What makes musicians infer teaching intentions 🤔?

## Progress Workshop 2021

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Teaching

Deliberate teaching might be unique in human beings and seems to play an important role in skill transmission (Thornton & Raihani, 2008; Tomasello, 2016).

Teachers are likely to change their behaviour when demonstrating a skill to learners.

- Talking to infants (Saint-Georges et al., 2013)
- Showing how to use a novel toy to infants (Brand et al., 2002)
- Similarly towards adult learners (Uther et al., 2007; McEllin et al., 2017)
- **Teaching musical expressions to students (Tominaga et al., in prep)**
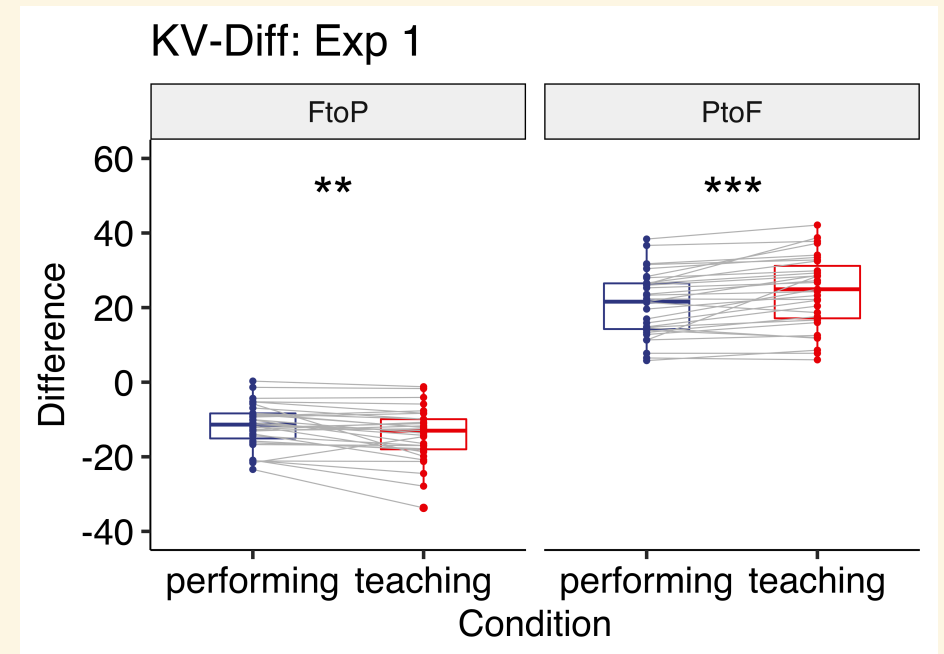
Can learners identify such pedagogical modifications?

- Infants are more likely to pay attention to infant-directed speech/action (Fernald, 1985; Brand et al., 2008)
- People use specific kinematics cues to discriminate between joint and teaching actions (McEllin et al., 2018)
- In music, people are able to infer emotions by listening to recorded performances (e.g., Akkermans et al., 2019; Gabrielsson & Juslin, 1996)

Motor expertise?

- Experts are more accurate to predict action outcomes (e.g., Aglioti et al., 2008; Sebanz & Shiffrar, 2009)
- Musicians seem to be better at decoding emotions from performances compared to non-musicians (e.g., Lima & Castro, 2011)

Current study

Which features of piano performance make musicians infer teaching intentions?

- Tempo in general (e.g., slower performance)
- Specific modulation for a particular technique (e.g., exaggerated articulation or dynamics)
- Something else?

Experiment 1: A simple music scale with two musical expressions as experimental stimuli

Experiment 2 (ongoing): Replicate the findings from Experiment 1 with a naturalistic piece of music
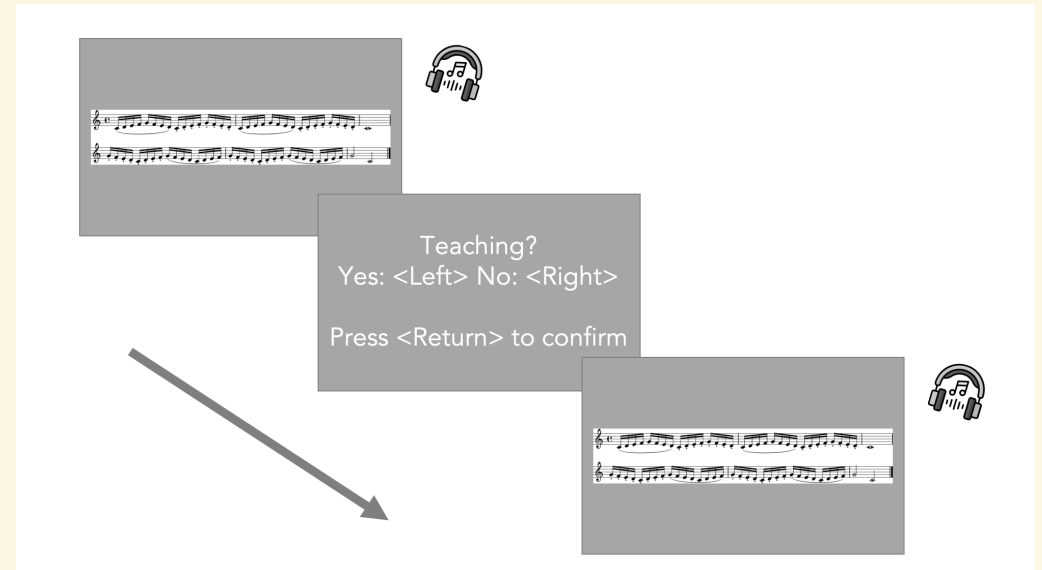
Experiment 1

Participants & Task

21 musicians (1 participant was excluded due to an experimental error)

- female: 13
- right-handed: 20
- average training years: 11.84 (SD = 5.62)

Musicians listened to a number of piano recordings and were asked to judge whether each recording was performed for teaching purposes (e.g., in a lesson) or as a part of a performance (e.g., in a concert).

Stimuli

48 articulation recordings

(smoothness of sound - legato/staccato)

48 dynamics recordings

(loudness of sound - forte/piano)

- Stimuli were randomly selected from our previous study, in which expert pianists performed th piece in order to teach (teaching condition) or perform their best (performing condition)
- Two blocks (articulation or dynamics): the order of the blocks was counterbalanced across participants
- 48 trials (recordings) per block: the order of the recordings was randomised within a block

Data analysis

- Each performance was quantified in terms of tempo, articulation, dynamics and dynamics contrast.
  - tempo: interonset intervals (IOIs)
  - articulation: key-overlap time (KOT)
  - dynamics: key velocity (KV)
  - dynamics contrast: KV difference between forte and piano or legato and staccato (KV-Diff)
- **Correlation analysis** between each performance feature and participants' judgments as "teaching"
- **Multiple regression** to determine which feature contributes the most for participants' judgments as "teaching"
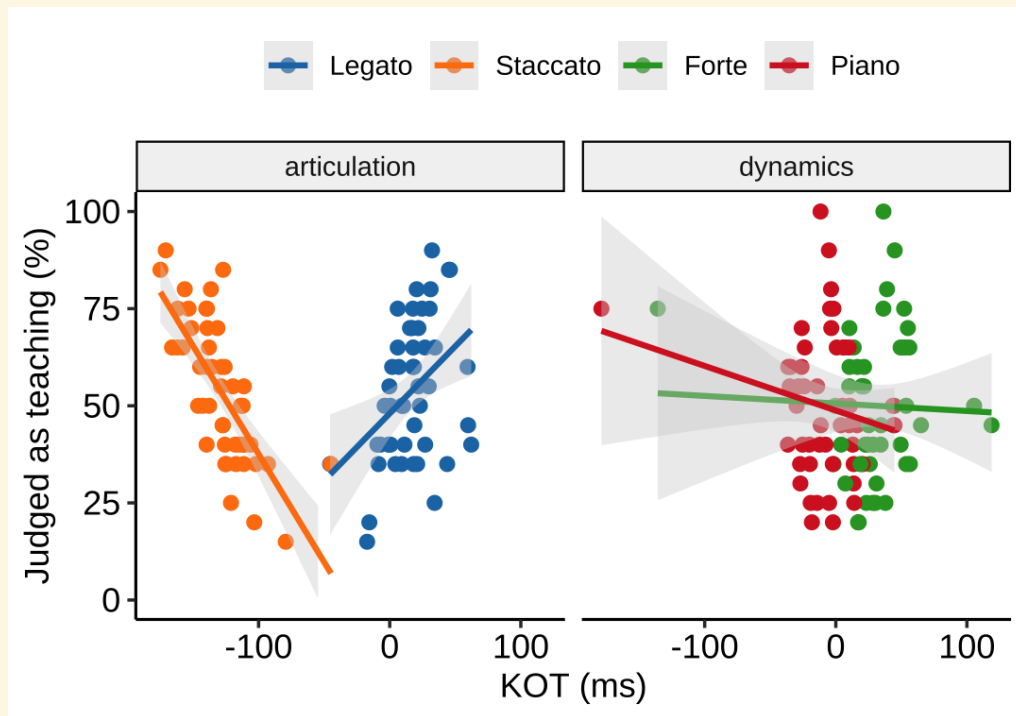
Tempo

- Interonset intervals were used to quantify tempo.
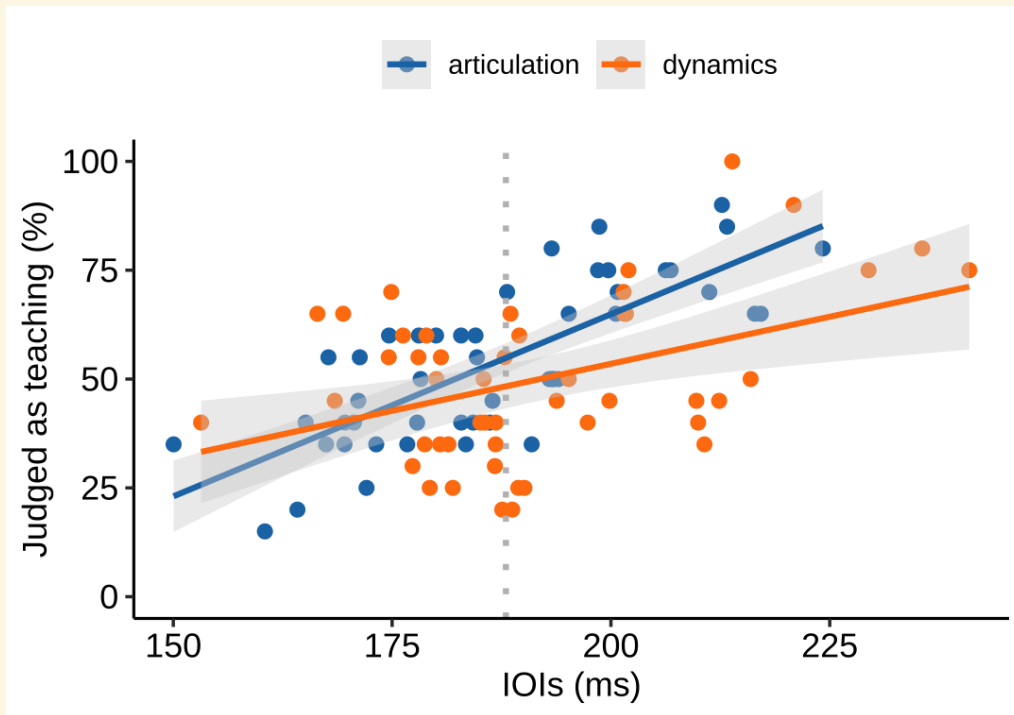
- Each dot represents each recording
- Slower performances were more likely to be judged as "teaching"
  - Articulation: $r = .77$, $p < 0.001$
  - Dynamics: $r = .42$, $p = 0.003$

Articulation

- Key overlap time was used to quantify articulation.
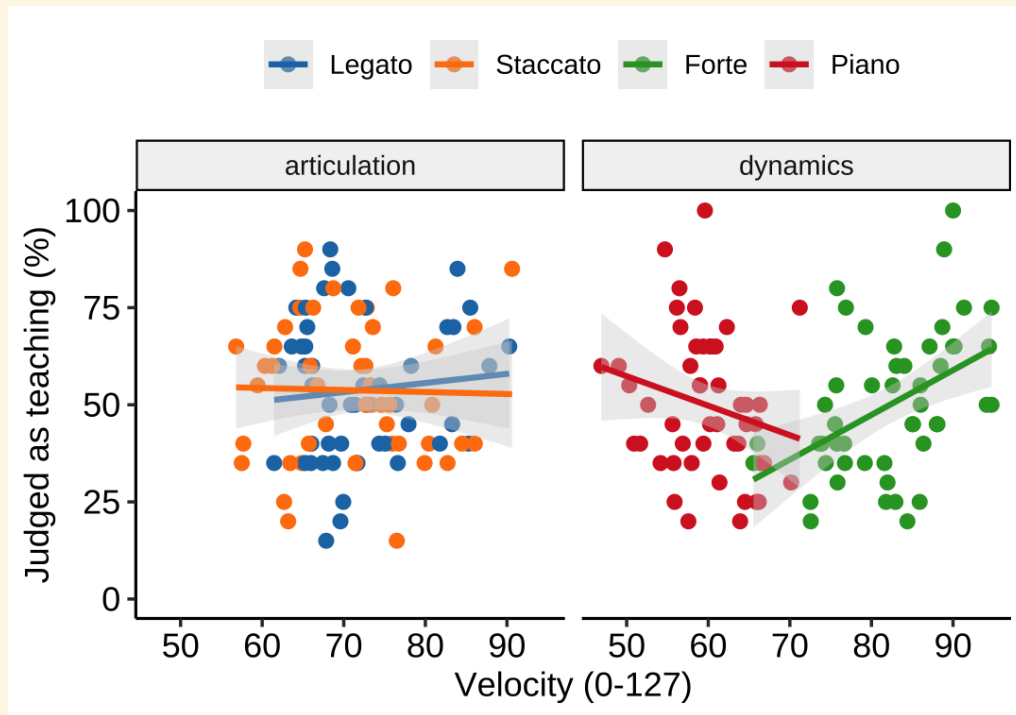

- Articulation

  - Performances with shorter staccato were more likely to be judged as "teaching": $r = -.73$, $p < 0.001$
  - Performances with longer legato were more likely to be judged as "teaching": $r = .40$, $p = 0.005$

- Dynamics

  - No significant relationships for forte and piano

Dynamics

- Key velocity was used to quantify dynamics.
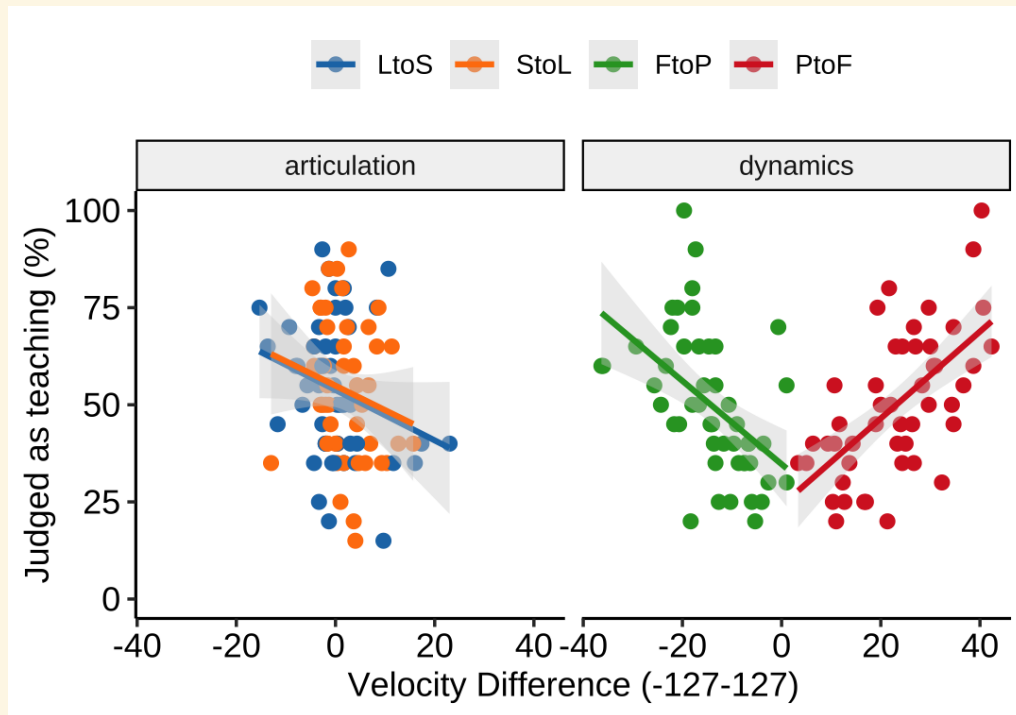

- Dynamics

  - Performances with louder forte were more likely to be judged as "teaching": $r = .45$, $p = 0.001$
  - No significant relationship between KV values for soft sound (i.e., piano) and participants' judgments as "teaching": $r = -.22$, $p = 0.13$

- Articulation

  - No significant relationships for legato and staccato

Dynamics contrast

- Key velocity difference between forte and piano or legato and staccato.

- Dynamics

  - Performances with larger contrasts between forte and piano were more likely to be judged as "teaching" (From Forte to Piano; r = -.50, p < 0.001, From Piano to Forte; r = .62, p < 0.001)

- Articulation

  - No significant relationships in terms of the contrasts between legato and staccato

Which feature of piano performance contributed the most?

4 performance features:

- Tempo (IOIs)
- Articulation (KOT)
- Dynamics (KV)
- Dynamics contrast (KV-Diff)

4 multiple regression models:

1. Legato: IOIs (articulation) + KOT (**legato**) + KV (**legato**) + KV-Diff (**LtoS**)
2. Staccato: IOIs (articulation) + KOT (**staccato**) + KV (**staccato**) + KV-Diff (**StoL**)
3. Forte: IOIs (dynamics) + KV (**forte**) + KV-Diff (**FtoP**) + KOT (**forte**)
4. Piano: IOIs (dynamics) + KV (**piano**) + KV-Diff (**PtoF**) + KOT (**piano**)

Articulation

1. Legato

- The model explained 64.63 % of the variance ($F(4, 43) = 22.5$, $p < 0.001$)
- **Tempo** (IOIs: $\beta = 0.78$, $p < 0.001$) and articulation for the legato parts (KOT: $\beta = 0.26$, $p = 0.004$) were significant predictors of participants' judgments as "teaching"

2. Staccato

- The model explained 63.97 % of the variance ($F(4, 43) = 21.9$, $p < 0.001$)
- **Tempo** (IOIs: $\beta = 0.52$, $p = 0.002$) and articulation for the staccato parts (KOT: $\beta = -0.28$, $p = 0.020$) were significant predictors of participants' judgments as "teaching"

Dynamics

3. Forte

- The model explained 35.9 % of the variance ($F(4, 43) = 7.6$, $p < 0.001$)
- Tempo (IOIs: $\beta = 0.35$, $p = 0.007$) and **dynamics for the forte parts** (KV: $\beta = 0.73$, $p = 0.048$) were significant predictors of participants' judgments as "teaching"

4. Piano

- The model explained 51.21 % of the variance ($F(4, 43) = 13.3$, $p < 0.001$)
- Tempo (IOIs: $\beta = 0.38$, $p < 0.001$) and **dynamics contrast from piano to forte** (KV-Diff: $\beta = 0.99$, $p < 0.001$) were significant predictors of participants' judgments as "teaching"

Discussion

In general, slower performances were more likely to be judged as teaching performances.

Technique-specific values were used depending on with which technique participants were listening to the piece (especially for dynamics).

- These cues were more or less consistent with what expert pianists exaggerated in our previous experiments

- Musicians (potential learners) seem to be consistent in the way they infer teaching intentions (as expert pianists intended)

- Experiment 2: 2 more participants!

Thank you

Special thanks to Fanni for data collection!

Experiment 2

(without statistical analysis)

Participants & Stimuli

Participants: 17 musicians so far (1 participant was excluded because s/he did not understand the instructions)

- female: 6
- right-handed: 15 (left: 1)
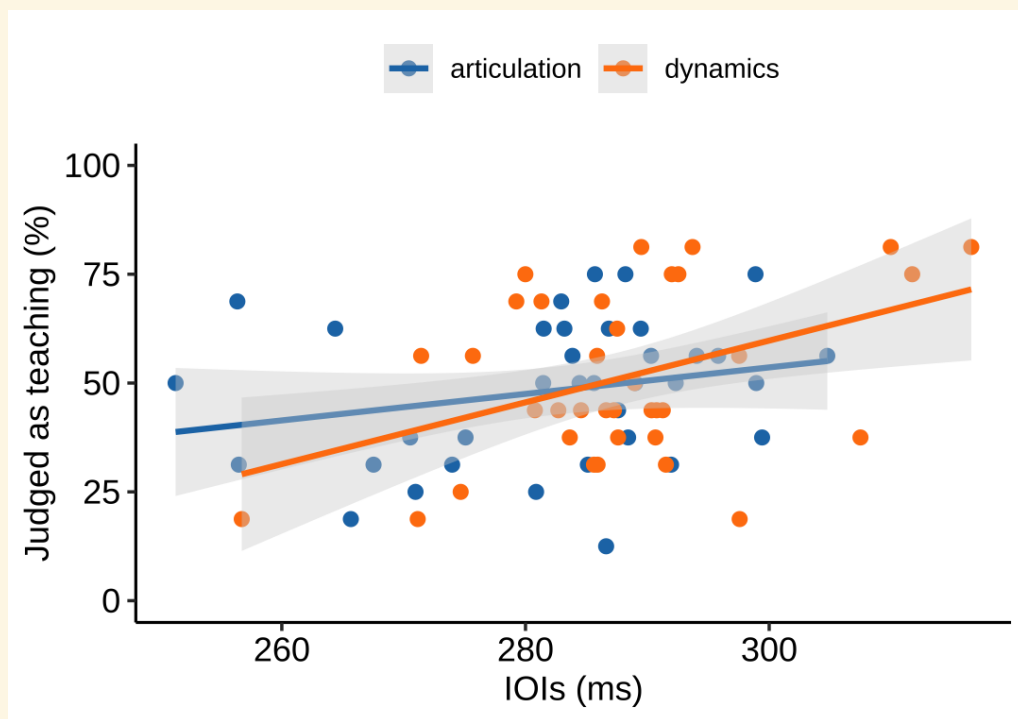- average training years: 12.81 (SD = 5.26)

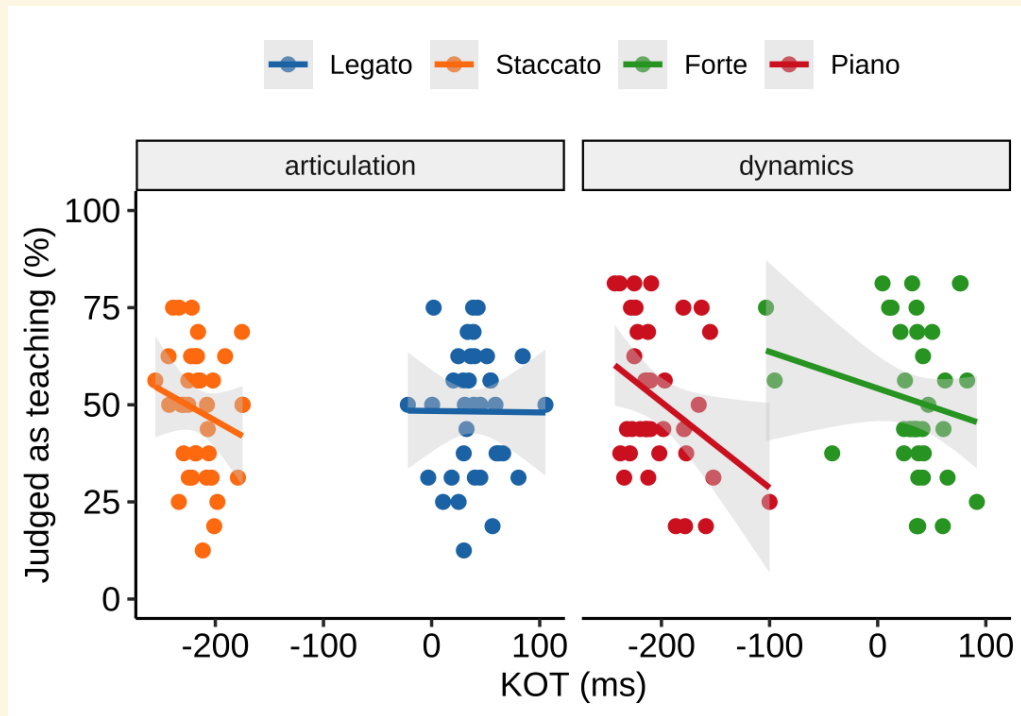36 articulation recordings

36 dynamics recordings

Tempo

- Interonset intervals were used to quantify tempo.

- Similar to Experiment 1
- Stronger relationship for dynamics recordings than articulation recordings?

Articulation

- Key overlap time was used to quantify articulation.

- Unlike Experiment 1, no clear relationship for articulation
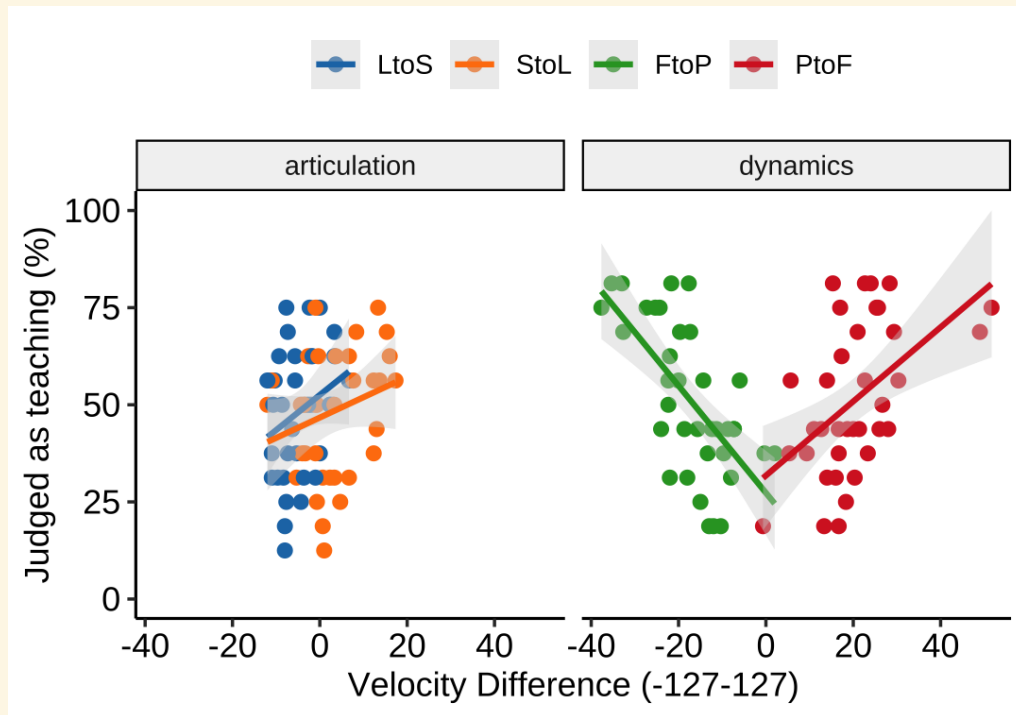
Dynamics

- Key velocity was used to quantify dynamics.
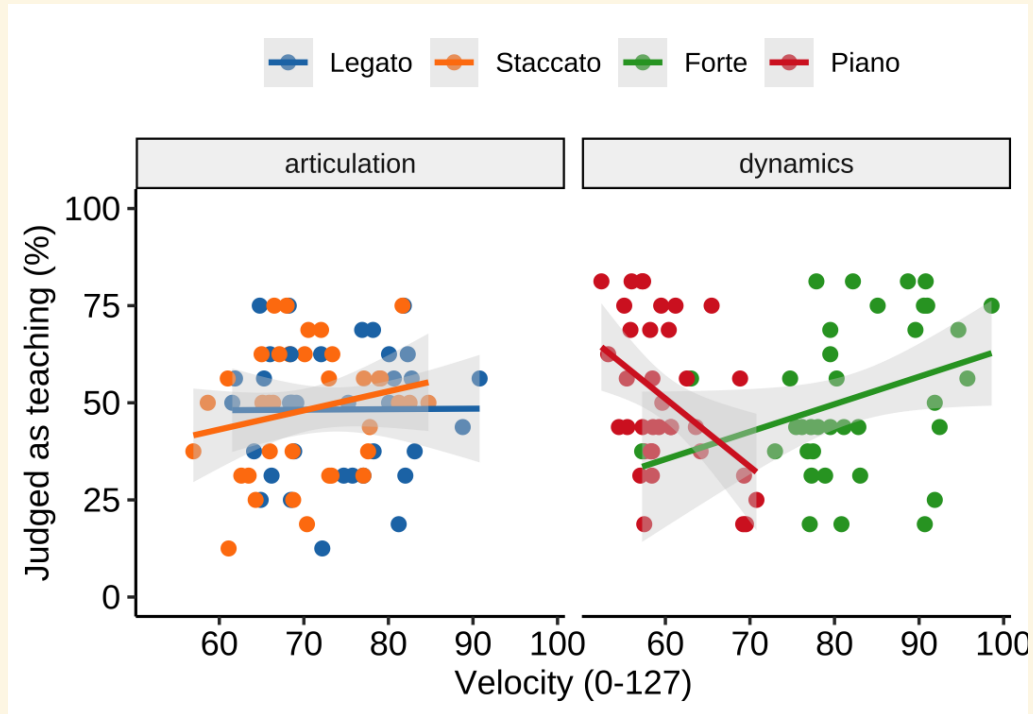
- Similar to Experiment 1
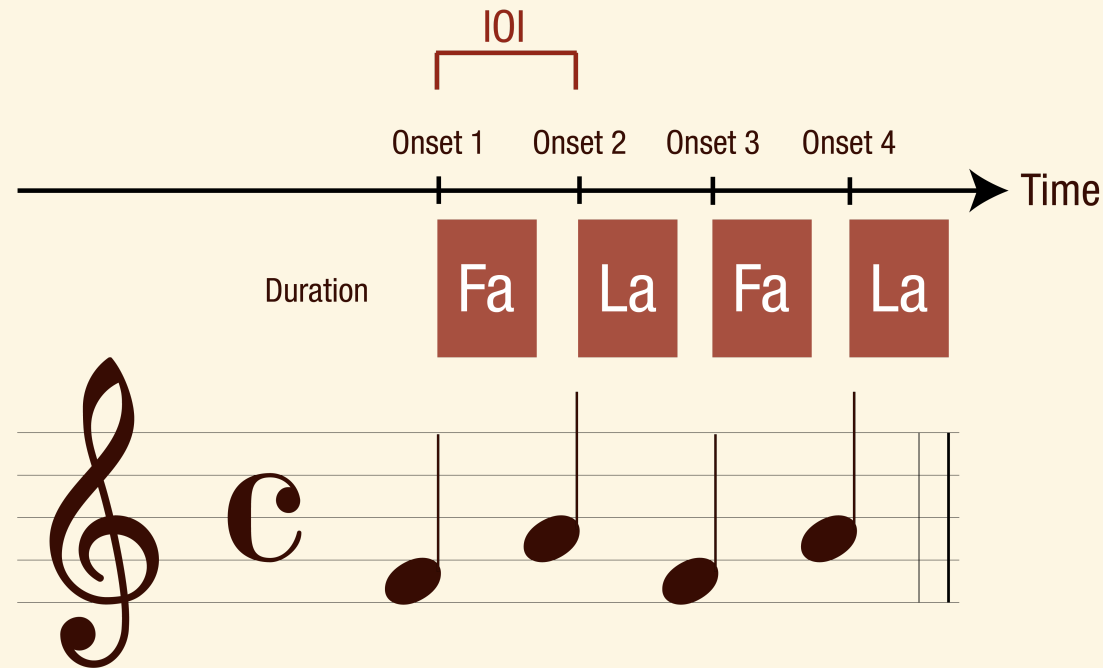- Maybe relationships for both forte and piano?

Dynamics contrast

- Key velocity difference between forte and piano or legato and staccato.

- Similar to Experiment 1
- Clear relationships for both FtoP and PtoF
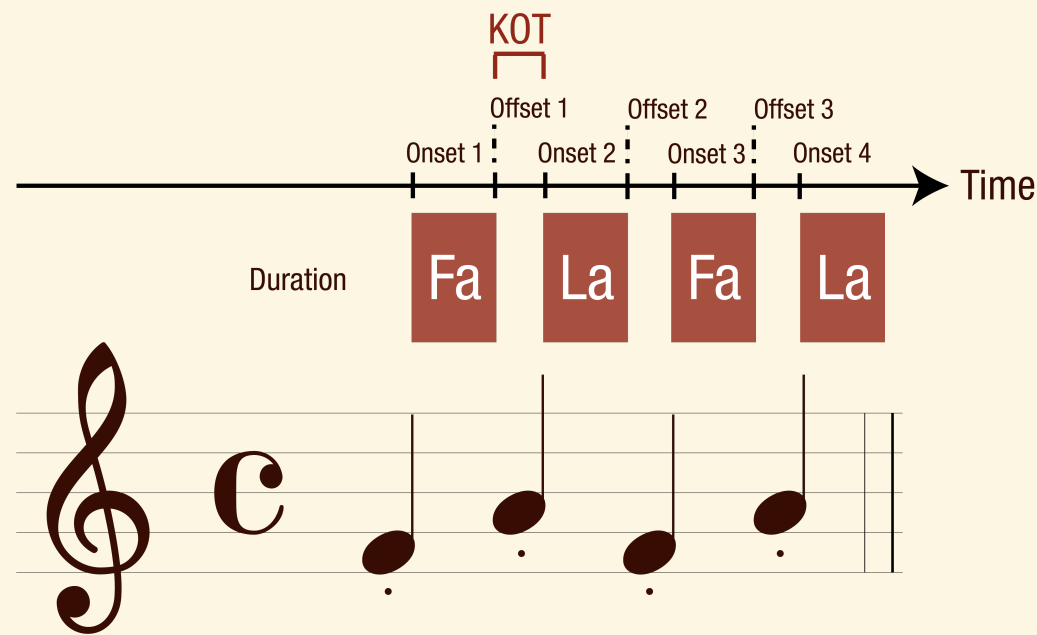
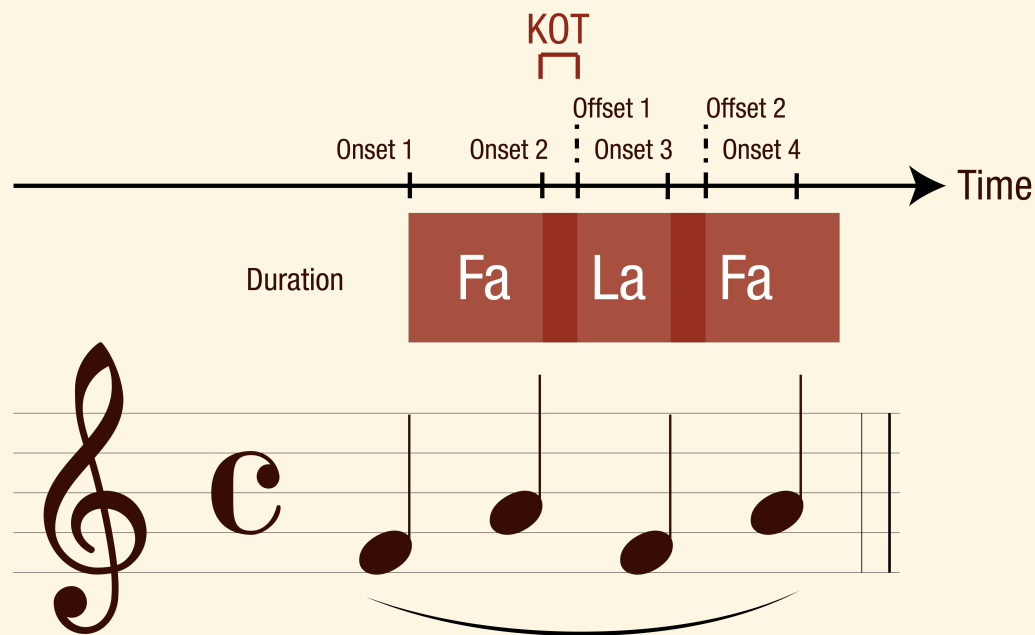# Tempo: interonset intervals (IOIs)

The intervals between the beginning of one note and that of the next note.

- Longer IOIs: slower tempo
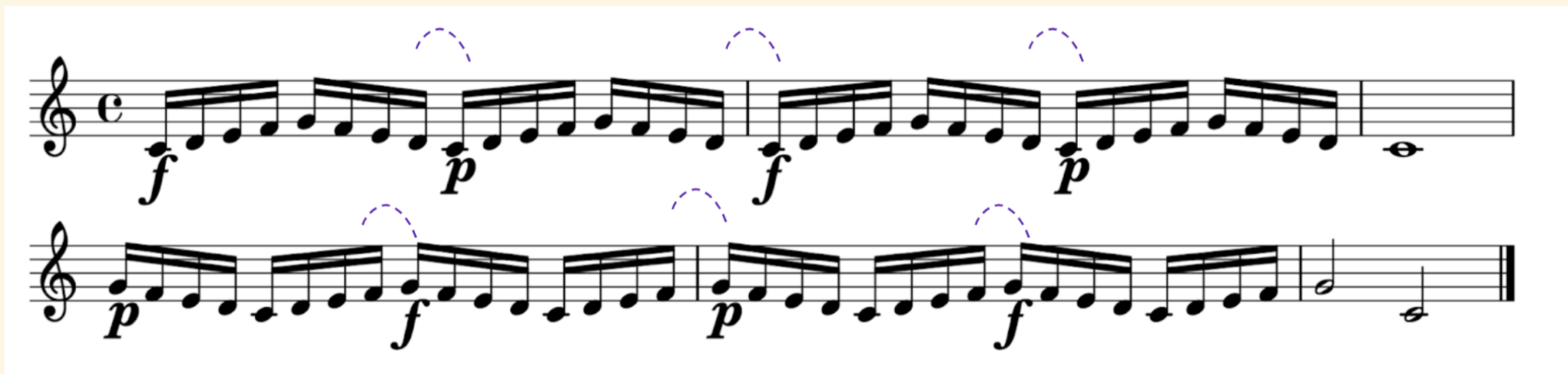- Shorter IOis: faster tempo

Articulation: key-overlap time (KOT)

Time overlap between two consecutive notes.

- Positive values: Legato styles
- Negative values: Staccato styles

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Dynamics contrast: Key velocity difference (KV-Diff)

Key velocity difference where a subcomponent of a technique changes.

- We are mainly interested in the change between forte and piano to illustrate the contrast