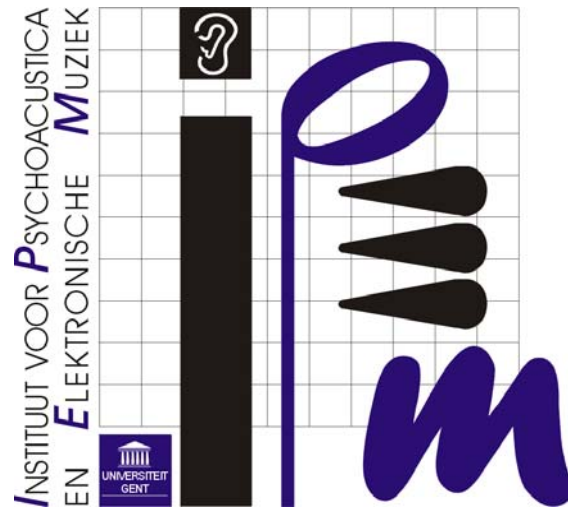




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<http://www.ipem.ugent.be/>

A user-oriented approach to Music Information Retrieval

Micheline Lesaffre, Marc Leman, Jean-Pierre Martens





OUTLINE

- Research @ IPEM
- CBMIR problems
- User-oriented CBMIR
- Conceptual framework
- User studies
- Survey on user context
- Semantic description of music
- MAMI Database
- Semantic Music Recommender



Research projects @ IPEM

CURRENT

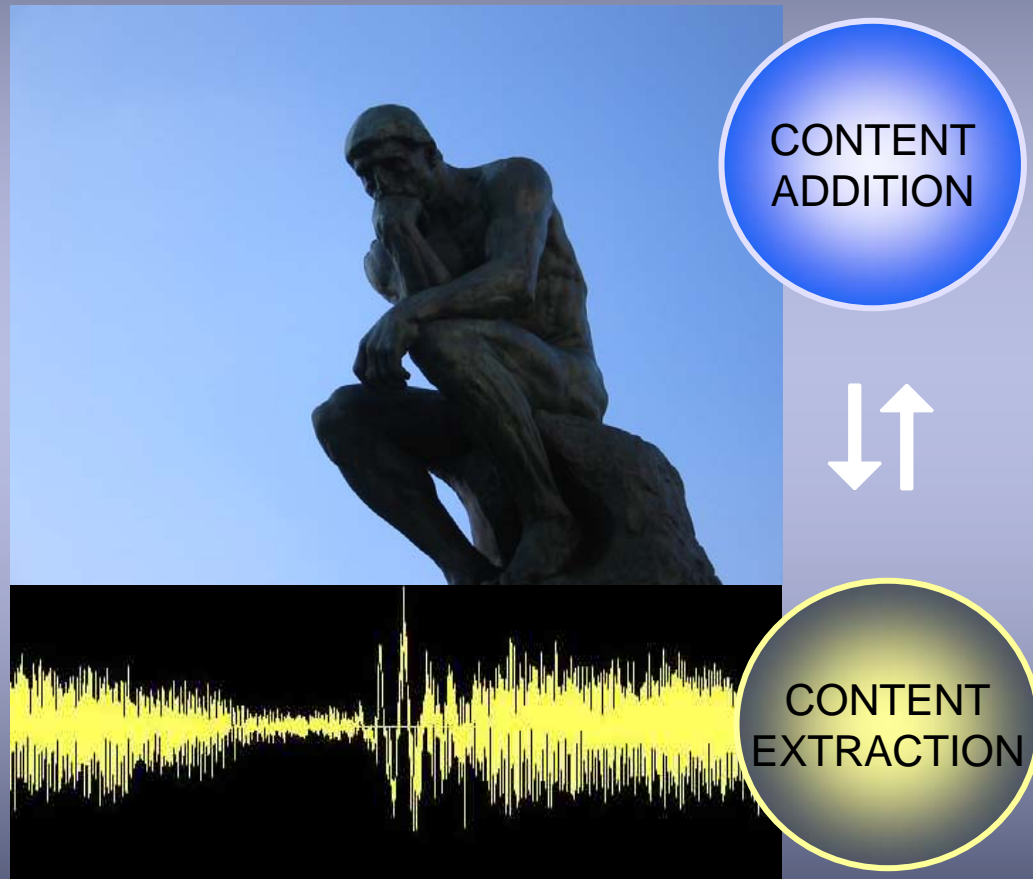
- DEKKMMA (POD): Digitalisation of the Ethnomusicological Sound Archive of KMMA
- ConGAS (EU, COST 287): Gestural Controlled Audio Systems
- GOASEMA (UGent): Semantic Description of Musical Audio
- S2S^2 (EU): Sound to Sense, Sense to Sound
- **DEMCO (FWO): new methods for the DEscription of Musical COntent**
- POFADEAM (EU): Preservation and On-line Fruition of Audio Documents
- MELO (UGent): Musical Electronic Learning Objects

PREVIOUS

- **IPEM Toolbox: an auditory toolbox for perception-based music analysis**
- IPEM-archive: Conservation and digitalization of the IPEM-archive
- SPEAC (UGent): Sensitive Processing of Artistic Content
- MEGA (EU, IST): Multisensory Expressive Gesture Applications
- ELDeM: Editing of the correspondence of composer Louis De Meester
- **MAMI (IWT): Musical Audio Mining - "Query-by-Humming"**

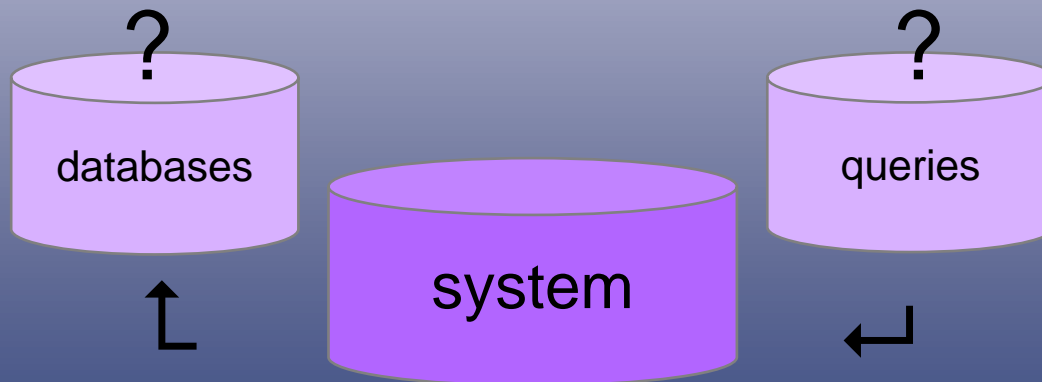
CBMIR: the missing link

Human information processing



Musical audio stream

a user-oriented approach





Conceptual framework for MIR

STRUCTURE		CONCEPT LEVEL		MUSICAL CONTENT FEATURES				
CONTEXTUAL	GLOBAL DESCRIPTORS	HIGH II	EXPRESSIVE	expression				
				affect- experience				
		HIGH I	STRUCTURAL	melody	harmony	rhythm	source	dynamics
				key profile	tonality cadence	patterns tempo	instrument voice	trajectory articulation
		MID	PERCEPTUAL					
				successive intervallic pattern	simultane intervallic pattern	beat i o i	spectral envelope	dynamic range sound level
NOT CONTEXTUAL	LOCAL DESCRIPTORS	LOW II	SENSORIAL	pitch		time	timbre	loudness
				periodicity pich pitch deviations fundamental frequency	note- duration onset offset	roughness spectral flux spectral- centroid	peak neural- energy	
		LOW I	ACOUSTICAL	frequency		duration	spectrum	intensity



User studies @ IPEM

EXPERIMENT 1

SPONTANEOUS BEHAVIOR

Production of vocal queries
« Query by Humming » paradigm

SURVEY

USER CONTEXT

User profile
Effects of demographic and musical background
Favorite music

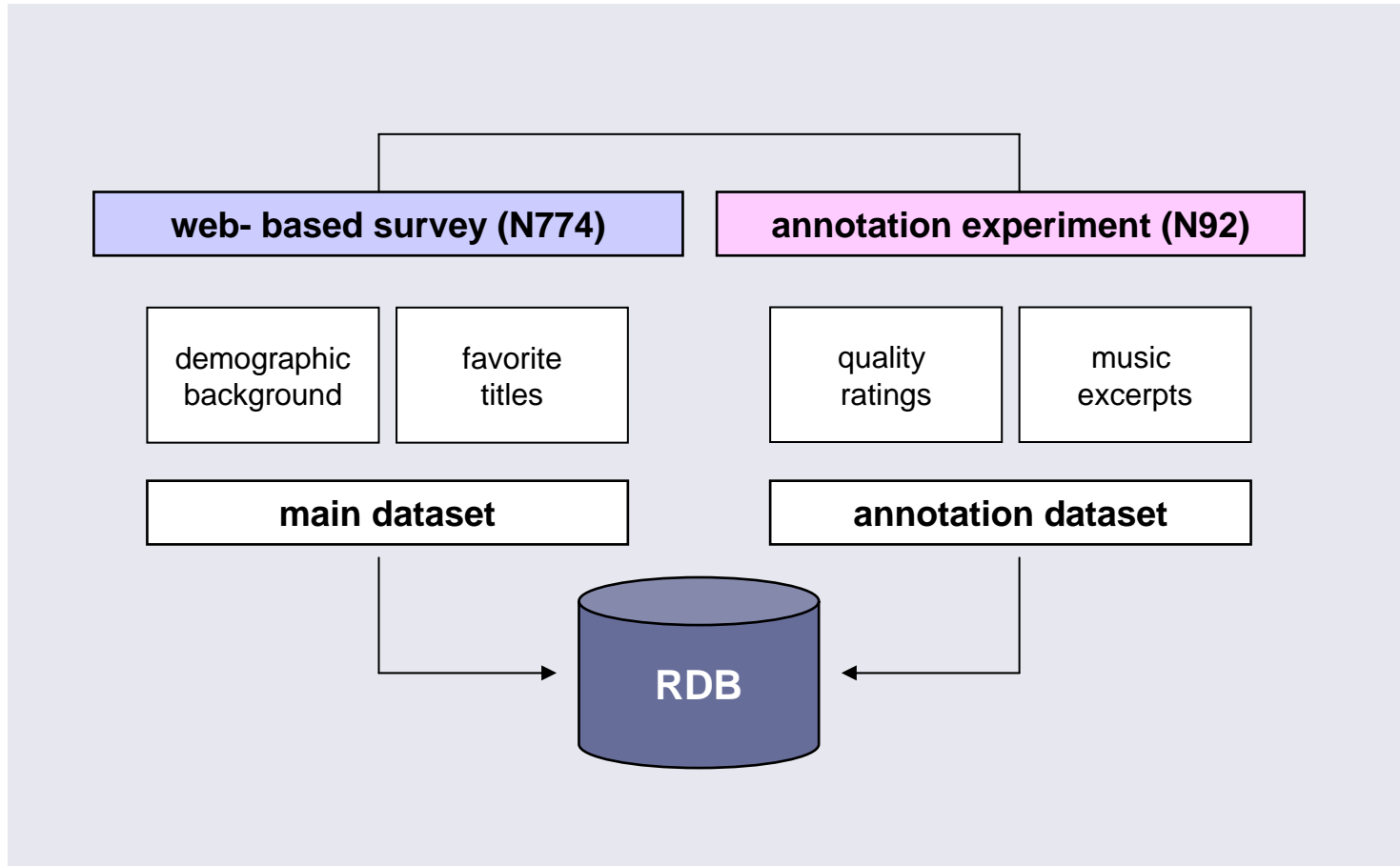
EXPERIMENT 2

QUALITY ANNOTATION

Semantic description



Global set-up





Survey

774 participants

Definition of genre preferences

Effects of gender, age, musical background and taste

Global profile of MIR system users

Favorites: database with preferred music

Recrutement of subjects for experiments



Global profile of MIR system users

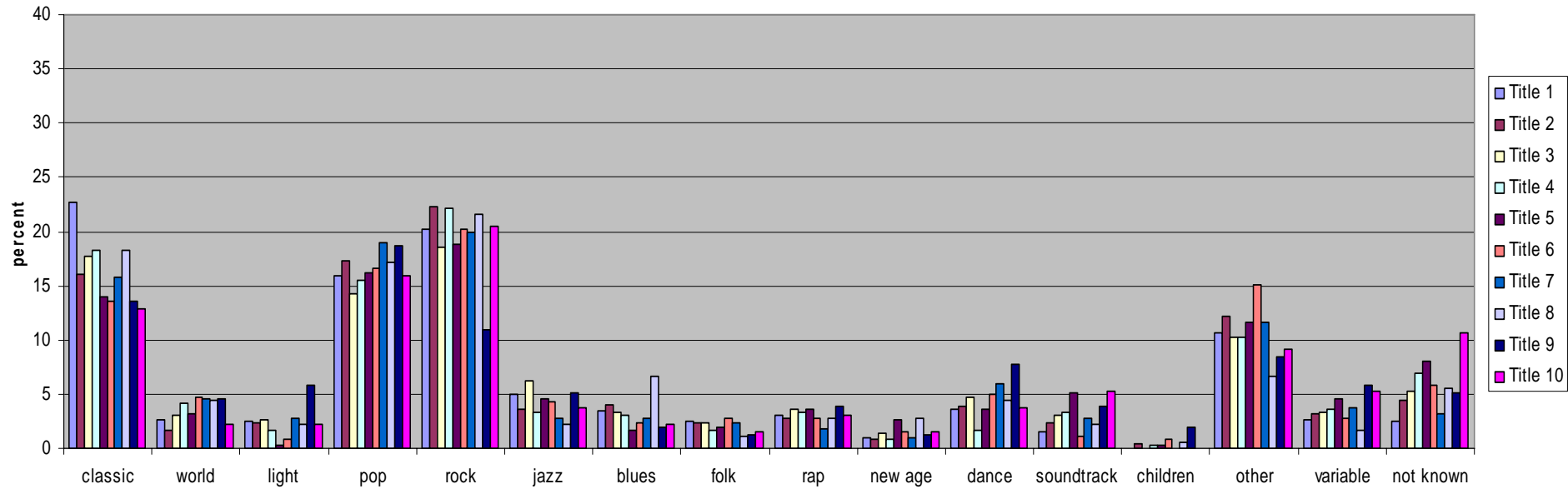
MIR system users . . .

- are young people (three quarters is younger than 35 years)
- use the internet regularly (92,6%)
- spend one third of their internet time on music related activities
- do not earn their living with music (more than 90 % is amateur)
- are actively involved with music:
 - about two out of three had a music education
 - one out of five has a high-level of music expertise
- have the broadest music taste between 12 and 25 years
- have pop, rock and classical music as preferred genres
- are good at genre description
- have difficulties assigning qualities to classical music
- assign most variability to classical music



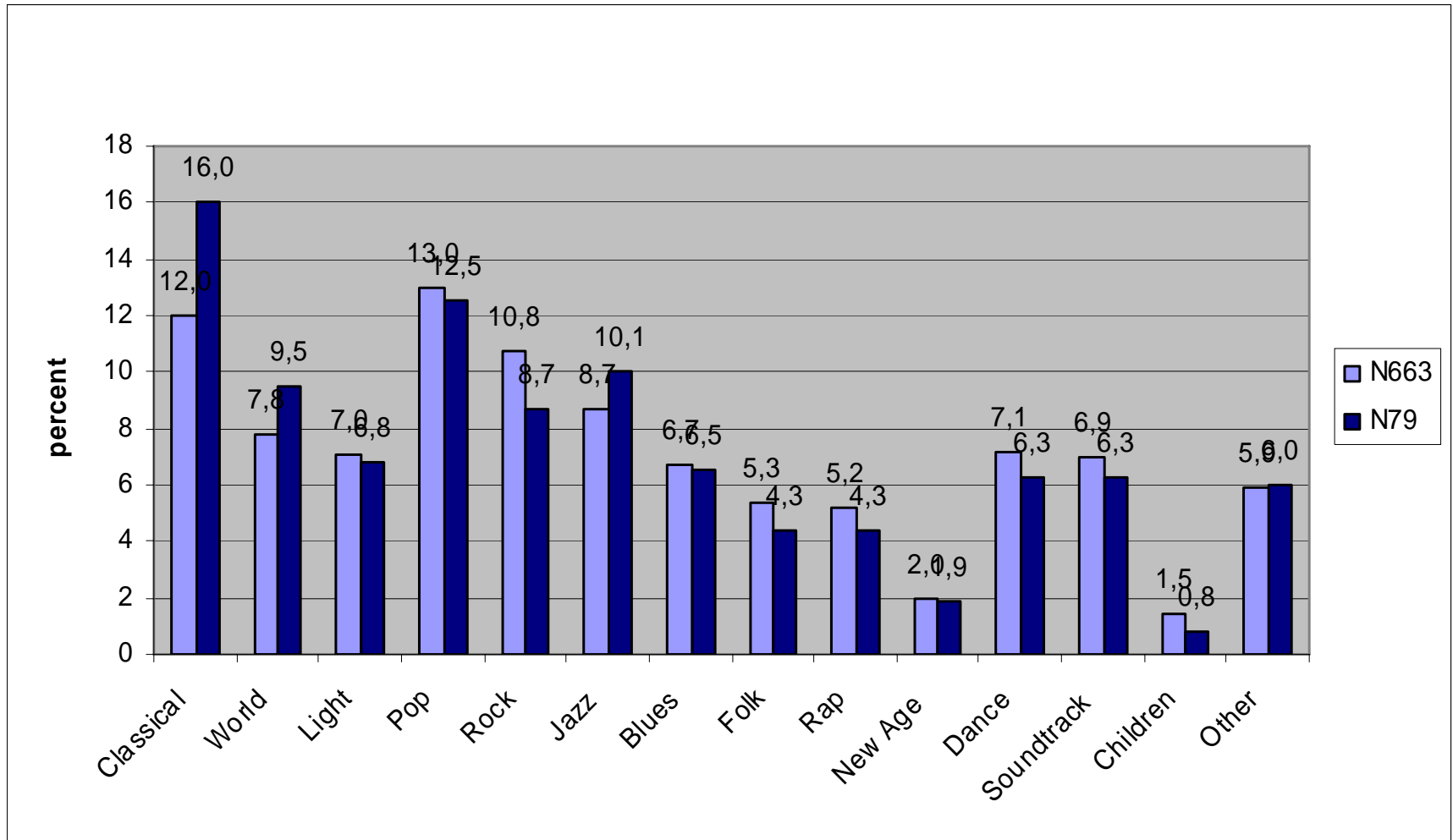
“Favorites”

distribution of genres in favorite titles 1-10



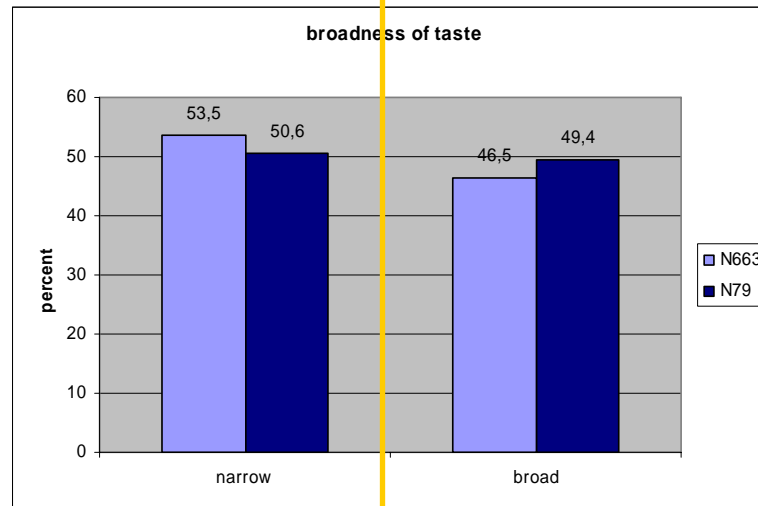
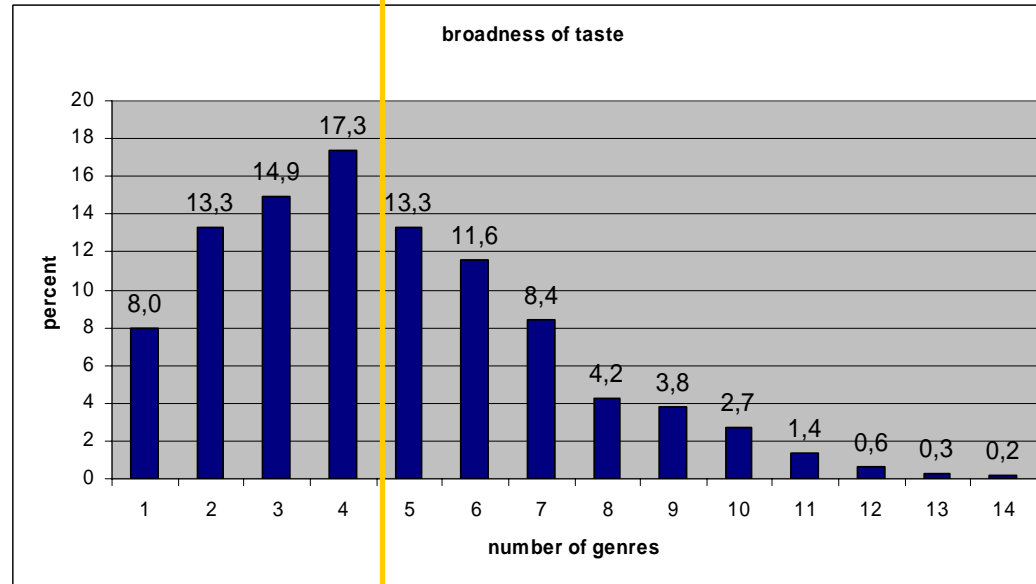


Comparison of genre preferences





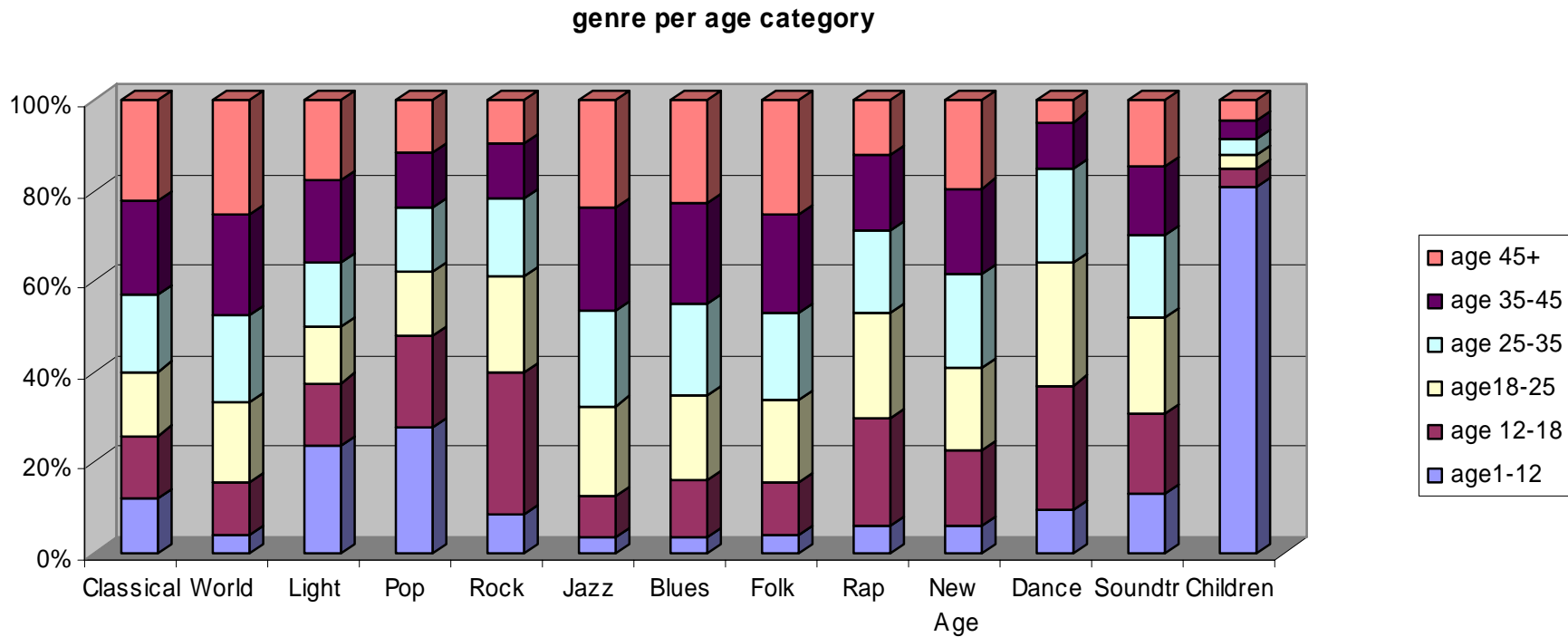
Broadness of taste





Evolution of taste

N=656



< 25 years: light, pop, rock, rap, dance

> 45 years: classical, world, jazz, blues, folk

most stable between 18-35 years



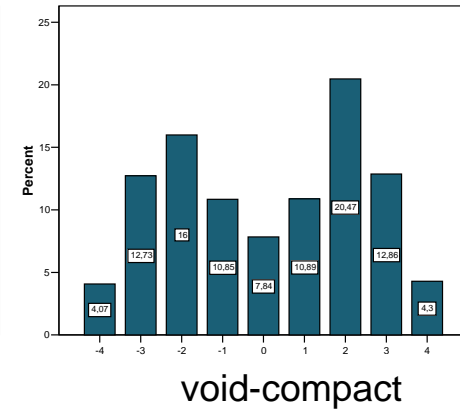
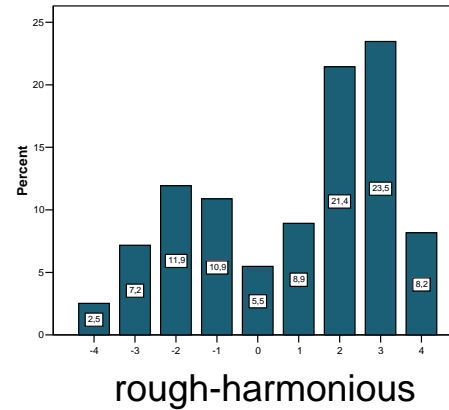
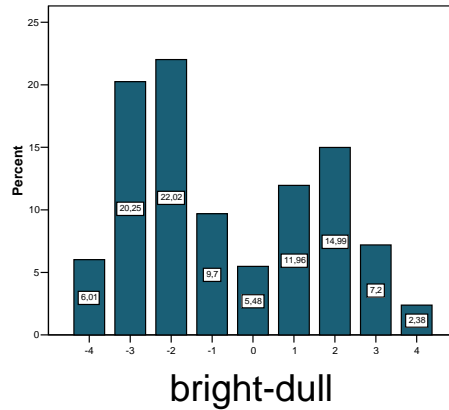
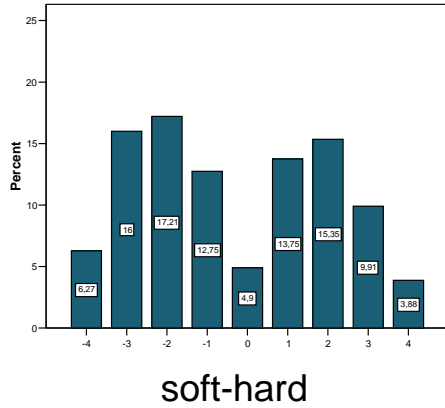
Model for the description of musical qualities

I. AFFECTIVE/EMOTIVE	II. STRUCTURAL	III. KINAESTHETIC
I.1 Appraisal (app)	II.1 Sonic	Gesture (mov)
Cheerful (cheer)	Soft/hard (SoHa)	Melody imitation (imi)
Sad (sad)	Clear/dull (CIDu)	
Carefree (care)	Rough/harmonious (RoHa)	IV. MEMORY
Anxious (anx)	Void/compact (VoCo)	No recognition (no)
Tender (tend)	Slow/quick (SloQu)	Style recognition (style)
Aggressive (aggr)	Flowing/stuttering (FloStu)	Vaguely known (vague)
Passionate (pass)	Dynamic/static (DySta)	Well known (well)
Restrained (restr)		
Most typical (mt)		
I.2 Interest	II.2 Pattern	V. JUDGEMENT
Annoying (anno)	Timbre (tim)	Beautiful/awful (BeAw)
Pleasing (plea)	Rhythm (rhy)	Difficult/easy (DiEa)
Touching (touch)	Melody (mel)	
Indifferent (indif)	None (no)	

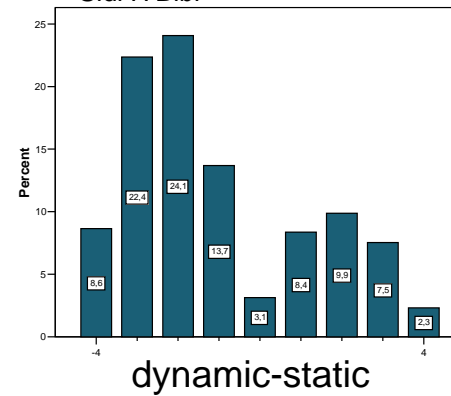
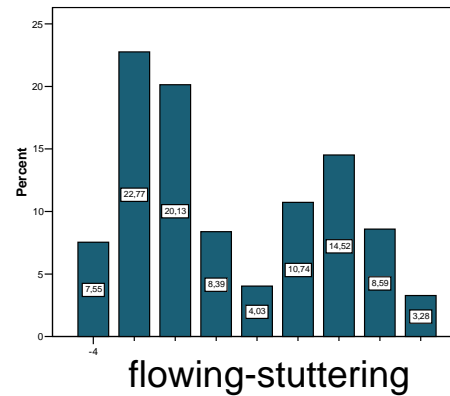
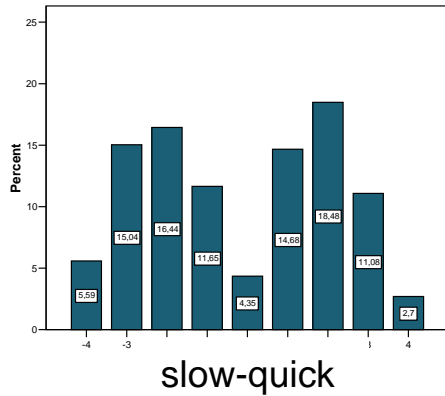


Description of structural features

Ex "bright": Fr. 45: Mozart,
Klaviersonate KV331

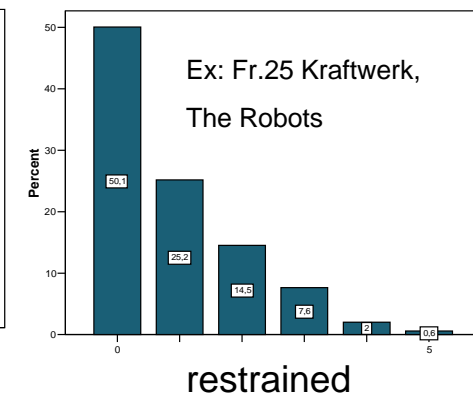
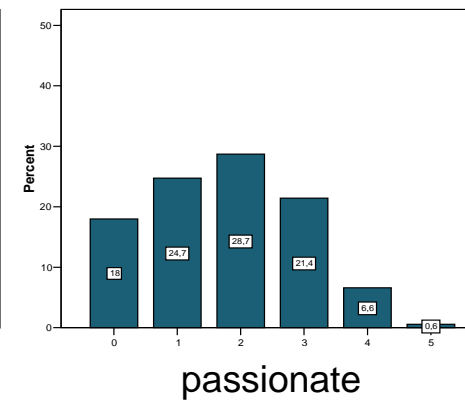
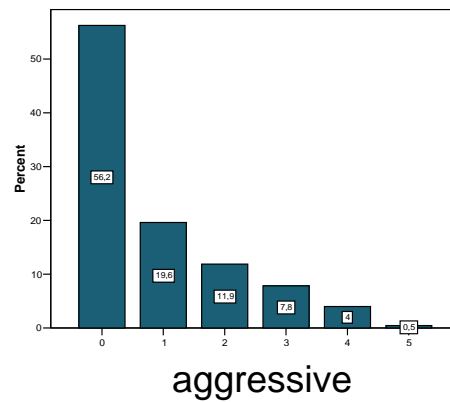
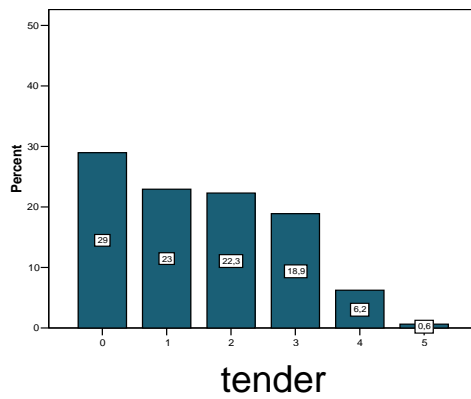
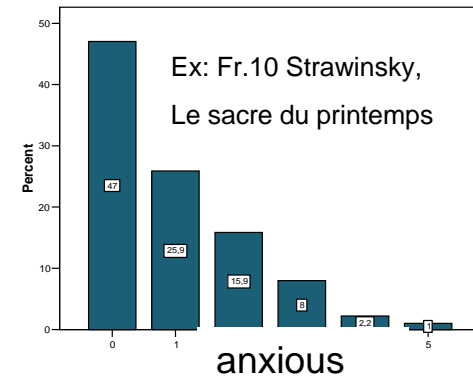
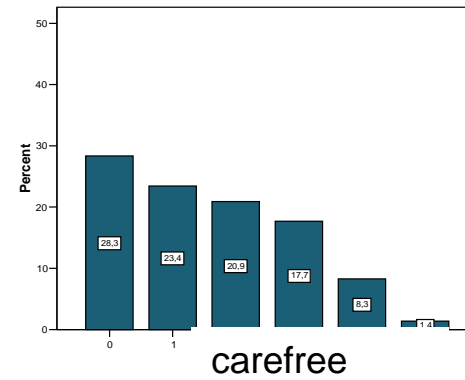
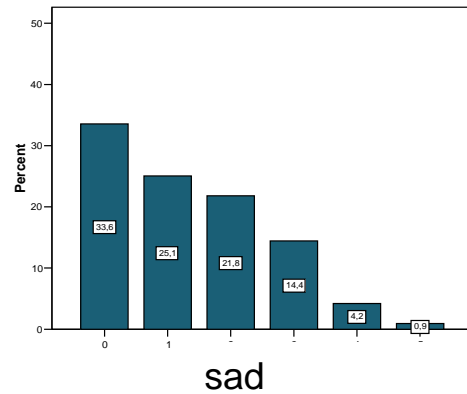
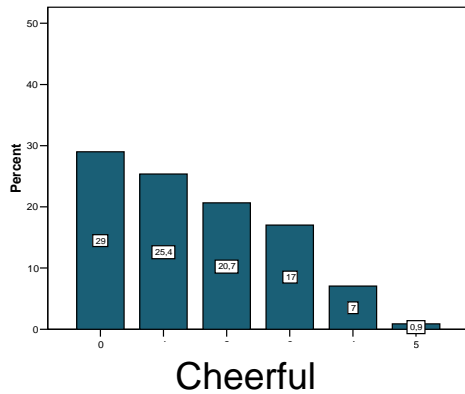


Ex "dybamic": Fr.153: Mano Negra,
Sidi H'Bibi





Description of affective/emotive features





Judgement

MOST BEAUTIFUL EXCERPT (Classical, fr.44 Bach, Erbarme Dich)

JUDGEMENT:

- **86,08%** moderate, rather or very beautiful

STRUCTURAL:

- **76 %** rather or very harmonious
- **87 %** rather or very flowing
- **73 %** rather or very bright
- **67%** rather or very slow

MEMORY:

- **53%** heard this piece before
- **35%** was familiar with the style

MOST DIFFICULT EXCERPT (Classical, fr. 132 Ligeti, Le grand macabre)

JUDGEMENT:

- **66%** moderate, rather or very difficult

STRUCTURAL:

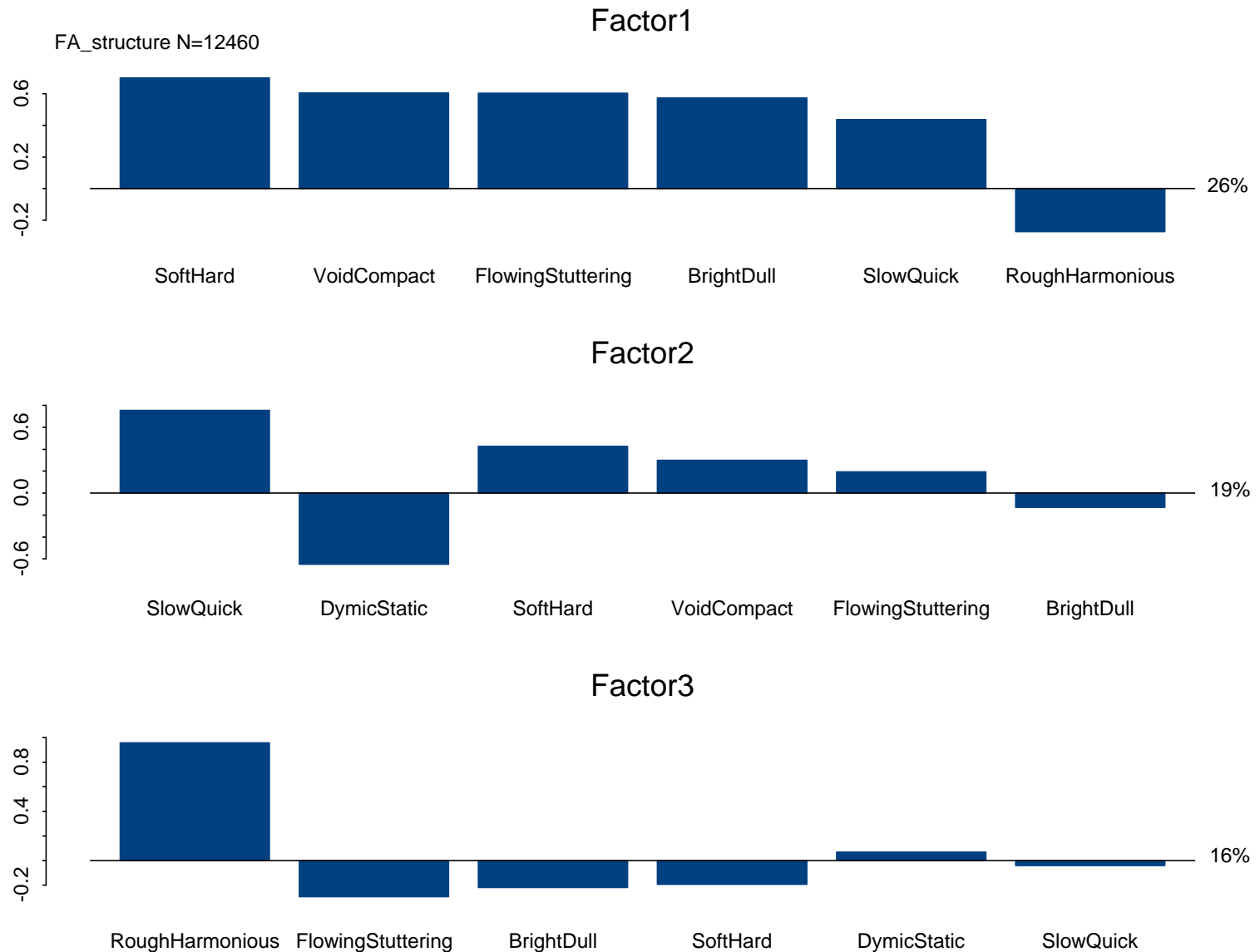
- **73 %** rather or very hard
- **81 %** rather or very rough
- **96 %** rather or very stuttering

MEMORY:

- **87%** did not know the piece



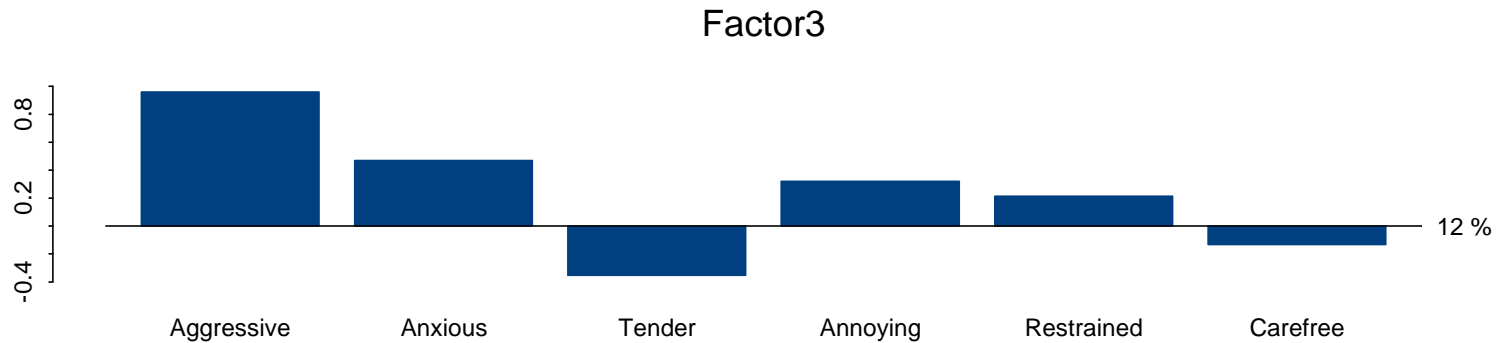
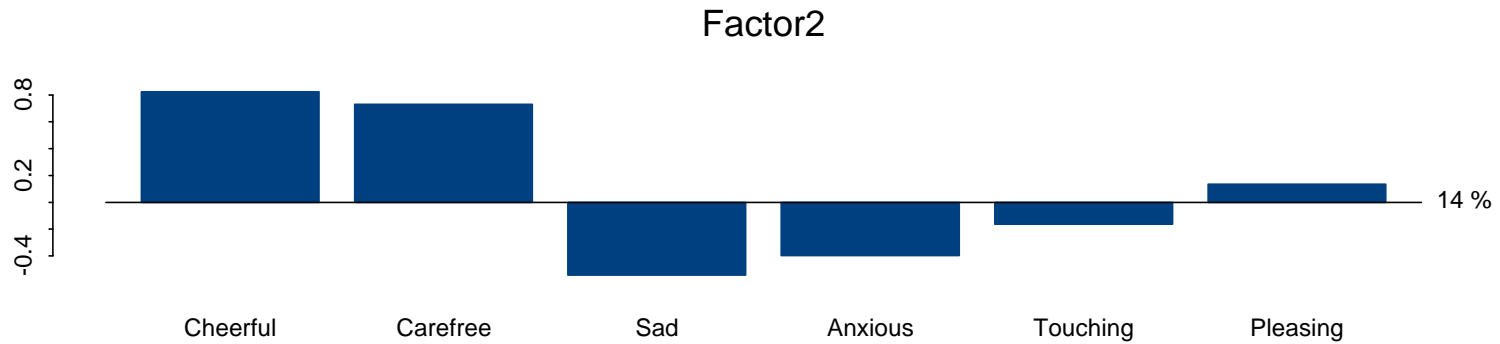
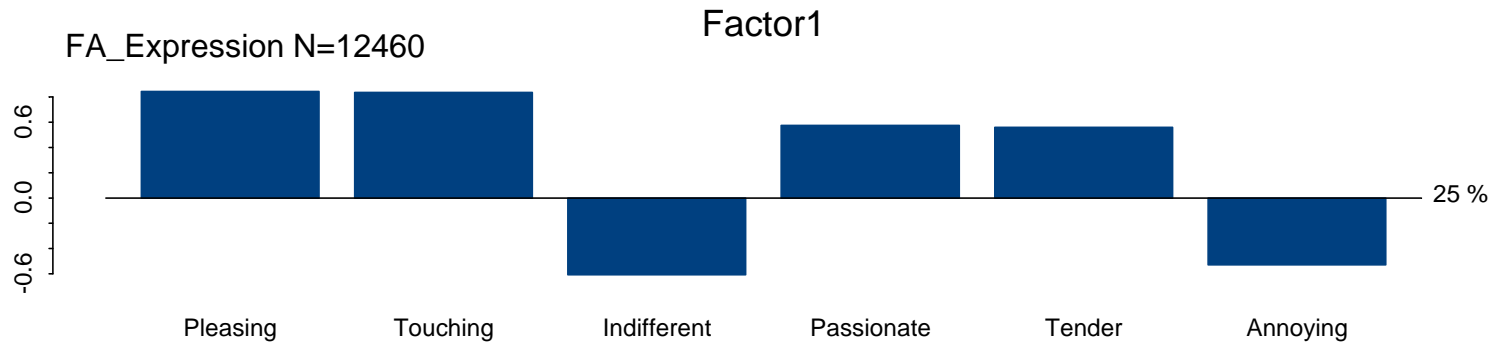
Factor analysis of structural descriptors





Factor analysis of affective/emotive descriptors

FA_Expression N=12460





Relationships among semantic descriptor groups

Non-parametric correlations:

- Affective/emotive descriptors * Structural descriptors

Approaches:

1. all 12640 (79*160) scores
2. scores per excerpt (sum over subjects)



Significant relationships: summary

CHEERFUL

- **quick** (0,467**)
- **dynamic** (-0,519**)

SAD

- **soft** (-0,608**)
- **slow** (-0,658**)
- **static** (0,558**)
- **void** (-0,604**)
- **flowing** (-0,531**)

CAREFREE

- **slow** (0,298**)
- **dynamic** (-0,318**)

TENDER

- **soft** (-0,830**)
- **slow** (-0,659**)
- **static** (0,527**)
- **void** (-0,726**)
- **flowing** (-0,718**)
- **harmonious** (0,638**)
- **bright** (-0,543**)

AGGRESSIVE

- **hard** (0,731**)
- **quick** (0,513**)
- **dynamic** (-0,410**)
- **compact** (0,639**)
- **stuttering** (0,639**)
- **rough** (-0,612**)
- **dull** (0,510)

A user-oriented approach to
Music Information Retrieval
DEMOS

Micheline Lesaffre, Marc Leman, Jean-Pierre Martens



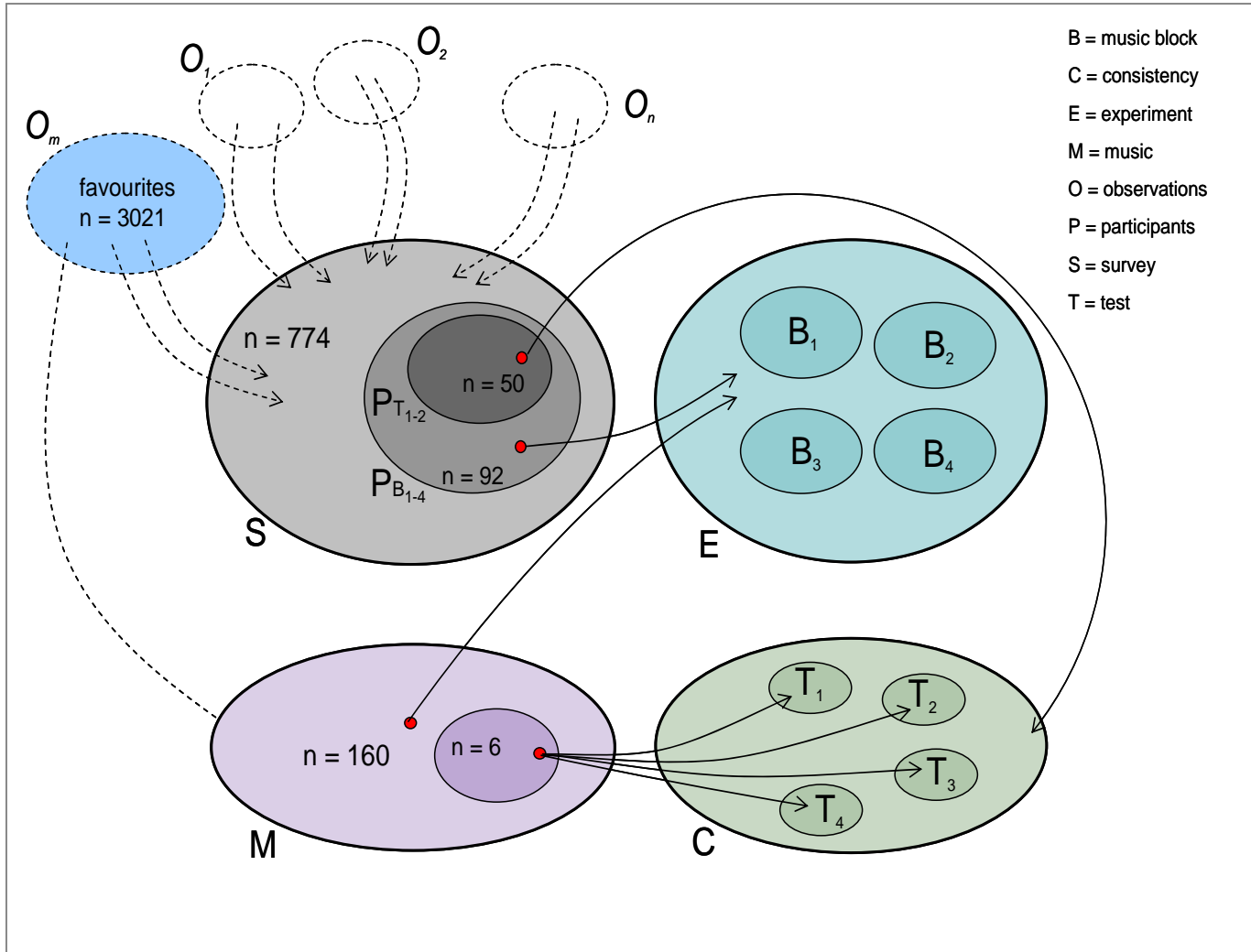


DEMOS

1. MAMI Query Builder
2. Semantic Music Recommender System



MAMI Database






MAMI Query Builder

MAMI Query Builder - Main Menu

MAMI Query Builder






Query the SURVEY Data

Query the EXPERIMENT Data

Query the AUDIO Data

RESET





MAMI QB Survey Data



MAMI Query Builder - Survey Wizard

Number of forms finished:

Participant selection




- Participants in the Survey
- Participants selected for the Experiment

Current Records in Selection 711

Intro | 2. General Background | 3. Cultural Background | 4. Internet Usage | 5. Musical Background | 6. Music Instrument | 7. Music Listening | 8. Musical Genres | 9. Musical Taste | 10. Favorites

MAMI Query Survey Data

(Click on the logo's for more information...)

Current Selection:

Number of Forms finished: All records All Participants

The part of the query you build in each page is shown in this field



MAMI QB: Survey: musical background

MAMI Query Builder - Survey Wizard

Number of forms finished:

Participant selection

- Participants in the Survey
- Participants selected for the Experiment

Current Records in Selection 432

Intro | 2. General Background | 3. Cultural Background | 4. Internet Usage | 5. Musical Background | 6. Music Instrument | 7. Music Listening | 8. Musical Genres | 9. Musical Taste | 10. Favorites

Musical Way

- <All>
- Listen
- Listen and practice

Musical Context

- <All>
- Amateur
- Professional

Musical Education

- <All>
- Yes
- No

Autodidact

- <All>
- yes
- no

Private

- <All>
- yes
- no

School

- <All>
- yes
- no

Conservatory

- <All>
- yes
- no

University

- <All>
- yes
- no

Education Level

- <All>
- Advanced
- Intermediate
- Basic
- None

Which Data do you want to retrieve?

- Musical Way
- Musical Context
- Musical Education
- Autodidact
- Private
- School
- Conservatory
- University
- Education Level
- Musical Expertise Level
- Musical Expertise Group

Current Selection:

Number of Forms finished: All records | All Participants

RESET SEARCH

No query selection made...



MAMI QB: Semantic Description: Expression

MAMI Query Builder - Experiment Wizard

Session: **<All>**
Session 1
Session 2
Session 3
Session 4

Current Records in Selection: 531

Introduction | **EXPRESSION** | EXPERIENCE | STRUCTURE | VARIABILITY | ACTIVITY | MEMORY | JUDGEMENT

Cheerful
 Sad
 Carefree
 Anxious
 Tender
 Aggressive
 Passionate
 Restrained

Most Typical Expression

Cheerfull
Sad
Carefree
Anxious
Tender
Aggressive
Passionate

Which Data do you want to retrieve?

Cheerful
 Sad
 Carefree
 Anxious
 Tender
 Aggressive
 Passionate
 Restrained
 Most Typical

Current Selection:
Expression: Anxious <= 2 AND Tender >= 2 AND Passionate = 4

RESET SEARCH



Semantic Music Recommender System (SeMuReS)



- Prototype / research tool
- User data
- Fuzzy logic functions
- Tested @ ACCENTA 2005



User profile

YOUR PROFILE



Year of birth :

How important is music in your life?

- 0 : not musically educated, little interested
- 1 : not musically educated, very interested
- 2 : musically educated, beginner's level
- 3 : musically educated, advanced level
- 4 : professional

START SEARCH

GENRE

- Classical
- Folk/Country
- Jazz
- Pop/Rock
- World/Ethnic

EMOTION

- | | YES | NO |
|------------|-------------------------------------|--------------------------|
| cheerful | <input type="checkbox"/> | <input type="checkbox"/> |
| sad | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| tender | <input type="checkbox"/> | <input type="checkbox"/> |
| passionate | <input type="checkbox"/> | <input type="checkbox"/> |
| anxious | <input type="checkbox"/> | <input type="checkbox"/> |
| aggressive | <input type="checkbox"/> | <input type="checkbox"/> |
| restrained | <input type="checkbox"/> | <input type="checkbox"/> |
| carefree | <input type="checkbox"/> | <input type="checkbox"/> |

SOUND

- soft hard
- clear dull
- rough harmonious
- void compact

MOVEMENT

- slow quick
- flowing stuttering
- dynamic static

26 musical fragments found

NR.	GENRE	TITLE	AUTHOR(S)	SCORE
44	Classical	Erbarne dich (Mattäus-Passion, BWV 244)	Johann Sebastian Bach	89%
7	Classical	Adagietto, Sehr langsam (Symphony No. 5 in C sharp minor)	Gustav Mahler	85%
42	Classical	Part VII (Partita for orgue "Christ, der du bist der helle Tag" BWV 766)	Johann Sebastian Bach	84%
12	Classical	Canzonetta. Andante (Concerto for Violin and Orchestra in D major op. 35)	Peter Ilyich Tchaikovsky	82%
82	Classical	La Carpinese	Athanasius Kircher	79%
1	Classical	Kommt, ihr Töchter, helft mir klagen (Mattäus-Passion, BWV 244)	Johann Sebastian Bach	77%
52	Classical	Our evenings (Pianosonata No. 1 "Along an overgrown path")	Leos Janacek	75%
122	Classical	Nocturne in F major op.15 No. 1	Frederic Chopin	74%
87	Classical	Andante (Pianoconcerto No. 23 in A major, KV 488)	Wolfgang Amadeus Mozart	72%
125	Classical	Andante con moto (Stringquartett No. 14 in D minor "Der Tod und das Madchen")	Franz Schubert	72%
48	Classical	Allegro (Concerto for Cello and Orchestra in B minor, op. 104)	Antonin Dvorák	70%
46	Classical	Che Faro senza Euridice (Orfeo ed Euridice)	Christoph Willibald von Gluck	69%
130	Classical	Gymnopédie No. 1 (Trois Gymnopédies)	Eric Satie	69%
3	Classical	Chaconne des Scaramouches, Frivelins et Arlequins (Le Bourgeois Gentilhomme)	Jean-Baptiste Lully	68%
89	Classical	Daphnis et Chloé	Maurice Ravel	68%
47	Classical	Sehr behaglich (Symphonie No. 4 in G major)	Gustav Mahler	68%
45	Classical	Andante grazioso, variation III (Klaviersonata in A major KV 331)	Wolfgang Amadeus Mozart	64%
88	Classical	Hongarian Dance No. 1 in G minor	Johannes Brahms	62%
129	Classical	Le ray au soleil	Johannes Ciconia	61%
11	Classical	Folia-Rodrigo Martinez	Anonymous	61%
127	Classical	Ouverture (Dido & Aeneas)	Henry Purcell	60%
128	Classical	Requiem aeternam (Requiem KV 626)	Wolfgang Amadeus Mozart	55%
50	Classical	Pavane de la Belle au Bois Dormant (Ma Mère L'Oye)	Maurice Ravel	55%
53	Classical	Third mouvement (Pianoconcerto No. 1 in C minor op. 18)	Sergei Rachmaninov	54%
49	Classical	Rapsody in Blue	George Gershwin	43%
123	Classical	Vorspiel (Die Walküre, first act)	Richard Wagner	20%

STOP search and listen to the most pleasing musical fragment



User satisfaction

How well does the music match your expectation?

not at all little average well very well

▶ || ■ 🔊

Nr : 44
Title : Erbarme dich (Mattäus-Passion, BWV 244)
Author(s) : Johann Sebastian Bach
Performer(s) : Choeur et orchestre du Collegium Vocale/Philippe Herreweghe
CD title : Matthäus-Passion
Publisher : Harmonia Mundi
Genre : Classical music

sad : 100% slow : 93% dynamic : 72%
soft : 95%

CLOSE



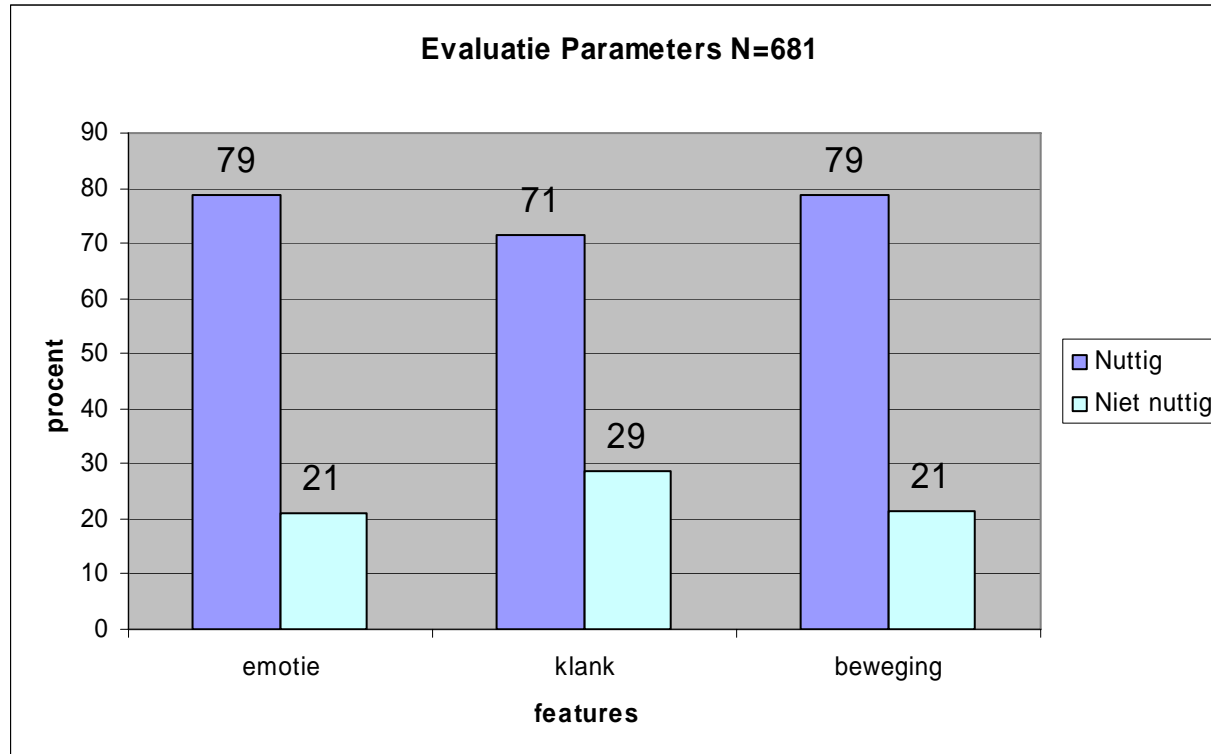
Test @ ACCENTA 2005

- N626: 334 female, 292 male
- Listened to 2993 fragments
- Selected 18415 adjectives

cheerful	1764	carefree	649	stuttering	323
bright	1271	not anxious	592	rough	285
flowing	1247	not restrained	570	anxious	271
passionate	1233	aggressive	554	not carefree	240
dynamic	1134	not aggressive	552	not tender	234
soft	1048	not sad	551	void	223
harmonious	893	sad	517	static	168
tender	843	slow	458	Not passionate	130
hard	837	compact	405	dull	124
quick	829	restrained	380	not cheerful	90

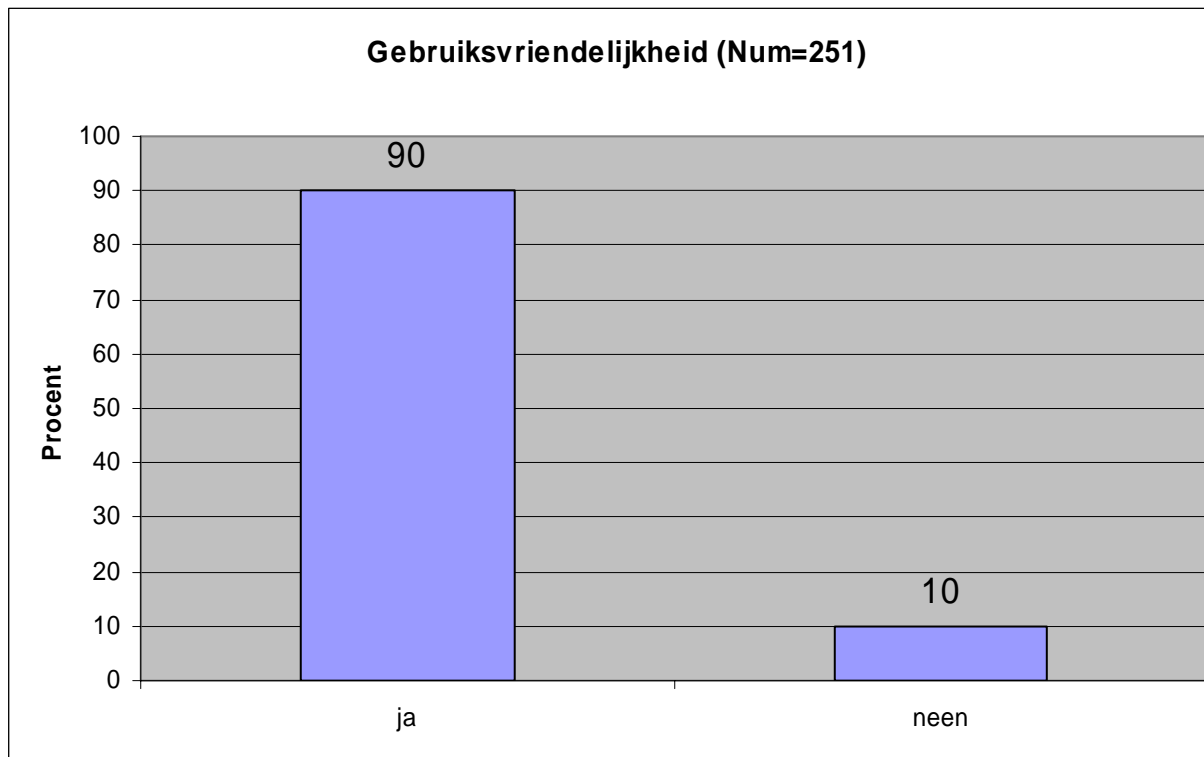


Is querying by emotion, sound and movement useful?





Is the system user-friendly?





Acknowledgements

- This research has been conducted at IPEM, Department of musicology at Ghent University in the framework of the MAMI project (IWT) for audio recognition.

<http://www.ipem.ugent.be/mami/>

- The authors wish to thank Liesbeth De Voogdt and Frank Desmet.

