



Technology matters:

**An experimental exploration on how the spatial cues
afforded by different audio playback devices
shape the perceived emotional expression of mediatized music**

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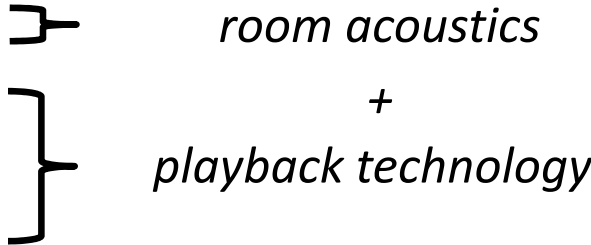
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INTRODUCTION

Main Research Question

- „Everyday music listening“ basically means *mediatized* music listening
 - Different listening spaces
 - Different storage/carrier technologies
 - Different playback devices
 - Different emitter systems



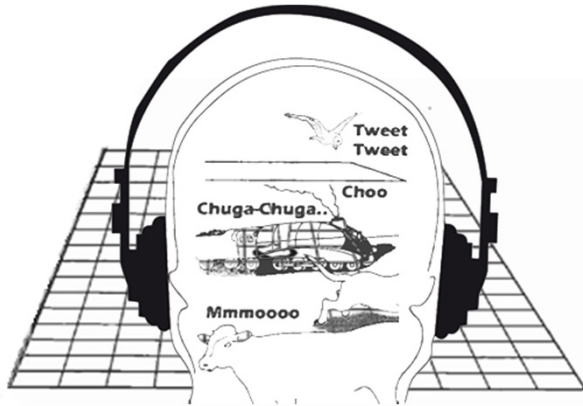
room acoustics
+
playback technology
- **Result: Complex alterations in morphology of *ambient sound field***
 - predictable according to physical laws
 - measurable and simulatable
 - noticeable and recognizable
- If “perceived emotional expression of music” is a result of situational affective/cognitive processing of “moving sonic forms” (Hanslick 1854) ...
- ... playback technology employed should alter it significantly!

Theoretical Arguments & Further Specification

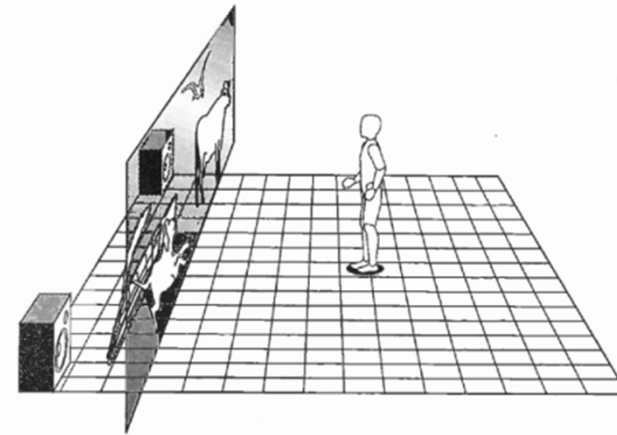
- **Arguments for acoustics-related „technology effects“ on emotional expression:**
 - Alteration of original expressive „acoustic cues“ (Juslin 2000)
 - Introduction of additional expressive „media cues“ (e.g. „grammophone nostalgia“)
- **Counterarguments:**
 - Alterations in morphology too minor to be relevant
 - Emotional expression mainly a function of music’s symbolic meaning
 - Technology effects foremost due to non-acoustic aspects of technology (quality expectations, style/fashion, mobility, comfort, socialness, cocooning, ...)
- **Research Strategy in present paper:**
 - Test single audio technology factor relevant for everyday listening: ***spatialization type***
 - Compare to well-known non-acoustic technology factor: ***quality expectation***
- **Research hypothesis:**

Spatialization Type & Quality Expectation (related to playback technology) both independently alter the perceived emotional expression of music

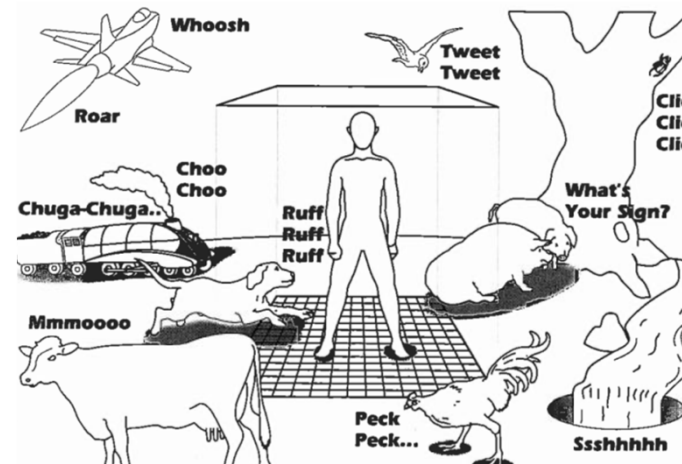
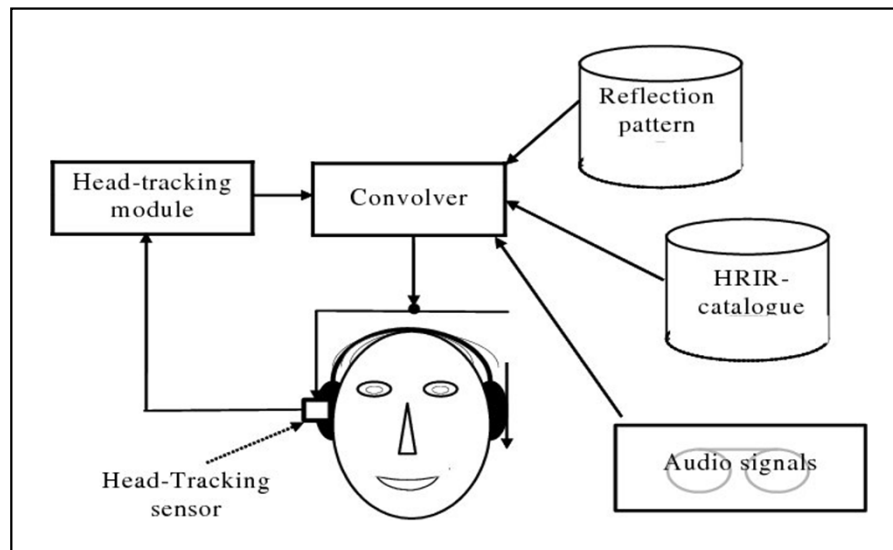
Music Spatialization & Dynamic Binaural Synthesis



„Headphone Stereo“
(ITD, ILD, monaural spatial cues)



„Stereo Speakers in Living Room“
(+ motion cues)



„Live Performance / Concert“
(+ motion cues & ,spatial detail‘)

METHODS

Experimental Design

- **3 x 2 Between-Subjects-Design with Repeated Measurements (4), SEM-Analysis:**
 - **Factors:** Spatialization Type (3) x Quality Expectation (2)
 - **Covariates:** Age, Sex, Education, Mood-State (PANAS), Mood Trait (NFA)
 - **Dependents:** Perceived Emotional Expression (4 latent factors) – repeated (4x)
Perceived Audio Quality (3 latent factors) – once at end
- **Sample:** 306 self-recruited laymen from Berlin (syst. stratified for sociodemographics)
- **Musical Stimuli** (quasi-anechoic single track audio recordings):
 1. Paul Gautier Quartet: „Contredanse“ (4:26m) – Vibrant Latin Jazz Tune
 2. Nick Drake: „River Man“ (4:23m) – Sad Pop Song
 3. Richard Strauss / Vienna Philh.: „Annen Polka“ (4:31m) – Happy Classical Piece
 4. Gustav Mahler / Vienna Philh.: „10th Symphony, 1st Movement“ (7:42m) – Dramatic Classical Piece
- **Treatment Realization:**
 - **Spatialization Type:** Binaurally simulated (mixed by prof. audio engineers) („Stereo-Headphones“, „Stereo-Unit-in-Living-Room“, „Performance-in-Concert-Hall“)
 - **Quality Expectation:** By additional instruction of investigator („you will listen to the music with a very new high fidelity spatial technology, pay attention!“)



Measurement 1: Perceived Emotional Expression

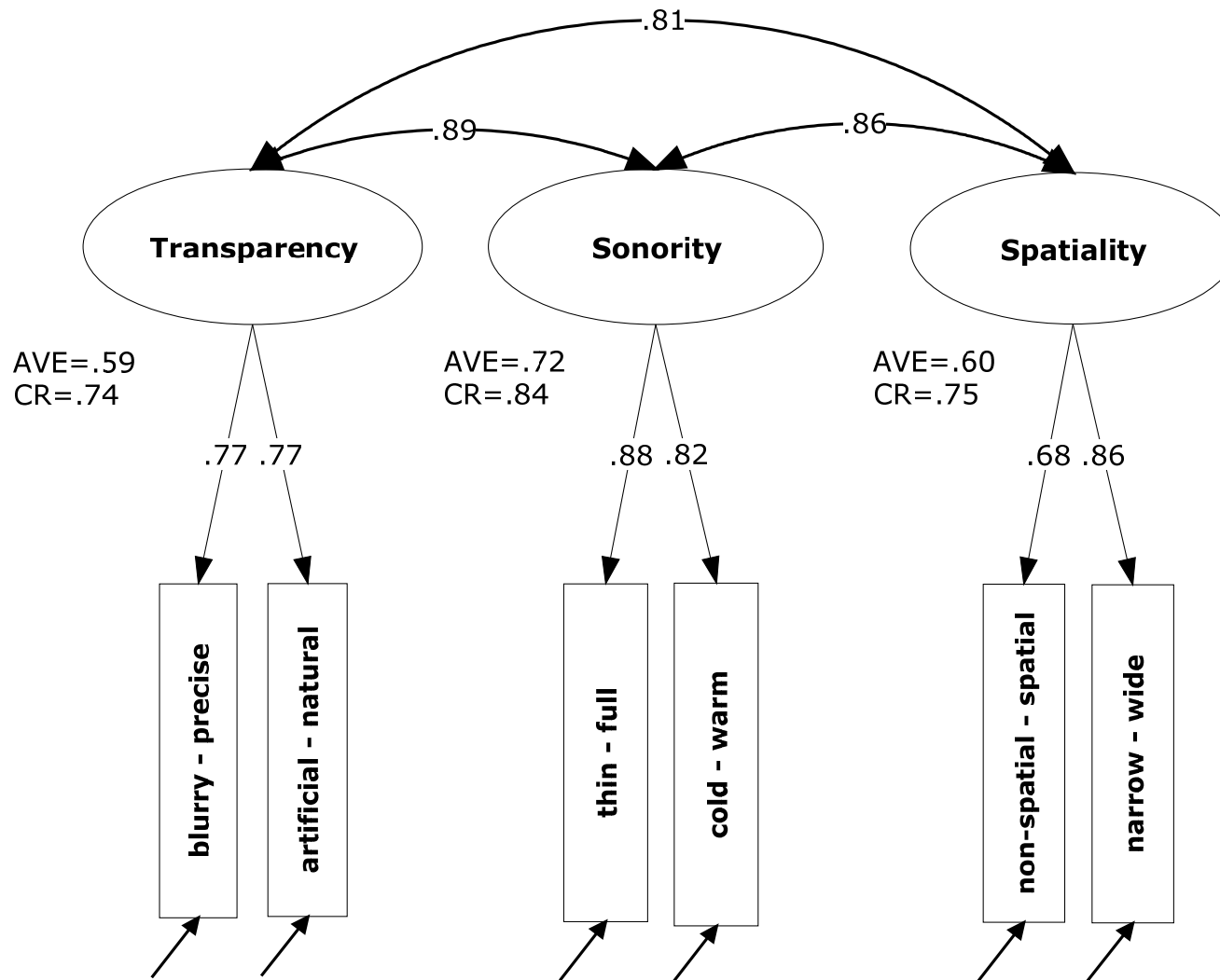
- 15 items administered after listening to each musical piece, as 5-point likert scale:
„Please rate how intense you felt that the music expressed the following emotions!“
- Own (German) instrument with assumed latent 4-factor structure:
 - **Factor 1: „Happiness & Joy“:**
 - pleasure
 - solemnity
 - humor
 - **Factor 2: „Love & Desire“:**
 - love
 - tenderness
 - hope
 - desire
 - **Factor 3: „Sadness & Pain “:**
 - sadness
 - disappointment
 - regret
 - pain
 - **Factor 4: „Anger & Tension“:**
 - anger
 - outrage
 - irritation
 - tension
- Meant to represent the 4 quadrants of the emotional circumplex (Russel 1980)

Measurement 2: Perceived Audio Quality

- **7 items administered at end of experiment as 9-point semantic differentials:**
„Please rate how you perceived the overall audio quality!“
- **Own (German) instrument with assumed latent 3-factor structure:**
 - **Factor 1: „Transparency“:**
 - blurry – precise
 - artificial – natural
 - **Factor 2: „Sonority“:**
 - thin – full
 - cold – warm
 - **Factor 3: „Spatiality“:**
 - narrow – wide
 - non-spatial – spatial
- **Employed as „treatment check“:**
 - Are differences in spatialization perceived at all?
 - Are differences perceived in the spatial realm only?

RESULTS

Audio Quality: Measurement Results

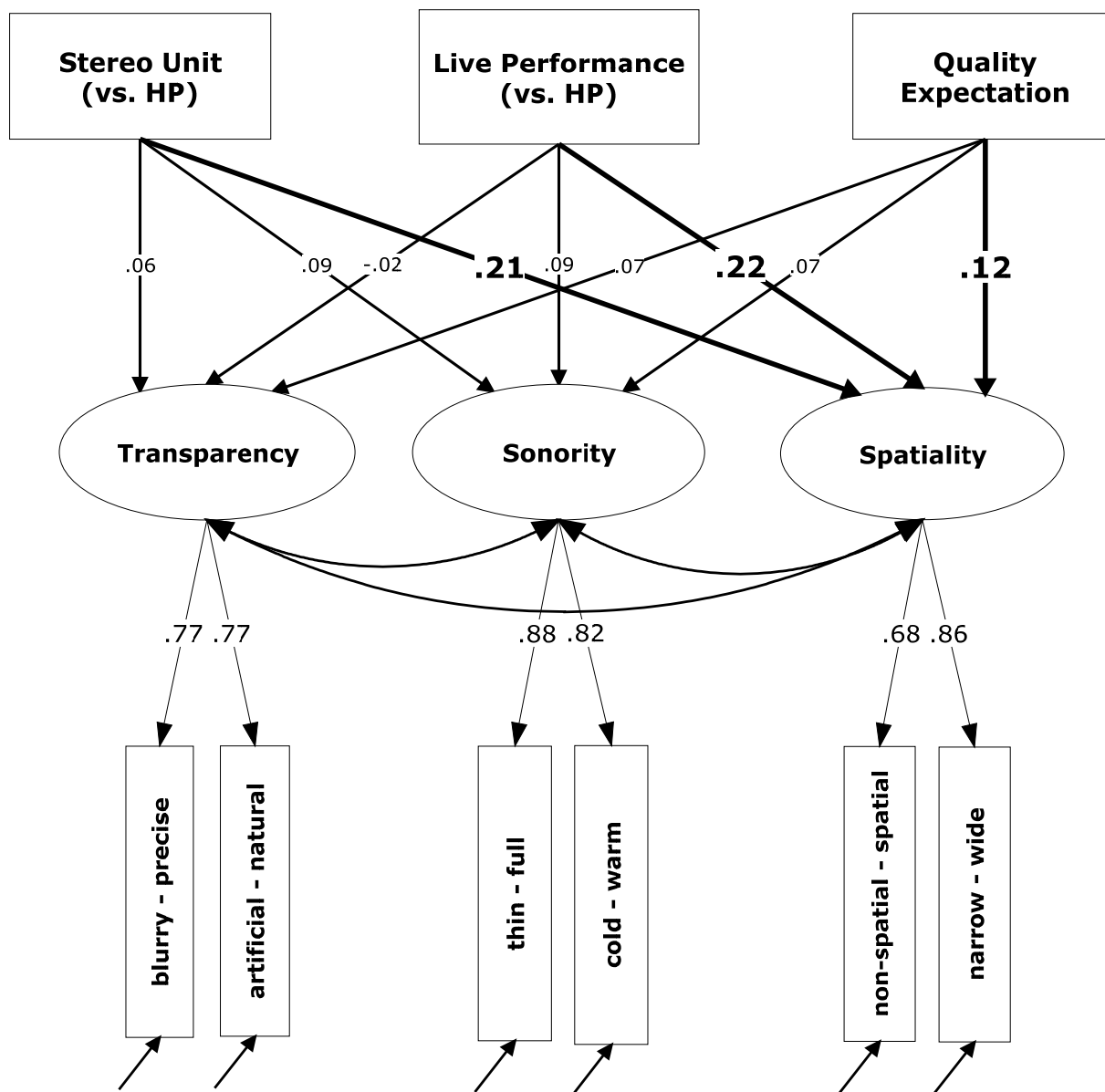


Confirmatory Factor Analysis

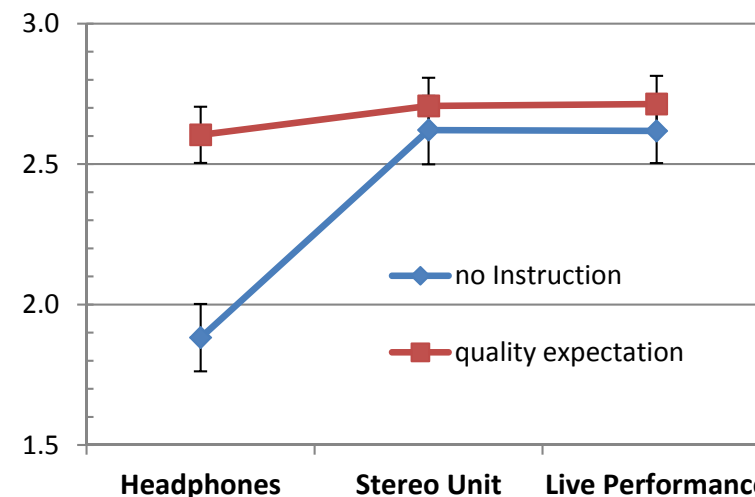
MLR-Estimation Mplus 6.12
n=304 missing values imputed
 $\chi^2 = 9.309$ df=6 p=0.16
RMSEA<.043 (.00-.09)
SRMR= 0.018
CFI = 0.992

All paths $p < .05$

Audio Quality: Structural Results



Spatiality
(estimated group means)



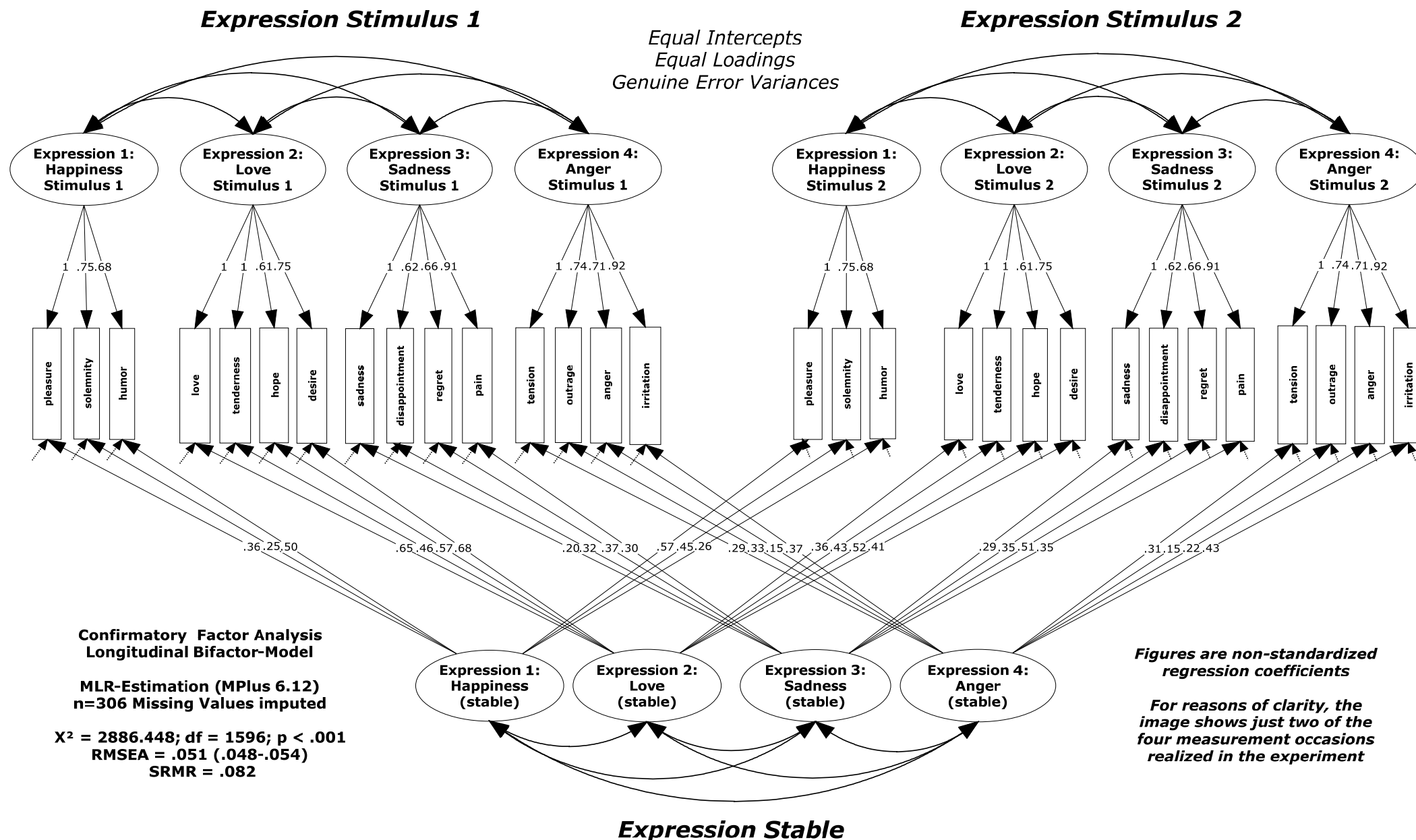
Structural Equation Model

MLR-Estimation Mplus 6.12
n=304 missing values imputed
 $\chi^2 = 35.221$ df=36 p=0.5
RMSEA < .001 (.00-.04)
SRMR = 0.016
CFI = 1.00

Controls are:
Age, Sex, Education,
NFA-seek, NFA-avoid,
PANAS-PA, PANAS-NA

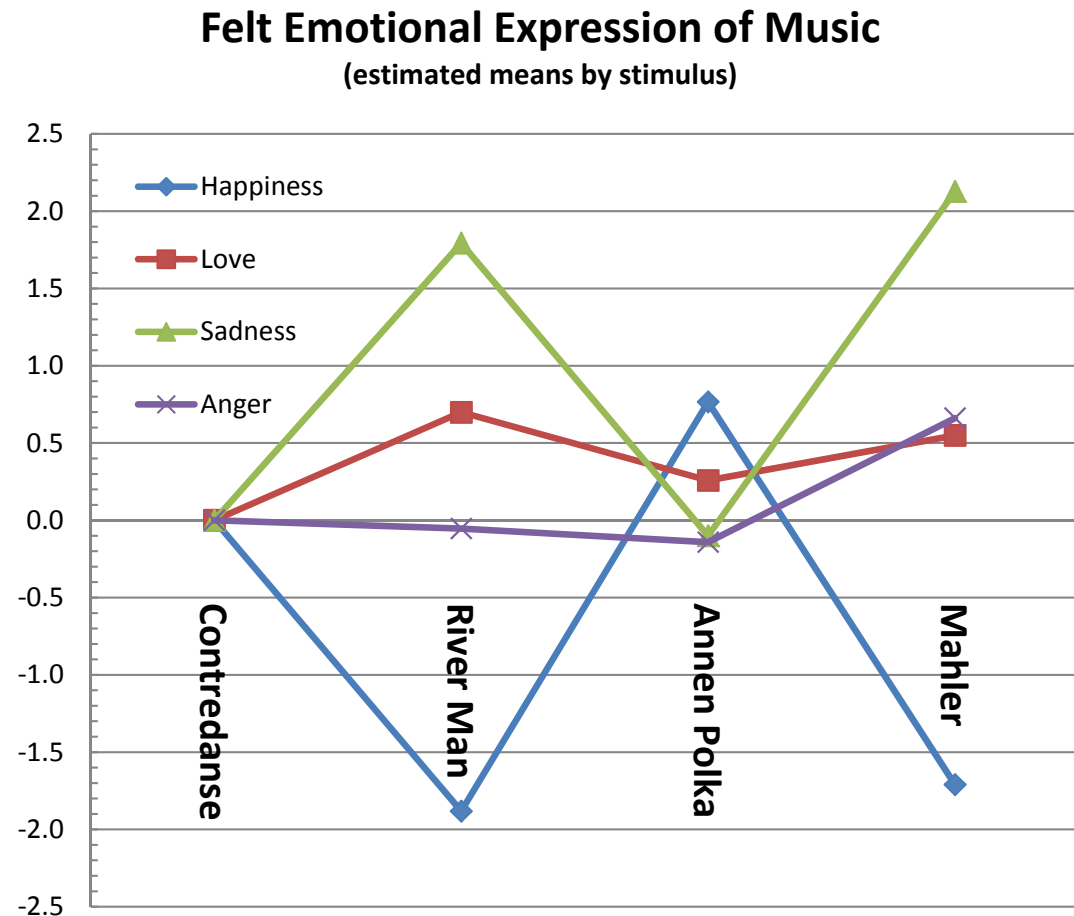
bold paths are p < .05

Emotional Expression: Measurement Results



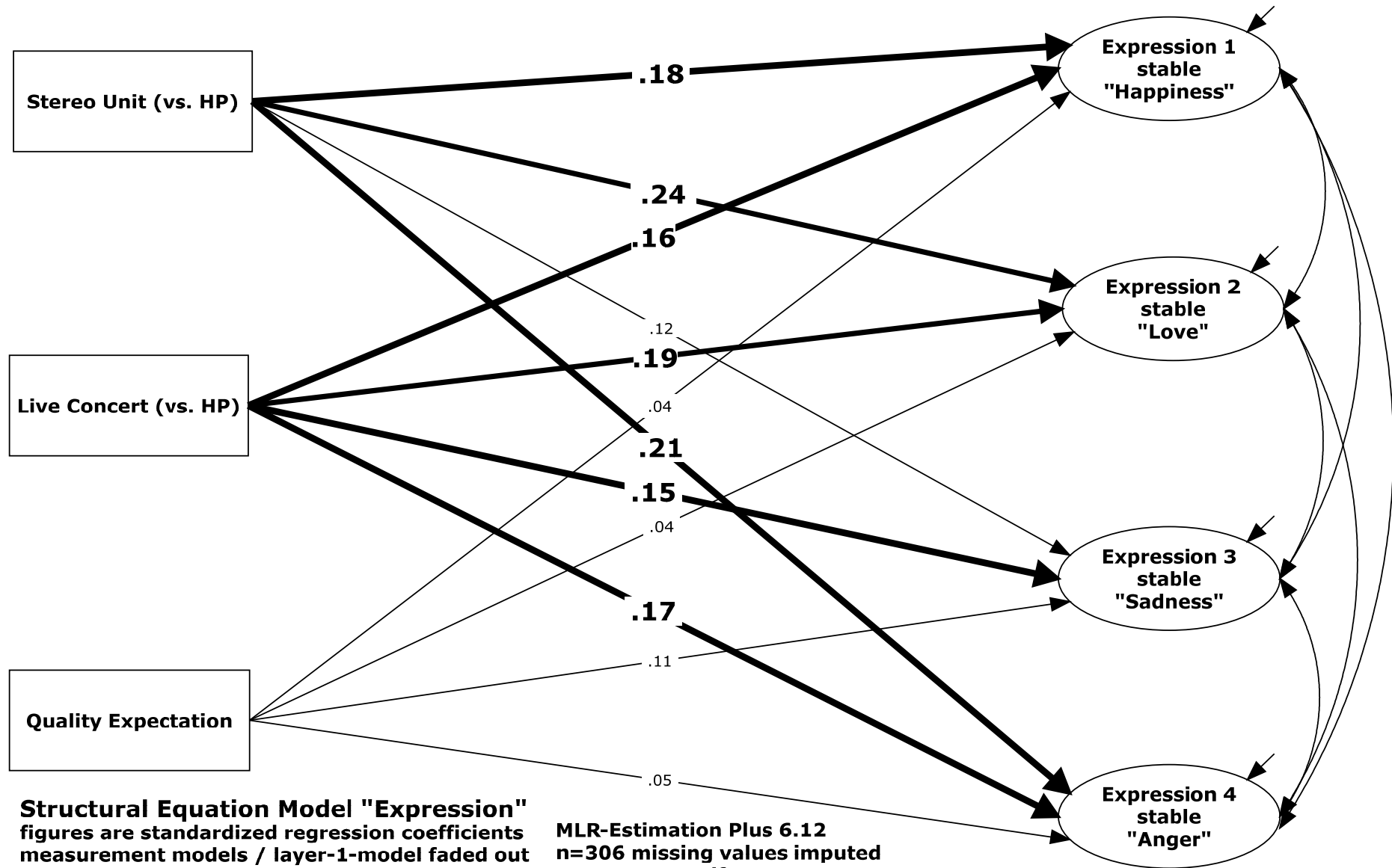
Emotional Expression: Structural Results Level 1

Stimulus	Expression Factor	Mean (z-score)
Contredanse	Happiness	0.000
	Love	0.000
	Sadness	0.000
	Anger	0.000
River Man	Happiness	-1.882
	Love	0.699
	Sadness	1.793
	Anger	-0.054
Annen Polka	Happiness	0.766
	Love	0.258
	Sadness	-0.100
	Anger	-0.142
Mahler 10th	Happiness	-1.711
	Love	0.549
	Sadness	2.128
	Anger	0.661



repeated measurement MANOVA:
comparison of factor means across musical pieces
(p < .05 significant differences in bold type)

Emotional Expression: Structural Results Level 2



Structural Equation Model "Expression"
figures are standardized regression coefficients
measurement models / layer-1-model faded out
control variables (faded out):
age, sex, education
NFA-seek, NFA-avoid, PANAS-NA, PANAS-PA

MLR-Estimation Plus 6.12
n=306 missing values imputed
 $\chi^2=6874.054$ df=4387 p<.001
RMSEA=.043 (.041-.045)
SRMR=.078

bold paths are significant (p<.05)

DISCUSSION

Measurement Models & Instrumental Effects

- **Measurement Models**

- Measurement models exhibit good fit indices
- Constructs exhibit good reliability & variance extraction
- Substantial amount of expression item variance attributable to technology effects

- **Stimulus Effects**

- stimuli able to induce very contrastive feelings of musical expression

- **Expectancy Effects**

- manipulation able to substantially increase (ceiling-effect!) audio quality ratings
→ *audio quality impression sensitive to technology related quality expectations*
- Increases independent of treatment and apply to felt *spatial* audio quality only
→ *instructional manipulation worked the way intended*
- manipulation not able to produce changes in felt musical expression
→ *felt musical expression not sensitive to technology related quality expectation*

Spatialization Technology Effects

- **Effects of technological spatialization on audio quality ratings**
 - influenced spatial audio quality ratings only
→ *no confounding of spatialization with overall sound impression*
 - No differences between „stereo unit“ and „live performance“ condition
→ ***motion cues*** *more important than ‘spatial detail’ for quality impression*
- **Effects of technological spatialization on felt musical expression**
 - Treatment influenced nearly all dimensions of felt musical expression
→ ***motion cues*** increase felt musical expression almost regardless of emotion type
 - No real differences between „stereo unit“ and „live performance“ condition
→ ***motion cues*** *more important than ‘spatial detail’ for felt musical expression*
- **Overall Conclusions:**
 - *Media technology matters! (at least in terms of spatialization)*
 - *Results seem to enforce “additional media cues hypothesis”*
 - *Immersion in everyday listening seems to rely more on sensorimotor inclusion of the subject than on ‘spatial detail’ (→ presence/embodiment debate)*

Outlook: Further Analyses & Future Research

- **Further Analyses (conducted right now):**
 - Do spatialization effects also apply to “felt musical emotions”?
→ *German adaptation of GEMS (Zentner et al. 2008) as dependent*
 - Do spatialization effects also apply to ANS-activity?
→ *Analysis of changes in SCR, BVP, skin temperature*
 - Do spatialization effects interact with media habits or genre preferences?
→ *Expand model by respective interaction terms*
- **Future research:**
 - Further potential technological mediators beyond spatialization?
→ *Bass-Level, Compression, Equalizer-Presets, Loudspeaker/Headphone-Types*
 - Getting out of the laboratory (ESM-Study on technological mediation)

Thank you for your patience!

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