

ESF Exploratory Workshop on
COGNITION OF EARLY POLYPHONY
Bringing together humanities and sciences

Graz (Austria), 12-14 April 2012

Convened by:
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SCIENTIFIC REPORT

1. Executive summary

The meeting was organised by the Centre for Systematic Musicology at the University of Grz, Austria. It was held in the main building of the University of Graz over two full days (Friday 13 to Saturday 14 April) with arrival, preliminary orientation, welcome ceremony and reception on Thursday 12 April and departure on Sunday 15 April. Including the ESF representative and the convenor, there were 19 active participants from 12 countries.

The main objective of the meeting was to deepen understanding of the “cognition of early polyphony” by bringing together leading researchers in relevant areas of humanities and sciences. The word “early” was understood to refer primarily to the 13th, 14th, 15th and 16th centuries, since Western polyphony emerged in about the 13th century, and major-minor tonality in about the 17th; note that many researchers understand “early music” to cover a much longer time span. The word “cognition” was interpreted in more diverse ways by participants. Presumably, all were referring in some way to information processing by human brains; but making and listening to music involves diverse forms of cognition. There was a tendency for humanities scholars to focus on cognitions associated with writing music (e.g. composing, transcribing), conceiving music (creating without written support), writing about music (e.g. theorising) and performing music (e.g. embodiment, fingering, auditory imagination), and for scientists to focus on cognitions associated with listening to music (e.g. perception of structure and consonance). These distinctions pointed toward a broad concept of cognition whose components interact with and inform each other. The workshop did not comprehensively cover all relevant aspects of cognition from a psychological viewpoint; major areas that were not represented by individual specialists include attention and memory.

The main focus of the program was on individual presentations. Participants were asked in advance to refer to the work of other participants during their presentation, crossing the humanities-sciences divide, and most did so. Cross-references were made possible by advance submission of draft presentations, which were available in the internet a few weeks before the workshop and in a printed booklet on arrival.

The program also featured three special sessions for the discussion of general issues. Special Session 1 “Identification of possible collaborators” aimed to help participants find co-authors for post-workshop submission to the Journal of Interdisciplinary Musicology (JIMS). At the time of the workshop, JIMS required that all submissions have at least two authors, the first two of which represent humanities and sciences in either order. Special Session 2 was entitled “Planning projects, grants, infrastructures”; Special Session 3, “Main conclusions, directions, implications”. The main content and conclusions of these sessions are discussed under point 3 below. Additional informal interaction happened during the opening reception, four 30-minute coffee breaks, two 2-hour lunch breaks, and two evening meals.

The general atmosphere was positive. Participants generally supported the workshop concept. Difficulties of communication between humanities and sciences were smaller than anticipated. At the start of the workshop, the convenor encouraged participants to address points of interdisciplinary conflict directly; when they later did so, discussions were constructive and there was a general feeling that representatives of both humanities and sciences had learned something from the exchange. This observation cannot be generalized

to all music researchers, because those colleagues who accepted our invitation to attend the workshop were presumably relatively open to and interested in interaction across the humanities-science divide (i.e. there was a process of self-selection). Evidence for this was the number of colleagues who did not accept an invitation in the last few months after some of the original participants dropped out; the number of rejected invitations was comparable to the number of participants.

Because the workshop covered such diverse topics, it is difficult to speak of a single main outcome. Indeed, the interdisciplinary discussion about epistemological differences suggested that the idea of a “main outcome” is biased toward sciences. Perhaps the most important outcome was simply that “cognition of early polyphony” is an interesting new area of research, in which a balance between humanities and sciences is possible and necessary. Further important outcomes of the workshop were as follows.

1. Interdisciplinary interaction

- a) Enhanced awareness of the general potential for humanities scholars and scientists to work together, even if they have previously worked in isolation. The workshop was a concrete demonstration that this approach is possible and fruitful.
- b) Identification of the kinds of question within the workshop theme “cognition of early polyphony” that can successfully be addressed by humanities scholars and scientists in collaboration.
- c) For scientists: both specific and general knowledge about the relevant current activities and approaches of humanities scholars; for humanities, vice-versa.
- d) Within the humanities, a fruitful interaction between ethnomusicology and historical musicology, including identification of parallel approaches to the role of social context and the function of music and music-making, which can be applied both to living music cultures of oral tradition and written testimonies of past music. Within the sciences, a fruitful interaction between psychology and computer science; an exchange of specific methods and findings.
- e) Improved awareness of differences in ways of thinking and use of language in different relevant disciplines - especially across the humanities-sciences divide. Strategies to clarify communication and avoid misunderstandings.
- f) Confirmation that problems of interdisciplinary communication are essentially the same in different countries, implying that lessons learned in one context may be applicable to other contexts. (There are also national differences, which were addressed separately.)
- g) Realistic assessment of the potential benefits of future interaction, including reduction of both exaggerated enthusiasm and exaggerated scepticism.
- h) The establishment of new contacts and potential collaborations that could lead to a lasting positive effect through regular interaction between humanities scholars and scientists in this area.

2. Academic content

- a) General insights into three key areas: Medieval and Renaissance musical culture and polyphonic texts; relevant psychological and neuroscientific findings and theories; and relevant mathematical and computational models and techniques.
- b) General insight into the overarching question of the difference between general human polyphonic capacities their encultured use. This discussion involved interdisciplinary interaction but at the same time maintained a separation of “nature” and “nurture”.

- c) Conclusions of individual presentations in part 2 below, and general conclusions listed in part 3.3.

There was general feeling agreement that bringing together humanities and sciences in a structured way has potential for generating new insight into cognition of early polyphony and, via that, to understanding the foundations of European culture. When contrasting research paradigms are brought together, they enable a more wholistic view of cultural artefacts, their historical context, and their appreciation in current cultural and scholarly practice. Effective interdisciplinary involves constructive personal interaction and the interchange of detailed knowledge, research concepts and research approaches. Existing structures to promote this kind of interaction in musicology may need renewal and more support, and new structures may be necessary.

This report was written by Richard Parncutt. I have attempted to do justice to the diverse contributions of all participants to discussions during the workshop and in email exchanges during preparation of this document. I have made every effort to avoid errors, but am fully responsible for any that may remain, given that final changes to this document have not been checked by workshop participants before publication. I thank Andreas Gaich for the recording and transcription of discussions during special sessions. Discussions following individual talks were also transcribed, and the transcriptions forwarded to the authors for their interest and for use while preparing journal submissions based on their talks; those transcriptions were not referred to while preparing this document.

2. Academic content

The meeting opened with a brief account of *Background, aims, methods and implications* by the convenor. The ESF representative gave a *Presentation of the European Science Foundation*, summarizing the goals of ESF exploratory workshops and opportunities for funding projects following from the workshop.

The program was drawn up according to two main principles. First, as far as possible, papers that addressed general or introductory issues were placed on the first day; papers addressing more specific issues were on the second day. Rationale: scientist participants were not necessarily familiar with materials that humanities scholars considered basic, and vice-versa. Second, we attempted to discourage one-sided discussions that were dominated by either humanities or sciences by alternating between humanities and science papers. This organisational principle contrasts with the usual approach of grouping similar papers into sessions.

Due to one cancelation and a request for a timetable change, some changes were made to the program. The final program is presented in section 4 below. The following summary is organised in the order in which papers were delivered. Each paragraph is conceived as a cross between an introduction and an abstract. It aims to explain the aim and approach of each speaker for colleagues outside of musicology. It also highlights the relationship to the topic of the workshop, and summarizes a few main points.

Frans Wiering spoke on *Modality and cognition in 15th century polyphony*. Modes are not only scalar patterns - they are also families of similar tunes, and familiar chants become modal prototypes. Historic modal classifications may reflect the psychology of recognizing a

melody or its character. But theoretic distinctions such as *authentic* versus *plagal* do not always translate clearly into musical practice. If early listeners heard more monophony than polyphony, polyphonic cognition might be an extrapolation of melodic cognition, suggesting a two-stage approach to computational research on structural cognition.

Tuomas Eerola considered *Probabilistic prediction of pitch-time expectations in Renaissance music*. One way to address cognition in early polyphony is to ask what listeners expect from moment to moment. In speech, we can predict the next word of an utterance based on the frequency of occurrence of strings of words of different lengths (n-grams) in speech to which a listener has previously been exposed. In music, the prediction is more complex because two dimensions interact: pitch and time.

Signe Rotter-Broman analysed *Contratenor parts in polyphonic songs from the late Trecento: Challenges for concepts of polyphony and improvisation*. Her concept of “cognition” was more closely related to processes of composition and improvisation, which were less distinct from each other than now. We can learn about such processes by comparing different notated polyphonic versions of the same song. Rotter-Broman applied this approach to the analysis of late Trecento polyphonic songs.

Barbara Tillmann spoke on *Learning and expectation of pitch structures: The role of cultural knowledge*. Listeners can acquire knowledge about pitch structures over short time periods (which can be studied in the laboratory as “miniature acculturation”) and long time periods (years of exposure to a given style). Tillmann distinguished between “sensory” processing involving short-term repetition and simple patterns, and “cognitive” processing involving the listener’s musical knowledge.

Pedro Memelsdorff regarded *Scribes as analysts: Codex Faenza and the transmission of instrumental polyphony in late Medieval Italy*. Scribes are often considered passive, notating a given musical tradition. In fact, they constantly interpreted (analyzed) the music they were writing and made interesting notational choices. That suggests that studies of transcription differences and errors, combined with detailed knowledge of cultural and historical context, can shed light on the cognition of early polyphony.

Richard Parncutt asked *Is the prevalence of pc-sets in scores a measure of consonance?* Computer databases allow interval combinations (pitch-class sets) to be counted. Major and minor triads (as later known) became the most common 3-pc sonorities in the 14th Century polyphony, and their dominance increased in the next two centuries - consistent with a psychological theory of consonance based on smoothness, harmonicity and familiarity.

Eleanor Selfridge-Field gave the first keynote, entitled *When is a dissonance a dissonance?* Issues of consonance and dissonance were central to the workshop and there were diverse opinions about how these terms should be defined - or whether they should be used at all. Selfridge-Field addressed two dichotomies: nature versus nurture (Is the origin of dissonance in the stimulus, physiology, or society?) and vertical versus horizontal (What is the relationship between simultaneous and successive forms of dissonance in different times and places?). On that basis, she addressed historical changes in concepts of dissonance in composers such as Machaut and Josquin.

Marcus Pearce moved *Towards an historically-informed audience*. An early listener can be computationally modelled by evaluating note-by-note expectations based on statistical analysis of computer databases. Expectations are relevant because of their aesthetic implications, as already recognized by Hanslick. Calculations based on sets of just 2 or 3 notes (2-grams, 3-grams) have high statistical power but low specificity; higher order n-grams have higher specificity but lower statistical power.

Frauke Jürgensen considered *Teaching keyboard improvisation in the Renaissance: Memory and the Fundamenta of Paumann and Buchner*. Improvisation is important for early music cognition because Renaissance listeners generally heard more improvised than notated music. Improvisations can be reconstructed (e.g. by computer models) by studying contemporary guides to improvisation. Like Rotter-Broman, Jürgensen referred to the book "Medieval Music and the Art of Memory" by Anna Maria Busse Berger, who unfortunately was unable to accept our invitation to give a keynote presentation.

Séverine Samson introduced *Cognitive and emotional brain processes in music*. Neuroscientific data suggest that the cognition of pitch structures cannot be separated from emotion. Memory and emotion (and hence dissonance) are processed in the hippocampus, the amygdala and other median structures of the temporal lobe – relevant for dissonance resolution in early music. Emotional responses can be derived from skin conductance and electromyography including zygomatic response from smiling muscles.

Rytis Ambrazevičius presented research on *Dissonance and tonality perception in Lithuanian traditional Schwebungsdiaphonie*. In Lithuanian *Sutartines*, singers deliberately create roughness (rapid beating = amplitude modulation) by singing intervals of about a major second. The music differs from Western music in several ways: the scale structure is different, rough sonorities are considered consonant (but according to a different concept of consonance), and principles of tension and resolution are applied differently. Like the presentation by Fūrniß, this presentation clarified distinctions between perceptual universals and cultural specifics that are necessary to understand the cognition of early polyphony.

Mary O'Neill spoke on *Perception of structure and multiple 'meanings' in thirteenth-century polyphony*. Perception of polyphony is inseparable from perception of singers and their bodies, and the music's cultural and religious connotations. Historic descriptions of Notre Dame polyphony reflect this corporality: the experience of independently moving voices was sometimes considered sexual and hence religiously inappropriate, and the new polyphonic complexity (or confusion) disguised the religious texts. Notation of musical time became more precise to ensure voice synchrony, which may have more generally affected time perception.

Tim Crawford considered *Lute tablatures as an embodiment of music cognition*. Tablatures are an important basis for reconstructing early music cognition because they indicate chromatic scale steps (whereas regular notation is diatonic). Moreover, performers following tablature use their bodies (or at least their hands) similarly to original performers. Tablature can help performers of early music try to get into the mind of the composer and period performers and listeners - an example of how embodiment can enable us to approach a more reliable or detailed understanding of historical cognition.

Michael Friebel analysed *The sixth rhythmic mode and its ordines in theory and practice*. Ordines are rhythmic modes or patterns in music of the 13th and 14th centuries. Rhythmic

modes are of interest for the cognition of early polyphony because they may reflect psychological processes of music recognition. Moreover, rhythm and pitch cannot be separated in perception or performance of early polyphony, because the rhythm of the individual parts determines which pitches are heard as simultaneities. Medieval rhythmic modes can be understood by applying the classification system of 13th-century theorist Anonymous 4 to the music of that time.

Tillman Weyde (with co-author Reiner de Valk) addressed the *Recognition of polyphonic structures from lute tablatures with machine learning*. A central issue in polyphonic cognition is the assignment of tones to voices (perceptual streams). If a computational system can perform this task and produce similar output to a human listener, the internal procedures of the system may be similar to human cognitive processes. This approach is based on machine learning with neural networks and Bayesian models, for both practical applications and exploring properties of the data, e.g. corpora from different periods or authors. The preprocessing for the learning systems aims to model perceptually and cognitively relevant features from the texts, also considering contextual information such as stylistic knowledge.

The presentation by Susanne Fürniss was entitled *Horizontal and vertical structure in contemporary Central African vocal counterpoint, and its oral transmission*. To understand the “emergence” of polyphony in Europe, we can also consider polyphony from other times and places. Aka polyphony and early Western vocal polyphony are both oral traditions (memory plays an important role) in a religious/spiritual context. Both tend to favour fourth, fifth and second intervals over thirds, based on a feeling for consonance in the general sense of sounding together. In both, singing promotes social cohesion. A general comparison that respects the cultural autonomy of the Aka might shed light on general human capacities for polyphonic performance and perception.

Jurij Snoj addressed *The conceptual and the empirical backgrounds of Zarlino's counterpoint theory*. Zarlino was an influential Renaissance music theorist. In the Pythagorean tradition, he regarded musical intervals as number ratios. Pythagorean ratios had prime factors 2 and 3; Zarlino considered ratios between numbers up to 6 (which from a modern viewpoint include prime factors 2, 3 and 5) to better account for third/sixth intervals (4:5, 5:6 etc.) and major/minor triads (considered as superpositions of intervals). This reflects a development in both musical thought and music-structural cognition. Snoj considered Zarlino's explanation of dissonance resolution and his aesthetic ideal of “nature”, which included mathematical physics (the “nature of sonorous number”), human hearing, and the world as perceived by humans.

In his keynote, which was transmitted by live video link from Ohio on two screens, David Huron addressed *Cultural conditioning of polyphonic perceptions*. In 2001, Huron published an influential article that related well-known rules of Renaissance polyphonic composition to more general principles of auditory scene analysis (ASA). Are such principles innate or learned? Huron presented examples consistent with the idea that they are mainly learned. Today, we can account for language acquisition by statistical learning models, which challenges Chomsky's concept of a “language acquisition device”. Recent progress in understanding the human genome has diminished expectations of finding language-specific genes; the same applies to “ASA genes” or “music genes”. Instead, we can predict the note-to-note expectations of Medieval and Renaissance listeners on the basis of statistical analyses of the musical styles that they presumably were familiar with.

3. Assessment of the results, contribution to the future direction of the field, outcome

Special session 1: Identification of possible collaborators

The aim of this session was to help workshop participants find collaborators to act as co-authors while they revised their presentations for publication in a special issue of the *Journal on Interdisciplinary Music Studies*. At the time of the workshop, the journal accepted submissions only if the first two authors were a humanities scholar and a scientist in either order. Following this session, authors were offered a choice between the existing guideline and single-authored papers with open review similar to *Current Anthropology* and *Behavior and Brain Sciences*, provided the guest editor/s is/are prepared to coordinate the procedure, and humanities contributions are primarily commented on by scientists and vice-versa.

There was considerable discussion about the definition of the terms “humanities” and “sciences” (including translations of these terms into other European languages) and the extent to which a given discipline or department belongs to one group or the other. Generally, differences in the meanings of disciplinary labels are due in part to different histories of epistemology in different research cultures. There was general agreement that “humanities” corresponds roughly to “Geisteswissenschaften” in German and “lettres et sciences humaines” in French (although in English and German the humanities are not normally divided into these two groups). Researchers interpret these terms differently, depending for example on where their research is situated on the humanities-sciences continuum. Many (but not all) researchers would agree with the following statement: Humanities and social sciences are similar in that they both address society and the human condition, but social sciences tend to be more positivist (“truth” is assumed to exist) and humanities tend to be more relativist (ideas and claims are considered relative to their social, historical, cultural, or political context). For clarity, the English term “sciences” should be confined to the natural, social and formal/structural sciences (the “formal/structural” idea is less common and brings together mathematics and computer science), but such a definition should not be misconstrued as a value judgment; the tacit assumption among some scientists that science (or at least “scientific method”) is somehow inherently superior to humanities is an important obstacle to constructive synergetic interdisciplinarity.

The word “science” has a different meaning in French and English. According to Wikipedia (consulted on 11 June 2012), French “science” means “un ensemble organisé de connaissances objectives, établies selon une démarche rationnelle, dans un domaine déterminé”. That is broader than English “science”, which may be defined as “a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe”. Both kinds of “science” can include “testable explanations”, but English “science” is more positivist. The English term “science” and the French term “science” are thus “faux amis”. French “science” includes “sciences humaines” (part of the humanities), but English “science” does not. Sociology, linguistics and economics are usually considered to be social sciences (sciences sociales, Sozialwissenschaften) but for some researchers they are also humanities (sciences humaines, Geisteswissenschaften); conversely, history, philosophy and anthropology are primarily humanities, but can also be social sciences.

The German term “Wissenschaft” has yet another meaning. Wissenschaft covers all academic research and teaching - including for example “lettres” in French and “Kulturwissenschaft” in German. Wissenschaft is broader than French “science”, which in turn broader than English “science”. The ESF often uses the English word “science” in the sense of “Wissenschaft”. It follows from our discussion that this usage is incorrect or at least misleading. The present document, for example, is not a “scientific report”; it might better be labeled “research report”, “summary of workshop findings”, or “workshop report”. A general correction of this error in the terminology and documentation of the ESF and other research infrastructures in continental Europe would promote interdisciplinary interactions among humanities scholars and scientists, and hence the goal of this workshop, by clarifying the independent and equal status of humanities scholars. It would avoid the disciplinary “othering” (or indirect discrimination) that can result from ambiguous or value-laden usage of the word “science”. When reformulating existing documents, it would be necessary to consider contextualized shades of meaning of English expressions such as academia, research, research and teaching, higher education, scholarship, and study – all of which can be translations of “Wissenschaft”.

It became clear from our discussions that different researchers, disciplines and nationalities have different concepts of these differences, which implies in turn that all claims made in the previous paragraphs must be considered as tentative. Differences of this kind can lead to misunderstandings that can hinder research progress, especially in an explicitly interdisciplinary setting. One possibility is to attempt to achieve general agreement on definitions, but given the inherent complexity of this project, at some point attention should be diverted back to specific research questions and practical issues of interaction in disciplinarily diverse research teams.

Since the workshop was about “cognition”, there was also some discussion of the meaning of this term. Cognitive science was originally a study of the mind with computational perspective. That is a scientific approach, but humanities scholars may focus more on understanding thinking and feeling from a hermeneutic perspective using scientific tools and results. At some universities, cognitive science is grouped with engineering, so it can be more or less easy for students and researchers to combine cognitive science with humanities. Similarly, the distinction between music theory and (historical) musicology in North America is different from the distinction between historical and systematic musicology in Europe. Within musicology, some researchers strive to separate subdisciplines while others strive for more overlap.

Some workshop participants were reluctant to classify participants and potential collaborators into two groups called “humanities scholars” and “scientists”, in part due to the uncertain meaning of the terms, and in part because they themselves belonged to both groups. An individual might be, say, 30% humanities and 70% sciences, but due to the uncertainty of the terms any such estimates must be very approximate. For future grant applications, it may be useful to write *as if* a clear division between humanities scholars and scientists is possible (at least in the title and abstract of the submission), because that immediately makes the epistemological diversity - and hence unusualness and research potential - of the application clear to reviewers and administrators. Later in the proposal, finer epistemological differentiation will be necessary.

Regarding the search for a suitable collaborator, rather than focusing on the humanities-science divide it may be more appropriate for first authors to look for collaborators with the most important relevant expertise that they do not have - regardless of disciplinary labels. That can be done in either a specific or general way. If one is looking for specific expertise on a specific question, the person in question may not exist and if s/he does exist the chances are not great that a deep collaboration can be created. If one is more interested in the big, general picture, just about any workshop participant could be a collaborator with just about any other participant, because any expert in a related field will generally have interesting and well-founded suggestions that one has not thought of (or through) oneself. It is also important to prevent the work from focusing too much on arbitrarily selected epistemologies at the expense of relevant or promising ideas from outside, whether or not they cross the humanities-sciences divide.

There was some discussion about the basic knowledge that humanities scholars need to collaborate with scientists and vice-versa. Each author should have deep specialist expertise in one discipline that is relevant for the project under consideration. It is also important to have at least some general knowledge of other relevant disciplines and to be open to surprising or challenging ideas from other disciplines. But today one person can hardly be recognized as an international expert in two contrasting disciplines.

How can we ensure non-superficial interdisciplinary interaction between humanities and sciences in future publications? How can we encourage transdisciplinarity in the sense that the participating disciplines are changed by the interaction? There were several suggestions:

1. Write a dialogue between two authors from contrasting epistemologies. The two authors need not agree on central issues. The strengths and weaknesses of given perspectives could be interpreted by the reader without the necessity for a clear conclusion in the paper itself.
2. Have each paper make several concrete connections to other papers in the workshop, focusing on connections that cross the humanities-sciences divide.
3. Randomise partnerships within the workshop. Partnerships that seem unlikely at the start may generate the most original ideas.
4. Following single-author contributions, invite commentaries from representatives of humanities and sciences with relevant expertise, then have the author reply to the commentaries. All commentaries and the reply would be published after the original paper. (This suggestion has now been adopted by the Journal of Interdisciplinary Music Studies and a new guideline has been prepared in which the submission is first reviewed in the usual way and then peer commentaries are invited.)
5. Peer commentary only for selected shorter target articles; only a few thousand words altogether.

Special Session 2: Future projects, grants and infrastructures

There was general agreement that a large European grant application in this area, submitted by an international consortium, should cover a broader area than “Cognition of Early Polyphony”. Several possible titles were suggested including social music perception, ancient accounts of the effects of music, cross-cultural study of music cognition, phylogenesis of music cognition, cultural knowledge and music cognition, emotion and the cognitive processing of polyphony, orality in different polyphonic traditions, emotion and music cognition, historic cognition. “Historic cognition” for example would place questions of

early music cognition in the context of more general questions of historic cognition; links between music and other areas of historic cognition would be created through approaches to the study of historical documents, approaches to computational models of aspects of cognition, linking computational and neuroscientific approaches, and founded speculation about differences between modern and historical cognition.

Since an application with such a large scope requires so much preparation and administration, it may also be interesting first to consider smaller, more specific projects with titles such as the role of emotion in cognitive processing of polyphony, analysis of polyphony as embodied art, issues of orality in polyphonic traditions, music transcription as a cognitive process, historical and cross-cultural study of consonance-dissonance concepts. There was general agreement that before attempting any grant application further meetings would be useful to identify specific areas of research and bring together more relevant existing expertise.

There were a number of suggestions on goals for smaller future projects.

1. The main aim might be to establish electronic databases of musical scores and use them for different purposes in research and performance. In our case, the database should include representative early music (symbolic notations and audio) from different times and locations, with extensive metadata; critical editions, information on historical context, evaluations by musicians; with links to relevant work in other areas of music information retrieval (e.g. the catalogue of Naxos recordings) and existing analyses.
2. Differences between early and more recent music (e.g. in statistical analysis of structures) could be used to systematically study effects of musical exposure on music cognition at different times and in different places. We might aim to build a model of an early listener that predicts different kinds of responses of early listeners to musical structures. At a more practical level, the aim could be to facilitate the sharing of tools (e.g. in computational score analysis) and corpora (e.g. edited historic scores) between humanities scholars and sciences and at the same time unify vocabularies for speaking about and analyzing music.
3. The general idea of polyphonic cognition could be applied to any kind of polyphony, not just early polyphony. Such a project would on the one hand emphasize the diversity of polyphonic styles across time and place (a typical humanities approach) while at the same time searching for general principles (which is more typical of sciences).
4. The more specific idea of “cognition of early polyphony” could be related to historical rules of composition in several voices, which always involved resolution of dissonance. Such rules would be seen in their historical context while at the same time speculating about possible underlying universals.
5. Psychological analyses of early polyphony could inspire contemporary composition or the development of new approaches to composition.
6. Learning is an important aspect of cognition generally and early music cognition in particular. How do music listeners learn about musical structures? How do these learning processes affect their note-by-note expectations and emotional responses? How does that depend on historical and cultural context? How can we separate nature from nurture? One might compare individuals with more or less experience of a given style to discover general principles of learning of pitch-time patterns. One can

also study errors made by medieval music scribes and make conclusions about their music cognition.

7. Writing as a reflection of cognitive processes. Examples of this include differences between different written versions of the same piece, which may reflect either the role of memory and improvisation; and the idea of a scribe as an interpretative filter, since in general it is not possible to transcribe anything without interpreting it.
8. Performance itself may be considered a form of research, and the knowledge of performers may be combined with that of humanities scholars and scientists. In general in musicological research there is a danger of becoming too abstract and neglecting the insights of performers. These insights may only emerge when interacting repeatedly with the musical material while trying to reconstruct musical performances. Intuitive explanations about “cognition” of performers may contrast with both those of humanities scholars and scientists suggesting that a confluence of all three will be most productive.
9. Embodiment is an interesting topic that was addressed occasionally at the workshop, but it is difficult to study empirically and model cognitively. An interdisciplinary approach would allow both non-sounding historical material and living, sounding polyphony in different cultures to be included. It is possible both to respect the uniqueness of each cultural context and to consider general human capacities.
10. Modeling in data-poor disciplines. The cognition of early polyphony is similar to human evolution in that it suffers from a paucity of reliable data. Just as there are not many fossilized humans, there are not many extant scores of medieval polyphony, since most music was performed from memory and/or improvised. This project would be about extrapolating across gaps in the data by borrowing information from other areas, such as knowledge of the social, historical, cultural and political context, or by considering the general question of computer modeling with inadequate data and its application to this specific area.
11. Regarding consonance and dissonance, scientists (psychoacousticians, neuroscientists) and humanities scholars (music theorists, historians) interpret these words differently and ethnomusicologists may even reject them altogether. Research on this topic must be careful about definitions and the use of materials obtained from observation and comparison of different cultures. Ethnomusicologists are particularly concerned to avoid jumping to conclusions about relationship between “objective”, operationalisable characteristics such as roughness, harmonicity or familiarity, and esthetic judgements. The simple terms such as pleasant and unpleasant as sometimes used by scientists are problematic because dissonance can also be enjoyed. It may also be interesting to study the effect of written texts (=lyrics) on the perception of consonance and dissonance, given that most early polyphony was sung.

There were also different suggestions regarding what might be funded in a smaller project.

1. We could apply for funding purely for mobility, workshops, and scholarly retreats so that humanities scholars and scientists in this area could spend time together with relatively open outcomes. Because the idea of this workshop is relatively new, several such events may be necessary before a clear plan for a large-scale research project emerges.
2. We could develop interdisciplinary training packages for graduate students and colleagues that address the general issues, methods, techniques from different disciplines that can be applied to our more specific questions. Workshops and summer schools could be organized by different participants. Funded PhD projects

might bring together specific pairs of disciplines, one from humanities and one from sciences, each with a supervisor (co-advisors).

3. One participant had experience of founding and administering a research group within a large international society. This approach was considered less promising because of the constraints imposed by the society.

Possible sources of funding include ESF-COST, HERA (Humanities in the European Research Area), Marie Curie, AHRC (in the UK, which is currently promoting collaborative networks) and any source of funding for summer schools or mobility in general (down to the level of individual universities or regional government). A COST application would be carried by an energetic and motivated expert with good secretarial support and good communications with several experts in different countries; this combination was presumably available among the participants in the workshop, but no specific leader for a future application emerged. Since the aim of COST is to promote networking and the visibility of existing research, funding could cover regular meetings, study trips, promotion of young researchers (e.g. a graduate school), interactions with relevant academic societies and the general public (in this case, also with performers), and preparation for other grants - but not new research.

Special session 3: Main conclusions, directions, implications

What can we learn about the cognition of early polyphony by bringing together the more reductionist scientific approaches with the richer and more detailed humanities approaches? For example, is it possible to leave out emotion and focus only on structure as some scientists suggest, or must emotion be included as some humanities scholars – but also neuroscientists - suggest? There was general agreement that humanities scholars and scientists can benefit from interaction in specific ways. Scientists who do experiments and build models need specialist humanities scholars to inform and remind them of the detailed context, and humanities scholars can use the opportunities offered by experiments and models to solve problems.

Historic music cognition has several different aspects that can be approached from different directions. These could be combined in future research to achieve convergent evidence for overarching theses. Convergent evidence is a powerful indicator that something approaching the “truth” has been found, especially when methods and epistemologies contrast and researchers have different motivations - so there is little chance of bias in a given direction. Approaches may for example include the historical approach to understanding musical scores using cognitive ideas. Conversely, early music can be used as a kind of “ground truth” for testing the generality of scientific theories (both psychological and neuroscientific) of music cognition. Or we can focus on the perception and cognition (“mental models”) of music listeners/performers, focusing on differences between modern listeners and early listeners (modern performers who are highly specialized in early music might participate in such a study). This would have immediate spinoffs for modern performances of early music and concepts of authenticity to which this kind of work could make a major contribution.

A consideration of generality does not exclude parallel considerations of specificity and vice-versa. This can be conceptualized as a process of zooming in and out. Humanities scholars may zoom in and look at the detail of individual pieces, after which scientists zoom out and consider more general questions. But humanities scholars may also zoom out and look at

the broader social and historical context, while scientists zoom in and look at the physical structure of the auditory stimulus. If humanities and sciences work together on a given question for a longer period, an interesting kind of hermeneutic or asymptotic research process emerges.

When applying for grant money, arguments based on comparing evidence from diverse epistemological approaches can be convincing. But at the same time, grant applications covering diverse epistemologies run a greater risk of rejection due to the inherent difficulty of pleasing reviewers with contrasting backgrounds.

Scientists tended to be more optimistic about possibilities for future research in this area. One reason was the discovery that, although “cognition” is usually regarded as a scientific topic, cognitive issues are already being considered in the research of humanities scholars. Humanities scholars may approach the same topic differently, but at least the topic is already being addressed from different angles. That implies a way forward in which scientists try to understand central issues from a humanities viewpoint and then operationalise them by turning them into experimental designs or computational models. The results are then returned to the humanities scholars who interpret them in a broader social, historical, cultural or political context.

Humanities scholars were more reserved or skeptical, pointing to the narrative nature of history and the role of political context (“master narratives”). Things that we only a few decades ago regarded as “simple truths” about Medieval music have become uncertain; scientists are often unaware of such developments. For this reason, humanities scholars may be more realistic in their skepticism about reaching common ground and “progress” in understanding of cognition early polyphony. But their prognosis may become more positive after more epistemological cross-pollination has taken place at events like this workshop.

From the perspective of humanities disciplines (especially ethnomusicology and history), it is dangerous to speak of “cognition of early polyphony” without a thorough historical and cultural contextualization. Humanities scholars find it difficult to convince scientists of the importance of historical and cultural context. To understand this point, scientists would have to consider a lot of historical and cultural detail in the search for generalities to understand underlying functioning; depending on how “scientific method” is conceived, that could be impossibly time consuming. This problem can be solved in part by combining and balancing research in humanities, in which context plays an important part, with scientific research in which context is treated superficially or neglected but other aspects come to the fore. It is important also to be open for a negative result, or long-term lack of convergence between different disciplines. One should not force interdisciplinary convergence when the content does not warrant it.

Humanities scholars tend to have less experience in collaboration; there are fewer humanities papers have multiple authors. So they are naturally skeptical about the potential of a multi-epistemological group to generate new and interesting ideas or even “findings” (as the scientists would say). They are uncomfortable with the idea that a scientist can provide tools that can be used by historians, even if the scientist knows little about the relevant history. The next generation of humanities scholars should be more open to collaboration and distance itself from the paradigm of the isolated scholar. We should teach our students about interdisciplinary collaboration and act as positive role models.

Even without a followup, the workshop will have achieved its goals in ways that are difficult to evaluate or monitor. Scientist participants got ideas about incorporating historical and cultural context into their future work and reported their intention to do so. Humanities scholars got ideas about applying general concepts to their specific questions and similarly reported their intention to do so.

We learned from workshop discussions that detailed interaction between humanities and sciences on issues of common interest is possible and feasible. This may not be true for all humanities scholars and scientists but it was certainly true for those who accepted the invitation to participate in the workshop. However, the presentations were still written by individuals and the time to discuss them was limited. This is a first step toward synergetic interaction, but several further steps can be envisaged before the interaction can be described as “deep”.

On the assumption that best interdisciplinary work crossing the humanities-science divide emerges from personal interactions between humanities scholars and scientists, the question arises as to how best to find colleagues from the other side of the humanities-sciences divide. The productivity of our discussions and the relative lack of such interactions in the academic literature suggest that it is best to work together with either colleagues with an explicit long-term interest in this kind of interdisciplinarity, and with younger colleagues who are relatively flexible in their outlook. Scientific conferences like ICMPC (in music psychology) and ISMIR (in music information sciences) could do more to attract humanities scholars to specific sessions on for example the perception of early music. Humanities conferences like MedRen or EuroMAC could do more to attract scientists to specific sessions on historical and music theoretical applications of psychology and computer science.

The main concrete follow-up of the workshop will be a special issue of the Journal of Interdisciplinary Studies on “Cognition of Early Polyphony”. The guest editors of this special issue will be workshop participants Barbara Tillmann and Frans Wiering; convenor Richard Parncutt is the academic editor of the journal as a whole. Following discussions at the workshop about the best way to synergize humanities and sciences in journal publications, a new guideline for the journal has been prepared which will also apply to this special issue. The special issue will be dedicated to Prof. Dr. Rudolf Flotzinger, who headed the Department of Musicology at the University of Graz from 1971 until 1999. During that time, he created the first Austrian Professorship of Systematic Musicology, a position now held by Richard Parncutt. Flotzinger’s most recent book, “Das sogenannte Organum” (ADEVA, 2011), brings together numerous research articles that in different ways shed light on the workshop theme “cognition of early polyphony”.

4. Final programme

The following listing has been revised to include last-minute changes.

Thursday 12 April 2012, central Graz

14:00-16:00 City stroll

Departure from lobby of Hotel Mariahilf

19:00-21:00 Opening ceremony and reception
Council chambers, Graz town hall, main square

Friday 13 April 2012, room SZ 01.18, main building, Uni Graz

08:00-08:55 Today's presenters load and test their computer files.

09:00-09.10 Background, aims, methods, implications
Richard Parncutt (Centre for Systematic Musicology, University Graz, Austria)

09.15-09.25 Presentation of the European Science Foundation
Csaba Pléh (Budapest University of Technology and Economics, Budapest, Hungary)

09.30-09.50 Modality and cognition in 16th century polyphony
Frans Wiering (Department of Information & Computing Sciences, Utrecht University, Netherlands)

10.00-10.20 Probabilistic prediction of pitch-time-expectations in Renaissance music
Tuomas Eerola (Department of Music, University of Jyväskylä, Finland)

10.30-10.55 Coffee / Tea Break

11:00-11:20 Contratenor parts in polyphonic songs from the late Trecento: Challenges for concepts of polyphony and improvisation
Signe Rotter-Broman (Musikwissenschaftliches Institut, Universität Kiel, Germany)

11.30-11:50 Learning and expectation of pitch structures: The role of cultural knowledge
Barbara Tillmann (Cognition Auditive et Psychoacoustique, Université Lyon 1, France)

12.00-13:30 Lunch, Galliano, Harrachgasse 22

14.00-14.20 Scribes as analysts: Codex Faenza and the transmission of instrumental polyphony in late Medieval Italy
Pedro Memelsdorff (Escola Superior de Musica de Catalunya, Barcelona, Spain)

14:30-14:50 Is the prevalence of pc-sets in scores a measure of consonance?
Richard Parncutt (Centre for Systematic Musicology, University Graz, Austria)

15:00-15:25 Special session 1: Identification of possible collaborators

15:30-15:55 Coffee / tea break

16:00-16:40 Keynote 1: When is a dissonance a dissonance?
Eleanor Selfridge-Field (Department of Music & CCRMA, Stanford University, USA)

- 17:00-17:20 Towards an historically-informed audience
 Marcus Pearce (Centre for Digital Music, Queen Mary University London, England)
- 17:30-17:50 Teaching keyboard improvisation in the Renaissance: Memory and the Fundamenta of Paumann and Buchner
 Frauke Jürgensen (Department of Music, University of Aberdeen, Scotland)
- 18.30-20:00 Dinner, Glöcklbräu, Glockenspielplatz 2-3 (old town)
- Saturday 14 April 2012, room SZ 01.18, main building, Uni Graz
- 09.00-09.20 Cognitive and emotional brain processes in music
 Séverine Samson (Neuropsychology and Auditory Cognition, Univ. Lille-Nord de France, France)
- 09.30-09:50 Dissonance and tonality perception in Lithuanian traditional Schwebungsdiaphonie
 Rytis Ambrazevičius (Kaunas Univ. of Technology & Lithuanian Academy of Music, Vilnius, Lithuania)
- 10.00-10.25 Coffee / Tea Break
- 10.30-10:50 Perception of structure and multiple 'meanings' in thirteenth-century polyphony
 Mary O'Neill (Department of Music, University of Birmingham, England)
- 11:00-11:20 Lute tablatures as an embodiment of music cognition
 Tim Crawford (Goldsmiths College, University of London, England)
- 11.30-11.50 The sixth rhythmic mode and its ordines in theory and practice
 Michael Friebe (Institut für Historische Musikforschung, Vienna, Austria)
- 12.00-13:30 Lunch, Weisses Kreuz, Heinrichstr. 67
- 14.00-14:25 Special session 2: Planning projects, grants, infrastructures
- 14:30-14:50 Polyphonic structure and harmonic progression in early string music
 Tillman Weyde (Department of Computing, City University London, England)
- 15:00-15:20 Horizontal and vertical structure in contemporary Central African vocal counterpoint, and its oral transmission
 Susanne Fűrniß (Écoanthropologie et ethnobiologie, Museum national d'histoire naturelle, Paris, France)
- 15:30-15:50 The conceptual and the empirical backgrounds of Zarlino's counterpoint theory
 Jurij Snoj (Research Centre of the Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia)
- 16.00-16.25 Coffee / Tea Break

16:30-17:10 Keynote 2: Cultural conditioning of polyphonic perceptions
David Huron (School of Music, Ohio State University, USA)

17:30-18:30 Special session 3: Main conclusions, directions, implications

19:00-20:00 Forest walk, departing from Hauptgebäude Uni Graz, main entrance

20:00-23:00 Workshop dinner, Häuserl im Wald, Roseggerweg 105, Graz

5. Final list of participants

Convenor (1):

Richard PARNCUTT, Centre for Systematic Musicology, University of Graz, Austria

Co-Convenors (2):

Andreas GAICH and Martin WINTER, Centre for Systematic Musicology, University of Graz, Austria

ESF Representative (1):

Csaba PLÉH, Department of Cognitive Science, Budapest University of Technology and Economics, Hungary

Other participants (17):

Rytis AMBRAZEVIČIUS, Department of Audiovisual Art Technologies, Kaunas University of Technology, Lithuania

Tim CRAWFORD, Department of Computing, Goldsmiths College, University of London, England

Tuomas EEROLA, Finnish Centre of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland

Michael FRIEBEL, Institut für historische Musikforschung, Vienna, Austria

Susanne FÜRNISS, Éco-anthropologie et ethnobiologie, Museum National d'Histoire Naturelle, France

David HURON, School of Music, Ohio State University, Columbus, OH, USA (temporary participation by video link)

Frauke JÜRGENSEN, Dept of Music, University of Aberdeen, Scotland

Pedro MEMELSDORFF, Escola Superior de Musica de Catalunya in Barcelona, Spain

Mary O'NEILL, Music Department, University of Birmingham, England

Marcus PEARCE, Centre for Digital Music, School of Electronic Engineering & Computer Science, Queen Mary University of London, England

Signe ROTTER-BROMAN, Musikwissenschaftliches Institut, Universität Kiel, Germany

Séverine SAMSON, Laboratoire de Neurosciences Fonctionnelles et Pathologies, Université Lille Nord de France

Eleanor SELFRIDGE-FIELD, Braun Music Center, Stanford University, USA

Jurij SNOJ, Institute of Musicology, University of Ljubljana, Slovenia

Barbara TILLMANN, Cognition Auditive et Psychoacoustique, University of Lyon 1, France

Tillman WEYDE, Department of Computing, City University, London, England

Frans WIERING, Department of Information and Computing Sciences, Utrecht University, Netherlands

6. Statistical information on participants

Including the ESF representative and the convenor, there were 19 active participants from 12 countries: Austria 2, England 4, Finland 1, France 3, Germany 1, Hungary 1, Lithuania 1, Netherlands 1, Scotland 1, Slovenia 1, Spain 1, USA 2. Of the active participants, 7 were female and 12 male. There was a good balance between younger, mid-career, and older researchers (the youngest participants were presumably Frauke Jürgensen and Signe Rotter-Broman).

The two participants from the USA were invited as keynotes and given extra time on the program in recognition of their unique research contribution to relevant research. The costs for Eleanor Selfridge-Field were covered by Land Steiermark. David Huron was unable to attend and presented his keynote by video link, which allowed him to take part in the final special session on the main outcomes of the workshop.

Please note the following two corrections to the previously submitted list of participants. The affiliation of Pedro Memelsdorff was incorrectly listed. Cristina Urchueguia (Switzerland) cancelled her trip a few days before the event due to illness.