**AMBIENT: Investigating Bodily Entrainment to Audiovisual Rhythms in Local and Remotely Connected Environments**

# 1 Excellence

## 1.1 State of the art, knowledge needs and project objectives

The main goals of AMBIENT are **to work towards a greater understanding of (a) the rhythms of indoor environments, (b) how people interact with such rhythms, and (c) how such rhythms can be captured and (re)created in a different environment**. The project will employ recent theories from the field of embodied sound/music cognition, combined with perspectives from the aesthetics of audiovisual media, the psychology of attention and prediction, behavioural patterns from human movement science, and experimental music technology.

The coronavirus crisis has led to a massive escalation of audiovisual telecommunication for both private and work-related business. This has demonstrated the possibilities of current consumer video conferencing systems, and the ability to gather groups of people in virtual 'rooms.' The rapid communication change has also uncovered several limitations of today's solutions. On the technology side, there are, for example, still unsolved issues when it comes to handling the *latency* of the transmitted signals, which leads to a reduced sense of immediacy and presence (Drioli et al., 2013). From a human-computer interaction perspective, there are still many *usability* issues. Think of, for example, the time spent on connecting and making microphones work at the beginning of online meetings. There are also several *conceptual* challenges in today's video conferencing systems, one of which is at the core of AMBIENT: the lack of **audiovisual contextual information**. This topic has been largely overlooked in the literature and has not been prioritised by the telecommunication industry.

Today's communication systems focus on optimising the 'foreground' transmission. The 'background' has not only been forgotten; it is actively removed using different types of 'background subtraction' and 'noise-cancelling' techniques. But this comes at the cost of also removing something that might be crucial for the overall experience: the **ambience** of the environments that people communicate between. The tendency to remove, blur, or replace people's visual backgrounds may be an effective method of focusing on the person in question. Asking people to turn off their microphones to avoid noise is another measure that helps communicate clearly and efficiently. But what are the side-effects of doing this type of 'background removal'? What do we lose when we reduce human communication to pixelated faces without sound?

AMBIENT will investigate physical and physical-virtual working environments (Figure 1), looking specifically at the 'background.' This is based on the assumption that the richness and complexity of small and 'unnoticeable' audiovisual stimuli are essential for our appreciation (or disapproval) of the *feeling* of a space. One of the novel aspects of AMBIENT is to use the concept of **rhythm**—here defined as ordered patterns in time—to understand more about the human experience of an environment. Some of these rhythms may be entirely *periodic*, such as the sound of an old-school

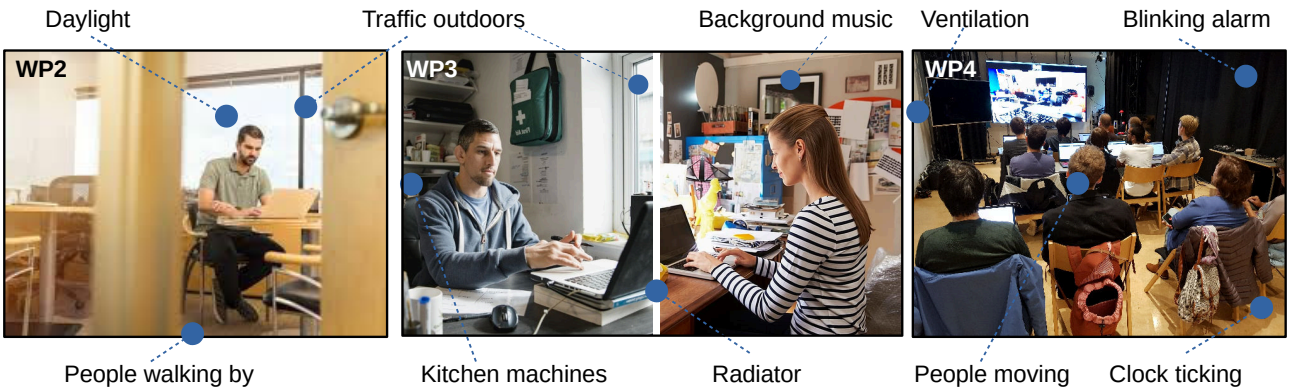


Figure 1: Some periodic auditory and visual stimuli in the environments to be studied in AMBIENT: individuals in offices (WP2), physical-virtual coworking (WP3), telematic classroom (WP4).

clock ticking in the background. However, most natural rhythms also have *variation* (Deleuze and Patton, 2004; Danielsen, 2018), such as the airflow of a ventilation system or the gentle motion of leaves in a tree outside a window. In music, it is the complementary role of repetition and variation that gives the sense of rhythm as a 'changing same' (Jones, 1976). Rhythms can be slow, for example, the 24-hour period of changing daylight. Or they can be fast, such as the footsteps of people rushing in and out of a corridor. Together, such regular and irregular events form a complex whole that may contribute to the environment's experienced ambience.

Another novel aspect of AMBIENT is to study the rhythms of an environment from a multimodal perspective, with a particular focus on both **audiovisual** and **spatiotemporal** features (Figure 2). Understanding how auditory and visual stimuli fuse into a coherent observable background pattern is at the core. This includes understanding how such audiovisual stimuli change over time and how they influence how we move and think. These are topics that have not yet been studied systematically. AMBIENT aims to provide new conceptual ideas on how the background can be included in tomorrow's telecommunication systems. This will be done by developing a set of theoretical models of ambience, embodiment, and interaction, informed by observation studies and experiments.

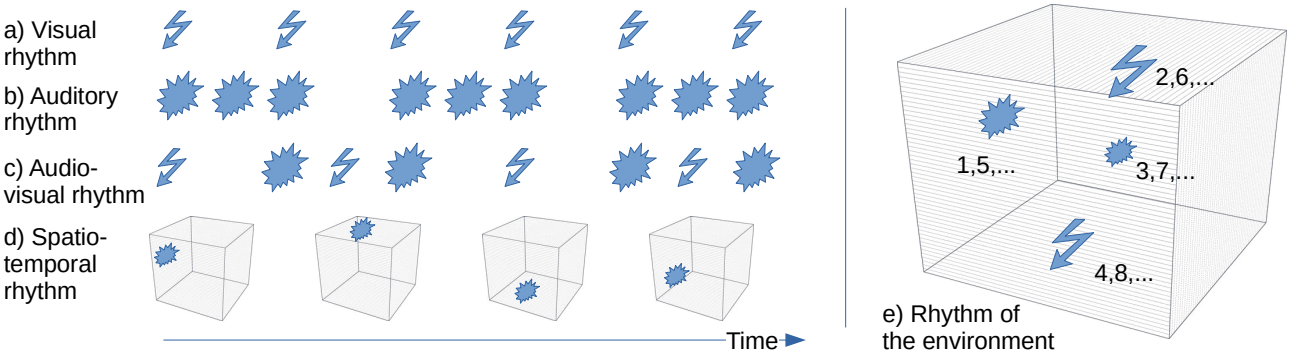


Figure 2: Rhythms can be constructed from different elements: (a) visual, (b) auditory, (c) audiovisual, (d) spatiotemporal, or (e) a combination of audiovisual and spatiotemporal. The numbers in (e) indicate the cyclic, temporal order of the events.

## 1.2 Research questions and hypotheses, theoretical approach and methodology

**RQ1: What contributes to the experienced ambience of an environment?** The first research question of AMBIENT sets out to fill what seems to be a 'hole' in the current literature in both sound and music research. Acoustic ecology has contributed to a better understanding of the importance of **soundscapes** (Schafer, 1977), including the soundscapes of wildlife (Krause, 2016), urban environments (Kang and Schulte-Fortkamp, 2018), and architectural sound and silence (Kakalis, 2019). Less focus has been put on the experience of everyday indoor environments, although there have been advances in anthropological studies of ambient sounds (Guillebaud, 2017) and the sounds of worship spaces (Guillebaud, 2020). However, there is a 'gap' between such ethnographic studies and aesthetics-based research on sound and music. In fact, the 'background' has not received much attention in the musicology literature, with some notable exceptions, such as writings about John Cage's *4'33"* (Cage, 1961; Larson, 2012) and the works of Arvo Pärt (Karnes, 2017). Much of the literature on **ambient music**, however, is primarily concerned with traditional 'foreground' perspectives, such as melody, harmony, and timbre (Lysaker, 2018; Adkins and Cummings, 2019). Interestingly, most studies on the experience of **background music** are from fields such as marketing and business psychology. However, they focus less on the music itself and more on how music can change the attitudes and behaviours of customers in shops and restaurants (Mehrabian, 1974; Milliman, 1982; Yalch and Spangenberg, 1990; Hul et al., 1997). One observation is that the literature on soundscapes, ambient music, and background music, devotes remarkably little attention to rhythm. AMBIENT will build on a growing understanding of the importance of rhythm in human experience (Danielsen, 2010; Guldbrandsen and Johnson, 2015; Cheyne et al., 2019), and contribute with theoretical models that include both audiovisual and spatiotemporal components. It will also explore the role of rhythms

exceeding the conscious 'now' (Heidegger, 1962; Husserl, 1991; Johnson, 2007). The hypothesis is that *the experienced ambience of an environment is largely based on the complex interactions of various layers of audiovisual and spatiotemporal rhythms.* AMBIENT will explore this by developing a taxonomy of the ambience of indoor environments, informed by empirical studies of people in their working environments.

**RQ2: How are people influenced by the rhythms of an environment?** The second research question builds on theories of embodied sound/music cognition (Clarke, 2005; Leman, 2008; Cox, 2016). The PI has contributed to this field with several studies on 'air instrument' performance, free-dancing to music, and sound-tracing (Jensenius, 2007). More recently, his attention has shifted towards music-related **micromotion**, and questions about whether/how sound and music can lead to spontaneous body motion even when people try to stand still. These studies have revealed that music does, indeed, make people move, albeit at a tiny scale (Jensenius, 2017; González Sánchez et al., 2018). The analyses of such standstill data also show a complex interplay between different types of bodily rhythms—such as breathing and pulse—and external rhythms. Quite a lot is known about the chronobiological nature of various body rhythms (Aschoff, 2013), but less is known about how body rhythms *entrain* to the rhythms of the environment. **Entrainment** is here used to describe the process by which independent rhythmical systems interact with each other (Clayton, 2012). A simple example of such entrainment is how people adjust their walking speed to others. There are also examples of more complex entrainment processes involved in the interpersonal coordination between music performers and perceivers (Clayton et al., 2020). An explanation for such behaviour has been proposed in the *dynamic attending* theory (Large and Jones, 1999) and the *predictive coding* theory (Kilner et al., 2007; Vuust et al., 2014). Still, there are many open questions as to how entrainment works for more complex rhythms (Danielsen et al., 2015; Câmara and Danielsen, 2018). AMBIENT will build on these theories, and investigate the roles of entrainment in the interaction between people and environments. The hypothesis is that *there is a continuous interaction between people and the environment, and that this interaction can be understood and modelled as an entrainment process.* AMBIENT will explore this through theoretical modelling and an experiment in which different physical environments are virtually connected over extended periods.

**RQ3: How can we develop technologies that analyse the rhythms of an environment, and transmit and (re)create such rhythms in a different environment?** The third research question springs out of the PI's experience of teaching in a telematic classroom setting in the novel two-campus master's programme *Music, Communication & Technology.* Here the students are physically split between Oslo and Trondheim (500 km apart). Still, they are virtually together in the MCT Portal, a teaching lab with state-of-the-art audiovisual communication technologies. The aim has been to create a 'common' ambience between two physically separate rooms, thereby creating a permanent *physical-virtual* environment. One of the MCT programme aims is to investigate—philosophically but also practically in a real-life context—how it is possible to overcome the 'flatness' of traditional video conferencing systems. This 'flatness' has been a limitation of telecommunication from the very beginning (Cook, 2015), and still prevails despite rapid developments in the fields of virtual and augmented reality. AMBIENT will build on theories of how telematics can be used for aesthetic interventions (Birringer, 1998), exploration of identity (Broadhurst and Machon, 2012), and the experience of presence (Ladly, 2007) and intimacy (Chatzichristodoulou and Zerihan, 2012). The hypothesis is that *it is possible to enhance the experience of a telematic environment through interactive (re)creation of ambience using auditory and visual stimuli.* This will be explored through theoretical modelling and creating an interactive audiovisual system that can 'augment' an environment in a subtle way.

**Theoretical Approach and Methodology** The research will be organised in five work packages (WPs), each of which will help answer the three main research questions (RQ1–3). Figure 3 shows relationships between the WPs, and details about the timeline are included in the Gantt chart in Table 1. Figure 4 summarises the methods used for data collection and processing.

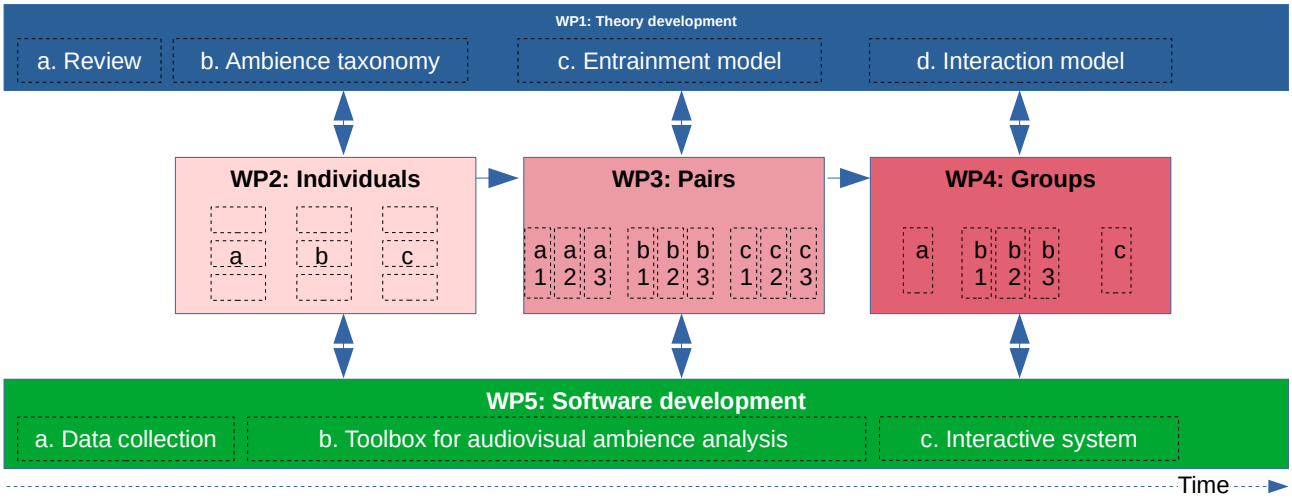


Figure 3: The relationships between work packages. The small boxes within WP2–4 indicate the different studies (a/b/c) and their phases (1/2/3). See WP sections for explanations.

**WP1: Theoretical Development** This work package will provide the theoretical foundation for the other WPs, and serve as a reference to the whole project. The first semester will be devoted to literature studies by the PI and a research assistant and will lay the ground for the monograph that the PI will complete at the end of the project. When the doctoral and postdoctoral researchers arrive, the focus will be on developing a taxonomy of indoor ambience. This will build on existing soundscape taxonomies (Schafer, 1977; Salamon et al., 2014; Guillebaud, 2017) and industry standards (Kim et al., 2006), and expand them to include audiovisual and spatiotemporal perspectives. Next, we will focus on developing an entrainment model, building on musical entrainment (Clayton et al., 2020), chronobiology (Pittendrigh, 1981), and neuroscience (Large et al., 2015). This will be used to create the interaction model, which will be based on knowledge from human-computer interaction and new interfaces for musical expression (Jensenius and Lyons, 2017).

**WP2: Observation study of individuals in their offices** This work package will study peoples' experiences of their offices' rhythms. The plan is to run three observation studies (indicated as a/b/c in Figure 3), each one month long and with three participants. These will give an in-depth understanding of a total of nine different offices and their usage. Each of the observation studies will have the same three phases. The first will focus on pre-observation interviews and questionnaires. This will be followed by a month-long quantitative data collection using a 360-degree camera and an ambisonics microphone mounted in the office ceiling. For privacy reasons, only a set of audiovisual features will be extracted and stored (see WP5). Participants will also wear an activity tracker during the period that they spend in the office space, which will capture continuous heart rate and motion information. Together these measured data will provide both 'internal' and 'external' measurements of the participants' activity in their offices. Additional self-reports and a final semi-structured interview will give qualitative information about people's experiences. We will use machine learning and statistical analyses based on the work of González Sánchez et al. (2018, 2019) to look for correlations between bodily rhythms (heart beats, movement patterns, etc.) and the environment (if any). The qualitative data will be used to get insight into the participant's subjective experience of their working environment.

**WP3: Observation study of physical-virtual workspaces** This observation study will build on knowledge from WP2 and will explore the concept of physical-virtual coworking. The idea is to recruit three pairs of people that normally work together, and set up a continuous audiovisual stream between their workspaces. It is often common to think of video conferencing as something turned on for meeting. Here the idea is to explore two physical rooms that are virtually connected for a sustained period. It resembles a shared physical office, except that it is set up as a shared physical-virtual space. This will be done by running three month-long experiments, each with two people and offices. The

data collection will be similar to that of WP2. The first week (indicated as a/b/c1 in Figure 3) will be an observation study of each participant's regular workspace, without being connected, and will serve as the 'baseline' condition. Then there will be two weeks (a/b/c2) during which the two workspaces will be continuously connected using a video conferencing system running on separate stationary PCs. During the last week (a/b/c3) the partners will be disconnected again and data from this week will act as a post-experiment 'control' condition. The main analytical focus will be on understanding more about the different experiences of working in a regular office, instead of a physical-virtual office space. We will use both statistical and machine learning techniques to look for entrainment between people, and whether this can be traced back to any of the environments' properties.

**WP4: Exploration of (re)creation of ambience in a telematic classroom** This WP will use the unique two-campus MCT Portal to explore different strategies for the (re)creation of ambience rhythms between two cities. The exploration will be done with the students in the MCT master's programme, as part of the course MCT4022. The first part (a in Figure 3) will consist of a pre-exploration analysis of the environment using the same setup as WP2–3. The only difference is that instead of activity trackers, the existing motion capture systems will collect high-quality activity data. This will be followed by systematic exploration (b1/2/3) of 'augmenting' the ambience of the space using subtle audiovisual effects, and finally, a post-exploration observation (c). The MCT Portal is equipped with multichannel audio and lighting systems that can be used to play sound or change the lighting in specific parts of the two physical rooms. This can be used to create subtle audiovisual rhythmic patterns in the space based on activity on the other side. For example, if a group of students talk together in one side of the room in Oslo, this may be represented using a subtle, abstract sound and lighting changes in a similar part of the room in Trondheim. This will give a sense of both the spatial location and the temporal unfolding of that interaction, without transmitting details of what was said and done. Questionnaires and semi-structured interviews will be used to collect feedback on the augmentations and will be used to refine the interactive system based on an iterative design methodology (Boehm, 1988).

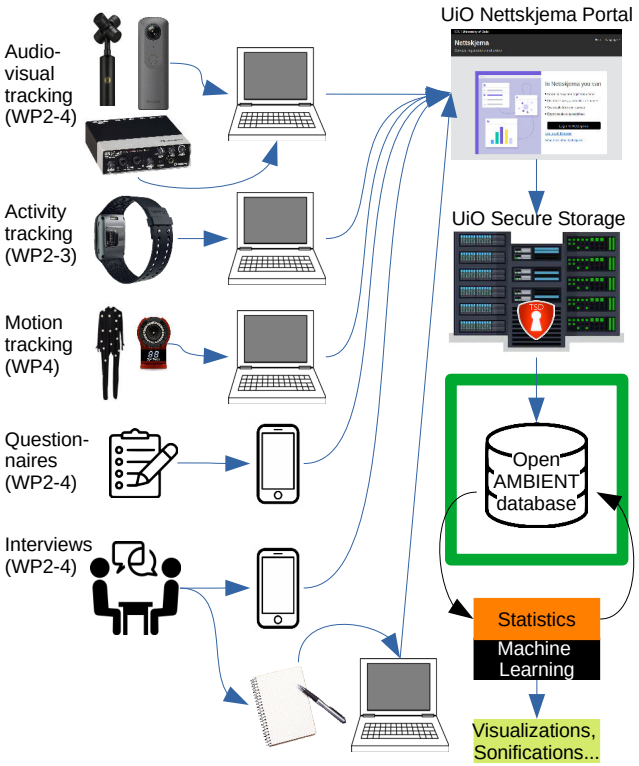


Figure 4: Sketch of the different data collection methods in WP2–4 and dataflow into the secure storage solution at UiO.

**WP5: Software development** This WP will supply the three empirical WPs with the necessary tools for data collection, data analysis, and interaction. The first year will be devoted to creating a reliable data collection solution from the 360-degree audio/video streams (WP5a). The toolbox for audiovisual and spatiotemporal analysis of the extracted features (WP5b) will be based on the PI's existing Musical Gestures Toolbox (Jensenius et al., 2005; Jensenius, 2018). The interactive ambience augmentation system (WP5c) will be developed to control the multichannel audio and lighting rig in the MCT Portal. All software will be developed using open tools (Python, Jupyter Notebooks and PureData) and released on GitHub with an open-source license (GPL).

**Risk Management** The most significant risk of AMBIENT is probably the data collection in WP2–4. Even though the data collection will be based on off-the-shelf technologies, it will push these technologies to the limit with continuous recording for one month at a time. There is a considerable

risk of hardware failure or losing some data along the way. That is why data collection is planned for relatively long periods and in multiple stages. If one part fails, it will still be possible to get data from others. Even if parts of the quantitative data collection were to fail—or if the analysis would not lead to meaningful results—there will be an extensive collection of qualitative data. The most considerable intellectual risk is whether it will be possible to find any rhythmic properties of the environments in question, or if it is possible to observe any effects on people. However, given the existing literature, and the PI's initial investigations, it is highly likely that it will be possible to develop both a taxonomy and models of entrainment and interaction. And, even independently of these models, the project's quantitative and qualitative data will give a unique and in-depth insight into people's working habits in both physical and physical-virtual settings.

**Interdisciplinary approach** The highly interdisciplinary approach taken in AMBIENT will allow for studying the phenomenon at hand from both 'soft' and 'hard' perspectives. This is challenging in many ways because it is necessary to combine a large set of seemingly incompatible theories and methods. If successful, such an integrated approach may lead to strong theoretical models backed up by extensive empirical data collection. Fortunately, the PI has an interdisciplinary background, spanning from the arts and humanities to the natural sciences and technology, and has successfully run several cross- and interdisciplinary projects. It also helps that the project will be located at RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, in which researchers from the fields of musicology, psychology, and informatics interact daily. The PI will ensure that the recruited doctoral and postdoctoral researchers will work cross-disciplinary as a team, while also developing their disciplinary expertise to be attractive on the job market.

**Ethical considerations and Data management** AMBIENT will study people over hours and days during their everyday lives. Thus, it is essential to pay close attention to how data is managed throughout the project's lifetime. The project will apply for approval from the Norwegian NSD Data Protection Services. All participation in the project is voluntary. The microphones and video cameras placed in the rooms will only be used as sensors. No audio or video will be recorded, only audiovisual features (such as quantity of motion and sound pressure level) will be extracted in realtime. Thus, all the quantitative data will be anonymous from the beginning. All the raw data will be sent through UiO's secure Nettskjema data collection portal and stored on servers at UiO (Figure 4), with only generic IDs used to label people. As much as possible of the cleaned and anonymised data will be made publicly available in an open AMBIENT database as part of the project's Open Science strategy.

**Gender and Diversity Perspectives** The aim is to recruit a diverse group of participants for the various observation studies, so that the dataset is representative in terms of gender, age, and ethnicity. The PI is actively working to recruit more women into the field of music technology through the WoNoMute initiative, and will pay particular attention to gender when hiring assistants and researchers for the project.

### 1.3 Novelty and ambition

The question of how the rhythms of everyday environments affect us is too complex to be answered through incremental efforts and requires a large-scale, ambitious and integrated approach. The highly interdisciplinary nature of AMBIENT is novel on its own. There are still few examples of projects that work across the arts and humanities, social and natural sciences, and in combination with the use and development of state-of-the-art technologies. AMBIENT aims to do this in full, combining empirical and experimental work with both theory and technology development.

What is particularly novel about AMBIENT is the use of rhythm as a guiding principle. There is an increasing body of research that supports the importance of temporality in human perception and cognition. Still we know relatively little about the complexity of temporal phenomena in everyday life. Here, recent models from music research may prove useful to explain also non-musical human activities and experiences. A fresh take on this includes the inclusion of visual elements (in addition

to the auditory) to understand the nature of environmental rhythms. Particularly novel is developing a theory of rhythms based on the spatiotemporal characteristics of audiovisual rhythms.

# 2 Impact

## 2.1 Potential for academic impact of the research project

A better understanding of audiovisual and spatiotemporal rhythms may lead to high scientific impact in many related disciplines, including sound(scape) studies, sound/music psychology, and human movement science. Findings from the empirical studies may lead to new hypotheses that can be tested in controlled experiments in psychology and neuroscience. The models and tools for audiovisual analysis are expected to impact informatics and human-computer interaction, which still struggle to include crossmodality in computational models. A deeper understanding of how people experience their everyday environments may also impact philosophy, media studies, architecture, acoustics, medicine, and physiotherapy.

## 2.2 Potential for societal impact of the research project

AMBIENT may have a societal impact in several ways. One is in the design of indoor environments. Increased knowledge about how time-based audiovisual stimuli impact people may be of particular importance for fields such as interior design and acoustics. As we have seen through the coronavirus crisis, there is also a need to improve the quality of audiovisual telecommunication. Today's video conferencing systems fail to deliver the *feeling* of being together. This is partly a question of developing better technologies, which AMBIENT will address through explorations of interactive ambience augmentations. Such augmentations can be based on transmitting code for creating abstract audiovisual representations. This can help in reducing processing and bandwidth, hence reducing the environmental footprint of the communication (Obringer et al., 2021). Better telecommunication is also a question about the aesthetics and embodied experiences of everyday environments, and how technologies can improve (or deteriorate) such experiences. More pleasant interaction will most likely also influence people's well-being.

AMBIENT targets several of the UN's Sustainable Development Goals. Developing better telecommunication systems is critical for tomorrow's infrastructure needs (#9), and is necessary to provide sustainable cities and communities (#11), not least by enabling less travel and reduced pollution (#13). Creating better physical-virtual interactions is also crucial for providing quality education (#4) and decent work (#8) to more people. Finally, today's technology has, to a large extent, been developed by (and for) healthy, working-age men. AMBIENT aims to explore how our working environments and related technologies can be developed for people of different gender (#5), and people of all ages and capabilities (#10).

## 2.3 Measures for communication and exploitation

**Target audiences of the project outputs** The primary communication channel to the academic community will be the publication of high-quality journal articles. A focus will be put on quality instead of quantity. Open channels will be used and all publications will be accompanied by openly available data and software (if relevant) so that it is possible to verify the findings. As a forerunner in the field of Open Science, the PI will push the team to explore new publication strategies, including registered reports, data and software papers, using open peer review systems, and so on. Throughout the project, team members will be encouraged to present regularly at major international academic conferences related to their expertise, such as music psychology (ESCOM, ICMPC, SEMPRE), music technology (NIME, SMC, ISMIR), and human movement science (ICHMSP, BIOMECHANICS). This is important to communicate the results to different fields and improve the early-career researchers' disciplinary networks. They will also benefit from RITMO's extensive international network, and internal funding possibilities for short term scientific missions within the Nordic Sound and Music

Computing Network (Copenhagen, Stockholm, Helsinki, Reykjavik) as well as the RITPART Network (UC Berkeley, McGill University, Toyohashi University).

**Dissemination, communication and engagement activities** In addition to the scholarly communication, AMBIENT members will be encouraged to participate in various types of public outreach activities, including the annual Open Day at UiO, the Cutting Edge innovation festival, and Researcher's Night. It will also be relevant to participate in one or more of RITMO's MusicLab events, which is focused on exploring Open Science concepts in real-world settings. The PI will also continue to explore the use of social media for the communication of research results. Two high-quality AMBIENT video documentaries will be produced to disseminate the results.

**Activities that will contribute to the realisation of the potential impacts** The plan is to invite relevant non-academic experts and industry professionals to the annual workshops (see Table 1). This includes interior architects and acousticians for the ambience workshop (M3), physiotherapists and medical doctors to the entrainment workshop (M4), and interaction designers and software engineers to the interaction workshop (M5). The aim is to increase knowledge transfer from the project to the different disciplines, hopefully leading to the desired impact. Another dissemination activity is through the students of the Music, Communication & Technology master's programme in WP4. It is expected that several of these students—but also other master's students from Departments of Musicology, Psychology, and Informatics—will write their master's theses on topics related to AMBIENT. They will be included as full members in the project team. This will give the students unique insights into the ongoing research, which they will bring into their various workplaces once they graduate.

# 3 Implementation

## 3.1 Project manager and project group

The **Project Manager**, Alexander Refsum Jensenius, is a professor of music technology at the University of Oslo. He has extensive academic leadership experience as Director of UiO's fourMs Lab (2008–), Head of Department of Musicology (2014–2017), Deputy Director of RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion (2017–), and Chair of the Steering Committee of the International Conference on New Interfaces for Musical Expression (2011–). The PI has performed interdisciplinary research throughout his entire career, with publications in musicology, music psychology, music technology, computer science, linguistics, and medicine. He has been named an Open Data Champion by SPARC Europe and is a member of the European University Association's Expert Group on Open Science/Science 2.0. Appalled by the low gender balance within music technology, he has helped establish an Oslo branch of Women in Nordic Music Technology (WoNoMute).

The **Project Group** will consist of three full-time researchers, as well as several students:

- PhD1 (100% 3-year position) will have a background in sound studies, musicology, or music psychology and will be responsible for conducting interviews and qualitative analyses in WP2–4.
- PhD2 (100% 3-year position) will have a background in music technology or creative computing and will be responsible for creating models and systems for exploring telematic ambience in WP4 and for developing novel multimodal analysis methods and software tools (WP5).
- Postdoc (100% 3-year position) will have a background in human movement science and will be responsible for motion and physiological measurements and quantitative analyses in WP2–4.
- Master's students from Departments of Musicology, Psychology and Informatics will be recruited to write their theses on topics related to the project. Two competitive master's scholarships will be available per year, one of which will be reserved for female music technology students.
- Several students will be hired as research assistants throughout the project. They will help with literature studies, data collection, transcription, dissemination, and organisation of events.

A **Local Expert Group** will be set up, including Prof. Anne Danielsen (rhythm studies), Prof. Bruno Laeng (crossmodal perception), Prof. Jonna Vuoskoski (music cognition), Prof. Yngvar Kjus (music and media studies). They will take part in seminars and give general advice to the project. They

will also serve as co-supervisors for the PhD fellows connected to their expertise and will contribute to the research output as co-authors on publications.

The international **Scientific Advisory Board** will include Prof. Marc Leman (musicology, Ghent University), Prof. Natasha Barrett (soundscapes/acousmatics, Norwegian Academy of Music), Prof. Jonathan Sterne (cultural studies, McGill University), Dr. Christine Guillebaud (sound ambience anthropology, CNRS), and Prof. Nicola Dibben (music psychology, Sheffield University). We will meet annually to get updates on the progress and help make choices for the project's future directions.

### 3.2 Project organisation and management

**Work Plan** The Gantt chart in Table 1 illustrates the structure of the project.

| **Year, Fall/Spring** | **22S** | **22F** | **23S** | **23F** | **24S** | **24F** | **25S** | **25F** |
|---|---|---|---|---|---|---|---|---|
| Project | M1 | M2 | | M3 | | M4 | | M5, M6, M7 |
| WP1 (Theory) | | | | D3 | D6 | D7 | D9 | D10, D11, D12 |
| WP2 (Individuals) | | | | D2 | | | | |
| WP3 (Pairs) | | | | | D5 | | | |
| WP4 (Groups) | | | | | | | | |
| WP5 (Development) | | D1 | | D4 | | D8 | | |
| PhD fellowships | | | | | | | | |
| Postdoc fellowship | | | | | | | | |
| Students and Research assistants | | | | | | | | |

Table 1: Gantt chart for AMBIENT, with individual lines for work packages (WPs) and indications of milestones and deliverables. General project activities are included at the top and the working periods of involved early-career researchers at the bottom.

**Milestones**

- M1. Startup: The PI will use the first semester to recruit the rest of the team. Together with a research assistant he will work on the ethical approval, data management plans, literature reviews (WP1a), development of the audiovisual data collection software (WP5a), the launch of a project website, social media accounts, and the creation of a project promotional video.
- M2. Kick-off seminar and first SAB meeting: The seminar will be organised at the arrival of the recruited researchers. The plan is to invite three international experts from fields outside the project's core expertise: architecture, chronobiology, and film studies.
- M3. Ambience Workshop and second SAB meeting: Here, it will be essential to get feedback on the ambience taxonomy (D3) and the measure of rhythmic ambientness (D4).
- M4. Entrainment Workshop and third SAB meeting. The entrainment model (D6) and results from the empirical study in WP3 will be presented and discussed.
- M5. Interaction Workshop and final SAB meeting. Here the interaction model (D7) and software (D8) will be presented and discussed. The SAB meeting will focus on the final publications and plans for future research.
- M6. PhD defences. The two PhD fellows will submit their dissertations after three years (D10, D11), and are planned to defend their theses in the following semester. At UiO, these are open and profiled events, so they will also serve as dissemination possibilities.
- M7. Closing. During the last year, the PI will wrap up the work from all WPs, archive data, create a final web page with easy and long-term access to all the deliverables, finalise the second video documentary, write the project report, complete the monograph (D12), and work on applications for follow-up research.

**Deliverables**

- D1. Software for audiovisual ambience recording and feature extraction (WP5a and WP5b)
- D2. Database of ambience recordings of offices (WP2)

- D3. Taxonomy of ambience in indoor environments (WP1b)
- D4. Model and implementation of a measure of rhythmic ambientness (WP5b)
- D5. Database of team recordings (WP3)
- D6. Entrainment model (WP1c)
- D7. Interaction model (WP1d)
- D8. Toolbox for interactive ambience augmentation (WP5c)
- D9. Publications (approx. 10) in internationally leading journals, proceedings, or anthologies.
- D10–11. PhD dissertations
- D12. Monograph by PI. This monograph is intended to summarise the findings from the project, and present the developed theories at length.

**Research Infrastructure and Research environment** The project will be based at RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, a Norwegian **Centre of Excellence** comprising a 50-strong group of researchers from musicology, psychology and informatics. The AMBIENT team will have full access to RITMO resources, including motion capture and physioligical measurement devices from the world-leading fourMs Lab. The project will also have access to the MCT Portal, a custom-built, two-campus, telematic learning space with state-of-the-art audiovisual communication technologies. The PI has been central in establishing both the fourMs Lab and the MCT Portal and therefore has in-depth knowledge and hands-on experience with all of the infrastructure. The project will receive administrative support from RITMO, and data management and storage support from the IT section and the University Library at UiO.

**Organisation and management structure** The project group will have weekly status meetings for progress updates and problem-solving. Longer monthly seminars will be used to develop ideas and present work in progress, review relevant literature and prepare publications. All AMBIENT researchers will also participate in ongoing RITMO activities, including the weekly Food & Paper seminar series, monthly fourMs Lab meetings, and biannual retreats. The doctoral fellows will follow PhD training at the Department of Musicology, and all early-career researchers will be enrolled in **RITMO's Career development programme**. This will equip them with general academic and transferable skills to succeed either within or outside of academia.

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