The existing Practice regarding the Application of Acoustic Cues in the Treatment of Elderly Patients with Dementia - a Scoped Literature Review

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Bachelor Thesis

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Abstract

Background: The number of people afflicted by age-related diseases like dementia and who therefore require medical attention is steadily growing worldwide. In addition to cognitive impairments, psychological and behavioural disturbances form as well an integral part of dementia syndromes and non-pharmacological therapies for the treatment of those, are moving increasingly into the focus of the clinical spectrum. Previous studies indicated that music coaching might be beneficial to improve psychological and behavioural symptoms. Therefore, this scoped literature review aims to explore the current literature to gain an insight into the existing practice in the application of acoustic cues in elderly care regarding the treatment of psychological and behavioural disturbances of dementia.

Methods: An electronic search on Scopus was conducted. Search keywords regarding music therapy, auditory cueing, dementia, and behavioural symptoms were searched in the MeSH (Medical Subject Headings) databases and were combined in a search string. For to the inclusion criteria, the PICOC-framework was utilized.

Results: 269 potential studies were initially identified which were supposed to address the research topic. Out of these 269 initial papers, 15 selected studies could finally be identified. The 15 studies included seven randomized control studies, one case series, one controlled clinical study, four meta-analyses, one systematic review and one literature review.

Conclusion: The scoped review revealed, that in elderly care the most commonly acoustic cues used were provided either in the form of active and live- or passive acoustic reproduction. Live acoustic cues often contained a mix of musical elements like melodies, sounds, tones, rhythms reproduced mostly improvised by a music facilitator using instrumental references or the human voice. Regarding passive acoustic cues, music songs tend to be played by a recorder, but also pre-recorded conversations which are not based on music but solely on the human voice were identified as acoustic cues. Moreover, the majority of the studies have shown improvements in relation to BPSD symptoms. In relation to the effects of specific acoustic cues, personalized and generic cues have been able to characterize effects but no difference in the effectiveness regarding the application of generic vs. personalized acoustic cues could be determined.

Introduction

Dementia is ranked as the fifth leading cause of death worldwide. This can be attributed to the increasing ageing of the population all over the world throughout the last few decades. As a result of the population's ageing, the number of people afflicted by age-related diseases and who require medical attention is steadily growing (Jerliu, Toçi, Burazeri, Ramadani & Brand, 2013; The World Health Organization, 2017). These age-related conditions predominantly include neurodegenerative diseases such as dementia, which is prevalent in almost 43% of adults aged 85 years (Alzheimer Association, 2012: Bellman, 2018). The most common form of dementia in high age is hereby Alzheimer's disease. According to the German Medical Journal (2013), more than 6 million people in Europe currently suffer from Alzheimer and calculations indicate that the number of affected people might reach ten million by 2040 in Europe.

Alzheimer's dementia is a progressive disease which leads to a loss of cognitive performance, brain functions and severely impairs the quality of life of affected individuals (Alzheimer's Association, 2012; Bellman, 2018). Impairments are particularly noticeable in memory, the ability to reason and problem-solve and in the progressing stages, in language (Cerejeira, Lagarto & Mukaetova-Ladinska 2012; Yiannopoulou & Papageorgiou, 2012). In addition to cognitive impairments, psychological and behavioural disturbances form as well an integral part of dementia syndromes. Behavioural symptoms include disturbances such as aggressive behaviour, psychomotor agitation, psychosis, apathy and emotional symptoms such as depression and anxiety (Cerejeira, et al., 2012; Cohen-Mansfield, 2013). The clinical picture of specific behavioural disruptions can be variable in the course of the disorder, but most patients experience a therapy-dependent, non-cognitive disorder at least at one point in the course of the disorder (Aalten, de Vugt, Jaspers, Jolles & Verhey, 2005).

Alzheimer's disease and the resulting dementia cannot be cured. However, the symptoms can be alleviated. Antipsychotics are often consulted in conventional therapy and are frequently used to treat the psychological symptoms (Cerejeira et al., 2012). Drugs such as acetylcholinesterase inhibitors, benzodiazepine, antidepressants, and neuroleptics are frequently used to treat states of anxiety, depression or agitation (Abraha, Cruz-Jentoft, Soiza, O'Mahony & Cherubini, 2015). Especially against delusional conditions, medications are often prescribed and used in institutions such as nursing homes (Abraha et. al, 2015; Locca, Büla, Zumbach & Bugnon, 2008).

In this context, the moderate or even inadequate efficacy of medications combined with their serious risks is more frequently the subject of criticism. Implications of antipsychotics, in older dementia patients, were for instance found to be associated with a higher risk in mortality (Abraha et. al, 2015). According to Cerejeira et al. (2012), pharmacological interventions often lead to the sedation and social isolation of the affected patients, which progressively reduces their autonomy. In the future, therefore, new aspects of care for incurable and progressive diseases will have to be researched on, that do not depend solely at a pharmacological level, as these implications already pose a great challenge for the health system today (Alzheimer Association, 2012; Rynning, 2008).

As a result of the aforementioned limitations of antipsychotics to alleviate psychological and behavioural symptoms, non-pharmacological therapies are moving increasingly into the treatment focus of the clinical spectrum. Although they are currently reportedly underused within the treatment pool, non-pharmacological therapies can be considered as a beneficial option in the treatment of dementia (Abraha et. al, 2015). Among the most widely used non-pharmacological treatments, in regard to Alzheimer's dementia, the use of cognitive training represents the leading one (Berg-Weger & Stewart, 2017). Also, more and more attempts are being made, with the help of emotion-oriented treatment approaches to address the emotions and experiences of individuals with Alzheimer's dementia, which have been as well positively associated with a decrease in behavioural symptoms (Institut für Qualität und Wirtschaftlichkeit im Gesundheitswesen, 2009).

Within the emotion-oriented care paradigm, increasing emphasis is being placed on holistic and individualised treatment methods, on maintaining patients' cognitive activation and the alleviation of psychological symptoms. Hereby, music coaching for dementia patients offers an opportunity to combine various elements of the non-pharmacological treatments previously mentioned and thus opens up to a distinct therapeutic approach. The concept of music therapy offers a wide history of treatments in different areas within the health spectrum, like in the therapy of speech disorders or rehabilitation for cognitive impairments due to stroke (Hurkmans, et al., 2012). However, the approach of music coaching for progressive neurocognitive disorders like dementia proposes a rather young approach in research. (Guetin, et al., 2009; Zhang, et al., 2017).

The present state of research indicates convincingly that behavioural deficits in dementia patients can often be seen in the context of unsatisfied needs (Cohen-Mansfield, 2013). These

needs can range from the desire of social contact and exchanges to alleviating states of boredom. The support of music therapeutic elements was found to satisfy these needs by facilitating communication, promote social interactions of the affected and gave the opportunity for retrospection (Raglio et al., 2008). Moreover, studies indicate that music coaching beneficially improve psychological and behavioural symptoms such as anxiety in people with dementia. Further, it was found to have favourable effects on the patient's memory by slowing down cognitive decline, depressive states and remain their general quality of life (Ueda, Suzukamo, Sato & Izumi, 2013). It enables patients to relax and to remain on their biographies, which generally resulted in the improvement of the mood of the affected individuals and led to positive emotions.

Hereby, music coaching with dementia patients involves listening and singing to pieces of music combined in a therapeutic way (Raglio et al., 2008). Music elements in music therapy also include acoustic cues, which are increasingly being placed at the centre of research, investigating the influence on emotional, cognitive or neurological functions of the brain structure. Acoustic cues can represent sounds, tones, voices or rhythms which are generated through an instrument or a technological device and which can be adapted generically or individually to the patient (Hurkmans et al., 2012). Here, there are currently various intervention models which are concerned with the representation of acoustic cues. The interventions that are momentarily used in elderly care, focus for instance on the reproduction of live acoustic cues, where an active intervention method is frequently used (Zang et al., 2016). Thereby a music mediator provides the acoustic cues with different instruments or also makes use of the voice. Here, the practice can be either delivered as a group or individual intervention, where patients are actively encouraged to participate in the exercises.

In addition, there are as well passive applications of acoustic cues based on music, in which various songs are played to the patients by a recorder. However, there are increasingly therapy models being developed using acoustic cues within the health paradigm that only emphasize on specific parameters such as rhythm, tempo or the pitch of different sounds (Schaefer, 2014). Thereby, for instance, the approach of rhythmic auditory cueing (RAC) offers a new area of treatment for patients with dementia. Traditionally, RAC has primarily been used in the rehabilitation of disorders which include motor deficits such as Parkinson's or Huntington's disease (Schaefer, 2014). With the treatment of RAC, specific auditory signals are used, which

are being played in a rhythmic pattern, usually with the help of a metronome. These projected rhythmic signals are intended to improve symptoms such as psychomotor agitation as according to Schaefer (2014), since rhythmic patterns and body movement are considered to be intuitively associated. Accordingly, Wittwer (2013), for instance, came to the conclusion in his study, that by playing rhythmic music and metronome signals, the Alzheimer patients' gait speed could be reduced.

Additionally, Zhang et al. (2017) state, that acoustic cues can be used to interrupt psychotic behavioural patterns, states of fear or confusion. However, in the spectrum of music coaching, there are also different approaches which are based solely on the human voice and do not use either musical or rhythmic elements. Thereby, the method of simulated presence (SPT) represents a new treatment path which is connected to alleviate psychological symptoms such as anxiety in patients with dementia (Zetteler, 2008). The Simulated Presence Therapy simulates the presence of family members or caretakers, whose voice is being recorded while talking about certain individualized positive events which occurred in the life of the patients (Zetteler, 2008). Accordingly, Gerdner (2012), confirms that the focus in the use of the acoustic cueing should lie on particularly individualized pieces of sounds for the affected patients, as individualized pieces can help to maintain biographical awareness, stimulate memories that preserve their identity and further help to relieve psychological and behavioural symptoms.

Although this seems to be a wide-ranging and highly promising field of prospective research, current studies on the use of acoustic cueing in the treatment of dementia provide only limited evidence in the understanding of the different acoustic cues which can be considered as suited. Additionally, so far, no theoretical foundation in the mechanism of the different cues could be established nor the question could be answered whether improvements in behavioural and psychological symptoms can be achieved by using personalized auditory cueing in demented patients. By reviewing the state of the art of acoustic coaching in dementia care, a clearer picture about the effects which have been found within different acoustic cues can be provided.

Therefore, this thesis aims to give an overview of the currently used acoustic cues and to explore to what extent acoustic cues can provide an improvement in behavioural and emotional disturbances in elderly people with dementia. As well a better picture of the effects of generic and personalized approaches will be provided. This will create valuable information that can help to design acoustic based interventions in dementia care and possibly enable

psychologists to enhance evidence-based practice. Thus, not only can the findings prove to be helpful within the developmental process of theoretical therapy models, but can additionally be taken into consideration with regard to the future implementations of health technologies within the care paradigm of the elderly dementia patients. Hereby three research questions were posed that serve as a basis for this literature review and which will be answered in the course of this review.

RQ 1: What types of 'acoustic cues' are currently used in the care of elderly people with dementia?

RQ2: What are the effects (behavioural, emotional) of 'acoustic cues' in the care of elderly people with dementia?

RQ 3: Are there differences in the effectivity of generic approaches vs personalized approaches?

Methods

Search procedure

An electronic search on Scopus, a database for scientific journals was conducted. The focus here was on the incorporation of peer-reviewed research to obtain a reliable source of content-related studies referring to the implementation of acoustic cues in elderly care. In order to provide a reliable scientific basis for the scope literature review, adherence to the PICOC-framework from Petticrew & Roberts (2006) was followed.

Search keywords regarding music therapy, auditory cueing, dementia, Alzheimer and behavioural symptoms were combined in a search string, limited to the English and German language. Further, no restrictions on the publication dates were made, since there is already relatively limited literature on this particular domain, it has been decided to expand the variety of results. The main terms: 'dementia', 'auditory cues' and 'behaviour' were searched in the MeSH (Medical Subject Headings) databases. The following main terms were extended with different terms and synonyms and distributed into three different sets:

Set 1: **dementia:** alzheimer, neurodegenerative disease, cognitive impairment, aged

Set 2: **auditory cues**: music therapy, auditory perception, acoustic stimulation, art therapies, music intervention, passive music, music, sound, simulated presence, music trigger

Set 3: **behaviour:** behavioral symptoms, emotion, lethargy, psychomotor, agitation, aggression, anxiety, depression, quality of life, well-being, nonpharmacological, intervention, bpsd, behavioral psychological symptoms of dementia

The general strategy was to search: Title, abstract & keywords; (set 1) AND (set2) AND (set 3). The SCOPUS database was used with the following search string:

TITLE-ABS-KEY ("dementia" OR alzheimer OR "neurodegenerative disease" OR aged OR "cognitive impairment") AND TITLE-ABS-KEY ("music therapy" OR "auditory perception" OR "acoustic stimulation" OR "art therapies" OR "music intervention" OR "passive music" OR music OR "auditory cues" OR sound OR "Simulated presence" OR "music trigger") AND TITLE-ABS-KEY ("behavioral symptoms" OR emotion* OR lethargy OR psychomotor OR agitation OR aggression OR anxiety OR depression OR quality AND of AND life OR well-being OR nonpharmacological AND intervention OR bpsd OR "behavioral psychological symptoms of dementia") AND NOT ("cancer") AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "German")) AND (LIMIT-TO (EXACTKEYWORD , "Human") OR LIMIT-TO (EXACTKEYWORD ,

"Dementia") OR LIMIT-TO (EXACTKEYWORD , "Music Therapy")) AND (LIMIT-TO (EXACTKEYWORD , "Aged"))

With regard to the search string, it is noticeable that additional restrictions have been imposed in the course of the selection process to the previously defined terms. Thus, for instance, besides specifying the language, restrictions have been made with regard to human test objects in order to extract animal experiments from the field of biochemistry. Furthermore, as well as studies in relation to cancer research were to henceforth be excluded. Also, the results for the specific keywords 'dementia', 'music therapy' and 'aged' were additionally highlighted in order to limit the range of articles and to address the research related aspects more specifically.

Criteria for selected studies for the literature review

In the following section, the inclusion and exclusion criteria that have been defined for the selection process are presented.

Inclusion criteria

For to the inclusion criteria, the PICOC-framework was used by Petticrew & Roberts (2006).

- Types of studies: (all) reviews, meta-analyses, protocols, randomised controlled trials, controlled clinical trials, case reports/series, findings of mixed-methods, qualitative and quantitative study design and empirical studies which are peer-reviewed, as these exhibit a higher degree of scientific validity.
- Population: elderly people regardless of gender, with the clinical condition of dementia or Alzheimer
- Intervention: the use of different sound, acoustic or auditory cues in the context of a therapeutic application which is used with the aim of alleviating behavioural and psychological symptoms in individuals with dementia. As well studies are included which were in line with the definition of music therapy and acoustic cues
- Comparison: nonpharmacological therapies, standard care, pharmacological interventions
- Outcomes: behavioural and psychological symptoms of dementia, well-being, quality of life
- Context: patients who reside in elderly care or are living at home

Exclusion Criteria

- Studies that include a different demographic than geriatric individuals
- Studies that include different neurodegenerative disorders or cognitive impairment which is not the result of dementia
- Studies that focus other than on the improvement of behavioural and psychological symptoms (e.g cognitive enhancement)
- Research on which acoustic elements have been paired with different therapies
- Studies which are not empirically conducted
- Full text not available
- Non-English and non-German

The performed selection process was applied by three following steps which were determined by the aforementioned in- and exclusion criteria. Firstly, encountered duplicates of papers were removed. Secondly, studies according to the relevance of their title and abstract were initially selected. After that, only studies with available full text were included. Finally, studies which could contribute to the study topic due to their subject-specific relevance were as well selected, out of reference lists during the full-text reviews.

Data extraction

Once appropriate studies were selected, two tables were created to present the contents of the data extraction and to further continue answering the three research questions. Table 1 focuses hereby on the contents of the main characteristics of the respective studies and Table 2 gives an overview of the interventions and results of the selected studies.

Table 1

Main characteristics of the selected studies conducted on acoustic cues in elderly care

Data extraction field	Information to be extracted
Author	Names of the authors who conducted the respective study. Here the first author will be mentioned.
Year of publication	The year the paper was published.
Country	The country the study was performed.
Study design	The methodological approach applied to the study which was used for the data

	collection (e.g Randomised Control Trial)
N	The number of participants included in the study. (For the meta-analyses, systematic reviews and literature reviews, the number of studies used and the total number of participants were also summarised here).
Population	The clinical picture, the age group and the place of residence of the study subjects are given. In this case, elderly patients with all stages of dementia residing in elderly care, nursing homes, day care, hospitals or at home.
Study goal	The intended outcome and the general aim of the study (e.g reduction or improvement of behavioural disturbances).
Time frame of the Intervention	The overall duration, the research experiment took place and the interventions were made available to the patients.
Measurements	A list of the chosen examination and assessment measurement of the different studies, to determine the experimental outcome values like the reduction of behavioural and psychological symptoms, are given (e.g Neuropsychiatric Inventory)

Table 2

Overview of the interventions and outcomes of the selected studies

Data extraction field	Information to be extracted
Type of acoustic intervention	A description of the intervention elements is given, in particular, which types of acoustic cues were used for the intervention and with which medium these were executed and provided. Additionally, more detailed information about the acoustic cues is provided here.
Live vs. recorded	Live music refers here to live music acts provided either by an expert, such as a music therapist or by a therapy group during the intervention with the help of musical instruments or through singing and rhythm which further requires the active participation of patients in the intervention. Recorded elements, in contrast, describe the application of pre-recorded auditory sounds which are not played live but are provided to the participants by technologies such as CD players or MP3 players. These interventions usually do not require participative actions on the part of the participants but include mostly passive listening to acoustic sounds in the form of music.
Generic vs. personalized	Here the term *generic* should describe that the acoustic cues have not been individually adapted to the test subjects and, for example, no efforts have been made to design the musical elements according to their preferences. The term *personalized*, on the other hand, should in this instance mean, that the participants during their interventions are provided with musical or acoustic cues that have been individually tailored to their individual tastes or preferences during their single or group sessions.

Outcome of treatment/Effects	The key findings of the experiment and their interpretation in regard to the study goals are presented. In relation to this, the p-values of the findings of the respective studies will be provided.
Reliability	The value of Cronbach's alpha and Cohen's Kappa were used to carry out a quality assessment of the experimental studies and to determine the internal consistency and retest reliability. Based on the scores, the reliability was marked according to the coefficient with stars. This practice is explained in more detail in Table 3.

Table 3

Quality assessment of the experimental studies

Classification	Cronbach's alpha	Cohen's Kappa	Label
Excellent	> 0.9	0.8	****
Good	> 0.8	0.5	***
Acceptable	> 0.7	0.2	**

In terms of quality assessment, the experimental studies were reviewed using the value of Cronbach's alpha and in addition using the value of Cohen's Kappa to determine the level of reliability. Reliability refers to the accuracy of the measurement and for this purpose, the internal consistency was identified by the value of Cronbach's alpha and interrater reliability was defined by the value of Cohen's-Kappa (Kimberlin & Winterstein, 2008). In many studies, these parameters are used as an indication for quality assessment (Bannigan & Watson, 2009). In order to provide a simple overview in the following table, stars were assigned for the reliability of the scores which range from two to four stars.

With an excellent quality of a study, where Cronbach' s alpha had a value of > 0.9 and Cohen' s Kappa had a value of 0.8, the reliability was rated with four stars. A Cronbach alpha of > 0.8 and a Cohen's Kappa of 0.5 was assumed for a good quality and the reliability was marked with three stars. At an acceptable quality with a Cronbach's alpha of > 0.7 and Cohen's Kappa of 0.2, two stars were awarded for reliability. If nothing else has been described in the studies with respect to these variables and no explicit reference has been made to methodological weaknesses,

the reliability of the studies has been determined using this scale. Not all studies used both values, however, the reliability was then assigned to the given value of Cronbach's alpha or Cohen's Kappa according to van den Berg and van der Kolk (2014).

Results

After entering the search string at Scopus at the beginning of April 2019, 269 potential studies were initially identified which were supposed to address the research topic *(Figure 1)*. After scanning through these 269 documents, the first subdivision by relevant titles, abstracts and keywords was undertaken. Based on this, 212 studies were excluded because they could not meet the requirements of the first subdivision. Proceeding therefrom, 57 documents could be selected for which the title, abstract and keywords were of interest. Subsequently, following a closer examination of the abstract, 22 further studies were excluded. The reasons for this are described in the flowchart below. Furthermore, 35 studies were identified in which the abstract could reveal a certain relevance. After examining the full-text of these papers, 22 studies were found where the inclusion and exclusion criteria did not match. Of the 13 documents proven to be particularly relevant, two articles from their reference lists could be added. Thus, 15 selected studies could finally be identified.

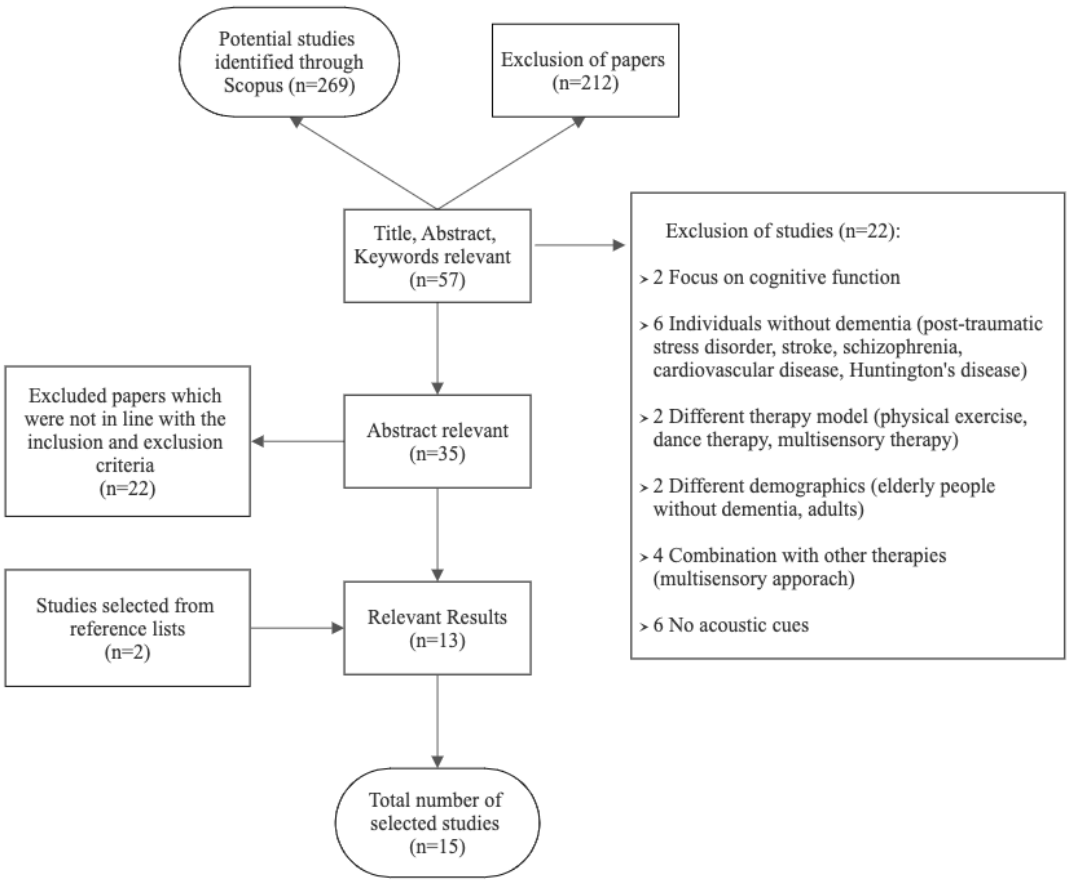

Figure 1 Flow chart illustrating the selection process of the papers

Description of the studies

In total, through the previous selection process, 15 studies were identified which will be used to answer the three formulated research questions. To provide an overview, the main characteristics of these 15 selected studies are summarized in Table 4. The 15 studies included seven randomized control studies [1, 2, 3, 6, 7, 8, 9], one case series [5], one controlled clinical study [4], four are meta-analyses [12, 13, 14, 15] one systematic review [10] and one literature review [11]. The studies are arranged in the table with the experimental studies at the beginning, followed by the systematic and literature review and finally the meta-analyses.

The studies range from the most recent one conducted in 2018 back to the year 1999. The countries in which the nine experimental studies were conducted range across the globe from Italy, France, United Kingdom, South Korea, Japan, Taiwan to the United States. The population of all selected studies included geriatric patients diagnosed with dementia (including Alzheimer's disease) living in a nursing home. The aim of all studies was also to examine with the application of acoustic or musical cues, the influence on the specific behavioural and psychological symptoms or the quality of life of the patients. Moreover, six out of the nine experimental studies indicate measures for their study quality, four studies [2, 3, 8, 9] could prove good reliability according to the pre-defined criteria in the method section and two studies [4, 6] showed moderate reliability.

For the purpose of answering the respective research questions, a table was created in which the relevant studies were listed according to their contents. Thereby the information of the 15 studies in Table 5 will be used to answer research question 1, 2, 3.

RQ 1: What types of 'acoustic cues' are currently used in the care of elderly people with dementia?

RQ2: What are the effects (behavioural, emotional) of 'acoustic cues' in the care of elderly people with dementia?

RQ 3: Are there differences in the effectivity of generic approaches vs personalized approaches?

Table 4
Main characteristics of the selected studies conducted on acoustic cues in elderly care

Author	Year of publication	Country	Study design	N	Population	Study goal	Time frame of the Intervention	Measurements
1. Raglio et al.	2015	Italy	RCT	120	Elderly people with dementia in elderly care	Effects on BPSD of dementia and Quality of life	10 weeks	NPI, CSDD, CBS-QoL, Music Therapy Checklist—Dementia
2. Hsu et al.	2014	United Kingdom	RCT	17	Geriatric people with dementia who reside in elderly care	Improvement of neuropsychiatric symptoms and well-being	7 months	NPI-NH, DCM
3. Raglio et al.	2010	Italy	RCT	60	Elderly people with dementia who reside in elderly care	Improvement of BPSD	6 months	NPI
4. Choi et al.	2009	South Korea	CCT	20	Geriatric people with Alzheimer dementia residing in daycare unit	Reduction BPSD and stress of caregiver	5 weeks	MMSE, GDS, GQoL, NPI-Q
5. Murphy et al.	2018	United States	Case series	17 (20)	Aged patients with Alzheimer dementia	Effects on mood and BPSD	8 months (follow up for 4 years)	RE-AIM framework (reach, effectiveness, adoption, implementation, and maintenance)
6. Narme et al.	2014	France	Single-centre RCT	48	Aged patients with moderate to severe Alzheimer's residing in a nursing home	Effects on Emotional, cognitive, and behavioural domain, caregiver distress	4 weeks	MMSE, EFE, CMAI, SIB
7. Sakamoto et al.	2013	Japan	RCT	39	Elderly patients with Alzheimer dementia residing in a nursing home	Reduction of BPSD, stress-level and quality of life	10 weeks	CDRS, MMSE, BEHAVE-AD
8. Sung et al.	2010	Taiwan	RCT	52	Geriatric patients with Alzheimer dementia residing in a nursing home	Reduction of Anxiety	6 weeks	RAID

9. Camberg et al.	1999	United States	RCT (Latin-Square Experimental Design)	54	Elderly people with Alzheimer's disease	Improvement of psycho-emotional well-being	4 weeks	SOAPD, Agitation visual analog scale, PARS, withdrawal visual analog scale, Facial diagrams of mood, SF-CMAIM, MOSES, MMSE, TSI, BANS, ADL-SPS
10. Abraha et al.	2017	Spain	Systematic review	Inclusion of 3 studies (subjects N=144)	Aged people with Alzheimer dementia		-	N/A
11. Blackburn	2014	United Kingdom	Literature Review	Inclusion of 6 studies (subjects N=458)	Geriatric patients with Alzheimer dementia	Improvement of BPSD, cognition and Quality of life	-	N/A
12. van der Steen et al.	2018	Netherlands	Meta-analysis	Inclusion of 43 studies (subjects N=1987)	Elderly patients with dementia	Effects on Emotional well-being and quality of life, mood disturbance, negative affect, BPSD, social behaviour, cognition	-	N/A
13. Zhang et al.	2016	China	Meta-analysis	Inclusion of 34 studies (subjects N=1757)	Geriatric persons with Alzheimer dementia residing in nursing homes or hospitals	Effects on BPSD and cognitive function	-	N/A
14. Ueda et al.	2013	Japan	Meta-analysis	Inclusion of 20 studies (subjects N=651)	Elderly people with Alzheimer dementia	Efficacy of on BPSD and cognitive function	-	N/A
15. Vasionyte & Madison	2013	Sweden	Meta-analysis	Inclusion of 19 studies (subjects N=478)	Geriatric people with Alzheimer dementia residing in nursing homes or hospitals	Effects on behavioural, cognitive and physiological function	-	N/A

Note. RCT, randomised controlled trials; CCT, Controlled Clinical Trials; BPSD, behavioural and psychological symptoms of dementia; N, number of participants; NPI, Neuropsychiatric Inventory; CBS-QoL; The Cornell-Brown Scale for Quality of Life; CSDD, Cornell Scale for Depression in Dementia; BEHAVE-AD, Behavioral Pathology in Alzheimer's Disease Rating Scale; NPI-NH, Neuropsychiatric Inventory for nursing homes; DCM, Dementia Care Mapping; MMSE, Mini-Mental State Examination; GDS, Geriatric Geriatric Depression Scale, GQoL, Geriatric Quality of Life; NPI-Q, Neuropsychiatric Inventory-Questionnaire; EFE, Emotional facial expressions; CMAI, Cohen-Mansfield Agitation Inventory; SIB, Severe Impairment Battery; CDRS, Clinical Dementia Rating Scale; RAID, Rating Anxiety in Dementia; SOAPD, Scale Observation of Agitation Persons with Dementia; PARS, Positive Affect Rating Scale; SF-CMAIM, Cohen-Mansfield Agitation Inventory

Multidimensional; MOSES, Multidimensional Observation Scale for Elderly Subjects; TSI, Test for Severe Impairment; BANS, Bedford Alzheimer's Nursing Scale; ADL-SPS, Activity Daily Living Self-Performance Scale

Table 5
Overview of the interventions and outcomes of the selected studies

	Type of acoustic cues	Live vs. recorded	Generic vs. personalized	Outcome/Effects	Reliability
1. Raglio et al. (2015)	Melodic sounds and rhythm produced by instruments used by certified music therapist (improvisation) and individualized listening to a preferred music playlist.	Both	Generic and personalized	No significant effect on BPSD, but reduction over time in NPI global score in all groups ($p \leq .001$), CSDD ($p = .001$), and CBS-QoL ($p = .01$).	N/A
2. Hsu et al. (2014)	Auditory cues produced by therapist (improvisation) which focus on vocal, musical properties, e.g. rhythm, tempo, the pitch of well-known songs and melodies.	Live	Generic	Improvement in neuropsychiatric symptoms ($p = 0.006$) and in levels of wellbeing ($p = 0.003$).	***
3. Raglio et al. (2010)	Non-verbal model based on sound–music improvisation using musical instruments.	Live	Generic	Significant reduction of BPSD could be measured.	***
4. Choi et al. (2009)	Singing songs, making musical instruments, playing instruments (piano, handbells), songwriting.	Live	Personalized	MMSE: no differences between the two groups, GDS and GQoL no significant differences, NPI-Q did not differ in two groups, Improvements in agitation, aggression, irritability/lability in music intervention group and caregivers distress.	**
5. Murphy et al. (2018)	Listening to music playlists on iPod Shuffle.	Recorded	Personalized	Improvement of mood by 62%, improved mood 461 times out of 822 encounters.	N/A
6. Narme et al. (2014)	Listening to music played on a CD player, different styles of music (e.g., classical instrumental; familiar songs from the 1950–80s).	Recorded	Generic	Significant positive changes in emotional states, a decrease in agitated behaviours.	**
7. Sakamoto et al. (2013)	Individual listening to music that was related to special memories and active participation in singing, clapping, or dancing with music facilitator.	Recorded	Personalized	Both intervention: Short term effects: statistically significant ($p < 0.05$.) Long term effects; statistical significance level of $p < 0.05$) in BEHAVE-AD.	N/A
8. Sung et al. (2010)	Preferred melodies/music according to the individualised music protocol by Gerdner (2001), via CD players.	Recorded	Personalized	Reduction of anxiety in experimental group ($F = 12.15$, $p = 0.001$).	***

9. Camberg et al. (1999)	Simulated presence personalized audio tape: containing memories with a family member; Placebo audio tape: recording of articles from the newspaper; headset and an auto-reverse tape recorder.	Recorded	Generic and personalized	The experimental group was equivalent to the usual care group (P = .141) and superior to placebo for happy facial expression (P = .001).	***
10. Abraha et al.	Studies that included Simulated presence intervention (personalised audio or videotape recording of family members or caregivers).	Recorded	Personalized	Quality of evidence was low, unable to draw effects of SPT.	-
11. Blackburn & Bradshaw	Inclusion of Studies which report on active music therapy (playing musical instruments or singing, individually or in a group) and passive music therapy listen to music).	Both	N/A	Reduction in anxiety, depression and agitated behaviour, Improvement of the Quality of life.	-
12. van der Steen et al.	Active and receptive musical elements.	Both	N/A	Low quality effects in the improvement of emotional well-being, anxiety, moderate evidence regarding the reduction of behavioural problems.	-
13. Zhang et al.	Any form and intervention method of music therapy.	Both	N/A	Significant positive effects on disruptive behaviour and on cognitive function.	-
14. Ueda et al.	Combination of methods such as singing, playing musical instruments, and/or listening to live performances on familiar music.	Both	N/A	Moderate effects on anxiety (p = 0.002) and small effects on behavioural symptoms >3 months large effects on anxiety.	-
15. Vasionyte & Madison	Studies which used all kinds of music therapy, (active or receptive music therapy, including different music directions like classical or relaxation).	Both	Generic and personalized	No effects regarding behavioural disturbances.	-

Note. BPSD; Behavioural and Psychological Symptoms of Dementia, CBS-QoL; The Cornell-Brown Scale for Quality of Life; CSDD, Cornell Scale for Depression in Dementia; NPI, Neuropsychiatric Inventory; N/A, not available; QoL, Quality of life; p, p-value; MMSE, Mini-Mental State Examination; GDS, Geriatric Depression Scale; GQoL, Geriatric Quality of Life; NPI-Q, Neuropsychiatric Inventory-Questionnaire, BEHAVE-AD, Behavioral Pathology in Alzheimer's Disease Rating Scale; SPT, Simulated Presence Therapy

RQ 1: What types of 'acoustic cues' are currently used in the care of elderly people with dementia?

Initially, a distinction could be made between live and recorded acoustic cues. Hereby, it can be said that the live acoustic cues in the selected studies rely more on the active reproduction of different melodies, sounds, tones, rhythms using instruments or the human voice. However, none of the studies seems to follow a certain framework, instead mostly a mix of improvising and playing random melodies, sounds, or rhythms were considered which could not be classified according to specific theories. Conclusively, in the category of recorded acoustic cues, musical elements such as songs and melodies make up the majority. Here, too, the reproduction of music is only partially subject to a theoretical basis. Well-known or preferred music pieces of the patients were often used here. This was different only in one study in which no music elements were used but in which the human voice was subject to a precisely defined theoretical basis.

In order to answer the first research question on what types of acoustic cues were applied in the chosen studies, here it was found that three [2, 3, 4] of the selected experimental studies match the definition of live music coaching and five of the selected studies [5, 6, 8, 7, 9], the focus lied on recorded acoustic cueing. Hereby an overview of the live music interventions will be given first, followed by an insight into the recorded elements of music coaching. One study could be identified which contained live and recorded cues [1] and therefore could be divided into both categories.

Live acoustic cues

In the randomized control study by Raglio et al. [1] geriatric patients with Alzheimer's disease residing in nursing homes, received an active music therapy two days a week. During the music sessions, rhythmic and melodic sounds were live produced by a therapist with instruments and the patients actively engaged to participate. Further, the certified therapist often made use of improvisation and did not follow any specific guidelines in providing the acoustic cues to the patients. A similar intervention was also used in the study of Hsu et al. [2]. Hereby the focus of the intervention was on an individual interactive music therapy provided by a therapist using live auditory and visual cues. During the music intervention, the expert referred to vocal and musical characteristics, e.g. rhythm, tempo, and pitch of well-known songs and melodies, and also used improvisation to actively involve patients, as in the previous study. Furthermore, it is noticeable

that these two interventions were carried out individually with the respective patients and the music facilitator and not, for instance, together in a group. On this occasion, a live acoustic intervention in a group setting has been provided in the study by Raglio et al. [3]. Individuals of the experimental group were provided with therapeutic live acoustic cues which were based on sound and music improvisations which were conveyed nonverbally through musical instruments. With regard to musical group interventions, in the study Choi et al. [4] also live musical elements were incorporated but where the intervention group was subjected to a 50-minute music therapy program, where the patients were singing songs collectively and playing instruments.

RQ2: What are the effects (behavioural, emotional) of 'acoustic cues' in the care of elderly people with dementia?

It can be said that it was difficult to directly determine which acoustic cues had particular effects on specific behavioural and psychological symptoms in dementia based on the results of the effects of the various studies. Improvements of emotional symptoms, like stabilization of mood, emotional well-being and reduction in anxiety and in behavioural symptoms, a decrease in agitated behaviour and aggression, could be observed.

It could be seen that almost all acoustic cues that could achieve effects were based on musical elements. Hereby, many studies often used a mixture of different acoustic cues and the execution of the interventions varied. It was also noticed that the therapy of simulated presence could achieve the least effects compared to the conventional approaches of music based acoustic cues.

With regard to the effects of acoustic elements, special emphasis was placed on the results of the four meta-analyses [12-15] as they represent the highest scientific reliability. Subsequently, findings from the two literature analyses [10, 11] are presented afterwards, followed by evidence from the nine experimental studies [1-9].

In relation to the inclusion criterion of the acoustic cues of the selected meta-analyses [12-15], it was noticed that all meta-analyses included types of active music therapies including singing, clapping, playing with instruments, receptive music therapies including listening to live or recorded music, generic selected, individualized or familiar music, performed in groups or in individual interventions with different styles of music, ranging from classical, native to relaxation music. One systematic review [10] was conducted about studies that only focused on

simulated presence intervention (personalised audio or videotape recordings of family members or caregivers). In addition, the meta-analyses included any type of dementia according to the diagnosis defined in the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV and International Classification of Diseases (ICD)-10.

The pool of studies was able to provide insightful information, as the four meta-analyses [12-15] focused specifically on the reduction of behavioural specific symptoms of dementia and cognition of the participants and the two systematic literature analyses [10, 11] tended to evaluate additional topics such as the improvement of quality of life. Furthermore, within the selected experimental studies [1-9], effects in relation to emotional well-being, mood disorders, negative affect or social behaviour and disturbances were as well investigated. Three of the four meta-analyses [12, 13, 14] were hereby able to provide evidence regarding effects on the improvement of BPSD or the overall quality of life of the participants. However, one meta-analysis [13] reported on rather positive effects and two others concluded moderate effects [12, 14] and one [15] could not conclude any significant effects with respect to BPSD symptoms.

Thus, one of the four meta-analyses by Zhang et al. [13] were able to report positive effects of disruptive behaviour −0.42 (-0.74 to −0.11) in the use of different forms of music therapeutic elements. In comparison, Ueda et al. [14] observed only moderate effects on anxiety ($p = 0.002$) and low effects on behavioural symptoms in dementia ($p = 0.003$). But concluded further, that studies lasting longer than 3 months showed greater effects in the reduction of anxiety ($p = 0.02$). Also, from the meta-analysis of van der Steen et al. [12], a similar conclusion was reached. Only inferior evidence of improvement of emotional well-being, quality of life, anxiety and moderate quality of evidence in relation to depressive symptoms and behavioural problems could be determined. Moreover, the study by Vasionyte and Madison [15] refers in their meta-analysis to non-significant effects of various acoustic cues on the behavioural symptoms of dementia patients.

With regard to the literature review of Blackburn and Bradshaw [11] a reduction of anxiety, depression, and agitated behaviour, as well as a general improvement in the subjects' quality of life ($p < 0.05$) through the implementation of acoustic therapy elements, could be identified. However, not all reviews were able to conclude significant effects. For example, Abraha et al. [10] described that the quality of evidence of simulated presence therapy effects on

a reduction of behaviour-specific and psychological symptoms and the improvement of quality of life was too low to present any significant effects.

These results also seem to be consistent with the experimental studies. Seven of the nine experimental studies [2-8] showed improvements in the reduction of behavioural and psychological symptoms of dementia patients. Thus, Hsu et al. [2] and Raglio et al. [3], both concluded a reduction regarding behavioural disturbances in the patients, measured through the Neuropsychiatric Inventory. Further, Hsu et al. [2], Murphy et al. [5], Narme et al. [6], Sakamoto et al. [7] reported positive effects on the mood of the participants and in overall emotional well-being. Moreover, in the study of Narme et al. [6] a decrease in agitated behaviour could as well be observed ($p = 0.004$) and a decrease of the global NPI score. Also, Sung et al. [8] were as well able to report a reduction of anxiety within the experimental group ($F = 12.15$, $p = 0.001$). Sakamoto et. al. [7] was also able to determine short-term and long-term effects in the two groups. In the assessment of the long-term effects of the two interventions, an improvement in the passive group was observed in relation to affective disorders (Z -2.3, $p < 0.025$); anxieties and phobias (Z -2.3, $p < 0.025$); (Z -2.3, $p < 0.025$). In comparison, to the interactive intervention group additionally a reduction of aggression, (Z -2.6, $p < 0.025$) could be observed. Hereby, Choi et al. [4] also referred to improvements in agitation and aggression in the participants who had received music intervention. But could not detect any change in depression or quality of life between the intervention group and those participants receiving standard care.
However, not all experimental studies were able to demonstrate effects. For example, Raglio et al. [1] concluded that there was no significant effect on behavioural disturbances, but a reduction over time in the NPI score in all groups could be determined ($p \leq .001$). Similarly, this is also evident in the results of Camberg et al [9]. The intervention of the simulated presence had no effect compared to the usual care ($P = .141$) but was superior to the placebo intervention with respect to the positive facial expression ($P = .001$).

RQ 3: Are there differences in the effectivity of generic approaches vs personalized approaches?

Here it was difficult to determine whether there were differences in the effects on behaviour-specific and psychological symptoms of dementia based on personalized and generic acoustic cues. However, it could be illustrated that personalized acoustic cues indicate a

reduction of anxiety and a tendency to stabilize mood and well-being. From the results of the generic acoustic cues an improvement of the BPSD-symptomology followed as well, but seem to have varying levels. This could be due to the reason that personalized acoustic cues mostly represent the mere listening to preferred music and generic elements mostly contained live acoustic cues transmitted by a music mediator, where the patients often were encouraged to actively participate in the intervention. These two interventions therefore seem to show a difference in the activity level, which is why the results of the studies can only be attributed to the acoustic cue itself to a limited extent.

Moreover, also at a closer look at the reliability of the nine experimental studies, the question cannot be answered explicitly, since only six studies report on the reliability altogether and besides that only four indicate good reliability of their study. However, from the results of this review, it can be seen that both approaches seem to be similarly beneficial with respect to BPSD-symptomatology.

Considering the question, it should be noted that in most of the nine selected experimental studies, however, no clear distinction has been made between the different approaches. Thereby, four of the nine studies [4, 5, 7, 8] offered personalized musical interventions according to the definition above. And three studies [2, 3, 6] were recognized by using generic approaches and two studies were [1, 9] identified where both approaches were compared to each other. In the following, an overview of their particular results will be given.

Personalized approaches

Regarding the application of the personalized approach, four studies [4, 5, 7, 8] were identified to be concerned with a personalized methodology whereby familiar music to dementia patients was either passively played, individually, in a group, or live during an interactive music session. Here, for example, Choi et al. [4] reported an improvement in BPSD symptomatology in relation to agitation and aggression of the participants. Further, Sung et al. [8] also pointed to a reduction in anxiety ($F = 12.15$, $p = 0.001$) of the participants of the experimental group who listened to preferred music on a CD player. Also, Sakamoto et al. [7] reported a reduction of anxiety and additionally noted further, that during the musical interventions of the two groups (interactive and passive) also expressions of positive emotions were reflected by the dementia patients by the application of individualized music, which was associated with special memories

to the participants. Also, Murphy et al. [5] were able to observe the improvement and stabilization of the mood of the participants.

In regard to the application, studies which carried out recorded music approaches indicated that the implementation of personalized acoustic cues was identified to be easier and more accessible for employees. Here, Sung et al. [8], Murphy [5] and Blackburn & Bradshaw [11] emphasize, that the use of recorded music elements is a cost-effective way of a non-pharmacological treatment method for dementia patients. Thereby there is no need for experts to carry out costly live interventions by using instruments. Moreover, Vasionyte and Madison [15] also describe in their meta-analysis that the practice of passive and personalized acoustic elements can be applied not only in retirement homes but to a greater extent at home with the help of the caregiver due to the simple implementation.

Generic approaches

Three studies conducted by Hsu et al. [2], Raglio et al. [3] and Narme et al. [6] were recognized in employing generic acoustic elements in accordance to the definition given previously. Thus, two of the three studies Hsu et al. [2] and Raglio et al. [3] focus mainly on live musical elements which in this case can be considered generic as they apply sound elements which are not individually tailored to the preferences of the patients but rather contain improvised acoustic cues which were delivered live in the course of the music coaching with instruments. Both Hsu et al. [2] and as well as Raglio et al. [3] were able to present an enhancement of the behavioural and psychological symptoms of dementia ($F = 4.09$, $p = 0.049$), and an improvement in the levels of well-being ($p = 0.003$). In the study by Narme et al. [6], it was also possible to observe a positive change in emotional states in the four-week musical intervention within the music treatment group. However, the study of Narme et al. [6] differed from the previous two insofar as the same acoustic elements were provided by a CD-player and were not performed live to the participants and were additionally applied to all patients without prior consideration of individual preferences. Here several songs of different music genres and styles were used to create a music playlist which was presented to the participants during their music coaching's sessions.

Further, three of the four meta-analyses [12,13,14] also provided insights into the relationship between generic and active music elements. For example, van der Steen et al. [12] reported that if only live elements and active music coaching were provided for the patients, the

effects on anxiety were smaller. Further, Udea et al. [14] could also conclude only moderate effects on anxiety and disruptive behaviour but also that these effects were not significantly lower than other forms of music therapy. However, Zang et al. [13] here concluded that the effects on behavioural and psychological symptoms such as agitation and anxiety were significantly higher when patients were given an interactive form along with a music therapist.

Approaches containing both personalized and generic acoustic elements

Two further studies by Raglio et al. [1] and Camberg et al. [9] examined and compared both individualized and generic cues. In the course of the study, Raglio et al. [1] compared an active form of music therapy which was hereby classified according to the previous definition as generic to a personalized music treatment. One group received an active music therapy two days a week in which rhythmic and melodic sounds were produced by a therapist and a passive music therapy where the participants individually solely listened to preferred music. Regarding the results, no effects in the global NPI scores and in quality of life could be observed between the two groups ($p \leq .001$). Although no difference could be found between the two groups, an improvement in delusions and anxiety was observed in both groups in the course of the intervention.

The study by Camberg et al. [9] also shows similar results. Thereby the intervention group received a personalized audio tape containing memories of a family member to simulate their presence in the form of a telephone conversation. The placebo group received individual recordings of random newspaper articles. The intervention of the simulated presence was equivalent to the usual care but superior to the placebo intervention in terms of positive facial expression ($p = .001$).

Discussion

The purpose of this scoped literature review was to explore the current literature to gain an insight into the existing practice in the application of acoustic cues in elderly care regarding the treatment of psychological and behavioural disturbances of dementia.

The review has mainly revealed that in elderly care, acoustic cues are provided either in the form of active and live- or passive acoustic reproduction. Live acoustic cues often contained a mix of musical elements like melodies, sounds, tones, rhythms reproduced mostly improvised by a music facilitator using instrumental references or the human voice. However, no specific guidelines were followed regarding pitch or tempo and duration of the provided acoustic cues. Regarding the recorded acoustic cues, often preferred music songs tend to be played by a recorder, but also pre-recorded conversations which are not based on music but solely on the human voice were identified as acoustic cues. Further, no studies were found such as the method of rhythmic auditory cueing.

Moreover, the majority of the studies have shown improvements in relation to the BPSD symptomatology. A reduction of anxiety, aggression, agitation was observed and additionally an increase of the quality of life, mood and emotional well-being of the patients. Regarding the effects of specific acoustic cues, studies of both categories, personalized and generic cues have been able to characterize effects in regard to effects on mood, emotions, and anxiety. However, it could not be determined precisely whether there is a difference in the effectiveness regarding the application of the two approaches.

Through the evaluation of the studies, a large variety of different acoustic intervention methods could be identified and further, it became apparent how broad the term of acoustic cues has been used within the research spectrum. In the majority of the studies, it was found that the emphasis of the interventions was much less specified as previously assumed, which could be attributed to an insufficient definition of a uniform umbrella term for acoustic cues. Hereby it was also noticeable that a large part of the acoustic cues was rather focused on musical sound elements, and most interventions of the selected studies tend to be particularly oriented towards music therapy concepts. Likewise, the respective studies described their acoustic interventions very differently and in several cases, the description was rather superficial or incomplete. In this context, it was noted that a broad mix of different acoustic cues was used at the same time, so several studies describe rhythmic background music and at the same time instrumentally

produced tones and music, which, however, could not be assigned to a treatment scheme like that of the RAC (rhythmic auditory cueing). This is also in line with the findings of McDermott, Ridder and Orrell (2012) according to their systematic review, where they additionally noted that in many conducted studies no distinction was drawn between music therapy and music activities. The reason might be primarily due to the fact that the application of acoustic cues poses still a young research subject within the healthcare domain, which is why there are probably still no exact criteria what acoustic cues should contain, so in many studies music therapy was equated with acoustic cues. Although all music interventions contain acoustic cues, not all acoustic cues use music as a basis. The research in music therapy has been going on for much longer, but the encapsulation of musical elements, in most of the reviewed studies was to be found fewer in the treatment of behavioural and psychological symptoms of dementia (McDermott, Ridder & Orrell, 2012). Presumably, the concept of music therapy offers a basis for most studies, which is used as an orientation.

Yet, the utilization of interventions with acoustic cues has been used more extensively in neurological research fields in the past, particularly for diseases such as Parkinson's disease, Huntington's disease or other cognitive impairments. With the current findings of the neurological mechanisms found by Gräber et al. (2014), also the reduction of behaviour and psychological specific symptoms in demented patients when they are exposed to acoustic cues, which appeared predominantly through the results of the selected studies, might be explained. Here Gräber et al. (2014), reported that acoustic cues seem to have produced improvements in the gait movement of Parkinson's patients. With regard to the potential working mechanism in neurodegenerative diseases, they pointed out that acoustic cues can as well have positive effects on agitation in Alzheimer patients for the reason that external acoustic stimulation could affect the neuronal population by desynchronizing the beta-band oscillations in the motor cortex, which are still largely present in low-stage patients. The results of the study of Zhang et al. (2016) suggest that sounds are stored in specific brain regions that are affected later in the degradation process and therefore the musical memory remains intact for an extended period of time, since different areas of the brain are affected differently in the course of dementia (Spiro, 2010). Through the processing of acoustic sound elements, according to Kölsch (2014) various brain regions, such as the auditory cortex, including Broca’s-area the amygdala, visual and motor areas can be identified. Thus, an acoustic stimulation of the mentioned neuronal brain areas can lead to

a release of endorphins, dopamine and at the same time a reduction of the cortisol level is induced. As a result, different emotions are elicited which are associated with memories, which can create a sense of comfort. During the reduction of stress hormones, a calming effect can occur which makes the individual more satisfied (Kölsch, 2014). This process might explain the influence on anxiety, aggression and mood elevation in dementia patients.

This working mechanism on the effects of music on the brain would imply, that any kind of live produced or recorded rhythm, sounds, melodies or music elements would produce an improvement of behavioural specific symptoms in the application of acoustic cues in demented patients. This can also be proven by the results of the 15 selected studies, which show that almost every kind of experience of music based acoustic cues, resulted in a reduction of behavioural disturbances. At the same time, it can also be explained why acoustic cues, which are based on musical elements in contrast to cues which are based on voices, achieve a better effect than the method of Simulated Presence Therapy because the recognition of voices in further stages of progressive dementia requires other brain areas than the recognition of music to those of speech and recognition which are affected by the degradation earlier (Ross, Cummings & Benson, 1990).

These assumptions give incentives and can facilitate the discussion about the development of a more conceptual design basis of acoustic elements in dementia research. Here the question was raised whether generic and individualized acoustic cues in their application unfold a difference in their effectiveness. The results of the 15 studies could hereby not provide enough information within the different effects on the BPSD-symptomatology. However, Vasionyte and Madison (2013) and Sakamoto et al. (2013) for example concluded that passively listening to recorded music elements is a more suitable approach to calm and relax individuals suffering from dementia which can reduce levels of anxiety, whereas the benefits of live music therapy, using generic music elements are helpful to stimulate attention, excitement and positive emotions. Nevertheless, the literature is increasingly directed towards the application of personalized therapy options. Here, Sung et al. (2010) indicate in their study that particularly in the last decade a major emphasis has been placed within the health care sector on tailored treatment concepts which focus on especially on the individual needs. This development could also be applied to acoustic cues.

With a closer look at the development and design of acoustic cues, it seems indispensable to immerse deeper into the matter of the various acoustic cues and to examine further their implications in regard to their application. Here not only the positive aspects should be taken into consideration but also the downsides that can arise during the implementation process. As far as the challenges of the acoustic cues are concerned, the dependence on either trained or untrained personnel was criticized throughout the selected 15 studies. Also, the performance for example of live acoustic cues seems to be more complex and costly and lack guidelines with regard to duration and intensity. In addition, Murphy et al. (2018) observed that patients can become less reactive if they are always exposed to the same acoustic cues. Further, Brawley (1992) also reports that elderly people suffer additionally from physiological deficits the older they are, which can complicate the application of acoustic cues. For example, most people develop hearing problems, and with dementia progressing, studies have shown that individuals find it more difficult to cognitively classify background noise, which could lead to a counterproductive effect and make patients nervous or even irritated. Vasionyte and Madison (2013) also confirm that in each individual case an observation must be made especially at the beginning of the therapy because in progressive stages of dementia and at higher age of the patients, an over-stimulation can emerge more easily which can increase cases agitation.

Therefore, with deliberate research into the implications of specific acoustic elements, the results can serve as a framework, whereby standardized guidelines can be created which can be used as a theoretical basis to tailor interventions more specifically to the needs of the affected individuals. Already today the use of acoustic cues can serve as an additional treatment to regular care due to their cost efficiency, their simplicity of implementation and the associated accessibility in the areas of elderly and home care, which exhibits no side effects and which can be applied, according to current knowledge in all phases of dementia.

Limitations

With regard to the limitations, a number of constraints during the execution of this literature review could be identified. These limitations were largely related to the methodology and occurred mainly within the search and selection process of the studies for this scoped review. Moreover, also weaknesses of the included studies have been detected.

First of all, it can be said that in the course of this literature analysis there was only

limited access to existing literature, as only related documents were searched in the Scopus database. This limited the search for such a young research topic, as the possibility of more extensive reports and analyses from other databases with a different focus was restricted. Thus, certainly, not all relevant articles about this specific topic could have been selected.

Secondly, it can further be indicated that errors may have occurred during the search process despite due to carefulness. To begin with, many papers were identified which tended to be traced back to music elements, which, however, relied less on specific acoustic elements. This may be due to the creation of the search string, which was oriented towards articles that contained 'music therapy' in the title, abstract or keywords. Hereby, the focus was led primarily on musical elements and therefore studies which aimed at solely on acoustic elements may only be found to a limited extent. On the other hand, terms from the MESH-library were used in the search string that was phrased specifically at acoustic elements to prevent this mistake, but there might still a possibility of a selection error. Additionally, the search process was only conducted by one reviewer.

In relation to the selection process, another limitation was found to be, that only published articles were included in the literature review. Furthermore, during the course of the selection process of the papers, it could have come to insufficient discrimination of relevant and irrelevant articles, which might result in a wrong judgement regarding the relevance of the selected articles. Therefore, the selection of studies of other researchers might differ on the same objective.

Furthermore, many of the studies included had a small sample size. With smaller sample sizes, often only limited representativeness can be achieved since in small samples the probability to observe all relevant group differences is smaller and therefore often holds the problem of unobserved heterogeneity and can, therefore, contain systematic distortions (Petticrew & Roberts, 2006), like different medication the patients received. In addition, the meta-analysis of Vasionyte and Madison (2013) reported on several methodological weaknesses of included studies regarding the intervention of music therapy. In addition, this literature review revealed that many of the experimental studies did not provide any information regarding the reliability of their measurements. Also, two studies could be identified which could achieve only moderate reliability in their execution. Additionally, some authors indicated that bias occurred in relation to the blinding or randomisation methods that were applied during their studies.

Further, many studies did not describe what stage of dementia their patients were in, this would also have been revealing in order to determine another factor that might play a role on the impact of acoustic elements on behaviour and psychological symptoms of demented persons. Besides that, it appeared that many of the experimental studies did not use a standardized framework of music reproduction. There was no clear structure in the transmission of music or a before defined theoretical basis, which the researchers employed when transmitting the acoustic elements to the patients. This might result in the difficulty of the representativeness of the respective studies as it is only partly possible to reproduce them because there is up to now a limited theoretical foundation for a standardized application of music interventions. Therefore, for these reasons the results, especially of the experimental studies, should be considered with caution.

Recommendations

In future research, it is first of all, recommended to consider several databases when carrying out further literature analyses regarding the topic of acoustic cues in the treatment of dementia, in order to reliably gain extensive access to a broad information pool. Moreover, more attention should be paid to the terminology of acoustic cues and subcategories should be defined. This would simplify the classification of the studies in order to allow a better comparison of the effects. A uniform guideline for the use of acoustic elements should also be developed to ensure reproducibility and reliability. Further, more randomized control studies with a larger and additionally a younger sample to counter high dropout rates should be conducted and several different acoustic cues should be compared on this occasion. Also, future studies could include factors related to user satisfaction to extend the present body of knowledge. In order to obtain more detailed information, different research approaches could be used such as mixed methods or qualitative approaches such as interview data.

Furthermore, the working mechanism of acoustic cues on the brain of dementia and additionally of different types of dementia should as well be better studied and additionally the stages of dementia should also be included, in order to obtain a broader spectrum concerning the effects of BPDS symptomatology in elderly patients

Relevance of the current literature review

This review has shown that so far, the use of a number of acoustic cues in the treatment of dementia in elderly people is already progressing. It has provided an insight into how acoustic cues have emerged and established themselves with their concepts in recent years of research. With the help of this literature research, a comprehensive overview for the reader was created and for an identification between the current state of literature and the relationship to the existing field of research of acoustic cues in the alleviation of BPSD symptomatology could be established and its relevance could be clarified. Thus, a solid background could be given about the importance of the discussion of neurodegenerative diseases in future societies and at the same time the need to expand the existing state of knowledge of therapy options. Furthermore, this review not only summarized basic knowledge and information but also critically questioned the application methodology of acoustic cues and identified gaps in knowledge and vulnerabilities.

With the further research on acoustic cues in the treatment of dementia, a new era can be opened in which the use of such interventions can experience a realistic implementation. Since the idea in the health sector is already moving in the direction of a holistic approach, in the future more attention should be paid to the personal factors of the development of acoustic cues. The question could be raised within the research of acoustic cues to what extent they have to be based on music, individually adapted to the patient's wishes and needs, since music, as already mentioned above, is connected to experience and memories. Based on research into the individualization of the acoustic cues, concepts can be developed based on the results which allow a generalization of the treatment in the future.

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