, 1999; Watson et al., 2019)
Light	(Burns et al., 2009; De Lepeleire et al., 2007; Figueiro et al., 2014; 2015; 2016; Hickman et al., 2007; Konis et al., 2018; Sloane et al., 2007; Wahnschaffe et al., 2017)
Multi-component	(R.-C. Chen et al., 2014; Cruz et al., 2011, 2013; Dimitriou et al., 2018; Gibson et al., 2017; Goldstein-Levitas, 2016; Griffiths et al., 2019; Heyn, 2003; Hutson et al., 2014; Kang et al., 2010; Litchke & Hodges, 2014; Marques et al., 2013; Olsen et al., 2000; Ozdemir Nuran, 2009; Satoh et al., 2017; Spildooren et al., 2019; Sposito et al., 2017; M.H. Yang et al., 2015)
Multisensory room	(Anderson et al., 2011; Baillon et al., 2004; Ball & Haight, 2005; Bauer et al., 2015; Bera, 2008; Bonora et al., 2011; Burns et al., 2000; 2004; Collier et al., 2010; Collier & Jakob, 2017; Cook, 2011; Dunn & Riley-Doucet, 2013; Hope, 1998; Klages et al., 2011; Lape, 2009; Maseda et al., 2014; 2018; Milev et al., 2008; Minner et al., 2004; Mitchell et al., 2015; Park et al., 2015; Pulsford et al., 2000; Riley-Doucet & Dunn, 2013; Sakamoto et al., 2013; Sánchez et al., 2016; Staal et al., 2003; Staal, 2012; van Diepen et al., 2002; van Weert et al., 2004; 2005a; 2005b; Woodrow, 1998)
Multisensory	(Baker et al., 2001; 2003; Bakshi, 2004; Bauer et al., 2012; Bunn et al., 2018; Burns et al., 2002; Chang et al., 2019; Charlesworth, 2001; Chung et al., 2016; Cui et al., 2017; Duffin, 2012; Eggert et al., 2015; Fitzsimmons et al., 2014; Forbes, 2004; Fu et al., 2013; Jensen, 1997; Knight et al., 2010; Kudoh et al., 2009; Leng et al., 2003; Loy & Peterson, 2008 ; Materne et al., 2014; Persaud, 2009; Remington, 2002; Riley-Doucet, 2009; Simard & Volicer, 2010; Staal et al., 2007; Stacpoole et al., 2015; Strøm et al., 2017; Verheijden Klompstra et al., 2014; Ward-Smith et al., 2009; Yang, Lee, et al., 2016a; Yang, Wang, et al., 2016b)
Music	(Belgrave, 2009; Y.-L. Chen & Pei, 2018; Cho, 2016; Chu et al., 2014; I. N. Clark et al., 2018; M. E. Clark et al., 1998; Cooke et al., 2010; Cox et al., 2014; Gerdner, 2000; Gerdner & Swanson, 1993; Gill & Englert, 2013; Gómez Gallego & Gómez García, 2017; Götell et al., 2000, 2003; Ho et al., 2018; Ing, 2016; Irish et al., 2006; Ledger & Baker, 2007; Y. Lin et al., 2011; Lord & Garner, 1993; Mandzuk et al., 2018; McDermott et al., 2014; Murphy et al., 2018; Okada et al., 2009; Onieva-Zafra et al., 2018; Raglio et al., 2015; Simmons-Stern et al., 2010, 2012; Solé et al., 2014; H.-C. Sung et al., 2010; H. Sung et al., 2012; Suzuki et al., 2004; Takahashi & Matsushita, 2006; Vink et al., 2013, 2014)
Nature	(Bossen, 2010; Detweiler et al., 2008; 2009; Dibert, 2015; Edwards et al., 2013; Goto et al., 2014; 2017; Liao et al., 2018; Lin et al., 2018; Scott et al., 2014; Watts & Hsieh, 2015)
Taste	(Hanssen & Kuven, 2016)
Touch	(Aveyard & Doherty, 2002; Hawranik et al., 2008; Moyle et al., 2014; Schaub et al., 2018; Skovdahl et al., 2007; Snyder et al., 1995; Suzuki et al., 2010; Woods et al., 2005, 2009)

Multisensory rooms (often through the use of fiber optic lights, bubble tubes, and spray projectors) are intended to produce improved behavior, such as reduced agitation (Baillon et al., 2004; Park et al., 2015), engagement (Riley-Doucet & Dunn, 2013), and improved mood (I. Burns et al., 2000). Most implementation settings were in institutions: specialized care ($n = 11$) and assisted living ($n = 9$). A range of professions facilitated the intervention: nurses aids ($n = 5$), occupational therapists ($n = 4$), nurses ($n = 3$), activity therapists ($n = 2$), research staff ($n = 2$), family caregivers ($n = 2$), general staff

($n = 2$), recreational staff ($n = 2$), and certified Snoezelen facilitators ($n = 1$). The majority ($n = 17$) of the articles about multisensory rooms described experimental studies, and others described observational studies ($n = 6$), feasibility studies ($n = 1$), clinical studies ($n = 1$), implementation studies ($n = 1$), and commentaries ($n = 6$) about the interventions. Surprisingly, only a few of these interventions ($n = 3$) were targeted to groups (Baillon et al., 2004; I. Burns et al., 2000; Pulsford et al., 2000) with a strong preference for using the room for one-on-one interactions. Multisensory rooms are not appropriate interventions for all persons living with dementia, and should be used in a targeted manner (Hope, 1998), and may be most appropriate for those with later stage dementia because engagement does not require significant language ability (Collier & Jakob, 2017).

Multisensory interventions ($n = 31$) include intentionally designed multisensory programs such as the Namaste Care program (Bunn et al., 2018; Duffin, 2012; McNeil & Westphal, 2018; Simard & Volicer, 2010; Stacpoole et al., 2015), which focuses on soothing people with advanced dementia using sound, touch, smell and taste (Duffin, 2012) and other programs which are designed to expose people living with dementia with a wide variety and types of sensory stimulation (Baker et al., 2001; Charlesworth, 2001; Minxue et al., 2017; Forbes, 2004; Knight et al., 2010; Leng et al., 2003; Ward-Smith et al., 2009). It also includes interventions that combine two specific sensory interventions, such as music and visual stimulation (Eggert et al., 2015; Loy & Petterson, 2008), and aromatics with touch (Fu et al., 2013; Yang, Lee, et al., 2016a; Yang, Wang, et al., 2016b). More than half of the multisensory intervention sources ($n = 19$) are experimental interventions, with some observational ($n = 6$), mixed methods ($n = 2$), and qualitative studies ($n = 1$). Since it is such a diverse and heterogeneous category of interventions, the top outcomes reflect those of the entire dataset: behavior, psychological/mood, and cognition. These types of interventions are most often tested in assisted living ($n = 15$), and multiple locations ($n = 7$). The relative high number of studies that were conducted in multiple locations indicates that these types of interventions may be easily replicable and usable in a variety of contexts. The targets of the intervention are also diverse, including: individual ($n = 15$), group ($n = 10$), both individual and group ($n = 4$), and unspecified ($n = 2$). The majority of the interventions were administered by staff ($n = 8$) or nurses or nurses aids ($n = 6$) or research staff ($n = 5$).

Multi-component interventions ($n = 18$) represent novel combinations of sensory therapies with other therapeutic approaches commonly targeted to this population, including: orientation therapy (explicitly mentioning and discussing dates, times, directions, names, etc. to reinforce these), reminiscence therapy, physical exercise, and motor stimulation therapy (activities such as painting and interactive games to improve functional ability and quality of life). Of the 18 multi-component interventions, half had an exercise component (Chen et al., 2014; T.-D. Dimitriou et al., 2018; Gibson et al., 2017; Goldstein-Levitas, 2016; Heyn, 2003; Hutson et al., 2014; Litchke & Hodges, 2014; Satoh et al., 2017; Spildooren et al., 2019), demonstrating the growing interest in incorporating sensory stimulation into other types of programming and our appreciation of the link between heart and brain health (Walker et al., 2017). These complex interventions are innovative, but none have been examined using a control arm, so our understanding of their effectiveness is relatively weak. A music component may be relatively easy to integrate into an existing program and seems to increase engagement (Heyn, 2003; Spildooren et al., 2019). The relatively high proportion of interventions in this category that have an exercise component explains why physical outcomes (such as heart rate and blood pressure) are more frequently reported in these multi-component interventions. Other common outcomes measured were as follows: behavior, psychological/mood, and other (primarily qualitative feedback on the sessions). Another notable sub-set of multi-component interventions is the combination of multisensory stimulation with motor stimulation (Cruz et al., 2011; 2013; Marques et al., 2013; Sposito et al., 2017) This approach is of special

interest because neither component requires the use of higher cognitive functioning, and is therefore appropriate for people of all levels of cognition (Sposito et al., 2017). Five of the articles describe uncontrolled before–after studies, three describe randomized controlled studies, three describe controlled before–after studies, two describe feasibility studies, and three describe observational studies. Due to the heterogeneous nature of these interventions, unsurprisingly, they were administered by a wide range of professionals and staff. Six of the interventions were administered by trained staff or research assistants, and five were administered by either a physiotherapist, exercise physiologist, dance movement therapist, or recreational therapist. Like many of the intervention categories, the most common locations were assisted living ($n = 7$) and specialized care ($n = 5$).

Nature interventions ($n = 11$) are a new trend in multisensory research. The interest in multisensory rooms has declined, partly because they rarely show improved outcomes as compared with staff interaction (Bauer et al., 2015) reminiscence therapy (Baillon et al., 2004) or music (Maseda et al., 2018), and hygiene concerns and capital costs (Anderson et al., 2011). Nature interventions (wander gardens, Zen gardens, etc.) is a multisensory environment that has fewer downsides, and some research has shown that older adults living with dementia prefer garden environments over Snoezelen rooms, spending considerable more time in them (Anderson et al., 2011; Goto et al., 2014). Nature interventions can stimulate reminiscence (Goto et al., 2014) and reduce the need for psychiatric medications (Detweiler et al., 2009). Martin (Martin, 2011) hypothesizes that viewing natural landscapes is calming because they stimulate a response in our evolutionary neurocircuitry. Simply listening to various nature sounds has also been demonstrated to reduce agitated behaviors in people living with dementia (Lin et al., 2018). Nature-based interventions have been explored in five experimental studies, four observational studies, and two commentaries. When specified, it is most commonly administered by staff ($n = 5$) and located in assisted living ($n = 5$) or specialized care ($n = 4$). Common outcomes measured are related to behavior, physical outcomes, cognition, psychological/mood, and overall (quality of life, etc.), an indication of its presumed global benefit.

Art ($n = 9$) for dementia is also a growing field. For people living with dementia, creating, handling, and looking at art is considered appropriate because they often do not require the retrieval of previous memories (Johnson et al., 2017), and because visual imagery combined with verbal discussion may promote memory (Tyack et al., 2017). Wellbeing is a common outcome measure for art interventions, with evidence that it enhances wellbeing (Johnson et al., 2017; Kinney & Rentz, 2005; Tyack et al., 2017) and quality of life (Rouch et al., 2018) in people living with dementia. The majority ($n = 7$) of the art interventions were conducted in a group setting. They were offered in the community ($n = 4$), specialized care ($n = 3$), day centers ($n = 1$), multiple locations ($n = 1$), and in an unspecified location ($n = 1$). Art had the highest proportion of any type of intervention that was offered in the community. This is because community settings are often art galleries, museums, and community centers. Art interventions, thereby, may have the added benefit of a community outing, and being a group activity. Interestingly, art interventions are most often administered by researchers ($n = 2$), but are also administered by family caregivers, staff, art instructors, or a combination. They are described in five experimental studies (including one crossover study and one randomized controlled study), three observational studies, and one commentary. They are primarily ($n = 7$) administered to groups of people living with dementia.

Light interventions ($n = 10$) involve exposing users to specific light frequencies (depending upon the time of day) and can be useful for people who are prone to seasonal affective disorder, do not typically receive much natural light, have trouble sleeping, or experience “sundowning” (confusion or agitation during late afternoon). The light influences gene expression to balance serotonin levels to regulate sleep. Light is mostly administered to individuals (via a lightbox (A. Burns et al., 2009), a light table (M G Figueiro et al., 2016), or luminaries (Mariana G Figueiro

et al., 2014, 2015)), although some interventions apply light to common areas (Hickman et al., 2007; Konis et al., 2018). However, some studies simply measured the relationship between how much light people received and their sleep patterns (De Lepeleire et al., 2007). Most light interventions are conducted in assisted living settings. Outcomes of interest are most often sleep-related (number of hours of sleep a night and number of times the user wakes up at night) and behavior-related (agitation, confusion, etc.). More than half of the studies ($n = 6$) did not require the intervention to be administered by anyone (being a passive intervention), and the others were administered by nurses ($n = 2$), research staff ($n = 1$), or staff ($n = 1$). Eight of the articles describe experimental studies, including three uncontrolled before–after studies, two crossover studies, and one randomized controlled trial.

Touch interventions ($n = 9$) involve gentle touching of the hands (Schaub et al., 2018; Snyder et al., 1995), feet (Moyle et al., 2014), other parts of the body, such as shoulders (Skovdahl et al., 2007; Suzuki et al., 2010; Woods et al., 2005, 2009). It may not even necessitate actual physical touch but simply holding the hands over the body and “energetically” touching the patient (Aveyard & Doherty, 2002; Hawranik et al., 2008). Nurses ($n = 5$), staff ($n = 1$), and trained therapists ($n = 3$) administer therapeutic touch in specialized care ($n = 5$) and assisted living ($n = 4$) settings. These interventions are always targeted to individuals. They are often used to treat agitation (Moyle et al., 2014; Schaub et al., 2018; Snyder et al., 1995; Woods et al., 2005, 2009). Touch is thought to induce relaxation and reduce agitation by stimulating the production of oxytocin (Moyle et al., 2014), reducing the production of the stress hormone cortisol (Woods et al., 2009), or stimulating a positive affective response (Schaub et al., 2018). Most interventions ($n = 7$) were experimental studies (including five randomized controlled trials), and all were administered individually. Control arms for experimental studies were either standard care (such as a leisure activity) (Schaub et al., 2018; Woods et al., 2009), a quiet presence (Moyle et al., 2014; Snyder et al., 1995), or simulated therapeutic touch (Hawranik et al., 2008). It is interesting that a relatively high number of interventions testing the effects of touch on people living with dementia were conducted with a randomized controlled trial, the “gold standard” in study designs. This may be because, compared to other forms of sensory therapies for dementia, in touch interventions it is easier to control the “dose” of the intervention and is therefore more amenable to such a study design.

The articles detailing **aromatic** interventions ($n = 7$) we found were primarily experimental interventions ($n = 4$) (JIMBO et al., 2009; Snow et al., 2004; Turten Kaymaz & Ozdemir, 2017; Watson et al., 2019). The scents tested ranged from lavender and lemon balm (Watson et al., 2019), lavender and thyme (Snow et al., 2004), lavender, tea tree and sweet orange (Gray & Clair, 2002), lavender only (Johannessen, 2013), rosemary and lemon in the morning and lavender and orange in the evening (JIMBO et al., 2009), and a mix of lemongrass and eucalyptus, with lavender (Turten Kaymaz & Ozdemir, 2017). The scents were most often used in a diffuser, but were also administered topically after dilution in a carrier oil (Turten Kaymaz & Ozdemir, 2017). Expressive behaviors such as agitation (Snow et al., 2004; Turten Kaymaz & Ozdemir, 2017; Watson et al., 2019) and aggression (Gray & Clair, 2002) were the most common outcomes measured. Like touch, aromatics were always administered to individuals, rather than in a group setting. Aromatic interventions were most often administered in assisted living ($n = 3$) and specialized care ($n = 2$) by nurses ($n = 2$), staff ($n = 2$), or an aromatherapist ($n = 1$). The mechanisms of action of these essential oils is not fully understood, but one hypothesis is that through the olfactory system, the oils enter the bloodstream, thereby producing therapeutic effects (Holmes & Ballard, 2004), even in those who have reduced olfactory functioning, as many people living with dementia experience (Behrman et al., 2014; Snow et al., 2004). However, Snow found that by applying oils on the skin and diffusing them into the air, that those with impaired olfactory functioning only responded to the oil applied

through the skin (Snow et al., 2004). Thus, showing that that is the best route of action for those people living with both dementia and impaired olfaction.

The final and least common type of intervention was **taste** ($n = 1$). Although taste was included in 24 other interventions (multisensory and multi-component interventions), taste as a singular intervention was only found in one instance. This was a “cultural food” observational intervention, where familiar tastes were introduced to individuals in Russia, Norway and South Africa who were living with dementia. This was intended to support quality of life because traditional foods “strengthen feelings of belonging, identity and heritage” (Hanssen & Kuven, 2016). The locations of intervention were unspecified and were administered by family members or nurses. It was an observational study that focused on the qualitative experiences of the participants.

Mapping the interventions in the literature

Below we map the data, describing the trends in the literature over time, across settings, senses targeted, outcomes measured, populations targeted, and study design.

Temporal trends. We looked to see how intervention type has changed in the last decade. Below is a description of how frequent each type of intervention is in the overall literature, as compared to the literature since 2010 (Table 2).

From this, we can see that the published research on art, multi-component, and music interventions have grown in the last decade, while touch and multisensory room interventions have declined in the research literature.

Setting. The distribution of location of the intervention is described below (Table 3).

We then looked at the top three interventions, by each type of setting and found the following trends (Figure 2).

Overall, the most common locations of intervention were assisted living and specialized care. However, there were some notable exceptions. Art interventions were often conducted in community settings, and multisensory interventions were often tested across multiple types of locations, an indication of their flexibility regarding setting type.

Table 2. Frequency of sensory interventions published before and after 2010.

Intervention	Overall frequency	Frequency since 2010
Music	40	29
Multisensory room	32	16
Multisensory	31	17
Multi-component	18	15
Art	9	8
Nature	11	9
Light	10	6
Touch	9	2
Aromatics	7	3
Taste	1	1
Unspecified	2	0

Table 3. Setting of sensory interventions.

Setting	N	%
Assisted living	67	39.2
Day center	13	7.6
Multiple locations	17	9.9
Community	5	2.9
Own home	7	4.1
Specialized care	44	25.7
Unspecified	18	10.5

Senses targeted. We analyzed which senses each intervention stimulated, and how many. Most commonly, interventions stimulated only one sense (Figure 3). The most common single sense stimulated was sound (Figure 4).

Purposefully targeting three senses is likely complex, and therefore less common. When designing an intervention, focusing on one or two deliberate senses is common, as is addressing as many as possible (although often taste is not incorporated due to health and hygiene reasons).

Outcomes measured. We categorized the outcome measures into the following categories: behavior (aggression, agitation, wandering, etc.), carer–patient relationship, cognition (memory, language, etc.), feasibility/cost, movement/mobility (balance, falls, etc.), other (e.g., qualitative description), overall (quality of life and wellbeing), physical (heart rate, pain scores, etc.), psychological/mood (depression, anxiety, etc.), sleep (hours of sleep per day, etc.), and unspecified. Each intervention reported between one and six outcomes, for a total of 339 outcomes reported across 170 articles. The outcome categories, in order of frequency of reporting were: behavior ($n = 115$), psychological/mood ($n = 66$), cognition ($n = 37$), physical ($n = 28$), other ($n = 26$), overall ($n = 23$), sleep ($n = 16$), movement/mobility ($n = 11$), carer–patient relationship ($n = 4$), and feasibility/cost ($n = 4$). The outcomes reported, by intervention category are detailed in the figure below (Figure 5).

From this we can see what types of sensory interventions have been used to trigger these various categories of outcomes. We can also look at what type of outcome is most commonly reported, by type of intervention, as shown in Table 4.

Population targeted. We recorded whether the sensory intervention was targeted to individuals ($n=84$), groups ($n=58$) or both ($n=9$), or unspecified ($n=20$). Some interventions are obviously targeted only to individuals (e.g., aromatics and touch). 80% of art interventions, and 62% of music interventions are targeted towards groups; the rest to individuals, a mix of both, or unspecified. Multisensory room interventions are targeted towards individuals in 70% of cases. The number drops to 61% for multi-component interventions, 60% for light, 47% for multisensory, and 40% for nature interventions.

Study design. Of the 171 articles, 108 described experimental studies. Of those studies, 40 were randomized controlled (including pilot) studies, including eight three (or four) armed randomized controlled trials. The breakdown of RCTs, by intervention type, is described below (Table 5).

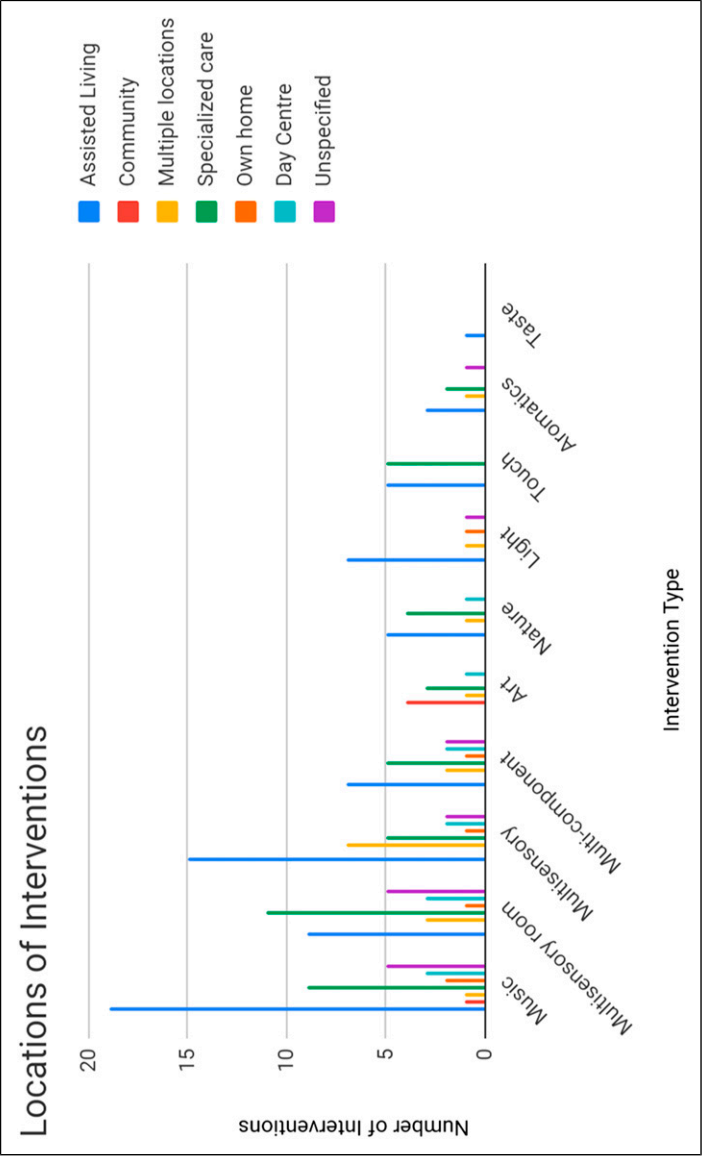


Figure 2. Locations of sensory interventions.

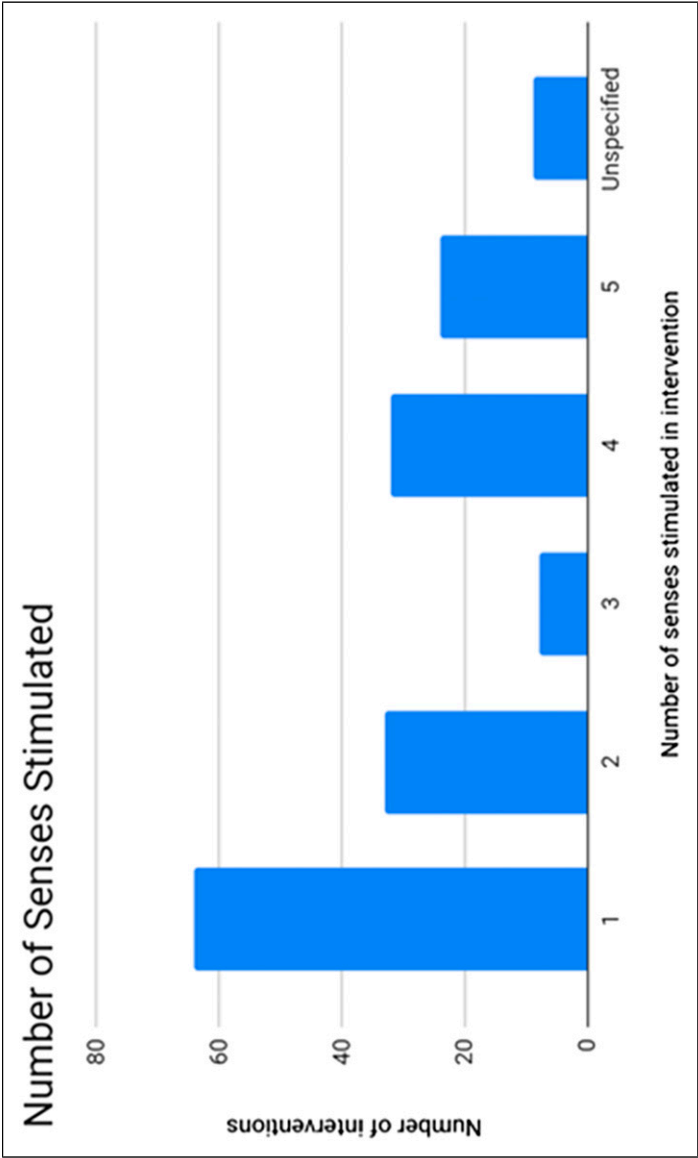


Figure 3. Senses stimulated in the sensory interventions.

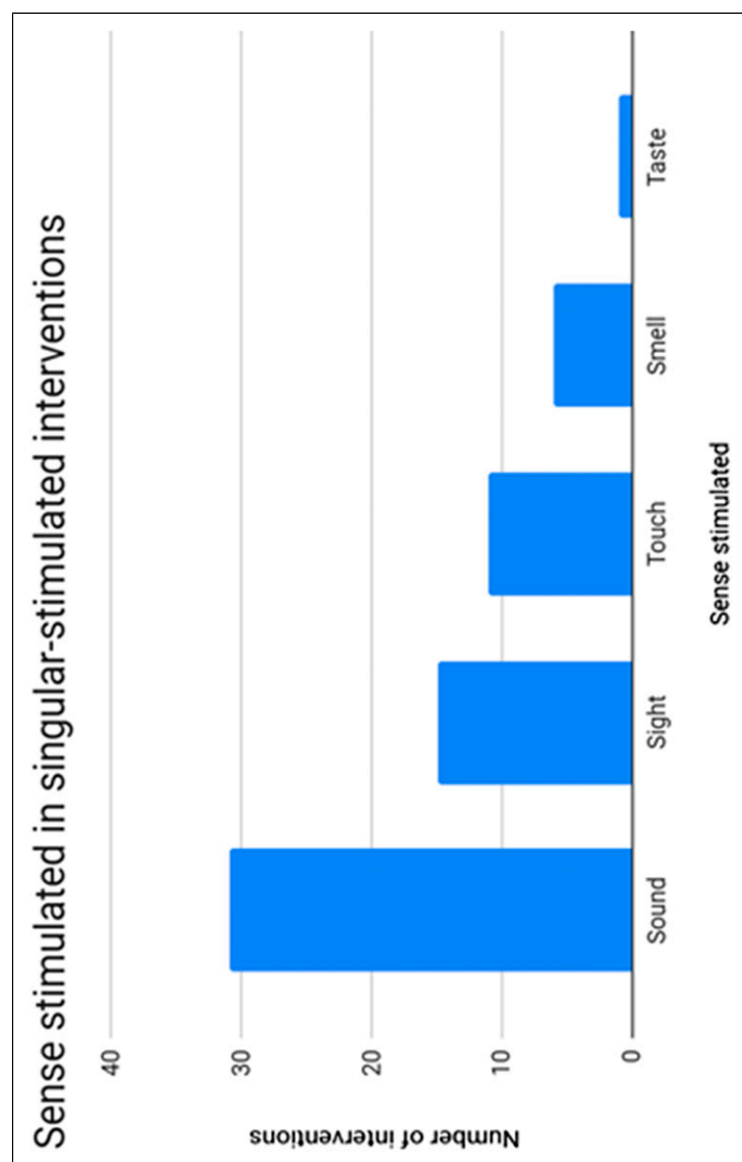


Figure 4. Types of senses stimulated, when only one sense stimulated.

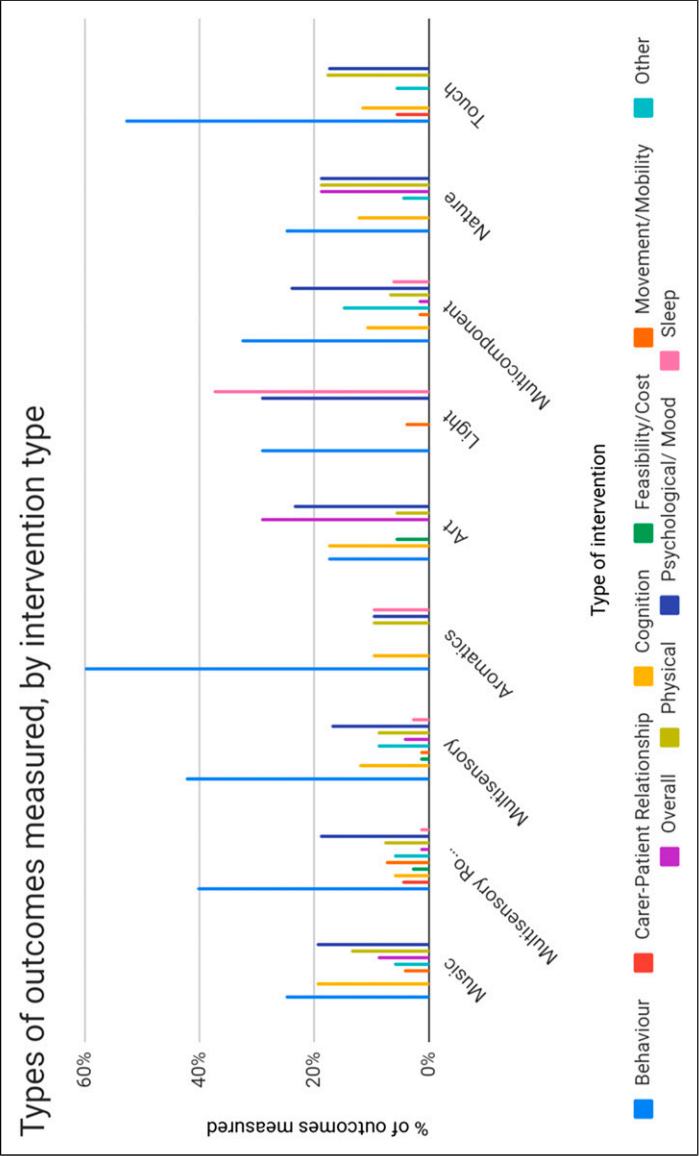


Figure 5. Outcomes reported, by sensory intervention type.

Table 4. Most common intervention category, by outcome measure.

Outcome measure	Intervention category that most frequently reported the outcome measure (% of outcome measures in that outcome measure category)
Behavior	Aromatics (54.5%)
Carer–patient relationship	Multisensory room (4.6%)
Cognition	Music (19.7%)
Feasibility/cost	Art (5.9%)
Movement/mobility	Multisensory room (7.7%)
Other	Multi-component intervention (10.0%)
Overall	Art (29.4%)
Physical	Nature-based (15.8%)
Psychological/mood	Light (29.2%); Art (23.5%)
Sleep	Light (37.5%)

Table 5. Number of RCTs (including three or four armed RCTs) by intervention type.

Intervention	Number of RCTs	Number of 3 (or 4)-armed RCTs
Music	10 (Chen & Pei, 2018; Chu et al., 2014; Cooke et al., 2010; Ho et al., 2018; Ing, 2016; Irish et al., 2006; Lord & Garner, 1993; Raglio et al., 2015; A C Vink et al., 2013; Annemieke C Vink et al., 2014)	1 (Lord & Garner, 1993)
Multisensory room	9 (Baillon et al., 2004; Collier et al., 2010; Klages et al., 2011; Maseda et al., 2014; 2018; Milev et al., 2008; Sakamoto et al., 2013; Sánchez et al., 2016; van Diepen et al., 2002)	1 (Maseda et al., 2014)
Multisensory	10 (R Baker et al., 2001; Roger Baker et al., 2003; Charlesworth, 2001; Forbes, 2004; Fu et al., 2013; Kudoh et al., 2009; Leng et al., 2003; Staal et al., 2007; Strøm et al., 2017; Y.-P. Yang et al., 2016a)	1 (Strøm et al., 2017)
Multi-component	3 (Dimitriou et al., 2018; Hutson et al., 2014; M.-H. Yang et al., 2015)	2 (Dimitriou et al., 2018; M.-H. Yang et al., 2015)
Art	1 (Rouch et al., 2018)	0
Nature-based	1 (Goto et al., 2017)	1 (Goto et al., 2017)
Touch	5 (Moyle et al., 2014; Snyder et al., 1995; Suzuki et al., 2010; Woods et al., 2005, 2009)	3 (Snyder et al., 1995; Woods et al., 2005, 2009)
Light	1 (Burns et al., 2009)	0
Aromatics	1 (Watson et al., 2019)	1 (Watson et al., 2019)
Taste	0	0
Overall	41	11

Discussion

Our scoping review of sensory interventions for people living with dementia found a growing and diverse international body of literature. Sensory approaches were shown to be used internationally and targeted a cohort of older adults (average mean age 82.2 years). Overall, the participants were

66% female, unsurprising due to women's increased longevity (WHO, 2020b). There were a few notable studies that were conducted in veterans' hospitals and only had male participants (Chen et al., 2014; Detweiler et al., 2008; 2009; Lane et al., 2016). Due to the inconsistency in reporting (only 84 of 170 articles reporting this information), we were unable to distinguish which types of interventions were targeted to which types of dementias. Since one could imagine that particular sensory interventions might be better suited to specific types of dementias, better reporting of this information would improve our understanding how to best implement and target sensory interventions. However, this is likely poorly reported because many sensory programs cannot logistically target specific dementias.

Our results add to the review literature on sensory interventions. Our findings, however, differ from other reviews. For example, Strøm and colleagues (Strøm et al., 2016) conducted a systematic review of sensory interventions for persons living with dementia. They focused on the effectiveness of these interventions. Although they included types of interventions that we did not (toy therapy, doll therapy, and pet therapy), our review included more studies ($n = 170$ versus $n = 55$) and as a scoping review, our search was more inclusive in terms of study type, allowing both commentary papers and qualitative studies. They found that, due to the heterogeneity in sample size, population, and length of intervention, it was difficult to draw any conclusions about effectiveness of types of sensory interventions (Strøm et al., 2016). This demonstrates the heterogeneity of the literature and the challenge of declaring what works because they are primarily complex interventions implemented in a range of contexts (Pawson et al., 2005). Dimitriou and Tsolaki (T. D. Dimitriou & Tsolaki, 2017) conducted a similar systematic review of sensory interventions for people living with dementia but restricted their search to only RCTs and only those targeting sleep outcomes. They found that only light interventions had been proven to improve sleep outcomes for those living with dementia. Our findings that light interventions were the most popular for targeting sleep outcomes, align with their results. As such, our scoping review, although not intended to provide definitive conclusions about what interventions work, adds to the scholarship by summarizing the types of sensory interventions, what locations and resources are used to implement them, and what outcomes are sought. With these data, care managers can select the type of sensory intervention that may be feasible in their context and produce the outcomes most important to their population.

When we began our scoping review, we had not found any previous scoping reviews on our topic. However, while we were conducting our review, a scoping review on the topic was published (Smith & D'Amico, 2019). In comparison to Smith's scoping review (Smith & D'Amico, 2019) of sensory stimulation for people with dementia, our review is more comprehensive, including considerably more articles ($n = 47$ vs. $n = 170$). This is primarily because they focused on the Occupational Therapy literature and included only articles with evidence Levels I–III (systematic reviews, meta-analyses, randomized controlled trials, controlled trials, and before–after studies). As scoping reviews are designed to map the existing literature and not to determine what works (The Joanna Briggs Institute, 2015), we did not create criteria based on level of evidence. In addition, our review included more articles because our search databases included Academic Search Complete and the Summon search tool, both of which are multi-disciplinary. As such our review is more comprehensive and applicable to the overall field of dementia care and can inform the practice of a wide variety of care managers and clinicians. However, the Smith & D'Amico article assessed the effectiveness of sensory interventions for people living with dementia, which our review did not do. It is difficult to compare their results to ours because they investigated effectiveness and our review mapped out the literature. In addition, they included many several types of interventions that we did not include (e.g., Montessori, animal assisted therapy, dance, and yoga).

There is considerable disagreement in the literature regarding what constitutes a “sensory intervention” or an “environment-based intervention.” There is consensus that music, light, aromatics, multisensory rooms (including nature), touch, and gustatory interventions all constitute sensory interventions (Strøm et al., 2016). However, some authors also include pet therapy (Behrman et al., 2014), robot therapy, and doll therapy (Strøm et al., 2016). Regarding what constitutes an “environment-based intervention,” multisensory rooms and nature interventions are common, but some authors also include Montessori-based programs (Padilla, 2011). We did not include Montessori-based programming because they are often categorized as “behavior management techniques” and grouped with interventions such as low noise and caregiver education (T.-D. Dimitriou et al., 2018; T. D. Dimitriou & Tsolaki, 2017). Since every conceivable psychosocial intervention involves at least one of the senses, and therefore stimulates at least one sense, we tried to be restrictive and guided by the concept of whether the intervention was intended to deliberately stimulate a sense, or whether there was a different proposed mechanism of action. For example, we did not include doll therapy because the mechanism of action is to stimulate a memory of a relationship, and the therapeutic effect is relational versus based on sensory stimulation. One could argue that this is also the case for animal assisted therapy. Even with our restrictive definition of what constitutes a sensory intervention, our review was large ($n = 170$), an indication of the field’s interest in sensory interventions.

Others (Behrman et al., 2014) have proposed the development of individualized sensory interventions. Since sensory loss is common and diverse among those living with dementia, this type of approach has merit. However, we propose a more complex decision-making approach to developing sensory interventions, based on outcomes valued by patients and families, the target of the intervention (individuals and/or groups), and setting. We have developed a tool that allows caregivers, care managers, and others determine what might be implemented in their setting (see Supplementary Material, and Figure 1). This tool was designed to help interested parties make intervention decisions. Our review has indicated that others in similar circumstances have done this. This tool is an interactive PDF, where the user selects the setting, intervention group target (individual, group, or both), and outcome of interest, and the tool then identifies which multisensory interventions have been used in that context. The logic which informs this tool was developed based on the outcomes of our scoping review, and can be updated, as new literature is produced. The results of our review (including our interactive tool) can be used to shape novel and appropriate sensory intervention development.

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Supplementary Material to
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Limitations

Our study had several limitations. First, we included papers since 1990. However, older interventions may not be relevant to modern users and contexts, and what the literature looked like 30 years ago may not be relevant today. However, since we only found eight articles from the 1990s, this older data likely did not significantly impact our findings. Another important limitation was that we did not include articles written in languages other than English. Sensory interventions are popular across the world, especially in Asia, and this decision likely left out much of the innovative scholarship from Asia and other areas where scientific literature is commonly published in languages other than English. In addition, we did not analyze our results by country, assuming that an intervention developed and tested in one country may be adequately transferred to another country. Care managers ought to be careful when interpreting results from jurisdictions with very different care models, resources, and professional training programs. Another considerable limitation to our study was the sub-categories that we developed from the literature. Although we iteratively

developed and tested the sub-categories that we developed in our multidisciplinary team (which included a professional caregiver) a different team with a different composition may have developed a different taxonomy. We propose that the sub-categories that we developed be a helpful starting point for other teams mapping the literature but urge that they be further tested and refined.

Conclusion

Through this scoping review, we have demonstrated how specific types of sensory interventions have been implemented across numerous settings, and target populations (individuals, groups, or both), and may target various outcomes, to better inform person-centered dementia care. Over the years, there have been trends in sensory therapeutic interventions. Music, multi-component, art and nature interventions have grown in popularity in the most recent decade, reflecting the strength of the evidence (as with music interventions), an emphasis on improving the quality of life of those living with dementia (as with art interventions), and novel approaches to multi-sensory rooms (nature interventions). In addition, creative combinations of more than one sensory intervention with or without other non-sensory interventions for people living with dementia (multi-component interventions) have emerged and show the greatest promise for future innovation and development.

From the literature, we developed a categorization system for “types” of sensory interventions. This categorization system may help future researchers and clinicians and ought to be further refined and tested. In addition, the large and diverse literature that we encountered required that we define sensory intervention as any intervention where the mechanism of action is theorized to be based on sensory stimulation (or sensory stimulations), not simply any intervention that incorporates one of the senses (because presumably all interventions do this). We hope that this definition will contribute to further clarification and theorization in the field.

Our findings can inform how caregivers and care workers can improve the care of individuals living with dementia. We have developed an interactive tool to help caregivers, care managers, and others determine what might be the best type of sensory intervention to implement in their setting. The interactive tool will help interested parties make intervention decisions based on what our scoping review has indicated that others in similar circumstances have done. The results of our review, including our interactive tool, can be used shape novel and appropriate sensory intervention development.

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