

UK Biobank

Hearing 'Speech-in-Noise' Test

Version 1.3

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This manual details the procedure for the Hearing 'Speech-in-Noise' Test at an Assessment Centre of the UK Biobank

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1 Introduction

1.1: This manual details the procedure for the Hearing ‘Speech-in-Noise’ Test at an Assessment Centre of the UK Biobank. This takes place at the 2nd ‘station’ of the Assessment Centre visit, as listed in Table 1.

Table 1: Sequence of assessment visit

	Visit station	Assessments undertaken
1	Reception	<ul style="list-style-type: none"> Welcome & registration Generating a USB key for Participants
2	Touch screen Section	<ul style="list-style-type: none"> Consent Touch screen questionnaire Hearing Test Cognitive function tests
3	Interview & blood pressure	<ul style="list-style-type: none"> Interviewer questionnaire Blood pressure measurement Measurement of arterial stiffness
4	Eye measurements	<ul style="list-style-type: none"> Visual acuity Refractometry Intraocular pressure Optical Coherence Tomography
5	Physical measurements	<ul style="list-style-type: none"> Height (Standing and Sitting) Hip & Waist measurement Weight and Bio-impedance measurement Hand-grip strength Ultrasound Bone Densitometry Spirometry (Lung function test)
6	Cardio-respiratory fitness test	<ul style="list-style-type: none"> Exercise/fitness ECG test
7	Sample collection & exit	<ul style="list-style-type: none"> Blood samples collected Urine sample collected Saliva sample collected
8	Web-based diet questionnaire	<ul style="list-style-type: none"> Dietary assessment

1.2: Throughout this document, the term 'Participant' signifies a study participant who is taking part in the Assessment Centre process, regardless of whether they eventually give or withhold consent to take part in the UK Biobank study.

1.3: The collection of data from assessment visits uses the direct data entry system of the Assessment Centre Environment (ACE).

1.4: At the start of their visit, each participant is issued with a USB key at the Reception station. This contains Participant ID, name, date of birth and gender. As the participant progresses between stations the USB key acts as an identifying token. The USB key is encrypted so can only be read by assessment centre computers. None of the participant's test data is transferred to the USB key. At the end of the assessment visit all identifying data on the USB key is removed

2 Staff

This procedure is performed by the Receptionist or any staff member who has received suitable training and has been granted the relevant module permissions. These staff can include: Study Interviewer, Duty Manager, Phlebotomist, Laboratory Technician or Measurement Technician. Two members of staff are always present to oversee the touch screen and web diet questionnaire areas. The Assessment Centre Manager oversees that all staff work in accordance with this procedure.

3 Hearing 'Speech-in-Noise' test procedure

3.1: When the participant has completed the touch-screen questionnaire, an on-screen message asks them to select 'Next' to begin the hearing and cognitive function tests. On the next screen a message asks the participant if they would like to try these tests. If they do, they can select the 'Next' button to start them. If they do not, a message is displayed to contact a member of staff. The Hearing 'Speech-in-Noise' Test has an 'Abandon' button, which is only used in the event of a participant having difficulty completing the test.

3.2: The speech-in-noise hearing test determines how well the participant can hear three spoken numbers played with a rushing noise in the background (also known as the digit triplet test). Each ear is tested separately; to minimise any learning effect the order of testing is evenly distributed between left side first (even numbered participant ID) and right side first (odd numbered participant ID).

3.3: Before proceeding, the participant selects from touch-screen options whether they are happy to do the test, whether they can hear on left only, right only or whether they are unable to do the test. If the participant indicates that they can only hear on one side, then only that side is tested.

We would now like to measure your hearing using the headphones provided.
Are you happy to do this?

(If you are wearing a hearing aid, please remove it before putting the headphones on. If you cannot find the headphones, or need assistance putting them on, then please ask a member of staff.)

1. Yes
2. I can only hear on the right side
3. I can only hear on the left side
4. No, I am unable to do this



Back Info Help Next

3.4: If the participant is wearing a hearing aid they are asked to remove it before putting the headphones on, and to ask a member of staff if they cannot find the headphones, or if they need assistance putting them on.

3.5: The headphones need to be orientated correctly (red tab over right ear). Background noise can be heard (owing to the open-plan design of the Assessment Centre), but is kept to a minimum by staff to reduce potential for distraction. Participants could also choose the volume at which the test was performed to take this into account.

3.6: A short video clip is played (section 8), then the participant selects the most comfortable volume from a scale of 1-5 (corresponding to 10, 20, 40, 70, or 100% of the maximum volume), by using the touch-screen to play a short recording in their ear. This is repeated when their second ear is tested, with the headphones remaining in the same orientation.

3.7: After listening to each sequence the participant enters the three numbers they have heard, using the number pad on the screen (any number sequence is allowed; e.g., a triple with the same digit: 999). If the participant cannot hear one or more numbers they are instructed to guess. The test takes 5 minutes to complete.

3.8: Once the participant has completed the hearing and/or cognitive function tests (or decides to skip this section) a message is displayed to contact a member of staff, who will then sign off this section of the visit. The participant remains at the touch-screen station and proceeds to the cognitive function tests, beginning with the Prospective memory (Shape) test.

4 Technical details about the hearing test

The digit triplets were generated at the Institute of Sound and Vibration Research, University of Southampton. The mixing with noise and compression for telephone use was carried out by the Royal National Institute for Deaf People (now Action on Hearing Loss), for their telephone test. The version used here is the same as the telephone test, with the exception that stereo files were used to allow left and right ear testing without any need for switching. Technical details about the hearing test are the subject of a MSc dissertation, entitled “The development of a new English sentence in noise test and an English number recognition test” by Stuart John Hall, University of Southampton (2006), which can be found in the ‘Related Documentation’ for the Hearing test.

5 Hearing test program

5.1: The three-number sequences (triplets) are generated according to these rules:

- All triplets are different
- No triplet is an ‘anagram’ of the previous triplet
- No triplet has the same digit in the same position as the previous triplet.

5.2: The sequence of the hearing test is as follows:

5.2.1: After the volume adjustment a message ‘Listen...’ is displayed

5.2.2: The sound triplet is played, the ‘Listen’ message removed and there is a pause of 0.1 seconds.

5.2.3: ‘Enter number’ is displayed, the keyboard is activated and the participant keys in 3 numbers, using ‘Clear’ to change any number not required, then touches the ‘Next’ button to indicate that they have completed entering their best guess at the number.

5.2.4: The keyboard is deactivated and there is a pause of 0.6 seconds before the next triplet or the end of the test.

Enter number

7 8 9

4 5 6

1 2 3

Clear 0 Next

Abandon

5.2.5: If the 'Abandon' button is pressed with the first ear tested, the participant is presented with an 'Are you sure?' message. If they select 'No', they are returned to the 'Enter number' step. If they select 'Yes', the second ear is then tested.

5.2.6: If the 'Abandon' button is pressed on the second ear tested, and the participant answers 'Yes' to the 'Are you sure?' message, the next message reads:

You have not yet finished. If you abandon now you will not be able to attempt it again. If the numbers are just unclear to you, please touch "No" then enter your best guess. If you are having some other difficulty with the test, please contact a member of staff for help. Are you still certain you wish to abandon the hearing check for this side?

6 Hearing test decision rules

6.1: Each sound sample consists of a triplet read out against a background of noise. The louder the noise, the more difficult it is to identify the triplet.

At the minimum noise level 1 unit, the ratio of the level of the triplet to the level of the noise (the signal-to-noise ratio) is +8 decibels (dB). An increase of 1 in the noise level corresponds to a reduction of -2 dB in the signal-to-noise ratio, up to a maximum level of 11 units, which corresponds to a signal-to-noise ratio of -12 dB. Thus the whole range spans 20 dB from +8 to -12 dB SNR.

Noise level (arbitrary units)	SNR (dB)
1	+8
2	+6
3	+4
4	+2
5	0
6	-2
7	-4
8	-6
9	-8
10	-10
11	-12

6.2: Fifteen sound samples (i.e. triplets) are presented in the test. The first five sound samples constitute the hunting phase (which aims to identify the best starting point for the assessment for each participant), where the SNR change is -4 dB (= 2 noise levels * -2 dB). During the early phase of recruitment, the first sound sample was presented at noise level 6 (-2 dB). This was then changed (from August 2009) to level 4 (+2 dB) to make it easier for participants with poor hearing to start the test.

6.3: If the participant correctly identifies the triplet, the next sound sample is presented at two noise levels higher, if still in the hunting phase and if all triplets have been correctly identified, otherwise at one noise level higher.

6.4: If the participant does not correctly identify the triplet, the next sound sample is presented at two noise levels lower, if they are still in the hunting phase and all triplets have not been correctly identified, otherwise at one noise level lower. Throughout the test, the noise level is capped so that if the noise level would be more than the maximum, then the maximum noise level is used (level 11, corresponding to -12 dB SNR), and if the level would be lower than the minimum, the minimum level is used (level 1, corresponding to +8 dB SNR).

6.5: Please note that while the first five rounds (i.e. sound samples) represent the 'hunting phase'; round eight is the first assessed round (i.e. the mean SNR is recorded as -99999 for rounds 1-7).

7 Data collection

7.1: For each triplet played, the following data are stored:

- The value of the triplet, e.g. '123'
- The signal-to-noise ratio of the triplet in each round
- The time that the user first entered a digit
- The time that the user last entered a digit
- The time that the user touched the next key
- Count of instances the Clear button is used
- The value of the number entered by the user
- Whether or not the user was correct

Times are measured from the instant the keyboard is activated. However, these data fields should not be used as an indicator of reaction time as participants were not explicitly instructed to complete the test as quickly as possible.

7.2: For each test the following data are stored, for each ear separately:

- Which ear(s) left/right is being tested
- The date and time the test started
- The volume level set by the user (5 levels: 10, 20, 40, 70, or 100% of maximum volume)
- The mean signal-to-noise for rounds 8 onwards (value of -99999 for rounds 1-7)
- Keystroke History
- Whether test was completed or abandoned

7.3: The Speech Reception Threshold (SRT) was also estimated (i.e. the final hearing test result in each ear), defined here as the signal-to-noise ratio at which half of the presented speech can be understood correctly. This was estimated as the value of the last round of the signal-to-noise ratio measurement for participants who completed all 15 rounds of the test.

8 Animated instructions

The following instructions are given as an animated demonstration:

Step	On-screen instruction
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- | | |
|---|---|
| 1 | The headphones should be fitted comfortably over your ears with the red connector over the RIGHT ear (as shown in the picture). |
| 2 | If you are wearing a hearing aid this should be removed for the test. |
| 3 | The test examines how well you can hear speech over background noise. |
| 4 | Adjust the volume up or down by pressing the numbered buttons on the screen. |
| 5 | You will hear static and a voice saying "The digits are..." followed by 3 digits. |
| 6 | Enter the digits you have heard. If you are unsure then guess. |
| 7 | There will be 15 sets of numbers for each ear. |
| 8 | Your progress will be shown by a bar at the bottom of the screen. |
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9 Progress bar indicator

A progress bar indicator is displayed along the lower part of the screen (beside the 'Abandon' button) with discrete separated blocks showing the number of triplets completed and to be completed.