Information on the Consonant Confusion Task (CCT) and Auditory Performance Task 1 (APT 1)

These are two monosyllable, closed-set speech tests. They are supplied as books of the stimulus pictures and a response sheet for photocopying. The test material is pre-recorded onto a CD with a calibration tone and six different orderings of the test words. Speech-shaped noise is recorded onto the second channel for testing in noise. It is envisaged that the typical set-up for carrying out the tests would be from a CD player to a two-channelled audiometer, with output through free-field speakers. The child's responses are recorded on the confusion matrix by the tester. Full directions are given in the response book.

Why do we need to do speech testing?
There is a need for new UK English speech test material for use in evaluating speech discrimination ability in children with hearing aids. Hearing aid fittings with signal processing and compression algorithms cannot be adequately verified by aided thresholds. A very common result arising from verifying hearing aids fittings with aided thresholds, is over-amplification of low frequency information, causing vowel sounds to mask out perception of quieter, high frequency consonant cues. Speech testing verifies the access a child has to acoustic cues in complex speech information, which cannot be represented by detection of simple signals.

The results from speech testing are important for those involved in the auditory habilitation, as well as for audiological considerations, although the information may be used for different purposes. For example the audiologist may be pleased to note that the child is detecting /s/ through the hearing aids. However speech results may show that the child is detecting /s/ but not discriminating between /s/ and /sh/, therefore listening games are needed to help the child discriminate between these contrasts, by the hearing support teacher.

What features are relevant to speech test material?
As children are passing through the stages of language development, and have different levels of hearing loss, speech materials need to be flexible in use. Ideally, speech test materials should be applicable from about three years of age up to teenage. The test material should have good reliability in different test situations and have face-validity to represent the features of speech information that a child could potentially perceive in everyday listening situations. The material should be sensitive to changes in perception that may be given by different types of signal processing within the hearing aid.

Not all of these factors will be covered by a single speech test. It is likely that a battery of speech tests may be necessary to define speech access and recognition for any one child. Two tests have been developed at the Department of Auditory Perception at Cambridge University in collaboration with *Chear,* an independent children's hearing assessment centre. These speech tests were initially developed for research studies on signal processing hearing aids with children. Two research studies used these tests

for outcome measures for different amplification algorithms in children (refs 1,2). The tests have been found to be useful in clinical paediatric audiology departments both in the MCHAS programme and at *Chear*. Many paediatric audiology departments already use the closed-set McCormick Toy Test (MTT) and Manchester Picture Tests (MPT) and the open set Manchester Junior Wordlists (MJW). These two new tests have a broader range of application and give supplementary information to the traditional speech tests used in the UK.

What information do these tests add?
The two closed-set tests are the Consonant Confusion Task (CCT), and the Auditory Performance Task (APT 1). Both are based on a four alternative choice format with four pictures of items with similar sounding words. Closed set testing can be applied across a range of ages and hearing losses. This format allows teaching of less familiar items, and can be presented repeatedly without losing validity, in the same way that the McCormick toy test can. Children do not usually become demoralised by incorrect performance as the pointing task encourages attempted word-recognition.

Familiarity of the Words
The CCT has words from the Reid Picture test chosen to be familiar to younger children, which is a critical factor in ease of discrimination. Nonsense or non-words (for example "*pish*") are much more difficult to discriminate than words which are familiar and in the recall vocabulary of children. Young children are likely to be familiar with "fish", but not perhaps "shish" (as in kebab). That makes discrimination of "fish" easier than "shish" or "pish" over and above the acoustic features of the different speech sounds (phonemes). The CCT is likely to be more appropriate to children at a younger age (maybe from 3 years) than the APT 1 (from about 5 years). It is acceptable however to teach the child an individual item that he/she is not familiar with such as "fan" or "pipe".

Why does the CCT give different information to the McCormick Toy Test?
The pairs of items of the McCormick Toy Test (for example cup/duck or shoe/spoon) have the same vowel sound. The vowel tends to be the most salient acoustic information in a word. This means that as long as the child can hear and identify the vowel they have a 50% chance of identifying the item correctly. In the CCT all four items have the same vowel and the child has to use consonant information to identify the right picture.

What other differences are there between the CCT and the APT 1?
The acoustic contrasts in the CCT are easier than the APT 1. On the first page of the CCT the words are: *owl, house, cow* and *mouse*. The initial speech sounds are /au/, /h/, /k/ and /m/. (Phonemes, as opposed to letters, are written between slashes.) These sounds differ from each other by many different acoustic features, the voicing (whether the larynx is vibrating), the place (where in the mouth the sound is made) and the manner of articulation (the way the sound is produced). A child can use any of these cues to discriminate the target word from the others. There are contrasting features in

both the initial and final positions of the word so if the child cannot access the acoustic information at the beginning of the word, he/she may do so from the sounds at the end of the word.

In the APT 1 the number of contrastive features between a set of four words is fewer and the type of contrasts are closer, making them more difficult to discriminate. For example in *boat, coat, goat, note* only the initial consonant is contrastive. The difference between two words may be only one feature, for example between *coat* and *goat,* it is only the voicing of the first consonant. The place and manner of articulation are the same. The difference between /n/ and /g/ is in the place and manner, and between /b/ and /g/ is place alone. The smaller the number of contrastive features between two words, the more difficult the discrimination is likely to be.

In the APT 1 there are two sets of vowel contrast sets with eight consonant confusion sets. In the CCT all the discriminations rely on consonant contrasts.

How are the results interpreted?
The results can be interpreted in several ways.

The total number of correct responses from two test runs may demonstrate better overall access to contrastive speech information for the higher scoring condition. However all other aspects of the test conditions must have been carried out in exactly the same way.

It is helpful to keep the confusion results to examine the errors that were made, information can be gained on the acoustic cues that are not being fully perceived or utilised. Qualitative information can be derived by looking at the confusions that were made by the child, as recorded on the confusion matrix. For example, if a child is not able to discriminate between *house* and *mouse,* one might consider whether the low frequency amplification was sufficient to allow perception of the acoustic cues for nasality.

Informal observation by the tester, on how difficult it is for the child to make the discrimination, is useful. Sometimes a child will be able to point quickly to each item, without applying much auditory concentration, whereas in other conditions they may make correct identifications, but it takes them longer and with clearly more cognitive effort.

What levels should the words be presented at?
The level of presentation is very important to avoid floor (child is performing at chance level of 25% correct) or ceiling (child is scoring over 95% correct). The performance-intensity function is steep for closed set tasks, so it may be helpful to do trial presentations at different levels to find an appropriate level for an individual child, which is neither too easy nor too difficult.

In assessing hearing aid characteristics it may be desirable to present the test at different levels to look at potential performance for example at a conversational speech level (65 dB), as well as at quiet (50 dB) and loud (80 dB) listening conditions.

Should words be presented live voice or from the CD?
Younger children may be able to perform the test with live voice presentation but not be able to maintain consistent attention with pre-recorded stimuli. However if any comparison is being made between two amplification conditions, the pre-recorded stimuli must be used for consistency. Discrimination of live voice speech is easier than pre-recorded words even when all visual and other cues are removed.

Should testing be in quiet or in noise?
Speech-shaped noise with the same spectral characteristics as the speech material is recorded onto the second channel for testing in noise. Presentation is usually through a two-channel audiometer so that the levels for the speech and noise can be adjusted independently. Consideration should be given to an appropriate signal to noise ratio for an individual child, with trial presentations as required.

Does closed set testing replace open set testing?
Closed set testing identifies the speech contrasts that a child can discriminate in optimum listening conditions. Open-set testing, where the child repeats the word that they hear (Manchester Junior Words, Cambridge Junior Words), is more representative of real world listening performance. When a child is old enough, and has sufficient residual hearing ability to perform open-set tests, these should be used to supplement the closed-set test results.

In addition, single word material can be supplemented by phrase or sentence tests (BKB sentences, ASL sentences). In all open-set testing the child should not have repeated testing with the same material, to prevent them becoming familiar with the words and thereby maintain the validity of the results.

If you would like information how to order either the CCT or APT 1 tests, please email josephine@chears.co.uk or phone 01763 263333, or leave a message on 01763 243546

Refs:

1. Marriage JE, Moore BCJ (2003) New speech tests reveal benefit of wide-dynamic-range, fast-acting compression for consonant discrimination in children with moderate-to-profound hearing loss. International Journal of Audiology 42: 418-425.
2. Marriage JE, Moore BCJ, Stone MA, Baer T (2004) Effects of three amplification strategies on speech discrimination performance in children with severe and profound hearing loss. (Under submission).