

The impact of an audience on performance

Background

- Part of the appeal of live music is the potential for interaction between audiences and performers, allowing the audience to impact the performers delivery
- Past research finds varying results regarding how an audience affects performers
 - Some studies find an intensification of performance characteristics and related movements in the presence of an audience (Moelants et al., 2012, Biasutti et al., 2016, Shikanai & Hachimura, 2014)
 - Some show consistencies regardless of audience presence (Schaerlaeken et al., 2017, Bishop et al., 2021)
- We examined how the presence of an audience influenced performance characteristics (dynamics and tempo) and movements (body sway) of a highly-experienced professional classical pianist**
- We tested this by having a professional pianist run a program of self-chosen music in rehearsal and and real-life concert conditions
 - Will dynamics (keystroke velocities) and tempo (inter-beat intervals) be more variable or remain consistent between rehearsal and concert conditions?
 - Will body sway movements become exaggerated or remain consistent between conditions? (analyses in progress)

Methods

Participants

- The participant was an internationally recognized pianist with over 15 years professional performing experience (Fig. 1)
- Two raters annotated the beats of all performances

Stimuli and apparatus

- The pianist performed a self-chosen program of six classical and romantic pieces (Table 1) during a rehearsal (audience absent) and concert (audience present) at McMaster University's LIVELab
- Performances were audio, video and MIDI (Yamaha Disklavier DC7 Concert Grand Piano) recorded
- Head motion data was measured with a Qualisys optical motion capture system with eight cameras during performances
- During the rehearsal the pianist wore a headband with two 10mm retroreflective markers attached at the top. These markers were moved to the pianist's hairpin at the back of the head during the concert due to their preference

Procedure

- Rehearsal:** The pianist performed their program alone three days before the concert in the evening. We asked them to play as if it were the real performance
- Concert:** The pianist performed their program in front of a sold-out audience (~100 audience members). The performance was also live-streamed on Youtube
- Following the performance, we asked the pianist to indicate moments of their program that were particularly emotionally expressive according to them

Analysis

- Dynamics:** we derived keystroke velocities from the MIDI data for each piece of each condition. These were further broken down into approximate ~30s paired segments representing the same musical material across rehearsal and concert conditions to allow for comparison
- Tempo:** we derived a measure of tempo by asking raters to manually annotate each beat, half-bar, or bar of each piece depending on tempo (Fig 2). From these we calculated the inter-beat intervals (IBIs) for each piece
- Movement:** we planned to derive measures of movement speed and energy for the ~30s paired segments. Because of the change in marker placement between rehearsal and concert, we are unable to use marker position data. We are investigating an alternative method of movement analysis—calculating differences in pixels frame-to-frame from the video data as a measure of overall body movement (e.g., Tschacher et al., 2023)



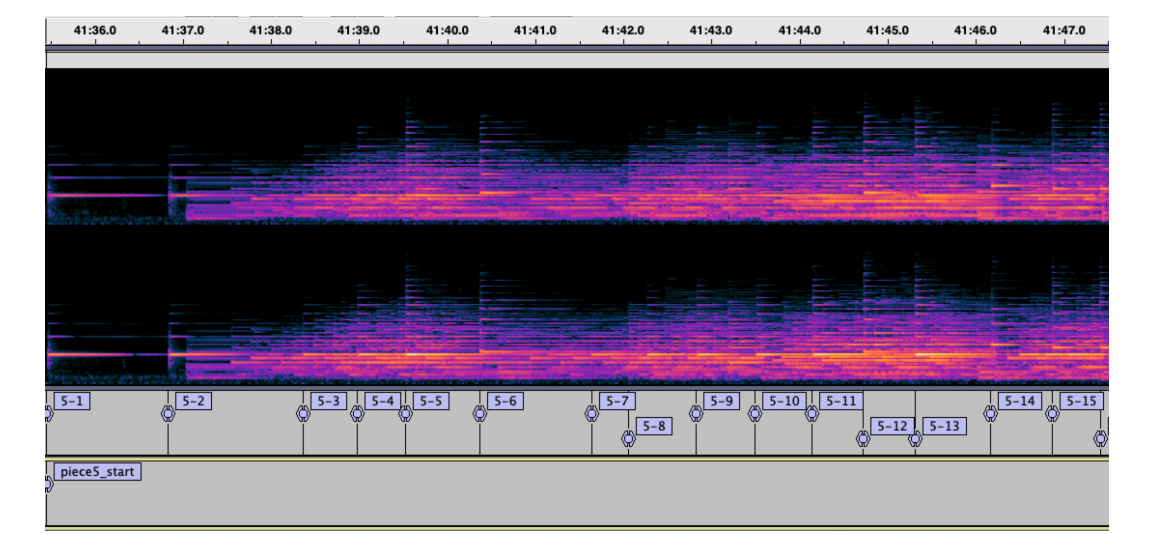
Figure 1. Video still from the rehearsal (left) and concert (right) condition



Figure 2. Beat annotation procedure. Raters followed along with the score (e.g., left) and used Audacity software to manually place a label in the audio time-series at each beat (right)

Table 1

Title	Composer	Metre
1. Sonata K45	D. Scarlatti	12/8
2. Sonata 213	D. Scarlatti	4/4
3. Novelette No. 8	R. Schumann	4/4
4. Sonata No. 3	S. Prokofiev	12/8
5. Etude Op. 25 No. 1	F. Chopin	4/4
6. Scherzo No. 2	F. Chopin	3/4



Results

Dynamics Results (keystroke velocities)

- There were no significant differences in either mean or variability of keystroke velocities in the paired epochs between rehearsal and concert conditions (Fig. 3, Fig. 4)

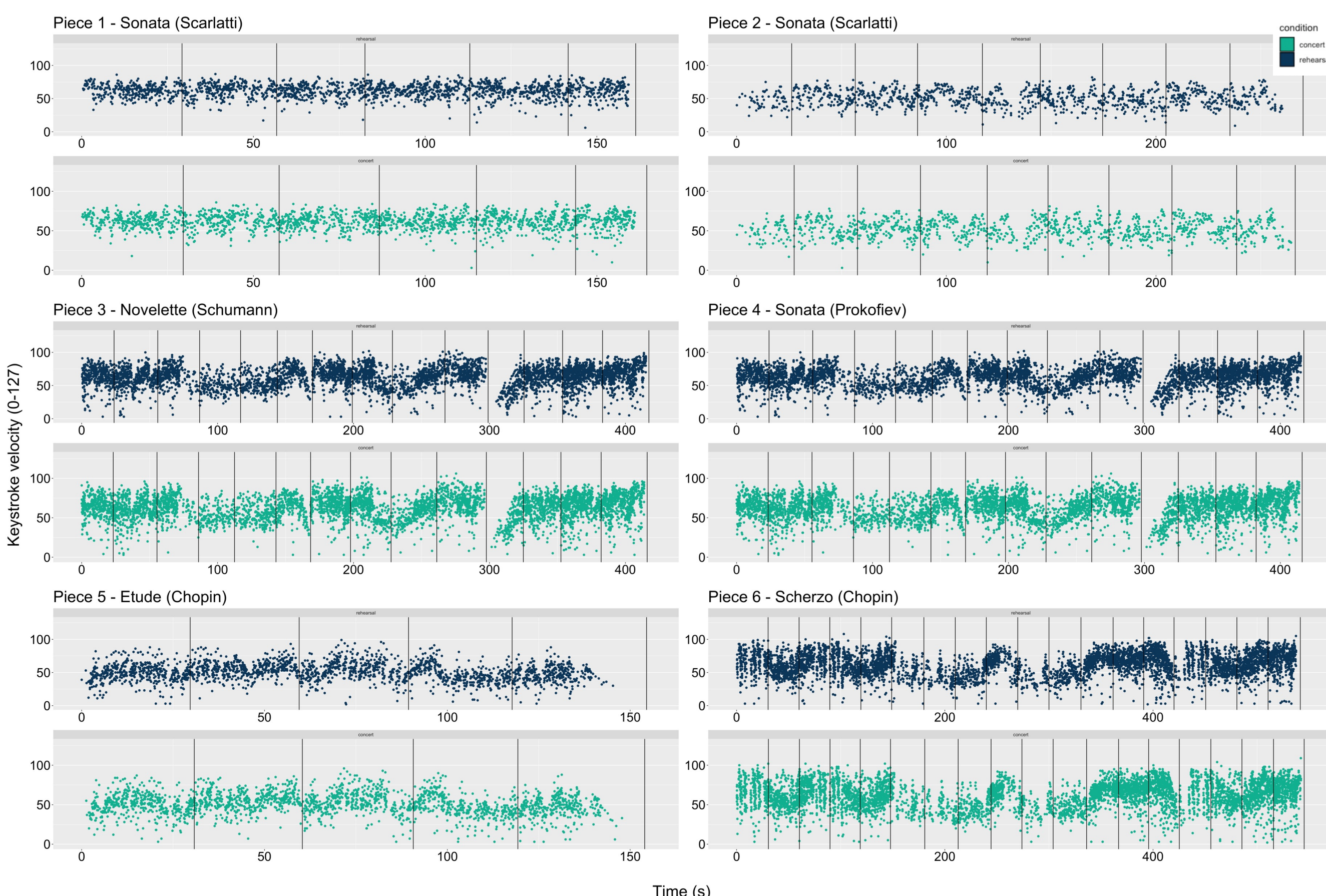


Figure 3. Raw MIDI data for each piece of each condition (rehearsal in blue, concert in teal). Vertical lines represent the paired 30s segments representing the same sections of music for comparison. The mean and variability of keystroke velocities were calculated for each segment

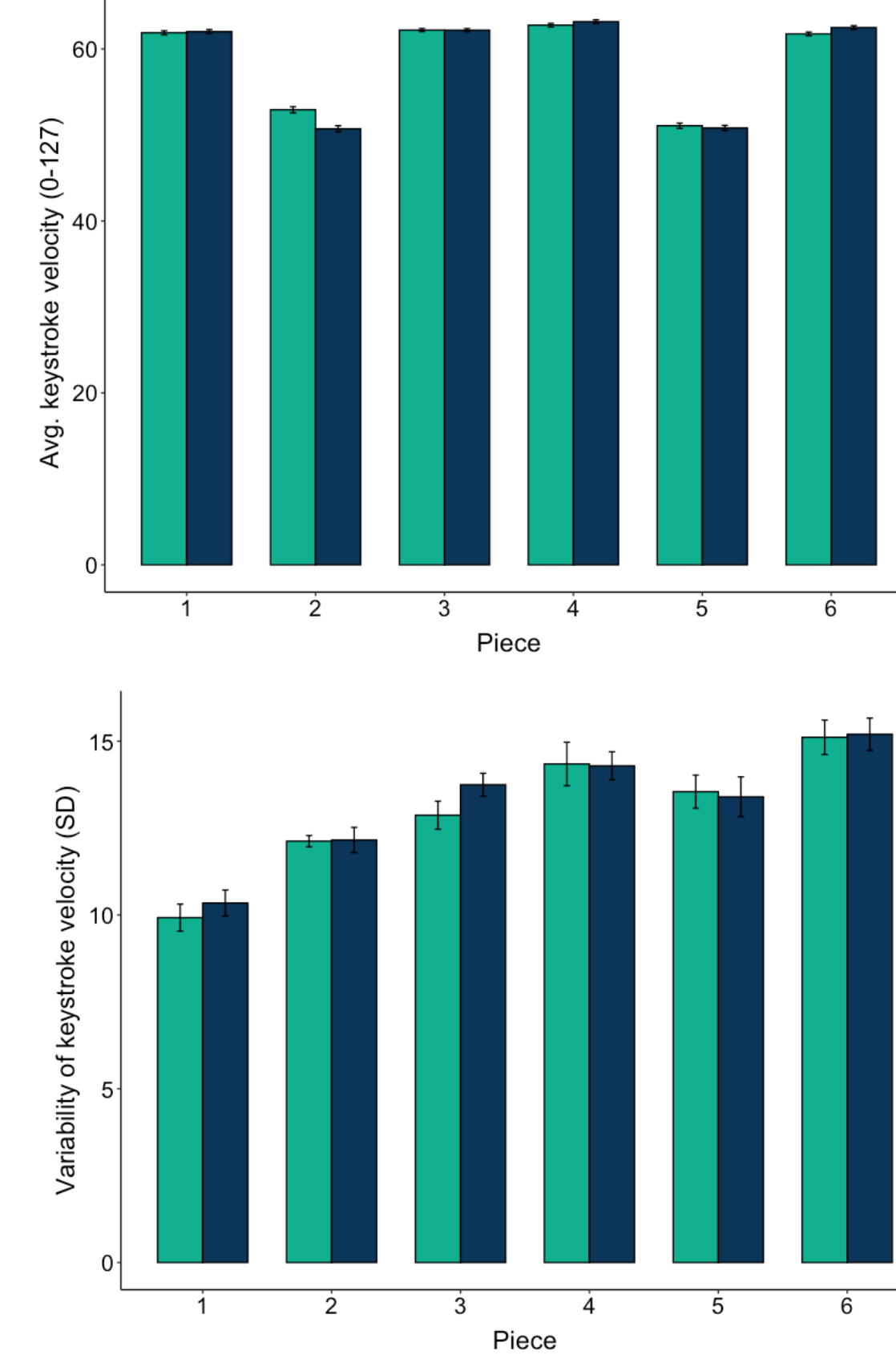


Figure 4. (Top) Average keystroke velocity for each piece of the rehearsal and concert conditions. (Bottom) Average variability for each piece of each condition

Tempo Results (Inter-beat intervals)

- The inter-beat intervals between rehearsal and concert conditions were very strongly correlated across all pieces

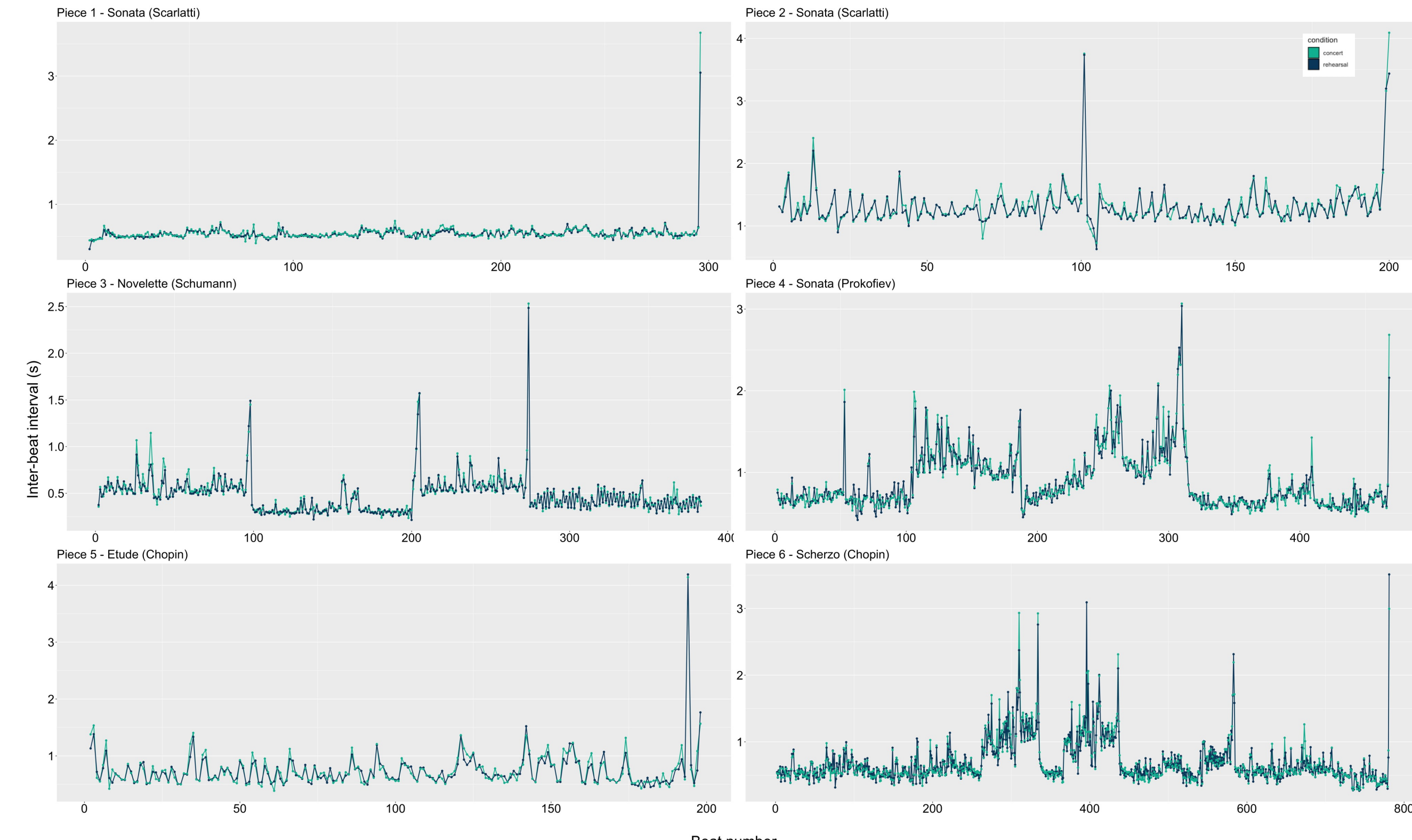


Figure 5. Tempo curves showing inter-beat intervals for each beat across the six pieces. Beats were marked in pieces 1, 2, 3, and 5. Half-bars were marked in piece 4. Bars were marked in piece 6. Only bars 1-383 are shown for piece 3

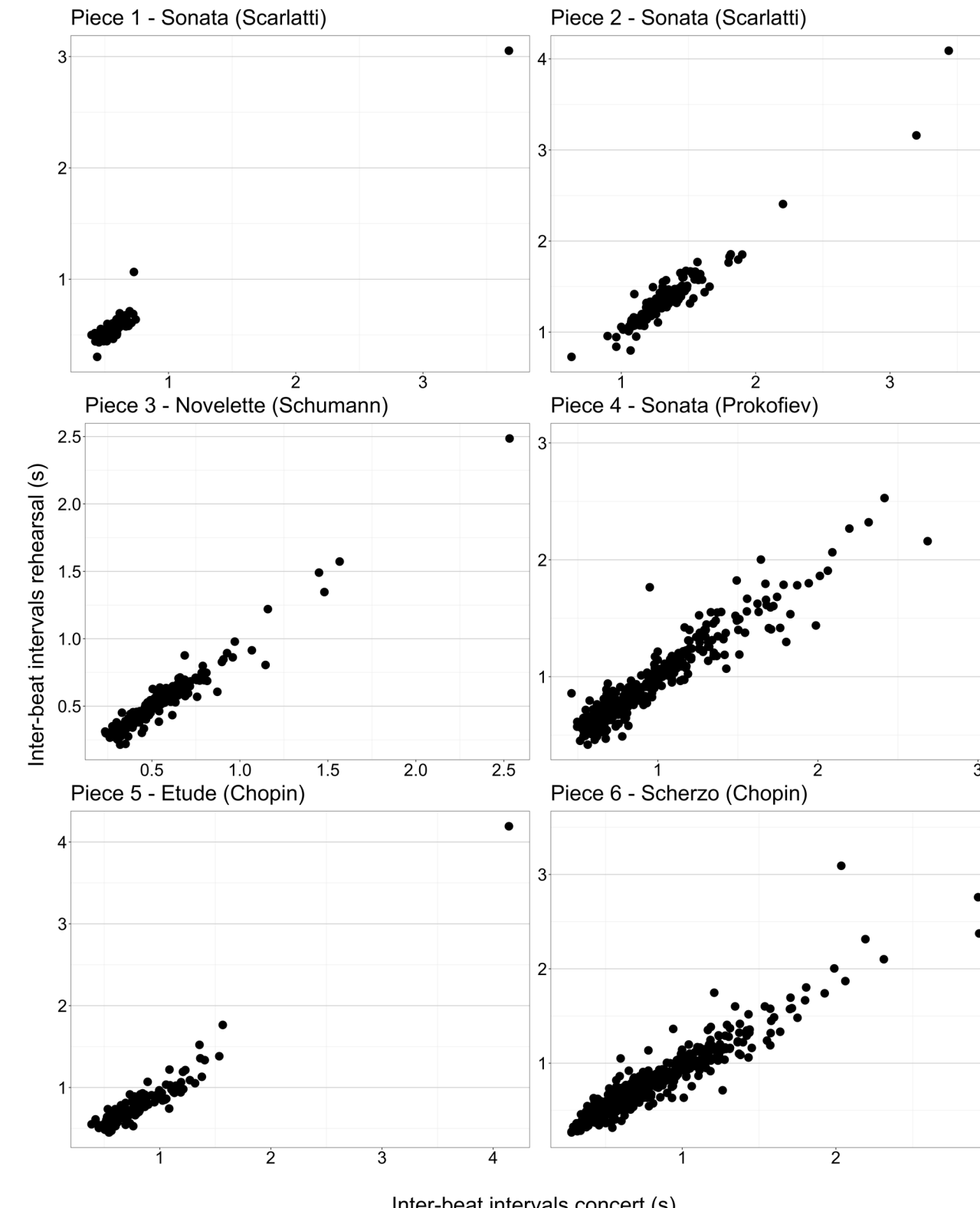


Figure 6. Correlations between the inter-beat intervals in the rehearsal and concert using scatter plots for each piece

Expressive Moments (ongoing)

- The pianist indicated 12 sections of the music that they deemed to be particularly expressive (Table 2)
- We are currently in process of analyzing the keystroke velocities and inter-beat intervals in these specific moments between conditions (see Fig. 7 for examples)

Piece	Measure	Beat number	Type of beat marked
1. Piece 2 - Sonata 213	17-24	17-24	Beat (quarter note)
2. Piece 2 - Sonata 213	17-24	17-24	Beat (quarter note)
3. Piece 3 - Novelette No. 8	1-8	1-8	Beat (quarter note)
4. Piece 3 - Novelette No. 8	1-8	1-8	Beat (quarter note)
5. Piece 3 - Novelette No. 8	1-8	1-8	Beat (quarter note)
6. Piece 4 - Sonata No. 3	11-19	11-19	Half bar (half note)
7. Piece 5 - Etude Op. 25 No. 1	1-18	1-18	Beat (quarter)
8. Piece 5 - Etude Op. 25 No. 1	20-24	20-24	Beat (quarter)
9. Piece 5 - Etude Op. 25 No. 1	25-28	25-28	Beat (quarter)
10. Piece 6 - Scherzo No. 2	209-242	209-242	Bar
11. Piece 6 - Scherzo No. 2	243-276	243-276	Bar
12. Piece 6 - Scherzo No. 2	277-310	277-310	Bar

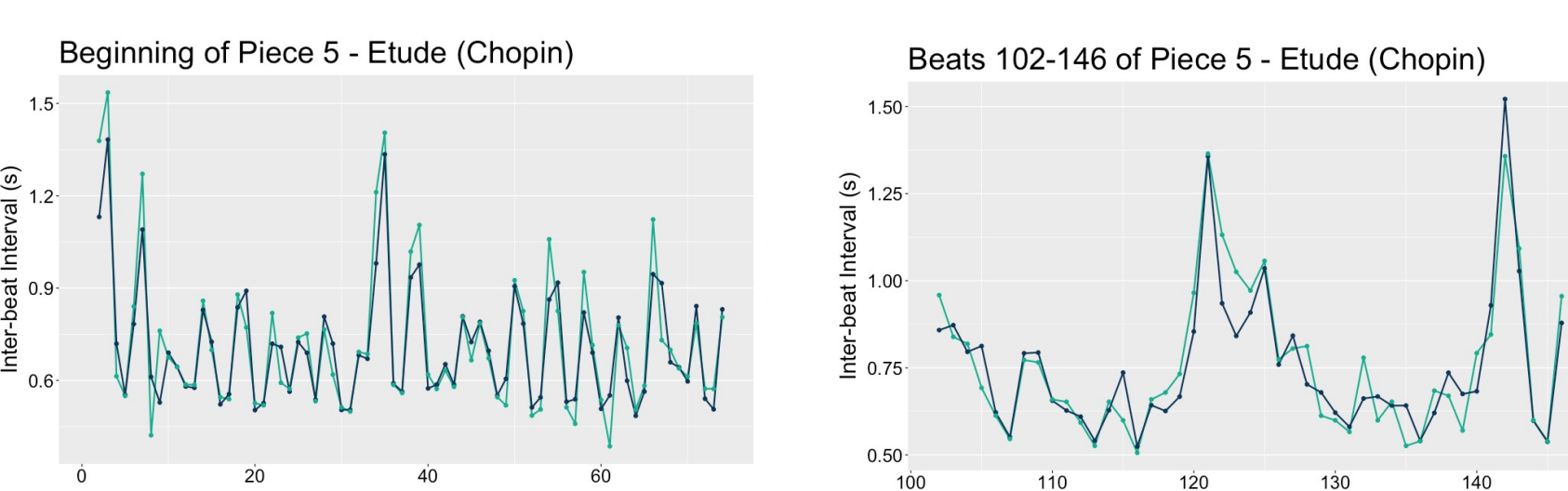


Figure 7. Inter-beat intervals for two of the expressive moments indicated by the pianist

Discussion

Both the dynamics and tempo were highly consistent between the concert and rehearsal

- The observed consistency may be due to the pianist's experience and the genre of music
 - The pianist is highly experienced and well-practiced, which may translate to consistency in performance
 - Classical music typically involves notes predetermined by the composer and expressive interpretation predetermined by the performer, so the performance may not change to a notable degree from across repetitions
- In the future we aim to analyze differences in overall body motion using video data
- We are continuing the analysis of specific moments the performer indicated as particularly emotionally expressive

Limitations

- Order effects are possible because the rehearsal occurred before the concert—however musicians are accustomed to this configuration, reducing artificiality of the experiment
- This is a case study. Factors such as the personality and experience of musicians, type of audience and performance, the type of music may significantly influence observed effects

Future directions

- Classical music is highly scripted which may result in higher consistencies across performances than for music that varies from performance to performance, such in the case of improvisation
- In the future, we will compare this classical performance to a jazz performance that is less scripted and contains improvisation, where the audience may engage to a greater degree in interaction with the performer

References

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