



Listen Carefully: An Exploratory Study of the Association Between Listening Effort and Cognitive Function

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Listen Carefully: An Exploratory Study of the Association Between Listening Effort and Cognitive Function



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ClinicalTrials.gov Identifier: NCT04593290

[Recruitment Status](#) ⓘ : Recruiting

[First Posted](#) ⓘ : October 19, 2020

[Last Update Posted](#) ⓘ : October 19, 2020

See [Contacts and Locations](#)

Sponsor:

Technical University of Denmark

Collaborator:

Danish Dementia Research Centre

Information provided by (Responsible Party):

Anja Maier, Technical University of Denmark

[Study Details](#)

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[No Results Posted](#)

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Study Description

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Brief Summary:

This study aims to investigate the association between listening effort and cognitive function for both cognitively healthy individuals and for patients with Mild Cognitive Impairment (MCI) in mid-to-late stages of life, and furthermore to investigate listening effort and cognitive function after several weeks of **hearing** aid use. Listening effort is measured by the recording of peak pupil dilation during a sentence-final word identification and recall (SWIR) test, cognitive performance is measured using a battery of pen and paper cognitive tests, and **hearing** loss is measured with pure tone audiometry (PTA). A select number of participants in both the cognitively healthy and MCI group will be administered **hearing** aids, and the study will re-test both listening effort and cognitive performance.

<u>Condition or disease</u> ⓘ	<u>Intervention/treatment</u> ⓘ	<u>Phase</u> ⓘ
Cognitive Impairment, Mild Hearing Loss	Device: Oticon Opn S 1 miniRITE hearing aid	Not Applicable

Detailed Description:

This is an exploratory proof-of-concept study and an exploratory intervention study with hearing aids in the context of listening effort. With a case (MCI) and control group (cognitively healthy), investigators will examine the associations between listening effort and cognitive function and assess the effect of hearing aid use on both listening effort and cognitive function test scores for those without hearing impairment. There is not sufficient literature to support a sample size calculation for this association study. Investigators will recruit approximately 50 participants. Half of these participants (n=25) will be individuals who have been diagnosed with MCI, according to the Winblad criteria (ICD10), with a Mini Mental State Examination (MMSE) score ≤ 26 . The control group of participants (n=25) will be cognitively healthy individuals. All participants will undergo both listening effort testing, coupled with pupillometry and cognitive performance testing, based on a battery of pen-and-paper neuropsychological tests.

As investigators aim to measure cognitive effort exerted when listening and understanding speech in noise, is important that all study participants exhibit a normal sensitivity threshold within the ear canal. This will be assessed using Pure Tone Audiometry (PTA).

Assessment scores for cognitive function will be recorded in a clinical setting, and will be based on a battery of pen-and-paper neuropsychological cognitive tests. The Stroop Test, Trail Making Test (part A & B), Symbol Digit Modalities Test (SDMT), Verbal Fluency Tests (category: animals and lexical), Rey Complex Figure Test and Logical Memory Test (Part A) will be administered.

The objective measure of listening effort, pupil dilation, will be recorded as a measure of task performance accuracy and pupil dilation will be measured during a SWIR test, which is used to measure speech identification and recall in varying background noise. Prior to the SWIR test, participants undergo an adaptive Danish Hearing in Noise Test (HINT), comprising a list of equally intelligible sentences to be repeated in varying decibel (dB) levels of background noise to determine the individual's speech reception threshold (SRT) at 80% correct responses.

During the SWIR test, the participant is fitted with PupilLabs' eye-tracking system, an open source system consisting of clip-in eye tracking hardware to be placed in a Virtual Reality (VR) headset. To prevent floor and ceiling effects that are independent to baseline pupil size, the illumination within the VR display is individually adapted to the individual's midpoint prior to data collection between dim (~30 lux) and bright (~230 lux), with an average illuminance of 110 lux. A software suite allows the capture and post-processing of the data feed, including pupil diameter. For the purpose of this study, the PupilLabs software is controlled via a MATLAB interface.

Everyone who participates in Part 1 (listening effort testing and cognitive testing) will be invited to participate in Part 2 (hearing aids). It is not a requirement to participate in the administration, 6-week use, and re-testing procedures involved in Part 2 of the study. All cognitively healthy participants will be invited to participate, only MCI patients with a live-in informant will be given this opportunity. After ear measurement and dome and wire length selection, Oticon Opn S 1 miniRITE hearing aid fitting will occur wirelessly using Genie software, followed by hearing aid use instructions. The fitting will use Open domes, the second generation of the National Acoustic Laboratories (NAL) fitting protocol (NAL-NL2) and will increase gain seven steps on top of Real Ear Unaided Gain (REUG) from 750 Hz to 6 kHz.

Study Design

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Study Type ⓘ :

Interventional (Clinical Trial)

Estimated Enrollment ⓘ :

50 participants

Allocation:

Non-Randomized

Intervention Model:

Parallel Assignment

Masking:

None (Open Label)

Primary Purpose:

Basic Science

Official Title:

Listen Carefully: An Exploratory Study of the Association Between Listening Effort and Cognitive Function

Actual Study Start Date ⓘ :

August 8, 2020

Estimated Primary Completion Date ⓘ :

April 30, 2021

Estimated Study Completion Date ⓘ :

April 30, 2021

Resource links provided by the National Library of Medicine



[MedlinePlus Genetics](#) related topics: [Nonsyndromic hearing loss](#)

[MedlinePlus](#) related topics: [Hearing Aids](#)

[U.S. FDA Resources](#)

Arms and Interventions

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<u>Arm</u> ⓘ	<u>Intervention/treatment</u> ⓘ
<p>Experimental: Mild Cognitive Impairment (MCI)</p> <p>MCI is defined as an early stage of cognitive decline that lies between normal age-matched cognitive function and the onset of very mild forms of dementia, and is associated with a slight but noticeable decline in abilities such as memory and thinking skills. Listening effort testing (with pupillometry) and cognitive testing will be administered for this group - and after a 6-week period of hearing aid use, these measures will be re-tested.</p>	<p>Device: Oticon Opn S 1 miniRITE hearing aid</p> <p>Everyone who participates in Part 1 (listening effort testing and cognitive testing) will be invited to participate in Part 2 (hearing aids). It is not a requirement to participate in the administration, 6-week use, and re-testing procedures involved in Part 2 of the study. All cognitively healthy participants will be invited to participate, only MCI patients with a live-in informant will be given this opportunity. After ear measurement and dome and wire length selection, Oticon Opn S 1 miniRITE hearing aid fitting will occur wirelessly using Genie software, followed by hearing aid use instructions. The fitting will use Open domes, the standard NAL-NL2 protocol, and will increase gain seven steps on top of Real Ear Unaided Gain (REUG) from 750 Hz to 6 kHz.</p>

Arm 	Intervention/treatment 
<p>Active Comparator: Cognitively Healthy</p> <p>This group is 40-85 years old and has no significant neurological or psychiatric disease. Listening effort testing (with pupillometry) and cognitive testing will be administered for this group - and after a 6-week period of hearing aid use, these measures will be re-tested.</p>	<p>Device: Oticon Opn S 1 miniRITE hearing aid</p> <p>Everyone who participates in Part 1 (listening effort testing and cognitive testing) will be invited to participate in Part 2 (hearing aids). It is not a requirement to participate in the administration, 6-week use, and re-testing procedures involved in Part 2 of the study. All cognitively healthy participants will be invited to participate, only MCI patients with a live-in informant will be given this opportunity. After ear measurement and dome and wire length selection, Oticon Opn S 1 miniRITE hearing aid fitting will occur wirelessly using Genie software, followed by hearing aid use instructions. The fitting will use Open domes, the standard NAL-NL2 protocol, and will increase gain seven steps on top of Real Ear Unaided Gain (REUG) from 750 Hz to 6 kHz.</p>

Outcome Measures

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Primary Outcome Measures :

1. Listening effort [Time Frame: Baseline, pre-intervention]

Listening effort will be measured by the percent of correctly recalled words in the SWIR test and the time-bound pattern in the pupil dilation traces during the SWIR test.

2. The Stroop Color and Word test [Time Frame: Baseline, pre-intervention]

Neuropsychological test extensively used to assess the ability to inhibit cognitive interference that occurs when the processing of a specific stimulus feature impedes the simultaneous processing of a second stimulus attribute, well-known as the Stroop Effect.

Measure: time (seconds) and number of mistakes.

Increased time corresponds to poorer performance. Increased mistakes correspond to poorer performance.

3. Rey Complex Figure Test [Time Frame: Baseline, pre-intervention]

Neuropsychological assessment, administered by trained neuropsychologist, where examinees are asked to reproduce a complicated line drawing, first by copying it freehand and then drawing it from recall. This tests both recognition and recall, and uses visuospatial abilities, memory, attention, planning, working memory and executive functions.

Measure: Accuracy scores between 0 and 2 on 18 figure elements (from 0 to a maximum of 36) on both copy and delayed recall

Higher score = improved performance

4. Symbol-Digit Modalities Test [Time Frame: Baseline, pre-intervention]

Neuropsychological assessment commonly used in clinical and research settings to assess neurological dysfunction. The participant has 90 seconds to pair specific numbers with given geometric figures. Like other substitution tasks, performance is underpinned by attention, perceptual speed, motor speed, and visual scanning.

Measure: Total score based on number of pairings made in 90 seconds (maximum of 110 pairings).

Higher score corresponds to improved performance.

5. Trail Making Test A and B [Time Frame: Baseline, pre-intervention]

Neuropsychological test of visual attention and task switching. It consists of two parts in which the subject is instructed to connect a set of 25 dots as quickly as possible while still maintaining accuracy. Test A has participants follow numbers sequentially, while Test B has participants follow alternating numbers and letters, sequentially. The test can provide information about visual search speed, scanning, speed of processing, mental flexibility, as well as executive functioning.

Measure: Test A - total time (seconds) required to connect 25 numbers, Test B - total time (seconds) required to connect 13 numbers and alphabet to letter H.

Increased time corresponds to poorer performance.

6. Verbal Fluency Test (category and lexical) [Time Frame: Baseline, pre-intervention]

Participants are given 1 minute to produce as many unique words as possible within a semantic category (category fluency) or starting with a given letter (letter fluency). Category fluency tasks rely on language representations of semantic concepts, whereas lexical and action word task rely more on the central executive component of working memory.

Measure: Number of unique words identified within 1 minute.

More words correspond to improved performance.

7. Logical Memory Test A [Time Frame: Baseline, pre-intervention]

The Logical Memory test (part A) is a subtest of the Wechsler Memory Scale-Revised, and is a standardised assessment of narrative episodic memory. A short story is orally presented and the examinee is asked to recall the story verbatim. 25-35 minutes later, free recall of the story is again elicited (delayed recall), and a series of 30 questions are asked about the story.

Measure: scores between 0 and 1 on specific pieces of the story (maximum score of 25) in both immediate and delayed recall. For the questions, a score of 0 or 1 is given to the corresponding 30 questions (maximum score of 30).

Higher score corresponds to improved performance.

Secondary Outcome Measures ⓘ :

1. Listening effort post-**hearing** aid use [Time Frame: Post-intervention, after 6 weeks of intervention (hearing aid use)]

Listening effort will be measured by the percent of correctly recalled words in the SWIR test and the time-bound pattern in the pupil dilation traces during the SWIR test.

2. Logical Memory Test A post-**hearing** aid use [Time Frame: Post-intervention, after 6 weeks of intervention (hearing aid use)]

The Logical Memory test (part A) is a subtest of the Wechsler Memory Scale-Revised, and is a standardised assessment of narrative episodic memory. A short story is orally presented and the examinee is asked to recall the story verbatim. 25-35 minutes later, free recall of the story is again elicited (delayed recall), and a series of 30 questions are asked about the story.

Measure: scores between 0 and 1 on specific pieces of the story (maximum score of 25) in both immediate and delayed recall. For the questions, a score of 0 or 1 is given to the corresponding 30 questions (maximum score of 30).

A higher score corresponds to improved performance

3. Verbal Fluency Test (category and lexical) post-**hearing** aid use [Time Frame: Post-intervention, after 6 weeks of intervention (hearing aid use)]

Participants are given 1 minute to produce as many unique words as possible within a semantic category (category fluency) or starting with a given letter (letter fluency). Category fluency tasks rely on language representations of semantic concepts, whereas lexical and action word task rely more on the central executive component of working memory.

Measure: Number of unique words identified within 1 minute.

More words corresponds to improved performance.

4. Trail Making Test A and B - post-**hearing** aid use [Time Frame: Post-intervention, after 6 weeks of intervention (hearing aid use)]

Neuropsychological test of visual attention and task switching. It consists of two parts in which the subject is instructed to connect a set of 25 dots as quickly as possible while still maintaining accuracy. Test A has participants follow numbers sequentially, while Test B has participants follow alternating numbers and letters, sequentially. The test can provide information about visual search speed, scanning, speed of processing, mental flexibility, as well as executive functioning.

Measure: Test A - total time (seconds) required to connect 25 numbers, Test B - total time (seconds) required to connect 13 numbers and alphabet to letter H.

Increased time corresponds to poorer performance.

5. Symbol-Digit Modalities Test [Time Frame: Post-intervention, after 6 weeks of intervention (hearing aid use)]

Neuropsychological assessment commonly used in clinical and research settings to assess neurological dysfunction. The participant has 90 seconds to pair specific numbers with given geometric figures. Like other substitution tasks, performance is underpinned by attention, perceptual speed, motor speed and visual scanning.

Measure: Total score based on number of pairings made in 90 seconds (maximum of 110 pairings).

Higher score corresponds to improved performance.

6. Rey Complex Figure Test [Time Frame: Post-intervention, after 6 weeks of intervention (hearing aid use)]

Neuropsychological assessment where participants are asked to reproduce a complicated line drawing, first by copying it freehand and then drawing it from recall. This tests both recognition and recall, and uses visuospatial abilities, memory, attention, planning, working memory and executive functions.

Measure: Accuracy scores between 0 and 2 on 18 figure elements (from 0 to a maximum of 36) on both copy and delayed recall.

Higher score corresponds to improved performance.

7. The Stroop Color and Word test [Time Frame: Post-intervention, after 6 weeks of intervention (hearing aid use)]

Neuropsychological test extensively used to assess the ability to inhibit cognitive interference that occurs when the processing of a specific stimulus feature impedes the simultaneous processing of a

second stimulus attribute, well-known as the Stroop Effect.

Measure: time (seconds) and number of mistakes.

Increased time corresponds to poorer performance. Increased mistakes correspond to poorer performance.

Eligibility Criteria

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Information from the National Library of Medicine



Choosing to participate in a study is an important personal decision. Talk with your doctor and family members or friends about deciding to join a study. To learn more about this study, you or your doctor may contact the study research staff using the contacts provided below. For general information, [Learn About Clinical Studies](#).

Ages Eligible for Study:

40 Years to 85 Years (Adult, Older Adult)

Sexes Eligible for Study:

All

Accepts Healthy Volunteers:

Yes

Criteria

MCI group

Inclusion Criteria:

- Is 40-85 years old;
- Has no other significant neurological or psychiatric disease;
- Has normal hearing (0 - 25 dB thresholds from 250 -6 kHz) measured using PTA;
- Has normal or corrected to normal vision;
- Has an MCI diagnosis, according to Winblad criteria, with a score on the Mini Mental State Examination (MMSE) less than or equal to 26 (MMSE \leq 26);
- Has a CDR = 0.5;
- Speaks Danish as native language

- (For part 2 of the study - hearing aid use) has a live-in informant.

Exclusion Criteria:

- Takes medication or treatment that could impact the pupillary dilation: eye drops (e.g. atropine or phenylephrine);
- Takes medication or treatment that could impact cognitive function;
- Abuses alcohol or drugs;
- Is unable to comply with study procedures.

Cognitively healthy group:

Inclusion criteria:

- Is 40-85 years old;
- Has a score above 26 on the Mini Mental State Examination (MMSE) (MMSE > 26);
- Has a CDR Global score = 0;
- Has no significant neurological or psychiatric disease;
- Has Normal hearing (0 - 25 dB thresholds from 250 - 6 kHz) measured using PTA;
- Has Normal or corrected to normal vision;
- Speaks Danish as a native language.

Exclusion criteria:

- Meets the criteria for MCI (Winblad criteria) or dementia (ICD 10);
- Takes medication or treatment that could impact the pupillary dilation: eye drops (e.g. atropine or phenylephrine);
- Takes medication or treatment that could impact cognitive function;
- Abuses alcohol or drugs;
- Is unable to comply with study procedures.

Contacts and Locations

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Information from the National Library of Medicine



To learn more about this study, you or your doctor may contact the study research staff using the contact information provided by the sponsor.

*Please refer to this study by its ClinicalTrials.gov identifier (NCT number): **NCT04593290***

Contacts

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Sponsors and Collaborators

Technical University of Denmark

Danish Dementia Research Centre

Investigators

Principal Investigator: Anja Maier, Ph.D. DTU - Technical University of Denmark

More Information

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Publications:

[Pichora-Fuller MK, Kramer SE, Eckert MA, Edwards B, Hornsby BW, Humes LE, Lemke U, Lunner T, Matthen M, Mackersie CL, Naylor G, Phillips NA, Richter M, Rudner M, Sommers MS, Tremblay KL, Wingfield A. Hearing Impairment and Cognitive Energy: The Framework for Understanding Effortful Listening \(FUEL\). Ear Hear. 2016 Jul-Aug;37 Suppl 1:5S-27S. doi: 10.1097/AUD.0000000000000312.](#)

[Zekveld AA, Kramer SE, Festen JM. Cognitive load during speech perception in noise: the influence of age, hearing loss, and cognition on the pupil response. Ear Hear. 2011 Jul-Aug;32\(4\):498-510. doi: 10.1097/AUD.0b013e31820512bb.](#)

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[Panza F, Solfrizzi V, Logroscino G. Age-related hearing impairment-a risk factor and frailty marker for dementia and AD. Nat Rev Neurol. 2015 Mar;11\(3\):166-75. doi: 10.1038/nrneurol.2015.12. Epub 2015 Feb 17. Review.](#)

[Livingston G, Huntley J, Sommerlad A, Ames D, Ballard C, Banerjee S, Brayne C, Burns A, Cohen-Mansfield J, Cooper C, Costafreda SG, Dias A, Fox N, Gitlin LN, Howard R, Kales HC, Kivimäki M, Larson EB, Ogunniyi A, Orgeta V, Ritchie K, Rockwood K, Sampson EL, Samus Q, Schneider LS, Selbæk G, Teri L, Mukadam N.](#)

[Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet. 2020 Aug 8;396\(10248\):413-446. doi: 10.1016/S0140-6736\(20\)30367-6. Epub 2020 Jul 30. Review.](#)

[Griffiths TD, Lad M, Kumar S, Holmes E, McMurray B, Maguire EA, Billig AJ, Sedley W. How Can Hearing Loss Cause Dementia? Neuron. 2020 Nov 11;108\(3\):401-412. doi: 10.1016/j.neuron.2020.08.003. Epub 2020 Aug 31. Review.](#)

Responsible Party:

Anja Maier, Professor, Deputy Head of Division, Group Leader, Technical University of Denmark

ClinicalTrials.gov Identifier:

[NCT04593290](#) [History of Changes](#)

Other Study ID Numbers:

19042404

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Last Update Posted:

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Last Verified:

October 2020

Individual Participant Data (IPD) Sharing Statement:

Plan to Share IPD:

No

Studies a U.S. FDA-regulated Drug Product:

No

Studies a U.S. FDA-regulated Device Product:

No

Additional relevant MeSH terms:

Hearing Loss

Hearing Disorders

Cognitive Dysfunction

Cognition Disorders

Neurocognitive Disorders

Mental Disorders

Ear Diseases

Otorhinolaryngologic Diseases

Sensation Disorders

Neurologic Manifestations

Nervous System Diseases