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Coping strategies for community singing among older adults living with hearing impairment: A mixed methods study

Graduate thesis in Medicine
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Trondheim, June 2017

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Summary in Norwegian

Bakgrunn

Evnen til å kommunisere er avgjørende for menneskelig samspill. Hele 62% av nordmenn over 65 år har en hørselshemning som påvirker kommunikasjonsevnen. Med en aldrende befolkning vil dette bli et økende problem som krever stadig mer ressurser, også globalt. Tiltak som holder oss friske og velfungerende inn i alderdommen vil slik være viktig for et godt og effektivt helsevesen.

Dagens hørselsrehabilitering består i stor grad av å tilpasse høreapparat. Treningsprogrammer som underviser i mestringsstrategier er lite brukt, selv om mestringsstrategier er viktige for å kompensere for hørselstap. Et bredere tilbud for rehabilitering kunne vært interessant.

Mål og metode

Mange eldre driver med musikk, særlig korsang. Korsang har en rekke helseeffekter, men hvordan korsang virker på folk med en hørselsnedsettelse er ikke kjent. Studien utforsket eldre hørselshemmede sangeres mestringsstrategier og opplevelser av å synge i kor ved intervjuer. Høreevnen hos sangerne og en gruppe eldre aktive hørselshemmede som ikke hadde drevet med musikk ble også sammenlignet etter omfattende hørselstesting.

Resultater

Sangerne opplevde koret som et inkluderende fellesskap og en arena for selvrealisering inndelt i to auditive scenarier, sang og muntlig samtale. Samtalescenariet ble oppfattet som mer krevende enn sangscenariet. Både å *bruke visuell støtte*, i form av å se på dirigenten og å se ansiktet til den man snakker med, samt *å lage et optimalt lydmiljø*, i form av kraftig nok lyd og begrenset bakgrunnsstøy var viktig for begge scenarier. *Å møte forberedt* var en strategi som kun ble brukt ved sang. Egenøving kan kompensere for eventuelle vansker, en strategi som vanskelig kan benyttes ved samtale. En del av sangerne foretrakk å stå blandet kontra stemmevis, da dette ga et bredere lydbilde å orientere i, gjennom tydeligere harmonier og rytmiske innsatser. Å forsøke blandet oppstilling kan slik tenkes å være fordelaktig.

Konklusjon

Våre funn trekker fram korsang som en velegnet sosial arena for personer som lever med hørselsnedsettelser. Dette kan tenkes å utnyttes i hørselsrehabilitering for å lette noe av byrden helsevesenet venter i årene fremover. I så tilfelle må rammer, innhold, dose og ventet effekt for et slikt rehabiliteringsprogram være objekt for videre forskning.

Acknowledgments

I would like to thank my supervisor Dr. Ellen Jaatun for excellent guidance throughout this project, from start-up to completion, by providing constructive feedback, being supportive, and optimistic.

I would also like to thank my co-supervisor Dr. Tara French who has offered practical insight in the field of community choir and a methodological approach that was difficult to seek elsewhere. The team will also thank the Faculty of Medicine and Health Sciences NTNU for allowing us to conduct this study and providing the facilities for testing.

I am also grateful to my co-supervisors Eline Lello and Dr. Jon Øygarden at NTNU Audiology, as well as the bachelor students Craig Furunes, Siv-Anne Ludvigsen, Silje Karin Slettevoll and Maren Sande, for valuable interdisciplinary collaboration and guidance that has offered me insight in their field of expertise in auditory testing.

Last, but not least I am most grateful to The Norwegian Choir Association, The Norwegian Trekking Association, and their members for participating patiently in the testing procedure and providing me with insight into their experiences from being hearing impaired and singing in a choir.

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Background

The ability to communicate, especially using the spoken word, is essential for human interaction. Difficulties perceiving speech are common among older adults, creating potential difficulties in social interaction as the years pass by. Research has shown that hearing losses and increasing age makes perception of speech more difficult, especially in background noise[1], which is the typical setting for organized social interaction. *Wellbeing* and *Quality of Life (QoL)* are parameters that may suffer in reduced social participation[2]. Hallberg found negative correlation between self-reported hearing-related problems and *psychological general wellbeing (PGWB)*[3]. The hearing loss and following communication problems may lead to a vicious circle of isolation, at least in women[4, 5], which may reduce mental stimuli and physical activity, resulting in a loss of function and a declining health[6]. Every way to reduce the extent of this vicious circle, utilizing the remaining ability to hear and limiting the morbidity of hearing losses, could contribute to reduce an increasing burden of disease.

Presbycusis, physiological sensorineural hearing loss, is a natural part of the aging process, affecting some individuals harder than other. The pathophysiology is complex and affects both the inner and outer hair cells of the inner ear, as well as the vascular structures and the ganglion cells. The hair cells of the cochlea cannot regenerate, and the destructions create permanent hearing losses. The most characteristic trait of presbycusis is a progressive, symmetric bilateral loss in the higher frequencies developing over decades[7]. The higher frequencies carry the consonants, defining the syllables, often spoken at low intensity. Losses in these frequencies lead to reduced sensibility in interpreting auditory stimuli and complicate perception of speech[8].

The HUNT-studies estimate 62% of Norwegians above 65 years of age to have a hearing loss affecting the ability to communicate[9]. The problem is global, ranked 15th at WHO's report "The global burden of disease: 2004 update", and assumed to rank 7th in 2030[10]. While the world's population is aging, ever increasing the resources needed in the health sector, facilitating healthy aging is crucial to operate a viable health service[11]. Hence, this problem asks for more holistic options for rehabilitation among older adults, both in the auditory field and in general.

Hearing rehabilitation today is mostly focused upon fitting hearing devices[12], that may end up being unused[13]. Although there have been huge advancements in the field of hearing aids, moving from analog to digital devices that are programmed to amplify the personal hearing loss. Over the last years the recommended hearing aid fitting protocol has not changed that much, focusing to improve the patient's communication abilities and ability to perceive

speech[14].Other aspects of the sonic environment has got a very limited focus during the fitting process, normally performed in a sound proof room. However, in most hearing aids, different programs for filtering of unwanted noise such as wind, or amplification of specific sounds such as music, is a common feature. Other auditory rehabilitation programs may be effective as well; both individual programs improving listening and speech perception, and group training programs reducing limitations and improving quality of life. However, these programs are poorly used due to both low availability and low adherence[15]. Such a program is *The Active Communication Education Program (ACE)[16]*, teaching coping strategies. This program significantly reduces participation restrictions and communication activity limitations, and improve well-being among older adults[17].

Self-learned coping strategies can also modulate the consequences of hearing losses. Hallberg et al found that an infrequent use of *maladaptive behaviour* and a frequent use of non-verbal *strategies* were related to a high level of PGWB[3]. Strategies was said to be *actions intended to enhance communication or at least to minimize the effects of the hearing loss*, while maladaptive behaviours were defined as *detracting from or inhibiting the communication process*. QoL could not be predicted by audiometric data alone in this study, pointing out the necessity of developing coping strategies for compensating a loss of function. Stimulating this process could be beneficial.

Hearing loss inhibits social processes[6]. Participating in social and meaningful activities reduces functional decline and mortality in older adults over a longer perspective, as well as increasing well-being[18]. Attending activities generating well-being is also thought to enhance neuroplasticity[19]. Social activities this way, make a great arena for developing the functional and structural pathways in the brain. Simply put, the brain's plasticity and ability to change is the foundation for learning[20]. The plasticity diminishes with age, reducing cortical plasticity from unimodal motor training in older adults[21]. Music, however, offers multimodal stimuli, which has also been shown to enhance plasticity in older adults[22].

Music offers a good setting for socialising throughout life, also into later life. An empirical study exploring amateurs' musical activity in later life found among other factors increased QoL and a sense of community while performing music[23]. In addition, musical activity induces development of more effective central auditory pathways[24]. Musical training from early age develops a more robust and effective auditory processing that offsets the age-related declines in auditory function, preserving speech understanding in noise, auditory temporal processing,

and auditory working memory[25]. These effects apply despite of comparative hearing losses[26]. Relationships between the degree of enhanced auditory processing and number of years training are often found in studies, suggesting the advantages to be a result of musical training, instead of inborn differences[27].

Community-based activities improve health and well-being[28]. Musical community-based activities, in form of community singing, is common among amateurs of all ages. In 2015 there were 69.751 registered singers in Norway[29]. Today 29.107 of these are registered in The Norwegian Choir Association, 12.650 older than 60 years[30]. This numbers makes community singing one of the most common cultural activities in Norway. Community singing is associated with improvement of psychological QoL in older adults[31], as well as maintained general health[32]. A randomised controlled trial found community singing to be a cost-effective activity to improve mental health-related QoL, and reduce anxiety and depression[33]. However, no differences were found 3 months after intervention, suggesting continuous participation important to benefit from such activity. Group singing also promotes cognitive function, by improving episodic memory, executive function and short term working memory for people with mild dementia[34]. Effects of community singing are explored for a range of conditions[35], but these effects are poorly explored among people living with hearing impairment.

Objective

Through performing and instructing music I have both felt and seen how musical performance can act as both a social arena and an arena for learning and development. Today there is an extensive focus on physical exercise for preserving good physical health, not only for the young and healthy, but for older adults experiencing impairments as well. Community singing has subjective effects upon physical health, positively affecting breathing, lung function, posture and body control[36, 37]. This made me wonder whether auditory training, especially in form of musical performance, can be beneficial for cerebral function and physical health? Musical performance, like singing, is challenging by coordinating melody, harmony, rhythm, lyrics, and emotion, involving multiple parts of the brain. The key for synchronizing all these aspects is the auditory system, often with decreasing performance among older adults. Despite this, performing music in later life is common. I wondered how it feels performing music while experiencing a hearing decline, and how suffering from a loss of hearing affects the individual's performance of music. Community choirs are available even in the most remote areas in Norway. If singing in community choirs have a targeted effect on medical problems, choirs

could be used for as an intervention and thereby contribute to reduce the increasing burden on healthcare services due to demographic change.

Hearing impairment and perception of music is perceived to be a challenging field, and proved to be a field modestly explored, especially for performing music in later life. The interest of exploring the field in depth therefore requires a qualitative approach. In addition, it enables a deeper understanding of psychoacoustical processing of information in social contexts among hearing impaired. Using experimental test batteries, may help to explore any theoretical differences that may be found in larger test populations of people who perform music over time and suffer from hearing impairment. However, in this study the test population is limited, and consequently, the quantitative approach will serve the purpose to describe the test population and provide valuable experience in using quantitative data.

The study employed mixed methods to investigate strategies to perceive sounds in noise among older singers with impaired hearing. The study aimed to answer the following research question:

What are the strategies hearing impaired singers use to improve their ability to hear, perceive, and tune themselves in a choir setting?

Methods

The mixed methods approach included a quantitative study to document the extent of hearing impairment among the participants included, and a qualitative study to explore the experience of singing with a hearing impairment. To verify the inclusion criteria, the hearing threshold was measured first. The collection of the psychometric test data and the interview was conducted in a random order for practical reasons.

Recruitment

The test group was recruited from a range of choirs, mostly members of The Norwegian Choir Association[a], an organisation open to all genres, ages and levels of ambition. The control group was mainly recruited from members of the Norwegian Trekking Association[b]. Some of the people from The Norwegian Trekking association met the inclusion criteria of the test group, and were included to the test group instead. A few participants were recruited through posters.

[a] Norges korforbund: https://kor.no/om-oss/in-english
[b] Norges turistforening: https://english.dnt.no/

Ethics

All participants were fully informed about the aims of the study (approved by REC Central[c]) and provided written consent.

Inclusion/Exclusion

Participants were included by the criteria listed in Table 1. Hearing impairment was defined as a hearing threshold below 25 dB HL[d] for 500, 1000, 2000 and 4000 Hz annotated as a Pure Tone Average (PTA) 4[e] > 25 dB HL. We also collected demographical data, such as educational level, medical history and weekly activities (see appendix for questionnaires).

Table 1 Inclusion and exclusion criteria

Inclusion	**Exclusion**
Bilateral PTA 4 > 25dBHL verified by pure tone audiometry	Not filling the criteria for inclusion
Age > 60 years	Control group: Former musical activity
Norwegian as first language	
Open ear canals verified by video otoscopy	
≥ One social activity on a weekly basis	
Singers: singing in choir on a weekly basis	

Testing environment

All the audiometric tests were performed in sound proof rooms with audiological equipment in accordance with the International Standard for Pure-tone air and bone conduction audiometry (ISO 8253-1:2010)[38]. The technical equipment used in this study was set up according to Furunes et al.[39].

Audiometric tests

All participants were initially tested to verify that they met the inclusion criteria. Video otoscopy was performed and printed, verifying open ear canals and excluding potential pathology. Pure tone audiometry was performed following the Recommended Procedure of British Society of Audiology[40] and The International Standard for pure tone audiometry[38],

[c] Regional Committees for Medical And Health Research Ethics: https://helseforskning.etikkom.no/komiteerogmoter/midt/sekretariat?region=10797&p_dim=34989&_ikbLanguageCode=us

[d] Hearing Level

[e] Pure Tone Average 4, the mean value of air-conducted hearing thresholds in both ears in following frequencies: 500, 1000, 2000 and 4000 Hz

measuring pure-tone thresholds for air- and bone conduction. Bilateral PTA 4 was calculated immediately after testing.

Psychoacoustic tests

Three tests were chosen to explore psychoacoustic abilities among the participants. The tests should give us a deeper understanding of how the hearing impairment affected the test population in relation to a standardized test. We also wanted to compare this results with a control group not participating in music.

The sequential order for performing the psychoacoustic test battery were randomly organised for practical reasons.

Gaps-in-Noise detection – GIN

Temporal resolution is one of the components of temporal aural processing, and define an individual's ability to detect small and sudden changes in sound stimuli, hence is an important property for understanding speech in noise[41]. This ability can be explored by Gaps-in-Noise tests[42]. An adaptive binaural three-alternative forced-choice method developed by Baker[43], was used for all measurements. The test measured the smallest detective gap in milliseconds (ms), by presenting three alternatives of 70 dB SPL[f] white noise, one of them containing a 0 dB gap.

Difference Limen of Frequency - DLF

Spectral resolution describes the individual's ability to percept differences in frequencies. Exploring this function is often done by doing differential limen of frequency tasks[41]. An adaptive binaural four-alternative forced-choice method, presenting four 70 dB SPL pure-tone sequences, was used for all measurements. The test was programmed in MATLAB by Øygarden, based on Moore & Vinay[44]. Three of the sequences held four identical tones, while the last sequence held a ABAB-pattern, with frequency alteration. Both the order of the sequences and the volume of each tone were randomised. The test measured the individuals' smallest perceptible increment of frequency in following frequencies represented in the human voice: 250, 500, 1000, 2000, and 3000 Hz. The scoring system used Weber's Law, $K=\Delta f/f$, and the results were given in Weber fractions[45]. The Difference Limen of Frequency describes the sensitivity of frequency discrimination.

[f] Sound Pressure Level

Speech-in-noise test - SIN

Lately, there has been efforts for developing tests representing real life conditions. Speech-in-noise testing today may be routine practice for some academic communities, while being rather unknown for others. The test measure speech perception in noise versus in a quiet environment and provide information for choosing the appropriate amplification strategy for a hearing aid[46]. The test protocol, developed by Øygarden[47], offered multiple phrases of three words, while playing 65 dB SPL noise. The noise was produced by playing the words from the protocol backwards. The test was conducted in quasi-free sound field[g] as shown in Fig. 1, following the International Standard for Sound field audiometry with pure-tone and narrow-band test signals (ISO 8253-2:2009)[48]. The measurements were done in three sequences: Threshold 1 (T1) presenting phrases from speaker 1 without noise, threshold 2 (T2) presenting words and noise from speaker 1, and threshold 3 (T3) presenting phrases from speaker 1 and noise from speaker 2 and 3. Every sequence has increasing difficulty by reducing the phrases' intensity for finding a threshold.

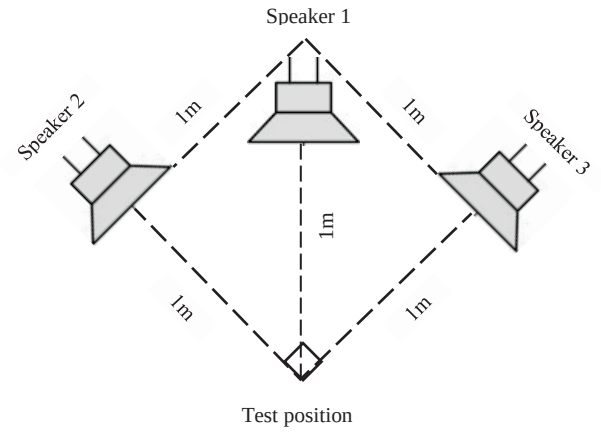

Figure 1 Setup for Speech-in-noise test – a quasi-free sound field

Interview

The singers participated in semi structured interviews exploring their experience of singing, with a particular focus on coping strategies used while attending choir rehearsal. Topics included experience of interaction, benefits and difficulties from singing in a choir, and physical changes in voice, hearing and health, were openly discussed. The interviews were recorded and

[g] A sound field where the boundaries of the room exert only a moderate effect on the sound waves. A completely free sound field is difficult to achieve due to the need of placing both people and instruments in the field.

later transcribed, condensed and analysed for emerging and recurring themes, by using thematic analysis[49]. The interviews were conducted in a sound proof room for privacy.

Results

The participants included 22 singers and 10 active older adults with no history of music activity as controls. A schematic presentation of the inclusion and exclusion is shown in Fig. 2.

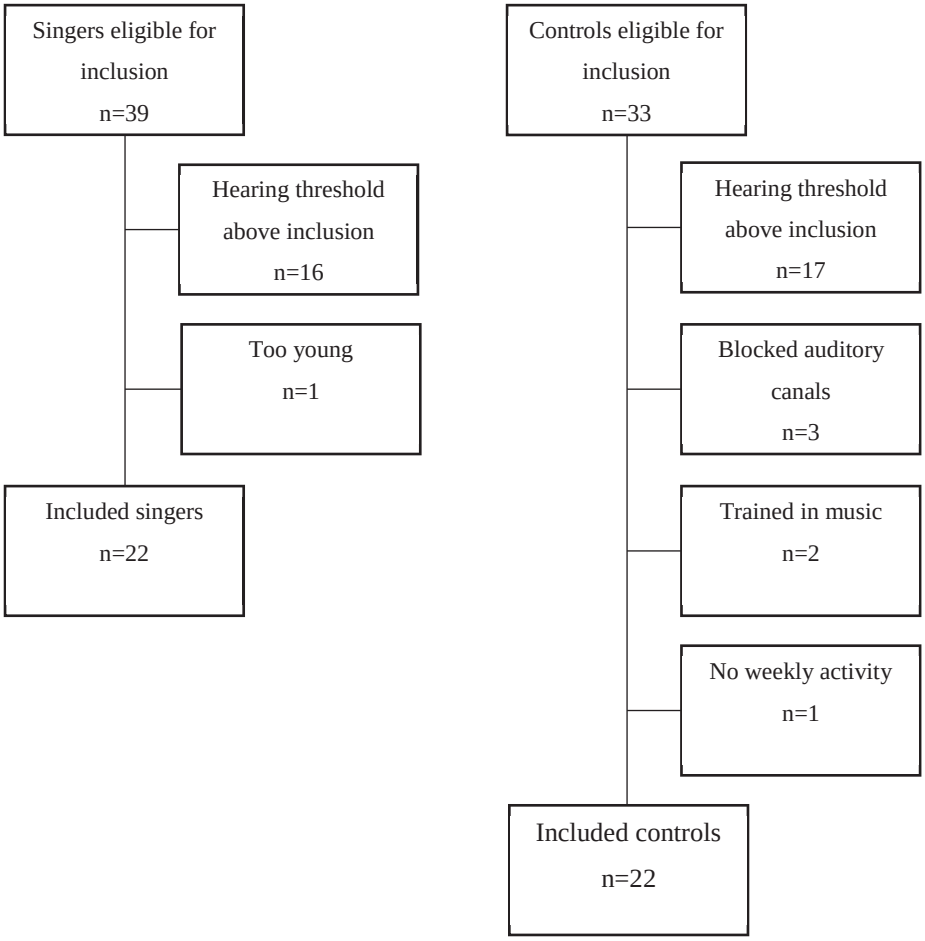

Figure 2 Flow chart of study sample

Strategies were explored in two different scenarios during rehearsal; singing and verbal conversation. Both coping strategies and maladaptive behaviours were identified. The singing scenario was perceived as rewarding, in contrast to the less rewarding scenario of verbal conversation. The mean of bilateral PTA 4 was 35,7dB HL in the singer group, contra 34,3dB HL in the control group, both groups having a pattern of hearing loss related to presbycusis. The spectral and temporal resolution of the test participants, based on the results from the psychoacoustic tests, showed tendencies of better performance in both Difference limen of

frequency and Gaps-in-noise compared with the control group of active older adults not engaged with music. The results of the Speech-in-noise test were ambiguous.

The pure tone audiometry showed comparable values in bilateral PTA 4, but more heterogenic results for unilateral hearing in the group of singers, min/max 25.0, 55.6 versus 26.9, 48.1 in the control group (Table 2).

Table 2 Pure tone average 4 in the two groups

Singers' PTA 4 (dBHL)	**PTA 4 Right**	**PTA 4 Left**	**PTA 4 bilateral**
Mean	35,2 (min 12,5, max 77,5)	36,2 (min 16,3, max 73,8)	35,7 (min 25,0, max 55,6)
Median	31,3	33,8	31,6
Controls' PTA 4 (dBHL)	**PTA 4 Right**	**PTA 4 Left**	**PTA 4 bilateral**
Mean	33,5 (min 23,8, max 47,5)	35,0 (min 27,5, max 48,8)	34,3 (min 26,9, max 48,1)
Median	32,5	33,1	32,5

The patterns of hearing losses were mostly related to presbycusis, with subnormal thresholds in the lower frequencies and increasing losses towards the higher frequencies (Fig. 3).

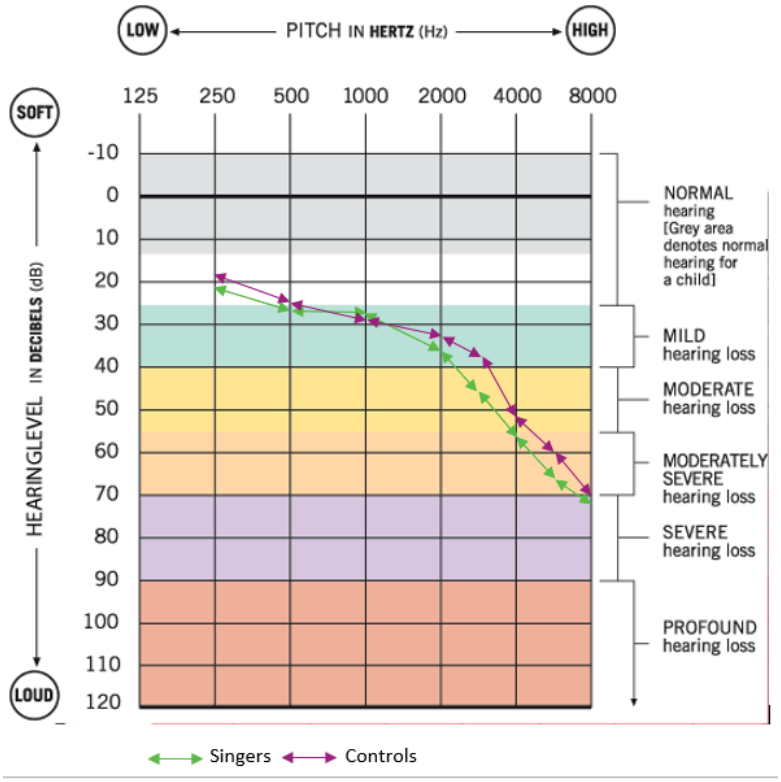

Figure 3 Audiogram based on mean thresholds for each frequency

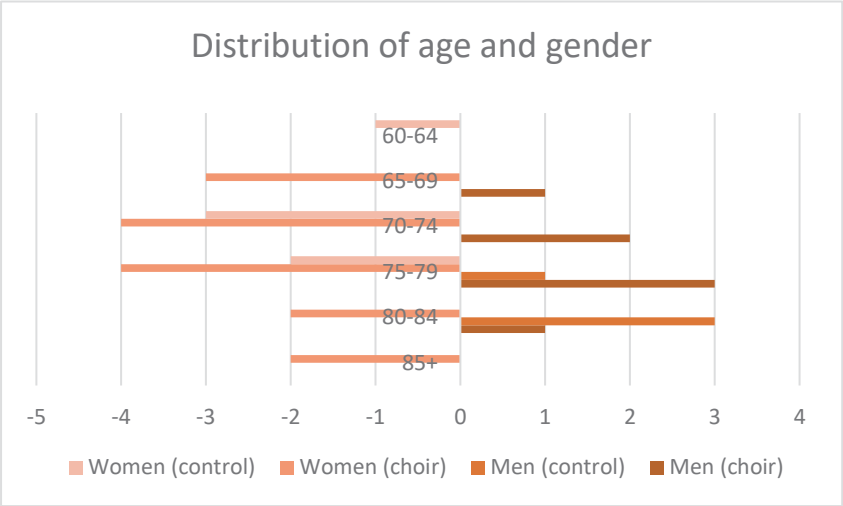

Figure 4 Distribution of age and gender in the two groups

For further demographical data, see Fig. 4 and Table 3.

Table 3 Age in the two groups

Age (years)	**Singers**	**Controls**
Mean	75,5 (min 66, max 89)	75,5 (min 61, max 83)
Median	75,5	75,5

Psychoacoustic tests

Exploring the spectral resolution, we found a tendency of better performance in the difference limen of frequency (DLF) in the singers group versus the control group (Fig. 5). The differences were largest in the lower frequencies, and less prominent in the higher frequencies. The DLF test was demanding and long-lasting (approx. 30 minutes in total). Two participants were excluded from the data set for DLF, because one produced extreme values while the second one chose to withdraw from the test due to poor performance.

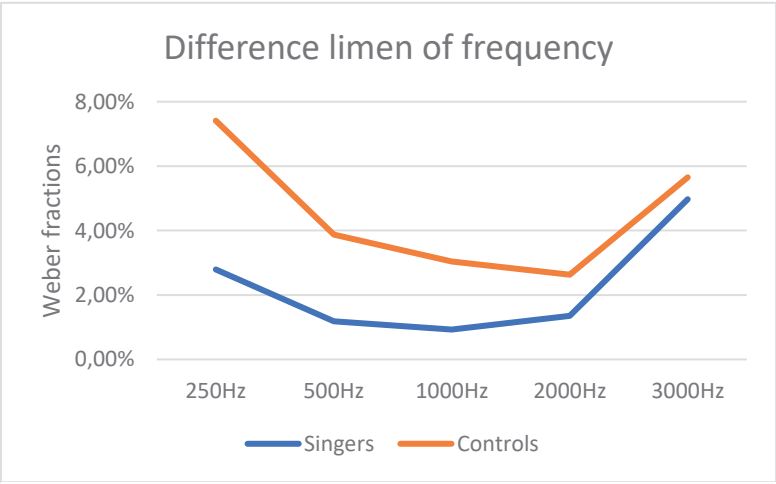

Figure 5 DLF's mean values in each frequency

Table 4 Results of the Gaps-in-noise test

Gaps in noise (ms)	Singers	Controls
Mean	7,50 (min 3,25, max 18,3)	8,58 (min 3,56, max 15,8)

Exploring the temporal resolution by doing Gaps-in-noise testing showed a tendency of better performance in the singer group versus the control group (Table 4).

Table 5 Results of the Speech-in-noise test

Speech in noise (dB)	Singers	Controls
Mean T1 (SPL)	38,8 (min 22,6, max 54,4)	41,1 (min 35,3, max 51,2)
Mean T2 (SNR*)	-1,2 (min -4,9, max 1,7)	-0,9 (min -4,2, max 2,1)
Mean T3 (SNR)	-5,1 (min -10,8, max 0,5)	-6,0 (min -9,1, max -2,4)
Mean SRM**	3,9	5,1

*Signal-to-Noise Ratio = Threshold - 65 dB SPL noise

**Spatial Release from Masking = T2 - T3

The speech-in-noise test did not present any clear differences between the two groups (Table 5). The control group although tend to produce slightly better values in Spatial Release from Masking, a concept describing the ability to use directional hearing.

The singers recruited were mostly attending choirs for older adults, but also a choir competing on higher level. The choirs arrange voice-testing before admission, for placing new singers in right part, and for assuring participation on equal footing. The years of musical training were reported between 1 and 63 years, with a mean value of 28,5 years.

Interview

Singers living with hearing impairment provided valuable information on several aspects of community singing. During consolidation and analysis of the interviews three main themes emerged, based upon statements of recurring content. Both main themes and their subthemes are listed in Fig. 6.

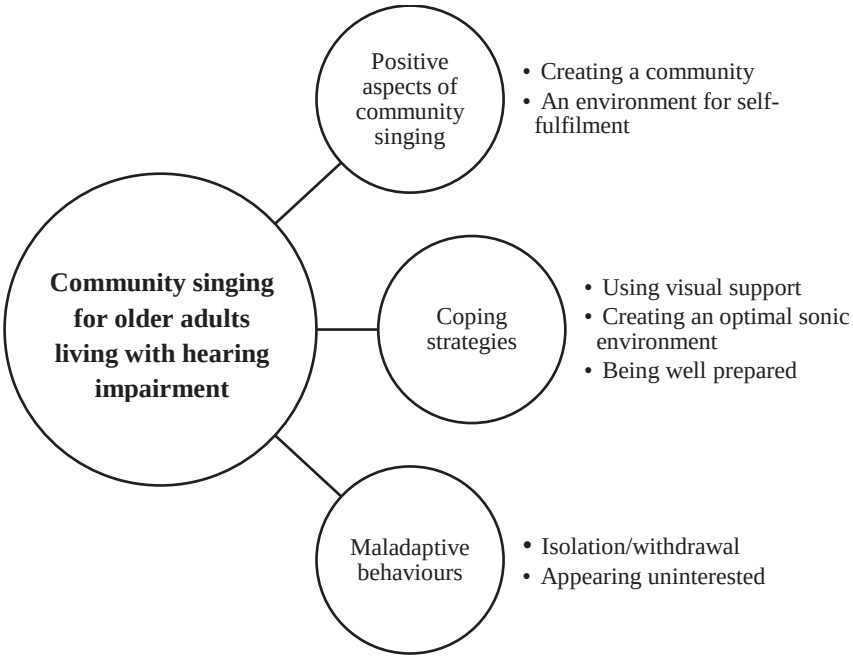

Figure 6 Mind map over emerging themes

Positive aspects of participating in community choirs

This theme encompassed positive aspects related to the participants experience of community singing. Their experiences were principally positive. Two subthemes emerged which depict the community experience and the creation of an environment for self-fulfilment.

Creating a community

Singing in a choir was reported to create a community of people where the participants filled several aspects of what could be defined as a strong and prosperous society. This was based on different aspects, such as providing a purpose to meet on a regular basis: "*The friends from my youth have moved from town (…), so it's the people in the choir I see the most. We're seeing each other once a week, and in addition the basses are practicing by themselves from time to time. I like it!"*

The participants were focused on avoiding social exclusion, which may be a strategy that may be helpful to include more introvert or shy participants: "*It is simply a very nice social environment. You're not experiencing cliques or groupings as you may experience in a lot of other settings. It is incredible."* The choirs also included singers in a wide range of age, which was positively perceived as well: *"The point is to meet and have good times together. I have sung in this choir for 25 years now. (…) At Christmastime several quit, two of the ladies were 98 and 93 years old. You can only imagine how great it is, that they could come from town by car, to attend rehearsal, see friends, drink coffee and have an enjoyable time singing."*

Participants reported to feel safe and included in the community of fellow singers. They felt supported within the activity, but also made close friends in life, providing support through hard times, such as during cancer treatment: "*I would say that singing in a choir is to have a family taking care of you. I got telephones and visits while being sick. They (the singers) were extremely valuable to me at that time. The choir has meant a lot to me."*

The community of fellow singers grew stronger also because of sharing experiences like travels and performance: "*To stand on stage and hear that you've won gold medal together… I never thought of getting this kind of experiences when I started."*

An environment for self-fulfilment

Participants reported a passion for singing, and the choir rehearsal offered a structured setting to practice their passion. The structured singing activity offered a setting where the participants were able to keep their voice in shape, and experience mental fulfillment, both related to well-being and cognitive abilities: *"Coming home from rehearsal I feel happy and relaxed. Accomplishing a song, feeling that we've done good, the musical experience… While using my singing skills, I get a feeling of fulfilment. I wouldn't manage without a choir."*

Coping strategies and maladaptive behaviours

The singers commented on strategies in two different scenarios during rehearsal; singing and oral conversation. The participants perceived conversation in groups to be increasingly difficult, while singing in choir was perceived to be an activity where the singers felt more confident. The coping strategies were partly the same in both scenarios (singing or conversation), although the participants reported more options for coping strategies during singing. Maladaptive behaviours were also used to some extent. The coping strategies and maladaptive behaviours are listed in Table 6.

Table 6 Coping strategies and maladaptive behaviours used in the two scenarios

Coping strategies for singing	**Coping strategies for oral conversation**
Using visual support	Using visual support
Creating an optimal sonic environment	Creating an optimal sonic environment
Being well prepared	
Maladaptive behaviours for singing	**Maladaptive behaviours for oral conversation**
No behaviours were reported	Isolation/withdrawal
	Appearing uninterested

Using visual support

Using visual support, by looking at the conductor's whole body such as arms, posture, facial expression, and lips, was a strategy suggested for better coping during singing. One participant described the importance of getting visual support from the director like this: *"I find it important that the conductor clearly shows when to start and how to express the song. I look for the tempo and when to sing fainter or louder. In addition, she mimes the lyrics."*

During oral conversation, inhibition of *using visual support*, in form of not seeing gestures and lips of the person speaking, was presented as an issue that made it difficult to percept speech: *"I appreciate seeing the director. The lady that conducted us before could be difficult to see, because she was short and standing behind the piano. It could be difficult to lip-read and hear what she said."*

Creating an optimal sonic environment

Creating an optimal sonic environment was a wide-ranging, dynamic strategy in both scenarios, asking for collective responsibility, preferably involving every singer.

While singing, this strategy involves offering sufficient sound intensity. All the singers reported listening to each other, especially for others singing the same part. The importance of getting auditory support, such as singing loud enough as a group, was pointed out by this singer: *"I sometimes feel that the volume gets too weak around me. This makes me insecure about my own singing. (…) I get reserved and it becomes difficult to hit the high pitches."* Using this strategy may cross a fine line, producing too high intensity, when music is supposed to be dynamically performed: *"I don't pay so much attention to each singer, if they're not standing out. There's one alto who's forcing (singing too loud) sometimes."*

Creating an optimal sonic environment during singing was preferred solved fundamentally different by six singers. Standing in mixed position (Fig. 7) was perceived more supportive by these individuals: *"I like to hear more parts at the same time. I have tried to tell the choir that we should mix, because it gives a better sound picture for the public as well, but then some say that they're to insecure in their own part to do so."* Better hearing the other parts was said to offer cues, as well as facilitating harmony. They also told of increasing confidence when mixing: *"We used to mix and didn't stand in settled positions from time to time. I was standing in between the basses, singing my part, the tenor. That's how you learn to be confident. I found it helpful."*

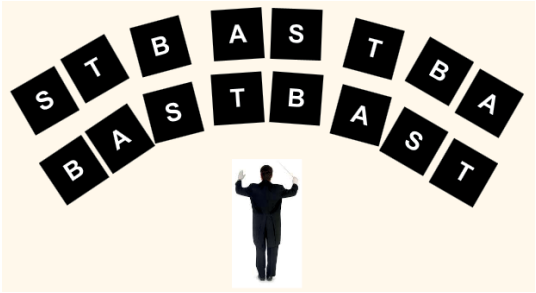

Figure 7 Mixed position. The singers stand organised in quartets, in contrast to standing grouped by parts.

Creating an optimal sonic environment required to balance on a fine line for oral conversation as well. Asking the neighbour for rephrasing was frequently used, producing a vicious circle of background noise: *"There's so many people chattering during rehearsals. It gets difficult to hear what the director's talking about, but we're good in helping each other, sitting together, so it is fine."* Although helping the individuals using this strategy, it apparently makes a problem according this singer: *"You can make better use of the rehearsals when concentrating and listening to the director instead of whispering and not paying attention. I detest when they (the other singers) make noise and waste our time."* Restraining themselves from asking the conductor or neighbours to repeat the message, and keep quiet, hence was an important part of this strategy.

Use of hearing aids

For *creating an optimal sonic environment*, using hearing aids are an established strategy, aiming to make the spoken word perceptible. Eight of the 22 singers mentioned to have adjusted hearing aids. Six of them took them off during rehearsals, related to unwanted amplification of sounds*: "They take in way in too much noise, so I can't hear the voices beside me. Then I'm only hearing my own voice. That's simply not good at all."* However, this strategy was said to be a problem in the scenario of oral conversation: *"If I wear my hearing aid while practicing, I hear better what the conductor says, but then the piano gets way too loud."*

Being well prepared

Being well prepared, by practicing at home, was presented an important strategy while singing. The key lies within the music itself: *"The sounds are controlled. You have the sheet music, right? There's four parts to relate to, all moving rhythmically in the same direction. It's fine!"* The music performed in choirs is usually planned and offers structure, mediated by the conductor. When having troubles coping, the singers practice: *"I memorize the lyrics. It is more fun to attend the choir when feeling you're doing it right. I want to be a step ahead."* For

learning the melodies, audio files were actively used: *"I can't read musical annotations, but I see as it goes up and down. To follow the audio files and watch the sheet of music at the same time is very helpful."*

This strategy was not used in oral conversation.

Maladaptive behaviours

No maladaptive behaviours were reported while singing.

Isolation and withdrawal was a strategy used by a minority of the participants for avoiding verbal conversation, avoiding inconvenient situations, for example one participant described feeling inhibited in social settings: *"I get passive taking contact. I'm afraid of approaching 2-3 strangers sitting together, because I don't know how I'll manage. The breaks in the choir, they're hideous. I just stand there and try to understand. The words simply vanish. (…) I'd like to participate."*

Appearing uninterested to humorous contributions, because of missing out, was also reported for minimizing the consequences of their hearing loss: *"I sometimes miss out on witty comments. To avoid doing so I must concentrate and pay much more attention, so sometimes I get lazy and think "ah, I don't care". If I really care, I miss out on less, of course."*

Discussion

The findings of this study suggest that community singing is an arena for coping among older adults living with hearing impairment. Emerging themes suggest that singers felt supported and safe in the community created, and emphasised the social aspects of community singing being particularly rewarding. The coping strategies *creating an optimal environment* and *using visual support* were used to compensate loss of function during both singing and oral conversation. Counter to presumptions of community singing being too difficult when living with a hearing loss, community singing seems to be a surprisingly safe arena for social interaction suited to prevent the negative consequences of hearing loss[2-6].

The findings suggest the fundament for making the singing scenario a safe arena for social interaction, seems to lie within the structure and regularity. The activity involves learning new melodies and lyrics in a setting of interaction, stimulating the brain's plasticity through a social and musical setting[19, 22]. When having troubles, coping is attained through *being well prepared*, practicing at home, making community singing a suitable activity for socialising despite living with a hearing loss.

This structure is facilitated by a leading conductor, adding visual support, providing an audio-visual context easier to orientate in, especially important in later life[50]. Use of visual support throughout the rehearsals may be used more deliberately in the scenario of oral conversation as well. To give written information and be visible to everyone while speaking, may enhance the strategies *using visual support* and c*reating an optimal sonic environment*, by reducing the background noise, making community singing an even more suited arena for older adults with hearing impairment.

Creating an optimal sonic environment during singing was characterised by offering each other auditory support. Six of the singers preferred standing in mixed position, getting auditory support from all parts. Although, most of the choirs stand sorted by parts, getting auditory support from their own part. Singing in mixed position offer a wider sound picture, containing more frequencies and rhythm to tune to. Auditory temporal processing decline with increasing age[51], presumably making the sensitivity of frequency and rhythm poorer. This way standing in mixed position may give a context easier to orientate in, versus getting support in the exact frequency the singer is trying to produce.

The sonic environment during singing was positively perceived. The musical sounds are organized and usually of a sufficient intensity, apparently making them available for even a hearing-impaired ear. Despite this, some felt that the volume could get too weak. This may be the case if standing beside uncertain singers, but the music being to faint to perceive, when having a hearing impairment, may be the case as well. If so, this may be a challenge, making the hearing-impaired singers uncertain or singing too loudly.

Methodological challenges

Tendencies of better performance were found for the singer group in Difference limen of frequency and Gaps-in-noise detection. The Speech-in-noise test presented more ambiguous results, suggesting a slightly better ability to use directional hearing for the control group. The test population was limited in number which make further statistical analysis inappropriate. Statistical analyses, except from mean and median values, are therefore not presented. The control group was also quite homogenous, recruiting most participants from the same organisation, potentially making them less representative as normal population.

While including active people with an assumed high functional level, two participants could not complete the test measuring Difference limen of frequency, implying the test battery being

too difficult. This may ask for a revision of the test battery in any future study exploring psychoacoustic abilities among a wider group of older adults.

Implications

The study documents the exploration of strategies and maladaptive behaviours among a group of singers in later life with a verified hearing impairment. These strategies may also be the actions singers with a normal hearing use during singing. If so, deliberate use of the strategies explored could provide helpful guidance to any choir. Especially singing in mixed position is often seen as being both difficult and intimidating, an idea that may, considering our findings, be a delusion. Accordingly, experimenting with mixed position could be interesting both for conductors and singers in general.

Further research

The singers using hearing aids preferred to take them off while singing, a strategy that made the scenario of oral conversation difficult. The fitting of hearing aids today is focused upon perceiving speech, and seems to function suboptimal while perceiving music, due to, among other factors, conversion and compression[52]. This is a field of great interest, research investigating both how hearing impairments affect music listening experiences, and how to develop devices supporting music perception. The present study supports the need of increased knowledge in this field, for reducing the limitations of living with a hearing loss.

Today's programs for hearing rehabilitation, except fitting of hearing aids, are poorly used due to low availability and low adherence[15]. This study presents community singing as both enjoyable and suitable for older adults living with hearing impairments. Community choirs are also highly available[29, 30], potentially making the challenges with the existing hearing rehabilitation programs, like ACE[16], less of a problem. A potential rehabilitation program using community singing could provide both a social arena facilitating activity among older adults and stimulate personal compensation of hearing loss, by teaching coping strategies and inhibiting the use of maladaptive behaviours. Such a program could potentially be an alternative to current practice, especially for those with a musical interest.

The findings of this study suggest that community singing is an arena for coping among older adults living with hearing impairment. Emerging themes suggest that singers felt supported and safe in the community created, and emphasised the social aspects of community singing being particularly rewarding. The coping strategies *creating an optimal environment* and *using visual support* were used to compensate loss of function during both singing and oral conversation.

Counter to presumptions of community singing being too difficult when living with a hearing loss, community singing seems to be a surprisingly safe arena for social interaction suited to prevent the negative consequences of hearing

Conclusion

By exploring the experiences of community singing, we have found that community singing is a suited activity for older adults living with hearing impairment, despite their hearing losses. Community singing was experienced as an arena for both coping, community and self-fulfilment, where the participants felt included, safe and supported. The coping strategies *using visual support*, *creating an optimal sonic environment* and *being well prepared* were used to compensate the loss of function in the scenario of singing. These coping strategies may be employed by other people living with hearing impairments, supporting them to partake community singing as equals who experience the positive aspects explored. Community singing may also have potential to relieve the health care system some of its' future challenges. The expected increase in burden of disease asks for available, motivating and cost-effective rehabilitation programs facilitating healthy aging. Our study suggests community singing to be an arena outside the health care system filling these criteria, potentially also having effects of rehabilitation, given a suited and adapted setting. The guidelines for such a setting could be object for future research, regarding form of training, effective doses and expected effect.

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Appendix 1

Deltakernummer: ☐☐ **Sanger:** ☐ **Kontroll:** ☐ **Dato:** ☐☐ / ☐☐ / ☐☐

Dag Måned År

Medisinsk historie

Tidligere medisinsk behandling		Medisinsk problemstilling	År for behandling	Vedvarende problemer?
Gjennomført operasjoner i ørene?	☐ Ja ☐ Nei			☐ Ja ☐ Nei
Nevrologisk sykdom?	☐ Ja ☐ Nei			☐ Ja ☐ Nei
Annet?	☐ Ja ☐ Nei			☐ Ja ☐ Nei

Andre sykdommer	Medikamenter

Øvrige kommentarer: _____

_____

_____

_____

_____

_____

Medisinsk historikk er hentet inn av: _____

Deltakernummer: ☐☐ **Sanger:** ☐ **Kontroll:** ☐ **Dato:** ☐☐ / ☐☐ / ☐☐

Dag Måned År

Personalia

Fødselsår: ☐☐☐☐

Kjønn: (kryss en)
- ☐ **Mann**
- ☐ **Kvinne**

Utdanning: (kryss en)
- ☐ **Grunnskole**
- ☐ **Videregående utdanning**
- ☐ **Høyere utdanning**

Yrke (hvis flere, oppgi det aktuelle)**:** _____

Yrkesaktiv?:
- ☐ **Ja**
- ☐ **Nei**

Beskrivelse av musikkutøvelse

Alder ved oppstart av musikalske aktiviteter: _____

Antall år aktiv musikkutøvelse: _____

Antall år pause fra musikkutøvelse: _____

Spiller instrument?:
- ☐ **Ja**
- ☐ **Nei**

Spiller:
- ☐ **Tangentinstrument** (piano, orgel, trekkspill osv.)
- ☐ **Strykeinstrument** (fiolin, bratsj, cello osv.)
- ☐ **Strengeinstrument** (gitar, mandolin, bass osv.)
- ☐ **Blåseinstrument** (trompet, saksofon osv.)
- ☐ **Annet** (spesifiser her): _____

Inklusjon-/Eksklusjonskriterier

	JA	NEI
Alder over 60 år	☐	☐
Norsk som morsmål	☐	☐
Synger i kor på ukentlig basis	☐	☐

Fylles ut av testpersonalet:	JA	NEI
Verfisert hørselstap > 25dB med audiogram (PTA4)	☐	☐

Dagsform

Hvordan vil du beskrive dagsformen din på en skala fra 1-10? 1 er din verst tenkelige dag og 10 er din beste tenkelige dag. (Sett ring rundt det som beskriver din dag best.)

1 2 3 4 5 6 7 8 9 10

Verste tenkelige dag **Beste tenkelige dag**