ARTICLE

Lost in music

Lauren Stewart on amusia, and the window it provides on musical development

Listening to music is effortless and highly rewarding for most of us. But people with congenital amusia have life-long difficulties in this regard – they don't recognise tunes that would be familiar to the rest of us and they can't tell one song from another. This article explores why music is so impenetrable to these people and explains how such individuals offer a unique window on to the typical development of the musical brain.

questions

How might congenital amusia affect the understanding of speech in tonal language cultures?

resources

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Learning that cognitive faculties can go awry, or even fail to develop, gives us special insight into abilities we often take for granted. The capacity to make sense of musical sound is one such example. In Western culture, someone would not count themselves as 'musical' unless they could boast prowess on a musical instrument. But the real prowess, without which musical performance could not develop, is the ability to make sense of musical sound. Music is not 'out there' in the world but must be constructed by our brains. Neural assemblies process pitch, timing and texture, keep track of interwoven melodic lines, and interpret incoming information in the context of the musical rules of our culture.

For most of us, this feat of sophisticated processing is not only effortless but highly rewarding. In contrast to this, a small minority of individuals are denied access to a musical world. Those with a disorder termed congenital amusia have normal hearing and are intellectually unimpaired but lack the implicit knowledge that allows the rest of us to spot 'wrong' notes, recognise familiar tunes from our culture or to tell one tune from another. Such individuals may find music impenetrable and confusing and go to great lengths to avoid it.

Interestingly, there is little overlap between these individuals and those who view themselves as 'tone-deaf' (Cuddy et al., 2005; Wise & Sloboda, 2008). While self-professed 'tone-deaf' individuals have problems that are restricted to musical production (not perception), those with amusia have a primary perceptual deficit that extends to singing because they cannot use auditory feedback as a guide for musical production.

Those with congenital amusia provide a window on musical development because, by characterising the ways in which musical perception can be compromised, we can start to build a picture of how the normal brain makes sense of musical sound. The study of disordered musical development forms part of a broader research endeavour that draws on experimental psychology, neuropsychology and neuroimaging in order to understand the cognitive neuroscience of music.

A hitch with pitch

Until recently, a problem in making sense of music was regarded as nothing more than an anecdotal curiosity. Some notable figures remarked upon their musical difficulties, including economist Milton Friedman, the revolutionary Che Guevara and former US president Ulysses S. Grant ('I know of only two tunes: one of them is Yankee Doodle Dandy and the other isn't').

The Montreal Battery for the Evaluation of Amusia (MBEA), developed by Isabelle Peretz at the University of Montreal, provides a way to empirically assess musical perception. Listeners discriminate pairs of musical phrases that are either identical or slightly different. In one subtest, the difference involves a note from the original phrase being replaced with a note from a different key; another involves a rearrangement of the timing of the original phrase. Individuals are classified as amusic when their scores fall outside the normal limits of performance – ascertained by testing several hundred individuals to determine a distribution of scores (Peretz et al., 2003).

Identifying individuals who are amusic according to the MBEA is just the first step. A major goal of the research is to understand what the core underlying deficit(s) could be in this musical disorder.

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So far, the problem appears to be one of pitch processing: those with amusia have particular difficulty in determining the direction of a pitch change. As a group, those with congenital amusia require pitch changes to exceed one semitone before the direction of pitch change can be successfully resolved (Foxton et al., 2004). One semitone is a common step size in Western music, meaning that those with congenital amusia are able to register pitch changes but are effectively deaf to the pattern of ups and downs ('contour') that makes a melody distinctive.

A problem that may result from this pitch discrimination problem, or exist in parallel with it, involves the capacity to hold on to music in memory. One amusic individual we have worked with complained of her inability to hold music in her head. This is a particular problem given that she is required to sing plainchant five times a day:

> When the music finishes the sound is gone – as though it has never happened. And this bewilders me with a sense of failure, to hold on to what I just heard. Others tell me if I try to remember I will, but I never do. I have no idea what people mean when they say, 'I have a tune going round in my head'. I have never had a tune tell out its music in my head, let alone repeat itself!

The perception of music depends upon the integration of events as they unfold in time. It seems that, for this amusic woman, music does not unfold in a continuous stream but is heard as a series of disconnected auditory 'snapshots'. It is interesting that she contrasts her lack of music with the often-reported phenomenon that music 'sticks' in the head. While the 'tune in the head' phenomenon has so far defied explanation, it is tempting to suggest that a lack of music in the head and exuberant musical imagery may reflect opposite ends of the same continuum.

When the feeling's gone

Nabokov, writing in his autobiography, *Speak, Memory* (1966), complains:

> Music, I regret to say, affects me merely as an arbitrary succession of more or less irritating sounds. Under certain emotional circumstances I can stand the spasms of a rich violin, but the concert piano and all wind instruments bore me in small doses and flay me in larger ones. (pp.35–36)

Although we cannot know whether Nabokov was a true amusic, in the sense of having impaired musical perception, his negative comments echo those made by some of the amusic individuals we have tested. When we played one participant an extract from Rachmaninov's Second Piano Concerto – the theme tune to *Brief Encounter* – she described it as 'banging that would be best avoided'. But it would be a mistake to assume that musical perceptual deficits necessarily preclude musical appreciation. Just as some cochlear implant users may learn to enjoy music despite the evidently impoverished signal they receive, it appears that some amusics are also able to experience music as fulfilling. A study we recently conducted (McDonald & Stewart, 2008) showed that, while those with amusia tended to use music in fewer everyday situations and identified less with commonly ascribed psychological effects of music, one third of the amusic participants reported normal levels of musical appreciation that were indistinguishable from a matched control group. The perceptual performance of these individuals was no better than the performance of the amusics who reported low levels of musical engagement, showing that there is no simple relationship between musical perception and appreciation.

What, then, can explain why some individuals are able to engage with music in a fulfilling way while others avoid it at all costs? One possibility is that even though these subgroups are apparently similar in their perceptual abilities, they could differ on a perceptual dimension that is not captured by the MBEA. The processing of timbre – the quality of a musical sound – may be compromised in some, but not other, amusics, which may explain the variability in the musical experience. Some indications for timbral, as well as pitch-based deficits come from the comments of several amusics, who report that music sounds like 'banging' or 'noise'.

Family affair

There is good evidence that amusia is a developmental disorder that is under genetic control. A recent study showed that 39 per cent of first degree relatives of those with amusia were similarly affected, compared with only 3 per cent of relatives

Family case study

A family-run music shop seems an unlikely place to study disordered musical perception. But John O'Neill's shop in Gortin, County Tyrone is where much of our recent research has taken place. His daughter, Anne, read an article I had written about congenital amusia and persuaded three generations of her family to take an online version of the Montreal Battery for the Evaluation of Amusia. Remarkably, half of them scored in the amusic range.

Even though Anne's father, John, struggles to make music himself, he always had musical aspirations for his children. More than 40 years ago, he bought his first son, Sean, a single-row melodian for Christmas and arranged for a local musician to show him the ropes. Before long, friends and neighbours caught on to the idea and sent their own children along to learn. But the interest exceeded the availability of instruments and, to keep the aspiring musicians supplied with fiddles, flutes and accordions, John started sourcing them from all over the world, resulting in the family business he runs today.

While music has become an enormous part of Sean's life, Anne, and several of her siblings, have struggled, despite years of accordion and Irish dancing lessons. 'I desperately wanted to be in a church choir and to be good at singing', she says. 'But every time I turned up the choirmaster said – "Okay, Anne, we have enough children now". I was terribly upset. I knew that however hard I tried, I would never be able to sing like the others. The teacher used to say, "Anne, why don't you play the tambourine?".' But because Anne's problem also extended to rhythm, she couldn't keep in time.

Anne's musical difficulties were readily apparent to her, owing to the musically enriched environment in which she grew up. But because the emphasis was always one of involvement rather than achievement, Anne was always able derive pleasure from being around music. 'Music brings great joy to us – it's an expression of our culture,' she says. 'My parents celebrated their golden wedding anniversary recently with a special mass. The grandchildren brought a flute to the altar as a symbol of how much music means to our family.'

of a non-amusic control group (Peretz et al., 2007).

Of course, it can be argued that amusic parents may raise their children in the absence of music, which would also result in inheritance of a musical perceptual disorder. But there are several arguments against such a view. First, infants have been shown to display a high level of musical sensitivity that amusic adults lack, suggesting that the amount of exposure required to develop musically is minimal. Second, if an absence of musical input were a factor, this cannot explain why some siblings within a generation may develop normally. The family case study described in the box on the previous page shows that congenital amusia can be present even in the context of a musically enriched environment, with many years of formal and informal musical training. Importantly, in this family, individuals with amusia coexist with siblings who display heightened levels of musical ability and engagement.

Investigation into pedigrees of amusia set the stage for elucidating candidate genes that may underlie amusia. Brain imaging studies (Hyde et al., 2007; Mandell et al., 2007) have found subtle differences in frontal and temporal cortical structure, and researchers have hypothesised that these findings reflect an under-connectivity between these two brain areas. Any candidate genes may be responsible for neuronal migration between these two areas in early development.

Conclusion

The study of disordered musical development sets in sharp relief the perceptual abilities that most of us take for granted. By investigating why musical perception fails to develop, we can start to build up a model of the components of normal musical perception. But the study of amusia also has broader significance: researchers are, for instance, using the disorder to ask whether pitch processing in music and language rely on shared or distinct neural resources and whether the pattern processing involved in musical perception bears any relation to other kinds of higher-order relational processing, both within, and outside the auditory domain.

For those with amusia, the recent focus of attention on the disorder is welcome: the likely biological origins of the disorder provide an account of the difficulties they were previously unable to explain. As researchers learn more about what amusic individuals can and can't perceive, there is always the possibility that this knowledge will help them gain access to a musical world. Just as deaf people learn to enjoy music by listening to its vibrations, those with amusia may be able to gain insight into their residual listening abilities. Many amusics can hear rhythm, and some can also dance: if the 'banging' of Rachmaninov doesn't make it onto their iPod, perhaps drum and bass could set their feet tapping.

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