PERCEPTION AND COGNITION OF MUSIC HARMONIC PATTERNS

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Content

1. The Perception of Harmonic Patterns in Music

1.1 General Notes

Let's include the selected relevant knowledge about the music perception of chord and harmonic music structures into the general outline. The course of perception is usually explained as an active and continuous mental process. According to U. Neisser[1] it may be described as continuous perception operations, under which the sensory data is organized within the mental cognitive structures. The perception takes place through schemes, or schedules of perception activities (operations), under which the suitable currently focused perception structures are separated. The schemes ensure the continuity of perception over time and the influence of the past over the future, i.e. experience on our expectations. Additionally within this context, the integration of perception, memory and motivation occurs.

During the perception process, there is a dual transformation: (1) transformation of external physical stimulus (external physical energy) in receptor(s) excitation and a stream of nerve impulses; (2) transformation of nerve impulses (under the Neisser's concept of the nerve model of perceived object)[2] into a resulting perception of mental nature. This dual transformation covers a) the physical, b) the neurophysiological and c) the mental phenomena. Under the music perception research, most frequent combinations of these phenomena entail either a–b or a–c.

The theoretical reflection of the perception process course follows both the subjective (mental) aspect and objective aspect, i.e. the nature or quality of the stimulus. These two items are defined in rather differing extent, whereas, they need to be rigorously accurately defined in order to carry out laboratory research.

Gestalt psychology demonstrated that the perception is executed under the influence of congenial tendencies towards creating structure within perception, which means that the perception field consists of a figure as a central dominant object, and a background that is behind or around the figure as something less apparent. The contribution of Gestalt advocates also consisted in the discovery of shape laws, according to which the stimuli elements are grouped under various shapes, or structures.

Just as significant is the role of images, standing against the perception as less apparent, stable and compact. Their formation is closely linked to attention as a mental status of concentration on a certain object. The quality of these conditions is closely linked with the stability and compactness of the perceived object and its structure. The last mentioned aspect of the perception process is broadly discussed in psychology as polarity of the whole and of the part. In a close relationship to the learning process, this dependence is interpreted as continuity and discontinuity, where the continuity of the perception process corresponds to the continuity of the perceived reality, while discontinuity corresponds to its division to partial elements. One of the symptoms of continual perception concerns the fact that the perception field is simultaneously internally divided into the figure and background.[3]

According to Burjanek, the musical content is a distinct figure on the backround of another sensory perceptions, which may be drawn or absorbed by a figure.[4] Some solo instrument may play as a figure with the accompanying orchestra as a background, or the melody can be the figure and the harmony can be the background.[5] Piaget talks about the process of centration with orientation towards focus with a figure and background. Let's also mention the theses of Gestalt psychology about new relationships between the elements within the structure and their mutual influence.

In terms of discriminating between the participation of the individual levels of personality in the perception process, the hierarchical structure is generally accepted, with the first detection stage followed by the discrimination stage, while the sensory level, followed by a higher level, perception level, and the highest mental level are involved, activating a wide participation of the perceiving subject's personality.

Perception represents a procedural analytical-synthetic act, taking place at the perception basis as biologically determined mechanisms, as well as a complex analytical-synthetic process. In terms of music thinking, it is possible to observe basic analytical micro-stages, where the components of thoughts originate, and synthetic ones where they connect to other parts of the continual perceptive image structure.[6] Analytical, as pointed out by B. Dušek, is usually linked to the relative pitch with the ability to discriminate the individual tones in chords.[7] "The Music thinking masters the series of perceptions by appreciating conformities and changes using memory and abstraction", while at a higher level of musical experience "the reproducible recapturing and anticipating moments of accurate non-visual cognition about a certain range of relationships midst auditory sensory continuity occur, or similarly summarized non-visual, reversible, reproducible realizations of some musical harmonic vertical complex occur, with the orientation and structuring function. These abstract thoughts compressed units may be developed into auditory images."[8] The development aspect of music experience, including the process of perceptive processing of a music stimulus may be presented, according to J. Burjanek, as follows:[9]

Table 1 Music experience structure scheme (From Burjanek, 1970)

Music experience	
a) receptive	b) imagined and thought
(with images and thought elements and operations)	b1 reproductive b2 fantasized, creative, inventive
Genetically is every b) dependent on a).	

The perception occurs selectively; the recipient (listener) thus selects the perceived based on what corresponds with his/her level of perception and abilities. This selectivity and quality of the perception process is subject to factors that are jointly identified as cognitive.

The cognitive approach looks at the human activity, whereof the response to music always concerns a certain degree of a subject's activity, not only as a passive response to a stimulus but as methods of processing input information using memory, images and other mental functions. The term cognitive is used for a wide range of meanings.[10] In its broad sense, it is used to denominate all cognitive processes without differentiating between the methods or theoretical backgrounds. In its narrower sense, it means a psychological movement which reduces the cognitive processes to the information processing processes.[11] This movement developed in the 1960s in the United States and gradually spread across the Anglo-Saxon countries and Europe. Cognitive psychology was anticipated by significant thought stimuli in psychology of the previous periods, such as distinguishing between the primary and secondary memory by W. James at the end of the 19th century, organization and structure of memory images by F. C. Barlett in the 1930s and development of this issue by R. C. Atkinson and R. M. Shiffrin in the 1960s into the concept of short-term and long-term memory. E. D. Broadbent transformed the attention, perception, short-term and long-term memory to the information processing processes.[12] The concept of cognitive processes focuses, within the cognitive psychology, not on the external behaviour and cognition but on internal cognitive processes, seen as the information processing processes. Cognitive psychology distinguishes between the cognitive processes of lower and higher degree. For instance, the process of perception is denominated with a more general term, i.e. processing of information mediated by the perception stimulus. The procedural and informative nature of information processing is, as an essential feature of the cognitive psychological approach, further complemented with the structure in terms of hierarchizing and modelling of cognitive processes. Subsequently, we talk about processing information at higher or lower levels. The cognitive processes occur in parallel and series and there is a mutual interaction. The essential aspect of cognitive psychology applied to the research of perception processes within the context of complex harmonic music structures concerns modularity. The models of cognitive processes overcome the traditional classifications of mental functions, primarily by categorizing the processes to further partial levels of information processing.[13] They may acts as a variable. The partial elements of cognitive processes are studied in terms of their interaction. The primary topics studied by the cognitive psychology cover mental representation research, mental model establishment research, study of mental contents, symbolic (sign) processes and intentionality, which also applies to music psychology of cognitive approach.

Mental representation as the process of visualization has been studied in psychology in terms of social psychological aspects; the generally psychological approach clearly dates further back and presented by Brentano at the end of 19th century and by K. Bühler and J. Piaget in the first half of the 20th century, still without the attribute of mental; later as the component of cognitive psychology, the cognition is seen as the information processing process, already in the form of mental representation.[14] The research of a sign and meaning was also applied, in terms of semiotics, to the area of music.[15]

In this paper, the term cognitive means mental cognitive procedures in terms of the identification or perceived chord structures, mental representation, analysis, comparison, etc., with the involvement of conscious attention, activation of music imagery and short-term and long-term memory. Thus, we do not consider the complex acts of experience in terms of aesthetics; nevertheless, they may follow the cognitive apperception stage up.[16]

Memory represents a significant mental characteristics internally interacting with the course of the music perception process. It is demonstrated through the process of recollection and recognition.[17] Via the cognitive and memory factor, as defined by Guilford,[18] it is possible to embed the important mental functions activated during apperception of pieces of music into a wider model of human thinking, as already seen with J. Burjanek. Guilford believes that the bond of the auditory memory at the content figural level is apparent; it is more apparent than at the symbolic or semantic level. In the area of recognized matters, we are either, based on the type of the recognized matters, in the figural area (at the degree of units, classes and relationships – using the Guilford's terminology) and maybe even in the symbolic area (if we wanted to find a place for activities related to the establishment of apperception templates).

In the process of perception the memory is the carrier of continuity. In Neisser's scheme commented above, the memory plays the role of an agent allowing to identify the meaning of perceived objects and thus complements the perception cycle to establish a meaningful entity.

The research studies of short-term memory capacity all agree that the number seven is the number which is usually not exceeded.[19] As mentioned below, it is possible to find an agreement, for example, with the number of elements in the Thackray's chord memory test, where the respondent is asked to remember a music stimulus (chord) and detect it in the following series of chords, containing maximum of seven chords.[20] The tasks of the melodic memory subtest by A. Bentley are at the low limit of five memory elements. In the test for rhythmical memory, which does not require a detailed remembering of the rhythmical structure of the example, but only a comparison of two versions, the number of elements varies from four to nine, with seven-element stimuli prevailing.[21]

Unlike the short-term memory, long-term memory is the vital prerequisite for mental retention of systemic melodic and tonally harmonic schemes included in the tuning, scales and system of keys that are the subject of music enculturation of each individual. It has been demonstrated that maintaining memory fingerprint of chords is simpler that of the individual tones, and that assessing the changes in major and minor quality of chords is more difficult than assessing the changes in tone pitch.[22]

The existence of dual polarity of psychological (subjective) and music structural (objective) conditions affecting the perception modalities has been accepted since the very beginning of music psychology experiments.

It was already O. Zich at the beginning of the 20th century who distinguished between the objective and subjective conditions in the context of analytical perception of chords (sets of tones). The objective conditions are represented by the music material and its variable structure and style; the subjective conditions primarily include memory for the relative tone pitch, i.e. for intervals, and the ability to hold in appreciate several tone pitches at the same time.[23]

The mutual relationship between the music stimulus and mental potential for its processing is pointed out, in the context of cognitive psychology, by C. L. Krumhansl.[24] She talks about objective music features of a stimulus that are perceived, and about mental experience corresponding with these perceived qualities. There is an active relationship between the objective and subjective. Additionally, she is also aware that there are objective music characteristics that are not perceived, resulting in a music experience of a subject that does not correspond with them. This actually very succinctly defined or even simplified approach to the perception process is nevertheless of a very significant methodological importance for conducting laboratory music experiments. No less is it important in the context of music education.

Therefore, we should define these external conditions more exactly. Using the ideas of J. Volek, it is possible to define the objective conditions based on three link degrees applied to the systemization of theoretical-harmonic topic. The *link of the first degree* includes grouping of tones over time with linear melodic linkage, resulting in melody, and groups of tones in the tonal space with vertical chord linkage, resulting in a chord.

The link of the second degree consists in a linear cluster of chords over time, as the essence of harmony. The harmonic link is, in terms of the number of participating music elements, more complicated than the first two as it links units that are already linked. The category also includes the clusters of chords in the tonal space, which linked vertically. The result is a polychordal texture. As the link of the third degree Volek talks about a group of melodic and harmonic fragments in the tonal space under vertical sound timber linkage. It results in a sound timbre complex (chord) as the basic unit.

Our paper primarily discusses the area of music stimuli with the link of the first degree in vertical chord sense, and a full link of the second degree, with the emphasis on the linear groups of chords over time, i.e. harmonic relationships.[25]

1.2 Perception of Static Chord Structures

The issue of psychological regularities of static chord structure perception was studied in great detail at the beginning of music psychology research in the second half of the 19th century. Let's mention the two most disputable issues, standing in the centre of the research. The first one addressing the issue of consonance and dissonance and the second one conserns monitoring the analytical and holistic aspect of static chord perception.

1.2.1 Consonance and Dissonance

From the historical perspective, consonance and dissonance are the most frequently discussed issues in music theory. Consonance and dissonance have been studied from various perspectives and functions. It is possible to trace the features of blending between theory and speculation, theory and empirics, reaching to the composition practice and music life. While we may say about early mathematical concepts of consonance with roots in the Pythagorean antique school, assessing consonance and dissonance based on frequency numerical ratios, that their applicability lies outside the music psychology area, the acoustic physiological and psychological aspects in a number of defined theories of consonance and dissonance are mutually linked based on whether they emphasize the acoustic physiological, acoustic psychological or musical social aspect. Additionally, it is possible to distinguish whether the music material was deemed to be musical static or rather under mutual vertical horizontal relationships or in terms of their vertical frequency (from two- to twelve-component, if in the context of tempered chromatics).

The topic of consonance and dissonance relates to the psychological variability of mental fingerprints resulting from the perception of two or more auditory stimuli in terms of the presence of a certain specific type of tension.

Additionally and at great length, Stumpf devoted his research to the tone fusion phenomenon. This issue was addressed in the second volume of Tonpsychologie, chapters Degrees of Tone Fusion and Source of Tone Fusion.[26] Stumpf observed fusion (Verschmelzung) in both harmonics, as well as harmonic intervals. Since the sequence of intervals arranged according to the degree of fusion was markedly similar to the sequence of intervals arranged according to their consonance, Stumpf deduced that the phenomenon of fusion is actually identical to consonance and dissonance. Stumpf's contribution to addressing the issue of the consonance and dissonance relationship consisted in, briefly said, his attempt to transfer the acoustic-physiological interpretation of consonant and dissonant intervals (H. Helmholtz) to the sphere of psychology.

Applying dyads, Stumpf observed (within the context of fusion) that if music amateurs, especially, are exposed to various types of intervals, even the "position" within the interval sequence ordered by their fusion, where from the subjects start recognizing two different tones, is changed and the interval can be perceived in an analytical manner. Teplov provides the following comment: "The leap from plain to complex perception of different individuals occurs in different positions of the respective sequence: for some already when switching from the perfect 8ve to the perfect 5th, for others when switching to the tritone or even just major seventh."[27]

Stumpf's experiments encouraged many other experimentalists who worked with preferential and absolute evaluation criteria, or with assessment of chords according to their usage or familiarity. Stumpf's contribution in addressing a wide spectrum of the relationship between consonance and dissonance consists in the fact that he presumed the acoustic physiological interpretations of consonance and dissonance of harmonic intervals and chords by applying the psychological approach. This conclusion is widespread although according to R. Plomb and W. Levelt, Stumpf later considered it as unsatisfactory.[28]

As already mentioned above, the phenomenon of consonance and dissonance in terms of mathematical physical and acoustic physiological was, of course, studied already before Stumpf. Let's remember at least the role of numbers and their ratios with old Greek Pythagoreans repeatedly applied in the 18th century by the Swiss mathematician, L. Euler, or the Helmholtz theory of beats.

One of the partial summaries of applied criteria to determine consonance and dissonance in music in the context of music psychological aspects was presented by C. F. Malmberg in the first third of the 20th century, and by the American psychologist, M. Guernsey, at the end of the 1920s. Malmberg reflected the following characteristics typical for chord consonance:

- smoothness,
- similarity, or unity,
- pleasantness,
- purity.

He went rather far in history – to the medieval theorist and composer, Franco of Cologne, and renowned mathematician of the 18th century, L. Euler. Nevertheless, by summarizing the approaches by H. Helmholtz, C. Stumpf, A. Faist, A. Mainong, T. Lipps, F. Krueger and others, he described the status of addressing this issue as it took shape during the second half of the 19th century and the beginning of the 20th century.[29]

Criteria of consonance and dissonance formulated differently M. Guernsey:[30]

- criterion of chord smoothness and roughness (H. Helmholtz),
- criterion of the degree of fusion (C. Stumpf, A. Faist, A. Meinong, A. Vitasek)
- criterion of preference upon pairs of succesive intervals, or absolute judgment of the intervals (like – dislike type) C. E. Seashore, C. F. Malmberg, C. W. Valentine),[31]
- conventional criterion, the habit or familiarity of the chord.

B. M. Teplov[32] carried out analysis and comparison of the results based on the above criteria. His outcomes may be briefly interpreted as follows: the first two criteria are identical in terms of the sequence of intervals (perfect 8ve, perfect 5th, perfect 4th, major 3rd, major 6th, minor 3rd, and minor 6th). By applying the third, preferential, criterion (identified as emotional by Teplov) the scale of intervals starts rather differently (major 3rd, minor 3rd, major 6th, minor 6th).

C. E. Seashore deemed the feeling for consonance of intervals to include the feeling for harmony and for this approach he was justly criticized by Teplov. Nevertheless, the Seashore's conglomerate of three criteria for determining consonance and dissonance, which he used in his well-known test set of 1919, may be regarded as applicable and confirming Seashore's preference of acoustic physiological aspects corresponding with their hereditary (innate) stability.

Thus Seashore's[33] criteria of consonance include:

- feeling of unity, or congruency – blending (however, not in the sense of Stumpf's fusion),
- smoothness with a relative absence of beats in the sense of experiments by H. Helmholtz),
- purity as analogy to pure sinus tones applied by W. Wundt.

Seashore more or less rejected the idea of Stumpf's fusion of tones as a psychological criterion of consonance. From the ontogenetic point of view, Seashore believed that this ability is not subject to the learning process but, on the contrary, it is already developed in children of the youngest age, and thus there is no significant difference between children and adults.

As adequate, B. M. Teplov[34] recognized only two out of four criteria by M. Guernsey, i.e. smoothness or roughness and degree of fusion. He calls them criteria of consonance and dissonance discrimination in their own sense of the word.[35] The third preferential, or emotional criterion, as called by Teplov, differs from the first two, because despite consonance once again formed with seven intervals just like with the first two criteria, their order within this category is different. The most "liked" intervals include sixths and thirds, not octaves and fifths. The fourth criterion of familiarity is usually applied, as shown below, in the context of the so called music consonance and dissonance, i.e. in the context of harmony.

Since it is, in terms of history, a rather extensive issue and, in terms of background and opinions, a widely stratified topic,[36] it is necessary to define the respective field relevant to our subject in greater detail. The context of the chapter discussing the consonance and dissonance evidently points out that we follow the vertical factors. According to the nomenclature by O. Šín, it concerns efficient (vertical) consonance and dissonance, not harmonic (horizontal) consonance and dissonance.[37]

K. Janeček used, for basically identical phenomena, the terms internal tranquillity and tension and external tranquillity and tension.[38] Furthermore, K. Risinger distinguishes between the internal static tension and internal dynamic tension (static and dynamic dissonance).[39]

The major and minor triads, their inversions and interval components, are considered consonance. The category of static dissonance includes clustered chords (e.g. C1, E1, G1) as well as harmonics intervals (e.g. C–D2); the category of dynamic dissonance covers other internally dynamically tense chords (e.g. C1, E1, G1, H1).

In the area of internal peace (consonance) and internal tension (dissonance) K. Risinger defines the acoustic-physiological component and the psychological component. The acoustic component is identical to Helmholtz's conclusions regarding the relationships between harmonics, combination tones and beat. The psychological component is understood to closely resemble the Stumpf's fusion phenomenon.

The psychological component is, within the scope of music perception of an individual as well as cultural unit, invariable; it does not change with octave transpositions, with position modifications of chords, or doubling of tones, as far as the type of inversion is maintained, e.g. triad.[40]

This specification of consonance and dissonance psychological component also defines the area to which the harmonic inversion principle applies. K. Janeček defines it as follows: "Chord inversion is as consonant or as dissonant as the original chord."[41]

Another very frequently raised issue concerns the question of assessing the dissonance of harmonic accompaniment to the melody line. At this point it is necessary to point out that in this case we are not involved only with consonantly dissonant vertical relationships but the component of harmonic (horizontal) consonance and dissonance joins in. The perception of consonance and dissonance is most frequently treated in terms of genetics, while it is usually the age when a child starts to catch the differences between consonance and dissonance that is monitored.

To conclude, lets summarize the general psychological rules regarding consonance and dissonance, as worded by B. Dušek.[42] They are as follows: (1) the rule of expansiveness of dissonance against consonance in a chord; (2) the rule of consonant chords asymmetry; (3) the already mentioned harmonic inversion rule; (4) the rule of disparity between the increased complexity of a structure and level of chord dissonance and (5) the rule of clear division between consonance and dissonance.

The continuous interest in the theories of consonance and dissonance during the 20th century was also accompanied by new summarizing outlines of the issue. The contribution by the N. Cazden falls under the area of enculturation theories of consonance and dissonance. He studied the issue of systematics of consonance and dissonance and the influence of the cultural environment during the 1940s up to 1970s. N. Cazden, based on the historical outline of the concept of consonance and dissonance consistently distinguished between the area of static and dynamic consonance and dissonance, while deeming the static qualities of consonance and dissonance (he himself used the term euphoria for this quality), despite undisputable and definitely supported also by experiments, to have only a marginal importance, since they are detached from the music context. According to him, a more significant dissonance concerns the dissonance based on the principle of expectation resulting from the context of music harmony.

Cazden distinguishes three levels of dissonance based on musical relationships and derived mental responses. The first level consists of dissonant non-harmonic or non-chord tone, inclined to address or release the dissonant tension within the context of a chord or harmony. The second level consists on the dissonant chord moment, which means evocation or waking up of the expectation of the following chord in the context of a harmonic movement. The third level is seen in the tonal centric dissonance, seen in the essential harmonic inclination from the dominant tonal area to the original area of tonal centre. Cazden proposes that *expectation* in the suggested music meaning is subject to learning reflecting a certain music cultural environment.[43] In terms of factors affecting the mental qualities perceived in this manner, he prioritizes the quality, or differences in the musical competencies of individuals.

The influence of culture and certain music environment (here the West-European equal tempered tuning) on the familiarity or acceptability (not pleasantness, consonance) of slightly adjusted perfect fifths was examined by Joos Vos.[44] He reached a conclusion that the most acceptable fifths are those that are only slightly modified, i.e. diminished or augmented from -6 to +2 cents.

R. Parncut attempted to summarize the questions related to consonance and dissonance in the context of cognitive music psychology. He sees the topic to cover the following four areas: (1) consonance of individual chords in movement, (2) consonance of pairs of subsequent chords, (3) unifying effect of melodic stream and (4) rigidity of a tonal structure in a harmonic movement. Parncut thinks this system is applicable to all music styles, including impressionism or jazz music of the 20th century.[45]

The topic of dissonance is once again elaborated at the end of the 20th century in the context of the sensory dissonance theory, derived from the existence of harmonics and studied by D. Huron.[46] As shown below, this approach generated a number of new experimental research studies. Although there are many theories and approaches to the issue identified with the terms of consonance and dissonance in the music theory, music acoustics and music psychology (Huron mentions eight most significant ones), at present it is possible to see the solution to consonance and dissonance of static chords and harmonic music structures from the following four theoretical positions.

Psycho-acoustic theories, which are based on physical characteristics of acoustic signals, such as the tone frequency ratio. Psycho-physiological theories, which are based on psychophysiological characteristics of the auditory system, such as the influence of basilar membrane. The cognitive theories based on the opinions that the determining factor for perceiving intervals and chords is their mental processing in the process of learning. The enculturation approach, which is based on the social cultural standards, internalized by the perceiving subject during his/her socialization.

In agreement with Hargreaves it may be stated that those theories with the prevalence of music psychological aspect could be divided into two groups. Theories that are not affected by the environment and enculturation and the present literature calls them, not really accurately, sensory consonance and dissonance of tones, whereas their basis consists in perception and mental processing of complex tones and their parts (harmonics). The second line consists of the so called music consonance and dissonance, which is more affected by experience during the development in ontogenesis under the enculturation and intentional music influence.[47]

1.2.2 Relationship between Holistic and Analytical

Relation between holistic and analytical has been studied in detail within the topic of static chord structure perception since the birth of research on music psychology. Carl Stumpf studied this issue in his pivotal work, Tonpsychologie, especially in its second volume published in 1890. Generally, the music research material was purified in order to eliminate the number of redundantly intervening variables relating to tone quality (timber, duration, volume, etc.). The specific Stumpf's approach meant analyzing the chord qualities over artificial sine tones produced under experimental condition. He grasped the analysis and sound detection (Heraushören) in terms of the sound timber effect (artificial depletion of tone spectrum) and the aspect of short-term memory by applying the analysis of memory images of sustained sound stimuli.[48] It is interesting to note that in terms of chord analysis Stumpf also focused on the role of attention,[49] and thus appreciated the importance of activity inside the percipient subject.

With his experiments, Stumpf introduced, as well as, partially answered several questions addressing the relationship between a part and the whole in perceiving static intervals and chords. While describing the respective issue it is possible to follow some synthesizing notes by Teplov. In general, the static chord perception means simultaneous perception of pitch as a reflection of certain frequency and perception of quality, known as timbre.[50] It is the result of harmonics spectrum, if just one tone is involved, or if a chord is involved then it is the result of each chord's tone's spectrum and the result of each tone's timbre. Depending on which aspect of perception prevails, there are two kinds of perceptions: timbre perception and harmonic perception.

"The whole trick in perceiving harmony consists in the fact that we simultaneously have one perception of the entire tone complex and several perceptions of tones constituting this complex. Under this rather limited degree of fusion, while experiencing the perception of harmony, we maintain, in addition to the perception of single tones, the perception of the tone complex as a whole. The auditory analysis does not interfere with this perception and does not cause it to break down into several individual perceptions; it just makes it more complex, more differentiated, richer and ample …"[51]

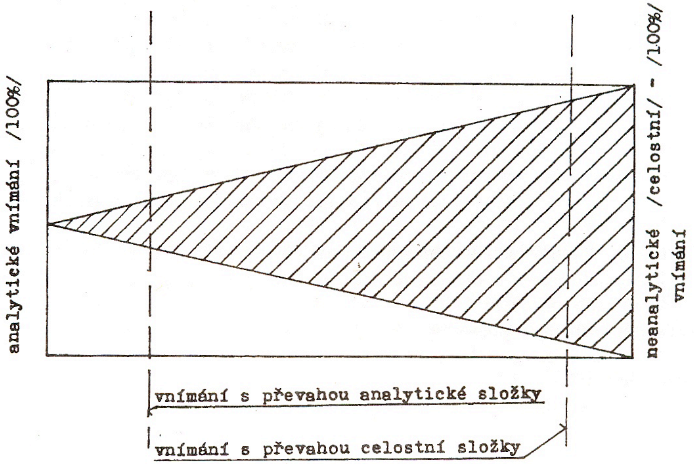
In order to respect the generally used terminology of music theory, it is necessary to replace the term harmony used in this Teplov's citation with the term chord and thus talk about the perception of chord. The second note concerns the dichotomy of timbre and harmonic perception often applied by Teplov. The thought is based on the fact that despite perception being a physiological and psychological process, the music structure is generally identified as a chord, regardless whether it is perceived as a timbre quality or not. The substantial quality distinguishing between both types of perception rather concerns their analytical or non-analytical, or holistic, nature.

Therefore, the terminology used by Teplov, timbre perception and harmonic perception, is not seen as entirely convenient and concise. One of the reasons is that every isolated tone, as well as a chord, demonstrates a timbre quality. On the contrary, we accept the description of static chord perception as provided by Teplov.[52] We intend to paraphrase it, only with modifying the terminology as mentioned above.

An analytically perceived chord contains several separated pitches. A non-analytically perceived chord is perceived as a holistically expressed sound unit. However, these two polarities prevail 100% only in theory. Every music perception of a chord consists of an analytical, pitch, element as well as the element or result of a non-analytical, holistic perception. Sometimes one element prevails, other times it is the other that takes the lead, based on the focus and the ability to separate and detect the tone element in our perception and the possibility of interpreting this element. In other words, even if the analytical, pitch, element prevails, the non-analytical, holistic, is not fully suppressed, and vice versa. In addition, the music analytical pitch perception of chords demonstrates, in terms of the qualitative approach, a higher level of musicality.[53]

The relationship between the analytical and non-analytical elements in a static chord perception, to the effect as described above, may be depicted using the following simplified scheme.

Figure 1 Relationship between the analytical and non-analytical (holistic) perception of static chords



It is entirely clear that Teplov's deductions are based on the holistic psychological apprehension of the perception process. Inspiration was brought primarily by Ernst Kurth, who gives opinion on this issue by specifying that the perception of chords is a simultaneous perception of individuality, elementariness, as well as perception of plurality, frequency of tone stimuli.[54]

It was also Max Meyer, who with several research studies contributed to the issue of analytical and non-analytical perception of chords. He championed the opinion that non-analytical perception and assessment of chords is, in its essence, actually identical to the perception and assessment of musical instruments according to their timbre quality.[55] Furthermore, he postulated that the analytical perception of a chord may not be demonstrated by mere verbal noting of a certain number,[56] but only by performing, i.e. singing or, in cases of tones not possible to be sung, orientation on a tuning fork.

The analysis of tone complexes and conditions under which it may be applied were the topic of essays by O. Zich. He classified two groups of conditions, subjective and objective, while he based his research on the statements by W. Wundt, H. Helmholtz, C. Stumpf and O. Hostinský.[57] Within the group of subjective conditions he places the memory for relative sound pitch, i.e. for intervals, first. Under objective conditions he summarizes the conclusions regarding the phenomena of fusion, tone detection, timbre and pitch distinction of tones, etc.

As an active composer, O. Zich applied, among others, one of the objective conditions, the same intensity of all tones in a chord, to orchestral practice. For example, triad, the first and fifth of which are played by trombones and trumpets, suppresses, or absorbs, the third played by the quieter instruments. It then results in the audible perfect fifth. Under the situation that the strongest exposure in instrumentation is given to the root, Zich believes it brings an impression that, in addition to the root, there is something like "sound haze" making the root somewhat fuller. The impression of compositeness in terms of analysability, however, does not exist.[58]

Upon reflection of one of the principal mental conditions for chord perception, i.e. establishment of an image of more simultaneously sounding tones, Zich notes the known fact that the chord is perceived in a differentiated manner by the musician (and, as very well known, not only by him/her). It is the soprano as an upholder of melody and the bass as the basis of harmony that captivate, sometimes exceptionally, also the middle tone.[59]

However, Zich's reasoning (soprano-upholder of melody, bass-basis of harmony) actually does not provide causal interpretation of the problem; they only represent the consequences of a general principle we are about to point out.

Let's proceed from the harmonic terminology applicable to the most important harmonic phenomena and their modification. Thus, we talk about chord position, root position, inversion and the position of triad. The determinant of these chord qualities concerns either the low or high voice, i.e. bass or soprano. The inner voices are far from having such an importance. In other words, the chord contour, i.e. soprano and bass, condense significant sound information (amplified further in the music context in terms of melody, rhythm, instrumentality, etc.) that are reflected in increased intensity of their perception and, only as a consequence of that, they processed intellectually with increased attention given in the theory. This is additionally and subsequently mirrored in the chord nomenclature and the instruction on harmony (voice leading, figured bass).

In relation to the perception of chords, E. Kurth has already been briefly mentioned. In terms of holistic approach to the issue and in the context of his third category of the triad "Strength, Space, Substance", he studies the patterns of the relationship between a part and the whole. He says: "... if the individual perceptions give effect, the pattern of components always acts in three forms: (1) effect of components on the whole, (2) (reverse) effect of the whole on the components and (3) modified effect of each component on the other individual components. All three partial phenomena express the idea that components not only have a different quantitative expression but also demonstrate qualitative changes."[60]

Under Kurth's approach, chords represent a formation, in which the originally inner kinetic energy that is the source, the root cause, of music melodic movement (Anfangsenergie), transforms to potential energy. Unlike the movement principle of melody, the chords represent the fixative vertical principle. However, even here the initial proto-energy is manifested in the vertical sense as expansiveness (Spannkraft) or as weight or gravity (Schwere, Last). Spannkraft is primarily used in dissonance and pushes upwards from bass to soprano; Schwere, The last has its role in consonant chords and acts downwards (from soprano to bass). Considering the energy aspect, the minor third is also seen as the fundamental chord interval able to bear the push and weight of the upper tones.[61]

The psychological analyses of chord perception were, in addition to the approaches mentioned above, further expanded through discovering new qualities of chords, which were defined with timbre and spatial attributes. For example, E. M. Hornbostel introduced the term *chord timbre* (he also used the term *chord quality*) and W. Köhler advocated terms *chord pitch and chord timbre* (e.g. major triad timbre), regardless of the key in which the chord is exposed.[62] The phenomenological understanding of chord timbre (analogy to interval timbre) is, for Hornbostel, closely related to timbre qualities entering our consciousness as an indivisible whole, without being linked to chord pitch and width. Although the chord and interval timbres are mutually related, they exist independent of each other. Therefore, the chord timbre does not consist of more interval timbres but it is something phenomenally new.

According to A. Wellek, there are two aspects in an isolated chord: linear and cyclic.[63] Wellek calls the linear aspect of the chord quality the overall or external width, divided into the so-called *double width* (Binnenbreite). The cyclic aspect of a chord, as interpreted by Wellek, is represented by a general chord timbre (e.g. major), a timbre defined by chord inversion (e.g. triad's timbre), specific chord timbre brightness (major triad brightness, diminished – Tristan darkness) and special, absolute, chord timbre linked to the key (e.g. triad C major timbre, triad E flat major timbre, etc.).

Along with discovering and denominating the chord qualities, experiments were attempted to demonstrate their presence in the perception process. O. Abraham and E. M. Hornbostel, for instance, tried to isolate the chord *width* from its timbre using dense tone clusters; H. Schole achieved a timbreless chord effect by isolating shortly exposed high tones.[64]

H. Husmann and, especially, H. P. Reinecke may be named as the continuators along the Helmholtz-Stumpf line, especially in terms of studying the elementary static chord stimuli, simply by using technically more advanced psychoacoustic methods.

In his experiments, Reinecke preferred the application of binaural method in order to eliminate all "disturbing" effects (in reality under natural acoustic conditions always present) of combinational tones.[65] He exposed the research subjects to isolated and chord stimuli, played separately into their right and left ears. The results of the assessment of intervals and chords were in many aspects consistent with the knowledge obtained from tests under natural acoustic conditions. The perfect 4th and major 3rd were often "combined" and perceived as chords.[66] Based on the results of his experiments, Reinecke deduces that the harmonic perception is influenced by the processes inside the auditory pathways, rather than the auditory experience.[67]

S. E. Gaede applied the binaural method in combination with the standardized administration of three Wing's subtests.[68] He approached the research of harmonic perception based on the premise that nervous links between the auditory organ and corresponding brain hemisphere are not as efficient as those between the auditory organ and the opposite brain hemisphere. In this respect, Gaede registered differences between a group of tested individuals with music training and a group of non-musicians. The group of musicians did not demonstrate any significant differences in the test results listened to with the right ear first and then the left ear. In non-musicians, Gaede discovered that the right hemisphere (i.e. left ear) demonstrates better results for chord tests (Wing's subtests No. 1 and 2) than the left. For the melodic test of music memory (Wing's test No. 3) he believed the better results were the ones with an active left hemisphere.

Similar conclusions were made by H. W. Gordon. Brief conclusions of his research in musically trained students confirm that the perception of melody is not demonstrated any differently in terms of the quality of perception between the left and right ears, however, the perception of chords demonstrates better performance if mediated by the left ear.[69]

Newly this issue is addressed by cognitive theoretical approaches and research, mostly conducted in laboratory conditions. R. Parncutt chose the theoretical approach to explain the perception of music harmonic rules of the Western music while applying psychoacoustic principles. He followed up on one very successful and generally accepted psychoacoustic models of perception of tone pitch parameters by E. Terhardt.[70] In the perception process, Parncutt emphasized the effect of masking, which results in elimination of audibility of some partial components.[71] Parncutt's perception model of sonority shows several attributes, out of which three are important: a degree of tone coherence – tonalness, tone multiplicity and perception importance – salience.[72]

The individual tones, chords in the perfect octave or major triads have, according to him, a very high degree of coherence, while diminished chords or sounds of bells show a relatively low degree of coherence. Multiplicity nominal value of one sounding tone expressed with a number 1 may, thanks to audibility of any harmonics, increase; on the contrary, in the case of a chord, this value may be, as a result of not perceiving all components of the chord, lower. Additionally, Parncutt introduces the term *perception significance,* or importance (salience). The perception salience is assessed in the context of all pitches under the tempered chromatics and in a close relationship to the perception root, with accumulated highest salience. All perception attributes defined by Parncutt were actually already reflected in theory, but they may be seen as one of the possible methods of finding the link between music theoretical and psychological areas. For instance, research of perception of static chords by T. Pechmann, where the variables include music theoretical parameters of chords (major-minor, chord pitch in the musical space) and psychological parameters (memory).[73]

1.3 Relationships in Harmonic Movement

The previous chapter analyzed the perception of statically assessed chords (chord structures). This chapter approaches the chords as harmonic phenomena, mental correlates of chords as acoustic units[74] in terms of the relationship towards the external environment. This kinetic approach to the perception of chords includes both micro-temporal dimensions of isolated chord perception and larger temporal dimensions, under which chord sequences are perceived and the action of which is amplified by the relationship between what faded away, what sounds at the moment and what is to follow. It is true that even a single chord is spread over a certain short period of time, i.e. it lasts and as such it is perceived, but it does not represent any music harmonic action. The kinetic-based approach is actually a static-kinetic approach,[75] as deduced by Janeček. It implies both vertical components (sound spatial), including sound timbres, and space temporal (vertically horizontal) in terms of the music structure hierarchy according to K. Risinger.[76]

Generally and psychologically speaking, they concern holistically perceived qualities. The holistic approach was advocated in 1890 by C. Ehrenfels, who, using the example of melody perception, overcame the element and associonistic concept. He didn't consider a melody to be a mere sum of the individual tone elements, but a new position quality (Gestaltqualität), which does not change even if the melody is transposed to a different key.[77] Additionally, it is important to point out that within the basic time space where the perception processes take place, the time consequence perception or orientation in time are distinguished.[78] Under our context it concerns the first mentioned aspect.

The time space where the harmonic relationships are perceived is embraced in various dimensions. In a more general respect, let's mention a frequently cited statement of Z. Lissa, who says: "The experience of music does not provide us with a clear "now"; it is always an intersection of the current, the past and the expected music structures. That is the only reason for us feeling the continuity of music works, experiencing the diversity of music structures one after another as a compact piece of music."[79]

The micro dimensional temporal relationships were the subject of experimental research already in the second half of the 19th century. H. Helmholtz and W. Wundt verified in detail the linear temporal relationships between acoustic stimulus and mental perception. Helmholtz explained the psychological combination of the previous, the current and future music stimuli based on the momentum of fine otholitic organs located in the auditory organ. The duration of this sound lingering is about 0.3s, while in every tenth of a second it drops to a tenth of its original volume.

Other research studies demonstrate that the temporal micro dimension of harmonic perception lasts from 1/6000 to 1/16 of a second. For example, Orlov defines more musical "non-point" pattern of presence delimited with a time interval 0.05–10.00s.[80] This space is large enough to accommodate most motifs and topics and it is where most of the harmonic and tonal action occurs.

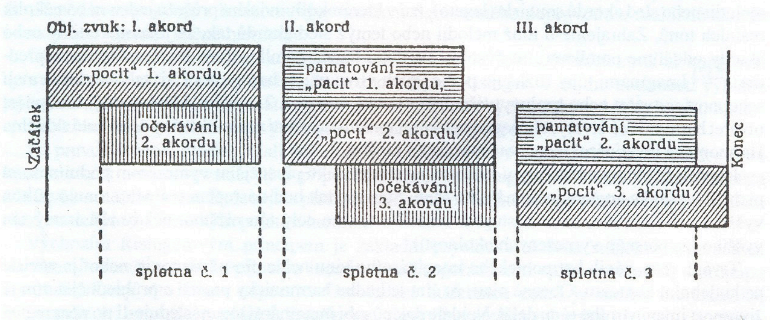
U. Neisser, the "father" of cognitive psychology, used in the 1960s terms analogical to computers, such as *iconic memory* (for visual perceptions) and *echoic memory* for auditory sensory perceptions, under which the auditory perception lasts for about one to two seconds after the stimuli expires.[81]

L. Janáček applied the conclusions of Helmholtz and Wundt to formulate his music theoretical opinions, out of which the most significant for our needs concerns the theory of spletna (twine). Janáček says: "A temporal union of chords of different brightness lies in the foundation of a twine of relative, resulting and pervading chord."[82] The temporal psychological effect of chords made Janáček use it to classify the chords (simple chord, relative chord, resulting chord and pervading chord).

"The chord that takes up the brightest part of our consciousness is the simple chord." "Spletna sounds in one tenth of a second and we do not even realize its less bright part. /…/. Of the relative chord, we often notice only a single tone – during half a second – and all its components blend and are lost in the future or previous clear chord."[83] Janáček rather simplified these relatively complicated chord relationships by identifying the cluster of fading tones as faded perceptive tones and sounding tones as perceptive tones.

J. Volek later commented on Janáček's opinions and accented the so called "deduction" as the second relationship basis between the chords suggested by Janáček. Just as "spletna" expresses the relationship between the current to previous, says Volek, then the deduction is an expression of the relationship between the present and future. Deduction, a feeling of future sound, also creates "spletna", together with blending the current perception and the feeling of the previous chord. This conglomerate of the previous, the current and the future in perception is illustrated by the following Volek's scheme:[84]

Figure 2 Scheme of chord structure with three "spletna" (After J. Volek 1961)



The relationship quality of chords as the basis for their existence within the music context already made C. Stumpf to advocate the terms of concordance and discordance (along with consonance and dissonance) as the terms for chord tension level that is actually not defined by their actual composition but by the position towards tonic.[85]

His idea roots from Riemann's perspective that the feeling of consonance and dissonance is based on the connection between music images, resulting from the chord perception in relation to other chords, in its logical relation.[86] It is known that Riemann, in this statement of his, approached the key as a space with functional chord relationships. With that, as the founder of theoretical functional harmony, he specified music perception, even in the area of harmony, as the identified logic of relations between chords in a key.

Rather a large group of opinions on harmonic events concerns the applications of phenomenological and dynamic psychological approaches. E. Kurth, by accenting the synesthetic moments and emphasizing dynamizing original "prehistoric" effects of music, advocated the presence of internal chord timber, both in chords and harmony.

Kurth believed that the timbre quality is included both in the static as well as dynamic harmony, even without the need to change the musical instrument. In addition, he further hierarchizes this fact in detail. The first level is represented by a single tone with latent harmonic tension. The second level concerns the timbre quality of multiple-element chord interval. The third level is formed by the movement of tones which, according to Kurth, results in traversing the calm colour effect of timbre quality and their rippling and glitter.[87] Kurth says: "The chord effect is produced by the action of chords radiating to other chords because the substance of music lies in the movement. The term of simultaneous timbre may be confronted with the term reflecting timbre; the relative effect always prevails, while there is not just one relative effect at the time but always several simultaneous ones; the most prominent is, however, the one resulting from the relationship to the immediately preceding chord; /.../ nevertheless, the previous chords also produce an effect that is more or less strong."[88]

J. N. Tulin expressed similar opinions to the issue of chord perception. He distinguishes between the perception of vertical sounds, calling them timbre functions, and perception of tonal functions.[89] Tjulin distinguished between two types of chords. The first type is "… simultaneous connection of at least two tones, observed out of the movement as a logical non-differentiated complex of tones evoking certain phonic effects…" The second one is "… a logically differentiated chord, certain harmonic unity, structural entity, belonging to a certain logical system of music thinking."[90] According to these deductions, the first type has "simultaneous timbre" (Kurth), or "phonism" (Tulin). The second type, as understood by Tulin, affects other chords in tonal relationships; according to Kurth, it has reflecting timbre, physiognomy derived from the relationship to other chords.

It was K. Janeček who significantly contributed, in terms of music theory, to the precise definition of the conditions under which the chords are perceived. He gives the rule of subsequent effect in chord perception the form of the so-called imaginary tone, which he defines as follows: "The tone, which actually died away, but still produces an effect, is called the imaginary tone (i.e. only virtual, not actually sounding)".[91]

In the melody and harmony context, Janeček explains the imaginary tone as follows: "If we play a melody or a sequence of chords in continuous manner (legato), one or several real tones sound at any vertical section. If we play the same melody or the same sequence of chords in a manner that the individual tones or chords are separated from each other with rests, then for the duration of every rest we can perceive the tones that sounded right before …"[92] Janeček classifies the imaginary tones according to their effect as: (1) harmonic, i.e. tones with an ability to create or co-create harmonic units, and (2) tonal, i.e. tones without the ability to create harmonic units, tones that merely affect the tonal design of a piece of music or its part. Harmonic imaginary tones are also tonal imaginary tones.

Janeček complements the outlined basic characteristics with more precise definition of the conditions under which the imaginary tone is discontinued. This happens either by a sound of a real tone higher or lower by a halftone or a real tone lower by a tone, sometimes also higher by a tone (under more precisely specified conditions).

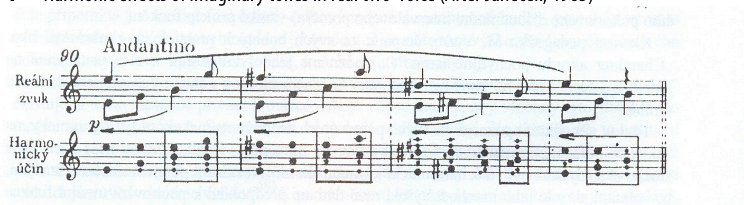
The duration, or end of a harmonic imaginary tone, may not be determined precisely as it depends on the music context. In general, the more the music is simpler and the more transparent in terms of harmony, the longer the existence of the imaginary tone. Thus the imaginary tone is the longest if followed by real silence. However, even here, as pointed out by Janeček, it is important how complex was the chord where the stream of music stopped. In terms of time, Janeček distinguishes between three types of imaginary tone's ends: (1) slow end, (2) normal end and (3) accelerated end.

The imaginary tones are used in various situations. A progressing single-voice in larger intervals is not just a sequence of individual tones, but a sequence of chords arising in each point of the vertical section as a result of co-action of the real tone and the imaginary harmonic tones. This phenomenon is shown in the scheme below. Back arrows illustrate the partial action of lingering chords already from the beginning of a measure, while the chords get gradually clear.

Figure 3 Harmonic effects of imaginary tones in real single-voice (After Janeček, 1965)

Not even two-voice is just a mere sequence of dyads but a sequence of richer chords, as shown in the scheme below.

Figure 4 Harmonic effects of imaginary tones in real two-voice (After Janeček, 1965)



Expressing chords with real tones, imaginary tones or together with the co-action of both (in a mixed manner) corresponds with the harmonic effect of alberti bass and the spreading of chords with the existence of latently perceived harmony.[93]

Karel Risinger integrated the general music psychological aspects of perceiving multiple-voice music structures into his hierarchical method of music analysis. In order to maintain the integrity of this explanation, his contribution has not been mentioned until now within the context of dynamic harmonic structures, although his hierarchical classification in the area of tone pitches also covers static vertical chords.

In actual fact, the question of whether to talk about this problem either as part of chord statics or harmonic kinetics appeared already in the case of Janeček's imaginary tones. However, the substance lay in something else. It was linked directly with the basic role of these imaginary tones as a connecting link between the static and kinetic concept of harmony.[94]

The underlying Risinger principle concerns the basic mental activity of a subject to order the perceived reality according to the identity principle, which rather enhances the orderliness, and the contrast principle, which stands in opposition to this effort. It is possible to organize the music entities in various ways: hierarchical, non-hierarchical and contra-hierarchical. The real perception of hierarchical entities always concerns synthesis, i.e. periodicity of identity and contrast.

There are two kinds of hierarchy: qualitative, where one element of the respective entity is superior to other elements, and quantitative, where the hierarchy is not defined by the centre, but the entity itself as an organized system. As an example of qualitative hierarchy, it is possible to mention the relationship between the tonic and non-tonic functions; as an example of quantitative hierarchy, a major triad with major and minor 3rd and perfect 5th. Both kinds of hierarchy may be combined, which is the case of a tonally perceived major triad.

In static vertical chords, the qualitative hierarchy is represented by the functional subordination of the chord whole to a single basic tone. This condition is met by the chords, the overall structure of which clearly shows the basic tone, e.g. major and minor triads, major-minor and major-major seventh, etc. The chords based on quantitative hierarchy include, for instance, the major or minor triads, but not diminished triad, augmented triad or cluster consisted of twelve half tones, which consist of two identical 3rds or identical 2nds.

The sequences of equal chords, where none of them form the centre (modal hierarchy), feature the quantitative hierarchy in harmony. The qualitative (tonal) hierarchy is based on the functional subordination to a single chord. It is known as functional, tonal or, more generally, as central.[95]

It is the functional relationship quality that Karel Janeček talks about when defining the principle of perfect tonic that controls the final chord sequences in harmonic movement, where the finish should establish an impression of strength equilibration, balance and calming. The principle of perfect tonic is also linked with the existence of the already mentioned imaginary tones. Janeček attaches the scope of general, natural law to the principle of perfect tonic.[96] It is a law that is not limited by certain style and its features, practices or conventions. He points out that the principle of perfect tonic may be evidenced in the previous style periods.[97] By combining the principle of perfect tonic and the principle of a leading tone (as a kinetic result of the sharpest half-tone dissonant interval relation), we get the functional principal.

Let's remember that this statement has experienced a long historic development of the European music culture of the melodic-harmonic period of the 17th, 18th and the first half of the 19th century, as well as a finding of its music theoretical rationale using the terms of chords, tonality and mental processing of these music harmonic phenomena. Regardless of whether we talk about the founder of harmony, G. Zarlino, by determining the triad to be the basic building block of harmony, or J. Ph. Rameau, the founder of theoretical harmony and originator of the idea of a root tone in a common chord and tonic in the harmonic sense of the word as a product of three main triads (tonic, dominant and subdominant), or speculation regarding the term of tonality by F. Fétis. With his approach, Fétis somewhat anticipates the holistic and structural concept of the psychological gestaltism, saying: "Nature does not present our sense of music with anything more but a number of tones (…). These tones, rather unorganized, are put into a logical relationship only by our intelligence combining feeling and will, and organizes them into various series, each of them corresponding with a certain formed system of perceptions. In this manner, i.e. via internal activity pursuant to the laws of our esprit, a tonality is born; its external presentation consists of the traditional scales of modern music, the major and minor scales."[98]

A. Basevi reached even deeper into the music psychological foundations of perception of harmonic tension and tranquillity. Unlike Fétis, he did not stick to the intervals, but he noted that in any key there is a single chord which is able to induce the harmonic perception of perfect tranquillity. This chord concerns the triad on the first degree (major or minor), which represents the centre of gravity of the key (centro d´attrazione). Among the other tones and chords, two more raise above the others, triads on a 4th and 5th degree, which may, for a while, act as a false centre of gravity. Therefore, Basevi explains the key and tonality as a result of interaction between the real centre of gravity and false centres of gravity, as the end (cadence), which is either authentic or plagal.[99]

M. Varró, a piano educationalist, applying her rich practical experience, says: "We can grasp the nature of the chord easier, (…) learn its physiognomy and deduce the individual parts that it is made of (…) and its cadence role in some major or minor key."[100]

In his essays Teplov repeatedly pointed out that the physiognomic perception of a chord, based on the "reflecting timbre" (Kurth), i.e. under a functional relationship, definitely brings along auditory analytical, as he says, harmonic perception of chords. If there is no auditory analysis of these chords, i.e. perception of chords as the plurality of pitches, there is also no condition to experience the tonal chord function. He applies the terminology of Kurth and Tulin and notes that it is possible to distinguish the seventh chord from a triad applying the "phonic effect", "simultaneous timbre"; however, it is possible to determine the chord as a subdominant or dominant based on its "reflecting timbre", its "physiognomy", established on the basis of mutual tonal relationships. Teplov's conditional association of chord analysis and melodic movement seems rather disputable. He attributes the ability to analyze individual chords only to individuals with absolute hearing. The individuals with relative hearing may, according to his opinion, have tone pitch images only within the individual melodic lines and individual voices in the multiple-voice movement.

It was O. Zich who considered the level of generality shown by the tonic effectiveness, or the possibility to deem this matter as an anthropologically given fact. He admitted that it is a phenomenon of phylogenetic nature. On the contrary, other harmonic relationships need to be understood differently, for instance those occurring when harmonizing the melody that may have several "correct" options.

This issue may be partially explained using the conclusions of Risinger and Janeček saying that the harmony includes components that are more or less general. The general, natural, components may be hierarchically (in terms of qualitative hierarchy) higher, be it the centre, be it the tonic in tonal harmony. These components acts are artistic music modification of the anthropological need of tranquillity and tension alternation. The peace and tension components may be organized differently (as a result of artistic thinking and conventions, codification of music theoretical conclusions, etc.). The result then concerns certain "patterns", i.e. harmonic static and dynamic means of expression, gradually mastered by every individual in their ontogenesis, by which the individuals are basically acculturated.

In cognitive music psychological research, certain stable harmonic phenomena canonized in "classical" harmonic rules are followed as features of harmonic music speech subject to culture and style. The research assesses the degree to which these rules are absorbed, listened to and perceived, or whether and to what degree are preferred under experimental situations. The observed features, here the variables, for example concern the correctness or incorrectness of harmonic voice leading in terms of occurrence of parallel fifths and octaves while the psychological variable concerns the level of musicality of respondents expressed in a number of years of systematic music education.[101] Another configuration of sound stimuli lies in the satisfactoriness of the harmonic ends, ending either on tonic or subdominant, where the clear tranquillity of major triads is disputed by clustered final cadence chords by adding minor seconds, etc.[102]

It was J. G. Roederer who attempted to provide the hypothetical outline of perception of changes in tonal and harmonic plan of pieces of music in terms of cognitive psychology. In the central nervous system of the listener the information about tones, their frequency and tonal relationships is coded as an imaginary list that is during a modulating piece of music, being restructured and this process is accompanied by a great number of partial mental operations. Thanks to the complexity of this process, it is possible to distinguish various degrees of quality and depth. Thus, in most research studies, there are two groups of listeners observed, with different level of their mental capacity to process the perceived acoustic and relevant information.[103]

The awareness and understanding of the hierarchy of relationships within a key represents another area of systemic research of cognitively focused studies, primarily represented by C. Krumhansl. These studies observe relationships of triads at individual degrees of a scale within a key,[104] resulting in the finding of mental sensibility for the determination of relationship of chords in a key, even without the link to their tonal status.[105] To investigate tonal hierarchies C. Krumhansl developed with R. Shepard so called probe tone technique.[106] These findings support the theses about strong psychological conditionality of links between the chords and tonal harmony.[107]

D. Huron tried to find the relationships between the rules of voice leading in classical harmony and some regularities of perception (law of continuity, law of tone fusion, etc.). His approach raises a number of new questions thanks to its multidimensionality.[108]

Due to the need to more precisely quantify the relationships within the tonic, the common harmonic terminology is modified in order to better capture not only the music theoretical relationships but also music psychological qualities that are linked to them. Thus, for example, for the relationships between the individual tones within a tonic, R. Parncutt advocates the term pitch commonability of tones, which describes the degree of perceived identity of tone pitch between two subsequently perceived chords; and, on the contrary, the term pitch distance, which expresses the degree of perceived proximity of two subsequent chords.[109]

In the context of harmonic movement, there are also changes in tonal centres as they are released, deviated to closer or further tonal spaces or completely changed. According to L. B. Meyer, the perception of tonal tension and its release, ambiguity and clarity are the substantial source of music aesthetic experience.[110] C. Krumhansl talks about more or less strong feeling of the tonal centre which may sometimes be ambiguous and changeable, other times definite and stable. The psychological experiences of these changes are, according to her, important as a means that makes it simpler for the listener to understand a more extensive tonal plan of a piece of music.[111]

The system of structure and hierarchy of the music material is also closely related to the principle of expectation. In Czech literature, this concept was studied by J. Doubravová, who classified three signs of temporal music structure: 1. motivation, 2. simultaneity, successiveness and conclusiveness, 3. genre quality. To specify the *simultaneity* more in detail, she notes that it is a psychological phenomenon based on the principle of expectation and fulfilment of expectation (Doubravová, p. 132). Simultaneity is linked to the complex perception of a piece of music, its thematic section, leitmotifs, etc. The simultaneity is also closely linked to *continuity,* enabling to perceive the piece of music in a structure and thus understand its artistic intention.

Leonard B. Meyer drew attention to the expectation in his book Emotion and Meaning. He studies the harmonic aspects primarily in the chapter Form, probability, and expectation.[112]

David Huron elaborated the *psychological theory of expectation*, which he called the *ITPRA theory*. This theory is based on five principles – *1. imagination response, 2. tension response, 3. prediction response, 4. reaction response, and 5. appraisal response*. Huron applies this theory to *topics* such as *meter, tonality, atonality, and form*. In the area of *tonality of Western music, he analyses the individual scale tones ("each scale tone appears to evoke a different psychological flavour of feeling" (Huron p. 144)*. He pays particular attention to the analysis of harmonic cadences, where he chooses out of four prototypes of Western music: 1. *Landini cadence, 2. gypsy or Magyar cadence, 3. authentic cadence employing a German sixth and cadential 6-4, and 4. jazz cadence ending on a tonic with added major seventh and ninth (Huron p. 155).*

1.4 Perception of Harmony in the Context of Elements of Music

In this chapter we are going to expand the space we have been active within so far with a set of music means of expression. The reason is our effort to cover the perception of harmonic music entities in a relatively comprehensive manner. In addition, this step brings us closer to the music itself and questions how not only an isolated chord or harmonic movement are perceived, but what is the role, or position of harmony in the complex perception of music with co-acting melody, its metro-rhythmical qualities, harmony, instrumentation, dynamics and other music means of expression.

J. Zich describes the hypothetical course of the perception process under the so-called observation focus on music (in addition to the experiential approach). As an important prerequisite, he points out that the recipient may observe either musically complex or musically non-complex qualities of music. The complex qualities are classified as temporal, tonal pitch and mixed. The harmonic relationships are integrated in the tonal pitch aspects (despite their perception being embedded within a time framework).

Among the harmonic complexes, he especially emphasizes the dissonance of chords, the degree of closeness of the chord relation. His observation regarding the perception and understanding of chords through a prototype, e.g. triad, seventh chord that may be distorted, by e.g. suspension, is also very interesting. Furthermore, Zich points out the phenomenon of tonal functionality, the overall degree of dissonance of music, postulates the importance of the harmonic movement (here obviously in the tonal pitch and temporal sphere) and tone field defined by the selection of pitch localities of the music.

Zich notes that it is actually surprising how many complex and non-complex musical "items" there are, which subsequently raises the question whether it is possible to observe all these components at the same time. Of course, it is not possible. And, as established by Zich, it is not even necessary: "It is sufficient if we pay full attention to just some main complexes or qualities, while others are only marginal to our conscience and the remaining are not practically perceived at all".[113] On the conditionality of the perceivable phenomena he adds that they depend on the abilities and familiarity of the listener with the piece of music.

This statement deserves to be slightly changed saying that not only "is it sufficient", but simply under the influence of generally psychological rules, the elements from a certain set of stimuli are segregated, as a co-result of the perceiving subject's activity, his/her level of perception and a number of other factors. It is thus clear that harmonic music structures are, under the spectrum of music means of expressions, realized only sometimes and under certain circumstances.

Attempting to determine these conditions on a general level might be illusory, as the perception process is intervened with a vast number of variables of both the music structural nature and psychological nature, which affect each other and create innumerable qualitative variants of the perception process. Nevertheless, despite this fact, the course of perception of harmonic music entities has been the subject of research, the results of which may be used to deduce several partial observations.

More often than harmony, it is the melody, pace, rhythm and dynamics that are appreciated.[114] In other words, harmony does not act as a figure, but as a background. With respect to the harmonic technical procedures of expression, the one with higher effect on the listeners concerned pause and chord dissonance (however, compared to other means of expression, only with a minimal difference).[115] In common recipients, the perception of harmonic structures is mostly holistic, non-analytical. Some research also provides information that the observation of harmonic action is mistaken for the assessment of changes in intensity of sounding music and its instrumentation. With this we get back to the perception of timbre quality, which is often used as a synonym for non-analytical manner of perception.[116]

The implied relationships may be expressed in more general context and causal manner by concluding that harmony has, as means of expression, a very complex structure and this makes it different from the simplicity of melodics, making it easier to perceive thanks to its simplicity. Therefore, significantly more in accordance with the rules of perception, melodics appears as a figure (in the psychological sense), whereas harmony is the background. Although harmony, to a certain point, implies an aspect of anthropology (tonic as a centre – calmness, other harmonic functions as an expression of tension), it is, as a system, highly significantly saturated with intellectuality, complexity and artificiality. Therefore, its conscious perception (or, at a higher level, performance apperception) cannot do without a certain higher, not common, music theory training. In this respect, its opposite poles concern "more anthropologic" components of music, namely metre, rhythm, dynamics and also timbre. The timbre quality represents, in the form of synesthetic connections, the prevailing manner of non-analytical perception of harmonic music entities.

Zich's statement integrates a large number of raised questions that are currently more thoroughly elaborated in the context of cognitive music psychology. This applies to the issue of familiarity with the apperceived music entity and resulting degree of expectation as well as to the ability of orientation within a music entity. Furthermore, it applies to the issue of attention, its focus and ability to separate, from a set of phenomena, the individual elements and use them in intellectual operations.

1.5 Conclusions

The key aspects of the music perception mentioned above may be, together with the application to the area of perception of static harmonic structures, harmonic movement and harmony as the musical means of expression, summarized into a conclusion with a certain impact, as seen later, on the discussion concerning the harmonic abilities in terms of its ontogenesis.

The most dominant aspect in the process of perception of harmonic music entities represents the relationship between a part and a whole, which is embraced in the context of *holistic timbre quality* as the prevailing approach to the perception of both static and dynamic harmonic structures as well as the harmony in the context of musical means of expression. The majority of mental apperception events actually occur at the axis of a relationship part – whole.

Above this common denominator, various intervening variables of mental functions and characteristics change, based on which partial situation in the changeable process of perception of harmonic music structures is concerned.

Through some kind of stable intersection, the proposed relationship is blended with the aspect of music *consonance* and *dissonance*, which is, in its multiple-dimensionality differently focused and it even impacts the higher aesthetic levels of the perception structure via the presence of preferential attitude activities of the perceiver.

Additionally, we can find tendencies here with roots in general human needs of *hierarchy and centricity* and there we can see the creative music modification of the anthropological given fact of the need of the alternation of tranquillity and tension. Apart from *cognitive* factors of music apperception, we may also see the potentials mediating the capture and awareness of typical signs of the harmonic music expression and thus enable their understanding or at least feeling as typical. The principle of *conventionality*[117] is included in many areas (perception and assessment of harmonic functions, perception and assessment of consonance and dissonance) of the harmonic music topic.

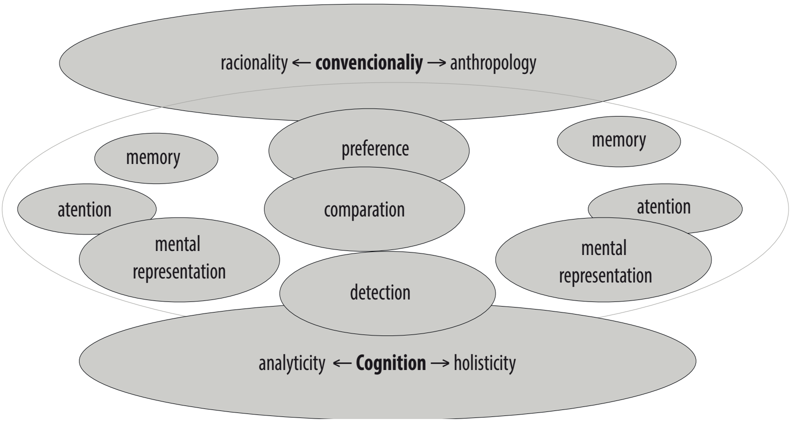
Recollection or mental representation of music structures including the pitch parameter (in intervals, chords and harmony) is significantly structured. This structure quality partial reflects the musical cultural conventions. Via the passive and active listening, the listener absorbs, internalizes the rules typical for his/her own culture. By applying these rules, which are saved in the long-term memory, the listener gets oriented in the perceived music structure to the point that satisfaction as well as expectation arise, in the music psychological and aesthetic sense.

If we accept the conventionality as one of the principles of existence and perception of harmonic universal principle in ontogenesis, it is possible to divide it to two components. The first is seen in the harmony, as the musical means of expression, being canonized, defined into a number of rules, development of which was subject to a wide theoretical and creative front. This type of crystalized manner of music speech may be regarded as *rational music conventionalization of harmony.*[118]

Nevertheless, more closely related to the observed aspects that the rational component of the process of conventionalization (currently in the context of music theory, teaching of harmony in specialized music education, etc.) appears to be the second component of that issue, which could be identified as *natural anthropological conventionalization*. In simplyits centre there are, among others, questions of the universality of music structures, reach of natural conventions, and so on.[119] The natural convention was not given, however, a person found it within the natural sound environment (consonance, pentatonic) and formed it based on psychological regularities.[120] Thus, in the hierarchy of the harmonic music material it is possible to see one of the examples of the most fundamental, the most general and the most universal manner of existence and organization of musical systems of expression. These features are present in, for example, harmonic feeling, having the tendency to organize the harmonic material in the tonally centric manner.[121]

The following scheme shows what has been said so far on the issue of mental activities and perception processing of harmonic music material, arranged in order to emphasize the relationships between the significant factors, signs and functions of the described processes.

Figure 5 Proceses of perception and cognition of the harmonic music material - chords and harmony



The scheme may be interpreted in a way that in the space between the rational and anthropological conventionality with analyticity and holisticity, there are processes of detection, comparison and preference, while their mutual closeness or distance expresses the tightness of the relationship that is variable. On the side, there are intervening significant cognitive mental functions, while their indicated placement or order is not supposed to mean anything significant about their relationship to the three activities lying in the centre of the scheme.

Based on the so far considered issue of perception of static chord structures, harmonic movement and perception of harmony in the context of music elements, the next chapter covers the issue of the harmony, here regarded in the context of music abilities as the potential to mentally process music harmonic stimuli.

Notes

[1] NEISSER, U. *Cognition and Reality*. San Francisco: Freeman, 1976.

[2] NEISSER, U. Cognitive Psychology. New York: Appleton – Century – Crofts, 1967.

[3] PARDEL, T. *Psychológia [The Psychology]*. Bratislava: [Psycho-didactic Tests] , 1982, p. 171 et seq.

[4] BURJANEK, J. *Hudební myšlení. Dvě studie k psychologii a estetice problému. [Music Thinking. Two Studies on the Psychology and Esthetics.]* Brno-Prague: State Educational Publishers, 1970, p. 92.

[5] PARDEL, T., B0ROŠ, J. Základy všeobecnej psychológie *[Basis of the General Psychology.]* Bratislava: Slovak Educational Publishers, 1979, p. 303.

[6] BURJANEK, J. *op.cit.*, p. 111.

[7] Viz. DUŠEK, B. *Úvod do hudební psychologie. [Introduction to the Psychology of Music]* 2nd ed. Plzeň: Faculty of Education, 1972, p. 42.

[8] BURJANEK, J., *op.cit.*, p. 111.

[9] *Ibid.*, pp. 83–84.

[10] HARGREAVES, D. J. *The Developmental Psychology of Music.* 6th. ed. Cambridge: University Press, 2001, p. 15.

[11] SEDLÁKOVÁ, M. *Vybrané kapitoly z kognitivní psychologie – mentální procesy a mentální reprezentace. [Selected Issues on the Cognitive Psychology – Mental Processes and Mental Representation]* Prague: Grada Publishing, 2004, p. 13.

[12] *Ibid.*, pp. 13–42.

[13] Viz. THOMPSON, W. F. - PARNCUTT, R. Perceptual Judgments of Triads and Dyads: Assesment of Psychoacoustic Model. *Music Perception* 1997, 14, 3, pp. 263–280.

[14] This is a reference to the application aspect of music pedagogy, which for at least one millennium has been studying the didactic methods how to establish images or mental representations of symbols of perceived tone pitches in the context of various music and style systems and tuning.

[15] Viz. VOLEK, J. Hudební struktura jako znak a hudba jako znakový systém – I až III. [Musical structure as a sign, and music as a sign system – I – III.] *Opus musicum,* 1981, 13, 5, pp. 129–142; 6, p. 6, pp. 161–174 and 10, pp. 289–295.

[16] Viz. ATKINSON, R. L. et al. *Psychologie. [The Psychology]* Prague: Victoria Publishing, 1995, p. 19 et seq. ; SLOBODA J. A. *The Musical Mind. (The Cognitive Psychology of Music).* Oxford: Clarendon Press, 1985 . Among the Czech music psychologists this question was addressed, for example, by J. Kulka, who distinguished between three types of artistic perception: 1. emotional, 2. rational with prevailing cognitive rational approach and 3. rational spontaneity, expressing the relative balance of the two former approaches. Viz. KULKA, J. Esteticko-psychologické otázky přípravy uměleckého zážitku. [Aesthetic-psychological aspects of the artistic perception preparation]. *Estetická výchova*, 9, 1985–86, pp. 265–266.

[17] The music memory is, however, specific, as mentioned by Burjanek, since"… the perceptive memory is always accompanied by the memory for internalized products as well as an emotional accents." Viz BURJANEK, J. op. cit., p. 80.

[18] Viz. PEŠINOVÁ, H. *K psychologii schopností. [On the Psychology of Abilities]* Prague: Academia 1975, pp. 25–29.

[19] Viz. MILLER, G. A. The Magical Number Seven Plus or Minus Two: Some Limits on Pur Capacity for Processing Information. *Psychological Rewiew*, 63, pp. 81–97.

[20] THACKRAY, R. Tests of Harmonic Perception. *Psychology of Music.* 1973, 1, pp. 49–57.

[21] Viz. BENTLEY, A. *Musical Ability in Children and its Measurement.* London: Harrap, 1966, pp. 77–78.

[22] PECHMANN T. Memory for Chords: The Retention of Pitch and Mode. *Music Perception* , 16, 1, 1998, pp. 43–54.

[23] Viz. ZICH, O. *Estetické vnímání hudby. [*The Aesthetic Perception of Music*]* Prague: Editio Supraphon, 1981, pp. 131–144.

[24] KRUMHANSL, C. L. *Cognitive Foundations of Musical Pitch*. Oxford: Oxford University Press, 2001, pp. 4–5.

[25] Viz. VOLEK, J. *Novodobé harmonické systémy z hlediska vědecké filosofie. [Contemporary Harmonic Systems* in Terms of Scientific Philosophy*]* Prague: Panton, 1961, pp. 72–73 and pp. 180–181.

[26] Ibid., p. 127 et seq. and p. 184 et seq., C. Stumpf advocated that the cause for fusion lies in the physiological disposition of the auditory and brain organ, whereas O. Zich saw the cause of fusion in being used to the first harmonics, despite not being normally audible.

[27] TEPLOV, B. M. *Psychologie hudebních schopností. .[The Psychology of Musical Abilities]* 2nd ed. Prague: Supraphon, 1968, p. 110.

[28] PLOMB, R. & LEVELT, W. J. M. Tonal consonance and critical bandwidth. *Journal of the Acoustical Society of America.* 1965, 38, pp. 548–560.

[29] MALMBERG, C. F. The Perception of Consonance and Dissonance. *Psychological Monographs.* 1918, 25, 2, pp. 93–133.

[30] GUERNSEY, M. The Role of Consonance and Dissonance in Music. *American Journal of Psychology.* 1928, 40, pp. 173–204.

[31] VALENTINE, C.W. The Aesthetic Appreciation of Musical Intervals among School Children and Adults. *British Journal of Psychology.* 6, 1913, pp.190–216 and VALENTINE, C.W. The Method of Comparison in Experiment with Musical Intervals and the Effect of Practise on the Appreciation of Discords, *British Journal of Psychology,* 7, 1914, pp. 118–135.

[32] TEPLOV, B. M. *op. cit.*, pp. 114–118.

[33] Viz. SEASHORE, C. *The Psychology of Musical Talent.* Boston: Silver, Burdet and Company, 1919, p. 147.

[34] TEPLOV, B. M. *op. cit.*, p. 114.

[35] TEPLOV, B. M. *ibid*. p. 114.

[36] Cf. WELLEK, A.- DAHLHAUS, C. Konsonanz -Dissonanz. *MGG*, part 7, pp. 1482–1516; PALISCA, C. V.- SPENDER, N. Consonance. *Grove Dictionary of Music and Musicians*, pp. 668–671.

[37] Cf. ŠÍN, O. *Úplná nauka o harmonii. [*A Complete Theory of Harmony*]* 6th ed. Prague: Hudební matice Umělecké besedy, 1949, pp. 6–7.

[38] JANEČEK, K. Současné harmonické problémy a jejich řešení. [Contemporary Harmonic Issues and their Solution.] *Musikologie* (Prague-Brno), IV, 1955, p. 91.

[39] RISINGER, K. K dnešnímu pojetí konsonance a disonance [Contemporary concept of consonance and dissonance]. In: *Sborník referátů z hudebně teoretických seminářů. [Proceedings of the Seminars on Music Theory]* Prague, Svaz českých skladatelů a koncertních umělců 1985, p. 63.

[40] Compare with the more detailed description of both components in the already mentioned Risinger's study as well as the paper of the same author Problem of Consonance and Dissonance in Modern Music -In: Leoš Janáček a soudobá hudba. *[Leoš Janáček and Contemporary Music]* Prague: Knižnice hudebních rozhledů. 1963, pp. 261–264.

[41] JANEČEK, K. *Základy moderní harmonie. [The Basis of Modern Harmony]* Prague: Czech Academy of the Science, 1965, p. 49.

[42] DUŠEK, B. *Psychologie hudby. [The Psychology of music]* 2nd ed. Prague: , 1982, pp. 73–76.

[43] Viz. CAZDEN, N. The definition of consonance and dissonance. *International Review of the Aesthetics and Sociology of Music.* 1980, 2, pp. 158–161.

[44] VOS, J. *The Perception of Pure and Tempered Musical Intervals.* Doctoral dissertation, University of Leiden, 1987.

[45] PARNCUTT, R. *Harmony: A Psychoacustical Approach.* Berlin: Springer-Verlag, 1989, p. 75.

[46] HURON, D. Tonal Consonance versus Tonal Fusion in Polyphonic Sonorities. *Music Perception,* 1993, 9, 2, pp. 135–154.

[47] HARGREAVES, D. J. *The Developmental Psychology of Music.* 6th ed. Cambridge: Cambridge University Press, 2001, pp. 92–93.

[48] Viz. STUMPF, C. *Tonpsychologie*. Band 2. Lepzig: Hirtzel, 1890, p. 318 et seq.

[49] Ibid., p. 276 et seq.

[50] See theory of two components of pitch, which Teplov accepts.

[51] TEPLOV, B. M. *op. cit*., p. 111.

[52] *Ibid.*, p. 113.

[53] However, here it is necessary to realize that this higher qualitative evaluation is applicable to the Western music culture and areas grown out of its roots. In music cultures using finer tone differences than half-tones and with, for example, more pronounced rhythm, this value hierarchization does not apply.

[54] Viz. KURTH, E. *Musikpsychologie.* Berlin: Max Hesses Verlag, 1931, p. 144.

[55] Cf. MEYER, M. Ueber Tonverschmelzung und die Theorie der Consonanz. *Zeitschrift für Psychologie*, 16, 1896.

[56] Meyer was talking about Stumpf's methodology of chord assessment. Stumpf asked the respondent how many tones they could hear.

[57] Zich also talks about the priority by O. Hostinský under the description of the fusion phenomenon already before Stumpf, in his work *Die Lehre von den musikalischen Klängen* published in 1897.

[58] For more details see ZICH, O. *Estetické vnímání hudby*, kapitola *Hudební vjem*, [*Aesthetic Perception of Music*, chapter *Music Perception*, pp. 117–156]. Completed edition (with the Aesthetics of Music), Jůzl, M. (ed.) Prague: Supraphon 1981.

[59] *Ibid.*, p. 139.

[60] KURTH, E. *op. cit.*, p. 143.

[61] For a more detailed critical review of Kurth see VOLEK, J. *Modern Harmonic Systems in Terms of Scientific Philosophy*. Prague: Knižnice hudebních rozhledů 1961, p. 64–74 and subsquent up to p. 107; JIRÁNEK, J. On the Question of the So-Called Dynamic Musicological Post-Riemann Concepts. *Hudební věda [Musicology]*, 4,1967, pp. 71–105, or newly also POLEDŇÁK, I. *Stručný slovník hudební psychologie*. *[Concise Dictionary of Music Psychology]* Prague: Supraphon, 1984, pp. 191–193.

[62] After WELLEK, A. *Musikpsychologie und Musikästhetik*. Frankfurt am Main: Akademische Verlagsgesellschaft, 1963, pp. 59–60.

[63] Compare the entire systém of psychological qualities of a tone, melody, dyad, chord, and harmony and contrapunctual texture, in general structured in terms of linearity and cyclicity in the above cited paper, pp. 54–55.

[64] WELLEK , A. *op. cit.*, p. 61.

[65] The combinational tones were discovered on the organs in the middle of the 18th century by G. A. Sorge and in the tract called *Trattato di Musica* from 1754 they were discussed by G. Tartini, and mathematically defined by H. Helmholtz; the term combinational frequency was later introduced by H. Husmann. Their research was later developed by a number of other scientists.

[66] Out of 41 test subjects, 63.3% assessed perfect fourth and major third as a chord, out of which 58.3% as a chord of three tones and 5% as a chord of four tones. More frequently this related to the perception of major third. As an example of the introspective expression of the subjective auditory feeling of one of the respondents we provide the following statement after the major third exposure: "The root is a bit deeper, also major third. Might be some triad. It seems like it but I am not sure if it is not a result of some habit."– REINECKE, P. *Experimentelle Beiträge zur Psychologie des musikalischen Hörens*. Hamburg: Musikverlag Hans Sikorski 1964, p. 47.

[67] REINECKE, P. *op. cit.*, p. 66.

[68] SHUTER, R. Psychometrische und experimentelle Studien zur musikalischen Begabung. – In: *Musikpädagogische Forschung*. Band 1. Laber -Verlag 1980, p. 51 et seq.

[69] After SHUTER, R. *op.cit.*, pp. 56–58.

[70] Cf. TERHARDT, E. Pitch, consonance, and harmony. *Journal of the Acoustical Society of America,* 1974, 55, pp. 1061–1069.

[71] Compare the absorption phenomenon already described by O. Zich in his thesis Aesthetic Perception of Music first published in 1910, newly ed. in Prague: Editio Supraphon, 1981, pp. 127–128.

[72] PARNCUTT, R. *Harmony: A Psychoacustical Approach.* Berlin: Springer-Verlag, 1989.

73 PECHMANN, T. Memory for Chords: The Retention of Pitch and Mode. *Music Perception*, 1998, 16, 1, pp. 43–54.

74 Viz. HRADECKÝ, E. *Úvod do studia tonální harmonie.[The Introduction to Studies of Tonal Harmony]* 2nd ed. Prague: Supraphon, 1972, pp. 191–194.

75 JANEČEK, K. *Základy moderní harmonie. [The Basis of Modern Harmony]* Prague: Czech Academy of the Science 1965, p. 268.

76 RISINGER, K. *Hierarchie hudebních celků v novodové evropské hudbě. [The Hierarchy of Musical Entities in Present-Day European Music]* Prague: Panton, 1969, pp. 11–12.

77 Adapted from PARDEL, T.-BOROŠ, J. *Principles of General Psychology*. Bratislava: Slov. pedag. nakl. 1979, p. 23, where, however, the term key is incorrectly replaced with the term scale („… one or another scale ...“).

78 Viz. PARDEL, T. *Psychológia [The Psychology]*. Bratislava: Psychodiagnostické a didaktické testy [Psychodiagnostics and Instructional Science Tests] 1982, p. 191.

79 LISSA, Z. O sluchaniu i rozumieniu utworów muzycznych. In: SZUMAN, S.-LISSA, Z. *Jak sluchac´ muzyki.* Warszawa: 1948, p. 82.

80 Viz. POLEDŇÁK, I. *Stručný slovník hudební psychologie. [Dictionary of the Music Psychology]* Prague: Supraphon, 1984, p. 44.

81 Srov. NEISSER, U. *Cognitive Psychology.* New York: Appleton-Century-Crofts, 1967.

82 Viz. JANÁČEK, L. *Hudebně teoretické dílo II.[Musical Theoretical Work]* Prague: Supraphon 1974, part *Úplnost harmonického života ve spletně*, *[The* Completeness of Harmonic Life in Spletna] pp. 247–249 and pp. 276–277. Let's just point out that Janáček talks about the twine also when it comes to the relationship between the individual tones.

83 *Ibid*., p. 276.

84 Volek, J. *op. cit*., pp. 257–259.

85 Using these terms taken from the medieval terminology, however with a different meaning, Stumpf responded to Riemann's ideas on fusion, or its limited application to the area of chords. Among others, Stumpf's enterprise proves that he did not fully adhere to the positions of static tonal elementarism as he is often accused of.

86 For Riemann, the only "absolute" consonance means tonic major or minor triad; he calls any other consonance as illusive consonance (Scheinkonsonanz).

87 KURTH, E. *op. cit*., pp. 246–249.

88 Ibid., pp. 244–245.

89 TULIN, J. N. *Učenije o garmonii.* Leningrad: Muzgiz, 1939, p. 25.

90 Ibid., p. 29.

91 JANEČEK, K. *op. cit.*, p. 157.

92 Ibid., p. 157.

93 For full explanation of the imaginary tone function see JANEČEK, K. *Základy moderní harmonie. [The Basis of Modern Harmony]* Prague: Czech Academy of the Science 1965, pp. 157–184.

94 Cf. JANEČEK, K. *op. cit*., p. 13.

95 Viz. RISINGER, K. *op. cit*., pp. 20–23.

96 Janeček distinguishes between general (natural) rules, including acoustic, physiological and psychological rules, and artistic rules (conventional). Viz. JANEČEK, K. *op. cit.,* p. 259.

97 ZICH, O. *Estetické vnímání hudby [*The Aesthetic Perception of Music] Prague: Supraphon, 1981, p. 145.

98 According HRADECKÝ, E. *Úvod do studia tonální harmonie. [The Introduction to the Study of Tonal Harmony]* 2nd ed. Prague: Supraphon, 1972, p. 169.

99 *Ibid*. pp. 169–170.

100 VARRÓ, M. Der lebendige Klavierunterricht, seine Methodik und Psychologie. Hamburg: 1929, p. l8.

101 POULIN-CHARRONNAT, B., BIGAND, E., MADURELL, F. The Influence of Voice Leading on Harmonic Priming. *Music Perception*, 2005, 22, 4, pp. 613–627.

102 This trend currently dominates the research at the European and North American universities. Its most influential publication platform is represented by the Music Perception journal.

103 ROEDERER, J. G. *Introduction to the Physics and Psychophysics of Music.* New York: Springer Verlag, 1973.

104 KRUMHANSL, C. L., BHARUCHA, J. J., KESSLER, E. J. Perceived Harmonic Structure of Chords in the Three Related Musical Keys. *Journal of Experimental Psychology: Human Perception and Performance*, 1982, 8, pp. 24–36.

105 BHARUCHA, J. J., KRUMHANSL, C. L. The Representation of Harmonic Structure of Music: Hierarchies of Stability as a Function of Context. *Cognition*, 1983, 13, pp. 63–102.

106 KRUMHANSL, C., SHEPARD, R. N. Quantification of the Hierarchy of Tonal Functions within a Diatonic Context. *Journal of Experimental Psychology: Human Perception and Performance,* 5, 1979, pp. 579–594.

107 Viz. KRUMHANSL, C. L. *Cognitive Foundations of Musical Pitch*. New York: Oxford University Press, 2001, pp. 191–192.

108 HURON, D. Tone and Voice: A Derivation of the Rule of Voice-Leading from Perceptual Principles, *Music Perception*, 19, 2001, pp. 1–64.

109 Viz. PARNCUTT, R. *Harmony: A Psychoacustical Approach.* Berlin: Springer-Verlag, 1989.

110 MEYER, L. B. *Emotion and Meaning in Music.* Chicago: University of Chicago Press, 1956.

111 KRUMHANSL, C. L. *Cognitive Foundations of Musical Pitch.* Oxfor: Oxford University Press, 2001, p. 214.

112 MEYER, L. B. *Emotion and Meaning in Music. Chicago, London: The University of Chicago Press, 1956,* pp. 56–60.

113 ZICH, J. *Kapitoly a studie z hudební estetiky. [Chapters of Musical Esthetics.]* Prague: Supraphon, 1975, p. 198.

114 This is agreed by O. Zich in the above cited study, p. 83, as well as by J. SKOPAL in the research paper On the Issue of Music Perception and Assessment by the Students of Music in 6th to 9th Class of Primary School. -In: *Proceedings of the Faculty of Education in Hradec Králové.* Prague: 1978, State Educational

Publishers, pp. 91–129, particularly p. 107, where the following results are provided (in relative frequency): tempo 82%, rhythm 65%, melody 55%, dynamics 47%, harmony 42%, polyphony 26%.

115 ZICH, O. *op. cit*., p. 83 and p. 103.

116 These results were also obtained by I. POLEDŇÁK under his research of music imagery development in his study Some Issues of the Music Imagery Development with Special Attention to the Listening to Music by Primary School Pupils. *Hudební věda*, 2, 1964, Vol. 4, p. 541–561 and 3, 1965, No. 1, pp. 3–18.

117 It is, for example, J. BURJANEK, who uses the term conventionalization in the context of its already cited monograph about the musical thinking as a means of the denominating act allowing us to communicate about music. Compare BURJANEK, J.: op. cit. p. 93. The principle of conventionalization extensively penetrates, for example, the production of music dramatic and programme symphonic genres in the neo-romanticism era. Compare also for example ZICH, O. *Symphonic Poems of Smetana. Analysis with respect to music aesthetics*. Prague: 1924 or SYCHRA, A. *Aesthetics of Dvořák's Symphonic Works*. Prague: 1959. Karel Janeček distinguishes between the general rules (natural), including acoustic, physiological and psychological rules, and artistic rules (conventional), see his Principles of Modern Harmony. Prague: ČSAV, 1965, p. 259.

118 Compare efforts of covering the gradal increase in rationality in the area of tonal systems (and not only there) as how advocated by Max Weber in the 1920s. For more details see BEK, M. *Vybrané problémy hudební sociologie [Selected Issued of Music Sociology].* Olomouc: Palacký University, 1993, p. 32–36.

119 M. Weber as well as K. Blaukopf tried to find answers to questions about universality of tonal systems, while focusing (together with others, E. M. Hornbostel, C. Sachs, M. Schneider, W. Wiora) on the issue of orderliness and systemic role of octaves, fifths and fourths as well as thirds in musical sequences.

120 Viz. WIORA,W. Die Natur der Musik und die Musik der Naturvolker. In WIORA, W. *Historische und systematische Musikwissenschaft. Ausgewahlte Aufsatze*. Tutzing: 1972, pp. 126–127.

121 Viz. RISINGER, K. *op. cit.*

2. Musical Abilities as a Potential to Recognize, Analyze, and Assess Chords and Harmony

2.1 Concept of General and Specific Abilities

Probably the most general common denominator of the majority of concepts of abilities concerns the fact it is a mental characteristic or a set of mental characteristics featuring availability, potentiality and mental readiness to do or perform something.[1] The abilities, as a psychological category, are of a hypothetical nature and are classified by various criteria and aspects, such as type of activity, kind of activated receptor, degree of abstraction, involvement of cognitive processes, complexity of mental activities, etc. Within the context of the structure of personality, a higher and more structured type of ability classification takes place; in addition to the hierarchizing the partial substructures, the mutual relationships are observed.

The music perception is affected by a number of factors. Most authors agree on the three principal components, namely the personality of the perceiving individual (the subject of perception), the musical work (the object of perception) and the communication process under which the relationships between the perceiving subject to the music object exists.[2] The following text covers the first of the factors mentioned above, the recipient's personality. Out of the personality qualities participating in the perception of music harmonic structures, we will focus on one of the partial musical abilities, ear for harmony, since we assume that it acts as an independent auditory ability in the qualitative respect.

Generally speaking, the theoretical background of this section of the book concerns the behavioural and psychometric concept of a personality. It focuses on the relationship, correlation concept of musical abilities. This approach is also applied to the music abilities which is understood as an organic part of the structure of musical abilities and, in general, of a personality. Within the context of this concept, we also reflect the testing of musical abilities as a highly formalized form of relationship between the music stimulus and response of a recipient, which may be statistically processed and subsequently interpreted.

This chapter focuses on the relationship, correlation and the factorial concept of musical abilities and the aspect of an ear for harmony, which is understood as an organic component of the musical ability structure of the recipient's personality. Within the context of this concept, music ability testing is applied both theoretically and practically as a highly formalized scheme of the relationship between music stimuli and the recipient's response that might be processed by applying mathematical and statistical methods, and subsequently interpreted.

2.1.1 Factorial Concept of Abilities and Musical Abilities

The aspect of harmonic abilities, similar to other abilities, may be examined in an analogical parallel with the theories of the so-called static structures of a personality, splitting it into two areas – the area of personality type differences and the area of factor concept application. In order to have a full picture, let's remember that dynamic personality models have been established as well, with prevalence of the learning process aspects, the depth psychology aspect, the theory of field, etc.[3]

The actual fact, at the basis of all factorial ability theories, is that all of the observed mental phenomena are classified and their various modifications are converted to a certain, rather limited, number of basic functional components. By applying the psychological tests, the obtained data is usually indicative of the variability of the reactions of research subjects to given tested situations (specific test tasks). If a musical ability test set is used, the results within every musical ability test are variable.

The issue of correlation may already be addressed in terms of the relationship just between various pairs of the tests. In such manner, it is possible to determine whether the performances shown in the subtests are linked, whether it is a positive or negative dependence and what is the degree of dependence. The degree of dependence of two test performances resulting from the correlation calculation and expressed with a correlation coefficient, however, does not provide the information regarding the origin of this dependence. It is limited to information about the structural aspect of a pair of performances but does not say anything about the substance of the factor that could be common to both performances. In other words, it does not determine the fact that is shared by both of these performances.

If many tests are used, the dependence structures are more complicated. In such case, every test may be correlated with every other test and the obtained correlation coefficients may be organized into correlation matrixes. They better characterize the closeness of the relationship and its polarity and simultaneously, they are the starting point for the factoring procedure. The factorial analysis, as a mathematical operation, then enables reducing a large number of the correlation coefficients arising from correlating many tests to the least possible number of basic dimensions, or factors, to which the performances in the respective subtests contribute to a variable degree. In other words, the tests are saturated with a factor or factors in variable extent.

The first factor theory of abilities and, in more general also the theory of personality with two factors – the general factor and specific factor – was established by Ch. Spearman. The limitations of his two-factor theory were eliminated by L. L. Thurstone and his specification of thirteen factors. P. E. Vernon continued in the work of Spearman and elaborated a hierarchical structure of abilities with four levels and the highest general g factor. Additionally, it was also C. Burt who designed the hierarchic structure of a personality, rating intelligence as the highest with relationships, association, perception and feeling located at lower levels.

C. Burt concluded on the basis of his research that "a special or group factor for musical ability existed".[4] Spearman's approach to the same problem shows that the specificity of musical abilities was one of the possible sources of arguments to correct his original opinion on the exceptionality of a single factor.[5]

J. P. Guilford was the representative of the second, so called anarchic concept of the intellectual structure. He does not see the abilities structured hierarchically but as a cluster of a certain number of independent factors which he sorts out based on three aspects – operation, contents and products. In his structure of abilities it is possible to find factors of perception, psychomotor factors and the factors of intelligence. The factor of perception includes the factor of sensitivity to colour, factor to sensitivity to sounds (of low, medium and high frequency), and the factors of auditory discrimination (tone pitch and volume discrimination). In the context of Guilford's matrix of cognitive factors the auditory learning, perception anticipation and auditory memory are, among others, active.

Based on Burt's and Spearman's opinions and especially Guilford's schemes it is clear that the music aspect of abilities is present in the structure of personality primarily as a group and special factor. Simultaneously, it indicates that the mental potentiality necessary for music activities is dependent not only on sensory-auditory factors but also on memory and other cognitive factors at various content levels.

2.1.2 Harmonic Abilities and Systematics of Music Abilities

Analogical to the concepts hierarchically classifying general and specific abilities, there have been attempts at making progress in specifying and structuring musical abilities. While for the personality schemes the umbrella factor concerned general ability (intelligence), for the area of musical abilities this term did not receive the expected acceptance in usage (maybe with H. D. Wing as the exception). It is usually just one general factor that is used or several factors of a less general nature.

Nevertheless, testing and the factorial method were not the only methods applied by music psychologists to establish musical ability systems.

Differently, and needless to say, more often, the researchers applied some kind of combination method which consisted in the fusion of several aspects. They primarily concerned general psychological categories (such as perception, memory, etc.) and music theory aspects (primarily identifying the qualities of a tone, harmony, etc.). The choice of music psychological and music theoretical aspects was based on pragmatic experience and specialisation of the author (thus the systematic by N. R. Korsakov, a composer, is, for instance, different from C. E. Seashore, atomistic oriented music psychologist).

Some hypothetical schemes of musical abilities show penetration of the development aspect, music activity aspect, etc. Therefore, it is no wonder that the concepts of various authors differ. The abilities are hierarchically regrouped and named differently, which is, needless to say, one of the significant accompanying consequences of the term plurality in music psychology and psychology in general.

Let's ponder over one more general quality evident in the musical ability structures. On the one hand, there are very complex, detailed schemes (e.g. by C. E. Seashore or F. Sedlák).[6] The opposite pole concerns simplified schemes, abstracting just a few of the most important abilities. It is the case for the Teplov's structure, which consists of three basic musical abilities. In relation to his concept, it is not possible to help thinking about the comparison between Teplov's abilities and the general factors; not because of the method that is used when defining them (it was diametrically different from the factorial analysis) but rather for the purpose to which these abilities, or factors, were named. We believe that in both cases there was an apparent effort to simplify, organize and describe the music ability terrain as accurately as possible.

Parallel to the description of musical ability systematics, the subsequent exposition will also monitor the representation and status of the ear for harmony in this systematics. It will represent the next step towards its gradual exploration. Firstly, the factorial approaches will be reflected, followed by mentioning the systematics as a result of the empirical-theoretical hypothetic structures of musical abilities.

2.1.3 Harmonic Abilities Tests and Factor Analysis

It was not a coincidence that the first factorial approaches were applied by P. Drake and H. D. Wing, psychologists who were the direct students of early protagonists of factorial analysis, C. Spearman and C. Burt. H. D. Wing was an excellent continuator of Spearman and conducted factorial analysis using the results of his own musical ability tests. For the first time, they appeared in Wing's unpublished dissertation to obtain the Master of Art degree in 1936. Wing designed twenty-one tests that he preliminary applied and then selected only those that correlated with the total test set score around the value of 0.5. It concerned a total of nine tests. Wing conducted the factorial analysis using the Thurston method to obtain the correlation matrix shown in the table below. The left column contains the test name and number. At this point it is necessary to add that the numbers correspond to the original test set numbering. The other columns contain the saturations with individual factors.

Table 2 Wing's factorial matrix (After Franklin, 1956)

Tests	Factors				
	I	II	III	IV	V
13 Intervals	0.779	0.380	0.075	–0.282	–0.214
11 Note in chord	0.516	0.275	0.201	–0.319	0.001
4 Rhythm	0.639	–0.390	–0.359	0.190	–0.265
1 No. of Notes	0.645	0.473	–0.372	0.055	–0.038
19 Which notes move	0.463	0.299	0.053	–0.229	–0.090
9 Discords	0.396	–0.528	0.394	0.299	0.165
12 Notation reading	0.588	–0.542	0.414	–0.241	–0.234
23 Melody dictation	0.735	0.457	0.054	0.219	0.166
7 Phrasing	0.514	–0.309	–0.408	–0.192	–0.015

As the table clearly demonstrates, Wing defined the following five factors: [7]

1. General factor, which he adopted under Burt's influence. However, Wing does not deem this factor to be the general intelligence but he assumes it could have about the same function as attention.
2. Factor linked to the ability to analyze relationships between music stimuli.
3. Factor expressing the ability to retain certain tones or their combinations in hearing imagery.
4. Factor linked not to cognitive acts but rather expressing the mood and feelings.
5. Notation factor.

His second factorial study was not done, until Wing had expanded the number of tests to twenty-six, out of which he subsequently selected seven that he subjected to the standardization process and new factorial analysis. Wing paid the greatest attention to the interpretation of the results of the third analysis, based on which he defined three factors. The correlation matrix below shows how these factors saturated all seven subtests.

Table 3 Factorial matrix of the 3rd Wing study (After Wing, 1941)

Tests	Factor (i)	Factor (ii)	Factor (iii)
(7) Judging best phrasing	0.765	0.354	–0.180
(1) Detecting number of notes in chord	0.681	–0.341	0.268
(2) Detecting change of notes in chord	0.669	–0.220	–0.094
(3) Detecting change of notes in melody	0.629	–0.595	–0.174
(5) Judging best harmony	0.638	0.058	0.267
(6) Judging best loudness	0.618	0.292	–0.065
(4) Judging best rhythm	0.421	0.452	–0.022
Average of saturation coefficients	0.632	0.000	0.000
Average of squares of saturation coefficients	0.408	0.134	0.031

Wing identified the first factor, considering all tests were positively saturated with this factor, as a general musical ability. Since he was aware of the possibility of simplifying the interpretation of this factor, he added that the term ability does not imply a simple capacity; on the contrary, it is, undoubtedly, a highly complex entity, though representing one group of mental processes.

The second bipolar factor is, within the context of this topic, a bit more interesting since it divides seven subtests of the Wing test set into two subgroups. The first includes tests mainly asking the respondent to write about phrasing, rhythmical accent, and judging crescendo and decrescendo and also the "better" or "worse" manner of melody harmonization. Wing called this group as a detection group, i.e. detecting changes in melody, harmony or a number of tones in chords that were played.

The third factor saturated only two tests - determination of the number of tones in a chord and the judgment of melody harmonization. Wing identified them as the only two tests, the substance of which consists in perception of the chords; other tests were then focused on the melodic and rhythmic aspects. Based on these findings, he concluded that this factor distinguishes between the respondents in terms of the quality of harmony perception.

The classification and interpretation of the three Wing's factors may be used to emphasize the fact that this method, in a way, suggested and actually even confirmed that the ear for harmony is a differentiated musical ability, registered here as factor No. 2 expressing the ability to judge musical harmonic patterns (etalons) of the melody harmonization manner. His second modality, obtained through detection tests, appeared as the ability to hear and perceive a particular harmonic change, better yet to localize this change within one of the harmonic voices.

The third factor, saturating two "harmonic subtests" (not all that were integrated in the test set), was explicitly interpreted by Wing as "harmonic". As tasks in both tests may be successfully completed via the holistic perception of chords, this factor may be featured as the chord factor that saturates the test of analytical holistic chord perception. Additionally, this statement is supported by the finding that the third "analytical-harmonic test", i.e. the test to determine the change of tone in a chord, was not saturated with this factor.

E. Franklin carried out an extensive research applying factorial analysis at the end of the 1940s.[8] Unlike Wing, who used his own tests in the research, Franklin used standardized test sets of C. E. Seashore and H. D. Wing and combined them with his own TMT test (Tonal Musical Talent) developed based on the Révész's test. At first, Franklin analyzed the results of two surveys with 236 students of the teacher's institute. Four factors came out of the first analysis and nine factors emerged from the second analysis. Franklin described them all, but the large number of used tests and perhaps even the used methods made the situation so complex that it was not possible to convincingly and psychologically interpret any of the factors to at least the same degree as in Wing's case. The same applied to the items determining the ear for harmony.

Wing's test set (together with Raven's matrix of intelligence) was applied again by Whittington in 1957. The sample of studied individuals was rather small (two groups of adolescent students, 24 students in each group, one group including musicians and the other including non-musicians). In the group of students engaged in music, the general factor most significantly saturated the following subtests: rhythm (0.81), harmony (0.77), chords (0.68), memory (0.67), intensity (0.63), phrasing (0.60), pitch (0.54) and intelligence (0.58). In the group of students not engaged in music the values were different, thus resulting in a very different order of the individual subtests in terms of the general factor saturation. In addition, it is useful to note how the position of harmonic subtests within the modified structure of the tested musical abilities changed - pitch (0.71), phrasing (0.65), intelligence (0.62), memory (0.54), rhythm (0.52), chords (0.44), intensity (0.34), harmony (0.29).[9]

McLeish[10] compared the validity of Seashore's test set to the tests with more musical testing material, i.e. Wing's test set and Hevner's Oregon Discrimination Test. One hundred students of psychology were tested. The general factor mostly saturated the memory (0.76), changes in tone pitch in chords (0.59) and rhythm (0.27) tests. The second bipolar factor saturated rhythm (0.52) and memory (0.31), compared to the tests containing immediate differentiation between sensory stimuli. Shuter discovered very high correlations between chord analysis, perception of pitch, musical memory and the ear for harmony in the McLeish research.[11] Independent of McLeish, E. Franklin, who carried out his research at about the same time, arrived at similar conclusions.[12]

In 1964, R. Shuter conducted a very extensive research with five groups of students.[13] Once again she applied the Wing's test set and there were five factors of rather disparate values obtained from each survey. However, looking at the situation through a prism of three harmonic subtests integrated in the Wing's test set, it seems a bit clearer.

For the first two research samples, the first factor most significantly saturated the following tests: chord test 0.728 and 0.521, harmony test 0.637 and 0.749. Additionally, for the other three groups, at least one test was saturated with the factor in values around 0.7. The two already mentioned groups (students of *Eastman School of Music* in Rochester, USA and the students of a teachers' college) manifested this phenomenon most significantly. Furthermore, it is obvious that in terms of bipolar factors there was not a single case when two different tests of harmonic perception would be in mutual contraposition.

Whellams' research responded to the continuous growth of new musical tests as well as to the expanding number of methods applied to the processing of the test results. F. S. Whellams wanted to compensate the increasingly felt confusion and minimal compatibility of the individual surveys by processing the data of the sixty most representative surveys using one common method (he chose the method of main component and varimax rotation). As a result, he obtained three factors: first, the tone pitch factor that saturated the melodic and tone pitch memory, second, the kinetic factor that saturated tests of rhythmical and melodic memory, and third, the harmonic factor that was identified as the analysis of chords and harmony. This factor saturated the tests of harmonic abilities, the ability to distinguish tone pitch and rhythmical abilities, and aesthetic experience and assessment.[14]

In Holmström's research the ear for harmony was not as expressive as with Wing, Shuter and Whellams. The author applied the first three Wing's subtests, his own rhythmical test, the test of music-related knowledge, the test of attitude to music education at school and the intelligence test to assess twelve hundred pupils of the second to seventh years of the Swedish primary schools. He also reflected grades in reading, writing and mathematics. The chord test was very significantly saturated with the so-called "alpha" factor, the value of which oscillated between 0.61 and 0.68.[15]

2.1.4 Harmonic Abilities within a Musical Abilities Systematics

Contrary to the previous methods providing the basis for musical ability structuring, the following chapter will cover the schemes defined by the theoretical-speculative method. Practically, all of them were drawn up as part of personality structure descriptions.

At the beginning, let's mention the concept of N. A. Rimsky-Korsakov, who was one of the few music composers to speak out on the topic of musical abilities. Korsakov distinguished the technical abilities necessary to play a musical instrument and sing, and the hearing abilities. He considered hearing abilities in elementary and higher forms. He classified two abilities under the elementary hearing abilities – harmonic hearing and ear for rhythm.

He sees the harmonic hearing in two modifications. The first is the ear for tuning, which is the ability to distinguish the "musical" intervals from the intervals not used in music. In other words, it concerns the hearing sensitivity to distinguish smaller than half-tone differences, but not in the elementary form as approached by Seashore and subsequently for example by Bentley, but in the context of tempered tuning and the key. Korsakov calls the second form of the hearing for harmony as the hearing of the key, which means the ability to distinguish the intervals and reproduce them with voice or instruments.

C. E. Seashore systematizes musical talents into five groups: (1) musical perceptions, (2) musical activities, (3) musical memory and musical fantasy, (4) musical intellect, and (5) musical feeling. In further classification resulting in twenty-five items, he respects the music expression aspect (pitch, intensity, timbre), then he emphasizes the psychological aspect (memory, imagination, etc.) to get to the higher musical intellectual abilities, such as free musical associations or general intellect. He crowns his classification with emotional and aesthetic abilities, such as musical taste or emotional reactions to music. He deems the item that he calls as the 'sense of consonance' to be the ability related to the harmonic aspect of music. It means the hearing performance and it is included in the first version of the Seashore's test set. The tasks consisted in answering a question – which of the two harmonic intervals is more consonant?

H. König elaborated detailed systematics of musical abilities, including the hearing of harmony.[16] He talks about the ability to reproduce the accompanying voices that may be in the form of harmonic or polyphonic accompaniment. The author also emphasizes memory as a very important function, linking it to tone pitch, chords, rhythm, etc.

Teplov criticized König's concept due to the prevalence of matching the music reproduction activities with musical abilities and, on the contrary, it lacks their psychological interpretation. "If we follow this path," says Teplov, "then we can assume a special ability of reproducing the leading voice in harmonic music, plus the ability of performing the same task in the polyphonic music. The list of abilities construed in this way could be limitlessly expanded."[17]

It is difficult to find an absolute solution to this issue; however, it seems that König's distinction between harmonic (homophonic) and polyphonic accompaniment is, to some degree, well-founded. We believe that either reproduction or even just "detection" of any of the voices, e.g. bass, is different in terms of quality since homophonic and polyphonic music are a result of different music thinking. This may be, for instance, reflected in the percipient's activities, such as anticipation of harmonic movement, completion, apprehension of voice movement contrast, etc.

B. M. Teplov defines three basic musical abilities, i.e. the sense of tonality, the "ability to emotionally distinguish tonal functions of melody tones (…), feel emotional expressiveness of tone pitch movement (…), the emotional or perception component of an ear for music (…) for an integral unity with the perception of music pitch, i.e. timbre separation pitch (…); it is demonstrated in the perception of melody, its cognition and sensitivity to accurate intonation." Teplov calls the second ability as hearing imagination; this ability enables one to "intentionally use hearing imageries that reflect tone pitch movement (…); it is possible to call them the hearing or reproduction component of the ear for music (…); the ability is expressed through the reproduction of melody based on hearing, especially during singing (…); in line with the sense for tonality it is the basis of the ear for harmony (…) and at a higher level of development it constitutes what is usually called the inner ear…" The third ability defined by Teplov concerns the sense for musical rhythm, i.e. the "ability to actively (in movement) experience music, feel emotional expressiveness of the musical rhythm and reproduce it accurately…"[18]

Although the hearing of harmony is not included among the three main abilities, Teplov pays great deal of attention to this phenomenon, studying it from various aspects. In terms of the structure it is understood, as already suggested, as some kind of an aggregate of the sense for tonality and musical imagination. Therefore, both abilities have been cited in detail. To conclude, Teplov understands the ear for harmony primarily as an ability related to the harmonic movement.

Max Schoen[19] divides his system of musical abilities into a main group (e.g. emotional understanding of music, artistic-virtuous abilities) and a secondary group (e.g. intelligence, long-term memory, strong will, etc.). Additionally, he also talks about musical qualities, under which he distinguishes hearing abilities, related to the individual tone characteristics (pitch, volume, etc.) and musical abilities, classified as melodic and harmonic. Within the latter, he distinguishes the hearing of consonance, the ability to analyse chords, the ability to distinguish chords, the ability to determine the sequence of chords and general sensitivity to harmony. A third area includes muscular qualities, such as strength, persistence, reaction time, etc. Schoen's concept of the hearing of harmony may be classified as activity-based, or closely linked to the performance that can be simulated under experimental test situations. Schoen reflects analytical as well as holistic, static as well as kinetic, aspects of the perception of harmony.

Ernest's classification of musical abilities could be simply described as holistically relational. As an especially important ability, K. D. Ernest presents the following:

1. the ability to distinguish the principal and secondary ideas;
2. the ability to distinguish the contrast, e.g. tension, release, change in the key and change in the musical mode;
3. the ability to understand the structure of a piece of music, e.g. in terms of its parts, their mutual relationships and texture (homophony-polyphony);
4. the ability to appreciate and understand expressive qualities of a piece of music;
5. the ability of active and focused listening with maximum involvement of memory.[20]

Ernest's systematics apparently became resigned to the elementary tone characteristics and analogically assigned abilities. Despite explicitly defined abilities, i.e. rather stable characteristics, the research overall exudes dynamism that could be compared to the Kurth's concept. The ability to grasp the contrast between the keys, postulated by Ernest under item 2, could be denominated as tonal contrast (e.g. in modulation or temporary modulation in a key).

Further to the Ernest's classification, let's remember the systematics by P. Michel with latent harmonic hearing abilities that could be identified in the fourth group. The first one covers differentiation abilities of the auditory analyzer (perception of music pitch, duration, volume and timbre); the second one concerns musical memory as the primary condition for reproduction activities; the third group includes motor skills linked to vocal and instrumental activities and the fourth one covers analytical skills for music perception and apprehension linked to thinking and fantasy.[21]

Lýsek's system of musical abilities is rather stratified.[22] The subgroup of basic abilities gained through general music education includes:

1. the sense for tone characteristics (volume, duration, timbre, pitch) and their changes;
2. the sense for rhythm, metre, dynamics, etc.;

3. the sense for consonance and dissonance;
4. the sense for relation of two or more tones (melodic and harmonic) and their changes (type of key (major or minor, tonality, transposition, temporary modulation, modulation);
5. musical memory and imagination, etc.

The modifications to the hearing of harmony, which are in general defined under items three and four, are closely linked to music practice in singing and listening. The sense of consonance and dissonance is of an exclusively perception nature. It means preferential evaluation of chords in the sense of *like – dislike* (Lýsek presented children with terms *nice – ugly).* Overall, Lýsek's systematics is close to M. Shoen's concept, but especially to the test of musicality of G. Révész, in particular under the "harmonic" part.

The development of conceptions about the structure of musical ability systematic is mirrored in the works of F. Sedlák. In one of his early books[23] Sedlák distinguishes the following abilities:

1. sensomotor-auditory 2. sensomotor-motor, 3. musical imagination and memory, 4. tonal feeling 5. harmonic feeling 6. musical intellectual abilities.

Sedlák deduces all his systematics of abilities from the musical activity analysis. He starts with the simplest musical operations and concludes with activities assuming artistic and creative abilities.He places the harmonic abilities, here called as the harmonic feeling, on a higher level, reflecting it is a more complex ability. The hearing of harmony maintains this position even in Sedlák's subsequent modified systematics.

Thus, in the systematics published in 1979, the harmonic feeling is seen as "the ability enabling one to understand and experience chords and harmonic functions in a piece of music."[24] Two levels down, under analytical and synthetic abilities forming the basis of musical perception, it talks about abilities enabling one to detect the individual musical means of construction, i.e. melody, rhythm and, among others, harmony.

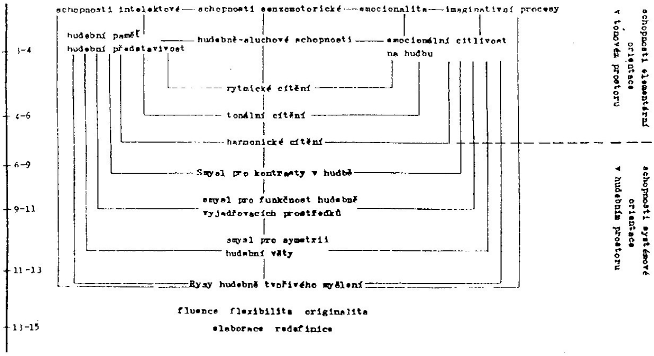
Basically, the identical hierarchy is maintained by Sedlák in his classification of musical abilities from 1981. The harmonic feeling is understood as a bit wider concept, i.e. as an ability to experience consonance and dissonance, analyze chords and determine sequences of chords and harmonic functions.[25] In his two last works,[26] Sedlák defines four groups of musical abilities (compared to the previous systematics consisting of six to nine groups). The apparent difference consists in the fact that analytical synthetic abilities, having been considered to be a separate component of abilities, are now more logically classified under a more general category, covering more specific musical ability qualities. This group also covers tonal and harmonic feeling as an expression for orientation within tonal relationships, harmony and polyphony.

Under the classification of J. Kulka,[27] the musical abilities are divided into two basic groups. The first one covers elementary abilities and the second covers systemic musical abilities. The elementary abilities include, for instance, musical sensory abilities for the pitch and duration of a tone, psychomotor abilities related to mental regulation of movement during musical activities, and musical memory abilities.

Musical systemic abilities include musical perception abilities and are called based on the terminology of music theory (melody, phrasing, dynamics, timbre, tonality, harmony and polyphony). Other components of systemic musical abilities concern imaginatively constructive musical abilities (musical imagination, fantasy and thinking) and musical intellectual abilities as abilities of theoretical reflection of music.[28]

The classification concept of M. Holas[29] is primarily based on the Kulka's ability systematics. Holas accordingly differentiates abilities into two groups, i.e. elementary and systemic orientation within the musical space. In his system, Holas applies the genetic aspect, the presence of which in other classifications is rather implied, as something like an ability hierarchizing element. Together with the graphic scheme of musical ability structure, Holas succeeded in accenting two determining aspects, the already mentioned genetic aspect and the systemic aspect. The harmonic feeling is genetically located to the period between a child's six and nine years of age. The complexity of this ability is also in line with its position on the border between the elementary and systemic orientation within the musical space.

Figure 6 Scheme of musical ability structure and position of harmonic feeling (After Holas, 1988)



The conducted analyses of musical abilities confirm that each of them reflects a musical ability, or abilities, corresponding to multiple-voice musical language. It has been confirmed by the results of factorial analyses as well as many musical ability schemes defined through a theoretical speculative method.

The factorial analysis method has been frequently linked to the application of "harmonic" subtests of the Wing's musical ability test set. As demonstrated, the general factors have saturated these subtests quite significantly.

As primarily shown by the systematics mentioned above, the ear for harmony is seen as an ability, the position of which within the hierarchy of musical abilities is somewhere on the boundary between the elementary and systemic areas of musical expression and the ability sphere, or is placed on the higher levels of the classification schemes.

2.1.5 Comparison of Definitions of Harmonic Abilities

The words of J. Fukač and I. Poledňák may only be confirmed, saying that "definitions specifying terms are one of the most important and efficient instruments of adequate understanding."[30] However, the definitions of the ear for music do not play this role. They manifest a clear effort to reflect, in a concentrated manner, the most important features and determinants of this hearing ability, but the economical formulations of the majority of the definitions represent a limit preventing the phenomenon to be defined succinctly and concisely along with the mention of all significant characteristics.

For instance, the older Teplov's brief and extremely general definition defines the ear for harmony as "an ear for music in its manifestation towards chords and also every multiple-voiced piece".[31] Kratochvil specifies the musical terrain, compared to the Teplov's "chords and multiple-voiced piece", as harmonic and polyphonic and says that "an ear for harmony is a qualitative original perception of harmony and polyphony, manifested through the characteristics of the process of perception, recognition and creation of harmony and polyphony as well as through sensitivity to purity and accuracy of harmonic and polyphonic intonation".[32]

Kratochvil calls a rather different, despite partially overlapping, nuance of this ability as harmonic feeling, representing "the ability to emotionally distinguish tonal functions in the chord sequence of a piece of music (…) as an ability of experiencing the emotional expression of the chord pitch movement within a key".[33]

Wellek talks about the ear for harmony in the context of the so-called relative hearing, including also interval hearing. It primarily consists in the ability to reproduce intervals (Wellek follows the conception of Révesz). Wellek notes that the ear for harmony is something original, not just a mere application of the interval hearing to chords. For instance, the key element of a piece of music, or catching the modulations, the harmonic sequences of cadences, etc. is rather a manifestation of the harmonic form of the relative hearing.[34]

The ontogenetic aspect flashes through the definition of the ear for harmony by Chvátilová, fully in accordance with the focus of her work. She defines the ear for harmony as a higher musical ability, the basic principle of which is the analysis of chords, followed by the ability to distinguish the quality of harmonization.[35]

Sedlák defines the ear for music as "an ability to analyze chords through hearing, distinguish consonance and dissonance, experience structures of the chords (harmony) as well as the polyphonic construction of a piece of music".[36] Both he and Kratochvil use the term harmonic feeling but, contrary to Kratochvil, Sedlák sees the harmonic feeling almost as synonym to the ear for harmony, emphasizing the tonal functional relationships. Therefore, according to Sedlák, the harmonic feeling should be seen in relationship to tonality and functional harmony.[37]

The negative phenomenon mentioned above, i.e. the confusion as regards the content and terminology, more easily infiltrates definitions and significantly less the test methodology, which, if carefully and expansively described, allows for continuous confrontation in terms of the terminology and content, and thus serves in eliminating the methodological inaccuracies and doubletalking with respect to the terminology.

2.2 Structure of Harmonic Abilities

We assume that the primary source of all the variability of the ear for music consists in the internal qualitative diversification of the phenomenon itself. While trying to respect this fact and based on the previous reflections of the ear for music in the musical ability systematics, its diagnosis and several selected definitions, we believe the following specification to be seemingly adequate.

Let's start with the character of the multiple-voiced musical language at the turn of the 17th century when two basic expression composition variants were established: a) harmonic homophony as the cadence controlled sequence of chords with various degrees of voice hierarchization from the so-called monophonic homophony, or accompanied monody, i.e. "a single leading melody over an accompanying chord fundamental bass basis, up to the so-called polyphonic homophony with the effort to achieve a balanced, or almost balanced, proportion of all voice components in the musical tissue, b) harmonic polyphony as a cadence controlled counterpoint of voices".[38]

The potential to recognize, analyse, and assess chords and harmony may be seen in seven modifications:

1. Tonaly harmonic and tonaly polyphonic feeling

In order to specify the first modification of the ear for harmony, we need to add its basic profiling psychological aspect, consisting in the periodicity of increasing and relaxing mental tension with harmonic musical means. This given anthropological fact, not gained through the intentional education but rather created in the process of sensomotor and psychological maturing, the process of functional education, during the interaction with musical language of the melodic-harmonic style outlined above is customarily called the feeling. More specifically said, this feeling relates to the musical expression space where the increase and decrease of this specific tension takes place. This space concerns the key where the harmonic actions occur. The mental quality, the ability to perceive, feel and adequately respond to these tonal relationships as patterns of certain musical expression may then be identified as a *tonally harmonic or tonally polyphonic feeling.*

2. Ability to recognize harmonic intervals and chords

A rather different quality of the ear for music may be mentioned in relation to the kind of artificially evoked, rather "non-musical", situation that is usually introduced for theoretical-analytical and psychological and mentally-diagnostic reasons rather than for artistic-aesthetic purposes. It concerns the detection and analysis of a single chord as a static vertical entity within harmonic structure. The chords of two, three, four and several elements may acquire up to an eleven-element form in the tempered musical environment, depending on the type of the scale and mode.

This static entity consisting of several elements may be generally perceived under sufficiently long exposure, as mentioned above, in the soprano and bass forms, both analytically and non-analytically (holistically). In the first case, the chord entity is divided into elements, tones (voices); in the second case it is perceived as a rather uniform entity. As an adequate denomination of these perception polarities, it is possible to use the mental availability of the hearing of chords, i.e. intervals and chords, which may further be qualitatively specified as analytical or non-analytical (holistic). More specifically, it is possible to identify these two modalities as analytical hearing of chords, i.e. intervals and chords on the one hand, and non-analytical (holistic) mental processing of chords on the other.

3. Ability to recognize harmonic homophony and harmonic polyphony

The third modification of the harmonic ability may be seen in the quality that is related to the horizontally kinetic form of harmony, as materialized in the harmonic homophony and harmonic polyphony. For both models, the differently hierarchized significance of voices is particularly symptomatic, in addition to cadence quality, with polarity of an accompanied single-voice in harmonic homophony on the one hand and the polarity of polyphonic homophony with a different degree and balance of the voice components in the musical tissue on the other.

In the harmonic polyphony, it concerns the cadence harmonic counterpoint where the significance of the voices, especially at the beginning and close, is determined by strict rules. In the suggested modes, based on the horizontal harmonic and polyphonic texture, it is an analytical method of perception that is rather significantly, with respect to the pace, dynamics and other means of expression, both as a part of the whole and in individual voices, represented. Essentially, it is always at least the soprano that is detached as the highest contour voice, or, depending on the circumstances, other voices. This manner of perception may be, in the structure of harmonic abilities, identified as the ability to recognize harmonic homophony and harmonic polyphony.

4. Ability to recognize harmonic intervals and chords within the musical space

A simpler and more or less laboratory version of this quality may be seen in the ability to appreciate only isolated chords with one another in terms of their placement within the tonal space. However, it is necessary to make sure that chord modification, especially the position, is rather compact, which concerns some aspects of the laboratory elaborateness. If it be to the contrary, mutual interference of tones in both chords could occur. The suggested relationship may be, in terms of abilities, identified as *the ear for chords in the tonal space* or also *spatial musical ear for chords.*

5. Inter-key harmonic and polyphonic feeling

The fifth modification of the ear for harmony is, in a way, a completion of the first mode of the ability for harmony. While the tonal harmonic and tonal polyphonic feeling was seen in the context of homogenous space of a single key, the new modification describes such quality of the harmonic feeling that consists not only in feeling single-tonal cadences, i.e. cadences in one key, but cadences within the space of two different keys. In other words, it is about appreciating the relationships between the compact two or more harmonic zones ordered successively within a larger harmonic temporal space, often formally specified. The partial ability corresponding to the implied conditions may be identified as *inter-key harmonic feeling,* in polyphonic modification as *inter-key polyphonic feeling.*

6. Feeling of consonance and dissonance of chords and connections of chords

It is understood as the ability to feel and assess the effect of chords in terms of greater or smaller (or even none) musical physiologic-mental tension. In other words, it actually concerns the involvement of other aspects of the relationship of perception or rather apperception activities of an individual to chords, the qualities of which are assessed with respect to the presence or absence of dissonant elements.[39] Both the static isolated chord complexes and chords created during continuous stream of music assessed primarily in a vertical manner may be regarded as chords. Although the perception of the subject of this quality may be considered to be an aesthetic assessment, we integrate this form of the subject-harmony relationship into our system and suggest the term *feeling of consonance and dissonance of intervals and chords and connections of chords*.

7. Ability to recognize harmony within a musical language

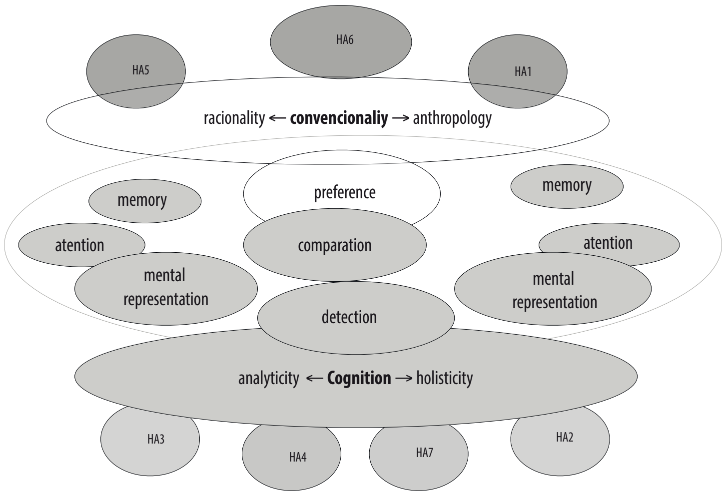
This modification complements the existing system with wider musical feature of the entire portfolio of musical means of expression. It consists in the competence to consciously identify harmonic musical language in the context of other musical means of expression.
The scheme below illustrates the entire system.

Table 4 Structure of the harmonic abilities

1.	Tonaly harmonic and tonaly polyphonic feeling
2.	Ability to recognize harmonic intervals and chords
3.	Ability to recognize harmonic homophony and harmonic polyphony
4.	Ability to recognize harmonic intervals and chords within the musical space
5.	Inter-key harmonic and polyphonic feeling
6.	Feeling of consonance and dissonance of chords and connections of chords
7.	Ability to recognize harmony within a musical language

At this point, it is possible to add the relationships with the just outlined seven components of the ear for music to the scheme of harmonic musical structure apperception.

Figure 7 Relationship between the perception activities and modifications of the harmony ability system



The position of the individual components of the harmonic abilities (1–7) suggests, among others, their qualitative link to the conventional or analytical-holistic factors. The top elipses contains the tonally harmonic and tonally polyphonic feeling, the recogtnition of chords in the musical space and the feeling of consonance and dissonance chords, i.e. items that, to a different degree, are saturated by the conventionality factor. The bottom elipses contains the remaining items, significantly covering the cognitivity factor and which are sequenced based on the linkage to the prevailing analytical or rather synthetic pattern of the perception process.

2.3 Harmonic Abilities Testing

The diagnostics of the harmonic abilities is, in terms of the problem principle, identical with the application of testing techniques. Musical ability testing forms an extensively developed field of music psychology from the 20th to 70th of the 20th century. Of the authors of dozens or maybe even hundreds of works on this topic, it is possible to briefly mention those who approached the issue in a wider context. Primarily, this group of authors includes C. E. Seashore, H. D. Wing, E. Franklin, E. Gordon, P. R. Farnsworth, Bentley, R. W. Lundin, J. B. Davies, D. J. Hargreaves, and others.[40] Perhaps the most comprehensive work was published by the music psychologist, R. Shuter, in 1968. The new version, prepared together with C. Gabriel, was published in 1981.[41] Among the Czech authors of reference or original works let us mention at least A. Cmíral, L. Daniel, F. Sedlák, L. Melkus, I. Poledňák, F. Rohánek, H. Chvátilová, M. Holas, and others.[42]

Music psychological tests are, in principle, standardized procedures for comparing individuals according to certain aspect relating or pertinent to their behaviour.[43] Individual differences are established by comparing their performance against the standards of performance, which are deduced under the standardization process based on representative samples of the target population. The standards usually relate to a certain age, i.e. the performance of individuals is compared to a typical score of individuals of similar age categories. In addition to standardized tests, researchers often used non-standardized types of testing and thus, this area will also be covered in this book.

Hargreaves[44] distinguishes three categories of tests. The first group includes tests of musical abilities (aptitudes). The best known tests falling under this category are those by Seashore, Bentley, Wing, Gordon, and others. The second category covers the significance tests, in the sense of determining certain achieved level of knowledge, knowing, performance or skill. This group is represented by, for instance, the test by Gordon or Aliferis. The third category includes tests of attitude to music. Hargreaves subdivides them further into tests that identify interest in music, and preferential tests, revealing taste, understanding, apprehension and sensitivity to music. This category is represented, for example, by the test set by K. Hevner.

The preferential tests ask the respondent to, for example, determine which one of a pair of intervals or chords is more consonant, or which of the two melodic phrases is better harmonized. Regarding the issue of a task that requires assessing the quality of harmonization, Gordon notes that it tests rather the adjustment to the adults' standard, not the musical ability itself. However, let's just add that even this "adjustment" undoubtedly reflects the musicality of an individual and it's so called musical acculturation aspect.[45]

In addition, the preferential tests may include modified, “distorted” fragments of pieces of music, for which the respondents are asked to determine whether the piece has been changed, or possibly which musical means of expression has undergone the change. In a way, these tests actually determine the level of familiarity of music literature and less the basic musical abilities. Therefore, it can be argued that the knowledge of played music fragments participates in the creation of differentiated conditions under test situations. On the other hand, however, it is actually a natural side effect of the chosen diagnostic method, reflecting the possible fact that different musicality of the respondents may be manifested through their more extensive or limited listening and performing skills.

The common feature of musical ability tests, integrating the ear for harmony as well, concerns the minimum requirements on the respondents in terms of the most elementary knowledge of music theory, and their perception nature (except for tests by Révész, Lýsek and some others where the perceptionality prevails).

In terms of the applied music material, the tests include both the static chord and music material. Unfortunately, a very common feature of all tests is the terminological and conceptual variability. Since all tests have been applied either in music pedagogy or psychology surveys or in music education practice, it confirms the known experience with difficult compatibility of the individual surveys’ results.

Tests introduced in the following two subchapters are presented on selection basis and are unavoidably fragmented. If the part is linked to another part of the test, the explanation will also cover that specific part. Most attention will be given to tests with the largest representation of “harmonic” tasks. This primarily is the case of the tests by G. Révész, H. Wing, F. Gordon, R. Thackray, and others.

2.3.1 Standardised Tests

Seashore’s test[46] (*The Seashore Measures of Musical Talents*), the first standardized test battery ever, integrated five items out of the originally defined 25 items of musicality called “talents”. Among others, they included a subtest called “sense of consonance”. It consisted of 50 items. The tasks consisted of assessing the harmonically exposed interval pairs. The respondent was asked to determine which interval in each pair seemed to be more consonant.

Seashore included this subtest only in his first version of the test set published in 1919, also covering the tests to determine the sensitivity of tone pitch, tone intensity, the sense of time and musical memory. In the next version of his test set, Seashore left out the item "sense of consonance", as he thought the instruction of asking the respondent to assess "better" or worse" consonance of intervals diverted children, especially, to rather think in terms of "like" or "dislike".[47] A more cogent argument, however, probably consisted in a very low validity of this subtest. Brown reports 0.17 and Mursell reports even a negative value of -0.27.[48]

The author of *The Oregon Music Discrimination Tests*, Kate Hevner, based her test on the assessment of pieces of famous composers.[49] The respondent was asked to assess four versions of the same piece and to determine the one that is the original. For the modified versions, the respondent was asked to determine the deformed musical means of expression, whether they concern the melody line, harmony or rhythm.[50] The test was subsequently standardized and rather simplified as it proved to be somewhat difficult. Instead of four versions, only one "original" and one "deformed" versions were exposed. The tested individual indicated the version he/she preferred, the deformed musical means of expression and the degree of certainty with his/her answer. The Oregon test may be classified as a preferential test. However, it also certainly integrates the analytical and knowledge aspects of music. The component is reflected under the context of other musical means of expression. We can say that Hevner's concept lies on the imaginary borderline between the music psychological and music aesthetic terrains.

The test set by H. D. Wing (*The Wing Standardized Tests of Musical Intelligence*) not only includes a distinctive number of subtests determining the ear for harmony, or it modifications, but in terms of the thoroughness of theoretical preparation, including the "area of harmony", at that time the test set represented an initiative of significant value. In addition, the scope of this test set undoubtedly contributed to the fact that the data obtained through Wing's test was, at that time, often subjected to factorial analyses and used in several multiple validity surveys of other researchers.

As already mentioned, Wing's[51] standardized set of musical ability tests was finalized after thorough theoretical and research preparation. It also analyzed some, at that time already existing, tests of the ear for harmony, with some tests developed by Wing. All were used in the pilot testing of 271 children,[52] proving three tests to be the best. These three tests were later included in the last standardized version of his test set. Wing identified them as the chord analysis, tone pitch change and harmony. Let us analyze their instructions in more detail.

The first test of the test set is called "Chord Analysis (Chords). Detecting the number of notes played in a single chord". The instruction says: "Either a single note or a chord (group of notes struck together) will be played. Write down the number of notes that are played …" The instruction also shows how to complete the record sheet, information on gramophone recording, etc. There are a total of 20 items.

With the name of this item, Wing informs about its analytical nature. However, it is obvious that in this performance, as examined by Kurth, Teplov, Meyer, and others, the non-analytical, holistic perception prevails.

The second subtest determines the ability to follow tone pitch changes sounding simultaneously in the complex with other tones, together forming a sensible chord. Wing called this subtest "Pitch Change: detecting a change in a single note in a repeated chord". The instruction says: "Two chords are played. Sometimes one note, not more, is changed in the second chord. If the two chords are the same, write "S" in the place provided for your answer. If there is noticeable change, state whether the altered note moves up or down. Write "U" for up and "D" for down. If in doubt, then guess." This subtest includes thirty questions.

This type of task, i.e. to follow tone pitch changes in chords, Wing used in the standardized test for the first time. It is actually a modification of a shorter task by Serejský (see below), under which the respondent is made to "detect" the tone and relate it to the chord entity heard. The task is in good correspondence with emphasis on the analytical nature of auditory performance and is more musical and dynamic. Its formulation is also clear and definite, which satisfies the administration under mass conditions. As explained below, the roots of this methodology may be, in principle, found in the works of Stumpf.

After the third subtest determining the music memory (determining tone changes in short melodic phrases of 3 to 10 tones) and the fourth subtest called rhythmical accent (assessing a more suitable rhythmical accent in two performances of the same melody), the fifth test reverts to the music means of expression. This time the subtest is called "Harmony - judging the better rhythmic accent in two performance of the same piece." Instruction says: "The same tune will be played twice. Sometimes the second playing has different notes below the tune (the notes played by the left hand may be different). If they are the same, please write "S". If they are different, write down which you think is the better, "A" or "B". If you notice a difference but cannot make up your mind, then guess."[53] The total number of tasks in this subtest is twenty. In this subtest, the procedure is designed similarly to Rupp, Exempljarskaja, Antosina, Teplov and many others, who, as shown below, applied similar tasks to primarily identify the degree of a child's -functional and consonantly dissonant- maturity.

The Wing's test set contains two more tests, addressing the issue of music dynamics (subtest No. 6) and phrasing, or articulation (subtest No. 7).

In the test set by H. S. Whistler and L. P. Thorpe (The Whistler and Thorpe Musical Aptitude Test),[54] consisting of five parts, the fourth subtest includes a task to assess fifteen pairs of chords and determine if the pairs are the same or different. If the chords are different, the respondents are asked to determine which one is higher and which is lower. The chord material contains eight pairs of major and minor triads and seven pairs of tetrachords. The test is called "tone pitch discrimination". We believe that it would be more accurate to talk about, for instance, pitch comparison of chords within the tonal space (analogically to F. Sedlák or M. Holas).[55]

The auditory tasks are also partially included in *The Gaston Test of Musicality*.[56] In the last version from 1958, in the second part (the first part examines the attitude to music) there are five tasks focusing on detecting the played tone in the subsequently exposed chord.

Musical abilities in terms of quality of the ear for music are also diagnosed by the test set by Edwin Gordon (*The Gordon Musical Aptitude Profile*),[57] which was developed at the College of Education University, Iowa, and published in 1965. The set consists of three parts. The first one determining tonal imagery addresses its melodic and modification through partial subtests. The author prefers more meaningful music phrases to isolated chords and intervals, as listening to them better reflects the orientation within the multiple-voice structure. Since both tests are closely related, we intend to describe both their melodic and version.

The task of the melodic tonal imagery test is as follows: a short melody is exposed, followed by some musical response, which is either a melody identical to the previous one or a different melody. The second melody is, however, enriched with several melodic tones ("extra notes"), which make the original melodic line less clear. The respondent is asked to decide whether the basic melodic lines are identical or different. To do so, he/she has to free his/her image of the basic melody from the added tones and then compare both versions.

In the modification of the tonal imagery test, the melodic voice (violin) of the first exposure is accompanied by the second, lower voice (cello). In the subsequent musical "response", the respondent is asked to focus on the lower voice (cello), which may be identical to or different from the first exposure. The sound is, once again, enriched with added melodic tones. The upper (violin) voice is always the same.

Gordon's test of the imagination asks the respondent to perceive and analyze successive tone sequences of two simultaneous melodic lines. Although this kind of tasks is rare in the musical tests, we believe Gordon found a rather optimum symbiosis of both the diagnostic and musical aspects.

A significant development in the music education practice was the test by the English music pedagogue, A. Bentley (The Bentley Measures of Musical Abilities). His test batery consists of four subtests: sensory sensitivity to the tone pitch, chord analysis, memory for melody and rhythm. The instruction for the chord analysis subtest says: " Test number three – chords. You will hear chords; that means group of notes played together. For example, here is a chord(played f1 sharp, c1sharp) containing two notes. Listen to the two notes played separately (example); and again together, as a chord (chord repeated). Here is another chord (g1, b1, e2) containing three notes. Listen to the three notes played separately (example); and together, as a chord (chord repeated). "Now listen to a chord containing four notes (g1sharp, b1, d2, f2); here are the four notes played separately; they will be played together, as chords. Listen carefully, and write down the number of notes you hear in each chord."[58]

The fourth out of the eight subtests of Holas' collective test of musical hearing abilities[59] includes a task determining feeling (asking for a number of tones in dyads, triads and tetrachords). The test of understanding the musical structure examines the ability to assess the "correctness" of the piano accompaniment to folk songs (played with violin). The respondent is exposed to three variants - correct, incorrect, and the third one with an accompaniment formed by a single function. Another subtest repeatedly applies the same principle but the number of means of expression is higher.

The respondent is to choose from the three variants of one melody. Some variants are intentionally performed without agogic, incorrect pace and with modified harmonization.

The objective of the overview below is to present, in more graphic form, a brief summary of the basic information about the tests described above. The table specifies the author of the test and year of the first publication, or its translation into the Czech language. The second column provides the name of the test item or the test tasks, if specified by the author. The third column contains a brief, succinct, description of the testing methodology, i.e. exposed musical material and activity of the respondent when solving the tasks.

Table 5 Overview of standardised tests of harmonic abilities

Author	Name of test item	Description of diagnostic methodology
Seashore, 1919	Consonance	Assesses consonance quality of intervals
Hevner, 1935	---	Determines which version of a piece of music is original and which is modified; which component of the expression is modified
Wing, 1948	Chord analysis, tone pitch change, harmony	Determines the number of tones in a static chord Determines change in one tone in a repeated chord; which voice was changed, assessing two harmonizations of one melody
Whistler-Thorpe, 1958	Pitch discrimination	Determines which pair of chords is higher, pitch comparison of chords in tonal space
Gaston, 1958	---	Identifies exposed tone in the subsequent chord
Gordon, 1965	Tonal imagery	Determines whether in a two-voice melody the second voice in the first part of the movement is the same as in the final part of the movement (first voice - soprano - remains unchanged)
Bentley, 1965	Chord analysis	Determines the number of tones in a static chord
Holas, 1985	---	Determines the number of tones in a static chord, assesses three versions of one melody harmonization, assesses three versions of one melody harmonization with change in some means of expression (pace, harmony)

2.3.2 Unstandardised Tests of Harmonic Abilities

The research of C. Stumpf is regarded as the first tests of the hearing for harmony (and first in the history of testing at all), which Stumpf used to verify the hypotheses about the relationship between acoustic stimuli and the physiological mental reactions of the examined individuals.[60]

In addition to many others, Stumpf used tasks asking the respondent whether he/she can hear one or two tones while exposing intervals of different distance (related to the fusion phenomenon – fusion of two different tones in an interval – as well as the application of this phenomenon as criteria for determining the degree of consonance and dissonance of intervals), to determine the number of tones in a static chord and whether the exposed tone was included in the previously played chord, to reproduce individual tones of chords, etc.[61] Thanks to the simplicity of the musical material and the methodology itself, these tasks have been used by the music pedagogue until today as elementary reference tests of musicality.

Based on Stumpf's model, similar surveys were carried out by his successors and mostly his pupils, A. Faist, H. Maissner and C. Malmberg,[62] who primarily validated the results of Stumpf's surveys regarding the fusion and consonance of intervals by increasing the number of respondents, age and musical aspects, etc.

Additionally, static intervals were the subject of a second group of research studies carried out at about the same timeframe as the research mentioned above. However, the respondents were not asked to analyze the intervals but to assess them as micro-aesthetic objects. The assessment scale provided usually consisted of two elements (like - dislike) or three elements (pleasant, unpleasant, and indifferent). These research studies were conducted by, for example, M. Guernsey, C. W. Valentine, C. F. Malmberg, O. Ortmann, and later by P. R. Farnsworth, and others.[63] The tasks of this type were initially also appreciated by C. E. Seashore (see above) and, as suggested below, by M. Schoen. Among Czech music pedagogues, similar research was carried out by F. Lýsek, and others, who applied it to triads and tetrachords.

At about the same time period, H. Rupp started to study interesting tonal aspects in the research of the ear for music.[64] He exposed his children, aged 6 and 8, to a two-voice melody, in prima volta finished on tonic, i.e. F major chord, and in seconda volta on the sixth degree, i.e. D minor chord latently harmonically felt as false close. The children assessed both closes identically. They didn't prefer either one. Therefore, Rupp deduced that the child's ability for harmony develops later than the ear for melody. E. Franklin[65] was one of those who argued against the simplification of Rupp's conclusion. He agreed with the thesis concerning the genetic priority of the ear for melody but he corrected it by postulating that the harmonic ability is, in this case, manifested by tonal feeling and the ability to feel tonal centre in the given situation represented by the major and minor triads (really sounding as a dyad).

It is clear that Rupp compared two rather precise tonal qualities, basically both acceptable from the "listener's" point of view. And this is the reason why children of early school age didn't detect any difference.

Likewise, the second Rupp's diagnostic methodology meant, at his time, so far an unused novelty. The task consisted in assessing three harmonizations of one melody played in the E major key. The assessment was done by five children of early school age. Rupp, identical to the previous research, actually applied the method of choice (originally derived in experimental aesthetic practice). To his surprise, children without hesitation accepted all three versions, thus not only the original, played in E major, but also those with left hand accompaniment in F major and D major (melody always in E major), even in such places where unrelated chords conflicted and resulted in clear dissonances.[66]

Figure 8 Original version – melody and accompaniment in E major

Figure 9 Second version – melody in E major, accompaniment in F major

Figure 10 Third version – melody in E major, accompaniment in D major

The basic principle of Rupp's research examining the perception of consonance and dissonance in movement, where the induced dissonance is the result of two parallel tonal ranges, was used many times in the following years in various modifications. As suggested below, the subsequent experiments, in particular, altered the tonal relationships of both ranges in terms of mutual relativity, density of position, stylization of the piano accompaniment and, of course, the actual musical material.

Therefore, already in the 1920s, Sofie Bel'ayeva-Exempl'arskaya conducted an experiment[67] with two harmonizations of the folk song, *In the field the birch stand*. The first version in E minor, the second with melody in E minor and accompaniment playing in A flat major.

A bit later, the similar methodology was used by M. N. Antoshina.[68] She exposed children, similarly to Rupp, to three versions; first version tonally simple, the accompaniment of the second version consisted only of the tonal chord and the third version was bitonal. The children were asked to say which version they preferred and why.

B. M. Teplov continued in the suggested melodic line.[69] In his research, he used, for instance, *German Song by Tchaikovsky (Album for the Young)* with the melody in E flat major and accompaniment in C major, and he complemented his research with data collected through individual interviews with the respondents. With respect to the relative completeness of the list of research activities conducted in this area, we should also mention at least G. Schünemann, R. Wick, H. J. Hair, L. Höchl, H. Moog,[70] and H. Chvátilová or M. Holas among the Czech authors.

The test by J. Kwalwasser also falls under the category of preferential tests;[71] the subject is asked to distinguish three three-element chord procedures ("correct" and "incorrect"). H. D. Wing worked on a similar test when putting together his test set. Unlike Kwalwasser, he used more extensive and tonally more specific examples taken from "classical music" and had respondents compare them with the reharmonized versions. Wing himself deemed his version as more versatile, including both the harmonic and polyphonic texture and with wider scope of difficulty.[72] Let us remember that this principle was applied to draw up the standardized and rather highly valued test set by K. Hevner.

The following text, step by step, discusses other tests designed in the 1920s and 1930s, out of which primarily the set of tests by Géza Révész was brought to the attention of the Czech expert public.

The first part of the test set by M. Schoen[73] was designed as test of perception of the basic tone qualities (duration, pitch, intensity). The second part tests, in particular, the more complex phenomena (musical memory, chord analysis, etc.). In addition, Schoen included three "harmonic" tests: preferential, assessing the consonantly dissonant effect of intervals (taken from the Seashore test set – 1919 version), the test of relative hearing, concerning the task to compare intervals with respect to their distance, and the chord analysis test, concerning the tasks to determine the number of tones in a static chord. Standardization was initiated on this test but was not completed.

In the 1920s in England, the test of musical abilities by H. Lowery was published.[74] It consisted of three subtests. The first one, called the cadence, contained tasks to assess cadences consisting of two chords. The tested individual was asked to identify whether in two exposed cadences, the second finishes less or more pleasantly than the first one. Unfortunately, the musical space to express nuances of tonally tension was reduced to such a degree in the cadences that the assessment of the degree of diminishing tonal tension, without space for increase, was questionable.[75] We believe that the cadences should have consisted of at least three (compare to Kwalwasser) or four chords and with explicit tonic at their beginning.[76]

Figure 11 Lowery's cadence test

Unlike Lowery's test focused on a single component of the hearing music, the test of musicality by G. Révész integrates many aspects found in the personality structure of musicality and is designed, in terms of the quality of the ability for harmony, in rather complex manner.[77]

In the third series of tests, respondents listen to chords played on the piano and their task is to vocally reproduce the individual chord tones bottom to top. Instead of vocal reproduction, it is possible to find and play the responses on the piano. This activity is then followed by analysis of multiple-tone chords, i.e. triads and tetrachords. For the first group of chords, Révész picked consonant chords and one slight dissonance (diminished triad). He identified them as consonant. The second group consists of dissonant chords. Révész used the Stumpf's nomenclature ("diskord – konkord" and analogically discordance – concordance). In the fourth group of tasks determining relative hearing (das relative Gehör) the respondent is exposed to an interval followed by a single tone and the tested individual is asked to sing (or play on the piano) the identical chord from the newly given tone. In principal, it concerns auditory or vocal transposition of intervals. Révész goes back to the issue of harmony in the fifth group of tests, called the harmonic apprehension and response (Sinn für Harmonie). One of the items in this test, i.e. singing or instrument reproduction of intervals or triads in their basic forms and inversions, is identical to the tasks in the analysis test of dyads and multiple-tone chords. Additionally, the tested individual is asked to assess the exposed thirds, fourths, fifths and major and minor triads in terms of consonance and dissonance and to determine the type of key for triads. The second subtest of this group contains a task exposing four-voice cadences (plagal and authentic cadences) and the tested individual is asked to reproduce with singing the leading voice. The third subtest consists in the examiner exposing a modulation. The tested individual is to say whether he/she thinks the sequence of chords reached the base key to the target key. Following the tasks related to the diagnosis of the ear for melody (memory for melody and reproductions based on hearing on the piano), the aspect is examined in the last test called the creative fantasy (die produktive Phantasie). The principle of this procedure is that the tested individual is asked to complete the initially exposed known melody after its interruption. As the second modification of the test of creative fantasy, deemed by Révész as diagnostically very solid, he recommends determining a suitable accompaniment to a just completed song on a musical instrument.

Some of Révész's tasks were used in the first part of the test set by M. Serejsky and K. Malceva.[78] They suggested to include a task into the fourth subtest asking the respondent to analyze dyads and multiple-tone chords, i.e. determine the number of tones (authors named this test as the analysis in the broader sense) and sign or play the individual tones (analysis in the narrower sense). In the seventh subtest, the respondent compares pairs of four-voice cadences and determines whether they are repeated verbatim or with modification (only possible in tenor or alt since bass and soprano always remain the same).

With respect to the modification of analysis, it may be noted that it is understood as one of the real tests of analysis (unlike the tests called the same but consisting in determining the number of tones, which, as already mentioned, does not require any analytical approach).

K. Malceva, this time individually,[79] studied relative hearing (said with the Wellek's nomenclature) and the ear for harmony as one of its modalities by exposing the respondents to three kinds of static chords (major and minor triad and dominant seventh chord) in closed and open positions. Their task was to determine the type of exposed chord.

At the end of the 1930s, the testing of musicality was also met with a response from the Czech music education. A. Cmíral, the Czech music educationist, recommended twelve themes adopted from the German and Anglo-American tests on how to diagnose musicality for the music pedagogical public in the context of his extensive book *Hudební pedagogika (Music Education)*.[80] Among others, it includes the task to determine the number of tones in dyads, triads and tetrachords, reproduce the highest tone in the static chord, assess the static intervals and chords in terms of their music effectiveness and assess harmonization of a folk tune.

F. Lýsek approached the test of musicality based on the research of Révész.[81] Lýsek studied the feeling in four-year-old children asking them whether triads are “nice” or “ugly”. He diagnosed the thinking by assessing harmonizations through basic functions, modulations or temporary modulations. He applied a number of diagnostic practices examining the aural skills as singing-reproduction analysis. Its nature basically consisted in the vocal reproduction of various chord complexes (intervals in natural voice position or out of this position with necessary transposition, major and minor triads or inversions, dominant and diminished tetrachords, etc.) in closed and open positions.

In his study on psychometric approaches[82] in music psychology, L. Daniel, as one of the first music pedagogues in postwar Czechoslovakia, positively coped with the music psychology foreign tests (he reflects on Seashore, Semjeonoff, Gaston, Kwalwasser, Dykem, Courtis and many others publishing between the wars; however, he completely omitted Wing).

In accordance with his music education approach emphasizing gradual mastering of the skills and strict staging and standardization of curriculum and pupils’ performance, he drew up a rough form of several tests of musical abilities (sense for rhythm, sense for pitch, tonal feeling and ear for harmony). He suggested testing the ear for harmony using the following tasks: determine when the second voice is added for the first time to the melody and to mark the beginning by underlining the syllable in the song text, determine the number of tones in the chord, identify the changes in harmony when a part of a piece of music is repeated and assess the correctness of the created second voice.

T. Madison once again (as many times before) based his research of musicality on intervals[83] as basic musical perception units. He used two test tasks: determine the distance of two harmonically exposed intervals and, in the test of tonal imagery, as called by Madison, find one different interval (e.g. perfect fifth F sharp - C sharp) among four transposed intervals (e.g. major sixths C-A, F-D, B-G).

Madison supported his interest in intervals primarily by validation values of research, where the results of his tests very closely corresponded to the assessments of music pedagogues.

R. W. Lundin[84] applied similar traditional approach. In the mid-1940s, he proposed a test set with 5 subtests. The first subtest contained the task to distinguish the distance of two harmonically exposed intervals and the second subtest aimed at assessing the identity or the difference of major or minor chord pairs.

The Gdansk diagnostic system of musical abilities by J. Horbulewicz and Z. Janczewski comprises the first diagnostic-instructional parts of six music education lessons followed by a test. The harmonic ability is covered in the first methodological unit. A teacher plays 10 pairs of triads on the piano; they are either identical or different. Then the teacher asks the children: "Do I play the same or different?" And children all respond.[85] At the end there is a short test of musicality (individual) that contains a test of rhythmical feeling, sense for pace, melody movement, sense for melody completion and chord analysis. The chord test consists of five items and the child is asked to determine the number of tones in one- to three-tone chords.[86]

The Gdansk diagnostic system of musicality is of comprehensive nature. Six music instruction lessons followed by the respective test are complemented with a questionnaire about the child and their family regarding music.

According to R. Thackray[87] to study the perception of harmony requires using several tests with differently profiled tasks. That is the only way to capture the broader scale of aspects of the perception of harmony. Thackray's plan is actually based on Wing's concept while partially modifying the pattern of test tasks.

Thackray's test set consists of three subtests. The first one, called single notes and cords, focuses on the identification of a chord in a melodic line, which contains from three to seven tones. The respondent's task is to mark, on the prepared record sheet, the position where the chord was played. In the second subtest, called change in harmony, a short movement is played twice. The tested individual is asked to mark the position where change in the chords occurred during the second exposition. The principle of the third, chordal memory subtest, lies in remembering the exposed chord and its identification in a sequence of three to five chords following the played chord.

One of the few music researches using polyphonic musical material was conducted by A. Zennati.[88] In her experiment, she exposed the respondents to fugue based on a well-known song. The respondents were asked to signal when they identified this song in any polyphonic voice.

The purpose of the examination of musicality by F. Sedlák[89] was to make the diagnosis of children moving from the first to the second level of primary schools easier for the teachers of music education. The examination consists of two parts: collective and individual. Sedlák divides the collective part into receptive and reproduction. Under the receptive section he recommends to test the feeling by the often used method, i.e. by determining the number of tones in the intervals (minor 3rd, major 6th, perfect 8ve, perfect 5th, major 2nd, and minor 2nd) and the major and minor triads and inversions. Additionally, he recommends the task when a triad is played followed by a tone; the respondent is asked to determine whether the tone was the bottom, middle or top tone in the chord (to assign numbers 1, 2 or 3).

In her research of the harmonic abilities development in children aged five to thirteen years, H. Chvátilová[90] used a music test, the first task of which consisted in assessing multiple-voice arrangements of four folk songs and determining the number of voices in that arrangement. The second task was to identify the tones of a static one- to three-tone chord and the third task was to compare several versions of folk song harmonization (see Rupp's and following research). Chvátilová also studied the influence of rather systematic music education (represented by the music school attendance) on the harmonic abilities development. The criterion concerned the assessment of consonance and the degree of dissonance of static chords, i.e. triads and tetrachords.

The test by Rohánek[91] with eleven subtests, primarily applied to students of the teaching profession, also contained tasks asking to determine the number of tones in a chord, identify change (movement) of any voice in the repeatedly exposed triad, assess the finality of harmonic cadences and the reproduction of bass and soprano in these cadences (compare to the methodology of Serejský and Malcevová, where alt and tenor were reproduced).

D. Fajkusová[92] examined the feeling by assessing consonance and dissonance of static triads and tetrachords (with the possible answer like - dislike). She studied the feeling as an advanced quality of the musical perception under assessment of four harmonization options: with respecting the latent harmony, bitonal, with the accompaniment on the tonic and with richly elaborated harmonization. The final task was to determine the number of tones in static chords and sing the individual tones.

The last three examples of the test methodologies are more closely related to education practice since their objective was to determine the musicality of applicants for a certain type of a music school. Additionally, they all expected the tested individuals to already have some knowledge of music theory.

The test by James Aliferis was fabricated to satisfy the needs to determine musicality during entrance examinations for a college (Music Achievement Test College Entrance Level).[93]

It consists of three basic units. Each unit is dominated by one musical means of expression: melody, harmony or rhythm. The tasks are divided into two groups. The first consists of examples with elementary musical elements. In the melodic unit these elements concern intervals, in the unit they concern isolated chords and in the rhythmical unit they concern rhythmical extracts. The second group of every unit contains more musical extracts (Aliferis calls them "idioms"). In principal, they are three-element motifs.

In the elementary section, the major, minor and diminished chords in basic positions and inversions as well as in a closed and mixed position are exposed. The respondent is given four options of the respective chord type. All types of inversions share the same bass tone with tenor and alt and soprano changing. The respondent is asked to determine which of the four chords in the sheet of music are identical to the sound played live on the piano or exposed as a recording. In the second musically "more meaningful" group, cadences (idioms) are exposed, each of them in three versions. The task for the respondent is to determine which of the versions is identical to the played example.

F. Spilka[94] proposed an initial test of musicality of three difficulty levels. In the first level, pupils assess chords according to their consonantly dissonant effects. In the second and third levels, music theory knowledge is expected. The bass and tenor (or alt) of the triad, intervals are reproduced. The respondents are asked to record them, assess the closes and take two- and multiple-voice listening dictation, etc.

Certain knowledge of music theory was also expected and actually also diagnosed by the research organized under the sponsorship of the Czech Music Society; the research verified the status of musicality in relation to the investigation of general music education effectiveness.[95] In the first class, pupils were asked to mark, in a line of triads, the tonic and dominant. In the seventh class they were asked to identify the triads spread out in the melody and determine which one is the tonic, subdominant and dominant.

Table 6 Overview of non-standardized tests of ear for harmony

Author	Name of test item	Description of diagnostic methodology
Stumpf, 1883, 1890		Determines the number of tones in interval (fusion, consonance). Determines the number of tones in a chord, reproduces the individual tones in a chord.
Faist, 1897 Maissner, 1914 Malmberg, 1913		Assesses the interval in terms of the fusion and consonance.
Guernsey, 1928 Valentine, 1915 Malmberg, 1918 Ortmann, 1927 Farnsworth, 1950		Assesses the intervals as micro-aesthetic object (like - dislike, pleasant ...).
Rupp, 1915 Bel'ayeva Exampl'arskaya, 1925 Antoshina, 1935 Teplov, 1968 Schünemann, 1930 Wicke, 1931 Höchel, 1960 Moog, 1967 Hair, 1979		Assesses the finality of melody, harmonic close. Assesses several versions of harmonization of one melody.

Kwalwasser, 1926		Assesses three-element cadences.
Schoen, 1923		Assesses consonantly dissonant effect of intervals, determines the number of tones in a static chord, distinguishes two intervals in terms of their distance.
Lowery, 1926	Cadence	Assesses the finality of the cadence.
Révész, 1920, 1947	Relative hearing Sense for harmony Creative fantasy	Reproduces the individual tones of dyads, triads and tetrachords. Transposes and reproduces the interval from a given tone. Reproduces intervals and triads (in different types of inversion). Determines the type of key in major and minor triads. Assesses the consonant and dissonant effect of intervals and chords. Reproduces voices of four-voice cadence. Assesses the finality of modulation. Creates accompaniment to a well-known folk song.
Serejsky, Maltseva, 1928	Analysis in the broader sense, Analysis in the narrower sense	Determine the number of tones in static chord. Reproduction (singing, playing the instrument) of tones in the static chord. Compare pairs of four-voice cadences. Identify changes in alt or tenor.
Maltseva, 1939	Relative hearing	Determines the kind of statically exposed chords (major and minor triad, dominant seventh chord).

Lýsek, 1947, 1955	Feeling, thinking	Assesses the aesthetic effect of static triads („nice - ugly“). Assesses the basic functions, modulations. Vocally reproduces intervals, major and minor triad, dominant and diminished seventh chord in closed and open position, in natural voice position or transposition.
Daniel, 1968	Hearing.	Determines where the second voice joins the melody. Assesses the identity of the second voice with latent harmony („correctness“ of the second voice). Identifies exposed tone in the following chord. Identifies change in harmony when piece of music is repeated.
Madison, 1942	Tonal imagery.	Distinguishes two intervals with respect to their distance. Identifies one different interval among four transposed intervals.
Lundin, 1949		Distinguishes two intervals with respect to their distance. Identifies the identity or difference of major and minor chords.
Fajkusová, 1964	Feeling, thinking	Assesses consonantly dissonant effect of triads and tetrachords. Assesses four versions of harmonization of the same melody. Determines the number of tones in the static chord and reproduce them (singing).
Horbulewicz Janczewski, 1966		Identifies the identity or different of pairs of major, minor chords and incomplete tetrachords. Determines the number of tones in one- to three-tone chords.

Thackray, 1973	Individual tones and chords Change in harmony Memory for harmony	Identifies the position where a chord is heard in a single-voice melody. Identifies the position where a chord changed in repeated movement. Identifies the position where previously exposed isolated chord is heard in the movement.
Sedlák, 1979		Determines the number of tones in dyads and triads. Determines the voice in the triad the repeated tone falls under.
Zennati, 1968		Determines when the theme of a well-known song appears in polyphony.
Chvátilová, 1979	Ear for harmony	Determines the number of voices in multiple-voice arrangement of a folk song. Determines the number of tones in the static one- to three-tone chords. Assesses several versions of harmonization of one melody. Assesses the consonantly dissonant effect of static triads and tetrachords.
Rohánek, 1983		Determines the number of tones in a static chord. Determines change in one tone in repeated chord. Assesses tonal finality of cadences. Reproduces bass and soprano in these cadences.
Aliferis, 1954	Imagery	Compares the sound form of static chords and cadences with four versions of the musical notation.

Spilka, 1956	Assessment of tone consonance	Assesses consonantly dissonant effect of chords. Reproduce voices in triads, intervals. Notation of intervals. Determines the type of harmonic close based on listening. Records two- and multiple-voice musical dictation.
Czech Music Society, 1985		Identifies basic function in musical notation. Identifies spread out triads in melody (T, S, D).

2.3.3 Validity and Reliability of the Harmonic Ability Tests

The most vital characteristics of any tests evidencing their quality are validity and reliability. Both these characteristics are presented by means of correlation coefficients. The methods of collecting the primary data and problems related to the definition of validity and reliability coefficients of some ear for harmony tests are discussed below.

Actually, every educational or psychological book addressing the issues of research methodology discusses the validity of tests in general. The validity of musical ability tests or ear for harmony tests is particularly considered in relation to three validation criteria. The first one, the criterion of content, expresses the degree to which the test situations (tasks) are representative considering the situations for which the test is designed. For example, it concerns the comparison of the test content with the content of a learning programme.[96] In particular and with respect to the special music education, the so-called predictive test validity is more interesting. Nevertheless, the discussion concerning the Seashore's test set, the manual of which defines strict predictive opinions on the development of musicality derived from the achieved score (e.g. tests of the discrimination sensitiveness for microintervals), pointed out the unstableness of this criterion. Probably the most used type of validity is the concurrent validity. It consists in comparing test scores with the grades in music education, music instrument playing, etc. However, these methods also have their pitfalls, primarily in the subjectivity of teachers' evaluations. Another limitation consists in the low number of subjects being involved in the validity process, especially in the case of evaluating instrument playing. It, as a matter of fact, negatively affects the statistical validity of the entire process.

A. Bentley[97] deals with the validity process of his test set in similar manner. Unfortunately, he only provides the correlation coefficient values for the entire test set, not for the individual subtests, i.e. not even the harmonic analysis test (ear for chords). In this respect, we found the descriptions of Gordon's validity process procedures, used in the following text, as more interesting.[98]

As already mentioned, great attention was drawn to the first Seashore test set from 1919. In the previous text, the validity values for the consonance subtest published by Brown[99] and Mursell[100] have already been given. The table below provides the validity values for other subtests, to allow comparison:

Table 7 Validity of Seashore's test of musical talents

	Tone pitch	Intensity	Time	Consonance	Rhythm	Memory	Average
Brown	0.15	0.11	0.15	0.17	0.17	0.41	0.35
Mursell	0.11	0.07	0.20	- 0.27	0.25	0.19	0.08

The Seashore's test (version from 1919) was subjected to validity procedures in the 1950s. Lundin's overview[101] shows that the correlations are not, in most cases, above 0.4. The lowest value was detected between the subtest of consonance and piano skills (-0.25). On the contrary, the highest correlation was obtained between the total score for the entire test set and the results achieved in the control music dictation at the end of the first year of college music education.[102] Shuter shows similar values, i.e. -0.27 to 0.41, median of 0.55.

The Gordon's test of harmonic imagery features validity, according to the test manual, from 0.52 to 0.72, median of 0.64. As the criterion, the evaluation by teachers was used. Together with the melodic imagery test, the harmonic test, as expected, shows slightly higher values, i.e. 0.54 to 0.83, median of 0.67[103]. Tarrel,[104] based on the validity process with 900 pupils, presents significantly lower values of 0.25 to 0.43, median of 0.38.

Shuter, based on the work by Christy, reports on the values of the Madison's test of tonal imagery (ear for chords – here intervals – in musical space).[105] Its validity oscillates between 0.24 and 0.54, with median of 0.41.

The test for the type of key discrimination (ear for chords) by R. Lundin[106] was subjected to the validity process by having been correlated with the results of melodic and harmonic dictation and the evaluation of students in terms of their overall musicality. The results were between 0.35 and 0.51, with median of 0.49.

Aliferis' initial test of musicality (ear for harmonic homophony), version of 1954, shows the correlation coefficient value, according to the test manual, of 0.53. Roby obtained a bit higher value, up to 0.66. For the tests of melody and harmony, taken together, the values once again rather increased, up to 0.77.[107]

All the values mentioned so far do not provide sufficient evidence for us to be able to express generalizing conclusions. Nevertheless, it is at least possible to organize the data based on the modifications of the ear for harmony, while ignoring such aspects as the type of validity process, the size of the validity sample, etc. We only provide the median values.

Table 8 Validity of some tests of harmonic abilities

Autor of the test	Type of harmonic ability	Validity
Seashore	Feeling of consonance and dissonance of intervals (6)	0.05
Gordon	Ability to recognize harmonic homophony and harmonic polyphony (3)	0.64; 0.38
Madison	Ability to recognize harmonic intervals and chords in the musical space (4)	0.41
Lundin	Ability to recognize harmonic intervals and chords (2)	0.49
Aliferis	Ability to recognize harmonic homophony and harmonic polyphony (3)	0.53; 0.56

The table shows that the validity of the ear for harmony tests appeared to be completely negative for the test of consonantly dissonant feeling; low values are also shown for the test of ear for chords (intervals) in musical space and ear for chords. Only two tests exceeded the threshold of 0.6, the tests by Gordon and Aliferis testing the ear for harmonic homophony. However, the repeated validity process for Gordon achieved only 0.38.

Altogether, these values are about the same (except for the tests of consonantly dissonant feeling) with the validity coefficients of all types of musical abilities, placed by E. H. Schneider[108] between the interval of 0.40 – 0.60.

The principle of assessing tests in terms of their reliability is examined by either each subject completing the same test twice (retesting method) or each subject takes two tests with similar profiles (parallel test method) and the results of both tests are correlated. The so-called split-half method represents a very economical procedure since only one test is necessary. The test is divided into two halves and the results of these two halves are correlated similarly as for the previously mentioned methods. If the results of even and odd items in the test are correlated, the procedure is called the pair-impair method.[109]

Likewise with the validity, the reliability values depend not only on the selected method but on many other factors. The ability tests generally show higher reliability than, for example, the personality tests.[110] Reliability of ear for harmony tests is, as evidenced below, in principle a bit higher than their validity. It was already confirmed by the Seashore's test of consonance (consonantly dissonant feeling of intervals), which, according to Lundin[111] showed reliability values between 0.30 and 0.62 and the median of 0.49. Farnsworth's results were even a bit higher, i.e. from 0.35 to 0.68 with the median of 0.56.[112] The reliability of Madison's tests of musical imagery (ear for intervals in a musical space) is also rather high. The values oscillate between 0.76 and 0.84.[113]

The overall high reliability of Wing's test set (0.91) may be attributed primarily to its two introductory subtests. The value of the first one, ear for chords test, is 0.76 and the value of the second one, assessing the ear for harmonic homophony, is 0.86. However, the fifth test of consonantly dissonant feeling shows a lower value of 0.42.[114]

The reliability of the Gordon's subtest of the ear for harmonic homophony is supported by the data included in the test manual, based on the standardization sample (from 0.66 to 0.85),[115] and by the Tarrel's survey[116] of 1,000 students aged 10 to 18 years. Here, the range is between 0.67 and 0.83.

The reliability of the chord analysis subtest (ear for chords) in the Bentley's test set is 0.71 and is quite close to the value of a similar test by Wing (0.76).[117]

By and large, unexpected differences are seen in the reliability coefficients of the Lundin's test of the ear for chords.[118] The value obtained based on a sample of 167 students of music (0.65) is still over the significant level. However, the 0.10 coefficient obtained based on a sample of 196 randomly selected students is very low. This rapid drop is even more interesting as it did not happen with any other subtest of the Lundin's test set. Unless it is an error, the critical role could be played by the coincidence in responses as direct consequence of the musicality of respondents.

On the contrary, Aliferis' test of the ear for harmonic homophony appears to be stable. The reliability of the first version from 1954 is 0.72, of the second version from 1962 up to 0.90 and is the highest among all the test set items.[119]

The reliability coefficients of the above mentioned tests of the harmonic ability are summarized in the table below.

Table 9 Reliability of some harmony tests

Author of Test	Type of the harmonic ability	Reliability
Seashore	Feeling of consonance and dissonance of chords and connections of chords (6)	0.49 - 0.56
Madison	Ability to recognize harmonic intervals and chords in the musical space (4)	0.76 - 0.84
Wing	Ability to recognize harmonic intervals and chords (2) Ability to recognize harmonic homophony and harmonic polyphony (3) Feeling of consonance and dissonance of chords and connections of chords (6)	0.76 0.86 0.42
Gordon	Ability to recognize harmonic homophony and harmonic polyphony (3)	0.65 - 0.85 0.67 - 0.83
Bentley	Ability to recognize harmonic intervals and chords (2)	0.71
Lundin	Ability to recognize harmonic intervals and chords (2)	0.65; 0.10
Aliferis	Ability to recognize harmonic homophony and harmonic polyphony (3)	0.72; 0.90

The tests of consonantly dissonant feeling (Seashore, Wing) demonstrate the lowest values under the level of usability.[120] On the other hand, the highest correlation coefficients of reliability were recorded with the tests of the ear for harmonic homophony and harmonic polyphony (Wing, Gordon and Aliferis). The situation with the test of the ear for chords is a bit more complicated. Two very different results of the same test received by Lundin from two different groups of respondents, more or less trained in music, point out certain unstableness of the test. We believe that one of the possible causes lies in the holistic perception of chords in the tests of this kind. The successful completion of tasks probably consists in the correct commencement of the test, in hitting the right "timbre" of the chord exposed at the beginning. Subsequently, it is quite easy even for the musically less trained respondents to holistically and mutually get excellent results as well as very poor results, even if the respondents make a mistake at the very beginning of the test (e.g. if the respondent thinks that major third is a major triad, or the subsequent diminished triad a bit richer in timbre to be a tetrachord, etc.). The issue of perception, as already discussed in the first chapter, is, of course, much more complicated. A more significantly holistic approach to the assessment of static chords, as discussed before, is however undeniable, as reflected by the surprisingly low reliability test with the respondents of the given level of musicality.

With respect to the other tests, it is very difficult to adopt any fundamental statement due to heterogeneity of the collected data and, additionally, as many tests have not undergone the standardization process nor the partial verification of their reliability.

If we compare, same as in the previous discussion regarding validity, the existing findings about the reliability of the tests of the ear for harmony with average values of the most frequently used tests of musical abilities oscillating between 0.80 and 0.90,[121] we will obtain identical correlation coefficients for the tests of the ear for the harmonic homophony and polyphony (Wing, Gordon, Aliferis). The rest is under the average.

2.3.4 Correlation Issues of Harmonic Abilities

The factorial analysis models have already integrated the ear for music and Whellams' analyses, mentioned in chapter 2, have registered it very clearly. Here, we are going to focus on the simpler relations. Compared to the multidimensional analyses, although this approach will reduce the number of variables within our workspace, we believe that the problem is approached with a relatively new factor that is represented by a six-element structure of the ear for harmony, defined in chapter 3. Therefore, now we are going to gradually verify the extent to which this structure of the ear for harmony is viable and the bipolar relationships within the system.

While thinking about correlations, it is necessary to firstly realize that they concern the results of a multiple abstraction process. The selection of qualities, i.e. certain abilities that we have identified as the ear for harmony, actually means a significant abstraction. Testing, quantification of performances and examination of the mutual relations between the variables represent additional two levels of abstraction. The fourth abstraction step consists in this relationship being expressed as a single number, the correlation coefficient.[122]

The correlation coefficient expresses the direction and the degree of dependence between the two tested performances. The validity of the coefficient is subject to two conditions: the basic set needs to have a normal two-dimensional distribution and the regression line needs to be a straight line. The interpretation of the correlation coefficients forms the key issue. In general, there may be three causes of the correlation: either there is a causal factor affecting both variables, either positively or negatively. The second situation occurs when one variable is the cause of the second one. In terms of the third situation, two variables may be partially identical, i.e. they can overlap.[123] For our issues, the first and third items should be considered primarily.

The essential factor involved in the interpretation of the correlation coefficients concerns the size and representativeness of the sample. Generally, the same coefficient expresses a higher dependence for a higher number of correlated pairs (bigger set). Additionally, attention should be given not only to the quantitative characteristics of the sample, but also to its homogeneity. Contrary to the experimental methodology, where it is recommended for the sample to be as homogenous as possible, it may be noted that: "The homogenization of a sample with respect to any variable reduces the correlation between this variable and any other variable."[124]

There are a number of explanations of the actual numerical values of the correlation coefficient, but the opinions are not completely identical. For instance, J. P. Guilford believes the coefficient of 0.20 to be weak, practically a useless relation; from 0.20 to 0.40 it is a low correlation; the coefficient from 0.40 to 0.70 represents medium correlation; whereas, from 0.70 to 0.90 it is high and above 0.90 it is very high. E. A. Chaddock defines these rules depending on two variables: if r is less than 0.30 and applicable to a small sample, it is a very low correlation. Other correlation intervals correspond to the Guilford's definition above.

2.3.5 Intercorrelation Issues of Harmonic Abilities Subtests

Valid correlation coefficients are available as a result of H. Wing's test set analyses. Three subtests of the ear for harmony included in this test set have been mutually correlated by several authors who, subsequently, factored them in the context of the entire subtest. These authors include, in particular, H. D. Wing himself, then E. Franklin, R. Shuter, G. Holmström, etc.

Wing bases his correlation matrix on a rather limited sample of 43 boys aged from 14 to 16 years. This sample is one of the many applied by Wing to obtain similar results. The table below shows the correlation coefficients between three subtests of the ear for harmony. The items are identified both with Wing's nomenclature and the terms of the modified ear for harmony:

Table 10 Intercorrelation of the harmony tests in Wing's test batery (After Wing, 1941)

	1	2	3
1. Number of tones in a chord -analysis of chords Ability to recognize harmonic intervals and chords (2)	x	0,509	0,491
2. Change of a tone in a chord Ability to recognize harmonic homophony and harmonic polyphony (3)	0,509	x	0,388
3 Assessment of more acceptable harmony Feeling of consonance and dissonance of chords and connections of chords (6)	0,491	0,388	x

Franklin's inter-correlation data is, once again, based on the correlation matrix of Wing's set factorial analysis, the Franklin's TMT test (Tonal

Musical Talent), two Seashore's tests, Franklin-Révész's rhythmical test and Anderberg's test of general intelligence.[125]

Out of this extensive matrix, the table below shows only the correlation coefficients of three Wing's subtests for the harmony. The test numbering is identical with the numbering in the previous table.

Table 11 Intercorrelation of the harmony tests in Wing's test (After Franklin, 1956)

	1.	2.	3.
1.	x	0,41	0,36
2.	0,41	x	0,55
3.	0,36	0,55	x

Notes

1 In both cases, the correlation coefficients are low and refer to a low affinity of all three tests performances in terms of their common musical ability base. It is also possible to note that this finding actually confirms the adequacy of the ear for harmony characteristics and the relative autonomy, or independence of the respective components. However, this note should be, at this point, adopted with utmost precaution. As seen, only two surveys, although independent, reflected the ear for harmony characteristics elements. Therefore, we can deem these raised statements to be the basis of the hypotheses, which, however, have to be duly defined and subsequently verified.
REBER, A. S. *Dictionary of Psycholog.* London: Penguin 1985, p. 1, and p. 50.

2 Viz. SEDLÁK, F. *Základy hudební psychologie [Basis of Music Psychology]*. Prague: State educational publishers 1990, p. 181.

3 The concept of static and dynamic structures of a personality is advocated by O. KOLAŘÍKOVÁ in her paper *Overview of the Theories of Static and Dynamic Structures of a Personality*. Prague: State educational publishers 1976, pp. 48-96.

4 "Most of all, perhaps, it might have been expected in the sphere of music, where not only innate instinct but also environmental encouragement are incomparably more favourable for some individuals than for others." BURT, C. *The Measurement of Mental Capacities.* Edinburgh: Oliver and Boyd 1927, p. 42.

5 SPEARMAN, C. *The Abilities of Man.* London: Macmillan 1926, p. 340.

6 SEDLÁK, F. has created over the years of his career several variants of musical ability concepts.

7 According WING, H. D. *Tests of Musical Ability in School Children*. Unpublished M. A. Thesis. London University, 1936, pp. 104–109.

8 FRANKLIN, E. *Tonality as a Basis for the Study of Musical Talent.* Göteborg: Gumperts Förlag, 1956, pp. 153–169.

9 After SHUTER, R. *The Psychology of Musical Ability.* London: Methuen, 1968, pp. 293-307.

10 Mc LEISCH, J. The Validation of Seashore s Measures of Musical Talent by Factorial Methods. *British Journal of Psychology*, 1950, 3, pp. 129–140.

11 SHUTER, R. *op. cit*., p. 183.

12 FRANKLIN, E. *op. cit*., pp. 172–177.

13 The research and analysis were elaborated by the author in her PhD thesis An Investigation of Hereditary and Environmental Factors in Musical Ability. PhD Thesis. London University 1964.

14 After SHUTER-DYSON, R. Psychometrische und experimentelle Studien zur musikalischen Begabung. In *Musikpädagogische Forschung. Bd. 1. Einzeluntersuchungen*. Laaber: Laaber-Verlag, 1980, pp. 50–60.

15 Compare to Holmström's Musicality and Prognosis, Uppsala, Almquist and Wiksells, 1963.

16 After TEPLOV, B. M. *Psychologie hudebních schopností. [The Psychology of Musical Abilities.]* Prague: Supraphon 1967, pp. 32–39.

[17] *Ibid*., pp. 32–37.
[18] *Ibid*., p. 198.
[19] SCHOEN, M. The Psychology od Music: A Survey for Teacher and Musician. New York: Ronald Press, 1940.
[20] Viz. ERNST, K. D. Hudobná výchova a jej ciele. [Goals of Music Education] In: *Hudobnopedagogické variácie 3 [Variations of Music Education 3].* Bratislava: Slovak Society for Music Education 1971, p. 19–30.
[21] MICHEL, P. *O hudebních schopnostech a dovednostech. [Music Abilities and Skills]* Prague: Editio Supraphon 1966.
[22] Viz. LÝSEK, F. *Úvod do hudební výchovy. [Introduction to the Music Teaching]* Prague: State Educational Publishers 1965, p. 38 et seq.
[23] Viz. SEDLÁK, F. *Hudební vývoj dítěte. [Musical Development of the Child.]* Prague: Supraphon, 1974, p. 55.
[24] SEDLÁK, F. *Didaktika hudební výchovy na 2. stupni základní školy.[Methodology of Music Teaching at the Second Level Primary School]* Prague: State Educational Publishers 1979, p. 37.
[25] SEDLÁK, F. *Úvod do psychologie hudby. [Introduction to the Psychology of Music]* Prague: State Educational Publishers 1981, p. 14.
[26] SEDLÁK, F. *Psychologie hudebních schopností a dovedností. [The Psychology of Musical Abilities and Skills.]* Prague: Supraphon 1989, s. 22–23; SEDLÁK, F. *Základy hudební psychologie. [Basis of Music Psychology]* Prague: Stát. pedag. nakl. 1990, p. 41–42.
[27] KULKA, J. Příspěvek k psychologii hudebního nadání. [Contribution to the Psychology of Musical Talent]*Estetická výchova*, 22, 1982, č. 8, pp. 203–204.
[28] Review of Kulka's system cf. HOLAS, M. *Psychologické základy hudební pedagogiky. [*Psychological Foundations of Musical Education *]* Prague: State Educational Publishers 1988, p. 27.
[29] HOLAS, M. *Psychologické základy hudební pedagogiky. [*Psychological Foundations of Musical Education *]* Prague: State Educational Publishers 1988, pp. 28–29.
[30] FUKAČ, J. – POLEDŇÁK, I. *Hudba a její pojmoslovný systém.[The System of Music Terminology]* Prague: Academia 1981, p. 16.
[31] TEPLOV, B. M. op. cit., p. 85 and p. 113.
[32] KRATOCHVIL, F. *Základy hudební výchovy. [Basis of Music Education]* Prague: State Educational Publishers 1964, p. 69–70.
[33] *Ibid*., p. 56.
[34] WELLEK, A. *Musikpsychologie und Musikästhetik.* Frankfurt am Main: Akademische Verlagsgesellschaft, 1963, p. 89.
[35] According CHVÁTILOVÁ, H. *Vývoj harmonického sluchu jako jedné z hudebních schopností.[Development of the Harmonic Hearing as a Musical Ability (Master Thesis)* Prague: Charles University, 1979.
[36] SEDLÁK, F. *Základy hudební psychologie. [*Basics of Music Psychology*]*Prague: State Educational Publishers 1990, p. 105.
[37] SEDLÁK, F. *Psychologie hudebních schopností a dovedností. [The Psychology of Musical Abilities and Skills.]*Prague: Supraphon 1989, p. 9.

38 KOHOUTEK, C. *Styles of Music in Tterms of the Composer.* Prague: Panton, p. 106. By this definition, we indirectly indicated the scope of the observed aspect from the temporal point of view; nevertheless, we consider the basic principles of the melodic-harmonic style as perceptively widely acceptable and topical even today, in spite of the principles of the music expression in the artificial music having been continuously developing.

39 K. Janeček came to four dissonant elements, including: 1. half-tone; 2. full tone; 3. tritone and 4. augmented tryad, which are three dissonant relations between two tones and one dissonant tri-relation. At least one of these dissonant elements is included in any dissonant chord. Chords that are consonant do not contain any dissonant element. For more details JANEČEK, K. Principles of Modern Harmony. Prague: ČSAV, 1965, chapter: Sound Characteristics of the Harmonic Material, pp. 46–66.

40 Viz. SEASHORE, C. E. *Measures of Musical Talent*. Chicago: C. H. STOELTING and Co 1919; WING, H. D. *Tests of Musical Ability and Appreciation*. Brit. Journal of Psychology, Monorg. Suppl., No 27, 1948; FRANKLIN, E. *Tonality as a Basis for the Study of Musical Talent*. Göteborg: Gumperts Förlag 1956; GORDON, E. *Musical Aptitude Profile*. Boston: Houghton Mifflin Company 1965; FARNSWORTH, P. R. *The Social Psychology of Music*. 2nd ed., Ames: Iowa State University Press 1969; BENTLEY, A. *Musical Ability in Children and Its Measurement*. London: Harrap 1966; LUNDIN, R. W. *An Objective Psychology of Music*. New York: The Ronald Press Company 1953; DAVIES, J. B. *The Psychology of Music*. London, Hutchinson 1978, HARGREAVES, D. J. *The Developmental Psychology of Music*. Cambridge: Cambridge University Press 1985.

41 SHUTER, R. *The Psychology of Musical Ability*. London: Methuen 1968; SHUTER-DYSON, R. – GABRIEL, C. *The psychology of Musical Ability*. 2nd ed. London: Methuen 1981.

42 See the following brief overview of some selected works: CMÍRAL, A. *Hudební pedagogika. [Music Education Partl I. – Psychology of Education.]* Prague: The Unity of the Music Institutes 1937; pp. 131–134; DANIEL, L. Aplikace psychometrických metod v hudební psychologii. [The Application of Psychometric Methods in Music Psychology] In: *Proceedings of the Department of Music, Palacký Universit Olomouc*. Prague: State Educational Publishers. 1969, pp. 63–74; SEDLÁK, F. K diagnostice hudebních schopností. [The Diagnosis Musical Abilities] *Estetická výchova*, 17, 1976, 1–3, pp. 9–10; 3–4, pp. 66-67; POLEDŇÁK, I. Testování jako jedna z metod hudební diagnostiky.[Testing as a Method of Musical Diagnosis]. *Estetická výchova,* 17, 1976, č. 1 a 2, p. 35–37, 49–50; ROHÁNEK, F. *Příspěvek k problematice zjišťování speciálních hudebních schopností*. *[*Surveys on the Issue of Special Musical Abilities] (PhD Thesis.) Prague: Charles University; 1983. CHVÁTILOVÁ, H. *[Development of the Harmonic Hearing as a Musical Ability (Thesis)* Prague: Charles University, 1979.; HOLAS, M. *Úvod do hudební diagnostiky*. *[*Introduction to the Music Diagnosis] Prague: State Educational Publishers. 1985.

[43] Srov. PICHOT, P. *Mentální testy*. *[The Mental Tests]* Prague: State Educational Publishers, 1970, p. 13.

[44] HARGREAVES, D. J. op. cit. p. 23 et seq.

[45] Let's remind, in relation to the issue of music acculturation, the creative aspect. We believe that every creative personality must have undergone the stage of acculturation. The more talent the person proved, the faster and better he/she absorbed the code of the previous rules, principles and habits, plus then he/she, based on his/her creative potential, exceeded it to create new artistic values.

[46] SEASHORE, C. E. *Measures of Musical Talent*. Chicago: C. H. Stoelting and Co 1919.

[47] SEASHORE, C. E. *Psychology of Music*. New York: Dover 1967, pp. 132–133.

[48] According WING, H. D. Tests of Musical Ability and Appreciation, *Brit. Journal of Psychology*, Monogr. Suppl., No27, 1948, p. 60.

[49] HEVNER, K. A. Study of Tests for Appreciation of Music. *Journal of Appl. Psycholog*. 15, 1931, pp. 575–583; HEVNER, K. A. – LANDSBURY, J. *Oregon Musical Discrimination Tests*. Chicago: C. H. Stoelting and Co 1935.

[50] Compare wih Hostinsky's method of partial variation, applied later by O. Zich.

[51] Viz. WING, H. D. *op. cit.*, pp. 32–33.

[52] WING, H. D. *Tests of Musical Ability in School Children*. Library of London University, 1936.

[53] All test instructions citated from WING, H. D. op. cit., 1948, pp. 50–51.

[54] WHISTLER, H. J. – THORPE, L. P. *Musical Aptitude Test.* Los Angeles: California Test Bureau 1950.

[55] SEDLÁK has used "orientation in the sound space", Holas has prefered "tonal, and music space".

[56] GASTON, E. T. *A Tests of Musicality*. Manual of Directions. Kansas: Lawrence 1958.

[57] GORDON, E. *Musical Aptitude Profile*. Boston: Hougton Miffilin Company 1965.

[58] BENTLEY, A. Musical Ability in Children and Its Measurement. London: Harrap 1966, s. 78.

[59] Viz. HOLAS, M. *Úvod do hudební diagnostiky.[*Introduction to the Music Diagnosis] Prague: State Educational Publishers 1985, p. 17 et seq.

[60] Viz. SHUTER, R. *op. cit.*, p. 25.

[61] See for details STUMPF, C. *Tonpsychologie II*. Leipzig: 1890, p. 362 et seq.

[62] Cf. FAIST, A. Versuche über Tonverschmelzung. *Zeitschrift für Psychologie*, 15, 1987; MEISSNER, H. *Beitrag zur Entwicklung des musikalischen Sinnes beim Kinde während des schulpflichtigen Alters*. Berlin: 1914; MALMBERG, C. F. The Perception of Consonance and Dissonance. *Psycholog. Monogr.,* 107, 1918. Reviewed also in TEPLOV, B. M. *Psychologie hudebních schopností. [The Psychology of Musical Abilities.]* Prague: Supraphon 1968, p. 110 et seq.

[63] GUERNSEY, M. The Role of Consonance and Dissonance in Music. *American Journal of Psychology*, 40, 1928; VALENTINE, C. W. The Method of Comparison in Experiment with Musical Intervals and the Effect of Practice on the Appreciation of Discords. *British Journal of Psychology,* 7, 1915, and later in *The Experimental Psychology of Beauty*, chapter Musical Intervals and Attitude

to Music, London, Methuen 1962, pp. 196–227; MALMBERG, C. F. *Iowa Studies in Psychology*, 7, 1918; MEYERS, C. S. *Text Book of Experimental Psychology*. London: 1911, pp. 27 a násl.

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65 Cf. FRANKLIN, E. *Tonality as a Basis for the Study of Musical Talent*. Göteborg: Gumperts Förlag 1956, pp. 55 et seq.

66 It seems that the facts discovered by Rupp and experimentally verified many times after that are hardly acceptable for an adult, especially music ecucators. The author of this monograph has had a chance to verify this in discussions with colleagues at the music theory seminar taught by prof. K. Risinger at the Faculty of Music Academy of Performin Arts in Prague.

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69 TEPLOV, B. M. *op. cit*., p. 120 et seq.

70 Viz. ABEL-STRUTH, S. - GRABEN, U. *Musikalische Hörfähigkeiten des Kindes*. Mainz: B. Schott´s Söhne 1979, p. 92 et seq.

71 KWALWASSER, J. *Tests of Melodic and Harmonic Sensitivity*. Camden, New Jersy: Victor Talking Machine Co. 1926.

72 Cf. WING, H. D. *op. cit.*, 1948, p. 27.

73 SCHOEN, M. The Validity of Tests of Musical Talent. *Journal of Comparative Psychology*, 3, 1923, pp. 101–113.

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76 Cf. with the opinion by R. Shuter in the chapter on tests of musical abilities in *The Psychology of Musical Ability*. London: Methuen 1968, p. 26.

77 A rather concise notion may be obtained from the Révész's study Prüfung der Musikalität. Zeitschrift für Psychologie, 85, 1920, pp. 163–209, and Einführung in die Musikpsychologie. 2. Aufl. Bern: A. Francke Verlag 1972, pp. 168–178. In a more brief version also from the English mutation, *Introduction to the Psychology of Music*. London: Longmans 1953, pp. 134–136.

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79 WELLEK, A. *Musikpsychologie und Musikästhetik*. Frankfurt am Main: Akademische Verlagsgesellschaft 1963, pp. 90–91.

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84 SHUTER, R. *op. cit.* pp. 279–292.

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89 SEDLÁK, F. *Didaktika hudební výchovy*. Prague: State Educational Publishers 1979, p. 64 et seq.

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115 GORDON, E. *op. cit*., pp. 48–50.

116 TARREL, V. V. *op. cit*., pp. 195–206.

117 BENTLEY, A. *op. cit*., pp. 88–89 and SHUTER, R. *op. cit*., p. 290.

118 Citated in SHUTER, R. *op. cit*., p. 290.

119 *Ibid.,* p. 292.

120 Whybrew states in his book Measurement and Evaluation in Music, Dubuque, Iowa: Brown 1962, table of coefficients of reliability as it have summarised Leonhard and House:
0,85–0,90; highg to very high; of value for individual measurement and diagnosis;
0,80–0.84; fairly high; of some value in individual measurement and higly satisfactory for group measurement;
0.70–0,79; rather low; adequate for group measurement but of doubtful value in individual measurement;

0,50–0,69; low; inadequate for individual measurement but of some value in group measurement;
0,50; very low; inadequate for use. Printed in SHUTER, R., *op. cit.*, p. 22.

121 SCHNEIDER, E. H. *op. cit.*, p. 896.

122 Cf. ŘÍČAN, P. – HAMPEJZOVÁ, O. *Prolegomena k faktorové analýze.* [Prolegomena to a Factor Analysis.] Prague: State Educational Publishers 1972, p. 16.

123 *Ibid.*

124 *Ibid.*, p. 100.

125 Intelligence test widespread in Sweden.

3. Development of Harmonic Potencial

The first and the second parts of this book discuss the significant theoretical and empirical issues of perception of harmony and harmonic competence. In this chapter we will focus on the music abilities system with an ontogenetic dimension. In the other words, the stratification of music perception qualities and the respective ability components of the harmonic abilities, which were traced in the previous two chapters, should also be presented in time conditioned variability of music development in the ontogenesis. The subchapters of the third part subsequently follow the more specific theoretical and empirical reflections of the development of the individual components of the set of harmonic abilities.

3.1 Theoretical Background of Mental Development

Since in the previous chapter we found out that the ear for music integrates primarily the mental cognitive functions, linked to the conventional aspects of apperception of the music structures and may be seen in more general context of musical thinking, the text to follow will look for supporting these theses in the respective ontogenetic theories, concepts and empirical research.[1] The usefulness of this approach may be seen, firstly, in the fact that based on them it will be easier to interpret and understand the diversely stratified information about the ear for harmony to be presented in the subsequent chapters. And secondly, we assume that this theoretical background will play an important role in implementing our research of the ear for harmony, both in the preparation and definition of the hypothesis as well as in the discussion about the obtained research results.

Therefore, let us bring up the most influential developmental psychology theories, looking at their contribution and share the points with the issue of musical ontogenesis.

The *biologizing* theory, the foundation of which was laid by the Darwin evolution concept of natural development, sees the substantial quality of a child's development in the gradual maturing process. Arnold Gesell, a notable advocate of this approach, believes that a child reaches a certain degree of maturity not based on how many opportunities the child has to learn, but rather on the achieved degree of readiness of his/her physical build and the nervous system. The development goes through a number of steps which may be either idle stages, or transient or unstable stages. The dynamics of the development lies in the transient stages during which the child gains new competencies and learns new things. During the idle stages, knowledge is consolidated and the development relatively stabilized. The maturing process covers all aspects of an individual's personality, inclusive of physical, intellectual and personality development.

Over the last few decades, this stream has also been related to the neurobiological research of the brain hemispheres, the application of binaural research methods as well as positron emission tomography and functional magnetic resonance, in monitoring the brain areas that are activated under different perception and reproduction activities.

Ethologists contributed to the study of human development by developing the comparison method of behaviour of various animal species. They believed that it may be easier to understand the development of humans if they are not segregated from the overall phylogenetic process but understood as part of the outcome of evolution. This concept has proved useful, especially when studying the behaviour of small children.

The majority of the *psychodynamic* theories approach human development as relationships and confrontations between the individual's development and the requirements of the social environment, while focusing their attention on the development of personality. Thus, in Freud's *psychosexual theory*, a personality undergoes five developmental stages where each stage confronts a type of conflict typical for that stage. If the respective stage is not mastered, the individual remains fixed to this stage even in his/her later development period.

Likewise, the Erikson's *psychosocial theory* divides individual development into eight genetic levels. The principal development determinant concerns the inner readiness of an individual to respond to the immediate social environment. For example, the initial hazy idea of a mother changes over the course of childhood into generation-conditioned social roles accompanied with psychosocial conflicts between the internal individual needs and the requirements imposed by the social environment.

The theories mentioned so far see the more significant role in the personal individuality of a person and his/her relative autonomy towards external social factors. The concepts to follow present the ontogenetic development as a result of the interaction between an individual and the environment, and the exogenous forces are seen as the dominant determinant. Thus, the *behavioural concept of learning* sees development as a sequence of newly gained experience, according to the theory of conditionality, through the classical establishment of conditioned or unconditioned reflexes or operative conditionality with positive or negative strengthening.

Social learning as another key factor in the developmental theories emphasizes observation and imitation of other people. Early studies in this area focused primarily on the child's imitation of the behaviour of their parents. In the 1960s and 1970s, the role of cognitive functions in the processes through which a child gains knowledge about the surrounding social environment began to be appreciated. According to A. Bandura, the cognitive processes, i.e. perception, memory, learning and thinking, play a critical role in what the individual focuses on, what he/she remembers as well as how he/she processes and interprets the perceived stimuli. The current concept of the social learning theory does not deem the learning process to be a simplified imitation process. If the individual observes a different personality model, he/she thinks about his/her subsequent behaviour as an event which may be addressed through their own individual manners.

As we have already mentioned in the chapter on perception processes, it is the cognitive psychology that significantly contributes to the enlightenment of their new aspects. It may be noted that the cognitive aspects in the apperception processes were studied and exposed to research already at the onset of music psychology; nevertheless, they were studied rather globally as by-product of elementally, holistically or behaviourally embraced approaches. Consequently, they were not described in sufficient detail in terms of theory or terminology.

The development-oriented branch of cognitive psychology was first established in the 1960s and it focused primarily on the interpretation of the mental representation development and mental states, i.e. hypothetic structures describing the mental state at the pre-representation level as well as at representation level. Around the beginning of the 1980s, the cognitive approach won full recognition in music psychology, especially thanks to John A. Sloboda, Carol L. Krumhansl, Andreas C. Lehmann and others, who worked on a number of particular issues of music cognition in neurophysiology, perception, ontogenesis, learning, music abilities and music creativity.[2]

In this respect, it was the Piaget's developmental cognitive (epistemological) theory that prepared the ground; this theory embraces the development as a sequence of four developmental steps during which a child's thinking goes through, in interaction with the environment, a number of internal reorganization.

At the foundation of cognitive psychology, there is an information-processing theory, which originally did not include the ontogenetic aspect at all. Under the information-processing approach, human thinking and its development is interpreted in analogy with the computer processor. Thinking and behaviour consist of simple processes manifested in early ontogenetic stages. During development with increasing experience, the capacity of the "processor" as well as the speed of information processing grows. These changes may be influenced by the subject and may be improved and refined up to automation. As noted by M. Sedláková, the classical longitudinal method has not actually been applied in cognitive psychology so far. It also applies to music psychology with prevailing research of mentally structural nature whereas the developmental aspect is studied primarily by the transversal method.

Another developmental theory applies the thesis on the influence of *historical, social and cultural experience.* At every level of the individual development, the individual interacts with the surrounding social environment and this interaction results in qualitative changes in the individual's mental functions. The individual actions of the subject are affected by a variety of cultural means (*mediators*) of physical, social conventional and symbolic nature. In the first half of the 20th century, these theses were elaborated by L. S. Vygotskij who instigated a surge of interest in this approach, both domestically and abroad. Chapter 3. 1. 2. discusses this issue in more detail.

It is obvious that each of the developmental theories focuses on a certain aspect of the developmental process. The respective approaches also cover the solution to basic developmental issues, i.e. (1) relationship and proportion of the external social and internal genetic determinants, and (2) whether the developmental process is a continuous sequence of the changes or rather a series of qualitatively separated successive developmental degrees. These issues are also related to the problem of existence of the critical, resp. sensitive periods with specific changes, which determine the subsequent continuity of the standard mental development.

If we were to preliminarily summarize the most significant psychological theories in terms of their contribution to the psychology of music ontogenesis in the ear of apperception of harmonic music structures and musical abilities, we would include primarily the following three psychological approaches: Gestalt psychology, which was mentioned primarily in the first chapter, and in the context of mental development accompanied by the powerful streams of cognitive and sociocultural theories. Let us add, despite the impact being significantly smaller, that the phenomenological (in the past) and biologizing, or neurobiological (at present and definitely in the future) approaches brought some stimuli as well.

3.1.1 Influence of Developmental Cognitive Psychology

At the end of the first chapter, we noted that the apperception actions and ability structure of the ear for harmony are notably saturated with the cognitive factor, primarily represented by memory, attention and imagination. Therefore, we believe to once again mention the Piaget's theory of cognitive development and cognitive stages, which overcame the previous psychological opinions on the cognitive development that were focused on biological theories as well as the theories of learning, and which apparently, and most significantly, influenced the current development psychology.[3]

Piaget focused on observing the interaction between the natural abilities of a child's maturing and his/her interactions with the environment. He believed that a child should be given space for exploring, within which the child acts as a mini-scientist conducting experiments and exploring the essence of things in the surrounding environment. The results of these everyday life "experiments" bring the child to defining some kind of partial "theories", called "schemes" by Piaget. Every new phenomenon the child is exposed to is included in his/her existing arsenal of "theories" and the child tries to assimilate it. If the newly discovered phenomena may not be included in the so-far established schemes, the child expands and revises them. Piaget called this process accommodation.

In the course of a child's ontogenesis of thinking and cogitation, Piaget located four qualitatively different development stages; he further stratified each of the respective stages. The overview of the main stages of the cognitive development is shown in the table below.

Table 12 Summary of stages of the cognitive development by J. Piaget

Development stage	Age
1. Sensorimotor	Birth – 2 years
2. Preoperational	2 – 7 years
3. Concrete operational	7 – 12 years
4. Formal operational	12 years and above

Let's go over the most important resulting features of the respective stages. An important ontogenetic result of the *sensorimotor stage* concerns a mental quality jointly called *object permanence*, which is manifested by the ability of the child who is able to hold an object in his/her consciousness, although it is not immediately available to his/her sensory perception. In other words, the child is capable of mental representation of a non-present object.

The *preoperational stage* is primarily characterized with using *symbols* and symbolic expression, i.e. words as symbols for things and objects, as symbols of sometimes not very similar objects. At the lower development stage, we are talking about the symbolic function sub-stage, followed by the intuitive symbol sub-stage at the age of four to five years. So far, words and images are not completely organized into logical complexes. Another typical feature of this preoperational stage concerns the lack of an ability, which Piaget entitled as *conservation*. In addition, this rather wide development stage is characterized by another, likewise key, conclusion saying that children are not able to focus their *attention* to more aspects of reality at the same time. At this stage, the visual impressions overlap the ability to accept other qualities, such as a number, weight, etc. Piaget also studied the sphere of social conventions and moral standards, looking for their close link to physical laws and material experience of children, which he called as moral realism.

In the third *concrete operational* stage, the child is already able to think about objects and events logically. The child understands the *stability* number, quantity and weight. The principle lies in the ability to sort objects in the order corresponding to various qualities.

Logical thinking in abstract terms is typical of the final *fourth stage.* In the context of this thesis and despite its universal depth, the Piaget's theory plays a rather controversial role. On the one hand, it explains the development of children's thinking in many details and, simultaneously, in generalizing theses, which should serve as guarantee of wider valid overlaps. On the other hand, however, certain circumstances calling for methodological caution when applying Piaget's conclusions to the field of musical development may not be ignored.

In general, Piaget based his research on a large number of partial individual observations and findings (he called his method as clinical). And it was specifically the individuality of the method that was the source of doubts regarding sufficient standardization of the conditions as well as the generalization of research results. All Piaget's tests were performed as some mini-physical experiments and they did not intervene in the aesthetic or artistic development of a child's psyche. Likewise, the ear of sociocultural relationships remained without conclusions, although Piaget partially studied them while studying the development of understanding for moral standards and attitudes. Nevertheless, despite the mentioned critical voices, Piaget's intellectual heritage was significantly reflected in a number of studies carried out by his successors, further elaborating the topics raised by Piaget. And additionally, the development cognitive theory proved its vitality in the application of some of its principles in the area of children's music ontogenesis, as shown by the contributions by H. Gardner and M. Pflederer. While Gardner attempted to continue in the development of Piaget's theoretical model, Pflederer (later as Zimmerman) empirically verified the development of the conservation ability. Gardner's conclusions will be reflected in the text below and Pflederer's thoughts will be analysed in chapter 3.3.7, on the development of the ability to appreciate harmony in the context of musical means of expression.

H. Gardner[4] considers Piaget's scientific concept representing the final stage of the cognitive development as too limiting and narrow. Gardner believes that a mature cognitive intellectual process entails more than logical rational thinking. Piaget staked too much on the matured forms of cognition known from logical scientific thinking, not sufficiently taking into account the novelty, intuition and creativity of the cognitive processes typical for writers, musicians and artists in general.

In the artistic behaviour, Gardner finds the combination of two basic aspects, subjective and objective, i.e. aesthetic objects representing objective personification of the subjective experience and, simultaneously, a development of the individuality of every independent personality. The art allows crossing the border between emotions and cognition as the aesthetic object is not only the source but also the result of the cognitive processes and emotional states.

Gardner compressed these mutually influencing as well as independent phenomena into *three principles*, which undergo ontogenetic development. The first principal is called *the making principle,* finally resulting in a creative process which is fully reflected in the activities of artists. *The perceiving principle* primarily lies in the discriminating functions. Additionally, it integrates the most cognitive elements and it may be noted that this principle is the closest to Piaget's development cognitive model. Gardner notes that this principle is the most pronounced in, for example, professional art critics. The process of initiation of emotional responses or even aesthetic experiences, which is especially dominant for auditory music activities, runs under the *feeling system.*

Gardner deems the ontogenetic development as a process under which the degree of interaction between the mentioned three systems increases, without any of them considered alone at any of the development stages. Additionally, Gardner focused on the explanation of the preoperational development stage during which a person masters the use of symbols. Symbols are organized in two different groups: denotative, where each symbol has its own meaning, and expressive, without precise reference to another aspect of the individual's experience. Some kinds of the symbolic groups may include activities with exposure to the first, second or both these qualities. In addition to the language, dance and drama art also includes music. The individual groups differ from each other, among others, in terms of definiteness of the relationship between these differentiating aspects and experience. Gardner concludes that the importance of the ontogenetic psychology primarily lies in the identification of the impact of specificity of the adults' symbolic system on the overall cognitive development and characteristics of the partial development changes.

Both, Piaget and Gardner, agree that the most important feature of the symbolic stage is *object permanence*, which is, as already mentioned, a gradually developing ability to maintain representation of a certain object that is no longer available to immediate sensory perception.

The actual Gardner's model of aesthetic development consists of two main development stages. The first one covers the period of the first year of age. During this period, all three systems, perceiving, feeling and making, are essentially constituted and, at the same time, differentiated. This stage is followed by a disproportionally longer six-year period of symbol application, which ends at around seven years of age. In the course of this second period, any elements of the symbolic system get incorporated into the resulting artistic activities, which firstly they concern as rather exploratory, subsequently followed by expansion and intensification up to specific cultural codes. The use of symbols is gradually more and more socialized and the proportion of respecting the system of conventions of the music cultural environment surrounding the child increases. Towards the end of this period, the principal parameters of the children's musical activities become broadly sensible as a result of a balanced structure and full integration into the system.

The subsequent development from the age of eight is described by gradual qualitative improvement of the parameters of cognitive qualities and partial skills, but Gardner does not see the nature of these changes to be likewise fundamental and determining compared to the changes of the "symbolic" period.

Gardner's model was reviewed by D. Hargreaves,[5] who noted that the role of the symbolic period within the entire ontogenesis is rather overrated and that even after the age of seven the child's ontogenetic development experiences other significant changes. We may certainly, and in principle, agree with him and, taking in all, Gardner himself does not rule out this option. Nevertheless, this stage is qualitatively independent to the point that it may be regarded as a specific case of a critical music development stage. In the following text, especially in the chapters on the development of two components of the ear for harmony – harmonic tonal feeling and feeling of consonance and dissonance of chords – it will become apparent that Gardner's second development stage, which these components undergo, enjoys indeed a relatively autonomous position as towards its end (between the ages 7 and 8) the development of these components is complete, as the early stage of future development changes occurring primarily in the music cognitive area.

It has already been mentioned that the cognitive information-processing theories look at the process of human thinking as a system of manipulation with symbols, comparable to a computer device, obtaining external information, registering them as symbols, combining them with other information, saving them and retrieving them with the ability to send them out to the external environment. Donald Broadbent[6] tried to record various situations affecting the attention of an individual when perceiving sounds and the ways in which they are stored in the memory.

The experiment, originally proposed to study the ear of sound perception, appeared to be applicable to a wider portfolio of cognitive processes. Unlike Piaget, the advocates of the information theory assume that during the ontogenetic development there are no fundamental changes in the structuring process of a child's thinking. The structure of thinking and behaviour consists, according to their opinion, of small simple process files presenting themselves very early during ontogenesis; these files allow the perception of data and its analysis, the learning process and integration of meanings. As a result of the growing experience, the capacity of these files gradually increases, making the mental processes run faster and better. An important feature of this improvement primarily concerns the expansion of a child's "network" of terms and knowledge. Therefore, the long-term memory plays a fundamental role.

R. Siegler,[7] another advocate of the development information theory, assumes that ontogenetic development is affected by three different mechanisms. The first one is similar to the already mentioned accommodation and assimilation process, known from Piaget's cognitive model. Siegler calls this mechanism *self-modification*. The second mechanism lies in *automation* of the mental operations. Thanks to this one, the child becomes more versed in *encoding* information and the selection of important information that is *decoded* to find *relationships* in between. This is principally the third mechanism of the entire process.

Over the last twenty years, the specific areas of music development were elaborated under the cognitive approach. It included the application of music symbol,[8] children's vocal presentation,[9] learning of infants, composition abilities and many other topics.

3.1.2 Influence of the Sociocultural Development Theory

The previous outline of psychological development concepts has already briefly mentioned the role of the individual experience of an individual in the interaction with the legacy of sociocultural and historical development and the historical development as well as the approach to the topic by L. S. Vygotsky. The real explanation of the understanding to the piece of art may only be possible if a widely embraced social and culture environment and social life aspects are taken into account.[10] Actually, every concept of a personality, which accepts the shaping impact of a social environment, takes into account the medium-term temporal dimension of ontogenesis, during which the individual gains several kinds of life experiences. They primarily include the sensory experience, kinetic and, the most importantly, social experience, embedded in communication, human speech, and emotional relationships, ethical experience and last, but not the least, the relationship of the individual to art.

Ideas by Vygotsky were further developed in the psychological concept of acquiring sensory etalons by A. V. Zaporotzetz.[11] It concerns a rather wide concept representing one of the fundamental aspects of the enculturation process. *Sensory etalons* represent a set of perceptions of values, characteristics and sensory shades of objects humanity separated during their historic development. These perceptions are fixed, among others, in the music tonal structures, the types of tuning as well as language systems, collocations and others. From the very beginning of the ontogenetic development these factors, as noted by J. V. Nazajkinskij, generally affect the development of perception, which a person acquires. The sensory etalons become the normatives affecting the person's individual perception of the surrounding world.[12]

The psychological stream advocating various elements of the external environment as a *context,* in which the mental qualities of an individual are ontogenetically established, also primarily covers from the Soviet psychological environment that A. N. Leontijev and B. M. Teplov already mentioned. Independent of Vygotskij, the sociocultural theory was developed in the 1930s by G. H. Mead.[13] The contextual aspects were studied also by previous American socially oriented pedagogues, such as J. Dewey, and socially oriented music psychologists, J. Mursell, P. Farnsworth, Ch. Seeger and others.[14] In the 1980s and 1990s, new aspects of the individual cognitive development under the influence of sociocultural environment were studied and described by B. A. Torch.[15]

As far as the title of the socialization process is concerned, it is possible to use the term enculturation by Herskowitz as it synthesizes all aspects and dimensions of the process of socialization and education. According to Herskowitz, the term enculturation may cover all displays of learnt behaviour and gaining experience, helping the individual during his/her life to acquire competences typical of his/her culture. It is a consciously and subconsciously determined process implemented within the framework of sanctions in a system of customs, habits, values and standards of the given culture. In the music education context, the term functional music education is used with similar meaning.[16]

R. Francès talks about tonal acculturation resulting in total feeling in his book La Perception de la Musique. D. J. Hargreaves considers the terms acculturation and enculturation to be equivalent,[17] nevertheless he prefers, likewise R. Francès,[18] the term acculturation. They both regard it as a process of socialization in the field of music (musical socialisation).[19] A superior term to acculturation is, according to Francès, *adaptation,* especially to the music language of the European music culture which took shape during the 17th and 19th centuries. The process of adaptation according to Francès covers two levels: as a music acculturation and music education.[20]

3. 2 Selected Issues of the Harmonic Abilities Development

In an analogy to the fundamental issues of the general development psychology it is possible to apply some of their aspects to the development of the ear for harmony. Its ontogenetic changes are usually studied: either (1) in *relations* to another music ability, or overall development of musicality, or (2) in its *own* development continuum. Then it primarily concerns the determination of the age of its evidenced primary occurrence, the development plateau or termination of the development. It also includes the issues of its development continuity or arrangement in steps, progression or even regression.

The most frequently applied development comparison concerns the comparison between the ear for melody, i.e. the ability to discriminate and operate with the melodic aspect of a music structure, which is more simplified than the chord or harmonic one. In general, it is believed that the ear for harmony develops relatively later than the ear for melody. According to the previous music psychologists M. Schoen[21] or H. Rupp,[22] the melody is correctly perceived at the early age, while the sensitivity to harmony is still insufficient. B. M. Teplov[23] and others who based their research on his conclusions principally agree with this statement.

Analogically, at present it has been confirmed that harmony as music stimulus is more complicated for perception than intensity, timbre, pace and other musical means of expression. T. Justus and J. Hutsler, looking into the cognitive music development relationships to the natural music principles and going all the way back to Pythagoras and Euler, confirm that the acceptance of tonally harmonic principles occurs already in childhood but relatively later than for detection of the melody line or perception of the relationships between the melodic tones to a scale or tonic.[24]

The thesis of early occurrence of certain harmonic perception parameters (using our nomenclature – parameters for tonally harmonic feeling) in preschool years was elaborated, for example, by German music psychologists, such as L. Hochel[25] and P. Michel,[26] as well as F. Sedlák.[27]

Tonally harmonic feeling is studied by F. Kratochvil, based on the theory of B. M. Teplov and his understanding of the melodic tonal feeling. He believes that in terms of ontogenesis, the tonal harmonic feeling develops earlier than the ear for harmonic homophony, which also confirms one part of Franklin's statement, which will be mentioned below.[28]

Similarly, E. Višňovská sees, as ontogenetically primary, the tonally melodic feeling, which is demonstrated by the ability to distinguish the end of the melody, compared to the tonally harmonic feeling, i.e. the ability to find this tranquillity within the harmonic structure of a tonic.[29]

New insights and clarifications regarding the perception of melodic series are provided by J. Sloboda, who places the development of the ability to accept characteristic structures and patterns to the period between five and ten years of age,[30] and thus continuing in the research of Moog,[31] Zennati[32] and some of his own, in particular.[33]

V. Příhoda, the classic of the Czech development psychology, regarded harmony as an important musical means of expression and linked it directly to the dynamics of music development in pubescence, in particular with the ability of analysis, which, if significantly developed, enables to understand and more fully experience extensive pieces of music and operas.[34] Under his influence, F. Lýsek[35] also placed the period of powerful development of harmonic feeling and interest in "spectacular harmonies" in the period of pubescence. Both Příhoda and Lýsek regarded harmony as a musical means of expression, which at this specific period is able to affect the "agitated" psyche of teenagers the most. On the other hand and at some other point in time, Lýsek notes that in the research of the apperception of 8th grade pupils, none of the respondents was able to verbally describe harmony and "mood" of a piece of music.[36]

To conclude the overview of relational references about the ear for harmony, let's point out a unique observation by A. Cmíral, who as part of his longitudinal research of music sensory and verbal development of two boys observed that one of them, at the age of three, spontaneously conducted and imitated playing the piano when listening to music. The piano accompaniment had a good rhythm but the boy, says Cmíral, "… caused harmonies considerably disordered."[37]

On overview of the basic stages of music development, including some components of the harmonic ability, is presented by R. Shuter-Dyson and C. Gabriel.[38]

Table 13 Harmonic abilities within the development of musicality (From R. Shuter-Dyson and C. Gabriel, 1981)

Age	
0-1	React to sound.
1-2	Spontaneous music making
2-3	Begins to reproduce phrases of song heard.
3-4	Conceives general plan of a melody; absolute pitch may develop if learn instrument.
4-5	Can discriminiate register of pitches; can tap back simple rhythms.
5-6	Understands louder/softer; can discriminate same from different in easy tonal or rhythm patterns.
6-7	Improved singing in tune; tonal music perceived better than atonal.
7-8	Appreciates consonance vs. dissonance.
8-9	Rhythmic performance tasks improved.
9-10	Rhythmic perception improves; melodic memory improves; two part melodies perceived; sence of cadence.
10-11	Harmonic sense becoming established. Some appreciation for finer points of music
12-17	Incerease in appreciation, cognitively and in emotional response.

The harmonic potential is included twice in the scheme; the key periods for the qualitative development changes of its two modifications, i.e. "assessment of consonance and dissonance" and "strengthening of harmonic feeling" are set for the ages 7 to 8 and 10 to 11 years. Nevertheless, the third key period is the age of 11 to 12, related to the last item in the table, i.e. "development of cognitive and emotional responses to music stimuli", which are related to the analysis of harmonic music structures.

Similarly as Shuter with Gabriel, Milan Holas[39] also assessed the ear for harmony in the complex of the music development. His model does not only provide the sequence of key abilities related to the respective age, but it is elaborated in terms of the structure of the observed abilities. The tonally harmonic feeling is, in terms of development, placed to the period between 6 and 9 years of age.

With respect to the applied methods, the majority of the mentioned opinions are based on research using transversal method. Not as many of them, e.g. A. Cmíral as well as a number of other famous music pedagogues (F. Lýsek, J. Černík, D. Hargreaves) monitoring the development of their own children and grandchildren, used the longitudinal method.

The question of congenial and acquired was opened by R. Parncut, presenting the issue of development of harmonics perception. He inclines to a thesis that the sensitivity is not congenial, but by gradual introduction of the auditory system to the harmonics, especially thanks to the excess of harmonics in the external sound environment. We may agree with D. Huron that this thesis included in his monograph on psychoacoustic approach to Western European harmony unnecessarily weakens the otherwise inspiring Parncut's perception of the harmonic model.[40]

3.3 Development of Harmonic Abilities

3.3.1 Tonaly harmonic and tonaly polyphonic feeling

As mentioned previously, tonally harmonic and tonally polyphonic feeling is more closely related to the factors of natural anthropological conventionality than to cognitive mental characteristics. Referencing Gardner, it has also been mentioned that during ontogenetic development key changes in the enculturation process occur in the critical developmental period at the beginning of early school age, thus this ability-related quality being constituted under the influence of the broadest musical environment should, at this point, be developmentally concluded. As a result, it may be deduced that the tonally harmonic feeling could be formed even earlier than the tonally melodic feeling as the key is best expressed with harmonic means. For example, the unstableness of half-tone leading tones is amplified by the fact that they form part of either the dominant chord (as ascending leading tone) or subdominant chord (descending leading tone) as their thirds with half-tone advancement to the tonic.[41]

On the other hand, the opinion that tonally harmonic feeling is constituted later than the tonally melodic feeling is supported by the fact that harmonic movement is made up of several voices and thus, at this age, the conditions for their adequate processing are not developed yet as they are for the more simplified one-voice melody. The confirmation or questioning of the suggested alternatives may be found in several empirical researches of tonally harmonic and tonally melodious feeling.

H. Moog found the seeds of the melodic tonal feeling already in children aged two to three years.[42] In his opinion, they manifest themselves by the child intonating incorrectly and then continues in a quasi new key related to this new not precisely intonated tone. This practice, despite understood not as the sign of the beginning of tonal feeling development but rather an expression of its negligence, may be seen in some children and adults who are not trained in singing, i.e. they do not manage the voice organ sufficiently, or perhaps the proprioceptive afferents paths are not created, as well as music memory and mental representation. In exceptional cases, it may be the results of overall musical retardation.

E. Franklin places the fixation of the melodic tonal feeling to a rather wide age interval between the 6th and 9th year. The development of other components of the ear for harmony (Franklin talks about the perception of harmony) may develop only after the development of the ear for melody (ear for perception of melody) and tonal feeling.[43] The formation and consolidation of the ear for tonality, or tonal feeling, ontogenetically presumes the ear for tone pitch discrimination, primarily in the area of smaller interval differences, and the feeling of consonance and dissonance of chords, but not the simultaneous perception of horizontal and vertical music parameters, i.e. of what concerns the ability of the ear for harmonic homophony and polyphony.

One of the first researchers studying tonal feeling development was H. Rupp, who individually observed his two children aged 6 and 8 years. He exposed them to a two-voice melody, which in prima volta finished on tonic and in seconda volta finished with a false close on the sixth degree. Children considered both closes in terms of their finality as equal and they did not prefer either one. Based on this, Rupp deduced that this kind of ability develops later than the ear for melody. However, Rupp's conclusion about the unformed tonal feeling may rather be interpreted by stating that both closes, both on the first and sixth degree, finalized the melody satisfactorily in principle, thus confirming that the tonally harmonic feeling is more or less fixated. Rupp's methodology was, in our opinion, rather affected by rather inappropriate selection of the musical material for test tasks because it insufficiently represented the studied issue. Perhaps, Rupp should have complemented the research with several other music-related questions, allowing to compare more contrast methods of finalization, e.g. on the tonic and on the dominant seventh chord or diminished triad or tetrachord on the seventh degree.[44]

We verified the development of tonally melodic feeling under one survey studying the parameters of the ear for tone pitch in children aged 8 to 12 years, attending primary school with extra music education classes.[45] The research sample included 160 pupils of the Třída Svornosti primary school with extra music education classes and 80 pupils of the Tchaikovsky primary school in Olomouc, representing a school with general music education classes. The respondents were divided into three groups. The first group included pupils of the A classes of the Olomouc music education model, the second group included pupils of the parallel B classes of the same school and the third group (C) included pupils of the Tchaikovsky primary school. The tasks consisted in comparing pairs of well-known folk songs in terms of satisfactoriness of their closes. The scores received in the respective age categories are summarized in the table below.

Table 14 Development of tonally melodic feeling of children aged 8 to 12 years (From J. Luska, 1992)

Age	School - class	Average score (%)
8 years	A	95
	B	94
	C	85
10 years	A	97
	B	87
	C	86
12 years	A	100
	B	96
	C	100

As shown in the table, the average score varies between 90 and 100%, which means that the development of the studied ability seems to be practically completed between the age of 8 and 12 years.

F. Sedlák puts the formation of the harmonic feeling between 5 and 6 years of age; the harmonic feeling formation immediately follows the development of the tonal feeling.[46]

Imberty played extracts of Bach chorales to children of various age groups asking them whether the extracts are finalized or not. The eight-year old children assess extracts with cadence ending on the tonic and with melody on the first degree as complete. Even in ten-year old children, he registered a number of cases when the melody finished with a full close on the fifth degree as the cause for assessing the cadence as unsatisfactorily finalized.[47]

In the research carried out by Sloboda,[48] which is discussed in detail below, the respondents were asked to assess pairs of cadences and say which one is "correct", i.e. satisfactorily finished, and which one is unsatisfactorily finished. The second cadence of the pair was a backward version of the first one. The table below provides the achieved scores in four age groups and a control group of adults. Underlined figures in the last two rows show no significant difference observed.

Table 15 Average score of development of tonal harmonic feeling test (From J. Sloboda, 1985)

Age	Score
5 years	5.6
7 years	7.3
9 years	9.3
11 years	10.5
Adults	11.6

The exposition on the tonally harmonic feeling may be concluded by noting that the development of the tonally harmonic feeling seems terminated around 9 and 10 years of age, which should be considered as conclusion with general applicability.

3.3.2 Ability to Recognize Harmonic Intervals and Chords

The overview of the diagnostic variants of the ear for chords implicated a rather wide portfolio of recipient's activation possibilities, starting from two-chord stimuli with differently structured sound (timbre) contrast up to the possibility of activating an analytical approach, imagery, or processes of mental representation and also short-term memory, particularly if the chord is presented in the context of several other chords. It is thus expected that the development of this ability may be spread over a longer period of time than the development of tonally harmonic and tonally polyphonic feeling.

A. Bentley devoted a great deal of attention to the ontogenetic aspects of this ability in the context of four musical abilities included in his test set. His research studying the ability to detect the number of tones in two- to four-tone chords offers rather representative results related to the actual development of the ear for chords as well as its relations to the subtests of two-tone pitch comparison, melodic and rhythmical memory. The following table sums up the average scores of the ear for chords test and their annual increase in relative frequencies.

Table 16 Average score and year-to-year increase in score of the ear for chords test, Bentley's test (From Bentley, 1966)

Age (years)	Average score	Year-to-year increase (%)
7	4.8	-
8	5.1	1.5
9	5.5	2.0
10	6.1	3.5
11	7.9	8.5
12	9.4	7.5
13	10.4	5.0
14	11.5	5.5

Average scores and the year-to-year increases in the observed age categories are depicted in the following charts.

Figure 12 Average score of Bentley's test in the individual age groups (From Bentley, 1966)

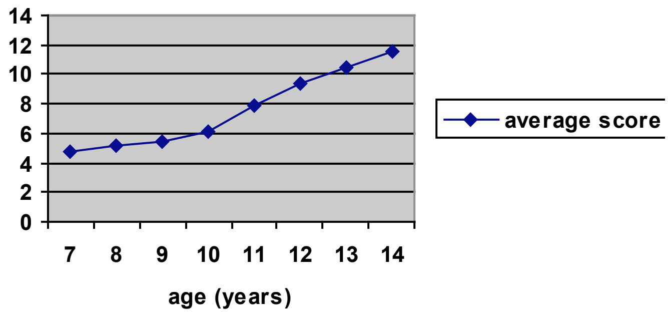


Figure 13 Graph illustration of year-to-year percentage increase in the average score of the ear for chords test (According to Bentley, 1966)

As shown above, the annual increase in the average score between eight and ten years of age amounts to only 1.5 to 3.5 %. The increase accelerates between the ages of eleven and twelve, amounting to between 7.5 and 8.5 %. In the following two years, the value slightly decreases to 5.0 and 5.5 %, while it remains significantly above the values of eight to ten years of age.

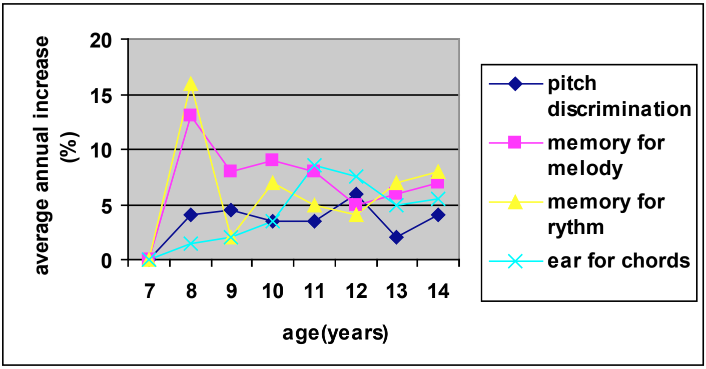
In addition, the results obtained by A. Bentley allow a comparison of the acceleration of the score increase of the individual subtests. The table below enables comparing the data of the ear for harmony test with the data related to the hearing discriminatory, the memory for tones in melody and rhythmical memory subtests.

Table 17 Year-to-year percentage increase in average scores of all Bentley's test set subtests (According to Bentley, 1966)

	Tone pitch discrimination	Memory for melody	Memory for rhythm	Ear for chords
7	---	---	---	---
8	4	13	16	1.5
9	4.5	8	2	2
10	3.5	9	7	3.5
11	3.5	8	5	8.5
12	6	5	4	7.5
13	2	6	7	5
14	4	7	8	5.5

The data presented in the table is depicted in the chart below.

Figure 14 Year-to-year increase in the average score of all subtest's in the Bentleys test set



The chart clearly shows the different dynamics in the score increases relevant to the individual subtests. While between seven and eight years of age the parameters of the memory subtests absolutely culminate, the tone pitch values increase relatively more slowly. We may also see that the incremental chart depicting the ear for chords seems to be, compared to the others, a bit more gradual without any significant leaps in the percentage increments. Bentley's comments on it: "Rhythmic memory is more highly developed at all ages of childhood than tonal memory; both appear to be more advanced than keen pitch discrimination; abaility to analyse chords develops more slowly than the rest".[49]

To development of harmonic ability he says: "The ability to analyse chords is weak in the majority of children below the age of eleven years, but there are some younger children who show ability considerably in excess of the average of their age group."[50]

Rather detailed information about the ontogenesis of the ear for harmonic intervals and chords was generated through the research carried out by R. Thackray at the beginning of the 1970s. The ear for chords was tested using three tasks: (1) find harmony in a one-voice melody; (2) in a repeated sequence of chords find one chord that was changed when played for the second time and (3) in a short harmonic movement identify the position with the chord that was previously played individually.[51]

In the first stage of the testing programme the test was applied to a sample of 417 children aged between 8 to 12 years in schools in Berkshire, Great Britain. The following table shows a similar kind of data observed with Bentley's test, i.e. average score and year-to-year increase in score in relative frequencies with respect to the age. The maximum score for each subtest was 10 with the maximum score for the entire test set of 30 points.

Table 18 Average score and year-to-year increase in score of the ear for chords tests Thackray I (From Thackray, 1973)

	Test 1		Test 2		Test 3		Full test set	
Age	Average score	Increase (%)	Average score	Increase (%)	Average score	Increase (%)	Average score	Increase (%)
8-9	7.5	-	3.4	-	3.3	-	14.2	-
9-10	7.7	2	3.5	1	3.4	1	14.6	1.33
10-11	8.8	11	3.8	3	4	6	16.6	6.6
11-12	9.8	10	4.6	8	5	10	19.4	9.3

In the second stage of his research, R. Thackray extended the tested sample to 885 respondents and also included respondents of 6 and 7 years of age. The following table sums up the results of this research.

Table 19 Average score and year-to-year increase in score of the ear for chords, Thackray II assessment (From Thackray, 1973)

	Test 1		Test 2		Test 3		Full test set	
Age	Average score	Increase (%)	Average score	Increase (%)	Average score	Increase (%)	Average score	Increase (%)
6-7	3.5	-	2.8	-	3.3	-	9.6	-
7-8	6.7	32	3.2	0.4	3.3	0	13.2	12
8-9	7.8	11	3.7	0.5	3.3	0	14.9	5.6
9-10	8.4	6	3.9	0.2	4.1	0.8	16.3	4.6
10-11	8.9	5	4	0.1	4.2	0.1	17.1	2.6
11-12	9.8	9	4.6	0.6	5	0.8	19.4	7.6

Both Thackray's researches allow comparing the average year-to-year score increase of the identical age groups. The percentage data are summarized in the table below.

Table 20 Score increase in the ear for chords tests, Thackray I and Thackray II assessments (in %) (From Thackray, 1973)

Age	Test 1		Test 2		Test 3	
	1st research	2nd research	1st research	2nd research	1st research	2nd research
7-8	-	32	-	4	-	0
8-9	-	11	-	5	-	0
9-10	2	6	1	2	1	8
10-11	11	5	3	1	6	1
11-12	10	9	8	6	10	8

Figure 15 Comparison of the average year-to-year score increase in test 1, Thackray I and II assessments (%)

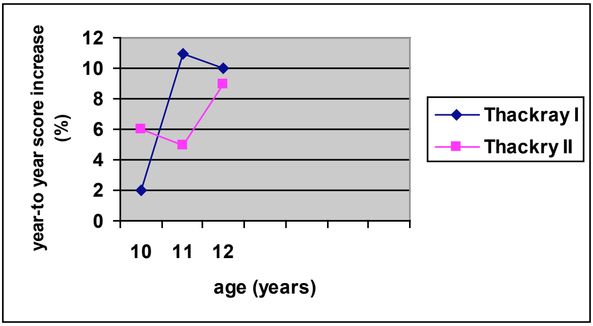


Figure 16 Comparison of the average year-to-year score increase in test 2, Thackray I and II assessments (%)

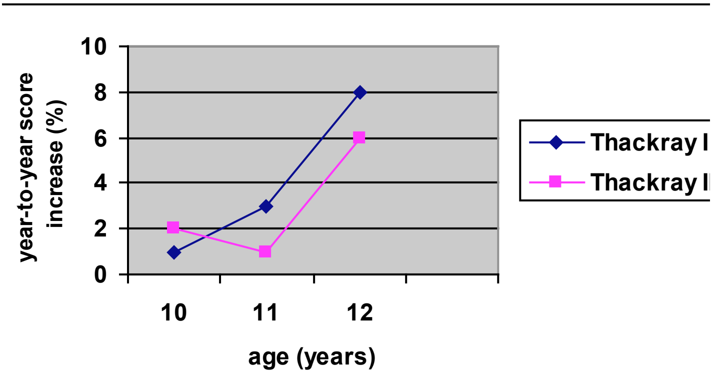
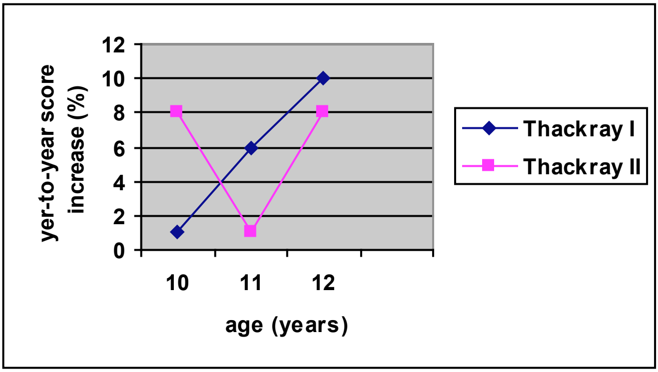


Figure 17 Comparison of the average year-to-year score increase in test 3, Thackray I and II assessments (%)



The charts demonstrate that the absolute frequency of correct responses in both researches and for all three subtests grows progressively. The scope of the achieved scores in individual cases was rather very wide, from 0 to 10 points. The average score for the first subtest oscillated between 7.7 and 9.8 points, for the second subtest between 3.3 and 5.0 points and the third subtest between 3.3 and 5.0 points.

The charts above provide information on whether and to what degree the progression of test scores in repeated researches of the monitored three age categories was identical or different. There is an obvious difference in subtest 1 in 10 years of age category (2% and 6%) and 11 years of age category (11% and 5%). Similarly, for subtest 3 there is a certain degree of difference in the 10 years of age category (1% and 8%) and 11 years (6% and 1%). The application of subtest 2 and application of subtests 1 and 3 in the 12 years of age category revealed only minimum differences in the score increase.

These findings may be explained by the fact that the repeatedly applied Thackray's test is, according to these criteria (while we are not monitoring its validity or reliability), "tuned" the best for the highest age category, i.e. the group of twelve-year old children. Furthermore, it is apparent that out of the tests determining the ear for chords, it is subtest 2 (change of a chord in the chord sequence) that appears to be the most stable in terms of increase.

Detailed knowledge of the methods used by Bentley and Thackray also allows us to compare their results in terms of percentage increase in the average scores. Thackray's three tests are marked as 1 to 3 and Bentley's test is test 4. Firstly, let's remind ourselves the tasks in these tests. Test

1 – distinguish the chord from one tone; test 2 – find a position in the harmonic movement where the chord was changed when played for the second time; test 3 – identify a position in the harmonic movement where the chord, previously individually played, could be heard; test 4 – determine the number of tones in a chord.

Table 21 Comparison of year-to-year increase in average scores of the ear for chords tests in Bentley and Thackray II

Age	Test 1	Test 2	Test 3	Test 4
8	32	0.4	0	1.5
9	11	0.5	0	2
10	6	0.2	0.8	3.5
11	6	0.1	0.1	8.5
12	9	0.6	0.8	7.5

The table clearly shows that all the tests included under the chords category behave independently, fully in accordance with the nature of the tested task. Test 1 requires discrimination of rather contrasting entities, a chord from a single tone. This is also reflected by increase in the score, which is most significant in the lowest age groups. A similar task, asking to determine the number of tones, which is usually not subjected to analysis but rather timbre comparison of chords, based on their sound volume, especially in dyads with a more contrast voice structure and analytical section, reports gradual increase in the score in rather higher age groups. This fully corresponds with the theses formulated above about the gradual increase in the cognitive functions in this age period used in perception. Tests 2 and 3 are, with respect to the nature of the respondent's activities, very similar. Both required involvement of musical memory and imagery; the very gradual increase in score may reflect almost constant status of this ability. It seems that the task, asking the respondent to notice similarity or difference of chords included in harmonic logical flow and where the conventional factor is reflected, shows certain apparent increase in all age groups, whereas if the respondent is asked to remember a more or less isolated chord, which was previously exposed, the progress is firstly practically zero and not until 10 to 12 years of age is there a slight increase, similar to the increase in test 2.

Although in our original concept the ear for chords manifested itself primarily through static chord tasks, Thackray's examples show that it is advisable to specify the characteristics of this ability more broadly. Based on the research carried out by Thackray, it is possible to note that the ear for chords may correspond with the activities not only discriminating between two qualities, i.e. one tone and chord arranged in a sequence of three to seven differently combined items, but also discriminating within several kinds. The typical representative of this approach concerns the tests by Wing and Bentley, with the options to choose from one-, two-, three- and four-tone chords, as well as the test applied in the Frankfurt research.

Additionally, the research carried out by Thackray revealed that it is justified to include the mental representation of chords when it is necessary to keep the exposed chord in the memory and identify the very same chord in subsequently played sequence of chords. We believe it is necessary to also include the tasks with certain harmonic musical logic into this category; for example, tasks when the change in one chord does not merely mean change in quality in the vertical interval respect (Thackray attempted to analyze the success rate of task completion in this subtest in terms of the number of tones generating the change), but also the chord and the horizontally harmonic respect. For instance, the task completed the best out of all 10 subtest items (67%) was represented with the only change in the second, from E1 to E1 sharp in the inner voice of the A major sixth chord (exposed in a wide harmony) to the augmented sixth chord. In the harmonic context it meant that in the first version, the A major triad changed to A major sixth chord and up to final D major triad, where functionally the first two chords seemed dominant and the final chord to be tonic. In the second version, the dominant major sixth chord was replaced with a dominant augmented sixth chord, which is apparently dissonant but aesthetically still acceptable.

The latter type of the task which is described in quite detail may also be considered for testing the ear for harmonic homophony and polyphony. However, same as in all the previous cases, there is one thing this type of tasks has in common – the polarity of analytical and global approach to the assessment of chords, however, without the need to actually carry out the analysis. Thus, it is never necessary to, for example, denominate a specific harmonic voice, its direction or its comparison with another voice. Therefore, it is included under the ear for chords.

The age of early school years, from five to seven, is the centre of attention of ten comprehensive Frankfurt tests of musicality,[52] which include the examination of the ear for harmony. The respondents were divided into two age groups, a group of five-year olds n=92 and a group of seven-year olds n=88. Both groups were exposed to ten extracts, variably playing individual tones and chords with fewer tones (dyads and triads) and chords with more tones (clusters). The researchers assumed that the respondents were going to assess the sound holisticity of chords and, thus, they used the name *chord density*, which is, in our opinion, more suitable than, for example, Bentley's *chord analysis*.

Table 22 Overview of correct answer scores in the ear for chords tests in the Frankfurt research (After S. Abel – Struth, 1979)

	Total (%)	5 years	6 years
One tone	84.7	81	88.4
2 to 3 tones	54.2	58.7	49.6
Clusters	86.8	88	87.96

The table shows a certain progression in the score generated based on the task identifying the isolated tones; for the clustered chords there is practically no apparent increase and for the assessment of dyads and triads there is a clear progression.

No differences were found in the development of contrast sound stimuli perception, in our case represented by the identification of the clustered chord, between the two age groups differing only by one year. This confirms the previously expressed statements that the development in this respect is basically completed.

The regression score in terms of ontogenesis makes us assume that during this age period the ear for chords, i.e. static intervals and chords in terms of their timbre assessment and context of two other more contrast alternatives with respect to timbre (single tone - cluster), is not fully pronounced and with repeated research the authors could have easily arrived at completely opposite results.[53]

The research methodology of Robert Petzold clearly reflects the effort to bring the research musical material as close as possible to the portfolio of their favourite songs. Therefore, Petzold, after an elaborate research encompassing a great number of school songs, chose typical song models, out of which he put together a test of 45 items. The research was drawn up as a longitudinal research and included 500 children, from the first to sixth class of a primary school in Wisconsin. All surveys were carried out individually. The music samples were recorded on a tape and in between each sample the children were given time to reproduce the presented extracts. The samples included, for example, models of ascending and descending spread out chord sequences. Petzold noted a significant increase in performance along with the age increase (here of course also affected by the development of voice skills, despite the test is called "auditory"). The most significant increase was found between those 6 and 7 years of age.[54]

H. Chvátilová studied the development of the ear for chords on one of the largest samples in terms of the number of respondents as well as the ages included. In her research, she included children attending the last two years of pre-school, first to eight classes of a primary school and control group of 18-year-old grammar school students, amounting to a total of 1046 respondents. The tested activities concerned the determination of the number of voices in one- to three- voice arrangements of well-known folk songs and determination of the number of tones in static chords.[55]

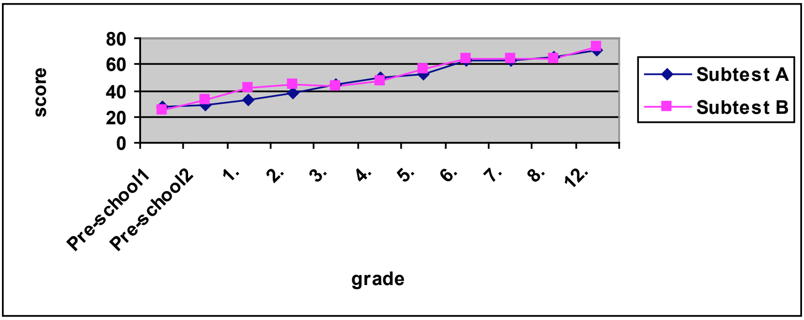
Chvátilová assumed the bigining of recognizing the harmony in children of six years old and the plató as a representation of completed development in the thirteen. The research among pre-school children was carried out as an individual survey and starting from the first class of a primary school, respondents were examined in groups. In her research report, the author presented the data regarding the achieved scores in absolute and relative frequencies in all monitored age categories. They are summarized in the table below.

Table 23 Overview of the ear for chords test scores (From Chvátilová 1979.)

Age	Subtest	
Pre-school 1 - younger children	27.8	24.8
Pre-school 2 - older children	29.3	32.6
First grade	32.3	41.4
Second grade	38.5	45
Third grade	44.3	43
Fourth grade	49.5	46.6
Fifth grade	52.3	55.8
Sixth grade	63	64
Seventh grade	63.5	64.2
Eighth grade	65	64
Twelfth grade	71	72

As the table shows, the scores for both subtests demonstrate a progressive trend and their comparison suggests that their development curves to be parallel. The following two charts depict the situation more schematically.

Figure 18 Development of the A and B subtest scores for chords (From Chvátilová, 1979)

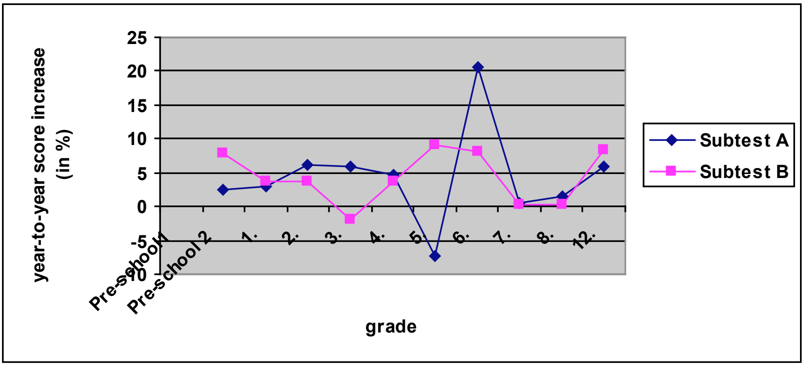


The chart clearly outlines a similar trend in correct answer frequency changes in the respective age groups for both subtests. The following table and the year-to-year increase in relative frequency chart provide even more detailed perspective of the ear for chords ontogenesis. Let's add that for Bentley they concerned the arithmetic averages of correct answers.

Table 24 Annual score increase in the ear for chords tests in % (From Chvátilová, 1979)

	Subtest	
	A	B
Pre-school 1- younger children	-	-
Pre-school 2 - older children	2.5	7.8
First grade	3	3.6
Second grade	6.25	3.6
Third grade	5.8	-2
Fourth grade	4.8	3.6
Fifth grade	-7.2	9.2
Sixth grade	20.7	8.2
Seventh grade	0.5	0.2
Eighth grade	1.5	0.4
Twelfth grade	6	8.4

Figure 19 Year-to-year score increase in correct answers in % (From Chvátilová, 1979)



The shape of charts clearly illustrates regression for both subtests. For the subtest A at the age of 12 years, it is 7.2%, for the subtest B at the age of 8 to 9 years, it is 2%. Based on this the author deduces that the ear for harmony develops in stages and observes "clear leaps at the ages of 5 to 6 years, 8 to 9 years and 11 to 12 years". This is a bit surprising, especially for the test determining the number of tones, which is very similar to Bentley's test, whereas the Bentley's development curve is gradual with acceleration between the eleventh and twelfth year (see chart above) and even the more detailed data on percentage increase in the average score oscillate from 1.5 to 3.5% during the more gradual period and from 7.5 to 8.5% during the accelerated period. The rough features of this development trend are also apparent in the research by Chvátilová (subtest A) but the drop in the fifth class changes the trend. We believe that the results may be significantly affected by one or two different surveys.[56] Nevertheless, these are only our assumptions as we used the data related to the full sample sets and we did not have the partial results of the individual surveys at our disposal.

Lýsek's data obtained in research, under which he exposed the respondents to major and minor triads asking them to distinguish between them, confirm the gradual score increase along with the increasing age. The following table shows the main research results.

Table 25 Score development in the ear for chords research (From Lýsek, 1955)

Age (years)	Score (%)	
	Six-four chords	Triads
8	21	-
9	37	-
10	-	59
11	67	63
12	-	73
13	78	-
14	-	93

Additionally, Lýsek asked the respondents to determine the key of eight-time themes. In twelve-year olds 67% of answers were correct and in fourteen-year olds 83% of answers were correct.[57]

Based on the presented results, the ear for harmonic intervals demonstrates a rather gradual progressive development across all monitored age groups. A similar pattern is expected for the following ability component – ear for harmonic homophony and polyphony.

3.3.3 Ability to Recognize Harmonic Homophony and Harmonic Polyphony

With respect to the ear for harmonic homophony and polyphony, we have already noted that this ability integrates cognitive functional components, the development of which affects the early, mid and late school years and adolescence. In the following text, we are going to study this ability in great detail using the abundance of material by E. Gordon, obtained when designing and standardizing his test set called Musical Aptitude Profile (MAP), and also lean on the results of one of the early researches by A. Zenatti.

The tonal imagery subtest by E. Gordon contains, in its second part called the harmony, twenty items representing 40 points of the gross score. The standardized score is elaborated individually for each of the seven subtests (including harmony) and covers the students of the 4th to 10th class aged 10 to 18 years. The centile standards are prepared for the 4th to 10th class of regular students and for three groups of music students (for 4th to 6th class, 7th to 9th class and 10th to 12th class).[58]

In order to allow easier monitoring of the test score development, we chose three centile values of 20, 50 and 80 in all age groups, which were, using the standardization tables, transformed into absolute score frequencies. The following table shows the values for all age categories. The first figure is the standard score; the second (after the slash) is the gross score.

Table 26 Increase in the ear for harmony score of the Gordon's MAP

Centiles	Age (years)								
	10	11	12	13	14	15	16	17	18
80	52/25	54/26	55/27	56/28	58/29	59/30	60/31	61/32	62/33
50	45/21	47/22	48/23	49/24	50/25	51/25	52/25	52/25	53/26
20	38/18	39/18	40/19	41/19	42/20	42/20	43/20	44/21	44/21

Figure 20 Increase in the score of the Gordon's MAP - 80 centiles

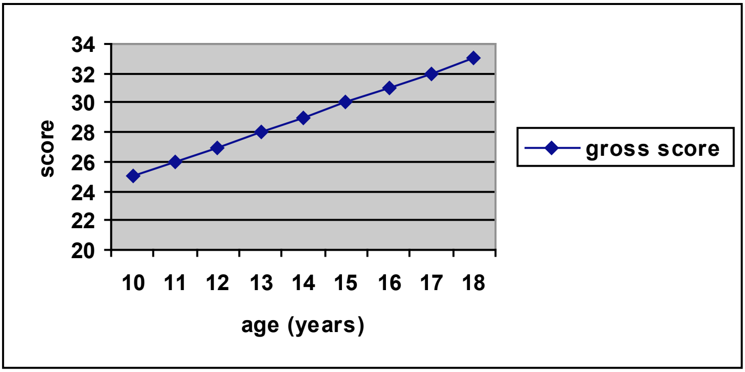


Figure 21 Increase in the score of the Gordon's MAP - 50 centiles

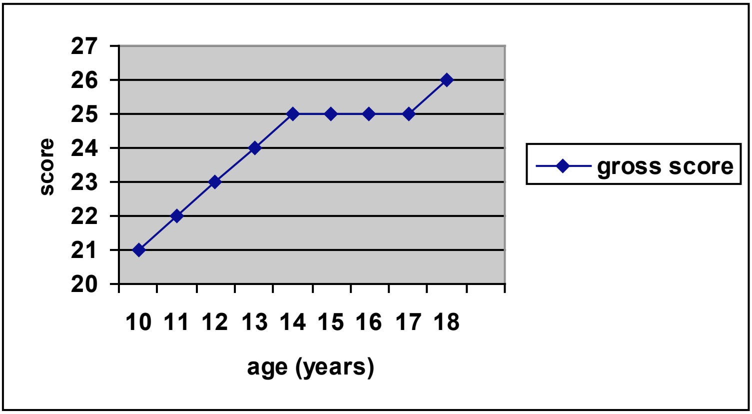
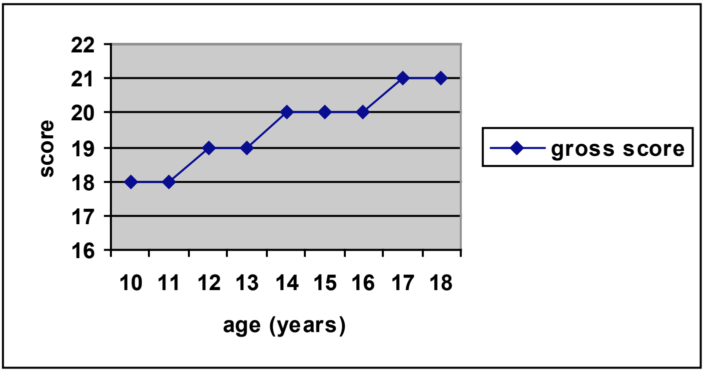


Figure 22 Increase in the score of the Gordon's MAP – 20 centiles



The chart clearly demonstrates a very gradual increase in the 80-centile group, while in the 50-centile group there is an apparent development plateau between 14 and 17 years of age. In the 20-centile group, the histograms show three clusters in which the score changes in two-year intervals, and one cluster with the development retardation between 14 and 16 years of age. We also have the standards for "students-musicians" available, divided into three groups according to the selected centile values of 80, 50 and 20.

Table 27 Increase in the ear for harmony score of the Gordon's MAP –version for students – musicians (From Gordon, 1965)

Centiles	Age (years)		
	10-12	13-15	16-18
80	57/29	61/32	66/36
50	49/24	53/26	58/29
20	41/19	45/21	49/24

Figure 23 Increase in the score of the Gordon's MAP/ students – musicians – 80 centiles

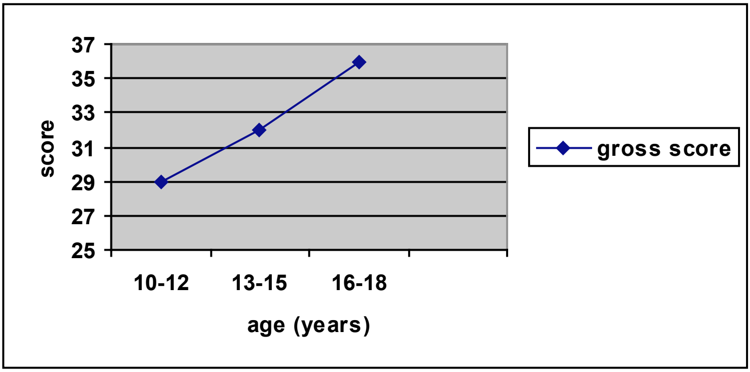


Figure 24 Increase in the score of the Gordon's MAP/ students – musicians – 50 centiles

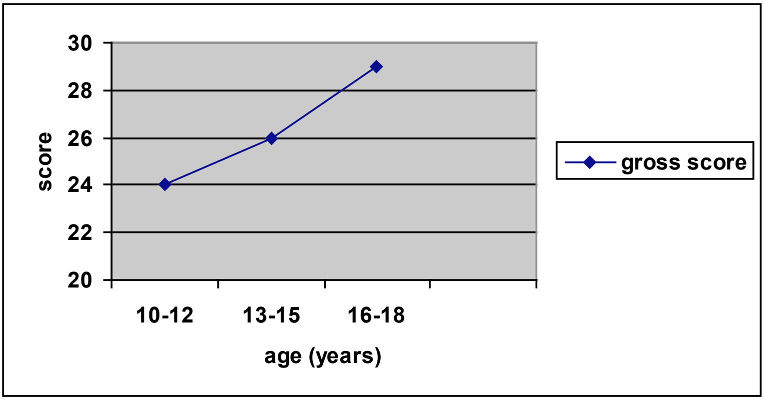
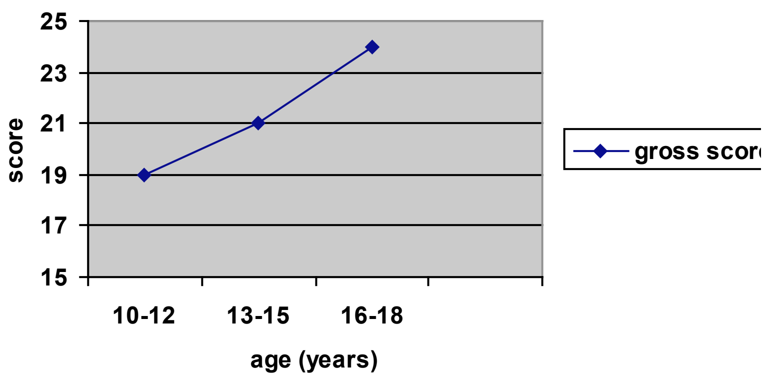


Figure 25 Increase in the score of the Gordon's MAP/ students – musicians – 20 centiles



The charts confirm the assumed systematic increase in the test scores. In the group achieving a higher score, the progression is more significant, especially in standards for the students-musicians.

In her research of the ear for polyphony, A. Zenatti[59] chose fugue in the song Malbrough s´en va-t-en guerre. Her respondents included girls of the age of 7:0–12:2, who were excellent in singing performance. 55 children were told that the melody would be "hidden" among several others and their task was to find it. The music stimulus was exposed six times in a two-voice arrangement, nine times in a three-voice arrangement and twelve-times in a four-voice arrangement. The children were assigned one point for each correct detection of the fugue theme. In each sample, the theme appeared only once, i.e. the maximum score was 27 points. The results are summarized in the table below.

Table 28 Results of the research by A. Zenatti (From Shuter-Dyson and Gabriel, 1981)

Age (years:months)	Number	Average score
7:0 - 8:3	16	13.7
8:5 - 10:1	21	19.8
10:3 - 12:2	18	21.9

The results indicate a clear increase in the score between 8 and 10 years of age. The data does not clearly provide the high and low scores but according to the author's references, even twelve-year old respondents experienced problems identifying the song if exposed in bass or tenor.

Among others, it was F. Lýsek[60] who applied Stumpf's methodology of detecting various tones in chords. However, unlike C. Stumpf, he did not approach the research in such detail but among countless chord options he selected several common modalities. For example, for the six-four chord E1, A1, C2 sharp the respondents achieved the following results when detecting the individual tones.

Table 29 The analysis of chords (From F. Lýsek, 1956)

Tones	Score (%)	
	11 years	12 years
e1	29	42
a1	11	27
c#2	65	89

R. Francés[61] experimentally verified the development in perception of polyphonic musical structures. Prior to the experiment, the respondents were introduced to the fugue theme and, subsequently, there were exposed to the entire fugue. During the listening there were asked to immediately indicate if they noted the fugue theme. The results confirmed that this ability improves with age and also appreciated the learning aspect. Francés believes that within the spectrum of many other experiments where he focused on various aspects of the apperception process, the role of learning is the most manifested in this area.

The monitored ability quality seems to be long-term and rather balanced with respect to the development, which confirms the assumptions made in the theoretical part and previous subchapter. Experiments demonstrated its certain developmental acceleration between 8 and 10 years of age.

3.3.4 Ability to Recognize the Harmonic Intervals and Chords in the Musical Space

The ear for chords in the musical space has not been frequently examined. The concept, as defined above, appears as the fourth subtest in the standardized test set by Whistler and Thorpe (The Whistler and Thorpe Musical Aptitude Test), designed for children aged 10 to 16. The centile standards are elaborated for younger (10 to 12 years) and older (13 to 16 years) groups.[62] The principle of the test task lies in assessing fifteen pairs of chords in terms of their mutual pitch relationship. Therefore, the authors called the test as a test of tone pitch discrimination. The individual test items use eight pairs of major and minor triads and seven pairs of the seventh chords.

In our approach to the ear for harmony structure, the respective diagnostic procedure is not regarded as pitch discrimination of tones but chords. Therefore, it is the ability to appreciate the pitch shift or identity of the chord structure. As far as we know, data manifesting the ontogenetic development pattern of this ability component has not been collected. However, in terms of the prediction validity Wing noted that the data could be satisfactory primarily under regular school conditions where there are students with diverse levels of musical abilities.[63]

Inspiring findings on the development of this ability in four- and five-year old children may later be found in the work of the Canadian music psychologist, Eugenia Costa-Giomi, from McGill University, Montreal. As a music stimulus, the scientist chose two simple songs – Drunken Sailor and En la Torre de una Iglesia. The first one in G Doric scale in even metre, the second one in F major and three fourth time. The songs were played on the piano in a simple arrangement, with the right hand playing a clear one-voice melody line and the left hand playing accompanying chords in close harmony at every beat. In the first song, the tonic minor triad alternated with a triad on the seventh degree. In the second song, the major tonic triad alternated with a dominant six-five chord. In each song, the chord functions were changed eight times, fully in compliance with their latent harmony. The children were asked to register the harmonic changes.[64]

The author applied the method of individual survey where each of the 167 children was firstly exposed to one of the two songs in its entirety and the child was asked to say "change" when the harmony changed. Subsequently, only the accompanying chord part of the second song was played and the child was, once again, asked to say "change" when the chord changed. This procedure was repeated again but with the second song played in its entirety first followed by the first songs chord accompaniment. The entire procedure was taped in order to allow undisturbed statistical processing of results and their assessment. Prior to the survey, children were briefly instructed during three fifteen-minute lessons over a course of one week. Children could watch the pianist's hands and then try to listen to both pieces of music with their ears covered and thus get the most adequate music image of both song versions.

The development of the average scores of correct answers, i.e. reactions to the harmonic changes both when exposed to entire songs with accompaniment and to individual chord accompaniment in four- and five-year old respondents, is shown in the table and two charts below. The standard deviation is in brackets.

Table 30 Average scores of the ear for chords in the musical space test (From E. Costa - Giomi, 1994)

	Song					
	En la Torre			Drunken Sailor		
Age	Harmony	Harmony + melody	Total	Harmony	Harmony + melody	Total
4 years	1.98	0.38	1.18	2.42	0.64	1.53
n = 82	(2.76)	(1.04)	(1.51)	(2.94)	(1.28)	(1.75)
5 years	5.03	1.47	3.25	5.91	2.2	4.05
n = 85	(2.84)	(2.84)	(2.06)	(2.11)	(2.11)	(1.66)

The results demonstrate that in more than 50% of cases the five-year old children managed to identify the change if only chord accompaniment was exposed. On the other hand, four-year old respondents predominantly failed this task. In the second version where the musical stimulus was exposed in the harmonic-melodic form, most four- and five-year old children failed, yet the total score between both age groups shows significant difference. E. Costa-Giomi concluded the research by saying that the abilities to perceive harmony in children of early school years are better than generally expected and that five-year old children are able to mentally process simple stimuli related to chord changes. She also found out that in terms of this music ability there are already differences between four-year old and five-year old children resulting from developmental changes. It is apparent that in both monitored groups, children were more successful in the task with simpler musical structure, i.e. individual chord accompaniment, than in the task with more difficult combined melodic-harmonic musical stimulus, as a result of the emerging ability to decentre the focus of their attention.

The relationship between the perception of tone pitch, key of chords and short-term memory was studied by T. Pechmann. His partial conclusions advocate chords as stimuli that are easier to hold in memory than individual tones. Furthermore, he examined the quality of the key of chord change perception and whether it makes a difference if the chords do not change within the tone space, e.g. G major – G minor, and if the chords change within the tone space (G major – E minor). Better results in detecting the key characteristics of chords were obtained when both the key and the pitch of chords within the tone space changed.[65]

3.3.5 Inter- Key Harmonic and Polyphonic Feeling

Henry Lowery, already mentioned in connection with the diagnostics of tonally harmonic feeling, also verified the function of the tonally memory test, which consisted in presenting the respondents with pairs of musical themes that were modulated and either identical or changed. The respondents were asked to identify the quality of the change. The test was piloted on 130 pupils of a girls' school aged 12 to 14 years. However, he did not develop this methodology further, despite Shuter noting that the reliability of 0.75 showed to be promising.[66]

Nevertheless, Lowerys methodology is not in full accordance with the ideas of G. Révész, whose approach gave the stimulus to define this ability component. We should rather speak about one of the diagnostic modifications of the ability to preserve the images of certain musical expression phenomenon, as discussed in connection to J. Piaget. It is F. Lýsek, whose approach is closer to his, and who based on experience deduced that twelve-year old pupils are able to appreciate a song with temporary modulation and modulation if the tonic triad is emphasized at the beginning of both parts.[67]

Our original concept of the inter-tonal harmonic and polyphonic feeling was expected to form a unit within the ear for harmony structure, with even representation of the conventional and cognitive elements, and to be a somewhat higher degree of the tonally harmonic feeling. After several partial researches using this testing method we did not consider the obtained results to be convincing. We actually believed that the cognitive factor, represented primarily by musical memory and tonal imagery that in terms of capacity exceed the limits of a regular child population, intervened significantly.[68]

In a way this assumption is confirmed by the experience of F. Lýsek who says that: "... based on how brightly and quickly the pupils understand the temporary modulation and modulation (...) we deduce their gifts, talents, geniuses, all together musicality." We could specify that it concerns a higher degree of musicality, once again in accordance with Lýsek, who adds: "... the ability of transposition seems to be one of the signs of high musicality of the highest quality".[69]

Although the results of verifying this component were not really positive, it does not mean our full resignation to solving this aspect. So far it just deviates from the assumptions and definitions we have used for the ear for harmony in our concept.

3.3.6 Feeling of Consonance and Dissonance of Chords and the Chord Connections

In the previous text, the issue of assessing the consonance and dissonance split into two groups with respect to the psychological aspects, i.e. sensory and musical group. In the following text we, once again, apply the pattern and stylization of sound or musical stimuli as the classification criterion.

Now, the individual procedures are going to be described in greater detail in relation to the changes in quality of examined ability parameters. Firstly, we are going to discuss the researches assessing consonance and dissonance of static chords and secondly, we are going to explain the issue of the so-called "false accompaniments".

3.3.6.1 The Static Chords

The psychological effect of consonance and dissonance of static chords has been studied as one of the oldest music theory topics. A brief overview of this topic under the music psychology concept was given in the chapter 1.2.1. At this point, we are going to focus on the selection of criteria monitored under the ontogenetic context.

Among others, it was C. M. Valentine who devoted his abundant and long-time research activities to the developmental aspects of the consonance and dissonance feeling according to a preferential criterion. The results of his work may still be regarded as a representative testimony reflecting not only the different approaches to addressing the raised questions but also the theoretical background the research projects were built upon.[70] Valentine studied the development of the ear for consonance and dissonance on isolated intervals. He asked the respondents a simple question whether they like or dislike the exposed interval (in Teplov's concept it concerns the emotional effect of intervals). The research included 198 pupils of 6 to 13 years of age who may be considered as the representative set of the respective age categories. A positive answer was given one point (+1), a negative was given a negative ponit (-1), an uncertain answer was given zero points. The results showed that the following intervals were evaluated positively: major 3rd, minor 3rd, perfect 8ve, minor 6th, major 6th, perfect 4th, augmented 4th (surprisingly) and perfect 5th. Dissonances of major 2nd, minor 7th, major 7th and minor 2nd were assessed positively by the children less than 10 years of age. Eleven-year olds firstly allocated a negative assessment to major 7th and minor 2nd, twelve-year olds negatively assessed also minor 2nd and in the group of thirteen-year olds the status stayed practically unchanged. Minor 7th was assessed negatively only by the control group of adult respondents. The changes in average values obtained by assessing the intervals according to the respective instructions are shown in the table below, where intervals are sorted into two groups, consonant and dissonant.

Table 31 The development of feeling of consonant and dissonant intervals (From Valentine, 1962)

	Age (years)								
	6	7	8	9	10	11	12	13	Adults
Consonance	27	33.1	34.5	35	31.7	33.5	20.4	22.9	24
Dissonance	25	35.6	26.5	17.2	9.2	-4	-15.8	-15	-26.2

In addition, Valentine verified the ability to discriminate between consonance and dissonance of intervals in a smaller sample of pupils of the girls' school who, since the age of seven, actively played a musical instrument and rather intensively listened to classical music. In this group, Valentine registered the discrimination of intervals as dissonant or consonant apparently earlier. The girls perceived the major 2nd, major 7th and minor 2nd as dissonant already at the age of 6 to 7. At the age of 9 they even deemed minor 7th as dissonant.[71]

R. Plomb carried out his research in the 1960s. Together with W. J. Levelt, they conducted an extensive research with non-musician respondents who were asked to assess the consonance of intervals. More specifically, they listened to different kinds of chords in different interval relationships and were asked to indicate whether they perceive them as consonant. The score of votes assessing the intervals as consonant was expressed in relative frequencies. Almost 80% of respondents assessed the major 3rd as consonant, about 70% assessed perfect 4th as consonant, 60% assessed minor 3rd as consonant and about 58% assessed perfect 5th as consonant. As noted by A. Špelda, even a rather high percentage of respondents considered highly out of tune unison to be consonant.[72]

F. Lýsek[73] studied the development of the ability to perceive consonance and dissonance of chords in four-, five- and six-year old children. He had them assess major and minor triads, augmented and diminished triads and minor (dominant) and diminished seventh chords. His findings are summarized in the table below.

Table 32 The development of the ability to assess consonance and dissonance of chords (From Lýsek 1955, 1956)

Chord	Age (years)		
	4	5	6
Major triad	consonant	consonant	consonant
Minor triad	consonant	consonant	consonant
Augmented triad	dissonant	dissonant	dissonant
Diminished triad	dissonant	dissonant	dissonant
Dominant seventh chord	dissonant	dissonant	cons.-disson.
Diminished seventh chord	dissonant	dissonant	dissonant

Comparing the results of Valentine and Lýsek, there is an apparent age shift between the discrimination of consonance and dissonance of chords (triads and tetrachords) and intervals. Therefore, it may be deduced that triads and chords consisting of more tones can be distinguished as consonant and dissonant earlier than intervals (dyads) in terms of ontogenesis.

H. Chvátilová[74] carried out her research in the same manner as Valentine. She exposed the respondents to four consonant (major and minor) chords, two diminished tetrachords, one diminished minor tetrachord and a dominant seventh chord in basic position and as six-five chord. The chords were played on the piano in one-line and two-line octaves (C1 sharp – G2 sharp). Children could assess them as either "nice" or "ugly".[75] The evaluation was done globally, as the proportion of all votes for consonance to all votes for dissonant and expressed as coefficient K. If the coefficient exceeds 1, the overall perception of consonance prevails; if the coefficient is below 1, the overall perception of dissonance prevails.

Assessed in accordance with the Janeček classification of consonance and dissonance,[76] the coefficient with four consonances and five dissonances used in the research could "ideally" be 0.8. The following table shows the values obtained in four age categories and two different groups based on the musicality and intensity of music activities of the respondents. The criterion concerned the regular attendance to a music school.

Table 33 Development of feeling of consonance and dissonance chords (From Chvátilová, 1979)

	Non-musicians		Musicians	
Age (years)	n	k	n	k
6-7	48	1.43	21	0.73
8-9	47	1.47	-	-
11-12	-	-	17	1.47
13-14	53	0.89	-	-

In the group of non-musicians, there is a clear shift of the dissonantly consonant coefficient k to the ideal form, deduced from the structure and consonantly dissonant characteristics of nine exposed chords, as the respondents get older. In the group of musicians aged 6 to 7 years the value of 0.73 seems to be quite real, although it is below 0.8, which indicates that not only major and minor chords but also, for example, a slightly dissonant dominant seventh chord could have been deemed to be consonant.[77]

Likewise above, the research carried out by J. Sloboda[78] examined the development of a consonantly dissonant feeling by asking the respondents to assess pairs of music stimuli, while one of them was played "correctly" and the other sounded dissonantly, i.e. "incorrectly". In the first test, the respondents were exposed to pairs of static chords in a four-voice arrangement (e.g. G, C#1 , G1, C2 as dissonant chord, containing dissonant major 7th, and consonant G major chord containing G, D1, G1, H1). In the second test,[79] the music stimulus was designed in a manner combining the harmonic-tonal (EH1) aspect, represented by four-voice cadences, and a consonantly dissonant aspect. However, the latter did not lie in the unsatisfactory quality of the close, as in the case of Lowery, but it meant that each chord of the "correct" classical cadence was "disrupted" with alterations of bass, tenor or alt voice. The soprano remained unchanged in both cadences of the same example.

Sloboda's test included twelve examples. For every correct answer it was possible to obtain one point, i.e. the maximum score was twelve points. The experiment was carried out in four age groups (6, 7, 9 and 11 years) and one control group of adult respondents. The table below shows average scores for all age groups obtained in both described tests.

Table 34 Average scores in the consonance and dissonance of chords feeling tests (From J. Sloboda, 1985)

	Age (years)				
	5	7	9	11	Adults
test 1	5.5	7.7	9.5	9.3	10.6
test 2	7.3	9.1	11.4	11.8	12

There was no statistically significant difference between the data underlined in the table. Therefore, the studied aspect of the ear for harmony does not show any significant development changes after the age of 9. Practically, Sloboda confirms the results of Valentine's research.

In the chapter studying the apperception of harmonic music entities we mentioned that the issue of consonance and dissonance may also intervene in other components of the ear for harmony. The research resources show that the relationship of the ear for consonance and dissonance of chords (HA6) feeling of, ability to recognize harmonic intervals and chords (HA2) is one of the closest ones.

In this respect, A. Zennati carried out her research in children aged 4:6 to 7:11 years in 1974.[80] Their task was to identify the identity or change in the pair of chords that were exposed twice. Half of the examples included consonant chord pairs and the other half included dissonant chord pairs. The success rate of completing the respective task, which, as already mentioned, falls under HA2, was significantly affected, according to Zennati, by the fact whether the examples played consonant or dissonant chords. The complete resulting scores are provided in the table below.

Table 35 Results of the static chord assessment research (From Zennati, 1974)

Age (years:months)	Number of respondents	Correct answers (%)
4:6 - 4:11	13	42.3
5:0 - 5:11	50	45
6:0 - 6:11	47	56.6
7:0 - 7:11	45	62.7

As the table clearly shows, the percentage increase primarily occurs between five-, six- and seven-year olds. However, with respect to our perspective, the most important finding is, as added by Zennati, that the five-year old respondents achieved better scores (despite not statistically confirmed) in examples containing consonant chords. It is obvious that their success rate was influence by the status of their musically acculturation process which was not terminated yet. In other words, under the consonant environment where they felt "home" in terms of auditory perception, their hearing discrimination process was smoother.

On the other hand, it is necessary to mention the secondary findings of Thackray,[81] who noted, during the research of the ear for chords mentioned above, that it was actually the dissonant chords in the tasks asking to identify them in the sequence of several chords that were easier and, thus, more frequently identified as in the cadences otherwise consisting of consonant chords they were more contrast and striking.

Recently, scientists have once again regenerated interest in the chord perception ontogenesis, primarily with respect to dyads, based on the criterion of consonance and degree of dissonance of intervals. Theoretically and experimentally, they actually revived Euler's theory of consonance, the source of which lies in the Pythagorean understanding of small numeric ratios as the ideal status of facts as well as the discovery of harmonics by J. Sauveurem.[82] The simpler the numeric ratio is the more harmonics are shared by both tones, with a high degree of sensory consonance. This group includes, primarily, a perfect 8ve (2:1 ratio), perfect 5th (3:2), perfect 4th (4:3), as well as major 3rd (5:4) and major 6th (5:3). On the contrary, intervals that do not share the lowest harmonics and the ratio of which is, for example, 15:16 (minor 2nd) demonstrate a high degree of sensory dissonance. Under these approaches it is expected that the ability to distinguish the degree of consonance or dissonance is independent of the learning process and process of enculturation. These theses were being confirmed with experiments in newborns exposed to consonant and dissonant intervals played from two speakers placed on the left and right. Children had the opportunity of spontaneous selection of one of the two speakers. Simultaneously, the time for how long the children managed to pay attention to the respective speaker was measured. This preferential temporal research methodology[83] was applied to four-month old babies by M. Zenther and J. Kagan, who presented the melodic line with a consonant or dissonant second voice. Major and minor thirds were presented as a consonant two-voice example and the dissonance appeared minor 2nds. The children preferred the consonant versions with the thirds.[84]

L. J. Trainor and B. M. Heinmiller expanded the methodology of research with the aspect of harmonics influence in dyads, based on the theory of sensory sensitivity to dissonance of chords. In their experiments, perfect 5ths and perfect 8ves were perceptionally confronted with the intervals of augmented 4th and minor 9th. Six-month old babies preferred consonant 5ths and 8ves.[85] Another preferential experiment, methodologically similar to the survey of R. Plomb and W. Levelt, was carried out by a team of McMasters University in Canada, including L. J. Trainor, C. D. Tsang and H. W. Cheung. They presented a two-tone consonant (perfect 5ths and perfect 8ves) and dissonant (augmented 4ths and minor 9ths) intervals to twenty eight- to ten-week babies and twenty fifteen- to seventeen-week babies. The intervals were exposed in one crotchet, two quavers and again, in one crotchet value. The procedure was laboratory adjusted to make sure the preferences may be significantly demonstrably registered and recorded. Once again, the children rather preferred the consonant intervals to the dissonant ones.[86]

A different version of the musical stimulus was used by E. G. Schellenberg and L. J. Trainor. They let a group of seven-month old children and a group of adult respondents distinguish between the perfect 4th interval and augmented 4th interval from the perfect 5th interval. The latter was presented as permanent background in various pitches with both kinds of 4th compared to it. Once again, the consonances from dissonances were better discriminated, i.e. augmented 4th from the perfect 5th than perfect 4th from the perfect 5th. In the discussion over the results, the authors reflect not only the aspect of consonance and dissonance, but also the distance of intervals, or their different frequencies. They note that although the perfect 5th and perfect 4th are more different when it comes to the distance compared to the perfect 5th and augmented 4th, the intervals distinguished based on the sensory consonance and dissonance are better discriminated, both in babies and adults.[87]

This series of surveys carried out during the second half of the 1990s and at the beginning of the following decade enriched the area of early ontogenesis with new perspectives that were not expected to be so intensive. Referring to Hargreaves it is possible to say that these surveys allowed the area of consonance and dissonance become a bit more organized and place the ability, eventually called the sensory consonance and dissonance, to the earliest age and consider it as the music psychology phenomenon in the area of the ear for harmony, or the perception of consonance and dissonance of chords, which is relatively independent of learning and the influence of the enculturation process.[88]

3.6.2 Diferent Parallel Tonal Areas

Although the issue of the developmental dynamics of the perception of consonance and dissonance of chords stylistically arranged as two different parallel tonal zones seems to be topical, based on the results of early surveys from the first third of the last century, primarily at the turn of pre-school and early school age, it features a certain developmental dimension, as confirmed by Teplov, reaching almost to the verge of adulthood.

Nevertheless, the first research was carried out by H. Rupp already at the beginning of the 20th century with a group of five children of early school age. His diagnostic procedure lay in assessing three patterns of simple single-voice harmonizations of one and the only melody. The melody played in parallel thirds and sixths and terminated with a tonic triad was, in the first version, accompanied with the basic harmonic functions. In the second version, the accompaniment was transposed to F major, while the sequence of harmonic functions remained the same. All respondents accepted this version without any major objections, except for one spot in the last measure, where on the first beat the dissonant chord of F, G#, H, E1 was played instead of the original tonic triad in E major, by replacing E with F in small octave in bass. Additionally, the second bitonal version was accepted rather without any hesitation, except for one spot on the subdominant, where on the first beat the chord of G1, C1#, G1# was played.

In both tonal zones, under the transposition of the harmonic accompaniment, slightly dissonant chords appeared which were found as completely satisfactory. In the two mentioned cases, always on the first beats and in the presence of 2nd in the respective resulting chord, however, the chords' auditory effect was dissonant thus making them as unacceptable for the respondents.[89]

The outlined methodology of determining the quality of consonance and dissonance perception, where the various degree of chord dissonance results from parallel tonal zones, has been repeated in the subsequent experiments many more times.

The research conducted in the 1920s by Sofia Bel'ayeva-Exempl'arskaya[90] in 29 children of early school years (5:6–6:6) modified the Rupp's methodological procedure by changing the key relationship between the exposed parallel zones. While in Rupp's methodology all the changes occurred in the major type of key, here the key of the accompaniment changed from E minor to A flat major with the sequence of harmonic functions unchanged. Thus it could be expected that children would respond to at least some dissonances less favourably than in Rupp's research. However, the author of the experiment points out that the version with "false" harmonization did not catch the children's attention at all; only one of the youngest respondents deemed the second extract worse.

Helmut Moog studied musical development of children of four to six years of age. He examined the topic using six series of tests. The fourth and fifth series contains musical harmonic aspects.

In the fourth series called the instrumental music he presented the following:

- Twelve-tone melody, 42 crotchets and quavers from his own piece called Brad from Stones for solos, choir and orchestra, he composed in 1957, adapted for the recorder;
- Introduction of the first movement of the Anton Webern 4^{th} symphony, 63 measures;
- Popular song Seeman, lass das Traümen;
- String quartet Sleep, baby, sleep – ten-measure lullaby in F major.

In the fifth series, Cacophony, he makes the following changes to the individual instrumental voices. For the first time, the part of the viola is changed, the melody line is kept but moved by half a tone higher; in the second extract, the second violin, viola and violoncello are moved by half a tone higher, while the melody remains exactly the same. In the third musical stimuli a simple four-measure tune is played–by violin in C major, second violin in D major, violoncello in H major and viola in A major. Rhythmically the voices are identical, harmonically they move independently and logically. Thus they create dissonant harmonies but the respective voices occurring in unrelated keys.

The conclusions may be summarized as follows: pre-school children do not have any experience with any kind of harmonic language. A child cannot assess the harmony at least until the end of their six years of age, possibly even later. Not even one child showed any dissatisfaction when listening to the cacophonic series No. 5. Pre-school children lacked the ability to analyze the individual tones of different pitches of chords in relation to other tones.[91] Moog, in his summation, says that his tests confirmed the similar research of Rupp (1915), Bel'ayeva-Exempl'arskaya (1926) and Stern (1952).

Another series of similar surveys was carried out by M. Antoshina[92] with 47 respondents, aged from 8 to 18 years. They were asked to assess three extracts. One with the "correct" harmonization, the second one accompanied only with the tonic chord and the third one with dissonance. The author observed that the dissonant pattern was entirely rejected by 27 respondents, i.e. 60%. Twenty nine-to-eleven-year old respondents, however, considered all three versions to be about equal. Out of these twenty respondents, five chose the dissonant version to be the absolutely satisfactory manner of harmonization. Compared to the previous group, their age went down to 8:6 to 9:6 years.

Additionally, B. M. Teplov[93] also contributed to the discussion about the feeling of consonance and dissonance of chords. He conducted a number of similar surveys, predominantly in adults. By doing so, he actually gave a clearer picture in terms of the relationship between the tonally melodic feeling, ear for tone pitch and feeling of consonance and dissonance of chords, less in terms of ontogenetic perspective. Nevertheless, we believe it to be beneficial to comment on his work.

Teplov described four threshold situations for the musicality status of adolescent and adult female respondents, whose music ontogenesis demonstrated an uneven development of the mentioned components of musicality.

For example, a sixteen-year-old female respondent preferred the dissonant version of accompaniment despite her ear for pitch and melodic tonal feeling being excellent. On the other hand, an adult female respondent with relatively less developed melodic tonal feeling definitely preferred the "correct" consonant versions in three subsequent tasks.

The second pair of respondents differed in the quality of their sensitivity to tone pitch differentiation and the ability to distinguish the quality of harmonization. The first individual of this pair, a thirteen-year old girl, demonstrated very limited ability to differentiate tone pitch and, simultaneously, she was not very certain in assessing dissonant harmonization; she totally and clearly preferred it twice, and she was not sure once which to prefer and once she rejected the dissonant version. The other respondent who considered the chromatic scale to be the same repeating tone clearly preferred consonant versions in three demonstrations.

The common feature of the examples mentioned above lies in the disproportion between the musical and mental age. In other words, all female respondents lagged in certain musical ability, which often concerned the feeling of consonance and dissonance of chords, far behind their physical and mental age, which also results in disharmony in co-ordinating the development of this type of ear for harmony with the tonal melodic feeling and pitch differentiation ability.

The chart below shows the schematic illustration of the mentioned atypical constellation status of three musical ability parameters as a result of uneven development in the ontogenesis of musicality. The individual female respondents are identified with letters A to D.

Table 36 Examples of atypical development of some musical abilities (From B. M. Teplov, 1968)

	Sense for tonality of melody	Ability to recognize harmonic intervals and chords (2)	Feeling of consonance and dissonance of chords and connections of chords (6)
A	-----------------	-----------------	------
B		------	----------
C	-	-	------------------
D	---		------------------

The outlined cases let us, at least transversally, assess the status of the mutual relationship between the observed elements. Very roughly speaking, in all four cases the ear for consonance and dissonance of chords correlates negatively with both ability elements.[94]

Hana Chvátilová also joined the discussion about the assessment of multiple-tone accompaniments. The description of the research sample is given in the respective subchapter. At this point, we are going to focus on the description of the test tasks and results.[95] The respondents were exposed to piano arrangements of a a very popular song among pre-school children "Travička zelená", polka Esmeralda by F. Hilmer and a popular 1960s song "I only want to be with you". The melody was always in C major and the left hand was playing a simply arranged accompaniment in different styles with chord spreading, rhythmical progressions, etc. The keys were combined as follows:

Table 37 Combination of keys in the research of the feeling of consonance and dissonance of chords (From Chvátilová, 1979)

	Version 1		Version 2	
	melody	accompaniment	melody	accompaniment
Extract 1	C major	C major	C major	F major
Extract 2	C major	A major	C major	C major
Extract 3	C major	A minor	C major	C major

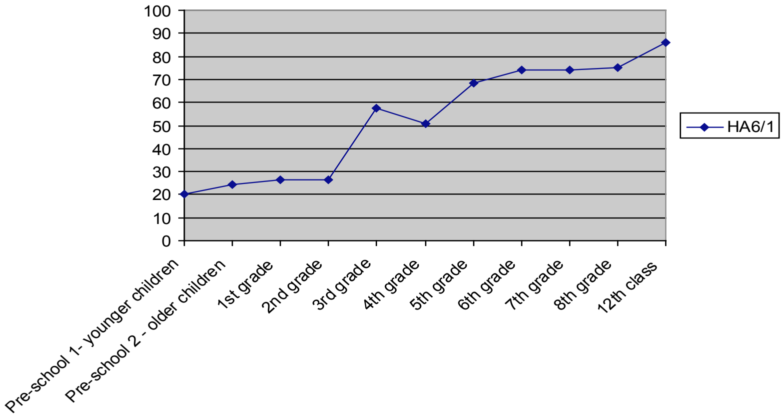
The scores obtained for the individual age groups are summarized in the table below.

Table 38 Overview of scores of the ear for of consonance and dissonance of chords test (From Chvátilová, 1979)

Grade	Score
Pre-school 1- younger children	20,3
Pre-school 2 - older children	24,3
First grade	26,6
Second grade	26,6
Third grade	57,3
Fourth grade	50,7
Fifth grade	68,3
Sixth grade	74
Seventh grade	74
Eighth grade	75,3
Twelfth grade	86

As the table clearly shows, the scores are predominantly progressive. To illustrate the situation better, see the charts below.

Figure 26 Development of scores of the feeling of consonance and dissonance of chords test (From Chvátilová, 1979)

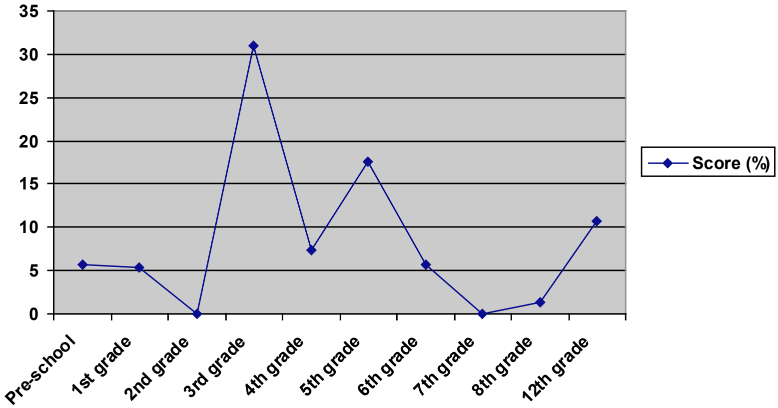


More detailed data of the increase in the subtest C scores (all positive answers) in relative frequencies are shown in the table below.

Table 39 Year-to-year changes in scores of the ear for consonance and dissonance of chords test (From Chvátilová, 1979)

Age	Score (%)
Pre-school	5.7
First grade	5.3
Second grade	0
Third grade	30.9
Fourth grade	7.4
Fifth grade	17.6
Sixth grade	5.7
Seventh grade	0
Eighth grade	1.3
Twelfth grade	10,7

Figure 27 Anual changes in scores of the feeling of consonance and dissonance of chords (From Chvátilová, 1979)



The percentage increase in the score is relatively irregular. While at the beginning and in the middle of the observed period, the increase amounts to about 5%, at the age of 9 years substantial increase occurs, which subsequently reduces but then drops back up to 17.6%. Considering possible deviations, it is possible to incline to the opinion that the development of this ability occurs with the progression of about 5%. Between 9 and 11 years of age a significant increase occurs, which slows down around 14 years of age. Nevertheless, until 18 years of age the development expressed as an increase by about 2% continues.

Therefore, we may note that while the development of the ability to distinguish consonantly dissonant qualities of static chords (chapter 3.3.6.1) terminates in children in a positive musical environment relatively early, around 8 to 9 years of age and in a regular population of children around 11 and 12 years of age, the perception of consonance and dissonance of chords styled as consonance or dissonant harmonizations of a melody develops over a longer period of time and stays unchanged only after the age of 18. As a result we could, in terms of the development perspective, further breakdown the HA6 component to HA6-1 and HA6-2.

3.3.7 Ability to recognize harmony within a musical language

In the stream of music, harmony, compared to other musical means of expression, feels relatively compact. As mentioned in the introductory chapter, its multidimensional and spatial qualities predetermine harmony to take the role of the background, establishing the space for the object (figure). This holistic feature represented as the timbre quality practically prevails and it acts as a determinant in the context of the relationship harmony – musical means of expression. From here it may be possible to deduce that the aspect of holisticity could correspond with a relatively early occurrence of the ability to identify or respond to the harmony as the musical means of expression. However, the studies examining the early development of musicality[96] do not practically cover this topic, except for research by G. Simons, who informs, in her paper dated 1964, about a research of spontaneous children' responses to various musical stimuli. Children aged 0:9 to 2:7 were exposed to the piano extracts differing in the degree of accent given to either one of the musical means of expression. The most apparent reactions were recorded to musical stimuli that were predominantly rhythmical. The rhythm was followed by significantly melodic extracts with prevalence of a consonantly harmonic component. Children responded the least to dissonant pieces of music.[97]

M. Pflederer-Zimmerman established the description of the preservation process, i.e. the ability to keep the image of perceived phenomenon under the change of any of its partial parameters, under music ontogenesis. During the course of the 1960s, 1970s and 1980s she carried out several researches.

In herfirst survey, she observed this ability using the changes of rhythmical, metric and melodic parameters.[98] The method was as follows: in the repeated version a certain musical means of expression, different from the observed one, was changed and respondents (8 five-year olds and 8 eight-year olds) were asked to prove that they are still able to recognize the observed parameter. For example, in the extract from one of Bartók's pieces, in the Album for the Young, the change from two-time metre to three-time meter was accompanied with the change of duration of the tones (and actually also instrumental timbreness since the theme was first played on the percussion and then on the piano). The statements where the child did not respond based on the change in metre, but, for instance, noted that both versions were identical or different in their tone duration were considered to be the sign of prevailing centration thinking typical for pre-operational stage.

In all the three observed musical means of expression, a clear difference in correct answer scores was recorded, favouring the older (eight-year-old) respondents, while for the rhythmical feeling, maybe thanks to its more significant very early developmental acceleration, the differences were not as large. The preservation of melody and metre showed very clear developmental gaps between the five-year olds and eight-year olds.

In one of the following surveys, Pflederer accompanied the melody with four different harmonizations. However, the melody was not repeated unchanged four times; once it was modified. The children were asked to identify this modified version. This time, only minor differences between both groups were observed – five-year-old children succeeded in 50% and eight-year-old children in 56%. The experimenter figured that at the age of five some children are already able to preserve the melodic parameter but otherwise this ability does not undergo any development change between the age of five and eight years. The performance is rather based on innate aptitude and any possible development may be expected in the following course of ontogenesis.[99]

Subsequent Pflederer's research as part of her doctoral thesis verified whether five-year-old and eight-year-old respondents are capable of telling apart two versions of the same melody, if the differences occur in metre, melody line and rhythm. The younger group of five-year-old respondents did not demonstrate this ability yet.

Third Pflederer's research[100] was conducted on larger scale in terms of the number of respondents and modified musical parameters. Once again she used pieces from Bartók's Album for the Young. The research sample included respondents aged 5, 7, 9 and 13 years, a total of 198. Children were exposed to four pieces of music. Each of them was repeated once and for the second time one of the seven parameters was modified: instrumentation, tempo, harmony, and the type of key and total melodic outline. The children were asked whether the original and changed versions were the same, different or same in certain respects and different in other respects. The following table shows examples of some selected representative answers, demonstrating apparent gradual development of the preservation process. In all cases the modified musical means of expression concerned the harmony. The stages of the preservation thinking development are identified as follows:

A - preservation thinking not formed
B - transitory stage
C - preservation thinking formed

Table 40 Development of the thinking preservation process (From Pflederer and Sechrest, 1968).

5 Years-Olds	
Development stage	**Respondent's answers. Questions**
A	Different, because on is playing with a whole bunch of keys and othe is only playing with two. *Were they same in any way?* No.
C	The second one was a chords. The first one didn ´t have chords. *Were they the same in any way?* Well, the song was the same and the piano was the same.

7 Years-Olds	
Development stage	**Respondent's answers. Questions**
A	Different. They were using more fingers than the first one. *Were the songs the same in anyway?* No.
B	That´s different because they played the piano. They played the piano with the other instruments. *Were they the same in any way?* Yes, the song was, but, um, but some of the music in the middle wasn´t because, um, the piano was playing.
C	If they took off the four, and then it would be the same. They had a low note after each note. They could be the same at the end if they tookaway the low notes. Yes, it´s just a little different. They had another new note after the other one. *Was there anything the same about them?* Not exactly. Just the notes if they didn´t put the new . . . it would be the same if they didn´t put the chord in it. Yeah, I think it would be the same.

9 Years-Olds	
Development stage	**Respondent's answers. Questions**
A	In the middle of the second song they started to play two hands together. *Were the songs the same in any way?* No.
B	The second one was played with two hands and the first one with one hand. *Were they the same in any way?* I do not know.
C	They were the same song, but two people were playing it. *What is that called?* A duet. They were the same. It was played with chords, but it was zhe same in the melody.

13 Years-Olds Development stage	Respondent's answers. Questions
A	Well, that´s still played by the piano and they added some chords to it. I ´d say it´s a little bit higher than the first one. *Are the tunes the same in amy way?* No.
B	It´s different because on every third note they played a chord or an interval. They played more than one note. *Were the tunes the same in any way?* The first notes were the same. It was different because it didn´t play the same amount of notes. *What do you mean by that?* It played three tones and then it moved, the last one had more of a chord.
C	Most of it was harmonized. Otherwise it was the same. *What was the same?* Well, the second one was the same as the first with harmony put ii. They add chords to that one. Otherwise it would be the same.

The results confirmed, likewise in the previous surveys conducted by Pflederer-Zimerman, the justification of the Piaget's thesis about the preservation process development in the ontogenesis of music thinking. Additionally, they generated some specific findings. For example, the research methodology analyzing the preservation of thinking had to be modified and the resulting changes shifted the concept and understanding of the term preservation in music ontogenesis to a certain point. In the conventional Piagets experiments, the child can directly see the changes performed with the objects (cylinders, bars, buttons, lines, etc.) and can be directly asked whether the changes took place. The child may also observe how the objects return to their original state and possibly watch the entire procedure one more time. The reality of music is, in principle, different; the child does not have the opportunity to observe both forms of the musical object at the same time, but at a certain, not distant though, time sequence. The pieces of music were always exposed one after another and, thus, their change may not be observed in parallel. Therefore, it is necessary to more significantly involve short-term memory and, since the respondents work with intangible musical stimuli, also imagination, which is reflected by a shift of the musical thinking preservation process to an older age.[101]

With respect to the mentioned researches, it is advisable to point out another fact. In her third and most extensive research, Pflederer did not use the metaphoric form of instructions used in the previous two researches. It seems, and has been confirmed by the experience of many researches, that for surveying the children of pre-school and early school age, it is more suitable to use this methodology.

In the 1960s, I. Poledňák, inspired by the co-operation with L. Melkus in the Research Institute of Education, Prague, focused on the research of music imagination development in children of early school age.[102] The accuracy and stability of the image of the piano piece of music Italian Song (Tchaikovsky's Album for the Young), which was didactically used in five teaching units in two classes, experimental and control, were examined using the method of partial object variation, applying the variants of four musical means of expression – rhythm, melody line, harmony and tempo. The quality of images was assessed indirectly based on noticing or omitting the difference.

The harmonic version consisted in the change of the major type of key in the second part of the piece to the minor key, while this change occurred along with other certain modifications of connections of chords, thus shifting the entire accompaniment lower. The children were asked whether they had heard the exposed piece of music before. If it was certain they had identified the piece, they were further asked whether the piece had been the same or played differently and also invited to determine where the difference had occurred.

The research by Poledňák focused on a single age category, children from 8 to 9 years old (3rd class). However, in order to be able to assess the research under some system of relationships, we are going to present the results of all four versions. The respondents were divided into four groups based on the quality of their answers. Category I included children who answered correctly; category II included those who caught the difference but were not able to specify it precisely; category III included respondents who notice the relationship between both versions but considered them to be identical, and category IV included pupils who did not notice the relationships of the version to the experimental piece of music. The results are summarized in the following two tables. The first table provides the results for the experimental class and the second one for the control class.

Table 41 Image formation related to musical means of expression - experimental group (From Poledňák, 1964)

Version	Group I	Group II	Group III	Group IV
Rhythmical	36	40	24	-
Melodic	8	48	16	28
Harmonic	44	40	4	12
Tempo	56	24	16	4

Table 42 Image formation related to musical means of expression - control group (From Poledňák, 1964)

Version	Group I	Group II	Group III	Group IV
Rhythmical	16	36	44	4
Melodic	4	60	12	24
Harmonic	36	24	4	28
Tempo	32	32	12	24

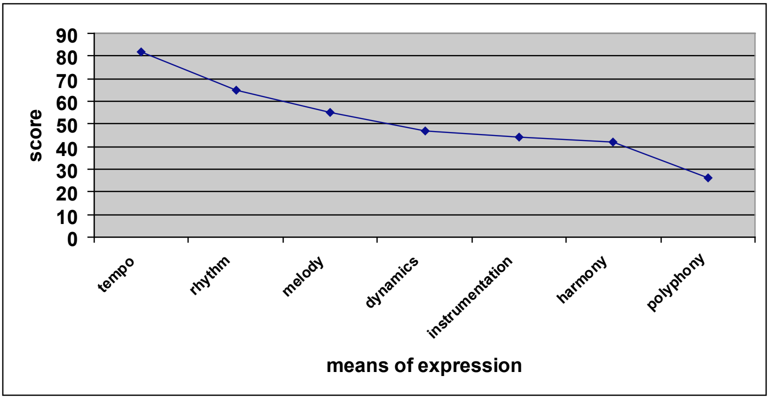
Both tables clearly demonstrate that 8 to 9 year old children show relatively the best percentage results in the harmonic version as the overall timbre change, including the shift in the harmonic accompaniment, which was the easiest to be identified.

In the diagnostic situations discussed so far the respondents did not have to be familiar with any special musical terminology. At this point we are going to make an exception in this respect and mention the large-scale survey carried out by J. Skopal in the 1980s under the research "listening to music". Skopal exposed the children to a five-measure single-voice extract from folk music and later he played the same extract in a three- to four-voice harmonic arrangement (melody line stayed in soprano). Children were given a questionnaire containing the names of musical means of expression (melody, harmony, polyphony, instrumentation, rhythm, tempo, dynamics) and based on the nature of the extract they were supposed to identify the means of expression that had changed. The average number of correct answers showed that the task was successfully completed by 42% of respondents of older school age. Skopal also notes that the success rate was better in pupils of the seventh grade than pupils of the eighth grade. The survey results are summarized in the table below.[103]

Table 43 Identification of harmony in the context of musical means of expression (From Skopal, 1984)

Tempo	82
Rhythm	65
Melody	55
Dynamics	47
Instrumentation	44
Harmony	42
Polyphony	26

Figure 28 Identification of harmony in the context of musical means of expression (From Skopal, 1984)



Out of the presented reflections on the development of the ability to identify harmony as a musical means of expression, the researches of M. Pflederer-Zimmerman, in particular, confirmed the developmental continuity abilities between the fifth and thirteenth year of age. However, it may be expected that the development continues even later in life. Secondarily, the research by Poledňák also confirmed, as in the case of other music harmonic parameters linked to the involvement of cognitive mental functions, significant influence of the sophisticated intentional education in music on their development.

Notes

1 Viz. HARGREAVES, D. J. *The Developmental Psychology of Music.* 3. ed. Cambridge: Cambridge University Press, 1990, pp. 10–28, HOFFMAN, L., PARIS, S., HALL, E., SCHELL, R. *Developmental Psychology Today*. 5. ed. New York: McGraw-Hill, Inc., 1988, pp. 38–41; VASTA, R., HAITH, M. M., MILLER, S. A. *Child Psychology. The Modern Science.* New York: John Wiley and Sons, Inc., 1992, pp. 27-57; SPRINTHALL, N. A., SPRINTHALL, R. C. *Educational Psychology. A Developmental Approach.* 5. ed. New York: McGraw-Hill, Inc., 1990, pp. 95–134.

2 Cf. LEHMANN, A. C. (ed.) Musical Cognition and Development. In COLWELL, R. RICHARDSON, C. (eds.) *The New Handbook of Research on Music Teaching and Learning*. Oxford-New York: Oxford University Press, 2002, pp. 443–460.

3 PIAGET, J. *Psychologie inteligence*. Prague: Stát. pedag. nakl. 1970; PIAGET, J. *Epistemology and Psychology of Functions*. Dordrecht-Boston, D. Reidel Publishing Company, 1977; PIAGET, J., INHELDER, B. *Psychologie dítěte. [Psychology of the Childe]*. Prague: State Educational Publishers 1970.

4 Viz. GARDNER, H. Developmental Psychology after Piaget: An Approach in Terms of Symbolization. *Human Development*, 1979, 22, p. 76.

5 Viz. HARGREAVES, D. J. *The Developmental Psychology of Music*. 3. ed. Cambridge: Cambridge University Press, 1990, p. 52.

6 Viz. BROADBENT, D. E. The Role of Auditory Localizationin Attention and Memory Span, *Journal of Experimental Psychology,* 1954, pp. 191–196.

7 Viz. SIEGLER, R. S. Information Processing Approaches to Development. In *Handbook of Child Psychology.* 4. ed. New York: Wiley, 1983, pp.129–211.

8 DAVIDSON, L – SCRIPP, L. Surveying the Coordinates of Cognitive Skills in Music. In COLWELL, R. J. (ed.) Handbook of Research on Music Teaching and Learning: A Project of the Music Educators National Conference, New York: Schirmer Books, 1992, pp. 392–413.

9 DAVIDSON, L. Songsinging by Young and Old:A Developmental Approach to Music. In AIELLO, R. Musical Perceptions. New York: Oxford University Press, 1994, pp. 99–130. STADLER, ELMER, S. Kinder singen Lieder: Über den Prozess der Kultivierung des vokalen Ausdrucks. Münster: Waxmann, 2002.

10 VYGOTSKY, L. S. *Psychologie umění. [The Psychology of Art]* Prague: Odeon, 1981, p. 113.

11 ZAPOROZETS, A. V.: Někotoryje psichologičeskije voprosy senzornogo vospitanija v rannom i doškol´nom vozraste. – In: *Senzornoje vospitanie doškol´nikov*. Moskva: Izd. APN RSFR, 1963.

12 NAZAIKINSKY, J. V. *O psychológii hudobného vnímania. [On the Perception of Music]* Bratislava: Opus 1980, p. 73.

13 Cf. STRAUSS, A. (ed.) *The Social Psychology of George Herbert Mead.* Chicago: University of Chicago Press, 1956.

[14] Cf. TORFF, B. Contextualization of Psychological Theory and Research. In COLWELL, R. (ed.) *MENC Handbook of Musical Cognition and Development.* Oxford: Oxford University Press, 2006, pp. 168–171.

[15] More see TORFF, B. A Comparative Review of Human Ability Theory. In COLWELL, R. (ed.) *MENC Handbook of Musical Cognition and Development.* Oxford: Oxford University Press, 2006, pp.165–188.

[16] Viz. HERSKOWITS, M. J. *Man and His Work. The Science of Cultural Antropology*. New York: Knopf, 1948, p. 542 et seq.

[17] HARGREAVES, D. J. *The Developmental Psychology of Music*. 7th ed. Cambridge: Cambridge University Press, 2001, p. 83.

[18] FRANCES, R. *La Perception de la Musique. [The Perception of Music]* 2nd ed. Paris: Librairie Philosophique J. Vrin, 1984, p. 9.

[19] HARGREAVES, D. J., op. cit., p. 91.

[20] Compare the debate focused to this topic within the Czech music education at 80´s of last century which resulted in designations funktional and intentional music education.

[21] SCHOEN, M. *The Psychology of Music.* New York: Roland Press, 1940, p. 230.

[22] RUPP, H. Über die Prüfung musikalischer Fähigkeiten. [On the Assessment of Musical Abilities.] *Zeitschrift für angewandte Psychologie*, 9, 1915, pp. 1–76.

[23] TEPLOV, B. M. *Psychologie hudebních schopností. [The Psychology of Musical Abilities.]* 2nd ed. Prague: Supraphon, 1968, p. 135.

[24] JUSTUS, T., HUTSLER, J. J Fundamental Issues in the Evolutionary Psychology of Music: Assessing Innateness and Domain Specificity. *Music Perception*, 2005, 23, p. 11.

[25] HÖCHEL, L. Einige Bemerkungen zur harmonischen Hörfähigkeit des Kindes. [Some remarks on harmonic hearing of the child.] *Musik in der Schule*, 1963, 14, 3, p. 109 and 116–118.

[26] MICHEL, P. Die Bedeutung der ersten Lebensjahre fur die musikalische Entwicklung. [The Importance of the Early Years of Musical Development.] In Proceedings of the 60 Birthday of J. Plavec. Prague: State Educational Publishers, 1965, p. 19.

[27] SEDLÁK, F. *Základy hudební psychologie. [*Basics of Music Psychology*]* Prague: State Educational Publishers, 1990, p.109.

[28] KRATOCHVIL, F. *Základy hudební výchovy. Část I. Hudebnost. [*Basics of Music Teaching*Part I. Musicality.]* Prague: State Educational Publishers, 1964, pp. 56–70.

[29] Cf. VIŠŇOVSKÁ, E. Harmonický sluch a metody jeho rozvíjania v ZDŠ. *[H*earing of Harmony and *M*ethods of *its D*eveloping in the *Basic School]* In *Proceedins of the Faculty of Education Bratislava located in Trnava*. Bratislava: Slovak Educational Publishers 1971, pp. 18–47.

[30] SLOBODA, J. *The Musical Mind. The Cognitive Psychology of Music*. Oxford: Clarendon Press, 1985, p. 210.

[31] Cf. MOOG, H. *The Musical Experience of the Pre-school Child*. London: Schott and Comp., Ltd., 1976.

[32] Cf. SLOBODA, J. *op.cit*., pp. 210–211.

[33] *Ibid*., p. 212, test number 4.
[34] PŘÍHODA, V. *Ontogeneze lidské psychiky I [*Ontogenesis of the Human Psyche.*]* Prague: State Educational Publishers, 1977, pp. 377–378.
[35] LÝSEK, F. *Hudebnost a zpěvnost ve světle výzkumů. [*Musicality and *Singing* in the Light of *R*esearch] Prague: State Educational Publishers, 1956, p. 27.
[36] *Ibid*., p. 96.
[37] CMÍRAL, A. K vývoji hudebního smyslu u dítěte. [The musical development in children] *Hudba a škola,* 1931–32, 4, p. 97.
[38] SHUTER-DYSON, R., GABRIEL, C. *The Psychology of Musical Ability.* 2. ed. London: Methuen 1981, p. 159.
[39] HOLAS, M. *Psychologické základy hudební pedagogiky*. *[*Psychological Foundations of Musical Education *]* Prague: State Educational Publishers, 1988, p. 29.
[40] HURON, D. Harmony: A Psychoacustical Approach by Richard Parncutt. *Psychology of Music,* 1991, 19, 2, p. 221.
[41] Cf. HRADECKÝ, E. *Úvod do studia tonální harmonie.[*Introduction to the Study of Tonal Harmony.] 2nd ed. Prague: Supraphon, 1972, where in the systematic part the author describes the principal harmonic relationships in extraordinary detail while emphasizing the psychological aspects accompanying this issue.
[42] MOOG, H. Das Musikerleben des vorschulplichtigen Kindes. [The Musical Life of Pre-School Children] *Bausteine fur Musikerziehung und Musikpflege,* Bd. 17. Mainz: 1968.
[43] FRANKLIN, E. *Tonality as a Basis for the Study of Musical Talent*. Göteborg: Gumperts Förlag, 1956, p. 59.
[44] RUPP, H. *op. cit*., pp. 1–76.
[45] Cf. LUSKA, J. Tónově výškový sluch žáků základní školy s rozšířeným vyučováním hudební výchovy. [Hearing of Pitch in Children of Basic School with Music SpecialisationN *Theory and Research in Music Education*, Prague: Czech Music Society, 1992, 2, 1, pp. 13–27.
[46] SEDLÁK, F. *Hudební vývoj dítěte*. *[Musical Development of the Child.]* Prague: Supraphon, 1974, p. 89.
[47] IMBERTY, M. *L ´acquisition des structures tonales chez l ´efant.* Paris, Klinksieck 1969. Print in Sloboda, J. *The Musical Mind. The Cognitive Psychology of Music.* Oxford: Clarendon Press, 1985, p. 211.
[48] Cf. SLOBODA, J. *ibid*., pp. 211–212.
[49] BENTLEY, A. Musical Ability in Children and Its Measurement. London: Harrap, 1966, p. 120.
[50] *Ibid*., p. 120.
[51] Viz. THACKRAY, R. Tests of Harmonic Perception, *Psychology of Music*, 1973, 1, 1, pp. 49–57.
[52] ABEL-STRUTH, S., GROEBEN, U., op. cit., Teil A, Teil B.
[53] In these relations we can also approach the results of one of another ten Frankfurt research studies, which analysed the degree of popularity of twelve pieces of classical music and higher popular music. Both groups preferred the contrast music extracts – fanfare signals and marching themes. Cf. cit. d. p. 14 et

seq. or Abel-Struth, S. Experiment on Music Recognition. *Psychology of Music*, Special Issue Proceedings of the Ninth International Seminar on Research in Music Education, 1982, p. 7–10.

54 PETZOLD, R. Auditory Perception of Musical Sounds by Children in the First Six Grades. *Cooperative Research Project 1051*, University of Visconsin. Printed in SHUTER, R. *The Psychology of Musical Ability.* London: Methuen, 1968, p. 82.

55 We pondered whether it was not a good idea to classify the first task as the harmonic homophony and polyphony. In the end, we reached an opinion that when an experienced person is asked to determine the number of voices, without any other specification, such as the direction of their movement, etc., it concerns the ear for chords. Of course, that in the third example, with the song adapted as a two-voice and voices are in countermovement and a side movement, and in the fourth example, with a three-voice adaptation and side movement of voices, the analytical method of perception should be activated.

56 Here, the results could have been affected by some atypical research group, which is not anything rare when it comes to research organized in schools. We had the same experience in some of our research projects as well as references regarding research implemented, for example, when applying Wing's test of musical abilities at the Faculty of Education in Banská Bystrica, Slovakia. It most probably concerns the inadvertent disturbing intervention of some mental factors, such as attention that could have been affected by low motivation or children or their increased tiredness. The cause could also lie in not establishing a sufficient working atmosphere in the classroom before testing, inadequate time of the day, poor comprehensibility of the instruction resulting from poor acoustics of the classroom, etc.

57 LÝSEK, F. *op. cit,,* p. 26.

58 The "music" students are students who are members of school music ensembles.

59 Print in SHUTER-DYSON, R., GABRIEL, C. *op. cit*., pp. 145–146.

60 LÝSEK, F. *op. cit*., p. 27.

61 FRANCÉS, R. *op. cit*., pp. 226–246.

62 See WHISTLER, H. S., THORPE, L. P. *Musical Aptitude Test*. Los Angeles: California Test Bureau, 1950.

63 After The Sixth Mental Measurement Yearbook, Highland Park, New York, Gryphon Press, o níž referuje SHUTER, R. *The Psychology of Musical Ability.* London: Methuen, 1968, p. 37.

64 COSTA-GIOMI, E. Recognition of Chord Changes by 4- and 5- Year-Old American and Argentine Children, *Journal of Research in Music Education,* 1994, 42, 1, pp. 68–85.

65 See PECHMAN, T. Memory for Chords: The Retention of Pitch and Mode. *Music Perception*, 1998, 16, 1, pp. 43–54.

66 From SHUTER-DYSON, R., GABRIEL, C. *op. cit*., p. 15.

67 LÝSEK, F. *op. cit.* p. 27 or Lýsek, F. *Úvod do hudební výchovy. [*Introduction to Music Teaching] Prague: State Educational Publishers, 1955, pp. 84–85.

68 It was also difficult to word out the instructions in a manner to be adequately understood. Perhaps the tonal feeling in inter-tonal relationships, on one side,

is well naturally absorbed that it is difficult to explain it verbally and keep it in memory for the period of time necessary to achieve the feeling of a new tonic, under the simultaneous maintaining of the original tonic.

69 LÝSEK, F. *Úvod do hudební výchovy. [*Introduction to Music Teaching] Prague: State Educational Publishers, 1955, p. 85 and p. 45.

70 Viz. VALENTINE, C. W.: The AestheticAppreciation of Musical Intervals among School-Children and Adults, *British Journal of Psychology.* 1913, 6, or The Method of Comparison in Experiments with Musical Intervals and the Effect of Practice on the Appreciation of Discords, *British Journal of Psychology*. 1915, 7. Overall, more recently in *The Experimental Psychology of Beauty*. London: Methuen, 1962, chpt. Musical Intervals and Attitudes to Music, pp.196–227.

71 *Ibid*., pp. 217–220.

72 ŠPELDA, A. *Hudební akustika. [*Acoustics of Music. *]* Prague: State Educational Publishers, 1978, pp. 252–253.

73 Cf. LÝSEK, F. *Hudebnost a zpěvnost ve světle výzkumů. [*Musicality and *Singing* in the Light of *R*esearch] Prague: State Educational Publishers., 1956, p. 26; Lýsek, F. *Úvod do hudební výchovy*. *[*Introduction to Music Teaching] Prague: State Educational Publishers, 1955, pp. 44–47.

74 Cf. CHVÁTILOVÁ, H. *Vývoj harmonického sluchu jako jedné z hudebních schopností.[D*evelopment of *H*earing *of Harmony* as one of the *M*usical Abilities] *(Thesis.)* Prague, 1979. Charles University.

75 It should be considered whether the expressions of nice and ugly provide a sufficiently fine distinction between sound timbres, especially in the area of dissonant chords. It seems that the probands of the older school years would have been able to also use more descriptive characteristics, such as the ones used by JANEČEK, K. when describing dissonant elements. A half-tone is, for example, obtrusively sharp, a full tone is pale and not obtrusive, tritone is pleasantly irritating but a chord with tritone sounds compact and blended. See more JANEČEK, K. *Základy moderní harmonie. [The Basis of Modern Harmony]* Prague: Czech Academy of the Science, pp. 50–52.

76 Ibid., pp. 46–51.

77 At this point it may be advisable to refer to Euler's or Sorge's classification of consonant and dissonant chords based on a bigger or smaller distance between the tone vibrations in a chord and assessing this relationship by the mathematical-speculative manner preferring the smallest numerical ratio. Both respected scholars active in the first half (Euler) or first two thirds (Sorge) of the 18th century considered the dominant seventh chord, with the ratio between its intervals of 4:5:6:7, to be one of the most basic chords. It is worth to point out this fact although the theory of harmony did not maintain this opinion as fundamental.

78 Cf. SLOBODA, J. *The Musical Mind. The Cognitive Psychology of Music.* Oxford: Clarendon Press, 1985, p. 211.

79 In SLOBODA'S report about the research, the order of tests is reversed.

80 From SHUTER-DYSON, R., Gabriel, C. *op. cit*., pp. 147–148.

81 THACKRAY, R. Tests of Harmonic Perception. *Psychology of Music*, 1973, 1, 1, pp. 54–57.

82 The role of Euler in the context of consonance and dissonance issue viz HRADECKÝ, E. *Úvod do studia tonální harmonie..[The Introduction to the Studies of Tonal Harmony]* 2nd ed. Prague : Supraphon, 1972, pp. 129–130.

83 Literature calls this research approach as a *looking – time preference procedure*.

84 Viz. THOMPSON, W. F., SCHELLENBERG, E. G. Listening to Music. In COLWELL, R. (Ed.) *MENC Handbook of Musical Cognition and Development*. Oxford; New York: Oxford University Press, 2006, p. 77.

85 TRAINOR, L. J. a HEINMILLER, B. M. The Development of Evaluative Responses to Music: Infants Prefer to Listen to Consonance over Disonance. *Infant Behavior and Development*. 1998, 21, pp. 77–88.

86 TRAINOR, LAUREL, J., TSANG, CHRISTINE, D., CHEUNG, VIVIAN H. W. Preference for Sensory Consonance in 2- and 4- Month- Old Infants. *Music Perception*. 2002, 20, pp. 187–194.

87 SCHELLENBERG, E. G., TRAINOR, L. J. Sensory Consonance and the Perceptual Similarity of Complex-Tone Harmonic Intervals: Tests of Adult and Infant listeners. *Journal of the Acoustical Society of America*. 1996, 100, pp. 3321–3328.

88 Viz. HARGREAVES, D. J. *The Developmental Psychology of Music*. 7. vyd. Cambridge: Cambridge University Press, 2001, p. 92.

89 RUPP, H. Über die Prüfung musikalischer Fähigkeiten. [On the Assessment of Musical Abilities], *Zeitschrift für angewandte Psychologie*. 1915, 9, pp. 1–76.

90 BELAIEW-EXEMPLARSKY, S. Das musikalische Empfinden im Vorschulalter. [The Musical Sensation of Pre-School Children] In *Zeitschrift fur angew. Psychologie*, 1926, 27, pp. 177–216.

91 MOOG, H. *The Musical Experience of the Pre-School Child*. London: Schott Music, 1976.

92 ANTOŠINA, M. Muzykal´no-teoretičeskije predmety kak otrasl muzikal´nogo vospitanija. In *Razvitije pianista*. Moskva: Muzgiz, 1935. From Teplov, B. M. *Psychologie hudebních schopností. [The Psychology of Musical Abolities]* Prague: Supraphon, 1968, p. 120 et seq.

93 TEPLOV, B. M. *op. cit*. p. 120 et seq.

94 In one of his individual researches, Teplov was inspired by Rupp's experiments. He even adopted his entire melody, including the stylization of harmonic accompaniment. In one of the dissonant versions, he only changed F major to E major. Rupp's methodology of experiments also influenced other Russian researchers, S. Beljajeva-Exempljarska and M. Antošinova. However, it is interesting that Teplov does not mention Rupp in his work, Psychology of Musical Abilities. Unfortunately, he even does not compare the obtained results, in spite of the similar methodology offereing such mutual comparison. Nevertheless, it is possible that his doctoral dissertation, which is the basis for the Psychology of Musical Abilities, Rupp was mentioned but maybe as a result of war events (book was completed in 1940 and published in 1947), this author was left out.

[95] Cf. CHVÁTILOVÁ, H. *Vývoj harmonického sluchu jako jedné z hudebních schopností.[Development of the Ear for Harmony as One of the Music Abilities]* (Diploma Thesis.) Charles University, Prague

[96] Cf. HARGREAVES, D. J. *The Developmental Psychology of Music*. 3rd ed. Cambridge: University Press, 1990, pp. 61–82 or SHUTER, R. *The Psychology of Musical Ability.* London: Methuen 1968, pp. 61–76; SHUTER-DYSON, R., GABRIEL, C. *The Psychology of Musical Ability*. 2nd ed. London: Methuen, 1981, pp. 103–128.

[97] SIMONS, G. M. Comparison of Incipent Music Responses among Very Young Twins and Singletons, *Journal of Research in Music Education*, 1964, 12, 2, pp. 212–226.

[98] PFLEDERER, M. The Responses of Children to Musical Tasks Embodying Piaget´s Principles of Conservation, *Journal of Research in Music Education*, 1964, 12, 2, pp. 251–268.

[99] This experiment demonstrated the influence of contrast between two stimuli which appeared in the experiments. Therefore, it is rather logical that two related means of expression (melody, harmony) appeared significantly different in the experiments that two different parameters (metre, timbre). Of course, there is another intervening aspect of generally valid development priority of the sense of rhythm, before the perception of melody (not in the sense of sensoric perception of tones).

[100] PFLEDERER, M. SECHREST, L. Conservation - type responses of children to music stimuli, *Council for Research in Music Education Bulletin*, 1968, 13, pp. 19–36.

[101] Compare the discussion on this topic, which contribute to Gardner (1973), Serafine (1980), Shuter-Dyson and Gabriel (1981). See for details HARGREAVES, D. J. *The Developmental Psychology of Music.* 3rd ed. Cambridge: University Press, 1990, p. 46.

[102] POLEDŇÁK, I.: Některé problémy rozvoje hudební představivosti se zvláštním zřetelem k poslechu hudby žáků mladšího školního věku. [Some Issues of Development of Musical Imagination with Special Reference to the Listening of Music in Children in First Stage of Basic Education] *Hudební věda*, 1964, 1, 4, pp. 541–561; 1965, 2, 1, pp. 3–18.

[103] SKOPAL found out that his results were distorted by an intervening factor of general familiarity (or rather unfamiliarity) of respondents with music terminology, including the term of harmony. Children mistook harmony for melody, instrumentation and dynamics. Therefore, the research did not study the degree of musical abilities but rather the degree of musical knowledge. This could have been one of the most significant causes for the finding of regressive development in correct answers in the pupils of seventh grade. See for details SKOPAL, J. K problematice vnímání a hodnocení hudby žáky 6.-9. ročníku základní devítileté školy. [The Issue of Perception and Assesment Music in Children in Second Stage of Basic. In *Sborník Pedagogické fakulty v Hradci Králové*.[Proceedings of Faculty of Education Hradec Králové] Prague: State Educational Publishers, 1978, p. 99 et seq.

4. Research on Harmonic Abilities Development

4.1 Problem, Objectives and Hypotheses

The previous chapters presented the ear for harmony not only as a system with a structure, but they also captured its development.

1. On one hand, the qualities linked to the existence of the natural principle of conventionality, represented by the tonally harmonic and tonally polyphonic feeling (1) were described.
2. The ability qualities affected by the cognitive mental functions were revealed ontogenetically differently in the harmonic abilities structure represented by the ability to recognize harmonic intervals and chords (2) and the ability to recognize harmonic homophony and harmonic polyphony (3).
3. In the third area we assume a more significant role of both the conventional and the cognitive factor. In the structure of the harmonic abilities it is primarily represented by the feeling of consonance and dissonance of chords and connections of chords (6).

The three suggested domains do not represent a comprehensive resume of the harmonic ability structure (the items 4, 5 and 7 were intentionally omitted), but they specify three directions we are going to follow in the empiric research. Its objective is to confirm or even better specify the developmental characteristics of the studied ability components obtained from the previous findings.

While for the first domain studied in research I we assume it is allocated, relatively definitely from the ontogenetic point of view, to early school years, for the second domain studied by research I and research II we assume the development to start in early school years and to finish in adolescence. In addition, we also presume the developmental curve to be better specified, in terms of its acceleration, especially between nine and ten years of age as it seems to be the most dynamic period in this respect. Although the third domain is already included in research I and research II, it is the centre of attention for research III. We assume the development curve to be evenly projected up to the late adolescence.

4.2 Methods

The data was collected through measurements with batery of tests of harmonic abilities, gradually developed as modifications of tests applied by A. Bentley, R. Thackray, and H. D. Wing. To describe the development, all three researches applied the cross-sectional method, allowing to include up to ten age categories simultaneously. The choice of the harmonyic ability components as well as of the type of tasks was subject to the objectives defined in the previous subchapter. The only independent variable concerns the age of respondents; the data collected by measurements are deemed as dependent variables.

The collected data was statistically processed by calculating the frequencies and basic statistical characteristics and depicting histograms for each age group. The differences between the age groups (years) were determined through the variance analysis and multiple comparison test by Tuckey, or alternatively through the Kruskal-Wallis analysis. The research was carried out at several urban primary and secondary schools in Central and Northern Moravia, pupils and students of which were to represent the current population of children and adolescents. The table below provides the list of schools involved into the research.

Table 43 List of schools involved into the research

Research	School
I.	ZŠ Terera, Olomouc
	ZŠ tř. Svornosti, Olomouc
	ZŠ tř. Heyrovského, Olomouc
	ZŠ ul. Videčská, Rožnov p.Radh.
II.	1. ZŠ Krnov
	2. ZŠ Krnov
	3. ZŠ Krnov
	4. ZŠ Krnov
	ZŠ ul. Dr Nedvěda, Olomouc
	SPgŠ Krnov
	ZŠ Rejskova ul., Prostějov
	ZŠ Melantrichova ul., Prostějov
	Gymnázium Prostějov

III.	ZŠ Terera, Olomouc ZŠ, tř. Svornosti, Olomouc ZŠ Videčská ul, Rožnov p.Radh. ZŠ tř. Heyrovského, Olomouc ZŠ tř.dr.Nedvěda, Olomouc 1. ZŠ Krnov 2. ZŠ Krnov 3. ZŠ Krnov 4. ZŠ Krnov SPgŠ Přerov SPgŠ Krnov

Legend:
ZŠ – basic school with the first and second stage of basic education
Gymnázium – general upper secondary school
SpgŠ – upper-secondary pedagogical school

4.3 Research I

The first research used a set of seven subtests. The description is given in the table below. In the column "harmonic ability component", with test A, the 1 means melodic tonal perception. The numbers after the strokes in the column "harmonic ability component" refer to the numbering of diagnostic tasks given in chapter 2. During statistical processing of data, the individual subtests were additionally identified with letters. For the sake of better understanding, we used both methods of identification in the following three tables, e.g. T1/A.

Table 44 Harmony ability components and diagnostic tasks in research I

Subtest	Harmonic abilities	Diagnostic tasks
T1/A	MF1	Assessing the tonal finality of melody
T2/B	HA1/2	Assessing the tonal finality of harmonic cadences
T3/C	HA3/5	Exposure of individual tone and chord. Determine whether the exposed tone is or is not included in the subsequent chord.
T4/D	HA3/3	Determine in which voice the repeatedly harmonically played chord changed.
T5/E	HA3/3	Determine in which voice the repeatedly played spread chord changed.
T6/F	HA6/2	Assess the consonance or dissonance of the harmonic accompaniment of melody.
T7/G	HA6/1	Assess static chords in terms of their consonance and degree of dissonance.

The tests mentioned above were successively applied to diagnose four groups of children aged 9, 11, 13 and 15 years. The T1, T2, T3, T5, T6, T7 subtests were used to test 677 children and the T4 test was used to test 504. The overview is given in the table below.

Table 45 Structure of the respondents' sample, research I

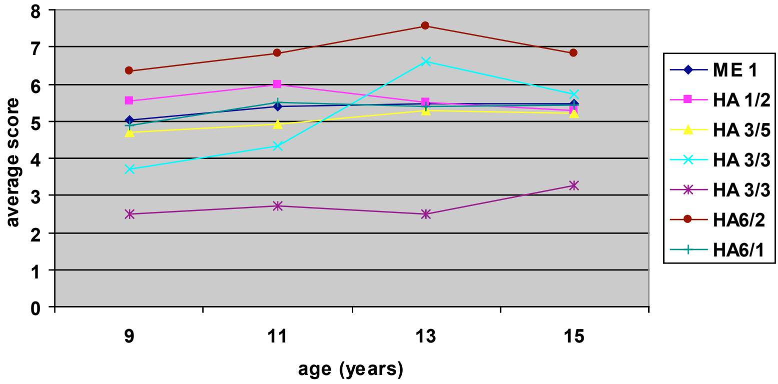
Test	Harmonic abilities	Number of respondents				
		9 years	11 years	13 years	15 years	total
T1/A	ME1	205	232	123	117	667
T2/B	HA1/2	205	232	123	117	667
T3/C	HA3/5	205	232	123	117	667
T4/D	HA3/3	130	134	123	117	504
T5/E	HA3/3	205	232	123	117	677
T6/F	HA6/2	205	232	123	117	677
T7/G	HA6/1	205	232	123	117	677

The following table shows average scores for the individual subtests and age groups, used to make the chart.

Table 46 Average scores, research I

Test	Harmonic abilities	Average score			
		9 years	11 years	13 years	15 years
T1/A	ME1	5,01	5,39	5,46	5,45
T2/B	HA1/2	5,53	5,97	5,50	5,28
T3/C	HA3/5	4,69	4,92	5,28	5,21
T4/D	HA3/3	3,69	4,32	6,59	5,74
T5/E	HA3/3	2,51	2,72	2,48	3,26
T6/F	HA6/2	6,36	6,84	7,55	6,84
T7/G	HA6/1	4,88	5,49	5,41	5,44

Figure 29 Average scores, research I



4.4 Research II

The following tests were applied in research II primarily focused on HA2 and HA3 components.

Table 47 Harmony ability components and diagnostic tasks in research II

Test	Harmonic abilities	Diagnostic task
T1/A	HA3/5	Exposure of a single tone and chord. Determined whether the exposed tone is or is not included in the subsequent chord.
T2/B	HA3/3	Determine the voice which changed in the repeatedly exposed chord (played harmonically).
T3/C	HA2/7	Identify a place in a harmonic movement where the chord, previously exposed separately, was played.
T4/D	HA2/6	Find one chord that was changed in the second exposure in a sequence of chords.
T5/E	HA2/1	Determine the number of tones in a chord.
T6/I	HA6/1	Assess static chords in terms of their consonance and degree of dissonance.

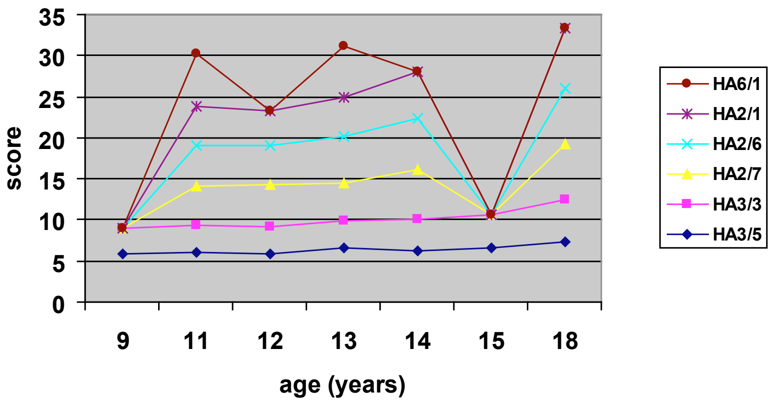
Table 48 Structure of the respondents' sample, research II

Test	Harmony ability	Number of respondents							
		9 years	11 years	12 years	13 years	14 years	15 years	18 years	Total
T1/A	HA3/5	204	366	109	222	105	115	212	1 333
T2/B	HA3/3	204	366	109	222	105	115	212	1 333
T3/C	HA2/7	-	116	109	94	105	-	212	636
T4/D	HA2/6	-	116	109	94	105	-	212	636
T5/E	HA2/1	-	116	109	94	105	-	212	636
T6/I	HA6/1	-	68	-	73	-	-	-	141

Table 49 Average scores, research II

Test	Harmonic abilities	Average score						
		9 years	11 years	12 years	13 years	14 years	15 years	18 years
T1/A	HA3/5	5,85	6,03	5,85	6,52	6,17	6,53	7,41
T2/B	HA3/3	3,14	3,36	3,33	3,39	3,85	4,03	5,1
T3/C	HA2/7	-	4,72	5,08	4,62	6,07	-	6,64
T4/D	HA2/6	-	4,9	4,8	5,62	6,26	-	6,9
T5/E	HA2/1	-	4,89	4,17	4,84	5,67	-	7,28
T6/I	HA6/1	-	6,35	-	6,12	-	-	-

Figure 30 Average scores, research II



4.5 Research III

The third research tested a single ear for harmony component, the feeling of consonance and dissonance (EH6).

Table 50 Harmony ability components and diagnostic tasks in research III

Test	Harmony ability	Diagnostic task
T1	HA6/1	Assess the static chords in terms of their consonance and degree of dissonance.

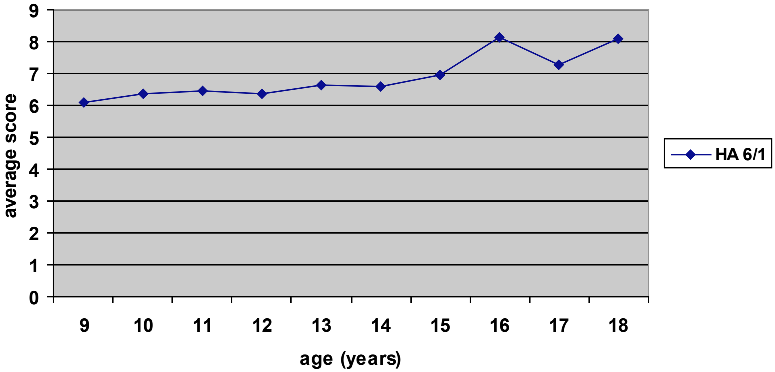
Table 51 Structure of the respondents' sample, research III

Test	T1
Harmonic ability	HA 6/1
Age	Number
9 years	205
10 years	42
11 years	295
12 years	68
13 years	212
14 years	86
15 years	147
16 years	34
17 years	51
18 years	89
Total	1,229

Table 52 Average scores, research III

Harmonic ability	HA 6/1
Age	Average score
9 years	6.1
10 years	6.37
11 years	6.46
12 years	6.35
13 years	6.65
14 years	6.6
15 years	6.95
16 years	8.15
17 years	7.27
18 years	8.09

Figure 31 Average scores, research III



4.6 Results and Discussion

1. In the light of the research I results, the first domain appears to be relatively similar to the conclusions of chapter 2.2, as well as in accordance with the established hypothesis. Significant differences were found between respondents aged 9 and 11, and 11 and 13, but not between 13 and 15 years of age. Therefore, it may be deduced that

the research outcomes by E. Franklin and J. Sloboda are, in principle, confirmed, only with a minor variance, i.e. in our research the plateau shifted by about one year higher. This variance could be accepted.

2. The second domain represented by the HA2 and HA3 components seemed rather unstable in research I, namely in the C, D and E subtests. Significant differences were found in the C subtest between the groups of 9 year olds and 13 year olds, even 15 year olds; in the D subtest between 9 year olds and 13 year olds (15 year olds). In research II extending the age span studied and monitoring the HA2 and HA3 components, the score increase was more systematic. In statistics, it was expressed with significantly different scores in the A subtest between the group of 18 year olds and all groups of younger respondents; in the B subtest between the group of 18 year olds and all groups of younger respondents and, additionally, between the group of 15 year olds and the group of 9 and 11 year olds. The C subtest appeared even more positively, since the significant difference was detected even between the 18 year olds and 14 year olds towards all younger groups. The distribution of the D subtest was the most positive. The numeric data and charts of all subtests show, and we may say it is not a regularly situated phenomenon on the development scale, temporary regression, which, however, does not interrupt the progressive trend in a score increase up to 18 years. Therefore, the thesis that cognitively saturated ear for harmony components (HA2 and HA3) develop over a rather long period of time, during the ontogenetic development, starting at the time of first year of mandatory school attendance and terminating at the end of secondary school attendance, with gradation in pubescence and adolescence.
3. The development of HA6 was monitored under the third domain. Compared to HA2 and HA3, the average score demonstrated a significantly more gradual increasing pattern, with a development plateau between 10 and 12 years of age and even a slight regression in the 12 year olds. A statistically significant difference was found only between the groups of the 15 and 17 year olds and the youngest category of 9 year olds, and also between the groups of the oldest respondents, i.e. 16 and 18 year olds, and all other younger groups. As demonstrated by the chart, there is an unexpected significant regression in the score of 17 year-old respondents, which may have been, for the most part, affected by rather unfavourable external conditions (extremely high temperatures under which the survey was carried out). Despite these

questionable findings we can obligatorily note that the development of the HA6 component is very different from the two previous groups; it is very gradual and actually statistically insignificant between the individual years during school years. Clear statistical differences appear only in comparison with older adolescent age groups.

Therefore, these findings in principle confirm our hypotheses about visible autonomy of the three domains defined above. However, the assumptions of indeed demonstrable development acceleration in the development of HA2 and HA3 between nine and ten years of age were not confirmed. The determination of age limits for the beginning, course and end of development of a certain music mental structure seems, in general, rather closely dependent on the applied diagnostic methodology and circumstances under which the tests are administered. Thus, we did not attempt to determine the typical, in terms of time strictly defined development standards of the ear for harmony components. We are sure that, having in mind the specificity of the individual music development as well as the circumstances affecting its diagnostics, we would be skating on thin ice of ill-founded speculation.

4.7 Conclusion

The conclusions presented below may be regarded as one of the contributions to objectivization of approach to the harmony ability and its development. The results of the first chapter, although divided into three parts, may be best approached as a complex, under which the ear for harmony was reflected in terms of apperception and structure. Each of these opinions brought its specifics, while the relatively new approach enabled to capture this complexity in ontogenetic development. What was suggested by the ear for harmony structure, here expanded to seven elements, and what was further developed in the approach respecting and integrating structurally ability, cognitive functional and music conventional aspects, it was applied as the starting point for the description of the ontogenetic development of the ear for harmony. Although the ear for harmony was studied relatively separately in his individual modification, the resulting ontogenetic model of the ear for harmony, based on our three surveys, formed around three axes:

1. naturally conventional;
2. cognitive, and
3. cognitively – socially conventional.

If we were to look for an answer to any of the basic ontogenetic questions in the conclusions, the papers profile clearly gives away that it would tackle the actual course of development and not relationships between external and internal determinants and their affecting roles in the development. In the development of the ear for harmony, three relatively independent lines related to the "axes" specified above may be pointed out. Apart from that, we did not register any supporting arguments to determine any critical period, considering we exclude extreme situations such as long-term children's deafness, mental and music deprivation, etc.. The main reason might be the fact that all aspects involved in establishing this ability are closely linked to cognitive and social aspects, which are relatively influenceable while the music development is capable of a relatively flexible response to their changes. In the research data of some of the studied ability component, cases of temporary regression occurred. Nevertheless, it is possible to note that the ontogenetic development of all studied parameters globally shows a progressive pattern, although mutually different.

To sum up, it is also possible to suggest directions of further analysis of this issue. One of the approaches, for example, could consist in the verification of the existing findings, not as much in the area of theory but in the empirical and research area. Additionally, it may be suggested to map out the relationship, or parallels in psychological and music historical dimensions of the ear for harmony, or harmonic perception. After all, both aspects share the mental correlate involved in the music phylogenesis and ontogenesis, despite in diametrically different thought and social dimensions in terms of time and quality. Our findings also indirectly defined the territory of intentional music education for the development of the respective components of the ear for harmony. It is thus possible to carry out an informed summary of known didactic approaches in relation to the ear for harmony components as well as music educational activities. This suggestion for future activities takes us back to the music educational reality, where the project focused on the ear for harmony emerged years ago.

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