Listener-informed Features for Time-varying Emotion Perception in Live Music Performance

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"It is not meaningful to have computational models that go beyond the level of human agreement, these levels of inter-rater agreement present a natural upper bound for any algorithmic approach."

-- A. Flexer, T.Grill. "The Problem of Limited Inter-rater Agreement in Modelling Music Similarity ", 2016

- Emotion perception is subjective
- "Glass ceiling" problem in music emotion recognition (MER) [1]
- There is a gap between cognitive mechanisms and typical MIR features [2]

[1] Panda, Renato, Ricardo Manuel Malheiro, and Rui Pedro Paiva. "Novel audio features for music emotion recognition." *IEEE Transactions on Affective Computing* 1 (2018): 1-1.
[2] Aucouturier, Jean-Julien, and Emmanuel Bigand. "Mel Cepstrum & Ann Ova: The Difficult Dialog Between MIR and Music Cognition." ISMIR. 2012.
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This study..

- To find out why participants express changes in perceived emotion at certain points in music

- To identify music features that more closely align with the underlying cognitive processes

Data Collection

Music Performance

- Live performance of **Arno Babajanian's Piano Trio in F# minor**, movements 1, 2
- 17 minutes in length/ Widely different chareacters/ Rarely known to public

Study Settings

- Initial study**: Live Concert Setting ->** collect emotion ratings
- Follow-up study**: Controlled Laboratory Setting ->** collect emotion ratings and interrogate reasons

Initial Study: Live Concert Setting

15 participants

Send a VA emotion rating when perceiving an emotion change

Babajanian Trio Live Performance
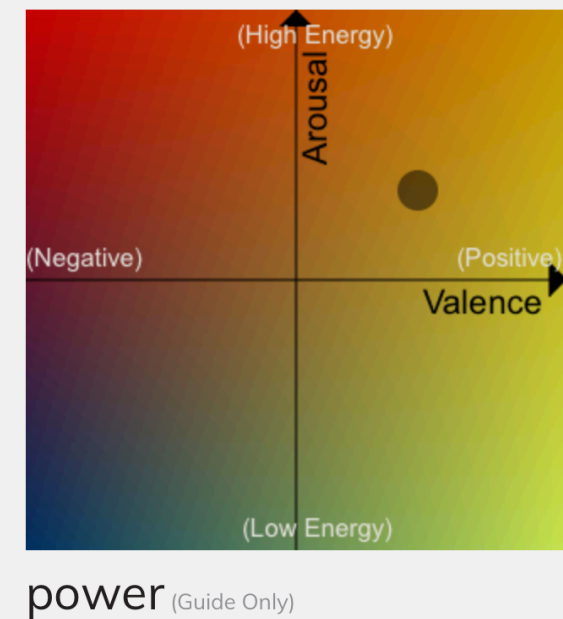
Mood Rater: Emotion Rating Tool based on Valence-Arousal (VA) space [1]

[1] F, György, M Barthet, and M. Sandler.(2013)
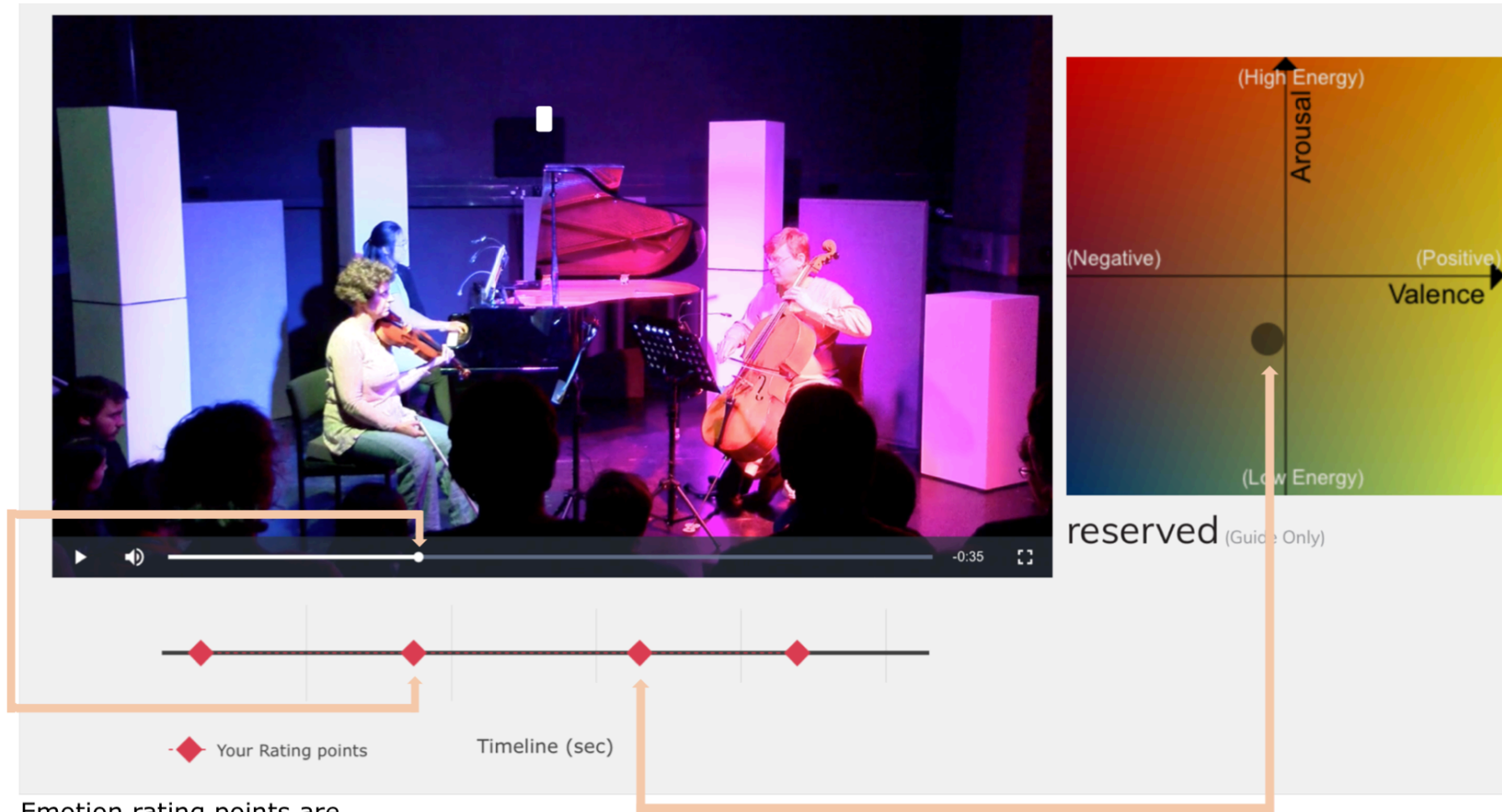
5

Follow-up Study: Laboratory Setting

1. Emotion Rating Task

21 participants

Rating Tool Interface

2. Reflection Task on 7 pre-selected segments

(High Energy)

Arousal

(Negative)   (Positive)

Valence

(Low Energy)

reserved (Guide Only)

Your Rating points

Timeline (sec)

Emotion rating points are
synchronised with video time slider

Red diamond indicators: corresponding valence-arousal
rating appears on hover, pop-up feedback window
appears on click

2. Reflection Task (cont.)

Pop-up window for annotating open-ended emotion judgement reasons

You rated the emotion as
Arousal= 0.356/1, Valence =0.459/1
Guide Tag= reserved

✕

Does this rating reflects well your perceived emotion at this moment?

☐ Yes

☐ No. I want to discard this VA rating
(skip the following questions if you choose this)

How clear is the emotion portrayed by the music at this moment?)

7 (Very Clear) ▲▼

Reasons behind your rating
(No limit in word length. The more the better.)

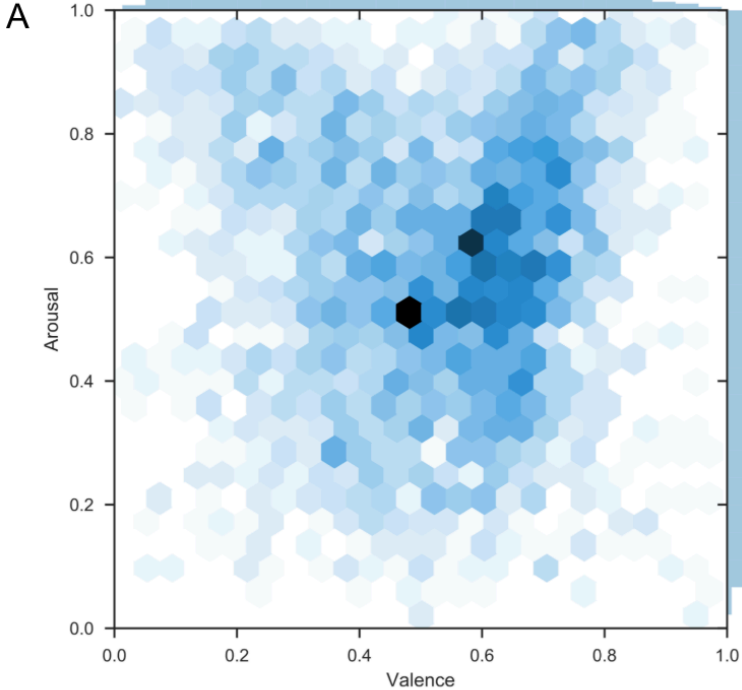Reasons? ☐ Same reasons as rating points nearby

Participant Musical Training
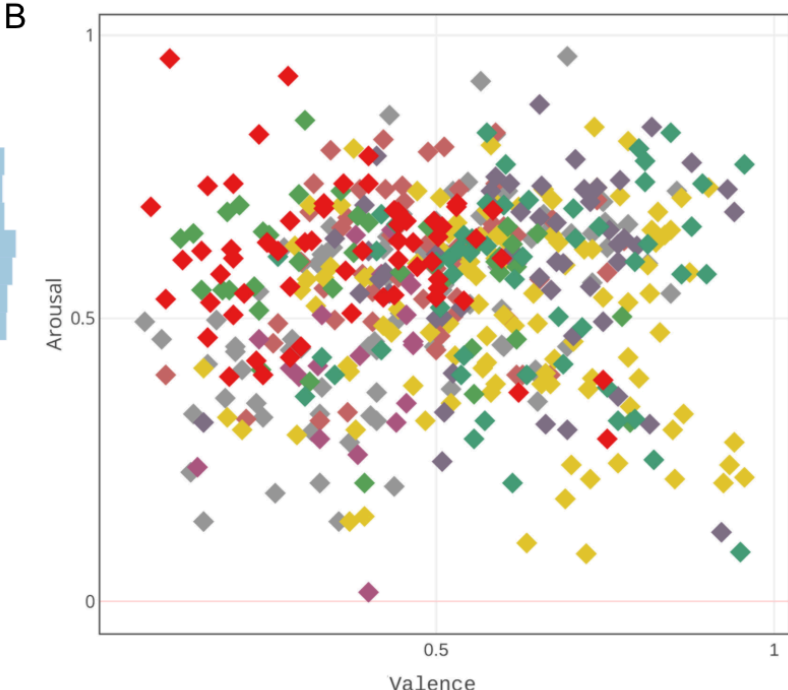
11 musicians, 10 non-musicians

Musicians demonstrate:
- Regular, daily practice of a musical instrument for 10+ years.
- Principle instruments: Piano (4), Guitar (4), Violin (1), Flute (1), Voice (1)

Distribution of Emotion Annotations Collected During the Follow-up Study

(A) Rating task (3181 points);
Histogram using hexagonal bins
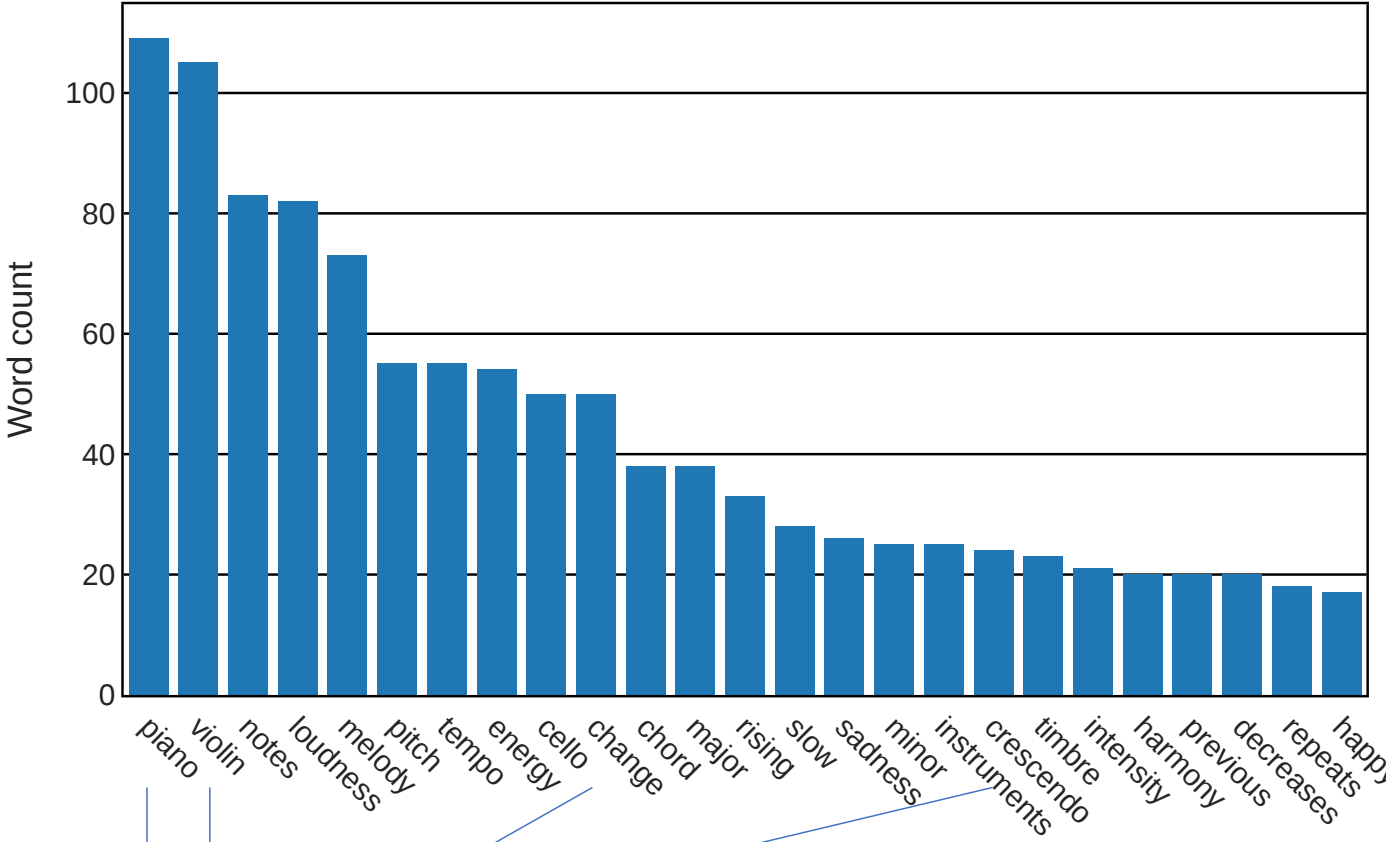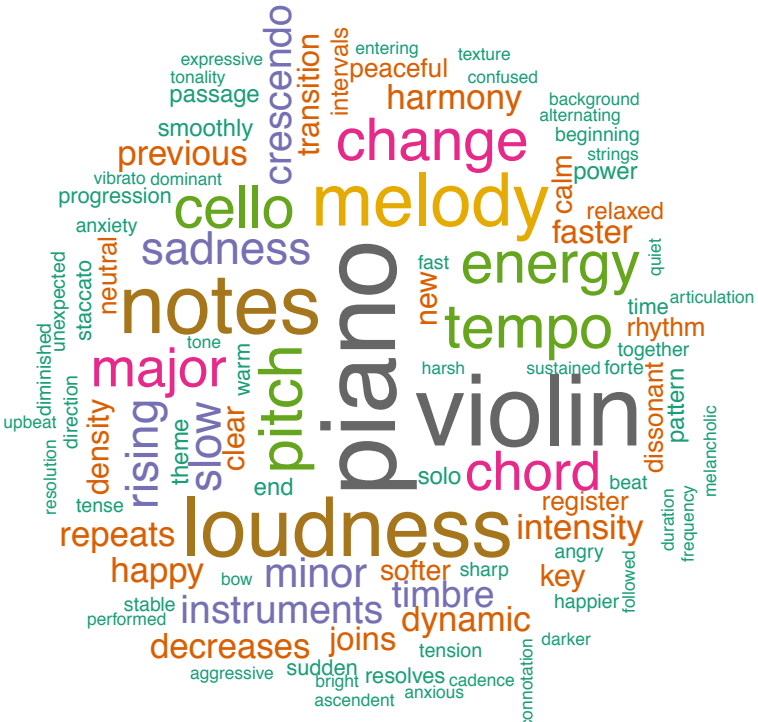
(B) Reflection task (483 points with explanations)

* rating points fell on separate segments are shown in different colours

Word Frequency of 483 rating explanations (7000+ words)

Most Frequent 25 words in comments

Instrument

Thematic Analysis of Feedback

Example Feedback

I think this point deserves more arousal and valence point[s]. The piano is sounding mysterious, with many embellishments, very playful themes (it has more energy and also adds some happiness)."
- Participant 19, Segment 2 (#443)

Extracted Codes + Resulting Themes

Piano (Instrument Entities)

Embellishment (Performer Eexpression)

Energy (Perceptual Acoustic Features)

7 Key Themes Identified

1. Instrument Entities

*"**Cello became a bit aggressive** and **violin became a bit more weak/soft/sad**"*

- Participant 8, Segment 3 (#166)

*"Even if the cello still plays a melody similar the previous section, **the harmony the piano gives it a darker connotation (more negative)**. At the same time, there is a dynamic crescendo (more arousal)"*

- Participant 15, Segment 1 (#369)

2. Expectation & Violation

*"Cello increases the loudness and **the progression is very unexpected;** it is hard to tell where the piece will go next."*

- Participant 10, Segment 4 (#224)

Themes (cont.)

3. Perceptual Acoustic Features

*"Violin only, **timbre bright**; **high pitch** leads to a high valence feeling. **slow tempo and relatively low loudness** lead to low valence..."*

- Participant 3, Segment 5 (#147)

4. Arrangements

*"This sections [sic] starts with a solo piano that slowly picks up in tempo and volume. **The cello and violin respond to the theme presented by the piano** which leads **to a conversation between the instruments that joins together** in the end with higher energy.''*

- Participant 19, Segment 3 (\448)

Themes (cont.)

5. Music Structure

" **Same pattern is repeated several times** with energy that moves the piece into a more aggressive mood. Because there is an accent on the second note of the pattern. "

- Participant 7, Segment 3 (#243)

6. Performer Expression

" The music is going back to the home chord of the major scale; and the melody is moving up. **Arpeggio makes valence higher**. "

- Participant 13, Segment 2 (#303)

7. Stage Setting

" The violin changes the length of the notes and with that the energy of the music. **Also as it does not have light it is less energy as in the other parts.**"

- Participant 21, Segment 5 (#482)

Connections with Current MIR Research

Instrument Entities → **Instrument recognition, Source separation**

Arrangement → **Multitrack audio dataset, Emotion prediction from multitrack audio**

Performer Expression → **Expressive playing techniques detection**

Conclusion

Incorporation of listener-informed features into MIR-based audio content analysis will benefit the future modelling of music emotion.

Special thanks to my collaborator,
Courtney N. Reed

Thank you!

Any questions?