

# **Inferior frontal gyrus activation predicts individual differences in perceptual learning of cochlear-implant simulations**

## **Supplementary methods: Working memory tests**

### **Nonword Memory Test**

The Nonword Memory Test (Gathercole and Baddeley, 1996) comprises 28 nonword items, each being an utterance of 2–5 syllables in duration that has no semantic referent but that is phonotactically legal in English (e.g. ‘doduloppity’, ‘strunfabe’). On each trial, the participant listened to the item over headphones and immediately repeated it aloud. The participant’s responses were marked online by the experimenter, and judged to be correct only for exact repetitions of the original items. However, consistent mispronunciations of certain phonemes, for example through lisping, were not treated as errors. No partial marks were awarded. Participants’ responses were recorded using a desktop microphone and saved for later score checking. Each item was scored as correct or incorrect and the score for each participant calculated as a total out of 28.

### **British Picture Vocabulary Scale (BPVS-II)**

In this test (BPVS-II) (Dunn et al., 1997), the participant’s task was to match the meaning of a word read by the experimenter to one of four pictures presented in a 2X2 array. The entire test comprises 168 English words (nouns, adjectives and verbs), which are divided into 14 Sets of increasing difficulty. As the test was designed to be administered to children as young as 3 years old, many of the initial items are relatively simple for the adult participant. For this reason, participants in the current study began the test with Set 9 (the start point recommended for Ages 16–21). If 1 or 0 errors were made on Set 9, the participant progressed to Set 10. The test was terminated at the end of the first set in which the participant made 8 or more errors — if this termination criterion was not met, administration continued until the last item of Set 14. In the

exceptional case that the participant made more than 1 error in Set 9, Set 8 was administered next. If an error score of more than 1 was obtained on Set 8, the experimenter would move back to Set 7. This would continue until a set with 1 or 0 errors was found; after running this Set, the test would resume at Set 10 and progress as normal. The total score was calculated as the item number of the last item administered, minus the total errors made.

## **Span Tasks**

### **Materials**

We tested the participant's capacity for lists of digits (forwards and backwards), rhyming letters, non-rhyming letters, words, nonwords and sentences. All forward tasks had 8 possible levels, one for each list length from 2--9 items. The Backward Digit Span had only 7 levels, from 2--8 items in length. The Digit Span tasks were taken from the Wechsler Adult Intelligence Scale (WAIS-III UK; Wechsler, 1997). The rhyming letters used were B, C, D, E, G, P, T, V. The non-rhyming letters were G, K, M, O, Q, R, Y, Z. The Words lists were constructed from English monosyllable nouns, adjectives and verbs with consonant-vowel-consonant (CVC) structure (e.g. king, reach, white, mouth). The lists were matched for mean frequency (Brown verbal frequency and Kucera-Francis written frequency), concreteness, familiarity and imageability. All values were obtained from the MRC Psycholinguistic Database (Wilson, 1988). Nonword items were constructed from the Word Span lists using a general approach of swapping word onsets and offsets to obtain phonotactically legal, non-lexical items of CVC structure (e.g., 'shill', 'woot', 'chate', 'dap').

Our Sentence Span test used items from the The Speed of Comprehension Task from the Speed and Capacity of Language Processing Test (SCOLP) (Baddeley et al., 1992). The items in this test have been referred to as 'The Silly Sentences', as they feature a mixture of statements whose meanings are acceptable (e.g., 'Squirrels live in trees', 'Butterflies have wings') and those whose meanings are factually incorrect or surreal

(e.g., 'Tigers have fins', 'Mothers are made in factories').

### **Procedure**

All of the tasks followed the same basic routine. The participant was instructed to give immediate verbal report of a list of items, which were presented over headphones. Each level featured two trials, of which the participant must report at least one correctly to proceed to the next level. A correct response must feature the correct items in the same order as presented by the experimenter (but in the reverse order for the Backward Digit Span). The first level contained 2-item lists and the list length increased by one item with for each subsequent level. Administration of the task was terminated if the participant scored 0 on both trials within the same level, or if all available trials had been administered.

For the digits, letters, words and nonwords, the participant had to report each item in its entirety. However, this was thought to be too taxing for the Sentence Span task. Therefore, in this task, the listener was asked only to repeat the final word from each sentence in a trial, in the order in which the sentences were presented. To ensure that the participant was attending to and processing the whole sentence, he/she was asked to make a semantic judgement, by button press, on each item as it was presented to indicate whether its meaning could be said to be true in the real world.

### **Scoring**

For each task, the participant's span was calculated as the list length of the last correctly-reported trial.

### **Composite score**

For the regression analysis of working memory capacity on the potential intelligibility effect in the functional data, we calculated a Working Memory Composite Score for each participant. We converted the raw scores in the Nonword Memory Test and each of the Span Tasks into z-scores for each participant, which were then averaged across all the tasks to obtain a composite z-score for use in the analysis.

## **References**

Baddeley AD, Emslie H, Nimmo-Smith I (1992) The Speed and Capacity of Language Processing (SCOLP) Test.

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