

The Sound of Teaching Music

Experts' sound modulation for novices

Progress workshop 2019
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Cultural transmission

- Skill transmission and cultural evolution (Whiten, 2017; Dukas, 2017)
- Expertise and expressive techniques
- Musical expression (Repp, 1998; Sloboda, 2000)
- Teaching behaviour of experts (Tomasello, 2016; Lombao et al., 2017)
- Cognitive processes of novices
 - ➡ Attention, memory, inductive reasoning, imitation etc.



*How do experts modulate
their behaviour
for teaching purposes?*

Motherese

- Infant-directed speech (Fernald, 1985)
- Acoustic cues from caregivers to infants (Kuhl, 2004)
 - Slower speech
 - Exaggeration (louder voice / higher pitch / a larger pitch contour)
- These cues could be used to transmit an expressive part of expertise?



Predictions

- Comparison between teaching and performing
- Experts would play ***more slowly*** when teaching than when performing
- Experts would ***exaggerate relevant properties*** of sound for teaching purposes
 - ➡ Articulation (smoothness): longer legato and shorter staccato
 - ➡ Dynamics (loudness): louder forte and smaller piano

Methods

- **Participants:** 20 pianists *Note: we recruited 36 and 16 were excluded from data analysis because of 1. a high pitch error rate (>10%; 3 trials out of 32 trials) and 2. a deviated tempo)
- **Task:** perform one excerpt of music with expression on a digital piano
- **Condition:**
 - ➡ **Teaching:** Play what you practised as if you were teaching it to students. Students already know how to produce the sequence of the tones and now are trying to **learn how to perform the piece expressively** by listening to your performance. Do your best as a teacher.
 - ➡ **Performing:** Play what you practised as if you were performing it to an audience. Do your best as a performer.

Stimuli

Articulation (slur: legato, dots: staccato)

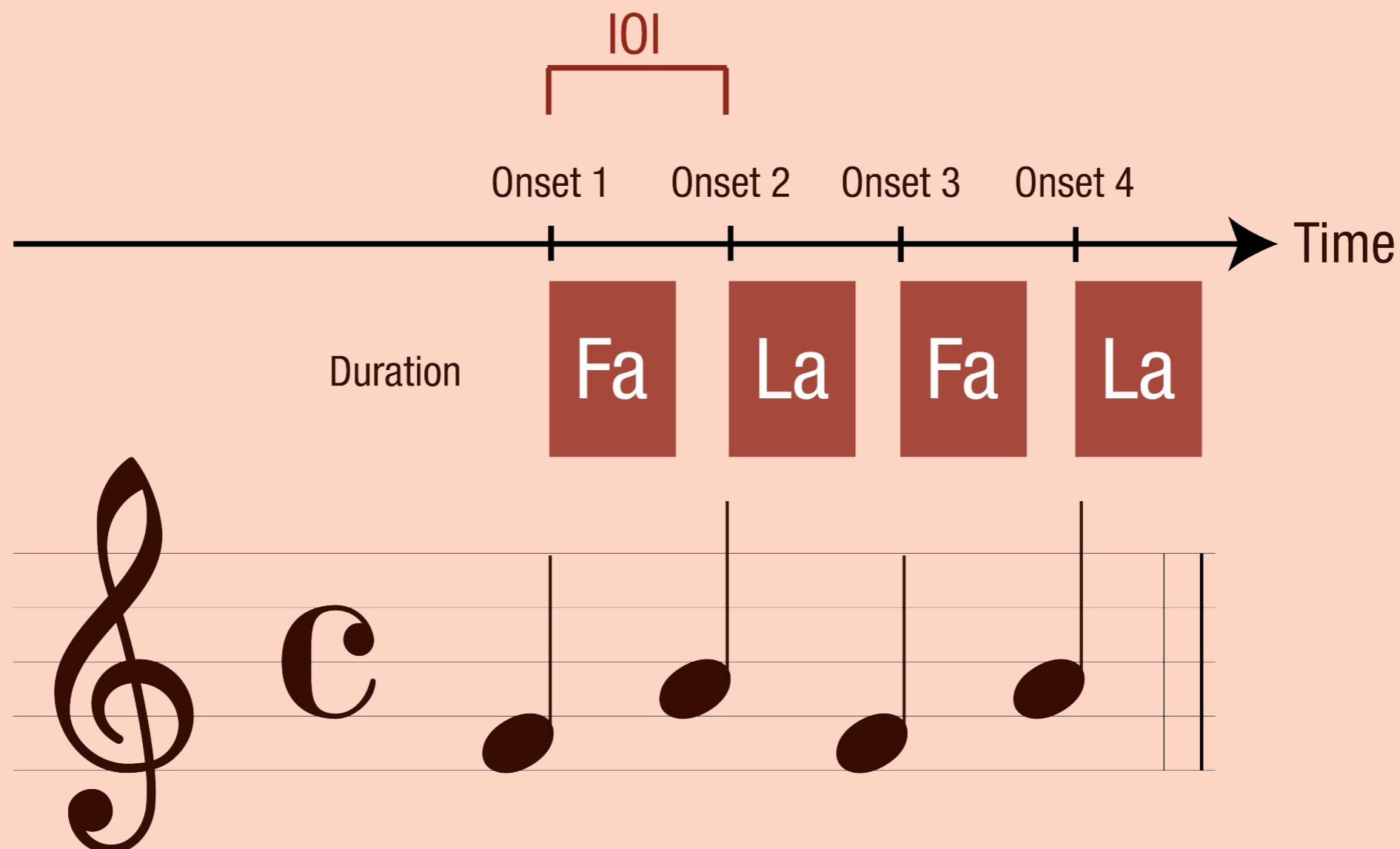


Dynamics (f: forte, p: piano)



Measurements

- *Tempo*: Interonset intervals (IOIs) - e.g., onset 2 - onset 1

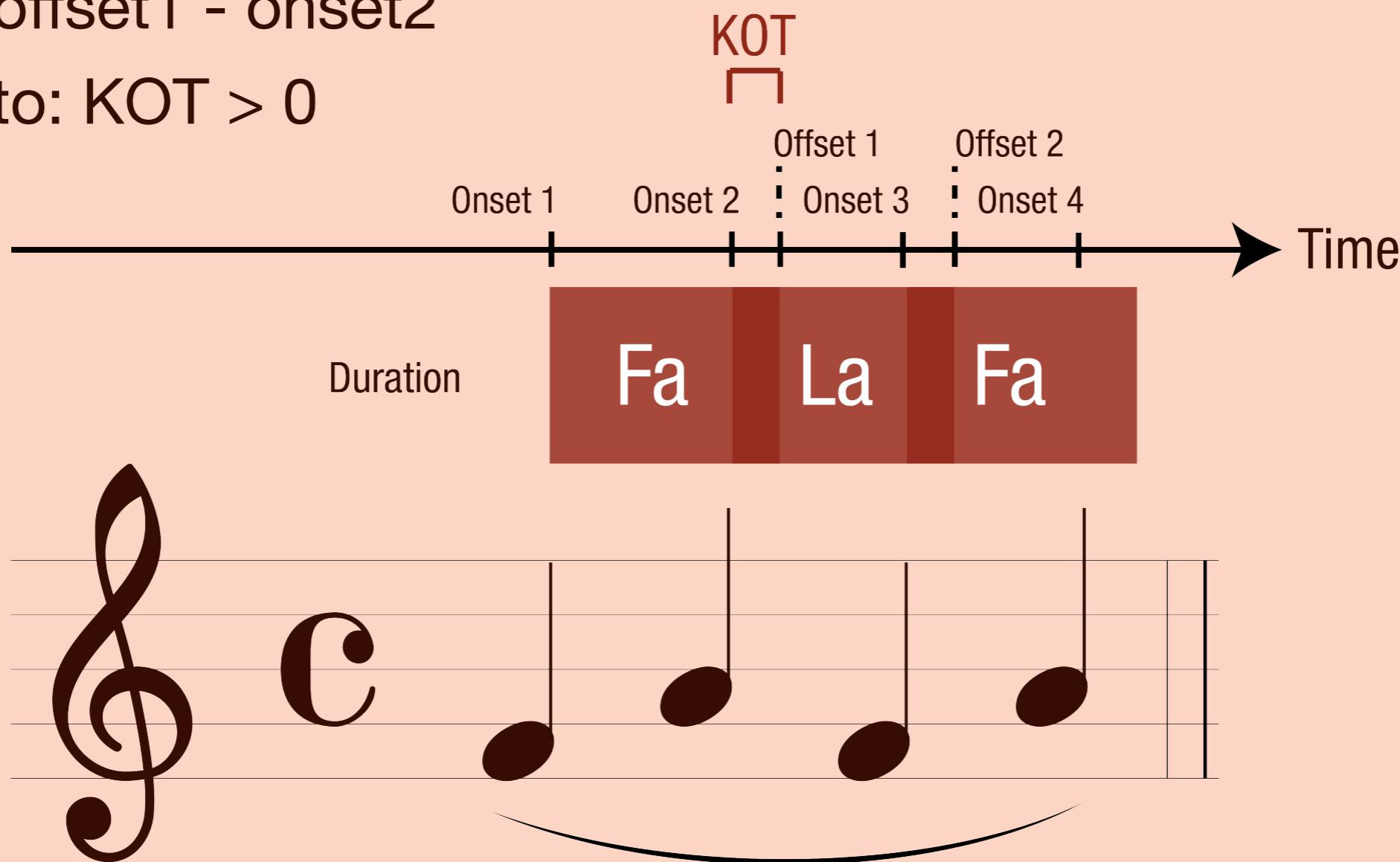


Measurements

- *Articulation (smoothness)*: Key-overlap time (KOT)

e.g., offset1 - onset2

Legato: KOT > 0

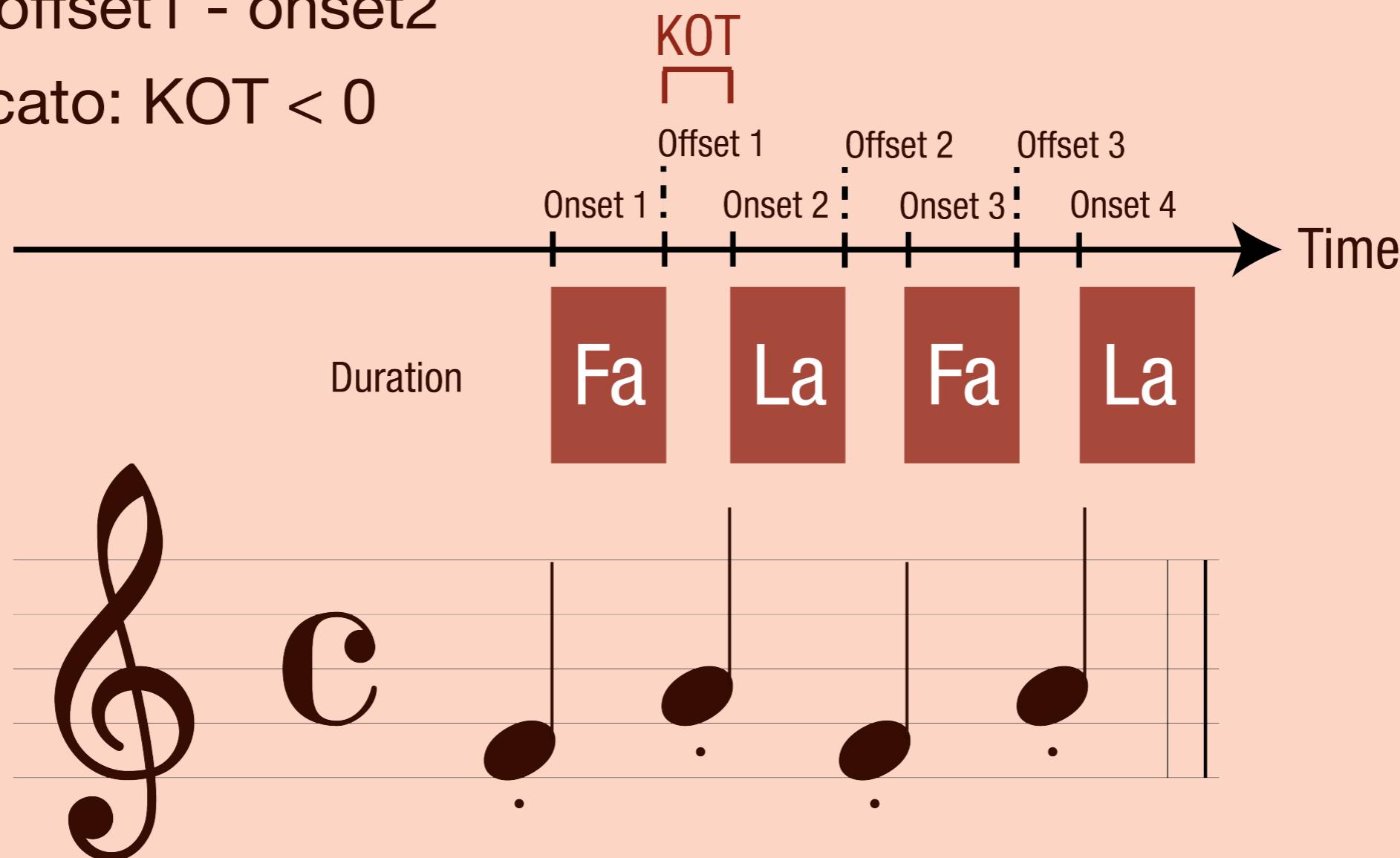


Measurements

- *Articulation (smoothness)*: Key-overlap time (KOT)

e.g., offset1 - onset2

Staccato: KOT < 0



Measurements

- *Dynamics (loudness)*: Key velocity (KV)
 - ➡ Forte (louder) and piano (softer)
 - ➡ 0 (minimum) to 127 (maximum)

Procedure

1. Practice

2. Instruction (teaching or performing)

3. Test trials (8 trials - 1 block)

4. Repeat 1-3 for each skill (articulation, dynamics) in each condition (teaching, performing) (32 trials - 4 blocks)

The orders of the conditions and the skills were counterbalanced across participants



Metronome
(8 beats / 80 bpm)

Start playing

*Do experts perform more
slowly for teaching
purposes?*

IOIs: tempo

- Articulation

Participants **played more slowly** in the teaching condition than in the performing condition

Condition: $F(1,19) = 4.82, p = 0.041, \eta^2 = 0.019$

- Dynamics

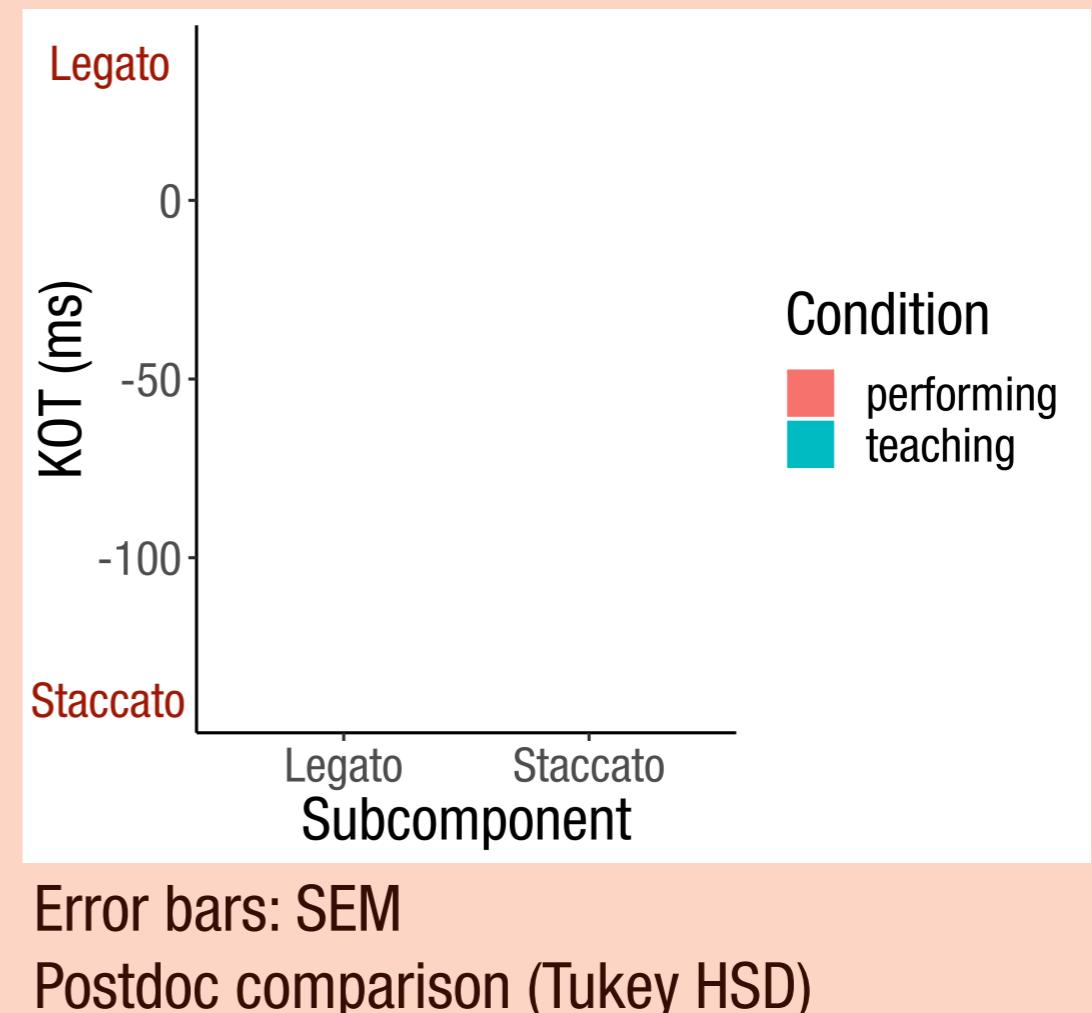
Participants did not play slower in the teaching condition than in the performing condition

Condition: $F(1,19) = 2.84, p = 0.11, \eta^2 = 0.011$

*Do experts exaggerate
legato and staccato for
teaching purposes?*

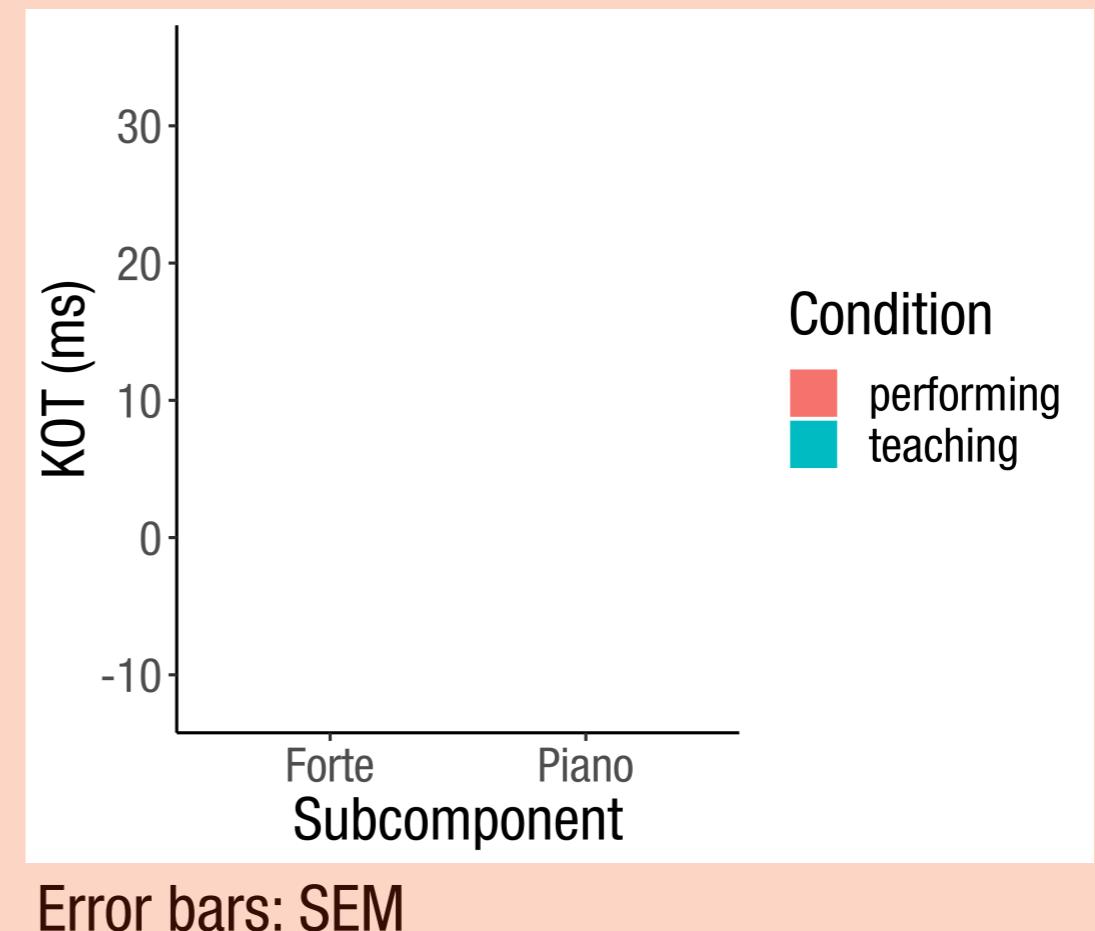
KOT: articulation

- Subcomponent: $F(1,19) = 859$,
 $p < 0.001$, $\eta^2 = 0.96$
- Condition x Subcomponent:
 $F(1,19) = 10.4$, $p = 0.004$, $\eta^2 = 0.020$
- Participants produced **longer legato and shorter staccato** in the teaching condition than in the performing condition



KOT: dynamics

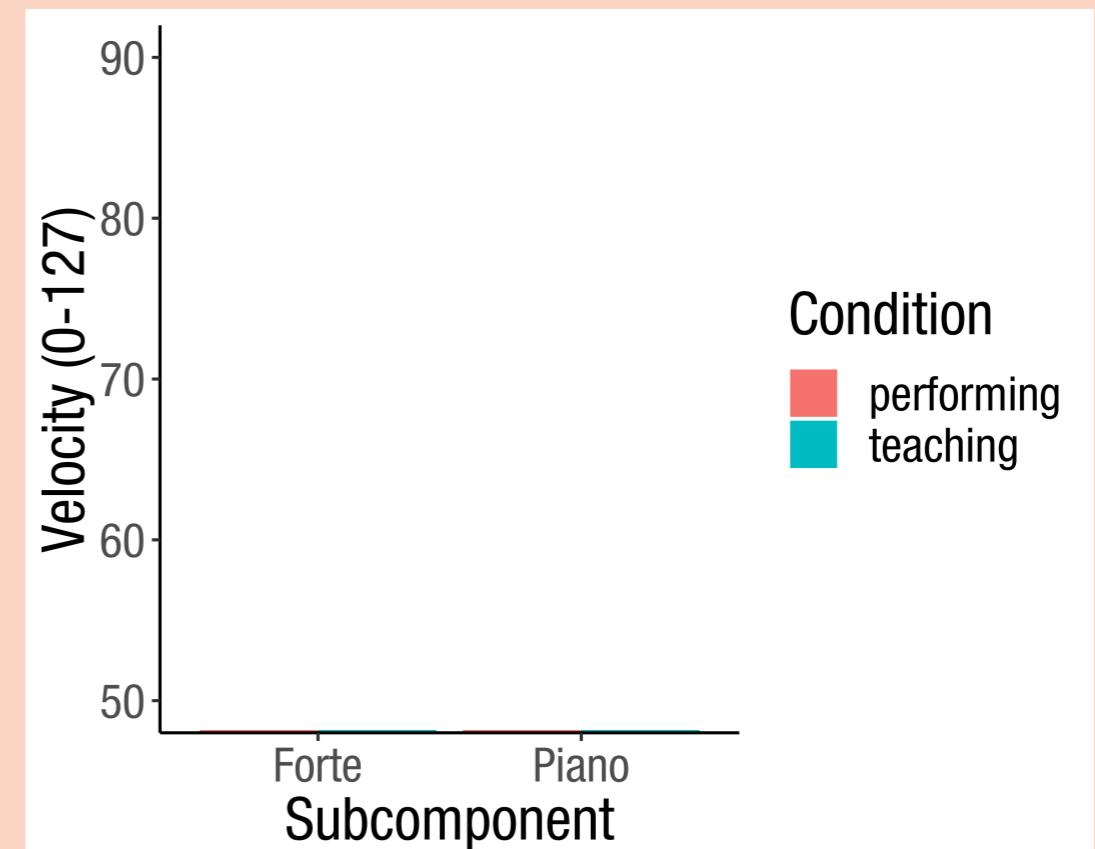
- Subcomponent: $F(1,19) = 323$,
 $p < 0.001$, $\eta^2 = 0.62$
- No effect of Condition: $F(1,19) = 0.001$, $p = 0.98$, $\eta^2 = 0.000$
- No Interaction: $F(1,19) = 0.57$,
 $p = 0.46$, $\eta^2 = 0.000$
- Participants did not modulate their performance in terms of articulation for dynamics for teaching purposes



*Do experts exaggerate
forte and piano for teaching
purposes?*

KV: dynamics

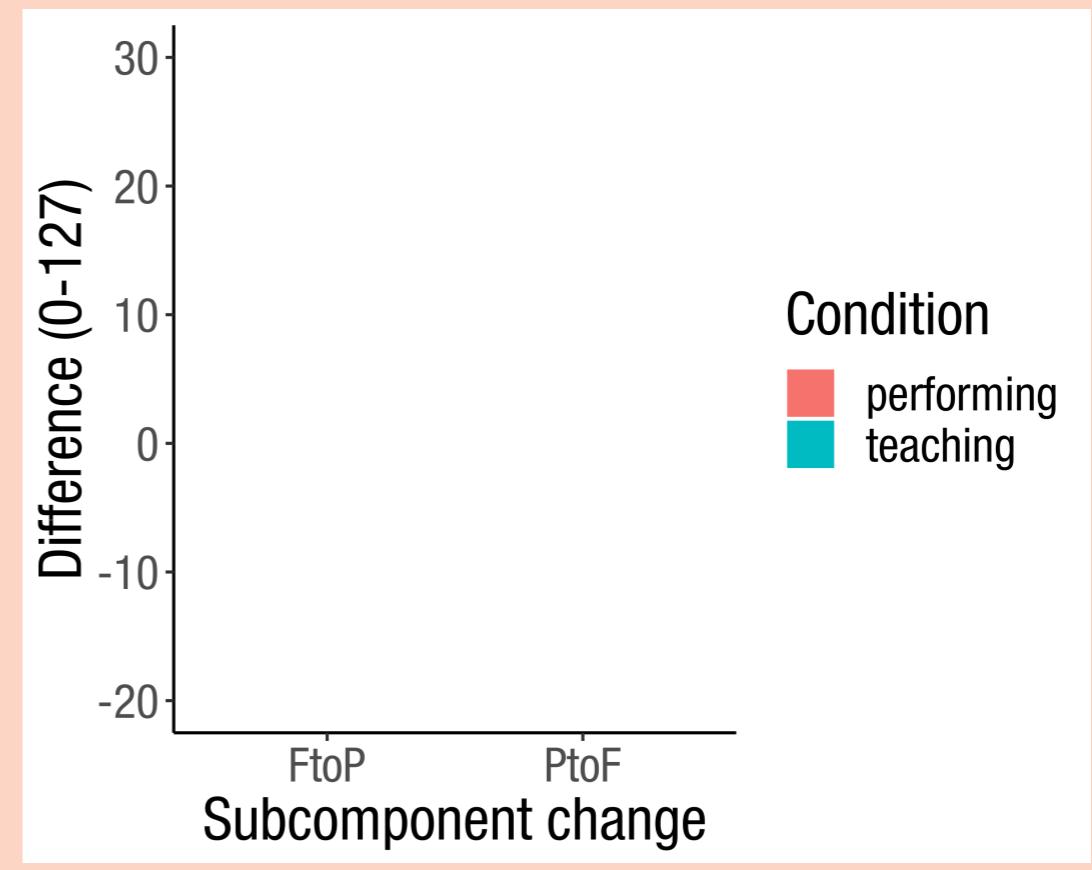
- Subcomponent: $F(1,19) = 194$,
 $p < 0.001$, $\eta^2 = 0.74$
- Condition x Subcomponent:
 $F(1,19) = 4.48$, $p = 0.048$, $\eta^2 = 0.003$
- Participants produced **louder forte** in the teaching condition than in the performing condition
- No difference for piano



Error bars: SEM
Postdoc comparison (Tukey HSD)

KV diff: dynamics

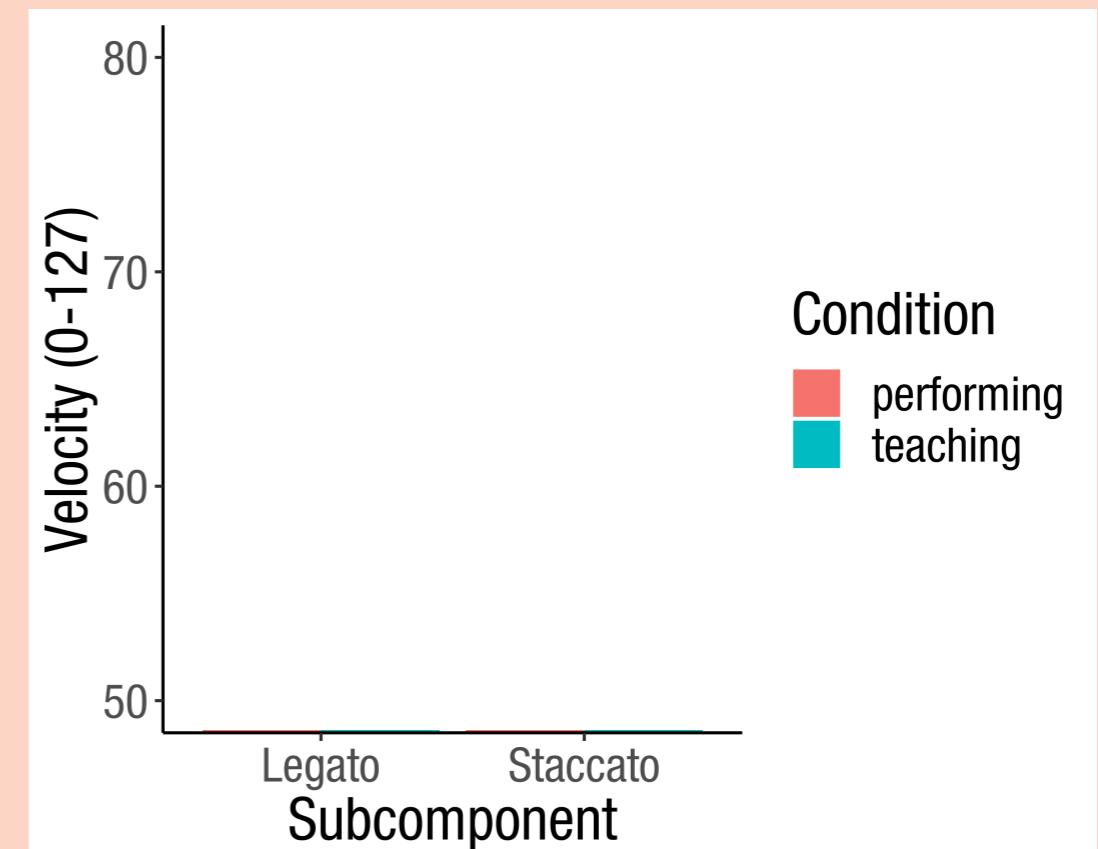
- To highlight a transition from forte to piano / piano to forte, we calculated KV difference between two notes
- Subcomponent: $F(1,19) = 113, p < 0.001, \eta^2 = 0.82$
- Condition x Subcomponent: $F(1,19) = 23.5, p = 0.048, \eta^2 = 0.030$
- Participants made a **larger contrast between forte and piano** in the teaching condition than in the performing condition



Error bars: SEM
Postdoc comparison (Tukey HSD)

KV: articulation

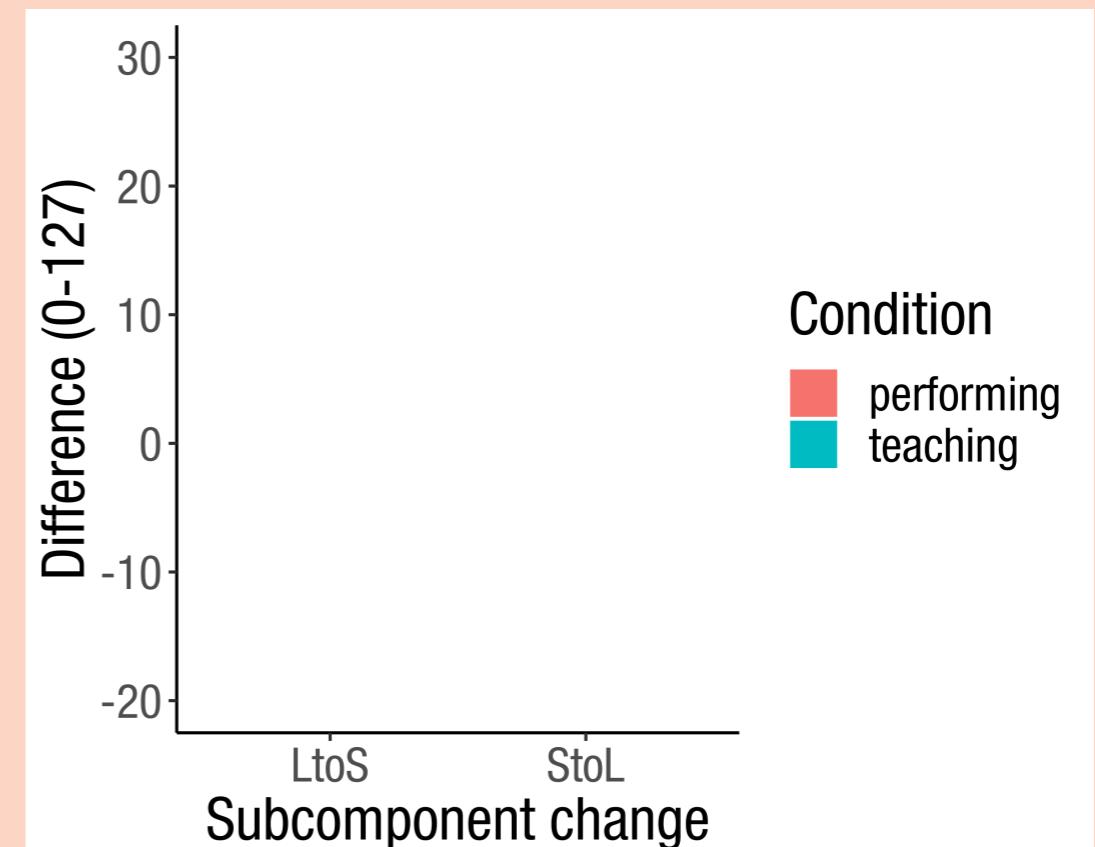
- Condition x Subcomponent:
 $F(1,19) = 8.18, p = 0.010, \eta^2 = 0.009$
- Participants produced **louder legato and staccato** in the teaching condition than in the performing condition



Error bars: SEM
Postdoc comparison (Tukey HSD)

KV diff: articulation

- Condition x Subcomponent:
 $F(1,19) = 7.55, p = 0.048, \eta^2 = 0.003$
- Participants produced **a larger contrast from legato to staccato** in the teaching condition than in the performing condition



Error bars: SEM
Postdoc comparison (Tukey HSD)

Summary

- Participants could produce expression in both conditions
- Participants **played slower** while playing the piece with **articulation**, but not with dynamics in the teaching condition than in the performing condition
- Participants **exaggerated legato and staccato** for teaching purposes
- Participants **exaggerated forte**, but not piano for teaching purposes
- Participants made **a larger contrast** between forte and piano in the teaching condition than in the performing condition

Discussion

- IOIs: Do experts perform more slowly for teaching purposes?
 - Slower demonstration might be helpful only for articulation?
 - No deliberate slowing down for both skills: because of the leading metronome?
- KOT: Do experts exaggerate legato and staccato for teaching purposes?
 - Clear exaggeration for articulation, but not for dynamics
- KV: Do experts exaggerate forte and piano for teaching purposes?
 - Partial exaggeration for dynamics / louder performance for articulation: didactic signals to draw novices' attention?
 - Experts might modulate their performance at specific points (e.g., transition points from forte to piano)

Future direction

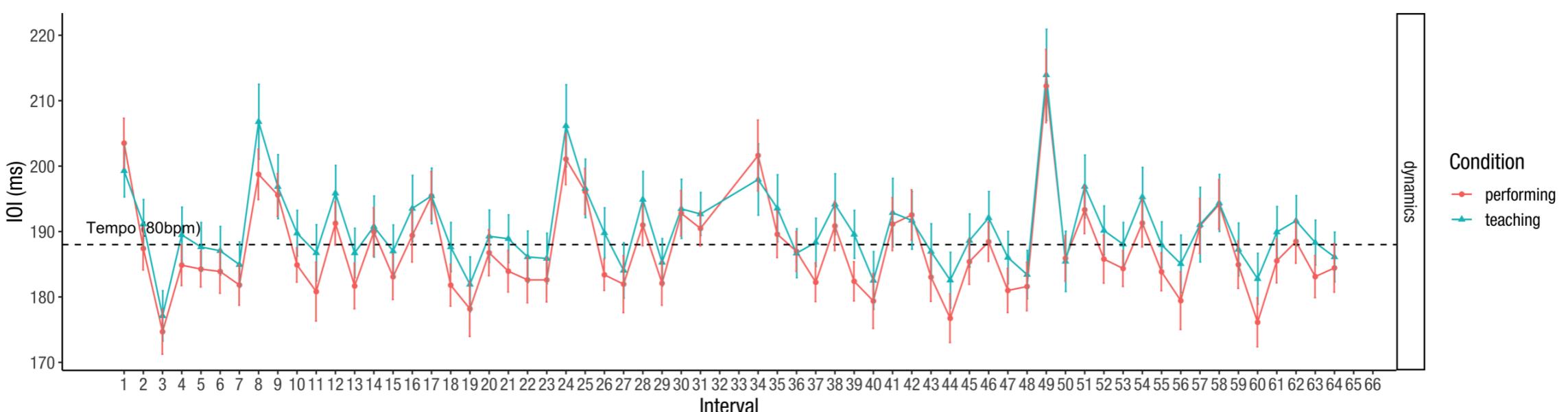
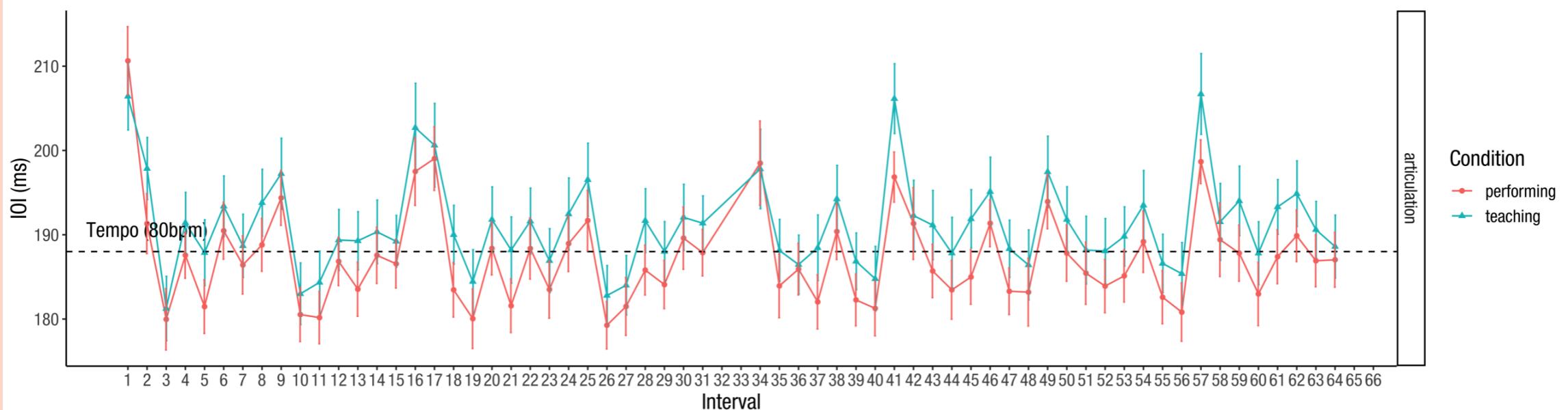
- Follow-up study
 - Same focus on expression between the teaching and performing condition
 - Use realistic music (based on Clementi's Sonatina)
- Which cues are crucial for novices?
- How interactions between experts and novices affect novice learning?

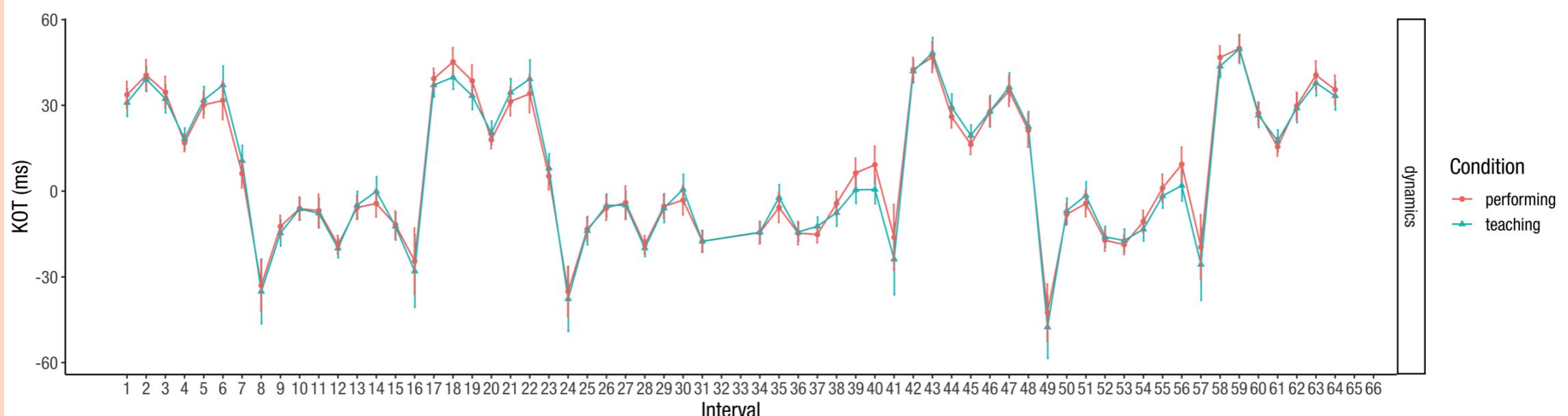
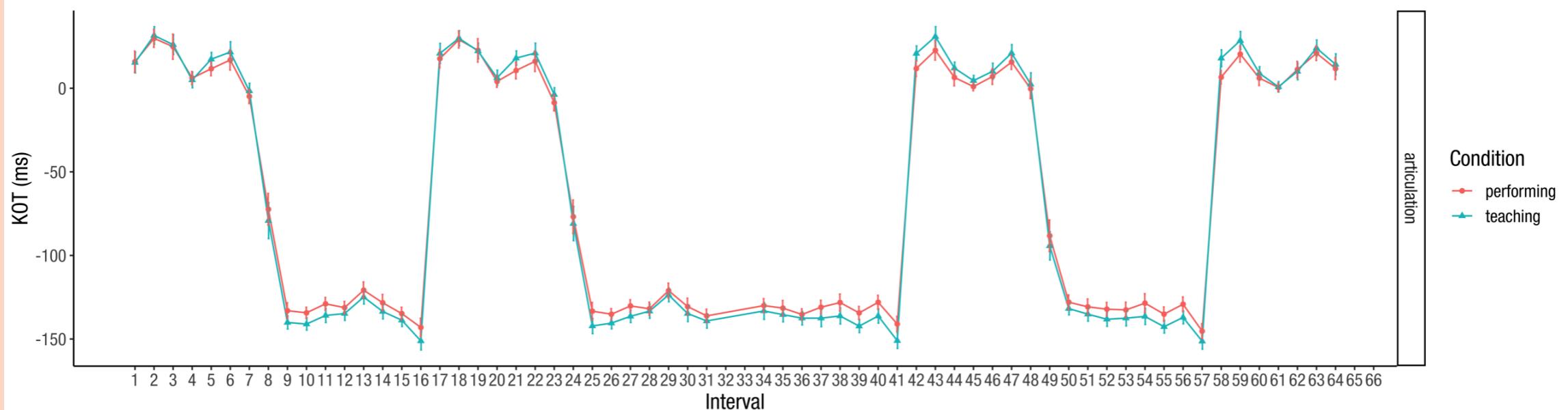
Stimuli



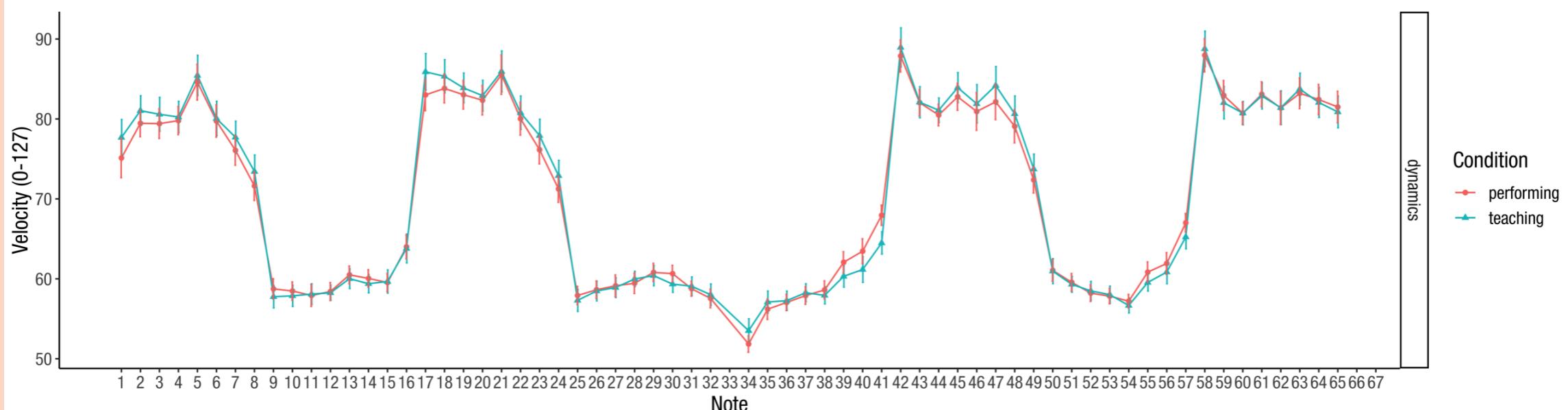
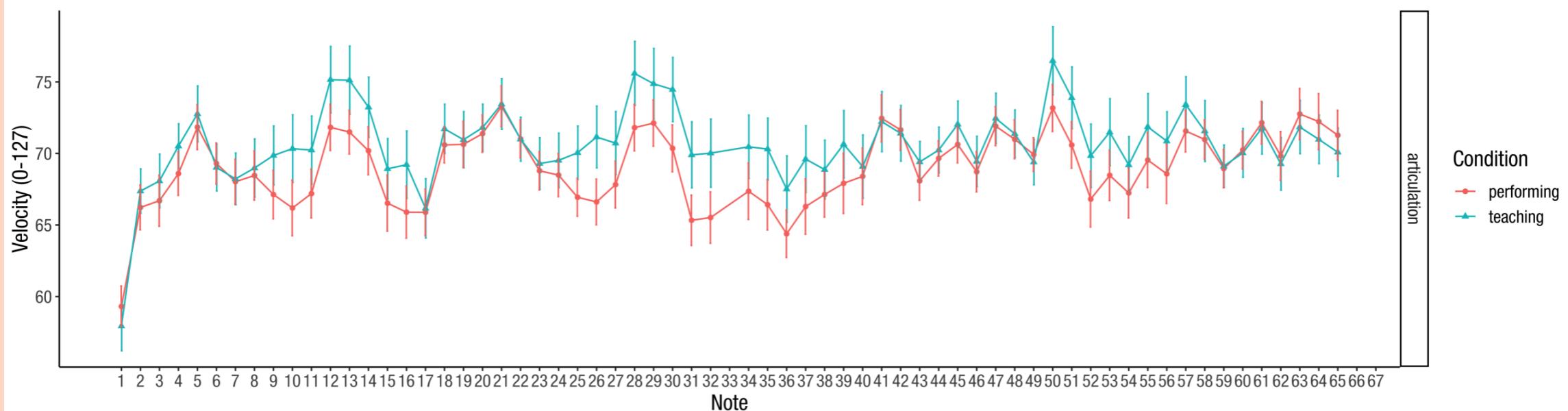
- Only 16th notes were analysed.
- Without musical expression - for the purpose of practice

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66





Musical score showing two staves of music. The top staff starts with a forte dynamic (**f**) and a grace note, followed by six eighth notes. It then has a piano dynamic (**p**) and six eighth notes. This pattern repeats three more times. The bottom staff starts with a piano dynamic (**p**) and six eighth notes, followed by a forte dynamic (**f**) and six eighth notes. This pattern repeats three more times. Measures are numbered 1 through 67 below the staff.



Musical score showing two staves of music. The top staff starts with a forte dynamic (**f**) and includes measures 1-16. The bottom staff starts with a piano dynamic (**p**) and includes measures 17-66. Measures are numbered below the staff.

