Progress in Understanding 'Tone Deafness'

Karen Wise, **Professor John Sloboda FBA**, *and* **Professor Isabelle Peretz** *describe recent research into the condition of tone deafness, or 'congenital amusia', and consider the phenomenon of those who are not apparently tone deaf but who classify themselves as such.*

Human beings are intrinsically musical. Music exists in every society; it is used to entertain, to persuade and to unite, for rituals and to mark important occasions; it can evoke profound feelings or simply make a workaday task pass more pleasantly.

We do not need any special training to relate to music in these ways. We are born with the perceptual capacities necessary to respond to musical sounds and over the first few years of life we come to know how the music of our culture works through our everyday encounters with it. That is, we learn to make sense of it by internalising its rules and structures, in a similar way to learning our native language. This implicit knowledge makes us sense, for example, the 'wrongness' of an out-of-key note. Most of us also have a large memory store of music, such that we can easily recognise a familiar tune. We often also recall information about it (its title, composer or artist) and the associations it has for us ('darling, they're playing our tune').

These abilities to understand and remember music are taken for granted by most of us, but there are a few people for whom these experiences are elusive. A music perception disorder occurring in otherwise healthy and normal adults was recently identified by Isabelle Peretz and colleagues in Montreal. They have named it 'congenital amusia'. Those affected have severe difficulties in basic musical tasks such as recognising familiar tunes, spotting wrong notes or changes to a tune, tapping with the beat and singing. By contrast they have no difficulties recognising other sounds and voices, or understanding speech prosody. Research is still in the relatively early stages, but here it seems is a group of people with a music-specific learning disability – the genuinely 'tone deaf'.

But that is not the whole story. The current estimate for the incidence of congenital amusia in the population – though this has yet to be verified by any large-scale studies – is 4%. But according to recent research, around 17% of Western adults consider themselves to be tone deaf. Most are not congenitally amusic by current criteria, so what is their story? Two obvious possibilities immediately present themselves. One is that the self-defined tone deaf have difficulties that are not assessed by the current measures. Another is that for some reason they believe they have difficulties when in fact they do not. Testing the former possibility requires identifying areas of omission and devising new measures. Testing the latter possibility also requires that any assessments used are indeed comprehensive. We have therefore devised new subtests for the standard assessment measure for congenital amusia, the Montreal Battery of Evaluation of Amusia (MBEA). In order to explain our strategy it is important first of all to give some theoretical context.

Musical ability is multidimensional

The term amusia is used almost exclusively in the neurological literature to refer to specific loss of musical abilities following brain injury, in analogy to the term aphasia for loss of linguistic functions. Like linguistic functions, musical functions can broadly be categorised into perception, production, memory and reading/writing. Clinical evidence, largely from case studies of brain injured patients, points to the existence of separable neural networks, or modules, specialised for specific aspects of musical and linguistic processes. A patient can lose musical functions while language functions remain intact, and vice versa. Furthermore, different aspects of musical (and linguistic) function can be separately disrupted. For example, different networks seem to process time information (rhythm and metre) and pitch information. Congenital amusia is conceptualised within models of music processing derived from these clinical studies, but occurs in the absence of known brain injury.

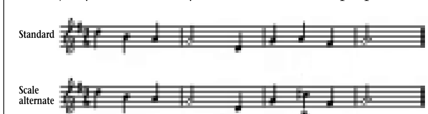
The Montreal Battery of Evaluation of Amusia

The MBEA was originally designed for use with brain injured patients to assess the main aspects of music perception. Normed for use with congenitally amusic persons, it contains 6 subtests assessing aspects of melodic processing, temporal processing and memory.

Melodic processing:	Scale Interval Contour
Temporal processing:	Rhythm Metre
Memory:	Incidental memory

Figure 1. *Construction of the MBEA*

Below are examples of a standard melody in the battery, and an altered version of it for the Scale test. The altered note (marked by an asterisk) is an out-of-key note and very noticeable to most people.



For the Interval test, a note of the melody is altered to another in the same key, while preserving the direction of the melody's movement. In the Contour test the altered note changes the contour – a note that goes higher relative to the previous one is changed to go down, or vice versa. In the Rhythm test a note is displaced in time. This changes its temporal relationship to the notes either side, and our perception of note groupings. In each of these four tests, altered notes can be anywhere in the melody except the first or last note.

Sound examples can be found at http://www.brams.umontreal.ca/plab/research/Stimuli/mbea_variety/mbea_variety_stimuli.html

The stimuli in the battery are derived from thirty specially-composed melodies. In the first four tests listed, participants hear a melody played twice, the second time either with or without an alteration (see figure 1). The task is to identify whether the two renditions are the same or different. In the metre test participants hear a longer harmonised version of each tune and are asked to identify whether it is a 'waltz' or a 'march'. In the memory test participants are asked to identify tunes previously heard in the battery from among unheard foils. All the tests are preceded by practice attempts on which the participants receive feedback to make sure they understand what is required. The general population perform very well on these tests, scoring on average around 86% correct over the whole battery. People with congenital amusia perform very poorly by comparison, often around chance level. The criterion for determining congenital amusia is a score of two standard deviations below the score of the general population.

We identified two elements of music reception not covered that are essential for a complete assessment. All the above tests except the metre test use single-line melodies, of a sort rarely heard in recorded music, where there is normally the added richness and complexity of harmony. Secondly, a primary reason for music listening is its emotional content. We therefore devised two new tests: Harmony and Emotion.

The Harmony Test

To respond to harmony we draw on our internalised mental representations (known in psychology as schemata) of the rules of music. When we hear a musical sequence we generate expectations, based on our prior knowledge, of what is likely to come next. We respond to the violation or fulfilment of those expectations; too much predictability and we might perceive the music as boring, too much violation of the rules and the music may become difficult to relate to. This latter scenario happens for many people when listening to *avant garde* music that dispenses with conventional Western tonal rules altogether.

It is thought that congenital amusia arises from a neurological deficit that makes it difficult to perceive small changes in pitch. People with congenital amusia often cannot detect pitch changes of the same size as the smallest pitch change in music – a semitone. Inability to perceive this basic building block of music would logically result in disruption of the development of schemata for pitch-based musical rules. We therefore expected that congenital amusics would be impaired in processing harmony as they are on the other pitch-based tests.

To test this we took the melodies of the MBEA and gave them a simple chordal accompaniment. Three harmonisations of each tune were produced by changing just the last two chords (the cadence). 'A' versions used a highly conventional ending, finishing on the key chord, with either a dominant or subdominant chord preceding it. These types of ending are the most common in western music, and give the subjective impression of sounding 'finished'. The final two chords in 'B' versions were from the right key, but were not the usual expected chords for an ending, thus sounding mildly unexpected and 'unfinished'. Finally, 'C' versions used chords from outside the key, that is, made up of 'wrong' notes. These versions severely violate expectations and are therefore subjectively jarring. We checked that the A, B and C harmonisations were indeed perceived as conventional, mildly unconventional and highly unconventional respectively by playing them to naïve listeners. It should be noted that these effects are due entirely to the musical context, as each chord was a conventional major or minor chord and would thus be harmonious if played in isolation.

Figure 2. *A conventionally harmonised ('A' version) tune and below it its highly unconventional alternative ('C' version)*

Changes only affect the last 2 chords.

Sound examples can be found at http://www.brams.umontreal.ca/plab/research/Stimuli/mbea_variety/mbea_variety_stimuli.html

In testing, pairs of stimuli were presented for a 'same-different' judgement to be consistent with the other subtests. Same pairs were always A–A (the conventional version repeated), while different pairs were either A–B or A–C.

We found that as predicted, amusics scored very poorly compared to controls. In addition, controls were sensitive to the degree of strangeness, with more correct responses to the A–C pairs than the A–B pairs, while the amusics were equally poor at both.

The Emotion Test

The question of whether people with congenital amusia respond emotionally to music in a similar way to the general population is thorny. Many report having no interest in music, and some even dislike and actively avoid it. Given amusics' problems with pitch-based tasks, including harmony perception, we needed to find a way of testing their emotion perception without this being reliant on pitch and harmony cues. The logic behind our test is this: performers can reliably convey basic emotions such as happiness, sadness, anger, fear and tenderness, in different performances of the same tune. They do this by varying parameters such as speed, volume, timbre, attack and articulation. These cues are similar to those that convey emotions in the human voice. Since amusics have no problems understanding speech prosody, we expected that they would be able to use these cues to distinguish differences in emotional intention between different performances of the same melody.

We asked a professional violinist to record each of the 30 melodies in 5 ways: sad, very sad, neutral, happy and very happy. We then asked naïve listeners to judge the emotion of the performances, in order to filter out any melodies whose inherent characteristics prevented them being perceived with different emotions (e.g. a sad tune that cannot be made to sound happy). Performances with the clearest emotional tone were paired up for a same-different task as before. Neutral versions were dropped because the lack of emotion was difficult for the violinist to portray and for listeners to identify. Same pairs were therefore made up of two performances of the same melody with the same emotional tone, but never the same performance twice – for example, happy-very happy. Different pairs were one sad and one happy performance.

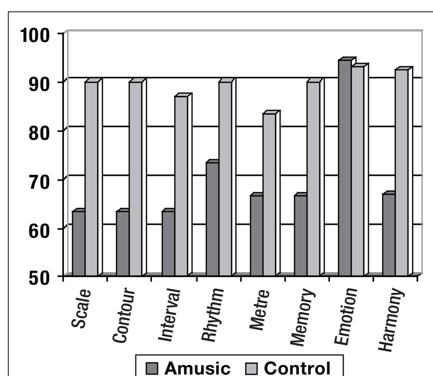


Figure 3. *Graph showing the performance of amusics and controls on the six original tests of the MBEA and the new Emotion and Harmony tests*

Results showed that in contrast to the other MBEA tests, the amusics performed as well as the controls. Figure 3 illustrates this in a graph of performance across all MBEA tests, old and new. There is therefore at least one aspect of musical understanding in which congenital amusics are unimpaired, where this understanding does not depend on pitch. There is a possibility that they were making the judgement based on a musically irrelevant cue such as length of the stimuli – the sad performances were markedly slower than the happy performances. A version of the test is currently being prepared with equal lengths of stimuli to rule out this possibility. Perhaps more importantly, we did not ask the participants to actually identify the emotions conveyed, and cannot tell much from this test about the emotions they themselves experience when listening to music.

Self-defined tone deafness

As mentioned at the beginning, a significant proportion of adults believe themselves to be tone deaf. The majority of them are not congenitally amusic based on the MBEA in its original form. When we tested a group of self-defined tone deaf (TD) participants with the two new tests, we found that like the amusics they performed as well as controls in the Emotion test. In the Harmony test, they performed much better than amusics and slightly, but significantly worse than controls in statistical terms. This pattern is the same in the original MBEA tests, however, it must be emphasised that the difference between the TD and controls is slight – around 83% correct as opposed to 86% – and their performance is very dissimilar to that of the amusics. At present the reason for the small difference between the TD and controls is not clear; there are similar numbers of low-scoring participants in both the TD and control groups who might be amusic.

In order to gain more insight into self-defined tone deafness, it made sense to us to ask people, both TD and not, about what tone deafness meant to them. From interviews we learned that to most people, tone deafness means a perceived inability to sing. Those who applied the label to themselves often reported negative experiences and embarrassment so acute they had excluded themselves from any further participation. One respondent said, ‘Mother would have loved me to have joined the church choir so I went … and I was told “you can’t sing” and I’ve never sung since. I’ve mimed all the way through my life really.’

At the beginning of the project one of our original intentions was to develop the extended MBEA into a version that could be made available to members of the public to self-administer. The aim would be to reassure a normal but musically unconfident population that they are not musically deficient, and provide encouragement to people who have (sometimes with great regret) given up on any hope of musical achievement and participation. However, the MBEA cannot reassure people that they can sing. In a parallel project at Keele University we have therefore been developing a broader battery of assessments to include production tasks (speech and singing) as well as exploring people’s views of their musical abilities, with the aim of determining more precisely the nature and causes of self-defined tone deafness.

Bibliography and Further Reading

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