The Puzzle of Absolute Pitch

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Abstract

Absolute pitch—the ability to name or produce a note of particular pitch in the absence of a reference note—is generally considered to be extremely rare. However, it has been found that native speakers of two different tone languages—Mandarin and Vietnamese—display a remarkably precise form of absolute pitch in enunciating words. Given these findings, it is proposed that absolute pitch may have evolved as a feature of speech, analogous to other features such as vowel quality. It is also conjectured that tone-language speakers generally acquire this feature during the 1st year of life, in the critical period when infants acquire other features of their native language. For speakers of non-tone languages, the acquisition of absolute pitch by rare individuals may be associated with a critical period of unusually long duration, so that it extends to the age at which the child can begin taking music lessons. According to this line of reasoning, the potential for acquiring absolute pitch is universal at birth, and can be realized by giving the infant the opportunity to associate pitches with verbal labels during the 1st year or so of life.

Keywords

pitch; music; speech

In May of 1763, just before the Mozart family set off on their famous tour of Europe, an anonymous letter was sent from Vienna to Augsburg, detailing some of 7-year-old Wolfgang's remarkable accomplishments. The letter included the following passage:

> I saw and heard how, when he was made to listen in another room, they would give him notes, now high, now low, not only on the pianoforte but on every other imaginable instrument as well, and he came out with the letter of the name of the note in an instant. Indeed, on hearing a bell toll or a clock, even a pocket-watch, strike, he was able at the same moment to name the note of the bell or time piece. (*Augsburgischer Intelligenz-Zettel*, 1763, cited in E.O. Deutsch, 1990, p. 21)

It is clear from this description that the young Mozart had absolute pitch, otherwise known as perfect pitch—a faculty that has been estimated to occur in less than one in ten thousand in our population. For people with absolute pitch, naming a note is as simple and immediate as, for example, identifying an object's color as red. Yet for most people, absolute pitch seems a mysterious and extraordinary gift—something that must surely be very difficult, or take some exceptional talent, to acquire. This impression is reinforced by the fact that most famous composers and performers—including Beethoven, Bach, Handel, Chopin, Toscanini, Solti, Heifetz, Menuhin, Rubenstein, and others—were known to possess this faculty.

The ability to judge one note in relation to another—known as relative pitch—is very common. Musicians have no difficulty in naming notes if they are first given a reference note. For example, if they are played the note C and given its name, they can easily identify the note a whole tone higher as D, the note two whole tones higher as E, and so on. What most people, including most musicians, cannot do is name a note that is presented in isolation.

As someone who has absolute pitch, I have always found it strange that most people find this labeling task so difficult. When we identify a color as red, we do not do so by comparing it with another color and then evaluating the relationship between the two. The labeling process is much more direct. A lack of absolute pitch therefore appears to be somewhat analogous to the rare syndrome of color anomia, in which the patient can recognize that two objects are of the same color, and can discriminate between different colors, but simply cannot label them. So the real puzzle concerning absolute pitch is not why some people possess it, but rather why it is so rare.

THE GENESIS OF ABSOLUTE PITCH

What do we know about the genesis of absolute pitch? Some investigators have suggested that it is acquired through learning. On the basis of this assumption, a number of researchers developed programs to train people to acquire it (see Takeuchi & Hulse, 1993, for a review). What was most noteworthy about these programs was their lack of success—people labored for many months to achieve absolute pitch, often without succeeding, and even when they were fairly successful, their perceptions did not have the immediacy and effortlessness of the perceptions of individuals who naturally possess this faculty.

There is considerable evidence that in order to acquire absolute pitch, the individual must have been exposed to musical notes and their names very early in life. For example, in a study of more than 600 musicians, Baharloo, Johnston, Service, Gitschier, and Freimer (1998) found that 40% of those who had started taking music lessons at or before age 4 reported having absolute pitch, whereas only 3% of those who had started musical training at or after age 9 did so. These findings point to a critical period for the development of absolute pitch, analogous to (and possibly parallel with) the critical period during which infants and young children acquire the speech sounds of their native language (Jusczyk, Friederici, Wessels, Svenkerud, & Jusczyk, 1993).

On the other hand, the involvement of a critical period may be only part of the picture. Baharloo et al. (1998) pointed out that most of their subjects who had begun taking music lessons at or before 6 years of age did not possess this faculty. Indeed, there is some evidence that a genetic, and so innate, predisposition is also involved (Baharloo et al., 1998; Profita & Bidder, 1988). Further evidence for the role of innate factors was provided by Schlaug, Jancke, Huang, and Steinmetz (1995), who observed that musicians with absolute pitch tend to have an unusual form of brain structure involving the planum temporale, an area in the temporal lobe that is critical to speech processing. This region is usually larger on the left side of the brain than on the right, and Schlaug et al. found that this leftward asymmetry, which emerges before birth, is greater among musicians with absolute pitch than among other individuals.

IMPLICIT ABSOLUTE PITCH

However, the intriguing question still remains as to why absolute pitch appears to be so rare. Many nonhuman species, such as songbirds, display absolute pitch (see, e.g., Njegovan, Ito, Mewhort, & Weisman, 1995; Takeuchi & Hulse, 1993), and it appears unlikely on general grounds that humans would not employ this simple feature of sound for the purpose of communication. Indeed, a num-

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ber of studies have shown that most people do in fact possess an implicit form of absolute pitch, even though they are unable to label notes directly. One body of evidence involves a musical illusion called the tritone paradox (D. Deutsch, 1991). To generate this illusion, two computer-produced tones that are related by a half-octave (or tritone) are played in succession. The tones are so constructed that their note names are clearly defined, but they are in principle ambiguous in terms of which octave they are in. When one of these tone pairs is played (say, C followed by F#), some listeners hear an ascending pattern, whereas other listeners hear a descending pattern instead. Yet when a different tone pair is played (say, G# followed by D), the first group of listeners hears a descending pattern, while the second group of listeners hears an ascending one.

More specifically, we can think of the 12 tones within the octave (known as pitch classes) as arranged in a circle, as in Figure 1. Most people, in making judgments of the tritone paradox, place tones in one region of the pitch-class circle as higher, and tones in the opposite region as lower. However, the orientation of the pitch-class circle with respect to height differs from one listener to another. Furthermore, listeners' judgments reflect a systematic relationship between pitch class and perceived height (D. Deutsch, 1991) showing that they must be employing some form of absolute pitch in making these judgments.

There is further evidence that absolute pitch, at least in partial form, is more prevalent than was traditionally assumed. Terhardt and Seewann (1983) observed that musicians who lacked absolute pitch were nevertheless able to judge to some extent whether or not a passage was played in the correct key.

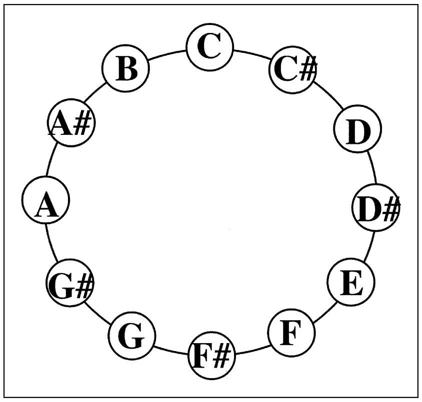

Fig. 1. The pitch-class circle. The scale in traditional Western music is produced by dividing the octave into 12 semitone steps, and each tone is given a name: C, C#, D, D#, E, F, F#, G, G#, A, A#, and B. The entire scale, as it ascends in height, is produced by repeating this succession of note names (or pitch classes) across octaves. People with absolute pitch are able to name the pitch of a note when it is presented in isolation; this ability is considered very rare.

Halpern (1989) found that musically untrained subjects were quite consistent in their choices of pitches when they were asked to hum the first notes of well-known songs on different occasions. Levitin (1994) had subjects sing two popular songs, and he compared their productions with the pitches that were used in the songs' recordings. He found that 44% of the subjects came within two semitones of the correct pitch for both songs. So he concluded that absolute pitch has two components: (a) long-term pitch memory, which is widespread, and (b) the ability to label pitches, which is rare.

TONE LANGUAGES

So why, then, do most people in our society have stable long-term memories for the absolute pitches of tones, even though they are unable to label the pitches that they have stored in memory? The answer might be found in tone languages. In Mandarin, for example, a word takes on an entirely different meaning depending on the *tone* in which it is enunciated—with a tone being defined both by its pitch contour and by its absolute pitch level. Pitches are therefore used to create verbal features, analogous to consonants and vowels. So, for example, when a speaker of Mandarin identifies the meaning of *ma* as "mother" when it is spoken in the first tone, or as "hemp" when it is spoken in the second tone, he or she is associating a particular pitch (or combination of pitches) with a verbal label. Analogously, when a person with absolute pitch identifies the sound of the note C# as "C#," or the note D as "D," he or she is also associating a pitch with a verbal label.

Supposing, then, that absolute pitch is used in tone languages to distinguish between the different meanings of a word, we should expect speakers of these languages to be very consistent from one day to another in the pitches in which they enunciate words. To examine this prediction, Henthorn, Dolson, and I (D. Deutsch, Henthorn, & Dolson, 1999) tested 7 native speakers of Vietnamese. Each subject served in two sessions, which were held on different days. In each session, the subject was handed the same list of 10 Vietnamese words to read out loud one time. The list spanned the range of tones in Vietnamese speech.

The speech samples were entered into computer memory, and an average pitch for each word was determined. We then calculated, for each subject, the difference between the average pitch for each word on Day 1 and Day 2, and we averaged these differences across the words in the list. The results showed extraordinary consistencies: All 7 subjects produced averaged pitch differences of less than 1.1 semitone, and 4 of the 7 subjects produced averaged pitch differences of less than 0.5 semitone.

In a second experiment, we employed 15 Mandarin speakers as subjects, and we used a list of words that spanned all four tones in Mandarin speech. Each subject again participated in two sessions that were held on different days, but in this case he or she recited the word list twice in each session, the readings being separated by roughly 20 s. We calculated four sets of difference scores: between the first readings on Day 1 and Day 2, between the second readings on Day 1 and Day 2, between the first and second readings on Day 1, and between the first and second readings on Day 2.

We again found remarkable consistencies. For all comparisons, half of the subjects produced averaged pitch differences of less than 0.5 semitone, and one third of the subjects produced averaged pitch differences of less than 0.25 semitone. Furthermore, statistical analyses found no significant differences in the degree of pitch consistency that occurred in reciting the word list on different days, compared with reciting it twice in immediate succession. We concluded that although the pitch discrepancies we found were remarkably small, they nevertheless underestimated the precision of the subjects' absolute pitch templates.

This study indicates that speakers of Vietnamese and Mandarin possess an extraordinarily precise form of absolute pitch that they employ in the enunciation of words in their native language. The results suggest that absolute pitch may have evolved as a feature of speech, analogous to other features such as vowel quality (see also Brown, 2000). One may further hypothesize that this feature is generally acquired during the 1st year of life, during the critical period in which infants acquire other features of speech (Jusczyk et al., 1993). Indeed, Saffran and Griepentrog (2001) showed that infants are able to remember absolute pitches, by demonstrating that 8-month-old infants could perform a perceptual learning task that necessitated referring to the absolute pitches of tones.

Why, then, do some rare individuals in the United States possess absolute pitch, even though they have not been given the opportunity to associate pitches with verbal labels during the critical period for speech acquisition? Perhaps for such individuals, this critical period is of longer duration, and extends to the age at which it is feasible for them to begin taking music lessons. Such a predisposition for an extended critical period might be genetically determined, and might also be associated with differences in brain organization (Schlaug et al., 1995).

CONCLUSION

Given the framework presented here, many issues remain to be explored. For example, psychologists do not know whether absolute pitch that is initially acquired for speech later generalizes to musical tones, though there is some evidence that this may be the case (see, e.g., Gregersen, Kowalsky, Kohn, & Marvin, 1999). If such generalization does occur, absolute pitch for music, although rare in the United States, would be quite prevalent in countries where tone languages are spoken. To this end, my colleagues and I are in the initial stages of carrying out a study comparing the prevalence of absolute pitch among music students in China and the United States, controlling for factors such as age of onset of musical training.

More generally, I am proposing that absolute pitch, which has traditionally been viewed as a musical faculty, originally evolved to subserve speech. As a corollary, I am also proposing that absolute pitch for speech and absolute pitch for music share common brain mechanisms. This suggestion contrasts with the view that has dominated thinking for decades, that the brain mechanisms subserving music and speech are distinct and separate. The findings and theoretical framework presented here lead to an additional question: What other linkages between speech and music exist, though they have not yet been identified? The uncovering of such linkages would be of considerable importance to understanding the evolutionary bases of these two forms of communication.

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Note

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