香港城市大學
City University of Hong Kong

Naming Sounds

Synecdoche as Association between Events, Sources, and Soundscape through Cognitive-Semantic Valorisation

Huawei Audio Engineering Lab, Hong Kong Research Centre, 30 August 2023

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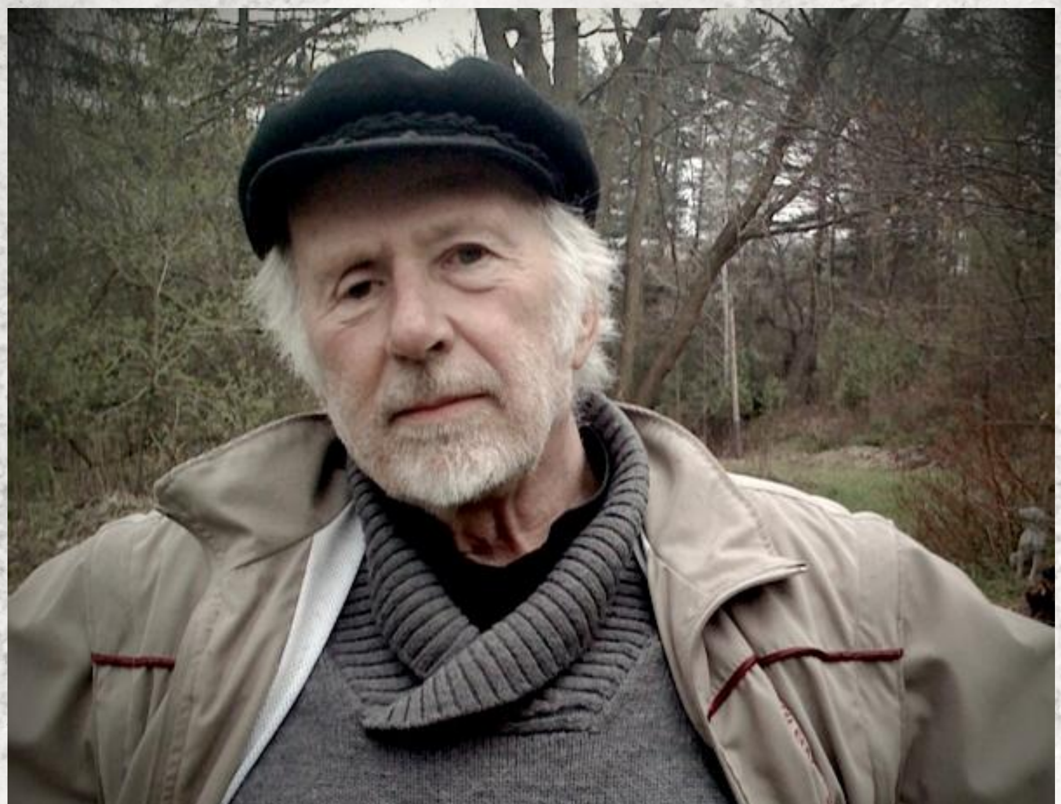
專業 創新 胸懷全球
Professional · Creative
For The World


Our Sonic Environment and
THE SOUNDSCAPE
the Tuning of the World
R. MURRAY SCHAFER
PIERRE SCHAEFFER
TRAITÉ DES OBJETS MUSICAUX
ESSAI INTERDISCIPLINES
Nouvelle édition
pizz.
SEUIL

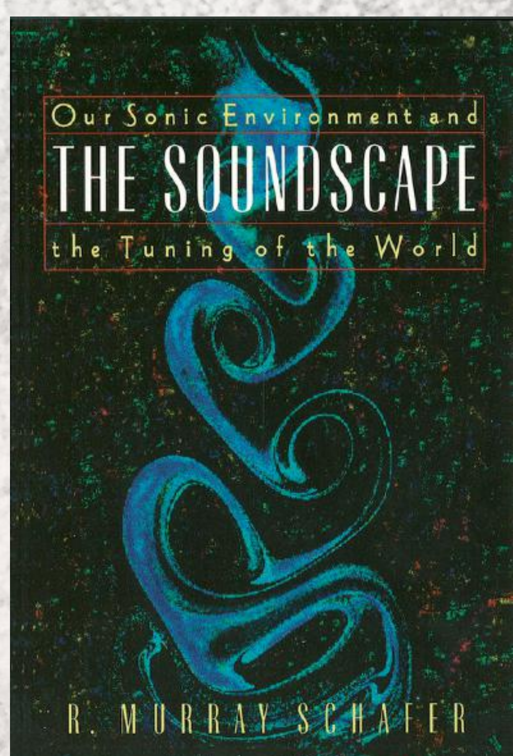
R Murray Schafer Canadian, *1933

Pierre Schaeffer French, *1910 †1995



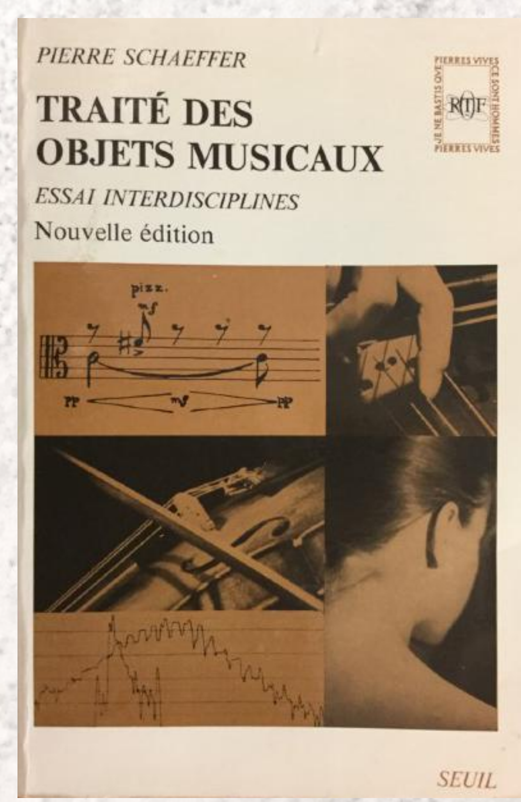
https://jonathaneennewton.files.wordpress.com/2012/10/r-murray-schafer-marcia-adair.jpeg

https://www.ctm-festival.de/archive/all-artists/p-t/pierre-schaeffer/

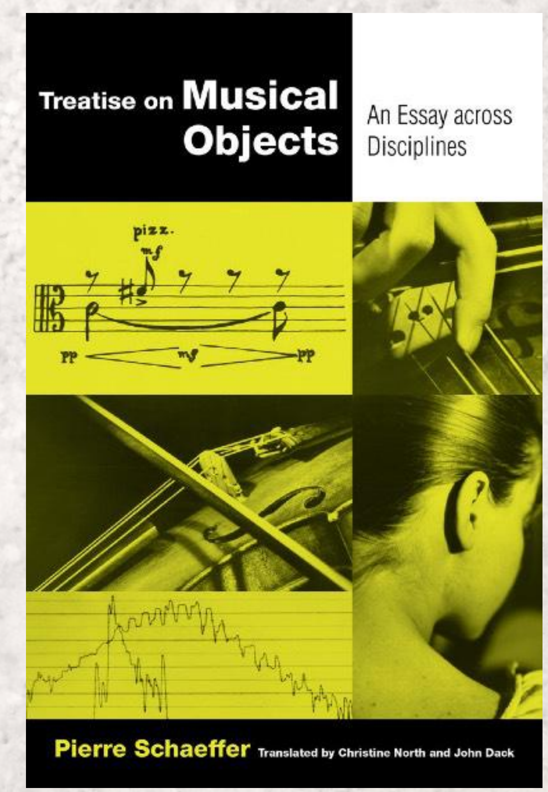


1977

https://www.googlefight.com/pierre+schaeffer-vs-r+murray+schafer.php



1966



2017

Cresson

Centre de Recherche sur l'Espace Sonore et l'environnement urbain
Grenoble, https://aau.archi.fr/cresson/

1995

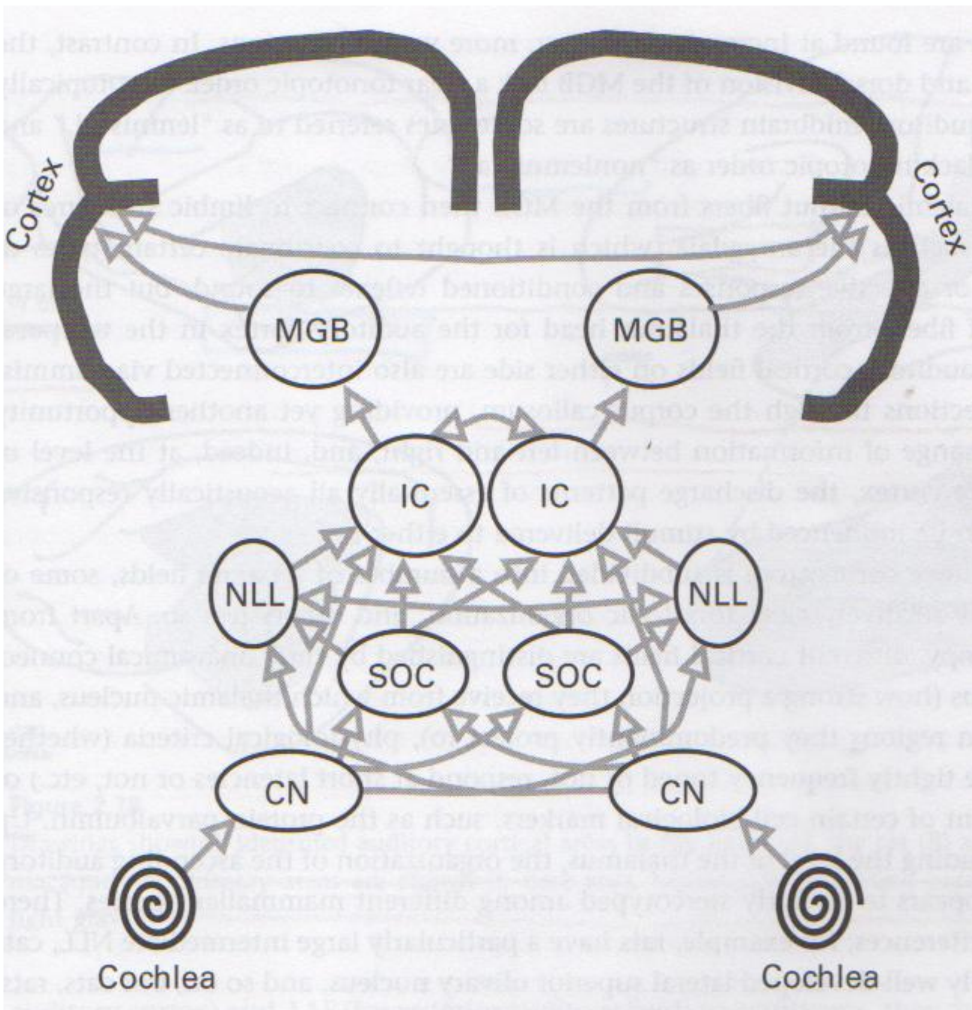
2006

Information processing stages (Schnupp et al. 2011; Mesulam 1998)

Sensation	physio-neurological, mainly reflexive (Moore & Linthicum 2011). brain stem = ancient brain structure, subserves auditory perception crucial to survival, "active 24/7"
Perception	neurological mediates between sensation and cognition (cf. afferent & efferent innervation)
Cognition	psychoacoustic models (Fastl & Zwicker 2007) neuro-psychological "computation in mentalese" (Fodor 1975)

auditory pathway

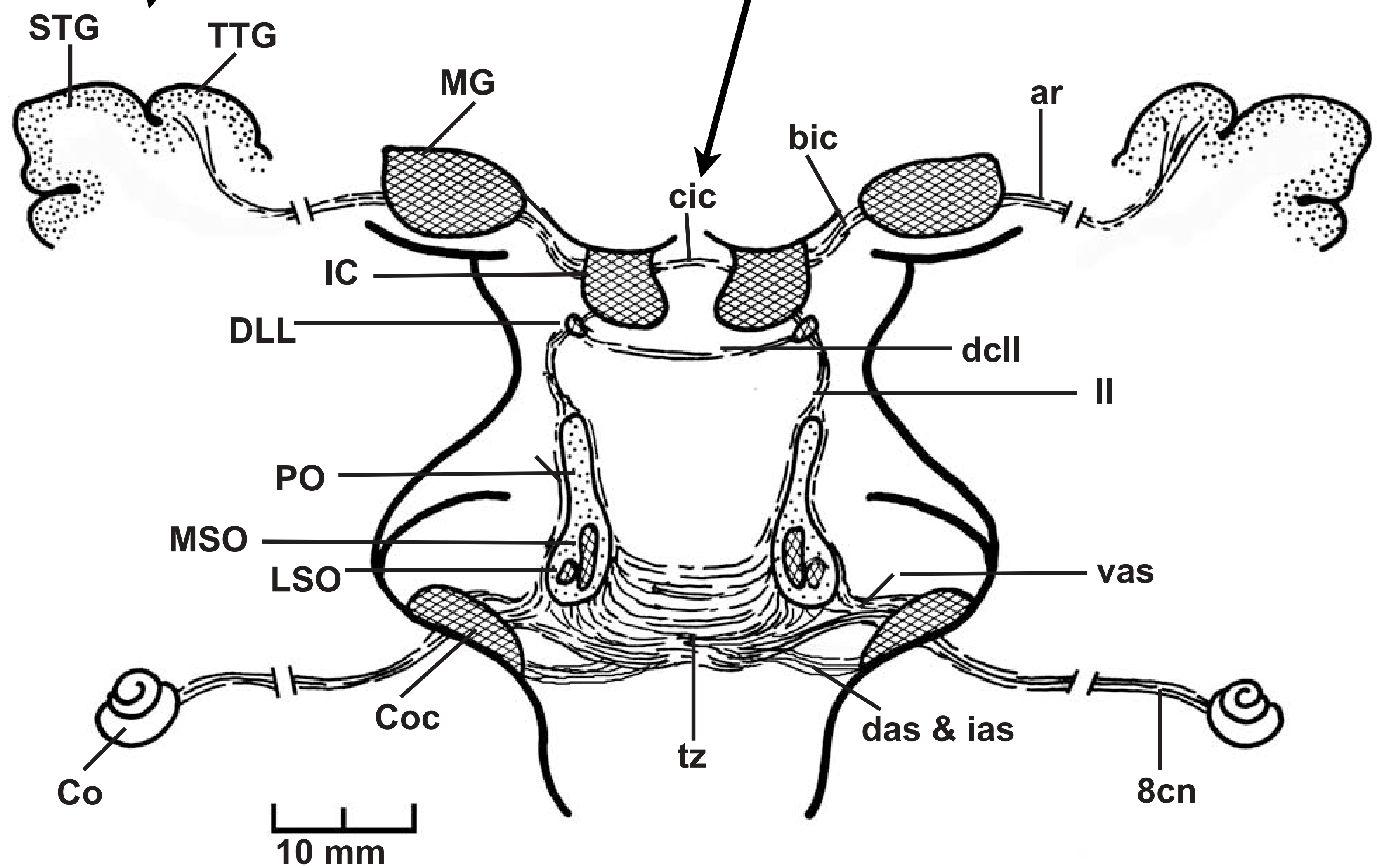
brainstem pathways converge in inferior colliculus (IC), in particular central nucleus (ICC)



Schnupp et al. p. 89

temporal gyrus (cortex)

commissure (bi-lateral connection) of inferior colliculus



AS p. 1242

Affect	auditory cognition, e.g. BRECVEMA (Juslin & Västfjäll 2008; Juslin 2013) all evaluative mental states (emotion, mood, preference… Juslin & Västfjäll 2008).
Emotion	affective states = valenced (Osgood et al. 1957; Mehrabian & Russell 1974; Russell 1979) relatively brief duration (cf. mood)
Appraisal	distinction induced vs. perceived emotion ≈ blurred (Gabrielsson & Lindström 2010) most emotions encountered in everyday listening, especially music (Juslin 2013) *Swedish Soundscape Quality Protocol* (Axelsson, Nilsson & Berglund 2010; Axelsson 2011)
Individual differences	broad personality traits (John & Srivastava 1999; Russell & Mehrabian 1977) narrow construct: noise sensitivity (Weinstein 1978; Belojevic et al. 2012)

Mechanisms of ***emotion induction*** are regarded as *information-processing devices at different levels of the brain, which utilize distinct types of information to guide future behavior*

mechanisms ⟷ **mental representations**

physical state that conveys some meaning or information about the state of the world within a specific processing system

emotions… are embodied phenomena that serve to guide action
continuous **interaction** between the perceiver and the ecology
sensori-motoric links… essential – see *Action-Sound Couplings*

Juslin, P. N. (2013). "From everyday emotions to aesthetic emotions: towards a unified theory of musical emotions". *Physics of life reviews*, *10*(3), 235-266.

BRECVEMA

Brain stem reflex

Rhythmic entrainment

Evaluative conditioning

Contagion

Visual imagery

Episodic memory

Musical expectancy

+ *Aesthetic judgement*

Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. Behavioral and brain sciences, 31(05), 559-575.

Schafer's event

*"**soundscape** is a perceptual construct originating in sound sources, distributed in space and time, in a physical environment" (BS/ISO 2014)*

two typological divisions of the sonic realm

Source **referential aspects** ∈ {'natural', 'human', 'society', 'mechanical', 'silence', 'indicators')

Significance **purpose** ∈ { 'keynote', 'signal', 'soundmark'}

https://www.nfb.ca/playlists/governor-general-awards-2009/viewing/listen/

sound event = *"smallest self-contained part of a soundscape" (Schafer 1977/94)*

Like Schaeffer's 'sound object', the *sound event* is a phenomenological object to which semantic meaning might be attributed, but – conversely – it is *not a "laboratory specimen"* and rather a "nonabstractable point of reference, *related to a whole* of greater magnitude than itself" (Schafer 1977/94 p. 274).

Sound as soundscape

(Schafer 1977; Truax 2001; Augoyard et al. 2006; Kang 2010)

"perceptual construct originating in sound sources, distributed in space and time, in a physical environment" (BS/ISO 2014)

Ubiquity *"everywhere"* (Amphoux 1995)
diffuse, unstable, omnidirectional sound (Hellström 2003)

Metabole *"metabolic effect is in time what ubiquity is in space"* (Chelkoff 1995; 2006)
whole soundscape perceived as a static entity ≈ blurred detail

Sound as event

event = smallest self-contained part of a soundscape (Schafer 1977)
two typological divisions of the sonic realm

Source referential aspects ∈ {'natural', 'human', 'society', 'mechanical', 'silence', 'indicators')

Significance purpose ∈ { 'keynote', 'signal', 'soundmark'}

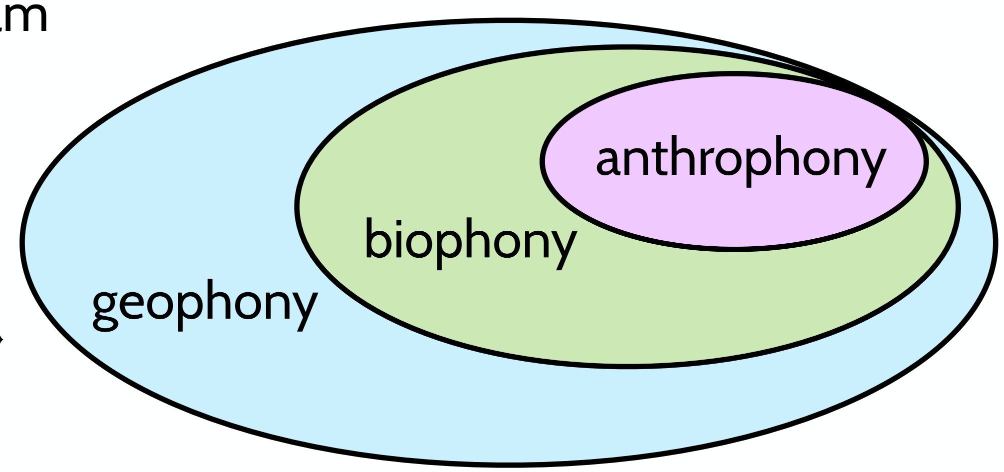
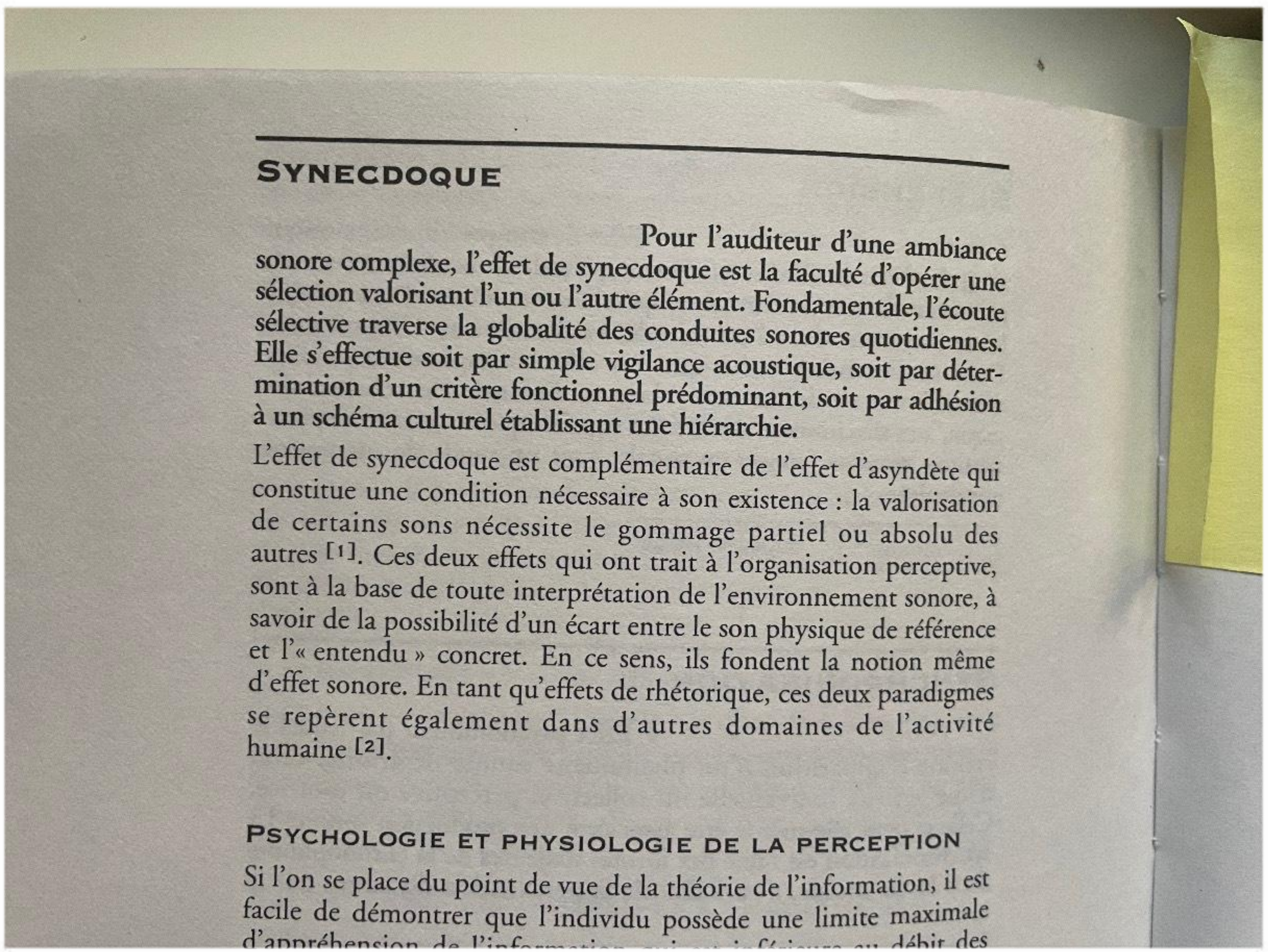


Fig. Three classes of sound by source. After Krause (2008).

Synechdoche

evaluation and selection (Thibaud 1995; cf. Västfjäll 2003; Bregman 1990)
organises perception of time; enables experience of duration (Thibaud 2006)
recognition (cf. Tuuri & Eerola 2012), language learning (Thibaud 2006)



SYNECDOQUE

Pour l'auditeur d'une ambiance sonore complexe, l'effet de synecdoque est la faculté d'opérer une sélection valorisant l'un ou l'autre élément. Fondamentale, l'écoute sélective traverse la globalité des conduites sonores quotidiennes. Elle s'effectue soit par simple vigilance acoustique, soit par détermination d'un critère fonctionnel prédominant, soit par adhésion à un schéma culturel établissant une hiérarchie.

L'effet de synecdoque est complémentaire de l'effet d'asyndète qui constitue une condition nécessaire à son existence : la valorisation de certains sons nécessite le gommage partiel ou absolu des autres [1]. Ces deux effets qui ont trait à l'organisation perceptive, sont à la base de toute interprétation de l'environnement sonore, à savoir de la possibilité d'un écart entre le son physique de référence et l'« entendu » concret. En ce sens, ils fondent la notion même d'effet sonore. En tant qu'effets de rhétorique, ces deux paradigmes se repèrent également dans d'autres domaines de l'activité humaine [2].

PSYCHOLOGIE ET PHYSIOLOGIE DE LA PERCEPTION

Si l'on se place du point de vue de la théorie de l'information, il est facile de démontrer que l'individu possède une limite maximale

Synechdoche

“sound gives access to what is happening” (Thibaud 2011)

Synechdoche is the basis of perceptive selection… the faculty of a sound to stand out from the whole, and be understood as an event… It emphasises the permanence of the attributed source [and makes it] more likely to be remembered. *Synechdoche* organises the perception of time and enables the experience of duration. (Thibaud 2006 p. 124-5).

It is not the sound itself that pertains to things in the world, but rather, we understand **sound as evidence of action**. Ecological listening is innate: we spontaneously attribute auditory phenomena to causal actions (Chion 2009 p. 471; see also Tuuri & Eerola 2012; Lindborg 2016).

Synechdoche is at the basis of language learning.

Synechdoche —> Auditory scene analysis

psychoacoustics —> signal detection theory

reverse hierarchy theory (Nahum et al. 2008)

— multiple representation levels

— we tend to access higher representation levels, with more ecological representation

— multiple low-level representations

if high-level representation accesses the most appropriate low-level representation for a task (this may take time), the two become equivalent

reduced listening (Schaeffer 1960)

gestalt rules

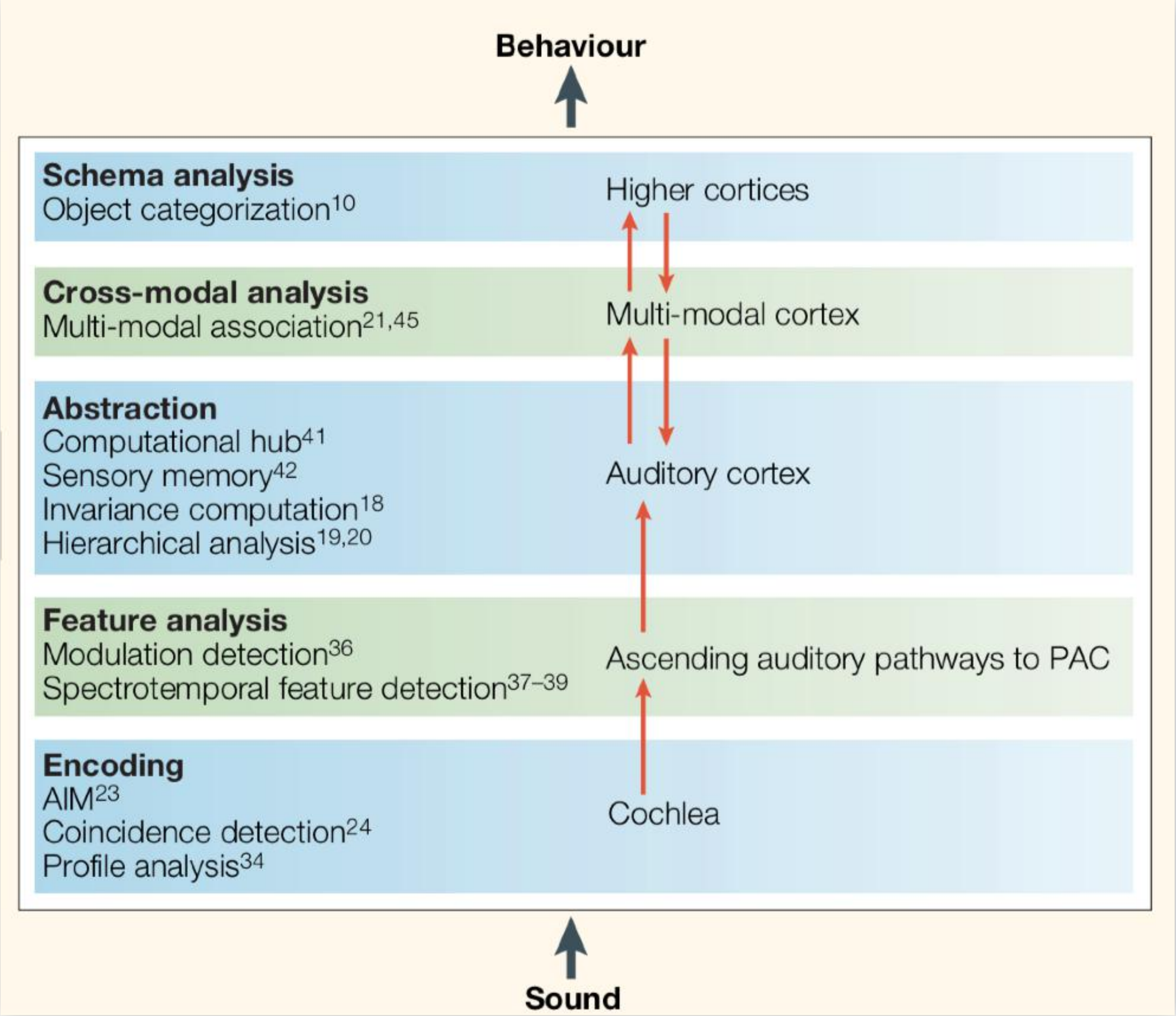
"the problem of auditory scene analysis can be tackled only with the help of additional assumptions about the likely properties of sounds emitted by sound sources in the real world" (Schnupp et al. p. 233 ff.)

common onset
harmonic structure
common interaural time difference

Synechdoche —> Auditory scene analysis

four principles for defining **auditory objects** (Griffiths and Warren 2004)

- pertain to things in the sensory world
- generalize across senses
- involve abstraction of sensory information
- separate the object from the rest of the world [auditory scene]



models are based explicitly on the formation of an auditory-object representation or image in the cochlea, where this image is present in the firing pattern of the auditory nerve fibres

both time-domain
and frequency-domain representations

Swedish Soundscape Quality Protocol

To what extent do you presently hear the following 5 types of sounds? Please tick off one response alternative per type of sound.

	Do not hear at all	A little	Moderately	A lot	Dominates completely
1. Traffic noise (e.g., cars, buses, trains, air-planes)	☐	☐	☐	☐	☐
2. Fan noise (e.g., ventilation)	☐	☐	☐	☐	☐
3. Other noise (e.g., construction noise, industry, machines, sirens, music, etc.)	☐	☐	☐	☐	☐
4. Sounds from human beings (e.g., conver-sation, laughter, children at play, footsteps)	☐	☐	☐	☐	☐
5. Natural sounds (e.g., wind whispering in the trees, flowing water, singing birds)	☐	☐	☐	☐	☐

Overall, how would you describe the present surrounding sound environment?

Very good	Good	Neither good, nor bad	Bad	Very bad
☐	☐	☐	☐	☐

To what extent do you agree with the 8 statements below on how you experience the present surrounding sound environment? Please tick off one response alternative per statement.

The sound environment is:	Agree completely	Agree largely	Neither agree, nor disagree	Disagree largely	Disagree completely
-- pleasant	☐	☐	☐	☐	☐
-- chaotic	☐	☐	☐	☐	☐
-- exciting	☐	☐	☐	☐	☐
-- uneventful	☐	☐	☐	☐	☐
-- calm	☐	☐	☐	☐	☐
-- annoying	☐	☐	☐	☐	☐
-- eventful	☐	☐	☐	☐	☐
-- monotonous	☐	☐	☐	☐	☐

Do you find the present surrounding sound environment appropriate for the present place?

Yes ☐

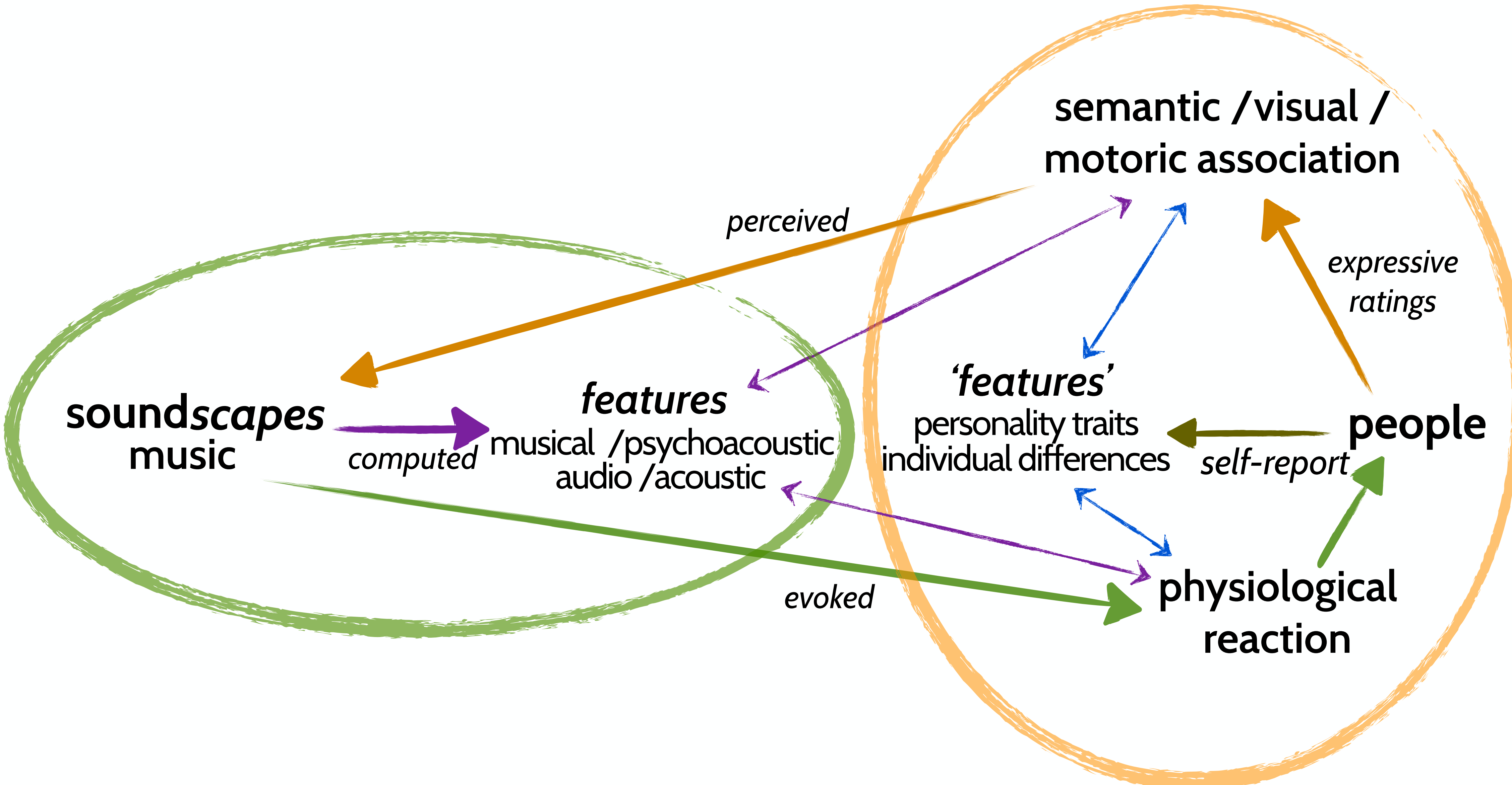
No ☐ If no, why not? ______________________

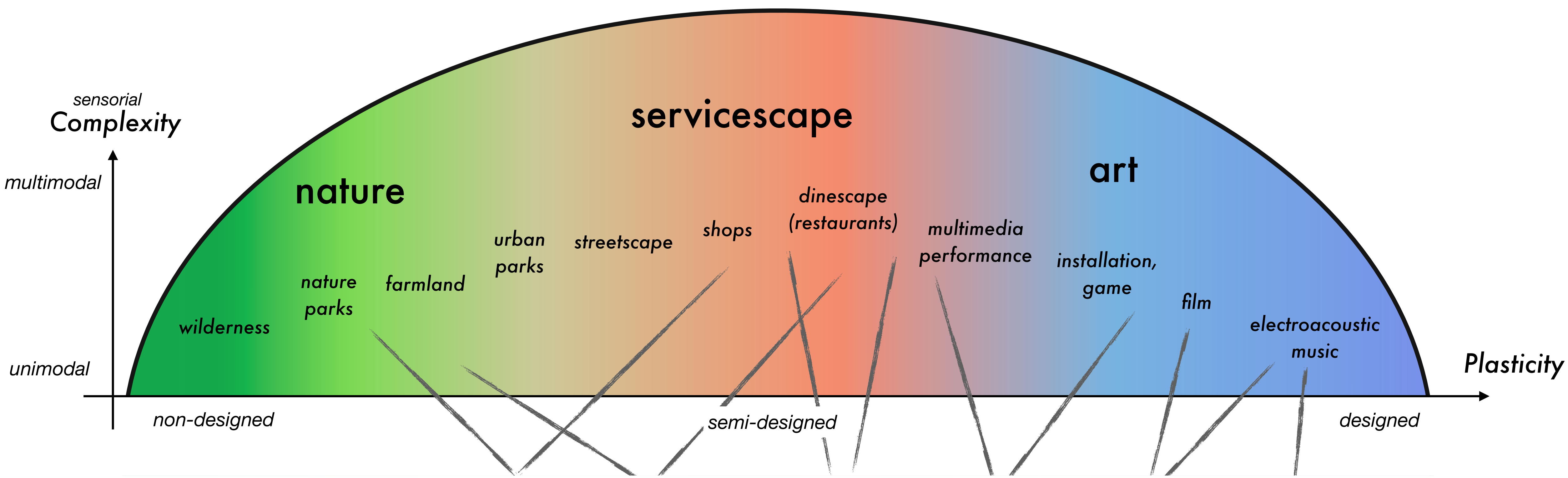
Overall, how would you describe the surrounding visual environment?

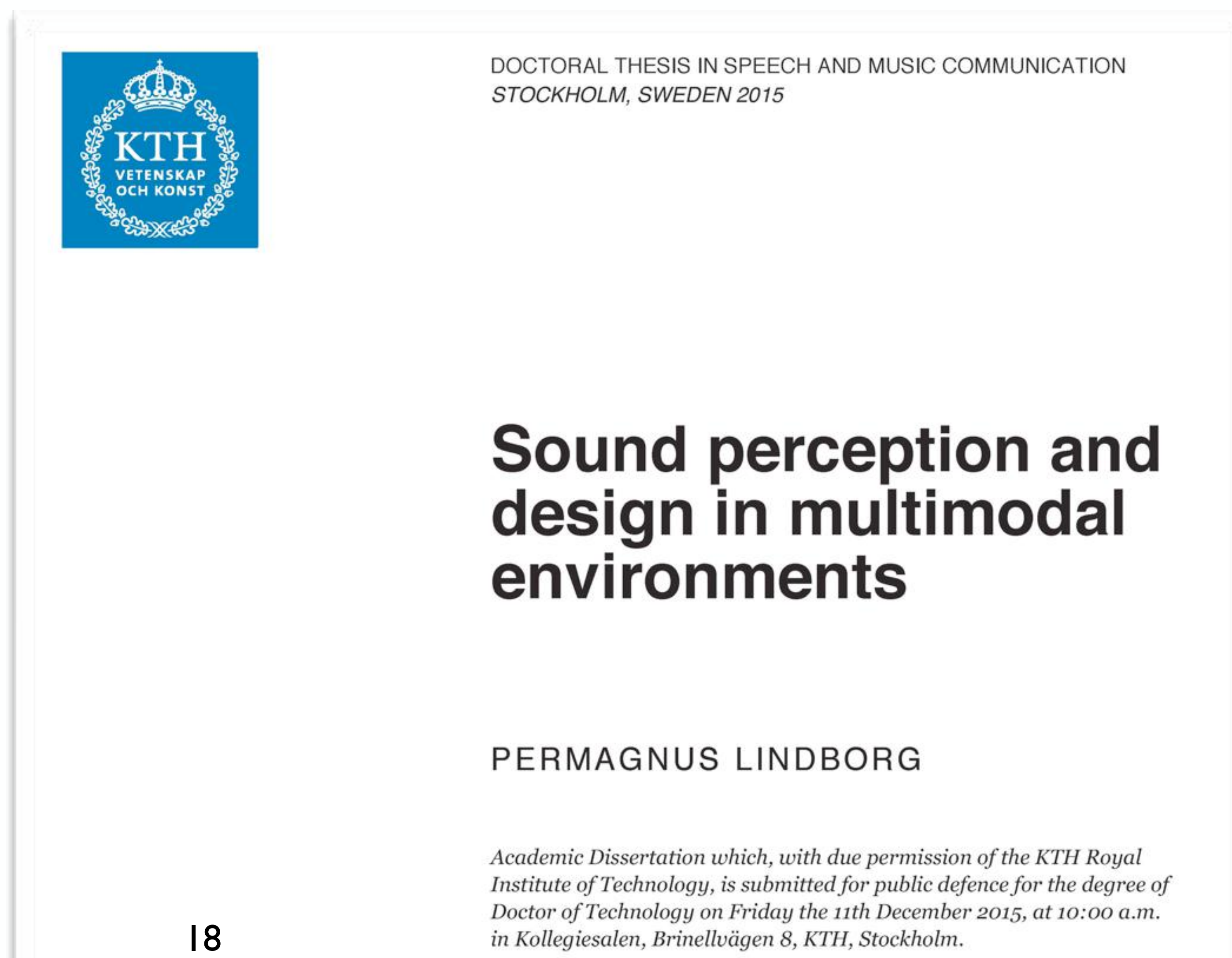
Very good	Good	Neither good, nor bad	Bad	Very bad
☐	☐	☐	☐	☐

Östen Axelsson

https://www.google.com.sg/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&ved=0ahUKEwi4ltn3scTWAhVEso8KHfxaCGsQjBwIBA&url=https%3A%2F%2Fmitti.se%2Fimages%2F1355721-650x.jpg&psig=AFQjCNED23Y85F36-jnvpEsAzMkKdafoCQ&ust=1506568170138116


semantic /visual /
motoric association
perceived
expressive
ratings
soundscapes
music
computed
features
musical /psychoacoustic
audio /acoustic
'features'
personality traits
individual differences
self-report
people
evoked
physiological
reaction




DOCTORAL THESIS IN SPEECH AND MUSIC COMMUNICATION
STOCKHOLM, SWEDEN 2015

KTH VETENSKAP OCH KONST

Sound perception and design in multimodal environments

PERMAGNUS LINDBORG

Academic Dissertation which, with due permission of the KTH Royal Institute of Technology, is submitted for public defence for the degree of Doctor of Technology on Friday the 11th December 2015, at 10:00 a.m. in Kollegiesalen, Brinellvägen 8, KTH, Stockholm.

How do we listen?

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Situations of listening

> As I close my door and walk down the stairs, the motor-driven lock mechanism heralds a sequence of percussive metallic clicks, in counterpoint with my creaking shoes and, through their door, laughter from the neighbor's child. I'm in a space with stone floor and concrete walls. I stop, hold my breath, and wait for the reverberation tails of all three sounds to fade out. Silence is relative, and my attention is seamlessly drawn sounds from the outside: cars, birds, rustling leaves. I'm late.

In what ways do we listen to the soundscape? How do our concurrent activities, moods, and abilities determine the listening mode? What is it that allows us to experience arbitrary sounds in an everyday environment as elements in a musical composition?

> I am running through the rainforest along one of my favorite tracks that circles the hill: one hour outdoors activating muscles, bones, and ligaments. A heightened awareness of my heart: when running, I pay it due attention and gratitude. Suddenly I realize that for some time there has been music in my mind's ear – a motive, an ostinato, a chord sequence – and that I have had no awareness whatsoever of the forest sounds, or my footsteps, or breathing. Yet in the instant this observation emerges, the music evaporates, and all that I hear is exactly forest, footsteps, and breathing. The music remains as a trace in memory: a mental notation.

Why do ways of listening sometimes feel categorically different? Are there multiple parallel processing streams in our mind that compete for attention, as it were, knocking on the door to our executive control room? Or is what we call 'conscience' an emergent property, a mental scheme in temporary equilibrium: froth bouncing on streams of multiple parallel processes?

> The concert hall ushers didn't let me enter carrying a small backpack and sent me back to the ticket desk. I managed to

The reader might recognize or recall similar situations of listening. There is an infinite range of such stories, yet it might be possible to describe the range of listening modes with a fairly small number of concepts. Occasionally consciously and most often not, we sense, perceive, and inquire the relations between three entities: the soundscape – the perceived acoustic environment; its constituent elements – the observed, implied, or imagined sources that produce the sounds we perceive; and ourselves. We have an innate capacity to evaluate sounds in terms of usefulness and danger. Listening is what mediates between the perceiving organism and its environment.

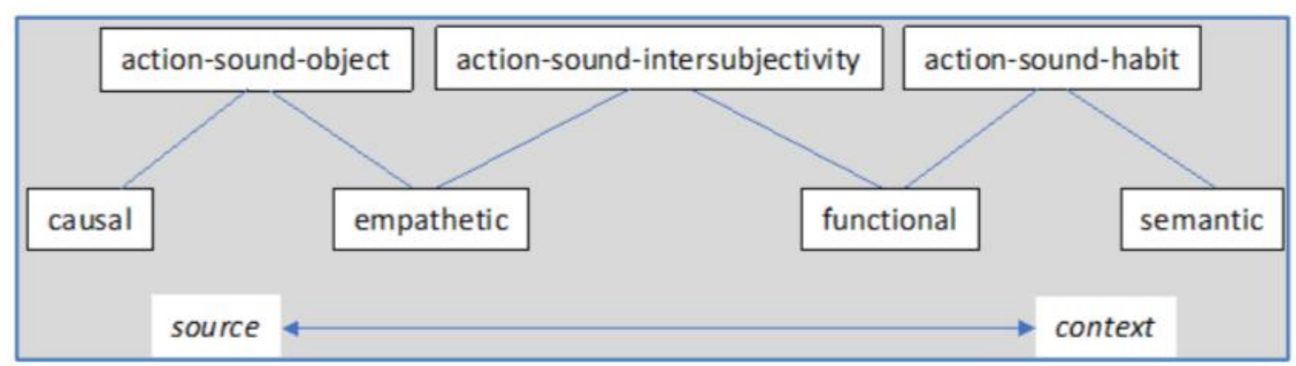

Figure 2. Associations between connotative (upper) and denotative (lower) listening modes. After Tuuri/ Eerola (2012).

The first situation
learn about our
and identifying th
other beings mig
Just as smelling
toxic plants, list
Sounds from sou
attention. As bio
faint sounds with
complexity, such
By contrast, shar
mechanism, signal danger even if the sounds are faint. The second vignette was about the internal process of sonic imagination. The principle of homeostasis explains an innate tendency to adapt our attitude towards the surroundings so as to maximize our chances of utilizing objects and beings to our benefit. Some soundscapes are dense in signals about danger, pleasure, friends and foes. Most often these are essential, but occasionally our survival instinct is suspended and the soundscape is largely ignored, or even replaced by something entirely different.

How do we listen?

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Situations of listening

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Schaeffer (1966)	Chion (2012)	Truax (2002)	Huron (2002)	Tuuri et al. (2007)	Tuuri/ Eerola (2012)	Juslin/ Västfjäll (2008)
ouïr	—	background listening	reflexive	pre-attentive	reflexive	brain stem reflex
					kinaesthetic	rhythmic entrainment
écouter	causal		connotative		connotative (three action-sound couplings)	evaluative conditioning
comprendre	semantic	listening-in-readiness	denotative	source-oriented	denotative (causal, empathetic, functional, semantic)	
			empathetic			emotional contagion
			associative	context-oriented		visual imagery
						episodic memory
entendre	reduced	listening-in-search		quality-oriented	reduced	musical expectancy
—	—		critical	(context-oriented)	critical	aesthetic judgement

Table 1. Overview of listening modes in different theories and frameworks.

nor second. Inexorably they bring on a crescendo to forte... Tartini on rampage... wild beating on everyone's eardrums. The audience writhes in awe.

ers/ Hogg 2006; further discussed in Vickers 2013, Vickers 2017), and Kai Tuuri's taxonomy for modes of listening

Journal of New Music Research
2012, Vol. 41, No. 2, pp. 137–152

Routledge
Taylor & Francis Group

Formulating a Revised Taxonomy for Modes of Listening

Kai Tuuri and Tuomas Eerola

University of Jyväskylä, Finland

Abstract

Listening to sounds or music is not a homogeneous act of grasping meanings by hearing. Yet it is often portrayed as such, especially when the intentional stance of a listener is overlooked. This paper distinguishes listening as the action-oriented intentional activity of making sense of the world. It is proposed that the multifaceted and heterogeneous nature of 'understanding by listening' can be outlined in terms of distinct modes of listening. Building upon previous accounts, a revised taxonomy of nine listening modes (reflexive, kinaesthetic, connotative, causal, empathetic, functional, semantic, reduced and critical listening) is proposed and illustrated by examples. Modes refer to different constituents of meaning-creation in the process of listening. In the taxonomy, they are schematically arranged into three levels (experiential, denotative and reflective). The theoretical framework of this revised taxonomy utilizes an embodied cognition paradigm. The experiential basis of meaning in listening is theoretically conceived of as emerging resonances between experiential patterns of sensations, structured

passive receiving'[1] of a sound and the latter as an intentional and attentional creation of meanings on the basis of the sonic experience. Intuit
acknowledge that this meaningful expe
dent on the way the sound is involved
and how we see its relevance to the conte
In most cases we do not experience sou
qualities or musical features; rather, we
sources and events taking place in a pa
ment. This already exemplifies two sep
listening, each referring to different ways
of potentially the same sound. The cen
article is to deepen understanding about
nature of knowing through sounds, and
coherent typology of different listening
basis of multidisciplinary literature, we w
each mode of listening is related to its
between the sound as an acoustic
perceiver's intentionality. In the cours
the different ways of meaning-creation h
been shaped to serve different aspects of
world.

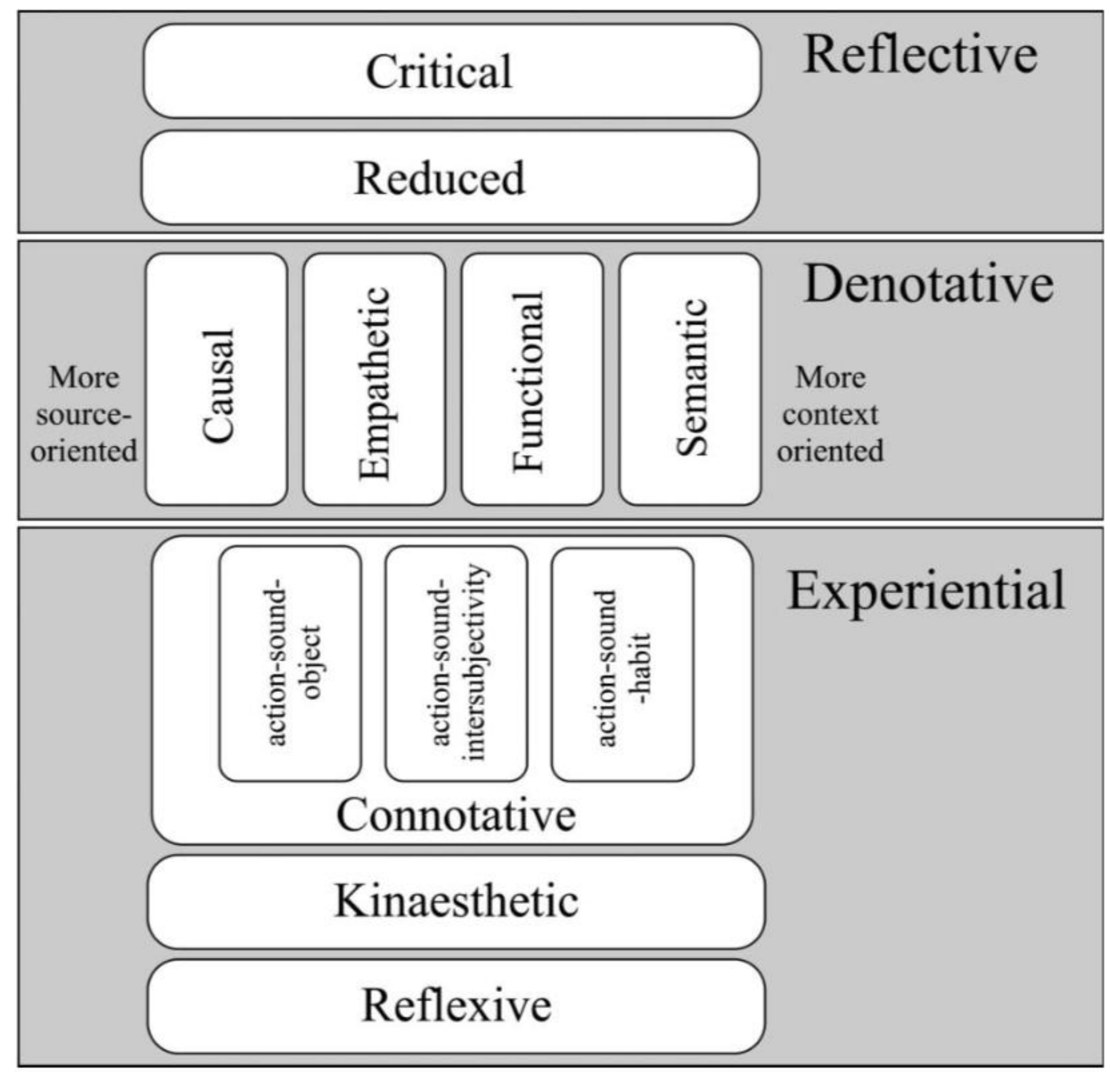


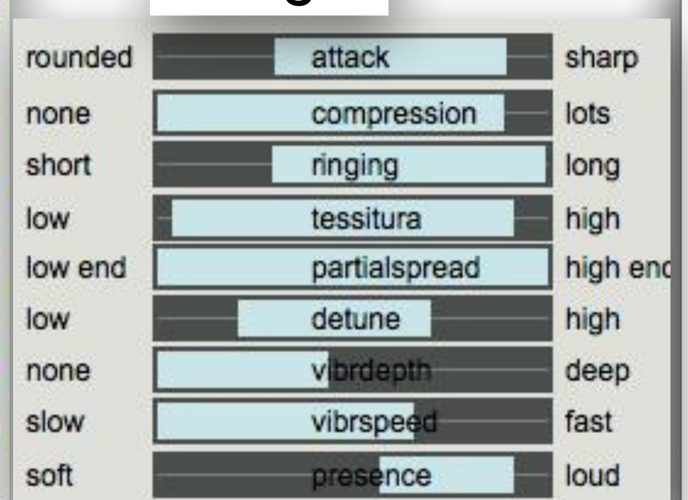
Fig. 3. Overview of the revised scheme for modes of listening.

Auditory system: ecological approach

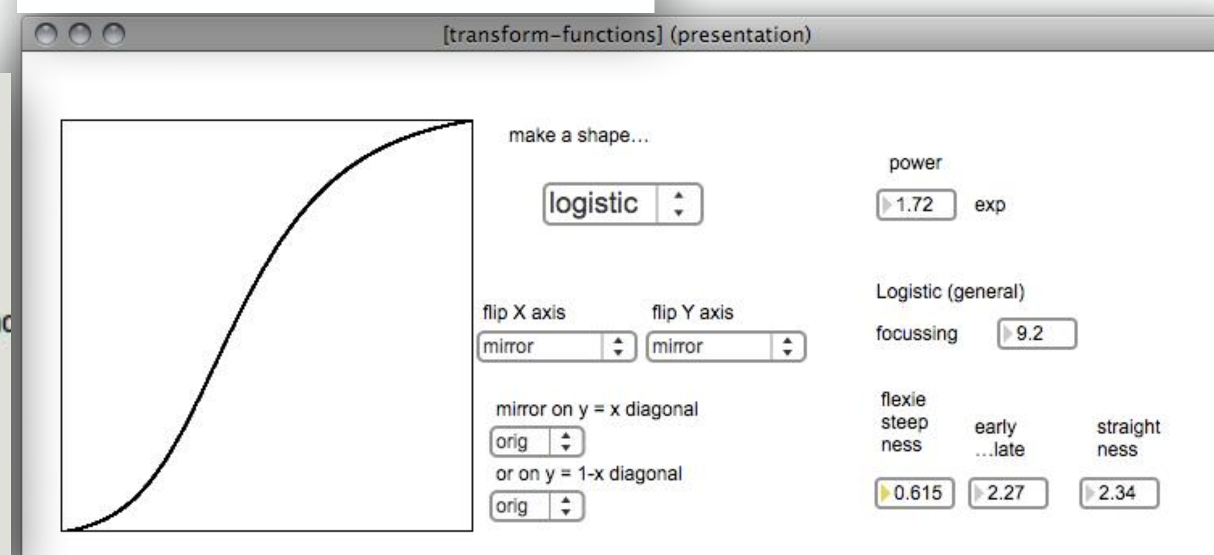
perceptual principles ~ cross-modal association (Lindborg & Friberg 2015, Lindborg 2016)

interactive parameter mapping

linkages



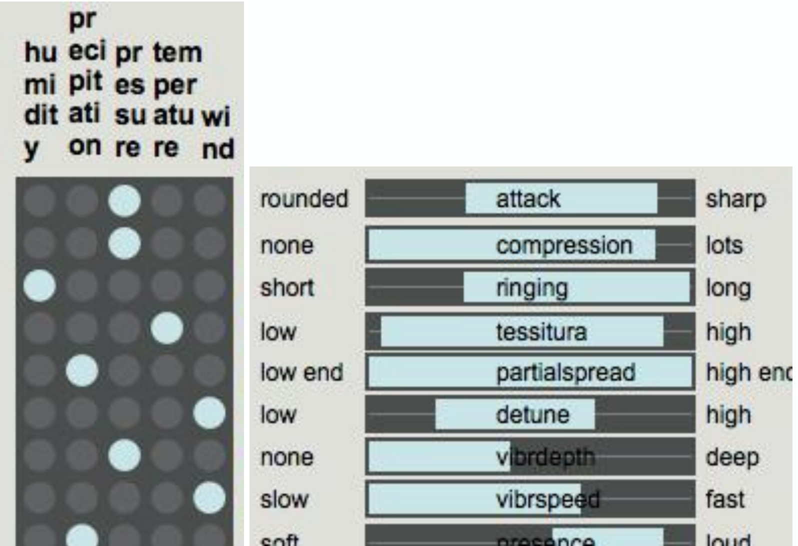
transfer functions



Auditory system:
ecological approach

(**reflexive**) “Is there an immediate danger!?”
•innate responses
•structural crossmodal associations

urgency ← switch “on”

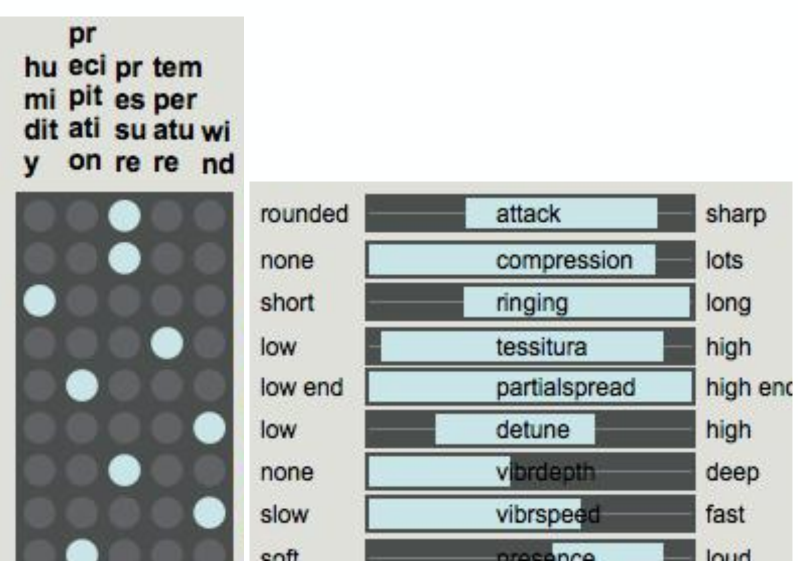


Auditory system:
ecological approach

(**kinaestethic**) affordances of perceptual experiences:
- "How does the sound physically manifest itself?"
- enactive perception (*doing*, cf. Noë 2004)

...harp-like structures scattered on a hill, lying on their back in the rain, with each drop causing a string to sound...

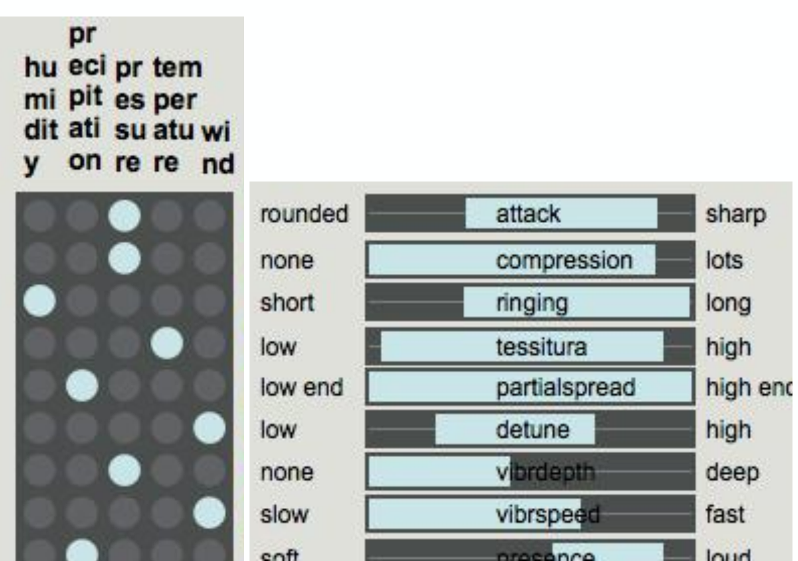
the pluck of a string is like a drop of rain ⟵ Karplus-Strong synthesis string model



Auditory system:
ecological approach

(**kinaestethic**) "Where does the sound come from?
Is it approaching or receding?"
•processing of spatial cues is largely pre-attentive
•gestural signatures (friend or foe)
•kinaesthetic action-sound couplings (mostly acquired)

geography ← *illusion of movement* ← spatialisation



Auditory system:
ecological approach

(**connotative**) *Kinaesthetic affordances* of perceptual experiences

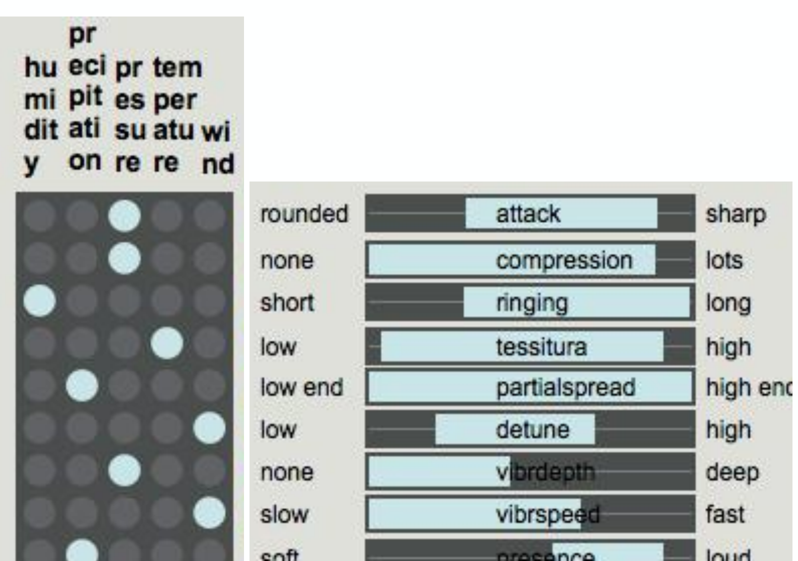
- "What does the sound *evoke* in me? Is it aggressive or inviting?"
- contextual orientations and anticipations
- listening mode depends on *emotional* crossmodal associations

cognitive appraisal of response alternatives (cf. "decisional consequences")

wind ← *illusion of 'bending'* ← harmonicity of chords [detuning]

pressure ← *emphasis* ← vibrato

humidity ← *resonance* ← feedback



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A taxonomy of sound sources in restaurants

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ABSTRACT

Restaurants are complex environments engaging all our senses. More or less designable sound sources, such as background music, voices, and kitchen noises, influence the overall perception of the soundscape. Previous research suggested typologies of sounds in some environmental contexts, such as urban parks and offices, but there is no detailed account that is relevant to restaurants. We collected on-site data in 40 restaurants ($n = 393$), including perceptual ratings, free-form annotations of characteristic sounds and whether they were liked or not, and free-form descriptive words for the environment as a whole. The annotations were subjected to cladistic analysis, yielding a multi-level taxonomy of perceived sound sources in restaurants (SSR) with good construct validity and external robustness. Further analysis revealed that voice-related characteristic sounds including a 'people' specifier were more liked than those without it ($d = 0.14$ SD), possibly due to an emotional crossmodal association mechanism. Liking of characteristic sounds differed between the first and last annotations that respondents made ($d = 0.21$ SD), which might be due to an initially positive bias being countered by exposure to a task inducing a mode of critical listening. Comparing the SSR taxonomy with previous classifications, we believe it will prove useful for field research, simulation design, and sound perception theory.

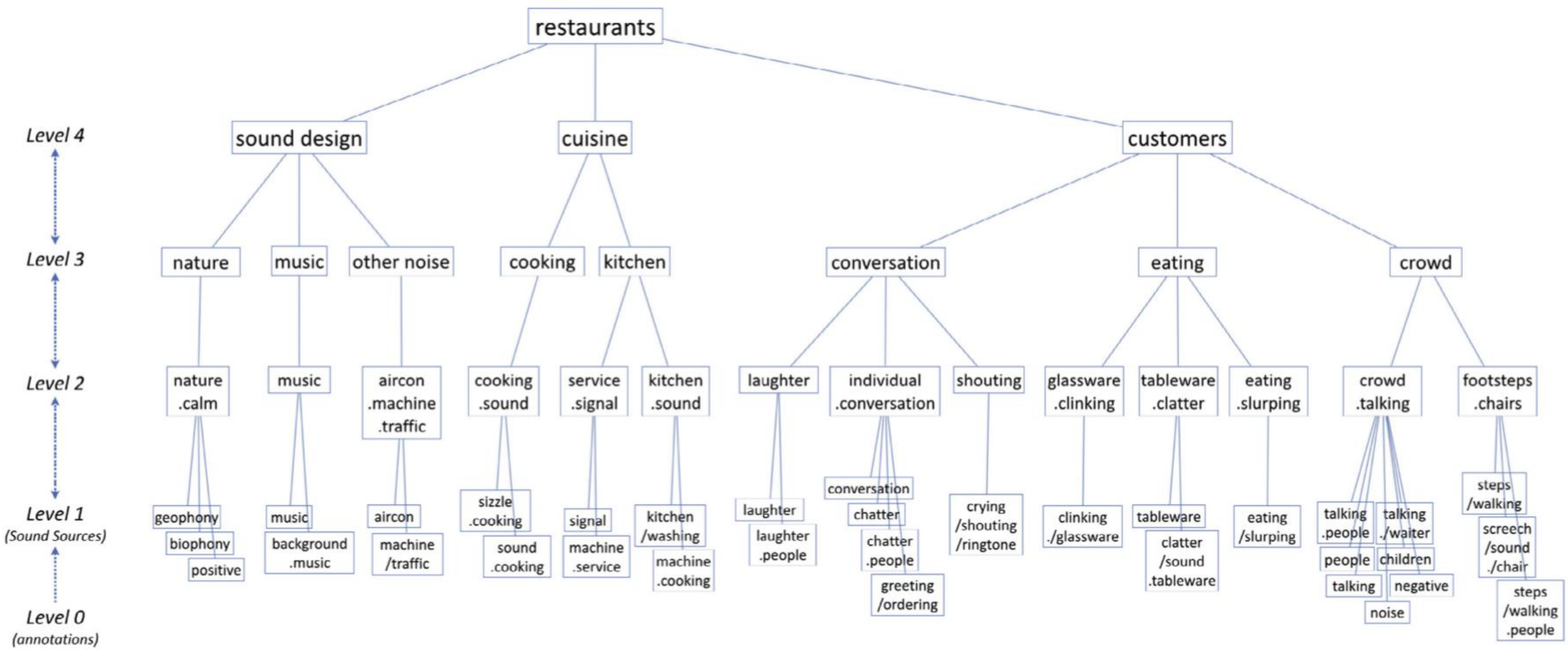
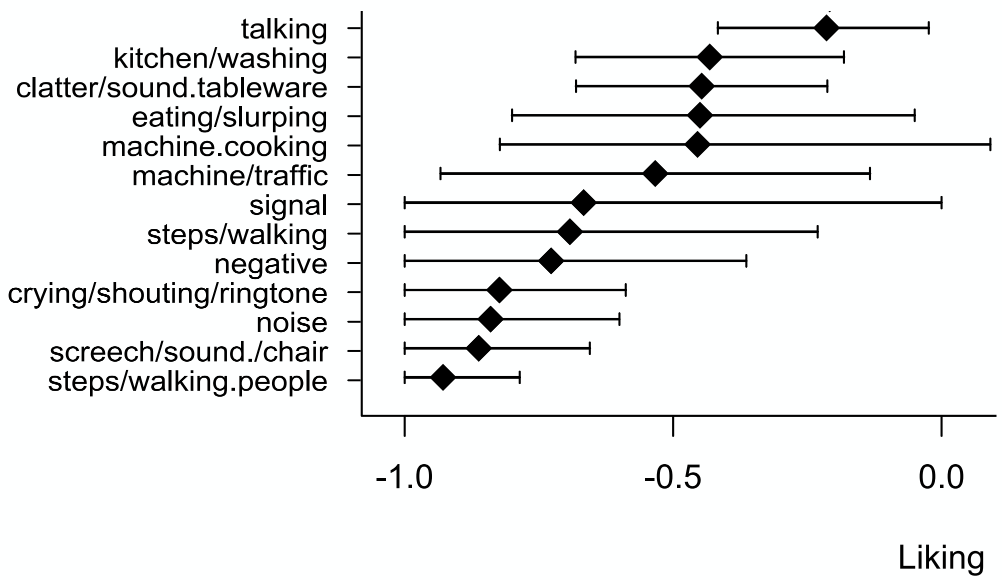
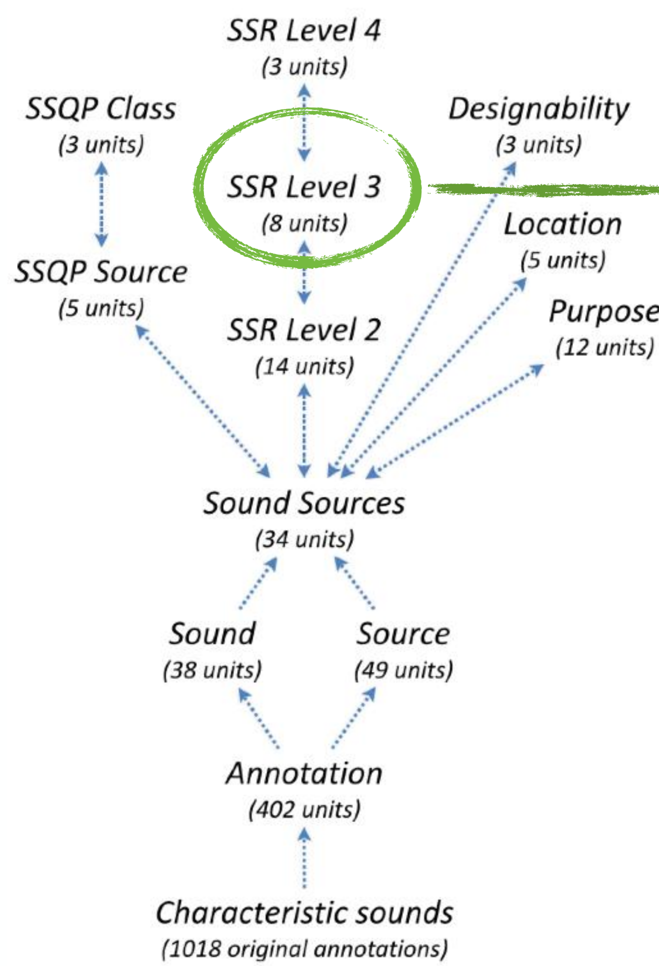


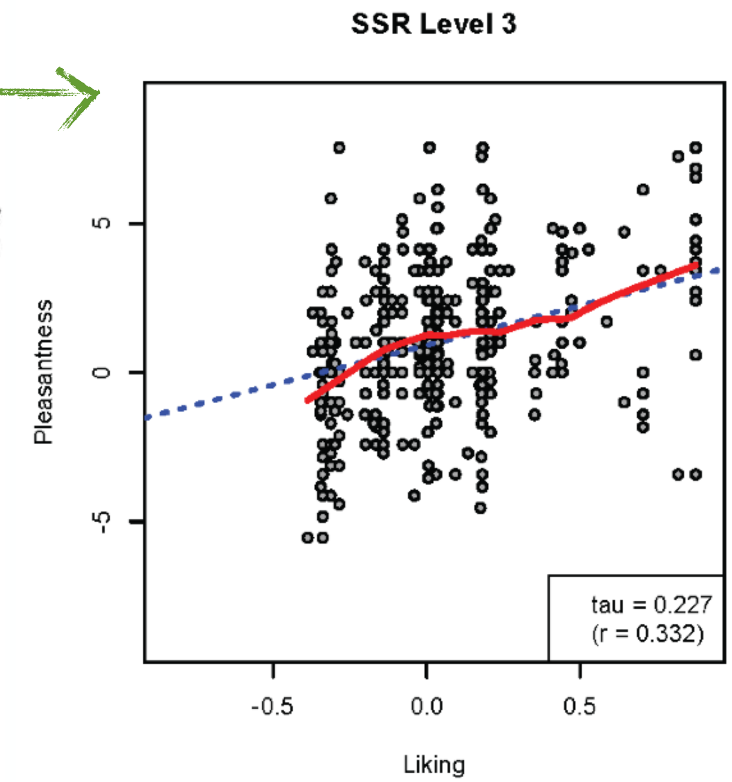
Fig. 6. Overview of the taxonomy of sound sources in restaurants (SSR).

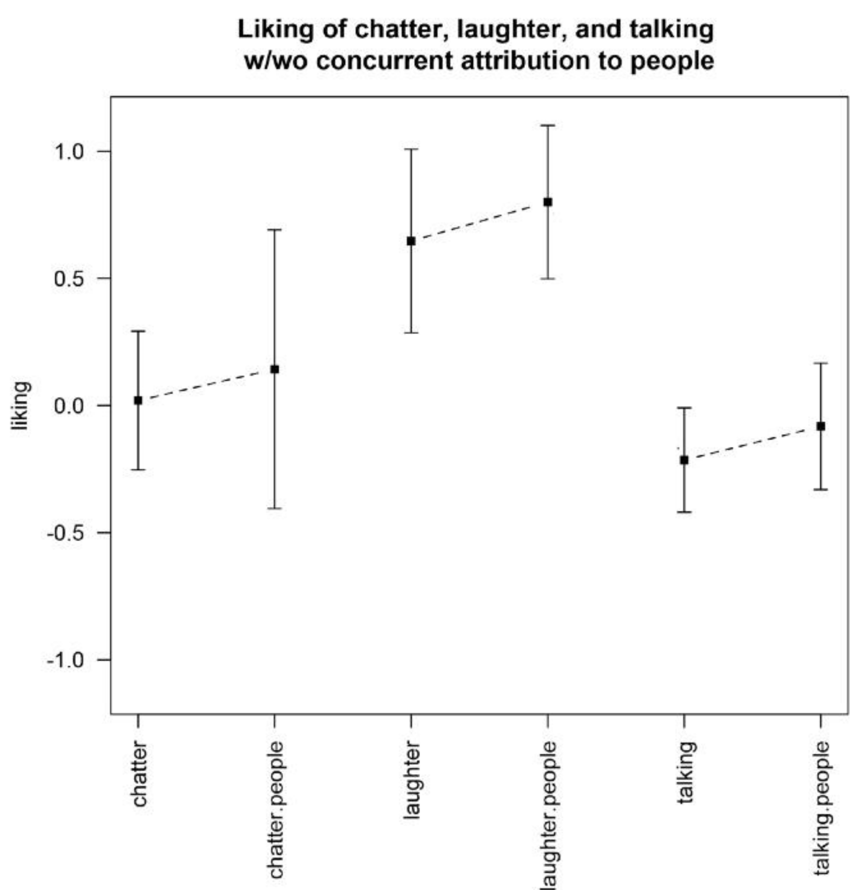
Lindborg PM (2016). "A taxonomy of sound sources in restaurants". *Applied Acoustics.*

Which sounds are liked or disliked in restaurants?









Restaurant sonic environment

Systematic classification of free-form annotations of characteristic sounds yielded a taxonomy (+validated).

Analysis revealed perceptual and crossmodal effects.

Example: voice-related annotations of characteristic sounds where 'people' was included as a specifier were more liked: possible emotional crossmodal association mechanism.

ORIGINAL RESEARCH article

Front. Psychol., 24 March 2021
Sec. Environmental Psychology
Volume 12 - 2021 | https://doi.org/10.3389/fpsyg.2021.570741

This article is part of the Research Topic
Human Perception of Environmental Sounds
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Soundscape in Times of Change: Case Study of a City Neighbourhood During the COVID-19 Lockdown

Sara Lenzi[1*] Juan Sádaba[2] PerMagnus Lindborg[3*]

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The coronavirus disease 2019 (COVID-19) lockdown meant a greatly reduced social and economic activity. Sound is of major importance to people's perception of the environment, and some remarked that the soundscape was changing for the better. But are these anecdotal reports based in truth? Has traffic noise from cars and airplanes really gone down, so that more birdsong can be heard? Have socially distanced people quietened down? This article presents a case study of the human perception of environmental sounds in an urban neighborhood in the Basque Country between 15 March and 25 May 2020. The social restrictions imposed through national legislation divided the 69-day period into three phases. We collected observations, field audio recordings, photography, and diary notes on 50 days. Experts in soundscape and architecture were presented with the recordings, in randomized order, and made two separate perceptual analyses. One group (N = 11) rated the recordings for pleasantness and eventfulness using an adapted version of the Swedish Soundscape Quality Protocol, and a partly overlapping group (N = 12) annotated perceived sound events with free-form semantic labels. The labels were systematically classified into a four-level Taxonomy of Sound Sources, allowing an estimation of the relative amounts of Natural, Human, and Technological sounds. Loudness and three descriptors developed for bioacoustics were extracted computationally. Analysis showed that Eventfulness, Acoustic Complexity, and Acoustic Richness increased significantly over the time period, while the amount of Technological sounds decreased. These observations were interpreted as reflecting changes in people's outdoor activities and behavior over the whole 69-day period, evidenced in an increased presence of Human sounds of voices and walking, and a significant shift from motorized vehicles toward personal mobility devices, again evidenced by perceived sounds. Quantitative results provided a backdrop against which qualitative analyses of diary notes and observations were interpreted in relation to the restrictions and the architectural specifics of the site. An integrated analysis of all sources pointed at the temporary suspension of human outdoor activity as the main reason for such a change. In the third phase, the progressive

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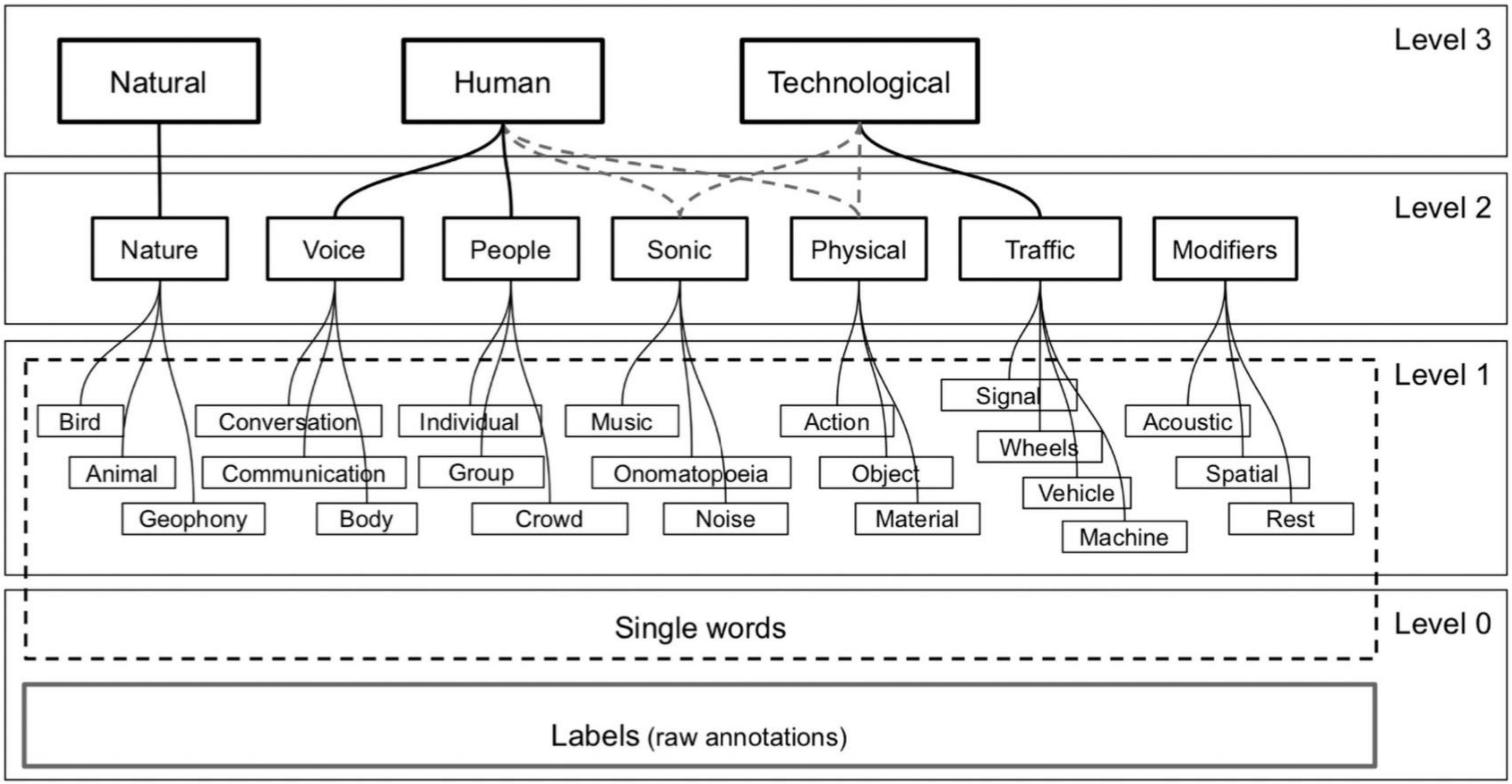

FIGURE 7 | Schematic representation of the Taxonomy of Sound Sources.

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DISTURBED SLEEP: ESTIMATING NIGHT-TIME SOUND ANNOYANCE AT A HOSPITAL WARD

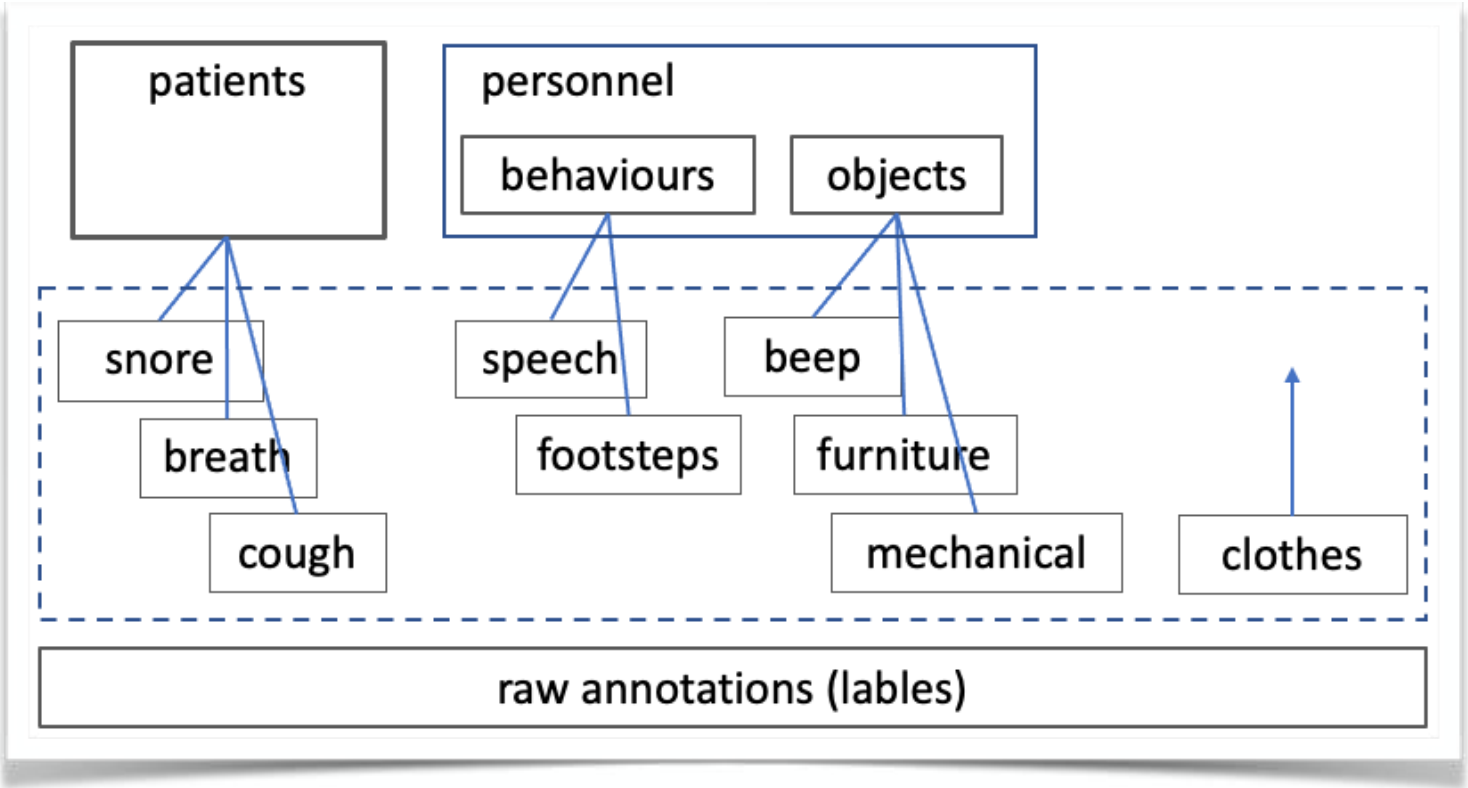
Sara Lenzi[1*] **PerMagnus Lindborg**[2] **Ningze Han** [2]
Simone Spagnol[3] **Daan Kamphuis**[4] **Elif Özcan**[1]
[1] Critical Alarms Lab, Delft University of Technology, The Netherlands
[2] School of Creative Media, City University Hong Kong, Hong Kong
[3] Iuav University of Venice, Italy [4] Reinier de Graaf Hospital, Delft, The Netherlands

ABSTRACT

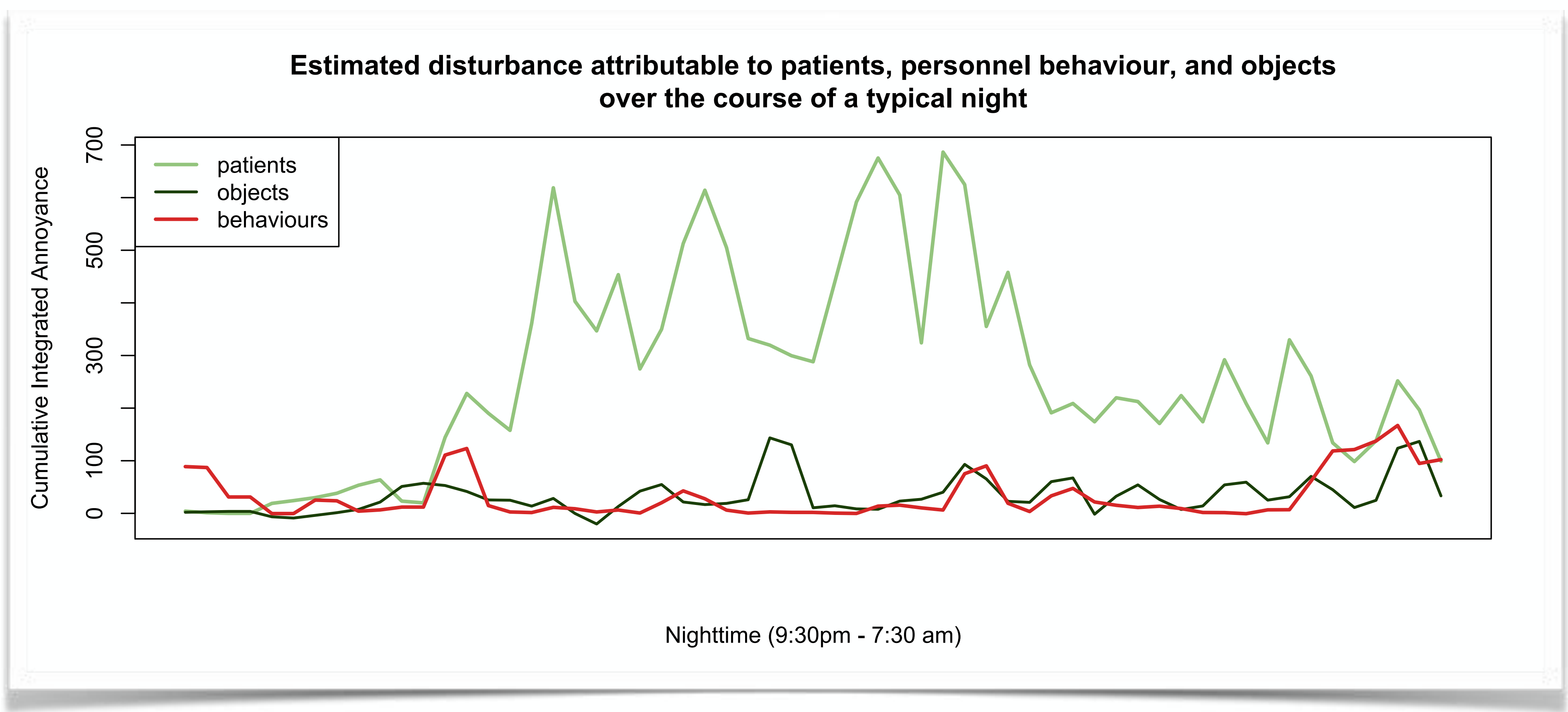
Hospital soundscapes are often associated with unhealthy sound levels and an overall perception of chaos and annoyance. Over the past four decades, concerns about the harmful effects of environmental noise on hospital stakeholders (patients, families, and healthcare professionals) were repeatedly raised by the scientific community. In this paper, the authors report a study they have conducted on the analysis of the soundscape of a multi-patient room in the Neurology unit in a Dutch hospital. The study employed sound source annotations by listeners to focus on what we claim is the most important emotional descriptor, namely annoyance. More than 9,000 sound events and their perceived annoyance were identified in over 400 night-time audio recordings. Analysis revealed that while patient-generated sounds such as snoring dominate the night-time soundscape and are identified as highly annoying, personnel-generated sounds such as speech might have an even higher accumulated annoyance when the duration of individual sound events is taken into account. This finding indicates the possibility of designerly approaches to improve the

1. INTRODUCTION

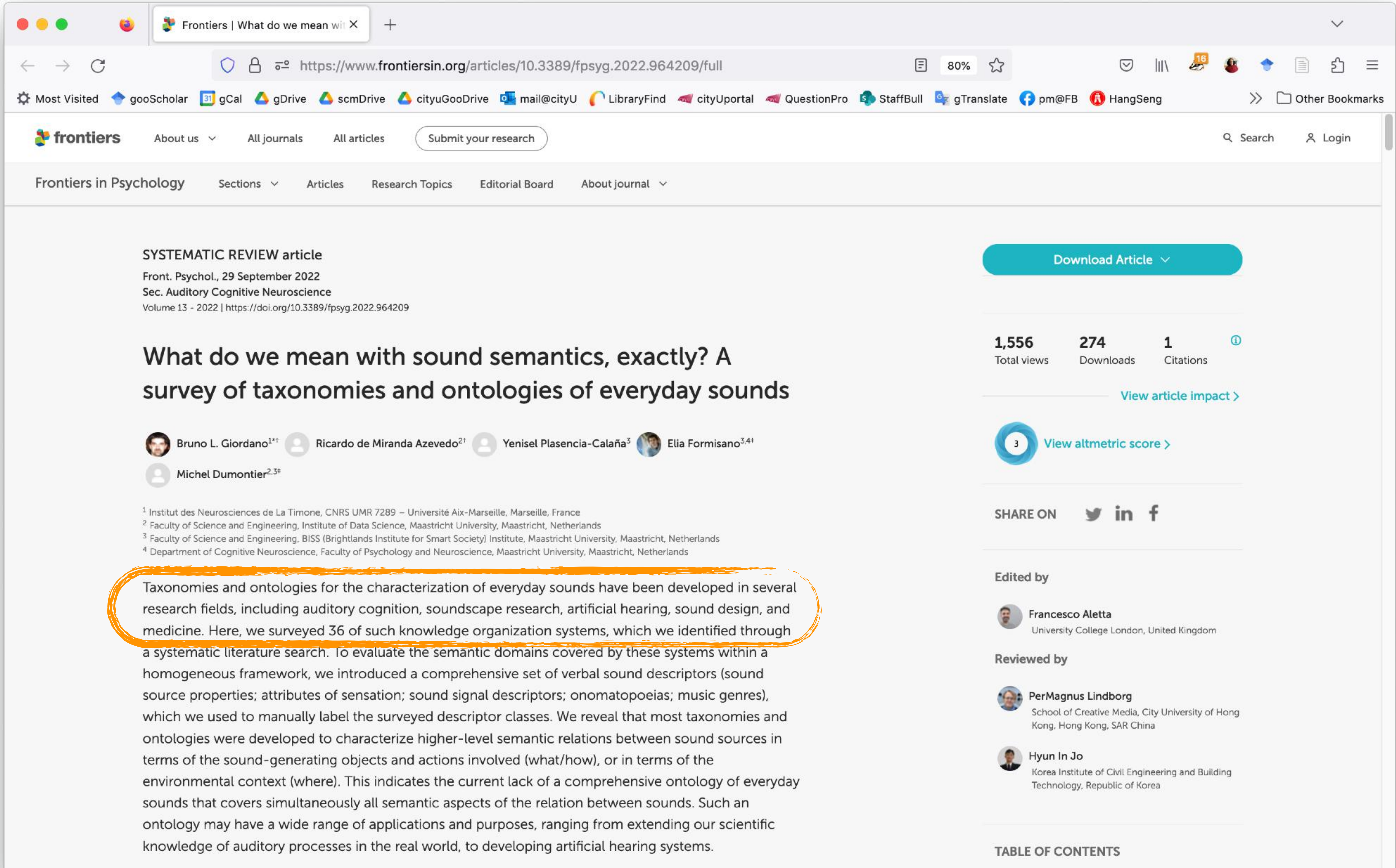
Since humans subconsciously perceive and react to sound even while asleep, sound events are a significant environmental factor that can interfere with our regular sleep patterns. As an external stressor, sound has been shown to cause neurophysiological changes in the brain, in particular in regions of the prefrontal cortex, amygdala, and hippocampus, which are involved in cognitive and emotional processing [1]. The listener's directed attention reorientation reflex is activated by sudden foreground sounds, and chaotic soundscapes do not provide sufficient time between sound events for psychological mechanisms, preventing arousal from returning to a normal, relaxed state ([2], p. 7). Interruptions by sound during sleep increases physiological and cardiovascular activity, disturbing sleep and augmenting the risk of stress, exhaustion, or mental health issues [3]. The detrimental impact of sound on sleep is recognized as a significant factor affecting human health and wellbeing, especially in hospitalised patients [4][5][6]. The recent thesis work by de Meyer [7] focuses on snoring as a major cause



patients
personnel
behaviours
objects
snore
breath
cough
speech
footsteps
beep
furniture
mechanical
clothes
raw annotations (lables)



Estimated disturbance attributable to patients, personnel behaviour, and objects over the course of a typical night
patients
objects
behaviours
Cumulative Integrated Annoyance
0
100
300
500
700
Nighttime (9:30pm - 7:30 am)



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SYSTEMATIC REVIEW article

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What do we mean with sound semantics, exactly? A survey of taxonomies and ontologies of everyday sounds

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Taxonomies and ontologies for the characterization of everyday sounds have been developed in several research fields, including auditory cognition, soundscape research, artificial hearing, sound design, and medicine. Here, we surveyed 36 of such knowledge organization systems, which we identified through a systematic literature search. To evaluate the semantic domains covered by these systems within a homogeneous framework, we introduced a comprehensive set of verbal sound descriptors (sound source properties; attributes of sensation; sound signal descriptors; onomatopoeias; music genres), which we used to manually label the surveyed descriptor classes. We reveal that most taxonomies and ontologies were developed to characterize higher-level semantic relations between sound sources in terms of the sound-generating objects and actions involved (what/how), or in terms of the environmental context (where). This indicates the current lack of a comprehensive ontology of everyday sounds that covers simultaneously all semantic aspects of the relation between sounds. Such an ontology may have a wide range of applications and purposes, ranging from extending our scientific knowledge of auditory processes in the real world, to developing artificial hearing systems.

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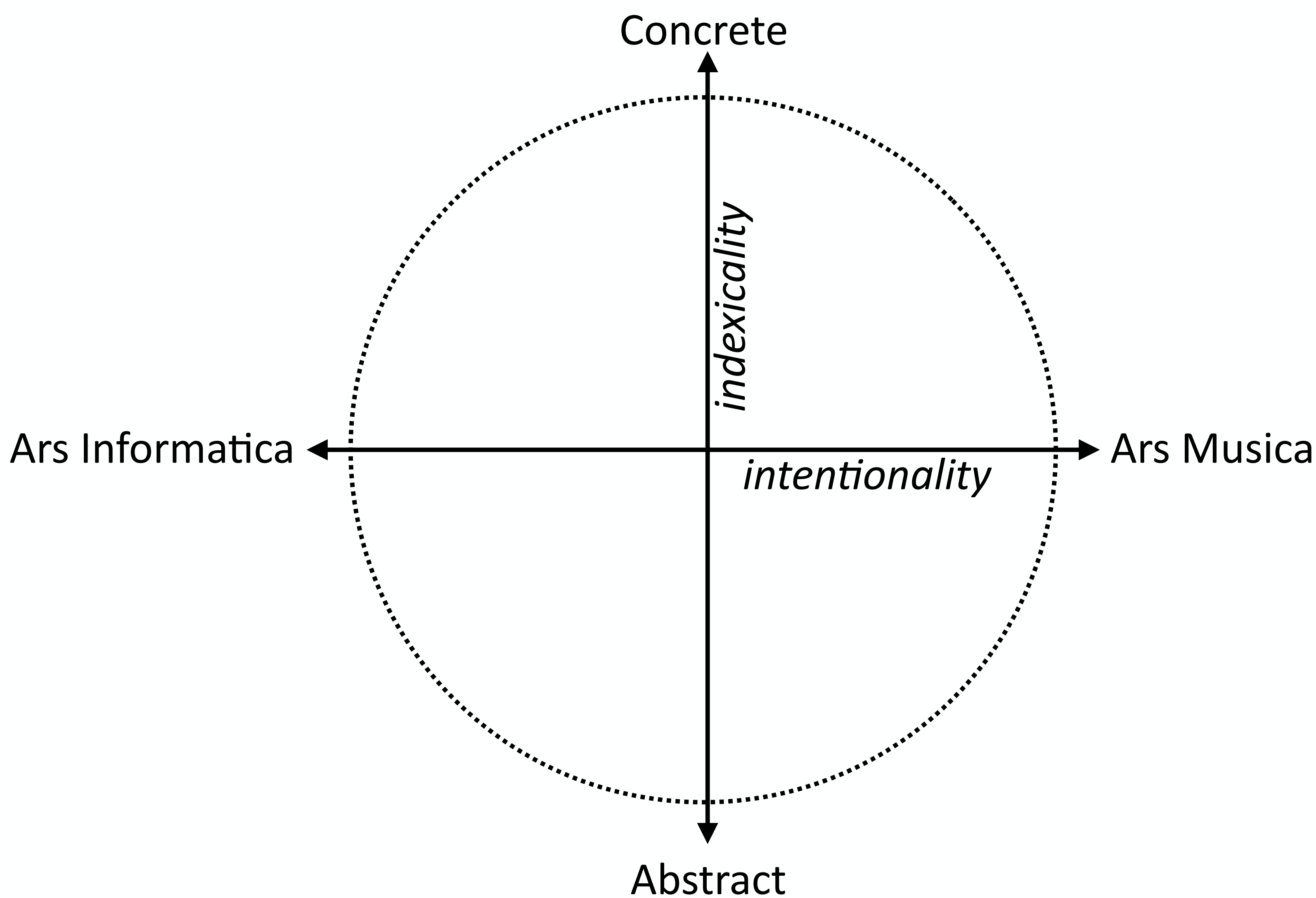
Sound design is to *composition* as graphic design is to visual imagination: a *method* for making

Aesthetic Perspective Space



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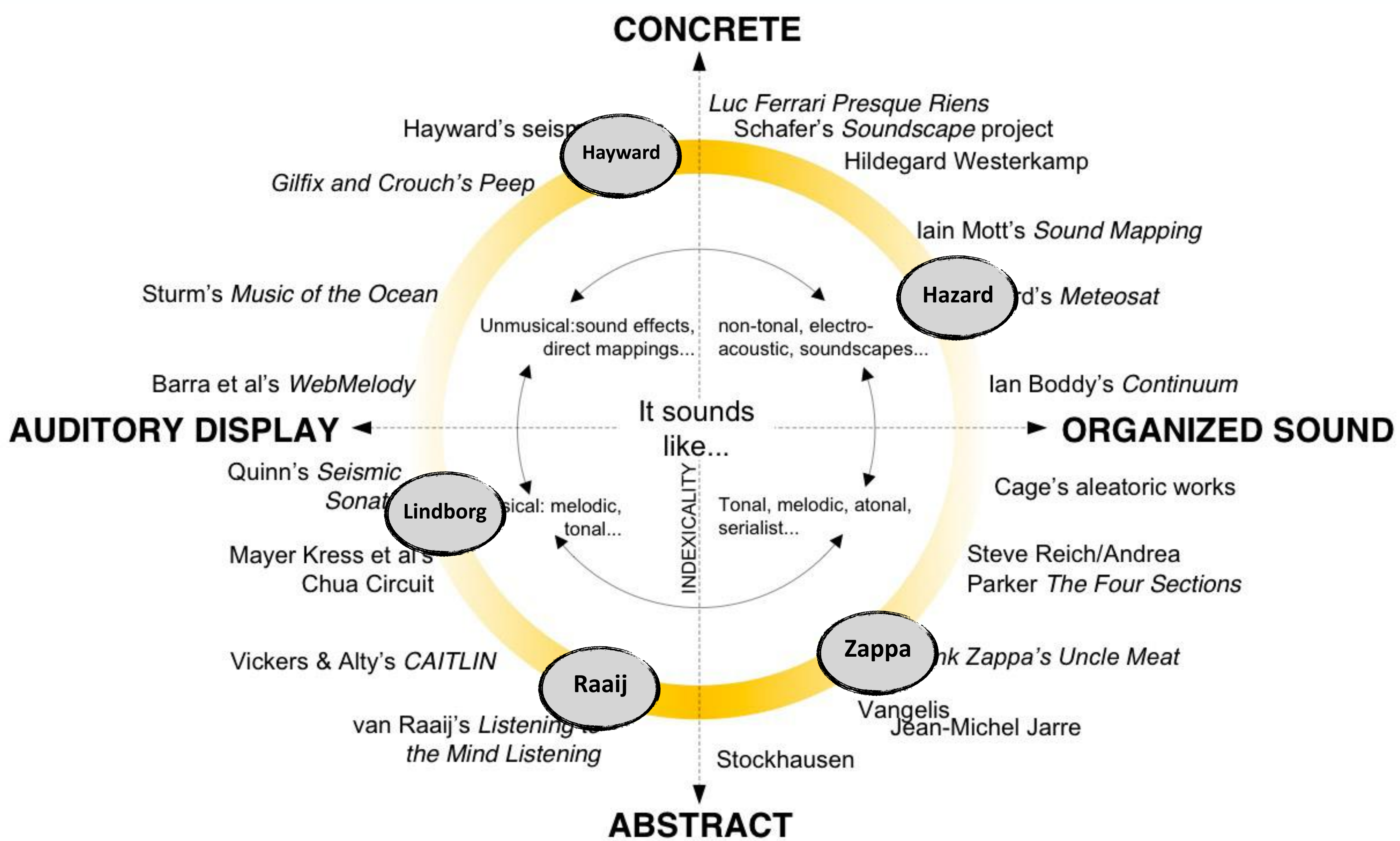

Vickers 2017

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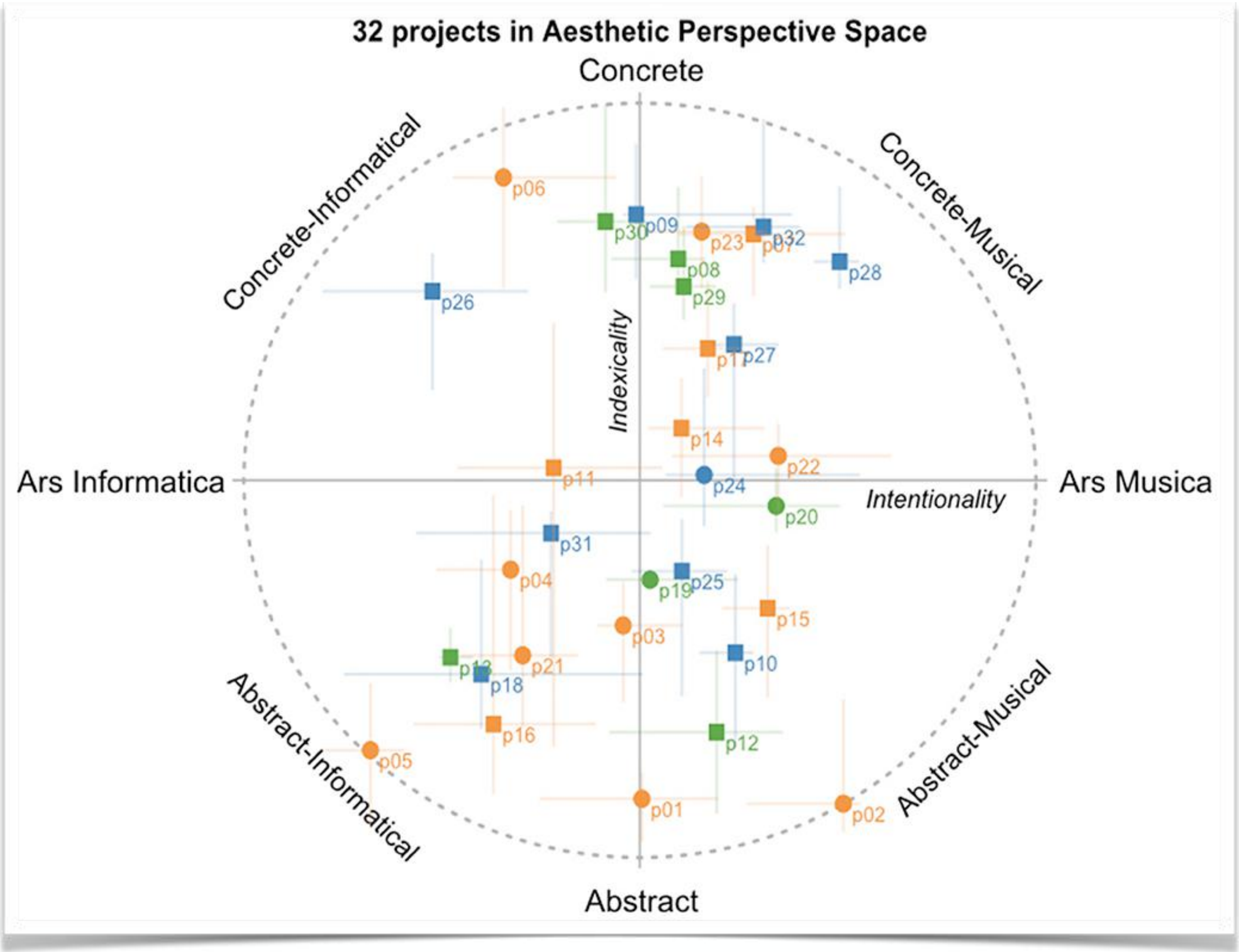
32 projects in Aesthetic Perspective Space
Concrete
Abstract
Ars Informatica
Ars Musica
Concrete-Informatical
Concrete-Musical
Abstract-Informatical
Abstract-Musical
Indexicality
Intentionality
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This article is part of the Research Topic
Data Perceptualization for Climate Science Communication
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Climate data sonification and visualization: An analysis of topics, aesthetics, and characteristics in 32 recent projects

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Introduction: It has proven a hard challenge to stimulate climate action with climate data. While scientists communicate through words, numbers, and diagrams, artists use movement, images, and sound. Sonification, the translation of data into sound, and visualization, offer techniques for representing climate data with often innovative and exciting results. The concept of sonification was initially defined in terms of engineering, and while this view remains dominant, researchers increasingly make use of knowledge from electroacoustic music (EAM) to make sonifications more convincing.

Methods: The Aesthetic Perspective Space (APS) is a two-dimensional model that bridges utilitarian-oriented sonification and music. We started with a review of 395 sonification projects, from which a corpus of 32 that target climate change was chosen; a subset of 18 also integrate visualization of the data. To clarify relationships with climate data sources, we determined topics and subtopics in a hierarchical classification. Media duration and lexical diversity in descriptions were determined. We developed a protocol to span the APS dimensions, Intentionality and Indexicality, and evaluated its circumplexity.

Results: We constructed 25 scales to cover a range of qualitative characteristics applicable to sonification and sonification-visualization projects, and through exploratory factor analysis, identified five essential aspects of the project descriptions, labeled Action, Technical, Context, Perspective, and Visualization. Through linear regression modeling, we investigated the prediction of aesthetic perspective from essential aspects, media duration, and lexical diversity. Significant regressions across the corpus were identified for Perspective ($ß = 0.41^{***}$) and lexical diversity ($ß = -0.23^{*}$) on Intentionality, and for Perspective ($ß = 0.36^{***}$) and Duration (logarithmic; $ß = -0.25^{*}$) on Indexicality.

Discussion: We discuss how these relationships play out in specific projects, also within the corpus subset

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