Which Aural Skills are Necessary for Composing, Performing and Understanding Electroacoustic Music, and to what Extent are they Teachable by Traditional Aural Training?

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This paper reports a study that sought to discover the necessary aural skills for composing, performing, and understanding electroacoustic (EA) music and the extent of their teachability by traditional aural training according to an analysis of a mixed-method (qualitative/quantitative) questionnaire completed by a purposive sample of 15 experts in the field of electroacoustics. The participants evaluated a list of 50 potentially necessary aural skills, which were gathered from skills described in existing, but insufficiently applied, aural training systems and theoretical methods related to aural perception in EA, and provided additional skills they found necessary for EA. The survey revealed that the aural skills deemed the most necessary for EA by the participants were not regarded as sufficiently teachable by traditional aural training and the majority of the skills considered teachable by traditional aural training were not thought of as significantly necessary for the EA musician. Moreover, among the 50 skills listed in the questionnaire 56 per cent were deemed at least very necessary by the participants, with only 18 per cent of them viewed as sufficiently teachable by traditional aural training. The main implication of this study is a pressing need for further development, research, and experimental testing of aural training methods for EA.

1. INTRODUCTION

Like all musicians, the electroacoustic (EA) music composer/performer must be aurally skilled in order to produce and perform artistic work, yet dedicated courses in aural training for EA are very hard to find in college and university programmes. The term *Electroacoustics* refers to energy transduction between electric and acoustic elements (*The American Heritage Dictionary of the English Language* 2006). As a broad field of study, electroacoustics represents 'the use of electricity for the creation, processing, manipulation, storage, presentation, distribution, perception, analysis, understanding or cognition of sound' (Austin 1996) and is sometimes referred to as *Electroacoustic Studies* (*EaSt*) or simply EA. *EA music* is broadly defined in this study as all music or sonic art that is not limited to pitched content and metric rhythms, and which incorporates an electroacoustic component. It has been widely used to describe sonic art of a wide array of styles and mediums including *musique concrète*, *elektronische Musik*, tape music, computer music, glitch, soundscape composition, live electronic music, radiophonic art, and many others.

The stylistic breadth of EA music allows for a practically limitless range of sound types and transformations (limited only by the boundaries of the human hearing), and therefore the aural skills offered by traditional aural training – including solfege, dictation, and score reading of mostly tonal and rhythmically metric content – have an arguably limited relevance to the creation, performance and understanding of EA music. The EA artist usually designs his or her own sound material, deals with aspects of space, manipulates spoken or sung content, and shapes the overall sound of his or her works, and therefore needs additional listening skills similar to those of the instrument builder, the acoustician, the phonetician, and the sound producer, among others.

While some methods such as Schafer's *Ear Cleaning*, Oliveros's *Deep Listening*, Schaeffer's *Solfège* and Smalley's *Spectro-morphology* have some success in remedying the inadequacies of traditional aural training, they are not significantly used for aural training in EA programmes by and large, perhaps due to a limited educational applicability within the stylistic breadth of EA, or, primarily in the case of Schaeffer and Smalley's methods, because they are not pedagogically formed as ear training programmes (or exercise books), but as comprehensive description and typification systems to be used by composers.

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In reality, many EA educators introduce specialised aural skills within compositional or analytical contexts, but without the methodical and rigorous repetition necessary for acquiring new skills. Many EA programmes still offer mandatory traditional aural training, while in other programmes dedicated aural training courses are not mandatory for EA students. Additionally, there is very little research and literature about aural training for EA. Since 2005, the (undergraduate) EaSt major at Concordia University's Music Department in Montreal has spearheaded a new approach to aural training for EA, which uses Auditory Scene Analysis (ASA) theory (See Bregman 1990) as a theoretical foundation. In 2006 the new aural training method replaced the mandatory traditional aural training for EA students while growing from a year-long three-credit course to a two-year-long twelve-credit aural training programme. However, additional research is necessary in order to disperse this local success to the wider community of EA educators.

Using a mix of quantitative and qualitative methods, this pilot research addressed two questions of primary importance for EA aural training: (1) which aural skills are necessary for composing, performing, and understanding EA music and (2) to what extent are they teachable by traditional aural training? A more detailed description of the participants and instrumentation is available in the method section of this study.

2. LITERATURE REVIEW

This section reviews the aural skills suggested in a few existing methods and theories that deal with aural perception in EA and in an alternative aural training approach for instrumental music, developed at the University of Kentucky in the 1990s, which has strong relevance to EA.

2.1. Pierre Schaeffer's *solfège* and typomorphology

In his book *Traité des objets musicaux* (1966) Schaeffer describes a new type of listening he terms *écoute réduite* (reduced listening), in which sounds are perceived through their sonic traits alone without relation to their sources, consequences or semantics; he described the individual sounds, now separated from their physical sources, as *objets sonores* (sound objects), which he considered as the basic units for EA composition (similar to notes in instrumental music). Schaeffer devised a descriptive system to analyse and categorise (typify) the sound objects into a coherent system that would allow a *Solfège de l'objet sonore* (solfege of sound objects) (1967). His typology is based on morphological traits of sound through examining two criteria: (1) matter (what we would hear if we could freeze the sound) and (2) shape (the temporal evolution of this matter). He defined seven morphological perceptual criteria as subcategories. 'Matter' criteria included mass (pitch and spectral distribution), harmonic timbre, and grain (microstructural aspects of sound matter); 'shape' criteria included dynamics (the temporal evolution of energy), allure (modulation of amplitude or frequency), melodic profile (a variation of the whole mass), and mass profile (variation within the mass). Schaeffer's concept of *solfège* is the ability to hear sound objects and classify them through this typomorphological system. The primary aural skill that Schaeffer emphasises is the ability to hear, label and categorise sound objects' timbres, small-scale morphologies, and transformations.

2.2. Denis Smalley's *Spectro-morphology*

Similarly, Denis Smalley's *Spectro-morphology* provides a large terminological and conceptual basis for describing the sound's spectrum and morphology. It was created primarily to provide listeners of EA music 'a perceptual affinity with its materials and structure' and to reassert the 'primacy of aural experience in music' (Smalley 1986), by providing a number of scales – or continuums – descriptive of the sounds' spectrum, temporal shaping, motion, organisation into larger structures, and space in great specificity and detail. However, although spectromorphology emphasises the ability to hear, identify and label sonic phenomena, transformations and relationships on all structural levels, its strength is primarily as a comprehensive labelling system, not so much as a perceptual training method. In other words, Smalley's system is not an aural training method, though it could serve as a theoretical framework for devising one.

2.3. R. Murray Schafer's *Ear Cleaning*

R. Murray Schafer's *Ear Cleaning* (1967) is a practice geared at increasing sonic awareness, with specific attention to environmental sounds, and to some extent internal (body) sounds; it is taught through a series of exercises which include soundwalks – a walking meditation with high level of sonic awareness – and highly participatory classroom activities that address acoustic aspects of sound, noise and music. His book *Sound Education* suggests '100 exercises in listening and sound making' to 'help students to listen more effectively' (1992: 7). Schafer divides the exercises in the book into three types: (1) exercises concerning aural perception and imagination, (2) exercises related to 'the making of sounds', and (3) exercises that address 'sound in society' (1992: 12). The exercises include activities such as sound identification and categorisation, vocal imitation of environmental sounds, sound recording for the purpose of focusing the aural awareness and investigating specific sounds, searching for variations of the same sound, and many exercises that address space and acoustics, among others.

2.4. Pauline Oliveros's *Deep Listening*

Pauline Oliveros's *Deep Listening* practice is also geared at developing a heightened level of aural awareness of global (environmental) and focal (internal) sounds, and distinguishes between involuntary hearing and the voluntary act of listening. The practice, however, is far removed from being simply an aural training method. It has evolved into a lifestyle practice shared by many certified deep-listening instructors, artists and practitioners, in which one becomes re-sensitised to the sonic environment (external and internal) through daily creative activities such as composition of deep listening exercises, maintaining sound, movement, and dream journals, and others. Among other activities, the Deep Listening Institute arranges workshops and summer retreats in which the members of the deep listening community meet and collaborate (Deep Listening Institute 2008). Similarly to *Ear Cleaning*, Oliveros's method involves attention, active listening, recognition of acoustic phenomena, and the ability to segregate individual sounds among others. However, the practice of *Deep Listening* is concerned primarily with sound as a means for heightened environmental and body awareness, devoid of analytical thought processes.

2.5. Kate Covington's alternative approach to aural training

At the University of Kentucky, Kate Covington (1992) developed an alternative approach to aural training that has strong relevance to all types of music. She criticises traditional aural training's focus on pitch and rhythm, and complete disregard for other important aspects of the musical experience, including timbre, dynamics, register, articulation, expression, flow and intonation, among others. She also complains that aural training is not strongly related to real musical experience. She classifies three types of musicians that should be able to benefit directly from aural training: (1) music creators – composers, (2) music recreators – performers and conductors, and (3) listeners – scholars, critics and music fans. She makes three basic assumptions: (1) that aural acuity is necessary for musicians, (2) that it can be developed and refined, and (3) that a dedicated aural training course is necessary. Paraphrasing Michael Rogers (1984) she subdivides the process of aural training into three stages: (1) perception, (2) labelling and (3) comprehension of structural relationships – only the first two significantly covered by traditional aural training. Her analysis of musicians' aural needs emphasises the awareness of structure on small- and large-scale levels. This includes the ability to hear and identify rhythm, texture and density, vertical/horizontal organisation of pitches, timbres, dynamics and formal segmentation and to understand their interactivity with the overall structure. Her comprehensive sound-related approach to aural training is extremely relevant to EA music.

In an article Covington wrote with Charles H. Lord (1994) she builds upon these concepts while further emphasising the importance of teaching aural skills in context. She criticises the consensual 'objectivist' approach to aural training, in which skills – for instance, interval identification – are taught in isolation with the assumption that the student would be able to transfer them to real musical situations. This assumption has little practical support, according to Covington and Lord. As an alternative, they offer what they term a 'constructivist' approach to aural training, in which all skills are taught in context. Multiple aural skills may be taught in a single authentic musical situation, allowing the students to interrelate different aspects of the aural experience, form patterns and build upon existing knowledge, activities that are important features of Jerome Bruner's *Discovery Learning Theory* (1961) and Leslie Hart's *Brain-Compatible Learning* (1983).

3. METHOD

3.1. Participants

Since the subject of aural training for EA is quite new and scarcely researched, it was necessary to select a purposive sample of qualified participants with significant experience in the field of EA and in aural training. A purposive sample is usually made of a small group of hand-picked individuals who can provide valuable, in-depth information on a specific subject – often a relatively new one, such as the one at hand – and to discover emerging trends. The participants are selected with a specific purpose in mind, and the collected data is intended for discovering additional possible avenues of research, not for arriving at conclusions that are generalisable to the larger population (Orcher 2005: 48). For that matter, the selection criteria are generally more important than the sample size. Small purposive samples are often used in the social and health sciences – in qualitative, quantitative and mixed research methods – and may be extremely valuable as long as the collected data are used for analytical – not statistical – generalisations and for case-to-case transfers (generalisations made from one case to similar cases – not to entire populations) (Collins et al. 2007: 273).

In this study, 15 EA composers, teachers and researchers from USA, Canada, the UK and Australia were selected to form an expert sample according to the following criteria: (1) the particpants needed to have ten years or more of professional experience in EA, (2) they should have had five years or more of musical and/or EA education, (3) they needed to demonstrate a significant involvement in the field of EA (participants who are 'very involved' or who are involved in EA as their 'main field of work' according to the questionnaire), and (4) 50 per cent of the participants had to have previous experience in teaching aural training. The final sample decidedly fulfilled all the criteria, with 67 per cent of the participants (n = 10) having over 20 years of experience in the field, 80 per cent (n = 12) being involved in EA as their main professional field, and 53 per cent (n = 8) having taught aural training courses. Additionally, all the participants had experience in EA composition, with 93 per cent (n = 14) considering it one of their main activities in the field; 80 per cent (n = 12) of the participants considered teaching EA as a main activity. Other significant activities indicated in the questionnaire included research (67 per cent), performance (53 per cent), and others (20 per cent) including administration, programming, production and development.

3.2. Instrument

The instrument was designed to collect both quantitative and qualitative data. It comprised three main sections: (1) demographics, (2) the aural skills necessary for EA and their teachability by traditional aural training, and (3) questions about the questionnaire. The demographics section primarily addressed the participants' qualifications and types of involvement in the field of EA. Its data was used for comparative analysis of the main results and to validate the participants' eligibility for the purposive sample.

The second, main part of the questionnaire included a list of 50 potentially necessary aural skills (see Appendix). For each individual skill, the participants indicated (1) the extent to which it is necessary for EA (from now on the *necessity variable*) on a five-degree (Likert-type) scale from 'not necessary' to 'absolutely necessary', and (2) the extent to which traditional aural training is capable of teaching this skill (from now on the *teachability variable*) on a five-degree scale from 'not capable' to 'perfectly capable'. The list of suggested aural skills was compiled from existing methods (EA, traditional and alternative) presented in the literature review as well as others suggested by a large number of EA practitioners in a recent collective brainstorming on the topic on ten EA-related mailing lists, including CEC-Conference, Sonic Arts Network, ACMA-L, Phonography and Sound List among others. An additional 'no opinion' choice was added to both scales in order to avoid a random selection when a participant was indecisive. The section concluded with open-ended questions in which the participants could elaborate more freely on (1) additional necessary aural skills and (2) other existing aural training methods.

The last section of the questionnaire included additional open-ended questions about the questionnaire itself, its clarity, its effectiveness, and any problems in responding to it. This part was created to assess the instrument's validity and reliability, and its findings will be discussed in the discussion section of this report.

4. RESULTS

Acknowledging the size and purposive nature of the expert sample of this study, all statistical analyses of the quantitative part of the survey were used to describe the participants' views as a group – not to represent the entire population of EA educators. The implications of the survey's results are nonetheless significant to the global EA community due to the participants' expertises, their geographic diversity, the large number of questions, the level of consensus among the participants more experienced in aural training, and the correlation with existing writings.

4.1. Major findings

In relation to the main research questions, the results show a fairly probable inverse relationship between the means of the necessity variable and of the teachability variable ($r = -0.6$, $p = 0$). Put plainly, the participants generally believe that the most necessary aural skills for EA are not very teachable by traditional aural training and those that are very teachable are usually the most unnecessary for EA. This trend is shown effectively in figure 1, in which the skills are arranged by order of necessity. The most visible feature is the clustering of skills that are very teachable by traditional aural training at the lowest necessity area on the right-hand side of the chart.

Furthermore, analysis of the data shows that 46 per cent of the skills listed in the questionnaire (1) were considered at least very necessary by the participants ($m \geqslant 4$) and (2) scored lass than 'somewhat capable' ($m < 3$) in the teachability scale. 28 per cent of the listed skills were thought to be very teachable by traditional aural training ($m \geqslant 4$). These skills collectively scored less than 'fairly necessary' on average ($m = 2.84$). Tables 1 and 2 provide more detailed evidence for the general trend described above by listing the skills considered most and least necessary for EA. While most of the top-ten most necessary skills may be beneficial for all musicians,

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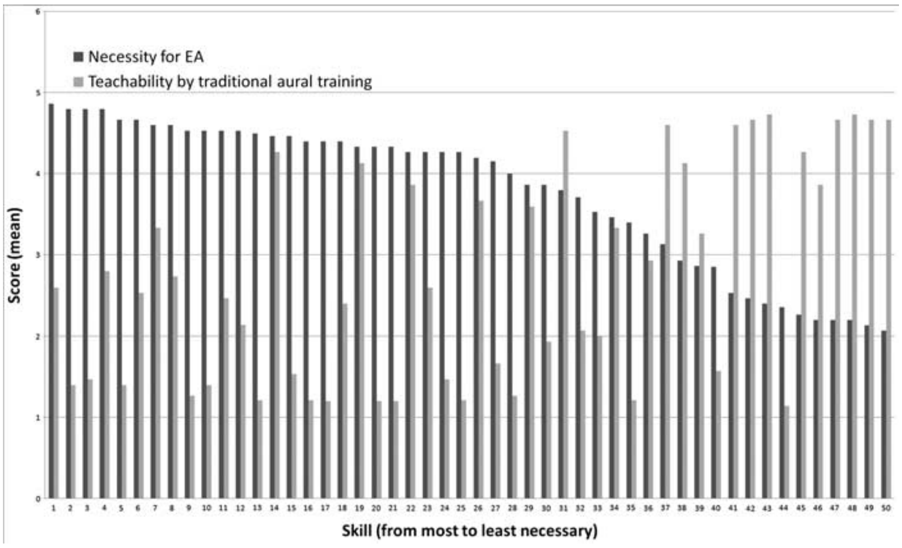

Figure 1. The necessity of the 50 listed aural skills and their teachability by traditional aural training.

Table 1. The ten skills considered most necessary for EA.

Skill		Score
1.	The ability to discriminate among levels of spectral complexity	$m = 4.86$
2.	Stream segregation: the ability to discriminate among simultaneous sounds	$m = 4.86$
3.	Recognition and description of amplitude envelopes	$m = 4.8$
4.	Identification of digital and analogue noise types	$m = 4.8$
5.	Discrimination among dynamic levels	$m = 4.67$
6.	Spatial definition	$m = 4.67$
7.	Sound typification	$m = 4.6$
8.	Strong auditory memory	$m = 4.6$
9.	Recognition of frequency ranges	$m = 4.53$
10.	Recognising contour and movement of simultaneous streams	$m = 4.53$

Table 2. The ten skills considered least necessary for EA.

Skill		Score
1.	Melodic dictation	$m = 2.06$
2.	Recognition of scale degree notes	$m = 2.13$
3.	Identification of ornaments	$m = 2.2$
4.	Sight singing in a polyphonic setting	$m = 2.2$
5.	Harmonic progression dictation	$m = 2.2$
6.	Identification of chord types	$m = 2.26$
7.	Knowledge of the International Phonetic Alphabet (IPA)	$m = 2.35$
8.	Sight singing melodies	$m = 2.4$
9.	Rhythmic dictation	$m = 2.46$
10.	Sight singing rhythms	$m = 2.53$

they are not typically addressed in traditional aural training. On the other hand, with the exception of no. 7, and to a lesser extent no. 3, the ten lowest-scoring skills are strongly related to traditional aural training.

Out of the 50 listed skills, twenty eight (56 per cent) were considered at least 'very necessary' ($m \geq 4$) by the participants; only five of them were considered more than somewhat teachable ($m > 3$) by traditional aural training (see Table 3). According to the participants, therefore, only 18 per cent of the very necessary aural skills for EA are significantly teachable by traditional aural training. Moreover, among these traditionally teachable skills, only auditory memory – the least teachable on the list ($m = 3.3$) – scored among the participants' 46 per cent most necessary skills.

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Table 3. The very necessary traditionally teachable skills.

Skill		Necessity	Teachability
1.	Strong auditory memory	$m = 4.6$	$m = 3.3$
2.	Identification of musical textures	$m = 4.5$	$m = 4.3$
3.	Recognition of musical form	$m = 4.3$	$m = 4.1$
4.	Recognizing gestural/motivic similarity and contrast	$m = 4.3$	$m = 3.9$
5.	Identifying musical instruments	$m = 4.2$	$m = 3.7$

Table 4. The five skills with the least variance in necessity-scoring.

Skill		*sd*
1.	The ability to discriminate among levels of spectral complexity	$\sigma = 0.35$
2.	Stream segregation: the ability to discriminate among simultaneous sounds	$\sigma = 0.41$
3.	Recognition and description of amplitude envelopes	$\sigma = 0.41$
4.	Discrimination among dynamic levels	$\sigma = 0.49$
5.	Spatial definition	$\sigma = 0.49$

4.2. Variance

Using standard deviation measurements, Tables 4–7 demonstrate the level of agreement among the participants regarding the necessity and teachability of specific skills. Overall, the participants agreed more strongly on which skills are most necessary than on those that are least necessary for EA. Therefore, the list of the most agreed-upon skills (Table 4) strongly resembles that of the most necessary skills (Table 1). Table 5 primarily reveals that the necessity of aural skills related to language and phonetics had the most variance, therefore was the least agreed upon.

Table 6 shows that regarding the teachability variable the participants most strongly agreed on the skills least teachable by traditional aural training, primarily those that require knowledge of acoustics, phonetics, and the ear's physiology, which traditional aural training is not equipped to provide. The least agreement in the teachability variable was on skills that are mostly related to instrumental music, such as articulation markings, register, and instrument recognition. There was also disagreement regarding the ability of traditional aural training to improve auditory memory and to teach the ability to segregate notes within a cluster (see Table 7). These disagreements may be the result of the participants' different concepts of traditional aural training due to their individual educational backgrounds.

4.3. Teaching experience in aural training

Among the 15 participants, eight had experience teaching aural training. At first glance, the data does not immediately demonstrate a major difference in the collective choices made by participants with experience in teaching aural training (group A) and those without it (group B). The necessity variable is quite directly correlated between the two groups ($r = 0.85$, $p = 0$) and the teachability variable even more so ($r = 0.97$, $p = 0$). The most significant difference between the two groups is the level of variance in the two main variables. Participants who taught aural training were generally more decisive as a group than those who did not; the average standard deviation for each skill was lower for group A in both variables. Perhaps more convincingly, group A included many more instances of consensus or near consensus ($\sigma < 0.5$) regarding individual skills on

Table 5. The five skills with the most variance in necessity-scoring.

Skill		*sd*
1.	Knowledge of the IPA	$\sigma = 1.39$
2.	Recognising stresses in verbal content	$\sigma = 1.33$
3.	Identifying articulation markings	$\sigma = 1.30$
4.	Intonation of verbal content	$\sigma = 1.25$
5.	Knowledge of the ear's physiology	$\sigma = 1.24$

Table 6. The five skills with the least variance in teachability by traditional aural training.

Skill		*sd*
1.	Knowledge of the IPA	$\sigma = 0.36$
2.	Recognising reflection colouration	$\sigma = 0.41$
3.	Recognising reverberation density	$\sigma = 0.41$
4.	Recognising reverberation time	$\sigma = 0.41$
5.	Knowledge of the ear's physiology	$\sigma = 0.41$

Table 7. The five skills with the most variance in teachability by traditional aural training.

Skill		*sd*
1.	Identification of articulation markings	$\sigma = 1.39$
2.	Recognising musical instruments	$\sigma = 1.35$
3.	Segregation of notes within a cluster	$\sigma = 1.35$
4.	Recognising register of different instruments	$\sigma = 1.24$
5.	Strong auditory memory	$\sigma = 1.23$

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Table 8. Skills with significantly different necessity variable between participants with (A) and without (B) teaching experience in aural training.

Skill		Group A	Group B
1.	Harmonic and melodic interval dictation	$m = 2.4$	$m = 3.8$
2.	Segregation of notes from a masking noise	$m = 4.63$	$m = 3.4$
3.	Recognising pitch contour in microtonal content	$m = 4.4$	$m = 3.3$
4.	Harmonic and melodic dictation	$m = 1.7$	$m = 2.7$
5.	Phonetic dictation	$m = 3.3$	$m = 2.3$

both variables than group B. In the necessity variable the participants of group A strongly agreed on twelve skills ($\sigma < 0.5$), on six of them with a perfect consensus ($\sigma = 0$), while group B only agreed on five skills with near consensus ($\sigma < 0.5$) and none with perfect consensus. In the teachability variable the difference between the groups is even more apparent: 24 skills (nearly half of the listed skills) were agreed upon with a standard deviation lower than 0.5 in group A, six of which had a perfect consensus, while in group B only three skills' teachability was agreed upon with near consensus, none with perfect consensus. These differences are likely to be due to a more solid grasp of the practical aspects of aural training by the participants of group A. However, a larger sample would be necessary to support this conclusion more persuasively.

Additional differences of some significance were observed between the two groups in the necessity variable means of a few individual skills (see Table 8). It appears that the participants of group B considered the skills involved in identifying intervals and harmonic and melodic sequences quite necessary for EA, while the participants of group A did not. On the other hand, the ability to segregate notes from a masking noise, the ability to recognise pitch contour of microtonal content, and phonetic dictation were considered more necessary by group A.

4.4. Analysis of responses to open questions

The second section of the questionnaire also included two open questions, which allowed the participants to elaborate further on the research questions. Using a grounded theory approach, as outlined by Glaser and Strauss (1967), the two questions reflect two core categories: (1) additional (necessary) aural skills and (2) additional aural training methods. After the participants submitted their online questionnaire, their responses to this part of the questionnaire were further discussed by email or phone when appropriate. All their statements were parsed and organised into concepts and categories, which allowed a descriptive and comparative analysis. The first core category is of the greatest relevance to the research questions, while the second is primarily important for designing further research.

4.5. Core category (1): additional aural skills

The participants were asked to offer additional necessary aural skills that were not among the listed 50 skills. Their responses belonged to two subcategories: (1) key abilities – fundamental skills that are used simultaneously with all other aural skills, and (2) further developments – skills and theoretical knowledge that are related to those on the list, but developed further.

4.5.1. Key abilities

The key abilities subcategory had the greatest response, with eight participants offering two key abilities: (1) flexibility of aural focus – the ability to switch the aural attention from microstructural elements to the macrostructure (five participants) and (2) aural attention (three participants).

- *Flexibility of aural focus*. Among the skills offered by participants, the ability to switch the level of aural attention among the different structural levels – partials, timbres, gestures, textures, structures – was the most recurring idea. Moreover, it was offered by participants with extensive experience in EA and in aural training: all five participants considered EA as their main professional field, four have more than 20 years of experience in EA, and four have teaching experience in aural training. Although the fifth participant had not taught an aural training course, he admitted to having taught aural skills as a significant part of his other teaching. Although the participants described this skill in different ways, such as 'listening through a soundscape from bottom-up or top down', 'texture/gesture discrimination', and the 'ability to move freely from integration to segregation of component aspects', further discussion revealed that they were referring to the same skill: the ability to aurally segregate the details of any sonic information and to integrate them into their larger structures – a type of aural-perceptual journey from a gestalt state to a focus on individual components and back to the gestalt (with a greater understanding of the aural information).

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- *Aural attention*. Three participants offered 'aural attention', 'focused listening' and 'aural awareness' as necessary skills. While aural attention is related to, and necessary for, flexibility of aural focus, these three participants were not as specific as the ones described above about how to use attention. Among the three participants only one had over 20 years of experience in the field, only one had teaching experience in aural training, and only one considered EA as his main field of work. While both groups touched upon related important abilities, the smaller group had less intimate knowledge of the practical issues of aural training, and therefore was more likely to generalise.

4.5.2. *Further developments*

Most of the additional skills offered by the participants were related to one or more of the listed skills with some further development or specifications. Eight participants suggested a variety of skills and knowledge related to aural skills, which addressed aspects of spectrum, space, time, transformations, language, acoustics and terminology.

- *Spectral detail and relationships*. Most notable were the comments related to recognition and description of spectral components and relationships, which were addressed by six participants. The suggested skills included the ability 'to hear and analyse sonic detail', to hear 'principal harmonic components within a complex sound', to recognise 'subtle spectral variations between different versions of a source sound', to identify 'sound sources', to evaluate 'implied, potentially available relationships among different sound objects', to recognise 'spectral similarity/difference', and to 'describe the materials'. In other words, the participants were interested in a higher aural discriminatory definition of the spectrum, the ability to discover timbral relationships, and the ability to describe spectral detail and relationships. These skills are strongly related to many of the skills listed in the questionnaire.

4.6. Core category (2): additional aural training methods

While knowledge of additional aural training methods does not directly contribute to the discussion of the main research questions, it has strong relevance for the possible directions of further research. Eleven participants commented on the subject. Seven participants suggested that methods should be developed by individual educators according to specific needs, and one participant explained that 'various exercises suggest themselves during work in classes'. Among these participants one offered to use visualisation techniques for aural training and another mentioned the newly developed method based on the fundamentals of ASA theory at Concordia University in Montreal. Among existing methods, Oliveros's *Deep Listening* and R. Murray Schafer's *Ear Cleaning* were offered by two participants. Three participants offered 'technical ear training courses designed for sound engineers' and one participant defended the importance of traditional aural training as 'part of the generic skills which a musician needs'. He noted that 'we need to filter out the most useful [skills]'.

5. DISCUSSION

This study sought to discover the necessary aural skills for composing, performing and understanding EA music and the extent of their teachability by traditional aural training according to the views of experts in the field of EA. The analysis of a mixed quantitative and qualitative questionnaire completed by 15 qualified experts revealed that the aural skills regarded as the most necessary for EA were not considered sufficiently teachable by traditional aural training and that the majority of the skills deemed teachable by traditional aural training were not considered significantly necessary for the EA musician. Among 50 skills listed in the questionnaire 56 per cent were thought to be at least very necessary by the participants, with only 18 per cent of these very necessary skills viewed as sufficiently teachable by traditional aural training. Standard deviation measurements revealed that the participants mostly agreed on which skills are the most necessary for EA and which are the least teachable by traditional aural training.

In an open-ended question, the participants were asked to provide additional aural skills necessary for EA. Two additional skills were most prominently addressed by several participants: (1) a flexibility of aural focus – the ability to aurally segregate the details of any sonic information and to integrate them into their larger structures – and (2) the ability to hear and describe spectral detail and relationships.

The conclusions regarding the inadequacy of traditional aural training for EA should come as no surprise since they have been repeatedly raised in the past, prominently by Pierre Schaeffer in the forward to his *solfège de l'objet sonore* (Schaeffer, Reibel and Ferreyra 1967). As previously reviewed, the effectiveness of traditional aural training has even been questioned in the context of tonal music by music educators such as Kate Covington and Charles Lord.

The conclusions regarding the aural skills deemed most necessary by the participants are also not surprising as many of them have been addressed in the existing methods presented in the literature review. For instance, the three skills considered most necessary – (1) discrimination among levels of spectral complexity, (2) stream segregation and (3) recognition and description of amplitude envelopes – and the ability to describe spectral detail and relationships (as additionally offered by the participants in response to an open question), strongly reflect Schaeffer's focus on *l'object sonore* (the sound object) and its shape, mass, timbre and motion in his *solfège* and typomorphological system. The same skills are also significantly related to Smalley's spectral typology, morphology and motion. Flexibility of aural focus is paralleled in Smalley's description of the 'structuring process' (Smalley 1986: 80). Skills related to space and acoustics also find parallels in Smalley's *Spectro-morphology* and perhaps more notably in Schafer's *Ear Cleaning*.

However, this study is the first of its kind (to my knowledge) in examining these issues in a structured manner through the views of a sample of experts in the field. No research has been previously dedicated to identifying and quantifying the necessity of specific aural skills for EA, and, consequently, no research has sought to measure the extent of such necessary skills' teachability by traditional aural training. At most, the inadequacy of traditional aural training to teach EA-related aural skills was argued philosophically or taken for granted. The findings of this study provide a list of 30 specific aural skills collectively agreed upon as at least 'very necessary' by the participants, which can be used as a preliminary guide in designing aural training for EA.

Several limitations of this study should be mentioned. While a purposive sample of 15 participants may be sufficient for a qualitative pilot study, a larger sample is necessary to establish the significance of this study's quantitative results, in particular those that are based on comparison and variance. The analysis of the results is therefore descriptive of the participants' views, not necessarily representative of the majority of EA educators. The participant selection was created by a purposive criteria filtering of an accessible population on the various EA-related mailing lists and discussion groups and therefore all participants are regularly exposed to similar issues and discussions, which could bias their responses. However, this population consists of the most actively involved EA musicians and is therefore greatly appropriate for the selection of qualified participants for a purposive sample. The final sample, nonetheless, is still limited to participants who were sufficiently interested in the issues of this study to participate. The somewhat lengthy questionnaire may have also contributed to this inevitable bias as it may have repelled potential participants. Additionally, two participants felt that the questionnaire was 'tied to traditional ways of thinking about the problem of ear-training' and that it reflected 'a standard model of instruction which might not be effective for some of the dimensions of this learning process' such as the 'experiential and sensual'. While both observations are legitimate, they warrant investigation and discussion that are outside the scope of this report.

However, the great majority of the participants believed that the questionnaire was very clear and effective, and that it will be 'enlightening as to how teachers in this field conceptualise areas of hearing and sonic comprehension and how they view approaches to skills'. Other strengths of this study include its primacy, its use of qualified experts, their geographical diversity, the fairly conclusive findings – especially considering the large number of questions, and their correlation with existing EA aural training approaches.

The implications of this study are quite straightforward: aural training for EA must be further researched, developed and tested. Traditional ear training is ill-equipped to provide the necessary skills for the EA musician, and therefore EA education will greatly benefit from aural training methods specialised for EA. The road ahead will undoubtedly be quite long and ever adjusting to the changing realities and needs of EA practice and study; nonetheless, several immediate research needs emerge. (1) New methods of aural training that address the necessities of the field should be developed and tested by EA educators worldwide. (2) Establishing perceptual and learning theoretical foundations for such newly developed methods (such as the ASA theoretical basis for the Concordia University EA aural training method) would improve their chances of pedagogical success and curricular acceptability by the institutions. (3) An experimental research to test newly developed methods would be an important next step in solidifying the educational need for new aural training methods, and in creating a literature base for further study of EA aural training. Potential experiments can be based on a pre- and post-treatment (treatment in this case being a semester-long or a year-long course) testing of specific EA-related aural skills, and identical testing of students in traditional aural training courses as control groups. The results of such experiments will allow a quantified evaluation of the pedagogical success in training specific aural skills through specific training methods.

Although the issues of aural training are very complex, important solutions are likely to be discovered by experimentation; therefore, EA educators must take courageous developmental and experimental initiatives concurrently with descriptive and philosophical studies of the subject, but without waiting for conclusive results from the latter.

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Appendix. The 50 potentially necessary aural skills of the questionnaire.

In order to avoid automatic response, the skills' order was shuffled in the questionnaire, not organised by type. The skills appear here in their original order.

	Skill (as it appeared in the questionnaire)
1.	Sight singing melodies
2.	Recognition of frequency ranges (spectral bands)
3.	Sight singing rhythms
4.	Segregation of aural streams (the ability to discriminate among simultaneous sound)
5.	Harmonic interval identification
6.	Knowledge of a specialised vocabulary to describe timbre
7.	Melodic interval identification
8.	Sound typification (the ability to categorise sound sources into timbral families)
9.	Chord-type identification
10.	Harmonicity level recognition (the ability to hear whether a sound is spectrally more complex than another)
11.	Recognition of scale degree notes in a tonal setting
12.	Discriminating among different dynamic levels
13.	Melodic dictation
14.	Recognition of minute dynamic variations
15.	Harmonic progression dictation
16.	Recognising and describing the amplitude envelope of a sound
17.	Rhythmic dictation
18.	Recognising the pitch contour of microtonal sounds
19.	Sight singing melodies in harmonic/polyphonic settings
20.	Recognising contour and movement of several simultaneous streams
21.	Recognising melodic contour
22.	A phonetic dictation (phonetic transcription of spoken/sung language)
23.	Recognising minute variations in the frequency-range of unpitched content
24.	Identifying articulation markings of individual notes
25.	Knowledge of the International Phonetic Alphabet (IPA)
26.	Identifying ornaments (trill, mordent, turn, appoggiatura, etc.)
27.	Identification of intonation of verbal content
28.	Knowledge of the ear's physiology
29.	Identifying stresses in verbal content
30.	Knowledge of ear health issues
31.	Recognising musical instruments
32.	Segregation of individual notes in a cluster
33.	Segregating notes from a masking noise (hearing through the noise)
34.	Recognising special instrumental effects (such as *tremolo*, *pizzicato*, *spiccato*, mutes, etc.)
35.	Recognising reverberation time (how long the reverberation lasts in a certain space)
36.	Recognising reverberation density (the density of the reflections)
37.	Hearing reflection colouring (the ability to spectrally compare the original sound with its reflections)
38.	Resonance (the ability to hear whether a certain space boosts certain frequencies)
39.	Strong auditory memory
40.	Spatial definition (an improved ability to hear where a sound comes from)
41.	Pre-delay (recognising the time between the original sound and the first reflections)
42.	Microtemporal discrimination (the ability to hear very small temporal differences in a sound's onset or duration)
43.	Macrotemporal discrimination (the ability to hear small variations in tempo)
44.	Identifying gestural or motivic similarity and variation
45.	Recognising register in different instruments
46.	Recognition of musical form (structure)
47.	Recognition of spatial coherence and spatial ambiguity
48.	Identifying noises (digital and analogue noises such as clipping, aliasing, quantisation error, hisses and hums, etc.)
49.	Recognition of musical textures (monophony, homophony, polyphony, etc.)
50.	Recognising phase relationships (interference)

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