Speech Intelligibility in common rooms in care facilities for older adults

- A first approach to the problems around speech intelligibility in care facilities for older adults -

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Introduction

1. Netherlands: 158,000 older adults live in nursing homes/care facilities
2. Biological ageing: visual and hearing problems
   - limit daily functioning
3. Hearing loss  communication problems
   - social isolation, loneliness, depression
Introduction

Existing acoustical guidelines: normal hearing persons

• How to translate these guidelines?
  normal hearing persons → older adults
Introduction

• What is the current state of speech intelligibility in common rooms?
• Do the objective measured parameters match the subjective perception of elderly people?
Speech Intelligibility
The degree to which is understood correctly by the listener

Presbyacusis
Hearing loss caused by ageing

Elderly Care
The setting in which the elderly care receiver lives

Room acoustics
Influencing speech intelligibility
Speech Intelligibility: the degree to which human speech is understood correctly by a listener

Three Factors
- **Source:** language, accent, content, volume
- **Transmission channel:** room, telephone
- **Receiver:** human auditory function
Presbyacusis: Hearing loss due to ageing

- Most severe: > 2000 Hz
- Increasing steepness with an increasing age
Framework
Presbyacausis and Speech Intelligibility

- Human speech envelope: 125 Hz – 8000 Hz
- Highest sound levels: 250 Hz
- Largest contribution to speech intelligibility: 2000 Hz + 4000 Hz
Framework
Room Acoustics - Transmission channel

Speech Intelligibility: parameter STI

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<th>0,1</th>
<th>0,2</th>
<th>0,3</th>
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<th>0,5</th>
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<tr>
<td>Unintelligible</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
<td>Excellent</td>
<td></td>
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Depends on the acoustic parameters:
1. Reverberation time (volume, shape, sound absorbing material)
2. Background noise level (building services, electrical equipment, activities)
Framework

Literature: acoustics in the care sector

Reverberation time:
acceptable values 0,4 - 0,7 s [Braam 2006]

Background noise level:
acceptable levels 30 - 40 dB(A) [Braam 2006]

STI:
class shift of 1 is suggested for presbyacusis [Nijs 2010]
Methodology

Field study in 8 common rooms

1. Objective measurements
2. Surveys (subjective)
3. Correlation analysis: objective – subjective results
Methodology
8 common rooms

Activity room

Common living room

Restaurant
Methodology
Objective measurements

Aim: determination of the room acoustic parameters in common rooms in the elderly care

Measured acoustic parameters [ISO 3382-1/2/3] [IEC 60268-16]
1. Reverberation time - $T_{20}$ room empty
2. Background noise level - $L_{Aeq}$ room empty + in use
3. Speech transmission Index - STI room empty + in use (omni) directional
Methodology

Objective measurements

Procedure and equipment

A. Omni microphone
B. Directional source
C. Omni source
Methodology

Surveys

Aim: gaining insight in the perception of speech intelligibility of elderly in common rooms

Questionnaire developed: 3 subsets of questions
1. Personal information - age, gender, possession of hearing aids
2. Subjects’ perception of its hearing condition regarding speech intelligibility
3. Subjects’ perception of the speech intelligibility in the room

Total: 77 subjects
Results & Analyses

Objective results
Reverberation time $T_{20}$

$T_{20}$ in 3 out of 8 rooms longer than recommended
Results & Analyses

Objective results

Background noise level $L_{Aeq}$

$L_{A,eq}$ in 6 out of 8 rooms levels exceeding recommended levels
Results & Analyses

Objective results
Speech intelligibility STI

STI empty room: ‘poor’ in 2 and ‘fair’ in 5 out of 8 rooms (class-shift)
Results & Analyses

Surveys

Statistical analysis of results: SPSS (77 questionnaires)
New indices: measure of perceived SI

1. Personal information - age, gender, possession/use of hearing aids
2. Subjects perception of its hearing condition regarding speech intelligibility $SI_c$
3. Subjects perception of the speech intelligibility in the room $SI_a$

1  2  3  4  5
Results & Analyses

Surveys

Influence of the room acoustics parameters on the perceived speech intelligibility:

\[ S_{I_c} - S_{I_a} = S_{I_r} \]

- \( S_{I_r} < 0 \) : negative effect room acoustics at SI
- \( S_{I_r} > 0 \) : positive effect room acoustics at SI
Results & Analyses

Surveys

Distinction of populations by one-way ANOVA:
SI_c - SI_a - SI_r - background noise nuisance

Age: no significant difference
Gender: no significant difference
Possession of hearing aids: significant difference for SI_c - SI_a
Results & Analyses
Surveys

Possession of hearing aids: significant difference for SI_c and SI_a

No significant difference for SI_r and Background noise Nuisance
Observations during the surveys

In conduction the surveys many inconsistencies were encountered:

- Having to repeat a question several times to a person claiming to have no trouble in understanding speech
- Respondents being influenced by other users of the room
- A general lack of interest on the subject

These and more observations are a reason to doubt the useability of the survey results
Correlation analysis performed:

- \( \text{SI}_a \) - with hearing aid
- \( \text{SI}_a \) - without hearing aid

- \( \text{SI}_r \)
Conclusions

Objective measurements

- Long reverberation times and high background noise levels are measured
- Low STI values are calculated
- Results indicate need of acoustical guidelines

Surveys

- High rating of speech intelligibility amongst elderly people
- Unlikely results are encountered
- Inconsistencies are observed in conducting the surveys
- Survey settings can not be compared due to varying types of activities
Conclusions

Correlation analysis

• Results imply very little influence of room acoustics on perceived speech intelligibility

Unlikely results are encountered:
• A higher noise level does not lead to a higher noise nuisance
• A longer RT leads to a higher speech intelligibility

The correlation analysis results are doubted based on the observations in conducting the surveys
Recommendations

Methodology

- Larger sample
- Distinction in common rooms
- Fixed STI measurement setup
- Include test in questionnaire
- Conditioning activity
- Use only yes- or no- questions

Towards guidelines

- Laboratory settings for speech intelligibility tests and field studies for perceptive tests
- Broaden research: more room functions and more target groups
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