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SYLWIA MAKOMASKA (Warszawa)

On the genesis of absolute pitch

ABSTRACT: The clear majority of people with a professional or amateur contact with music do not possess absolute pitch and get by perfectly well without it, making use of relative musical pitch. Yet many people dream of also fixing in their memory the actual pitches of the notes of the musical scale, which would effectively give them the chance to recognise and reproduce any chromatic pitch (C, C#, D, D#, etc.) without recourse to a reference note. Unfortunately, it almost always proves too late for them to develop absolute pitch.

The question of the factors determining the forming of absolute pitch is still the subject of quite heated discussion. Practically from the outset of the interest in the phenomenon of absolute pitch (i.e. from the second half of the nineteenth century) controversial theories arose regarding its origins. In discussion on the subject, there was a clash of two fundamental views, regarding absolute pitch either as an innate ability or, on the contrary, as an ability that could be acquired at any age. With time, there emerged an increasing number of hypotheses accounting for the origin of absolute pitch: from the theory of the limitless possibility of absolute pitch acquisition through the theories of innate factors and of early learning, to the latest theory that links absolute pitch to tonal languages.

The present paper shows the results of the research project on the occurrence of absolute pitch among young people in musical education in Poland (1175 pupils, aged 11–29) carried out in the years 2004–2007. The test results (pitch-naming tests) supported by the data from the survey (concerning e.g. musical education, familial aggregation of AP and etc.) are presented in the context of theories which attempt to investigate the source of absolute pitch (especially early musical training theory and genetic factors theory).

KEYWORDS: absolute pitch, the source of absolute pitch, absolute pitch acquisition, early musical training theory, genetic factors theory, tonal languages theory, familial aggregation of absolute pitch

The clear majority of people with a professional or amateur contact with music do not possess absolute pitch and get by perfectly well without it, making use of relative musical pitch. Yet many people dream of also fixing in their memory the actual pitches of the notes of the musical scale, which would effectively give them the chance to recognise and reproduce any chromatic pitch (C, C#, D, D#, etc.) without recourse to a reference note. Unfortunately, it almost always proves too late for them to develop absolute pitch.

Interest in the phenomenon of absolute pitch dates from the second half of the nineteenth century,[1] and practically from the outset, controversial theories arose regarding its origins. In discussion on the subject, there was a clash of two fundamental views, regarding absolute pitch either as an innate ability or, on the contrary, as an ability that could be acquired at any age. With time, there emerged an increasing number of hypotheses accounting for the origin of absolute pitch: from the theory of acquisition through the theories of innate factors and of early learning, to the latest theory that links absolute pitch to tonal languages.

The theory of the limitless possibility of acquiring absolute pitch

One of the first psychologists to regard the acquisition of absolute pitch as a matter of training was Max Meyer (1899).[2] In order to obtain experimental support for his thesis, he carried out exceptionally laborious training on himself and his colleague over a period of four months, ultimately achieving 60% and 64% of correct recognition of notes on a piano. This could have been regarded as a fairly good example of 'quasi-absolute pitch', which is characterised by the fixing in the permanent memory of one or a few models of chromatic pitch, were it not for the fact that when the exercises were discontinued the memory of the pitches soon disappeared entirely. Similar fruitless attempts were made by other scholars, such as Elena A. Maltseva, helen K. Mull and carl H. Wedell.[3]

In many cases, absolute pitch is still treated as a skill that can be developed regardless of age. One example here are the numerous programmes created for commercial purposes and sold on the Internet, for instance, assuring potential buyers that through suitable training they can acquire absolute pitch 'while they rest'. Here is an excerpt from an advertisement for one such programme: '"Perfect pitch ear training super course" will change your hearing

[1] Carl Stumpf, *Tonpsychologie* (Leipzig, 1883); Johannes A. Kries, 'Über das absolute Gehör', *Zeitschrift für Psychologie und Physiologie der Sinnesorgane* 3 (1892), 257–279; Otto Abraham, 'Das absolute Tonbewusstsein', *Internationale Musikgesellschaft: Sammelbande* 3 (1901), 1–86.

[2] Max Meyer, 'Is the memory of absolute pitch capable of development by training?', *Psychological Review* 6 (1899), 514–516.

[3] Elena A. Maltseva, 'Osnovniye elementy slukhovykh oshchushchniy', in *Obornik rabot fiziologo-psichologicheskoy sektsiy GIMN* (Moscow, 1925); Helen K. Mull, 'The acquisition of absolute pitch', *American Journal of Psychology* 36 (1925), 469–493; Carl H. Wedell, 'The nature of the absolute judgement of pitch', *Journal of Experimental Psychology* 17 (1934), 485–503.

for ever... Aren't you curious what it means to have perfect pitch, what it means to hear with such great precision? To hear like the greatest composers heard: Wolfgang A. Mozart, Fryderyk Chopin, Johan Sebastian Bach, Ludwig van Beethoven? To perform music like top-class musicians: Vladimir Horowitz, Artur Rubinstein, Miles Davis, Frank Sinatra...? All you have to do is order 2 CDs with step-by-step instructions for just $79.95. Order now! 110% guaranteed!'[4]

From a scholarly point of view, methods of this sort should be treated in humoristic terms. It is worth noting, however, that in the specialist literature, as well, in a work by Paul Brady (1970),[5] one finds a description of a case where an adult acquired, through several months of training, a recognition of piano notes close to nearly perfect absolute pitch,[6] at a level of 65% recognition of chromatic pitch. While there is no more exact information as to whether, and if so to what extent, this skill was retained over time, Brady, who was at once both the author and the sole participant in the research, ends his article with a description of a brief experiment which he carried out on himself five months after ending regular training. Out of five notes heard, he recognised four, the other time being a semitone out. In his opinion, this result testifies that absolute pitch is a skill that is hard to acquire, on one hand, but hard to lose, on the other.

The subject literature is dominated by descriptions of the defeat of the 'learning theory'. By the same stroke, they confirm the opposite approach, according to which the possession of absolute pitch is an innate phenomenon, in some vague way dependent upon heredity. Advocates of the 'innate factors theory' have been primarily people who themselves possessed absolute pitch, including such eminent authors as Géza Révész,[7] Albert Bachem[8] and Carl Emil Seashore[9].

[4] see<http://www.perfectpitch.com> accessed 10 December 2007 (retranslated from Polish).

[5] Paul Brady, 'Fixed-scale mechanism of absolute pitch', *Journal of the Acoustical Society of America* 48 (1970), 883–887.

[6] Warren Dixon Ward, 'Absolute Pitch', *Sound* 2 (1963), 14–21.

[7] Géza Révész, *Zur Grundlagen der Tonpsychologie* (Leipzig, 1913); Gēza Révész, *Introduction to the Psychology of Music* (London, 1953).

[8] Albert Bachem, 'Various types of absolute pitch', *Journal of the Acoustical Society of America* 9 (1937), 146–151; Bachem, 'Absolute pitch', *Journal of the Acoustical Society of America* 27 (1955), 1180–1185.

[9] Carl Emil Seashore, *Psychology of Music* (New York, 1938).

The theory of the acquisition of absolute pitch during early childhood

New light was thrown on the question of the genesis of absolute pitch by the results of research carried out in Japan during the 1980s.[10] This showed that in music schools in Japan, the percentage of children with absolute pitch was several times greater than in Europe. Even for the advocates of this theory, the drastic division of the human population and the isolation of a microscopic privileged minority has seemed a rather curious and incomprehensible fact. Oura and Eguchi[11] linked this to the fact that many children in Japan begin to learn music at the age of 3–4 years, thanks, among other things, to the popularity of learning through the Suzuki and Yamaha methods (regular music lessons begin several years before school age). With time, an increasing amount of data has attested a clearly positive correlation between possessing absolute pitch and beginning one's musical education at an early age.[12]

Particularly crucial in statistical terms are the results of a questionnaire study conducted among 600 students in the USA by a team led by Siamak Baharloo.[13] Of the 92 respondents who admitted to having absolute pitch, the majority began their musical training before the age of six. This confirms to a huge degree the hypothesis that commencing one's musical education at an early age is an essential condition for the acquisition of absolute pitch. What is primarily involved here is the association in a child's awareness of specific pitches with their musical names. A person with absolute pitch thereby learns to associate particular auditory stimuli with their corresponding names.[14] It is

[10] Yoko Oura and E. Eguchi, 'Is absolute pitch innate or acquired?', paper delivered to a seminar held in connection with the Sixteenth Brno International Music Festival (1981); Ken'ichi Miyazaki, 'Musical pitch identification by absolute pitch possessors', *Perception and Psychophysics* 44 (1988), 501–512.

[11] Oura and Eguchi, 'Is absolute pitch innate or acquired?'.

[12] Desmond Sergeant, 'Experimental investigation of absolute pitch', *Journal of Research in Music Education* 17 (1969), 135–143; Annie H. Takeuchi and Steward H. Hulse, 'Absolute pitch', *Psychological Bulletin* 113 (1993), 345–361; Peter K. Gregersen, Elena Kowalsky, Nina Kohn and Elisabeth W. Marvin, 'Absolute pitch: prevalence: ethnic variation, and estimation of the genetic component', *American Journal of Human Genetics* 65 (1999), 911–913.

[13] Siamak Baharloo, Paul A. Johnston, Susan K. Service, Jane Gitschier and Nelson B. Freimer, 'Absolute pitch: an approach for identification of genetic and non-genetic components', *American Journal of Human Genetics* 62 (1998), 224–231.

[14] Daniel J. Levitin and Robert J. Zatorre, 'On the nature of Early Music Training and Absolute Pitch: A Reply to Brown, Sachs, Cammuso, and Folstein', *Music Perception* 21 (2003), 105–110.

not known, however, how or why these associations are formed seemingly automatically.

An explanation of this phenomenon may be served by electrophysiological studies of brain function. These indicate that in persons with absolute pitch there occurs an increase in activity of those areas of the brain (rear part of the lateral dorsal cortex of the frontal lobe) which are responsible for maintaining associational connections in the memory.[15] By the same stroke, the area which enables one to recognise a stimulus by comparing it with a fixed memory model is activated.

There is also evidence that absolute pitch is a skill acquired in stages. First, a person masters the set of seven pitch chromas of the diatonic scale, which would accord with the limitations resulting from the 'magical number seven'.[16] This is probably due to a child at the beginning of its musical training (particularly when learning to play the piano) more frequently coming into contact with the notes corresponding to the white keys (and with melodies based on the key of C major). Consequently, these pitches are more stably fixed in the permanent memory. Such a distinct differentiation of the regularities in the recognition of the notes corresponding to the white and the black keys was observed in his research by Ken'ichi Miyazaki.[17] The results he obtained indicate that the subjects (young people) were probably still in the phase of the forming of their absolute pitch, since in the case of persons already possessing fully developed absolute pitch, no systematic differences can be observed.[18]

At this point, it is worth referring to the latest research by Miyazaki and Ogawa,[19] conducted in Yamaha music schools in Japan among 104 children aged 4–10. This showed that the system of musical education applied in these schools is geared above all to the teaching of absolute pitch; the results of the research made it possible to follow this process.

In the Yamaha method of musical training, the emphasis is placed on the gradual inculcation of the absolute note pitches. During the first semester of teaching, the children learn the notes c^1, d^1, e^1, f^1, g^1 and c and g, by listen-

[15] Robert J. Zatorre, David W. Perry, Christine A. Beckett, Christopher F. Westbury and Alan C. Evans, 'Functional autonomy of musical processing in listeners with absolute pitch and relative pitch', *Proceedings of the National Academy of Science USA* 95 (1998), 3172–3177.

[16] George Miller, 'The Magical Number Seven, Plus or Minus Two: Some Limits in Our Capacity for Processing Information', *Psychological Review* 63 (1956), 81–97.

[17] Miyazaki, 'Musical pitch identification' (see footnote 10).

[18] Marietta Morawska-Büngeler and Andrzej Rakowski, 'Badanie standardów i kategorii wysokości dźwięku w słuchu absolutnym' [Study of standards and categories of note pitch in absolute pitch], *Muzyka* 32/3 (1988), 3–20.

[19] K. Miyazaki and Yoko Ogawa, 'Learning absolute pitch by children: A cross-sectional study', *Music Perception* 24 (2006), 63–78.

ing, singing and playing the piano. The greatest attention is focussed on the three notes c^1, d^1 and e^1. The children learn songs based on these notes, initially singing (at first with the words, then by solmisation), and subsequently playing the song on the piano at the same time as singing in solmisation.

In the next stage of teaching, the remaining diatonic notes are introduced, using an identical method. At the same time, attention is drawn to the phenomenon of octave identity, with the teachers explaining that there are on the keyboard many notes 'do', for example. The children's repertoire is then expanded to include songs in the keys of G major and F major, which in practice means introducing the notes f sharp and b flat. During the second year of teaching, the notes c sharp, g sharp and d sharp are added. In this way, the twelve classes of note pitch are gradually introduced.

It turned out that the results of the listening tests of the recognition of chromatic musical pitches conducted in particular age groups gave an excellent reflection of the process of learning absolute pitch. The first period of education is characterised by the correct recognition of single diatonic notes (e.g. in the four-year-olds group, only the chromatic pitch C). In the group of six-year-olds, all the diatonic notes were recognised at a level above 60%, while after three more years of learning the children identified the twelve pitch classes with uniform ease (nine-year-olds).

The results not only confirm the theory of early learning and make it possible to explain how great accuracy arises in the recognition of white keys,[20] but they also enable an explanation to be found for such a high frequency of the occurrence of absolute pitch among Japanese musicians.

Of course, the considerations presented above show that, besides appropriate training, the moment when a child begins its musical training is also significant. Increasingly widespread during the last few years is the opinion that there exists a certain critical period that is particularly conducive to the development of absolute pitch, and also an age limit (the sixth year), after which the chances of developing absolute pitch are increasingly less.[21]

Supporters of the existence of an age limit to the acquisition of absolute pitch also point to a parallel between the phenomenon of absolute pitch and the acquisition of native-speaker-level language proficiency. This is mentioned by Oliver Vitouch,[22] referring to the studies of Patricia Kuhl and Elissa

[20] Miyazaki, 'Musical pitch identification', 501.

[21] Frank A. Russo, Deborah L. Windell and Lola L. Cuddy, 'Learning the "special note": Evidence for a critical period for Absolute Pitch acquisition', *Music Perception* 21 (2003), 119–127.

[22] Oliver Vitouch, 'Absolutist models of Absolute Pitch are absolutely misleading', *Music Perception* 21 (2003), 111–117.

L. Newport[23]. The learning of a language at a later age (after the sixth birthday) brings with it phonological and prosodic deficiencies ('foreign accent'), in spite of the possibility of achieving a high level of competence and fluency in the use of a foreign language.

Experiments supporting the 'early learning theory' appear to confirm that almost every person has the potential to develop absolute pitch, but only for a specific period of time during childhood, when there exist the physiological and developmental predispositions for noting the absolute, and not relative, dimension of pitch.

The theory of innate factors

The theory of the early acquisition of absolute pitch or the 'theory of the early learning of absolute pitch', as it has come to be worded in the literature, is currently the dominant theory in the opinions of specialists, although its successes also point to clear limitations. A number of studies have shown that the early musical initiation of a child clearly increases the probability of the forming of absolute pitch, but it by no means gives certainty in this respect.[24] In addition, as has been demonstrated,[25] there are people with absolute pitch who commenced their musical education above the age of nine, and even between their twelfth and fifteenth years. Such cases support the opposite theory, in which it is stressed that an early musical education is not absolutely essential to the acquisition of absolute pitch.

Among the advocates of such an approach are Walter A. Brown, Henry Sachs, Karen Cammuso and Susan F. Folstein.[26] They consider that absolute pitch is determined by innate genetic factors, which create in some children a physiologically privileged hearing ability and cause their greater interest in music. In this way, parents observing their children's behaviour arrange, at their request, as it were, an early access to music. Of course, this sounds logical, yet rather unconvincing for anyone who knows how little Japanese children, for example, have to say in the matter, in a situation where the parents

[23] Patricia K. Kuhl, 'A new view of language acquisition', *Proceedings of the National Academy of Science* 97 (2000), 11850–11857; Elissa L. Newport, 'Maturational constraints on language learning', *Cognitive Science* 14 (1990), 11–28.

[24] Warren Dixon Ward, 'Absolute pitch', in *The Psychology of Music*, ed. Diana Deutsch (New York, 1999), 265–298.

[25] Baharloo et al., 'Absolute pitch' (see footnote 13).

[26] Walter A. Brown, Henry Sachs, Karen Cammuso and Susan F. Folstein, 'Early music training and absolute pitch', *Music Perception* 19 (2002), 594–597.

choose to give their children a very early musical education using the Suzuki method[27] or the method adopted in Yamaha music schools.[28]

The attention drawn to the role of inborn factors has meant that in recent years absolute pitch has been investigated by geneticists, who often display a tendency to perceive absolute pitch in terms of a 'super power', that is, an exceptional talent and privilege and a genetically conditioned gift.

Geneticists' interest predictably focuses first and foremost on Japan, where, due to the high number of people with absolute pitch, the cases of the inheritance of this ability also prove to be proportionately much more frequent than in other countries. For example, Peter K. Gregersen,[29] on the basis of questionnaires answered by over 900 students of music theory in the USA, arrived at the conclusion that absolute pitch occurs more often among students of Asian origin (absolute pitch was claimed by 38 of 80 people of Asian origin, representing 47.5%, but only 75 of the 834 persons of non-Asian origin, or 9%). This shows that the possession of absolute pitch is determined by genetic factors. However, the basic accusation levelled at such an interpretation of the results was that Gregersen did not take account in his considerations of the role of early musical education.[30]

A similar track was followed by scholars from the University of California, San Francisco.[31] The aim of their research was to find the gene or genes responsible for absolute pitch. In surveys conducted among more than 600 people, almost half of those who declared that they possessed absolute pitch indicated that they had relatives with absolute pitch. On the other hand, however, almost half of those who began their musical education at the age of four and almost one-third of those who began taking music lessons aged 4–6 indicated that they possessed absolute pitch. After carrying out a multi-stage study, which included using the Internet to seek persons with absolute pitch, the scholars advanced the hypothesis that a gene responsible for absolute pitch must exist. In their opinion, it is a dominant gene, that is, if it was inherited from one of the parents, whilst the corresponding antigene was inherited from the other parent, then the gene responsible for absolute pitch would

[27] Shinischi Suzuki, *Nurtured by Love: A New Approach to Education* (Smithtown, New York, 1981) trans. Magdalena Jakóbczak-Rakowska as *Karmieni miłością – podstawy kształcenia talentu* (Warsaw, 2003).

[28] Miyazaki and Ogawa, 'Learning absolute pitch by children' (see footnote 19).

[29] Peter K. Gregersen, Elena Kowalsky, Nina Kohn and Elisabeth W. Marvin, 'Early childhood music education and predisposition to absolute pitch; teasing apart genes and the environment', *American Journal of Medical Genetics* 98 (2000), 280–282.

[30] Trevor Henthorn and Diana Deutsch, 'Ethnicity versus early environment: Comment on "Early childhood music education and predisposition to absolute pitch: teasing apart genes and environment" by Peter K. Gregersen, Elena Kowalsky, Nina Kohn and Elisabeth West Marvin (2000)', *American Journal of Human Genetics* 143 (2007), 911–913.

[31] Baharloo et al., 'Absolute pitch' (see footnote 13).

prevail. However, they also claimed that genetic predispositions are not enough. They constitute only a foundation, as it is environmental factors (including an early musical education) that determine the extent to which absolute pitch develops.[32]

In order to bring their research to a successful conclusion, the researchers assumed that they would need over 100 families whose members possessed absolute pitch. They would have to be subjected to auditory tests and also consent to providing a blood sample, which would allow DNA tests to be carried out. This is a difficult and extremely time-consuming task, which is why the search for the gene responsible for absolute pitch is still on-going and is already causing controversy. daniel J. Levitin and Robert J. Zatorre,[33] as supporters of the early learning theory, consider that the data collected by the UCSF team is unconvincing. In their opinion, if absolute pitch appears in a whole family, then it is highly likely that the children (the youngest generation) will, from infancy, have a natural contact with music and will be acquainted with the names of pitches. Of course, this has a direct link to the early learning theory. According to Levitin and Zatorre, crucial evidence that absolute pitch was determined by a gene and not by environmental factors would occur if it turned out that children from families with absolute pitch were often unable to develop absolute pitch.

Still unanswered is the question as to whether genetic predispositions condition an early musical education, or whether the starting point in the development of absolute pitch is not genes, but an early musical education. If one considers the two theories separately, then one may come to the conclusion that the theory of genetic factors has not succeeded in explaining why absolute pitch is usually acquired in childhood. On the other hand, the approach accentuating the role of environmental factors in the acquisition of absolute pitch does not account for the fact that not all children who begin their musical education at a sufficiently early age (before the critical period) develop absolute pitch.

[32] Ibid. See also Siamak Baharloo, Susan K. Service, Risch, N., Jane Gitchier and Nelson B. Freimer, 'Familial aggregation of absolute pitch', *American Journal of Human Genetics* 67 (2000), 755–758; Peter K. Gregersen, Elena Kowalsky, Nina Kohn and Elisabeth W. Marvin, 'Absolute pitch: prevalence: ethnic variation, and estimation of the genetic component', *American Journal of Human Genetics* 65 (1999), 911–913; Gregersen et al., 'Early childhood music education' (see footnote 29).

[33] Levitin and Zatorre, 'On the nature' (see footnote 14).

Absolute pitch and the development of cognitive processes

An attempt at a synthesising approach to the problem of the provenance of absolute pitch was made by Christina S. Chin of the University of California, Santa Cruz,[34] who proposed an explanation based on cognitive psychology. She considered absolute pitch to be a cognitive skill which develops in individuals with genetic predispositions for a particular 'cognitive style'. In addition, at a suitable age in childhood (before the critical period), these individuals passed through a suitable kind of musical training. Cognitive style is defined as a general, unconscious preference for processing information in a particular way.[35]

Chin seeks evidence to back her hypothesis in developmental psychology. She believes it more likely that young children acquire absolute pitch because they have not yet developed from one-dimensional to polydimensional thinking. In her considerations, Chin refers to Jean Piaget,[36] who defined this watershed in a child's development as the transition from pre-operative thinking to thinking in terms of specific operations. In order to test whether children had crossed this developmental threshold, Piaget employed a classic task involving two vessels with the same volume but different shape. The aim of the experiment was to see whether a child was able to notice and comprehend by itself that a short, wide glass can contain the same amount of liquid as a tall, slim glass. Younger children tend to focus on just one dimension of the vessel, namely height, and as a result they mistakenly conclude that the taller glass always contains more liquid. Older children are able to think simultaneously about both height and width.

In the case of music, the transition from pre-operative thinking occurs when an understanding of the relationship between a note name and a specific pitch is augmented by thinking in terms of intervals. Chin invokes the research of Desmond C. Sergeant and Serge Roche,[37] which shows that children aged 3–4 sing, for example, a song in the same key as they have been taught much more often than five- and six-year-olds. The older children much more often demonstrated, through transposition, their understanding of such

[34] Christina S. Chin, 'The development of Absolute Pitch: A theory concerning the roles of music training at an early developmental age and individual cognitive style', *Psychology of Music* 31 (2003), 155–171.

[35] Samuel Messick, 'The matter of style: Manifestations of personality in cognition, learning and teaching', *Educational Psychologist* 29 (1994), 121–136.

[36] Jean Piaget, *The Psychology of Intelligence* (London, 1950).

[37] Desmond C. Sergeant and Serge Roche, 'Perceptual shifts in the auditory information processing of young children', *Psychology of Music* 1 (1973), 39–48.

musical notions as the contour of a melody, the size of an interval or a sense of key.

In Chin's opinion, there are two factors which can facilitate the development of absolute pitch:

1. a suitable sort of musical training before the age of six,
2. genetic predispositions for interpreting the world by means of an analytical cognitive strategy.

It is important that the musical initiation take place before the sixth year, as that is the age when they are in the 'pre-operative' period (3–6 years) and have not yet begun to think about music and musical pitch in a relative way. Children with genetic predispositions for interpreting the world in an analytical way are classified as manifesting 'field independent' thinking. In contrast to their 'field-dependent' peers, they are characterised by analytical tendencies and by the assimilation of information without reference to a context. On the other hand, Chin considers that persons with a predisposition for absolute pitch display a tendency for 'narrow attention', which refers to the division of stimuli into components, and not taking them in integrally ('broad attention'). In her considerations, Chin thus combines elements of early learning theory, developmental psychology and genetic factors. Such an approach is not isolated in the literature.[38]

Within this context, it is worth mentioning one further area in which the genesis of absolute pitch may be sought – an area which has hitherto completely escaped the attention of scholars. As Andrzej Rakowski notes,[39] this concerns the earliest period in a child's life, during which, according to the commonly known laws of development, over a very short space of time some important mechanisms of perception and action become established for the whole of one's life. One may assume here, for example, that human infants, similarly to canine puppies, the chicks of many birds and young dolphins, are equipped with the ability to categorise in qualitative terms, and to fix in their memory, narrow segments of the scale of pitches, in other words, to memorise the absolute pitch of notes. Thus equipped, just a few months after birth, they enter the period of striking up acoustic communication with their environment. Above all, they learn to recognise their mother's voice and to respond to it with infant babble. Wishing to recognise and imitate the signals of its mother's voice, a child must, however, turn its attention away from absolute pitches, impossible to intone with an infant's voice due to the difference in scale, and focus its attention and the power of its auditory memory solely on

[38] Vitouch, 'Absolutist models' (see footnote 22); Levitin and Zatorre, 'On the nature' (see footnote 14).

[39] Andrzej Rakowski, 'Słuch absolutny' (guest paper), *Prace 50 Otwartego Seminarium z Akustyki* [Works of the fiftieth open seminar in acoustics] (Gliwice, 2003), 335–344.

the intonation of the voice. Thus are created constructs controlled by relative pitch.

On one hand, this process constitutes an initial element in the development of the linguistic communication proper to humankind, and on the other it creates conditions for the powerful inhibition of innate predispositions in the infant for employing absolute pitch. Taking this further, it may be assumed that the conditions for the progressive inhibition of absolute pitch could be restricted if, for example due to accidental circumstances, a child's voice were to 'attune itself' at the interval of an octave to the voice of its mother. There would then ensue what one may term the 'unconscious' discovery by the young organism of another dimension of pitch – the only dimension in which the phenomenon of absolute pitch has a chance of arising and developing.

Only in the last few years has the significance which the acoustic environment bears for the further process of the acquisition of the mother tongue during the first 12–18 months or so of a child's life been emphasised in the literature. As is shown by experimental data,[40] infants react extremely strongly to characteristic features of the language surrounding them and functioning within a given environment. Over subsequent stages of development, the auditory experience gained in this way enables the rapid acquisition of their own speech in the specific mother tongue that functions within the given environment. One may, therefore, advance the hypothesis that analogous phenomena arise in relation to elements of musical language, which is, after all, also a system of communication.[41]

Absolute pitch and tonal languages

Over recent years, another conception has appeared in the literature, according to which the possibility of developing absolute pitch is also influenced by the native language we use. This concerns especially tonal languages, in which words take on a completely different meaning depending on the pitch at which they are uttered (e.g. the word *ma* in Mandarin can have four meanings: 'mum', 'hemp', 'horse' and 'dishonour'). Consequently, persons employing tonal languages, such as Mandarin or Vietnamese, from childhood are more sensitive to changes in pitch and to absolute pitch than persons using, for example, English. This theory is propagated by the well-known music psychologist Diana Deutsch, who, in collaboration with Chinese

[40] Patricia K. Kuhl, 'A new view of language acquisition', *Proceedings of the National Academy of Science* 97 (2000), 11850–11857.

[41] Rakowski, 'Słuch absolutny' (see footnote 39).

scholars,[42] has conducted comparative research among American students, including students of Asian origin. This research shows unequivocally that the frequency of the occurrence of absolute pitch is much greater among persons employing a tonal language.

At the same time, this research has become a crucial voice in discussion of the influence of genetic factors. Reference has been made particularly clearly to the aforementioned research by Gregersen.[43] Trevor Henthorn and Deutsch,[44] after reanalysing the results obtained by Gregersen, questioned the conclusion of the role of genetic factors. Attention was drawn to the early musical education among Asian-origin students with absolute pitch. It was noted that the majority of the students of Asian origin gave Asian countries as the country of their early musical education, and so probably spent their early childhood in Asia. Given the method of musical education employed in Japan, for example,[45] it should be stated that this may have fundamental significance for the acquisition of absolute pitch.

Henthorn and Deutsch also observed that in comparison with students of Korean and Japanese origin, absolute pitch was possessed by the greatest proportion of individuals in the group of Chinese-origin students. The scholars emphasise, however, that Japanese and some dialects of Korean, although not numbered among tonal languages, belong to the group of pitch-accented languages, in which pitch plays a role in imparting lexical meaning. Exposure to these languages in early childhood may be significant in the creation of predispositions for the acquisition of absolute pitch. However, the two researchers are of the opinion that the primary influence in the possibility of developing absolute pitch are not genetic factors, but environmental factors.[46]

The genesis of absolute pitch – my own research

The question of the genesis of absolute pitch continues to cause much controversy, which is why it could not be ignored in the research project

[42] Diana Deutsch, Trevor Henthorn, Elizabeth W. Marvin and Hong Shuai Xu, 'Absolute pitch among American and Chinese conservatory students: Prevalence differences, and evidence for a speech-related critical period', *Journal of the Acoustical Society of America* 119 (2006), 719–722. Henthorn and Deutsch, 'Ethnicity versus early environment' (see footnote 30).

[43] Gregersen et al., 'Early childhood' (see footnote 29).

[44] Henthorn and Deutsch, 'Ethnicity versus early environment'.

[45] Miyazaki and Ogawa, 'Learning absolute pitch by children' (see footnote 19).

[46] Henthorn and Deutsch, 'Ethnicity versus early environment'.

on the prevalence of absolute pitch among young people in musical education in Poland carried out in the years 2004–2007.[47]

The screening research covered more than 1175 pupils of primary and secondary schools of music in Warsaw and students of the Fryderyk Chopin Academy of Music in Warsaw (now the University of Music) and the Institute of Musicology of Warsaw University, aged 11–29. The main aim of the research was to ascertain the frequency of the occurrence of absolute pitch among musical young Poles by using tests for passive absolute pitch in two versions, with 25 notes presented on the piano at intervals of 6 seconds and 2 seconds. The tests were accompanied by a questionnaire, which included questions regarding musical education, type of hearing, and also the occurrence of absolute pitch in families. The correlation of the results of the listening tests and the questionnaires not only enabled us to isolate persons possessing various kinds of absolute pitch, but, importantly, also provided information that might help to explain the genesis of absolute pitch.

The 'early learning' theory, according to which the commencement of musical education before the age of six is an essential condition for acquiring absolute pitch, is strictly linked to the question of the age at which formal musical education begins. This concerned in particular the analysis of the answers given by individuals who in the 6 second piano test obtained a result over 65%, and so, according to the criterion adopted after Warren Dixon Ward,[48] individuals possessing nearly perfect absolute pitch.

The combined analysis of the results of the questionnaires obtained in all the groups (the 1001 people who answered the relevant question in the questionnaire) confirms that the early commencement of musical education is characteristic of persons with absolute pitch (see Figure 1). In the group of 62 persons with absolute pitch, in over 70% of cases their musical education began at the age of 6 or 7, and in 17% of cases between the ages of 2 and 5. Only two persons gave an age from 8 to 10 as that when they began their musical education.

[47] Sylwia Makomaska, 'Występowanie różnych rodzajów słuchu absolutnego w środowisku młodzieży polskich szkół muzycznych' [The occurrence of various kinds of absolute pitch among young people in Polish music schools], unpublished Ph. D. thesis, Warsaw, 2008.

[48] Ward, 'Absolute Pitch' (see footnote 6).

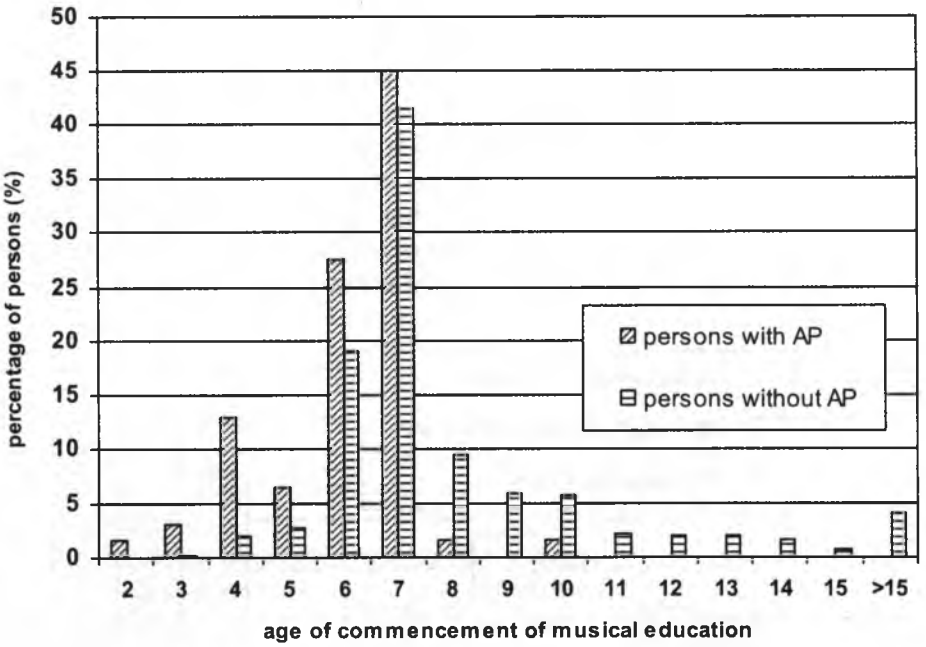

Figure 1. Age of commencement of musical education by 1001 pupils and students aged 11–29 in all groups studied (62 persons with absolute pitch, who in the 6 sec. piano test obtained a result above 65% of recognition of chromatic pitch; 939 persons without absolute pitch – in the 6 sec. piano test a result below 65%)

Generally speaking, the data obtained would appear to confirm the 'early learning' theory, although the upper threshold of the pre-operative period in the child's development (the 'critical period') was shifted to seven years of age, which is doubtless linked directly to the Polish system of musical education.

The issue of the genesis of absolute pitch is also reflected in the last question contained in the questionnaire: 'Is there or has there been anyone in your family with absolute pitch?' This time, the aim was to examine the phenomenon of absolute pitch within the context of genetics and the occurrence of absolute pitch in families. In the case of this question, the decision was taken to employ different criteria of correct answers obtained in the 6 second piano test: below 50% (for persons without absolute pitch), between 50% and 100% (persons with absolute pitch) and 100% of correct recognition of chromatic pitches (persons with full genuine absolute pitch).

The next graph (see Figure 2) gives a combined presentation of the percentages of answers to the question concerning the occurrence of cases of absolute pitch in their family given by 1008 persons. Most interesting of all is

the percentage breakdown of positive answers obtained thanks to the use of the three criteria for correct answers. In the group of persons without absolute pitch who in the 6 second piano test correctly recognised less than 50% of the notes presented, 125 respondents out of 894 (almost 14%) marked the answer 'yes'. Among those who had obtained more than 50% of correct answers in the 6 second piano test, but not 100%, 16 out of 78 individuals (20.5%) stated that cases of absolute pitch had occurred in their family. Interestingly, in the 36-person group of listeners who faultlessly identified all the notes presented in the 6 second piano test, 8 persons (22%) answered 'yes'.

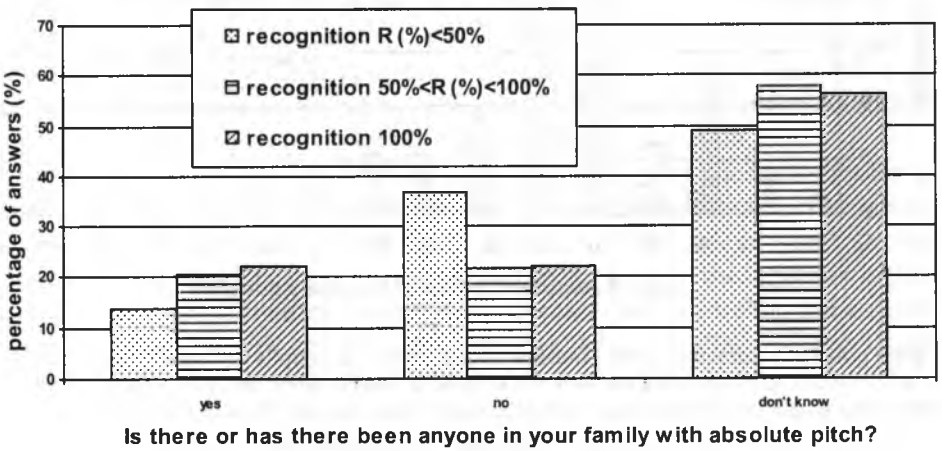

Figure 2. Percentage of answers to the question 'Is there or has there been anyone in your family with absolute pitch?' given by 1008 listeners aged 11–29, including 894 persons who in the 6 sec. piano test obtained a result <50%; 78 persons who in the 6 sec. piano test obtained a result 50<100%; 36 persons who in the 6 sec. piano test obtained a 100% result

The analysis of the answers given in particular groups leads to the conclusion that the percentages of genetic links rise in proportion to the percentages of increasing quality of absolute pitch, which to a certain extent may indicate the role of genetic factors in the acquisition and development of absolute pitch.

Of course, in order to obtain unequivocal results, supporting or negating the theory of genetic factors, further experimental studies would have to be carried out with the participation of members of the families of persons with absolute pitch. At this stage in the research, we can only assume that the phenomenon of absolute pitch probably occurs in the families, although only the verification of the data from those questioned would allow us to evaluate the role of genetic factors in the acquisition of absolute pitch.

Conclusion

The question of the factors determining the forming of absolute pitch is still the subject of quite heated discussion. Predominant at the present time appear to be theories which attempt to investigate the genesis of absolute pitch from many angles, endeavouring to combine the theory of early musical education with the theory of genetic factors and in some cases expanding this to include the theory of tonal languages.

Currently in progress are a number of different research projects aimed at providing experimental evidence supporting one or another of the theories accounting for the genesis of absolute pitch. One of the most interesting projects is that undertaken by Oliver Vitouch of Klagenfurt University and Miyazaki of Nijagata University, who in experimental studies are aiming, among other things, to track the process of the training of a chosen group of European children using a Japanese method and of Japanese children using European methods.[49]

Summarising the considerations of the factors influencing the forming of absolute pitch, it is worth noting that in the literature one frequently encounters the opinion that an early musical education is an essential condition for the acquisition of absolute pitch. At the same time, it would appear that the degree of necessity may differ individually depending on genetic background. Absolute pitch is thus treated as a combination of a certain (probably genetic) foundation, as yet not fully investigated, and appropriate input data applied at the right time.[50]

Translated by John Comber

[49] Oliver Vitouch, paper delivered to a symposium devoted to the perception of musical pitch, Fryderyk Chopin Academy of Music, Warsaw, 2005.

[50] Academic study financed in part from the research funds for the years 2006–2008 research project no. N105 028 31/3210.