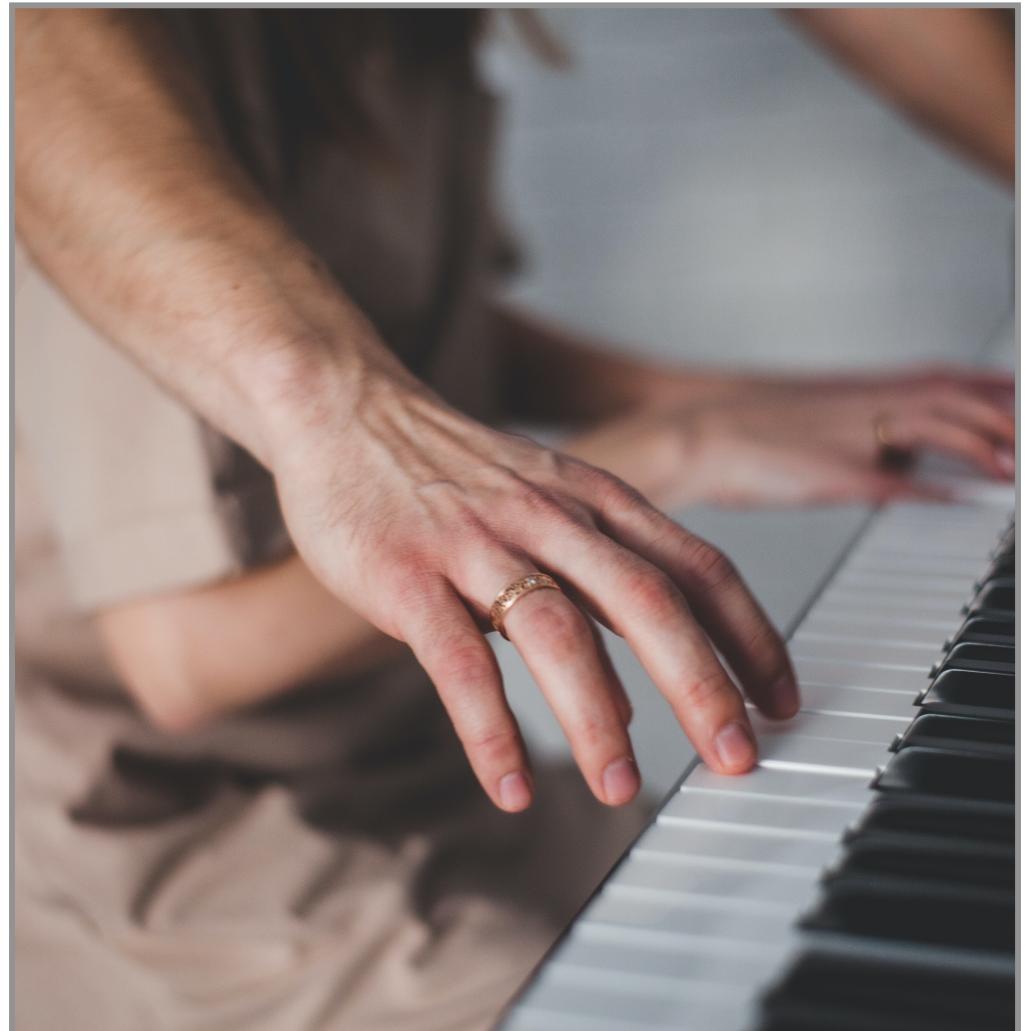


The Sound of Teaching Music

Transmitting expressive skills in piano performance

**Atsuko Tominaga
08.05.2023 @ PhD Defense**





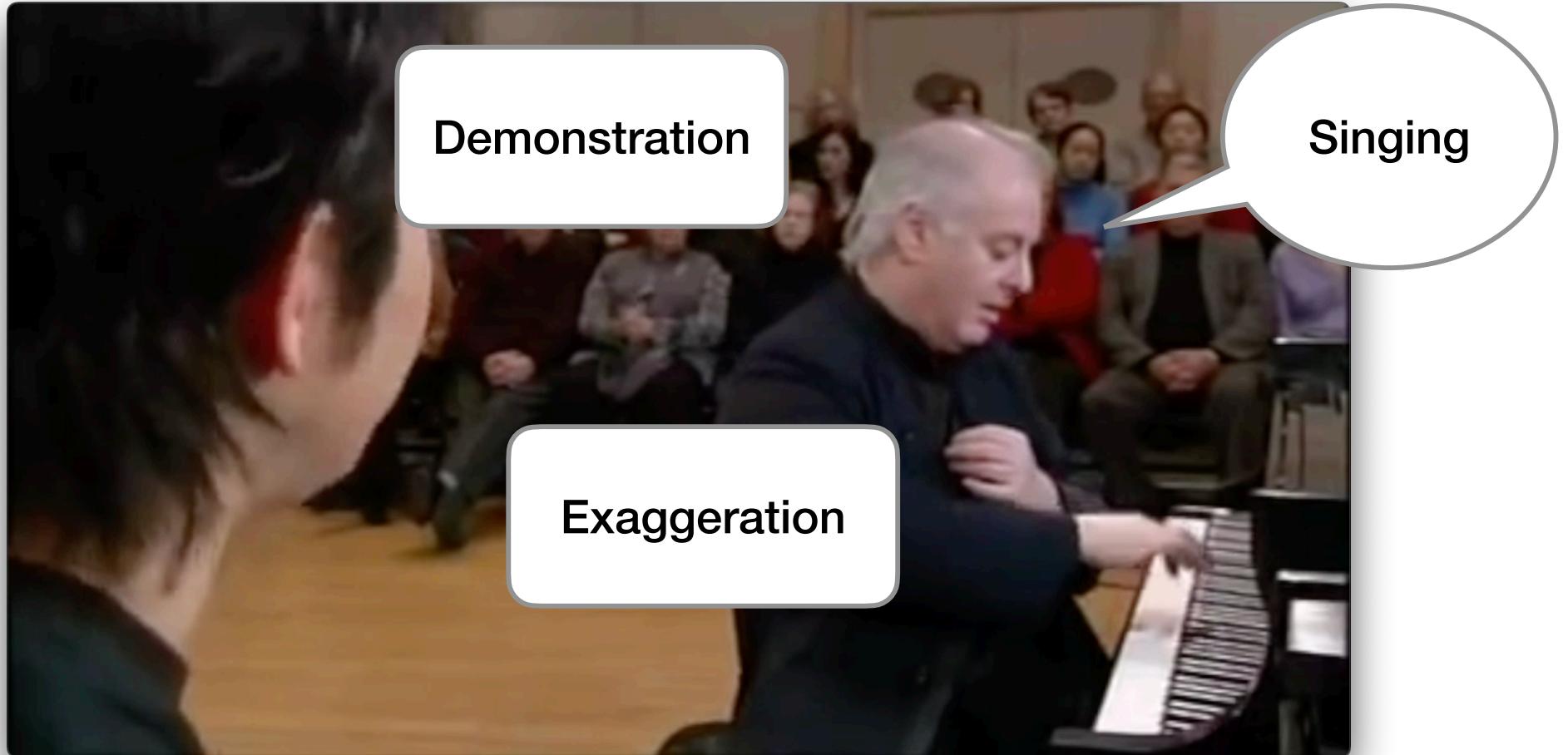


The role of teaching in skill transmission



Daniel Barenboim's masterclasses on Beethoven's piano sonatas at Symphony Hall, Chicago. January 2005





Demonstration

Singing

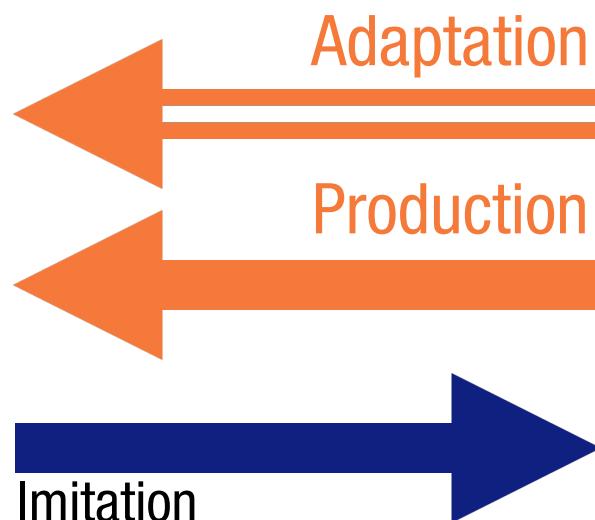
Exaggeration



Teaching as joint action

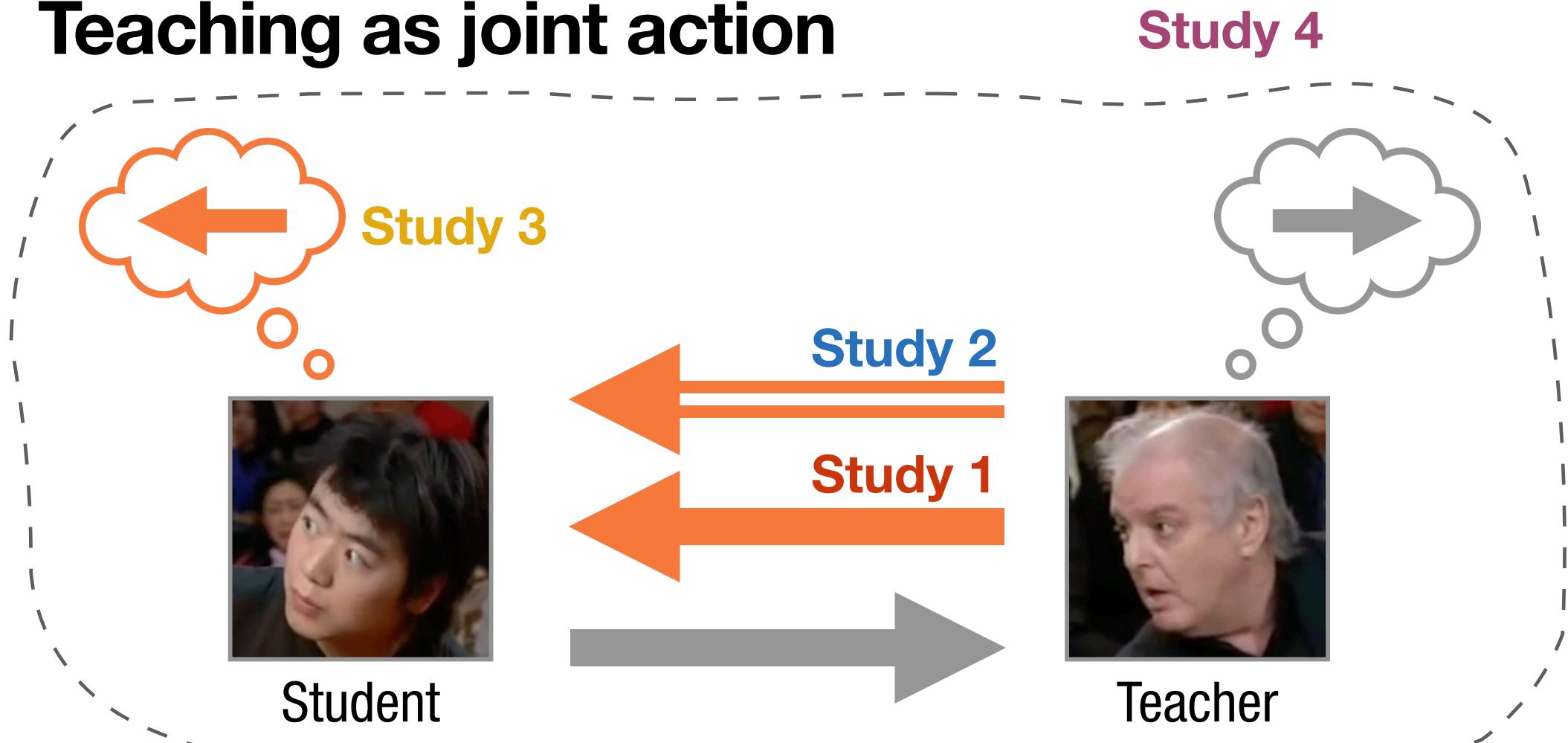


Student



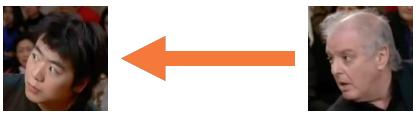
Teacher

Teaching as joint action



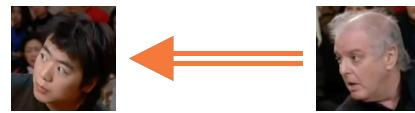
Research questions

Study 1



How do expert pianists **modulate** their performance **for teaching**

Study 2



How do expert pianists **adapt** their performance according to **novices' demonstrated skills?**

Study 3



What makes musicians infer teaching intentions when listening to expressive performance?

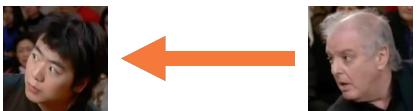
Study 4



How do experts teach musical expression **in the real world?**

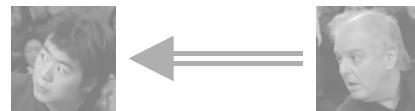
Research questions

Study 1



How do expert pianists **modulate** their performance **for teaching**

Study 2



How do expert pianists **adapt** their performance according to novices' demonstrated skills?

Study 3

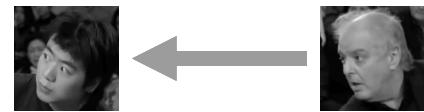


What makes musicians **infer teaching intentions** when listening to expressive performance?

Study 4

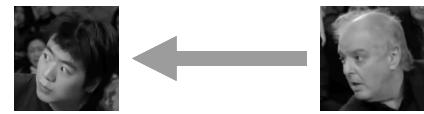


How do experts teach musical expression **in the real world?**



Sending pedagogical signals

- People use subtle bodily movements to **convey intentions to others** (Pezzulo et al, 2013; Pezzulo et al., 2019)
 - For teaching, infant-directed speech and action (so-called motherese, motionese: Saint-Georges et al., 2013, Brand et al., 2002)
 - **Slower** performance, **exaggerated** movements (e.g., Brand et al., 2002, McEllin et al., 2017)
 - These action modulations have the function to **highlight and deliver relevant information to learners** (Vesper & Sevdalis, 2020)



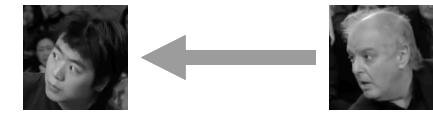
Teaching expressive performance

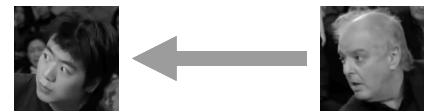
- In artistic contexts, performers **intentionally deviate from normative performance** to produce expressive performance (Vesper & Sevdalis, 2020)
- **Multiple parameters** to modify in performance
 - Musicians use expressive techniques such as **tempo**, **articulation** (smoothness), and **dynamics** (loudness) to **convey intentions and interpretations of music** to an audience (Meissner, 2021)
- If expert musicians have the intention to teach a **particular** technique, they **highlight the relevant aspects of the technique** to be taught

Participants and apparatus

Experiment 1

- 31 piano experts (15 female)
 - 12.45 years of practice on average ($SD = 5.66$)
- A weighted Yamaha MIDI digital piano





Design & Procedure

- Within-subjects design
 - Factors: 2 conditions (teaching vs. performing) x 2 techniques (articulation vs. dynamics)
 - 32 trials in total (2 conditions x 2 techniques x 8 trials)

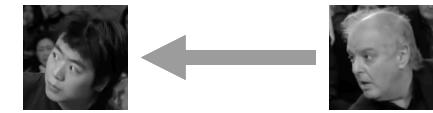
Teaching condition: Play the piece according to the notation as if you were teaching it to students

Performing condition: Play the piece according to the notation as if you were performing it to an audience

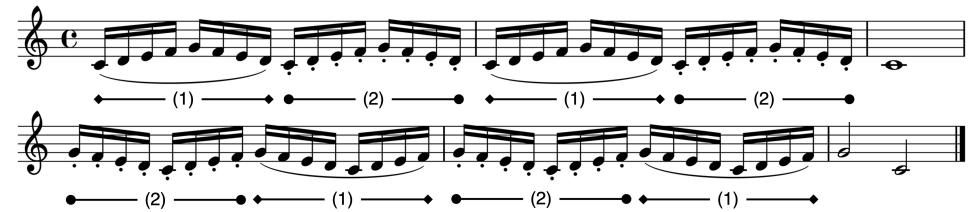
Stimuli

Experiment 1

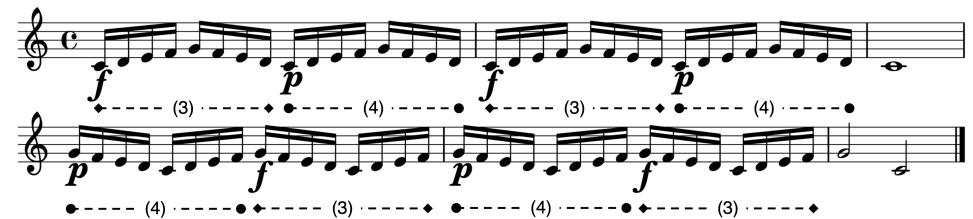
- One musical scale with two notated expressive techniques
- Articulation: Smoothness of sound
- Dynamics: Loudness of sound



(1) Articulation



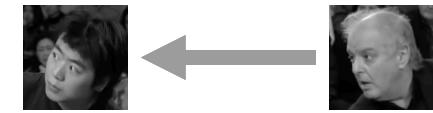
(2) Dynamics



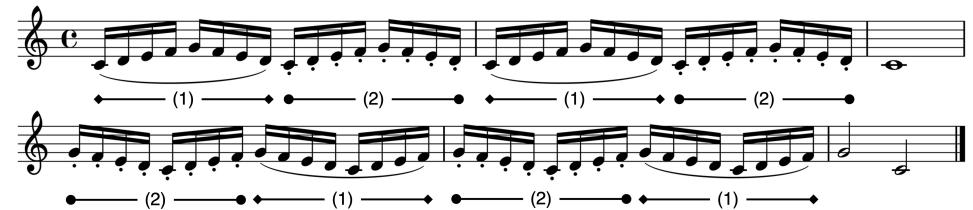
Stimuli

Experiment 1

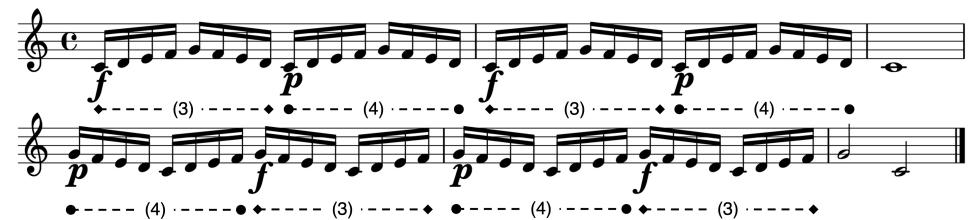
- One musical scale with two notated expressive techniques
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(1) Articulation



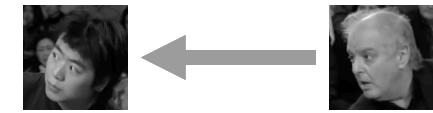
(2) Dynamics



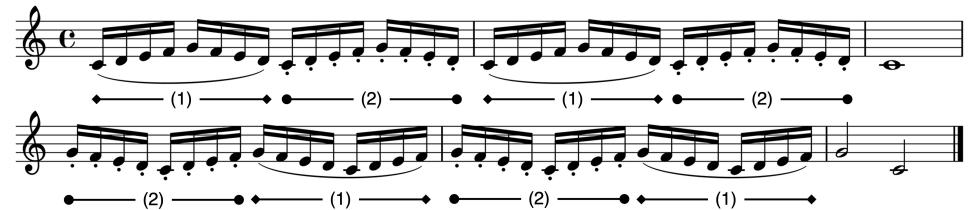
Stimuli

Experiment 1

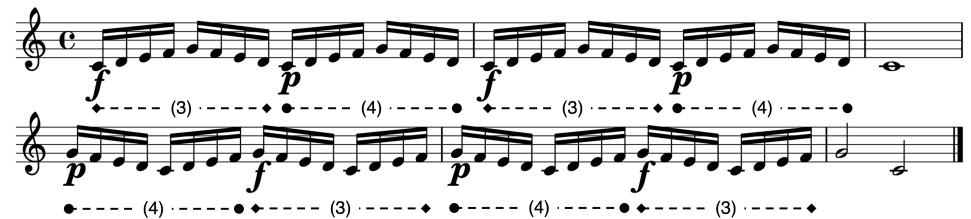
- One musical scale with two notated expressive techniques
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(1) Articulation



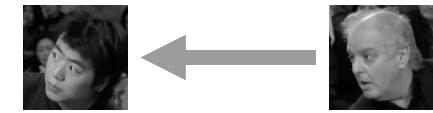
(2) Dynamics



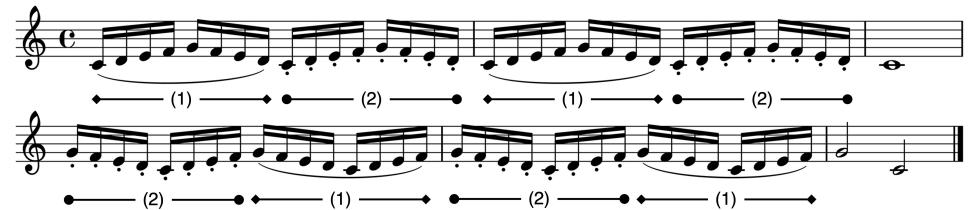
Stimuli

Experiment 1

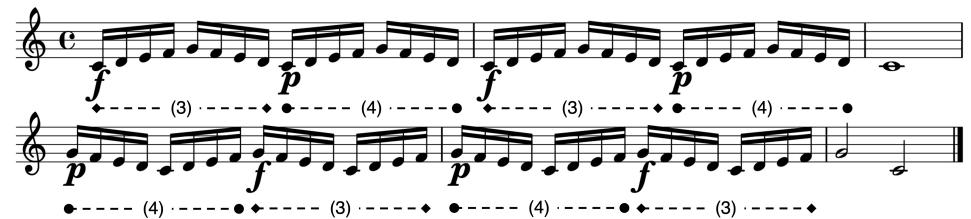
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(1) Articulation

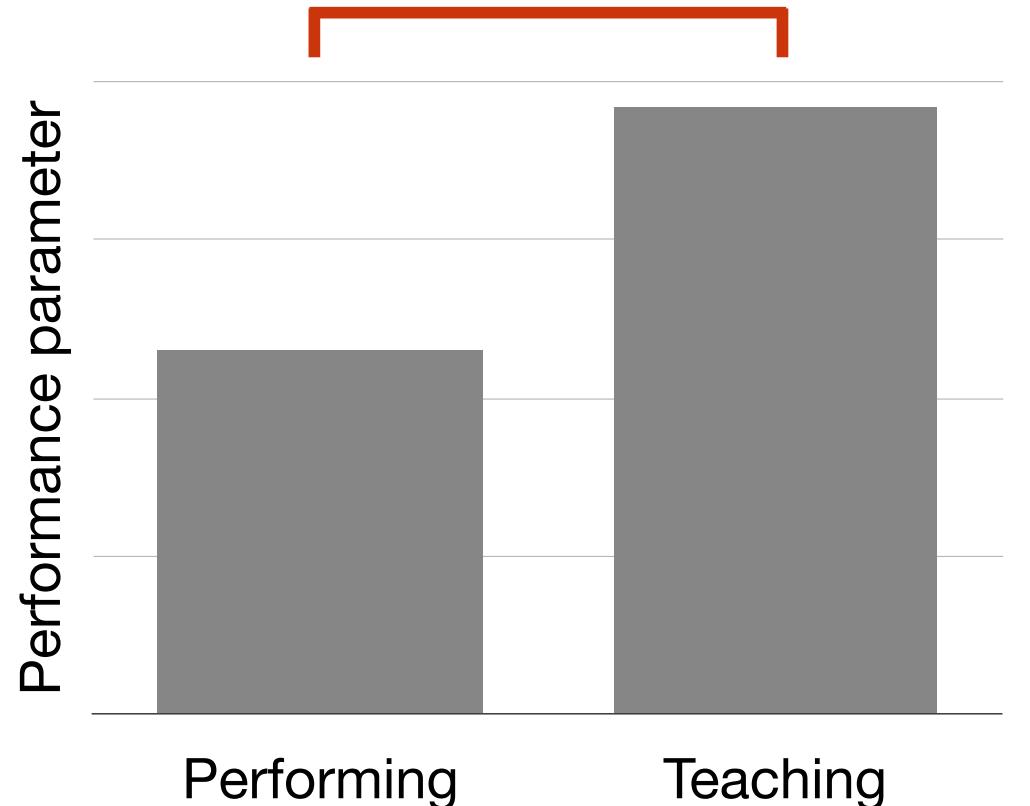


(2) Dynamics



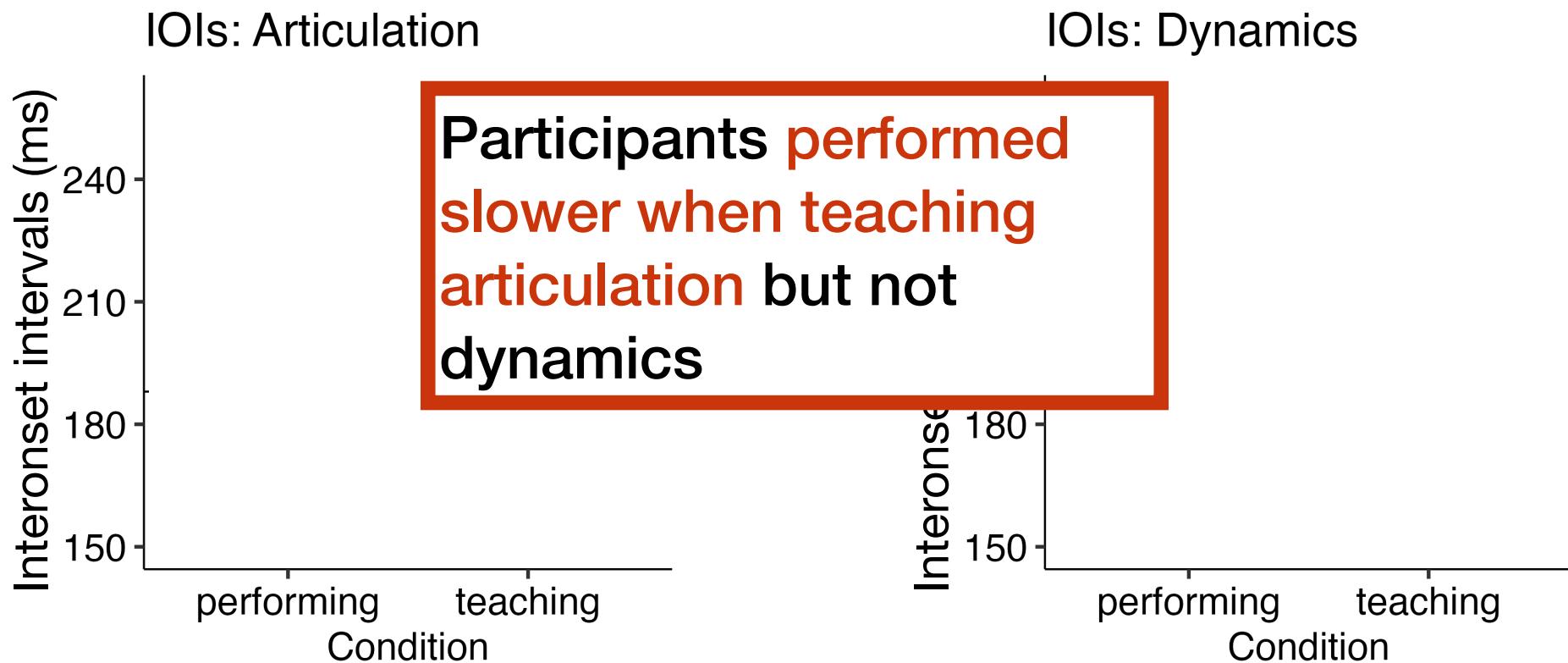
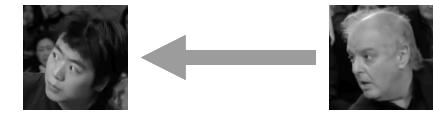
Predictions

- Expert pianists would **play slower** when teaching regardless of the technique to be taught
- Expert pianists would exaggerate relevant aspects of the technique to be taught
 - Produce **longer legato** and **shorter staccato** when teaching articulation
 - Produce **louder forte** and **softer piano** when teaching dynamics



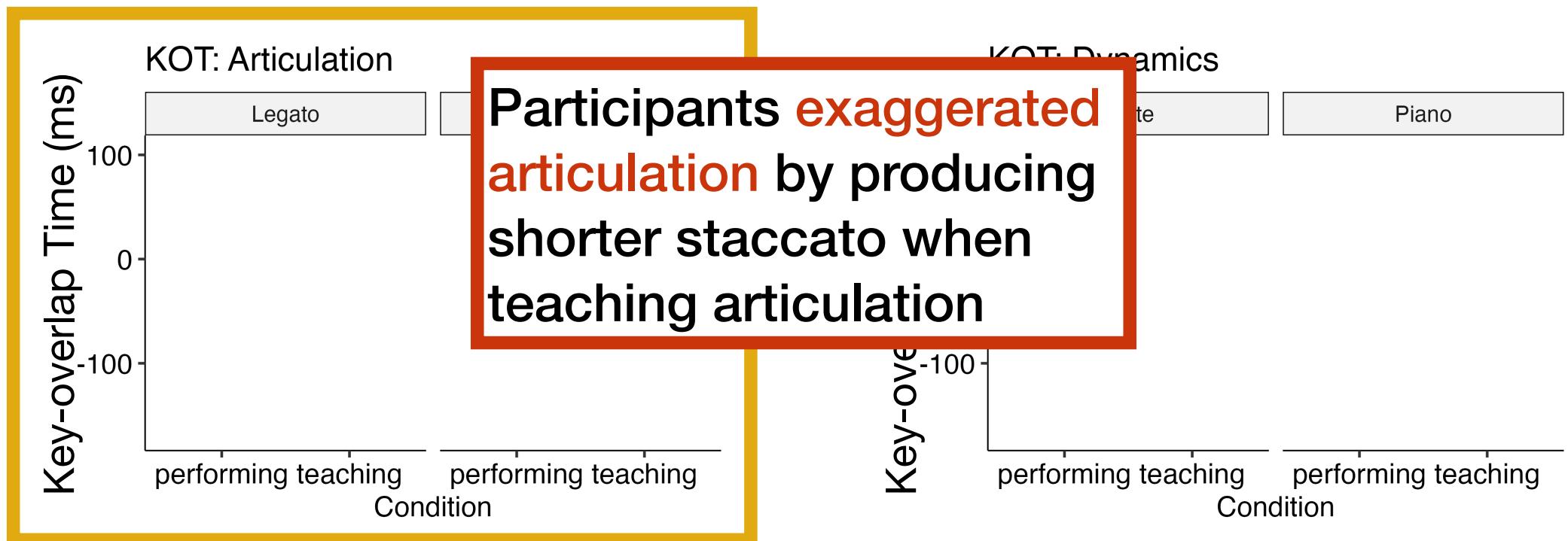
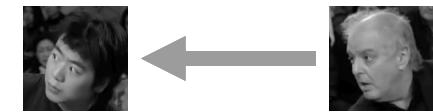
Tempo

Experiment 1



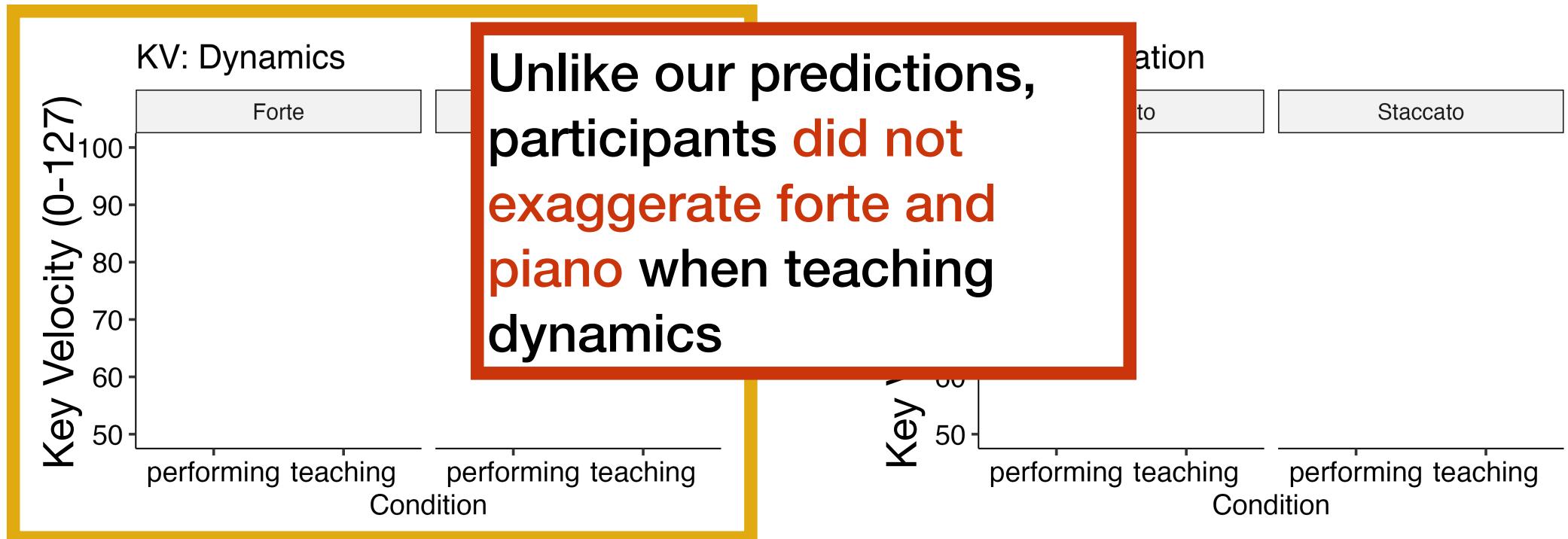
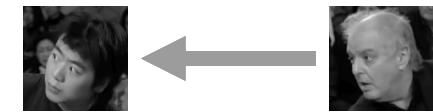
Smoothness

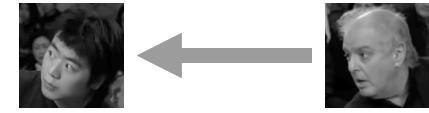
Experiment 1



Loudness

Experiment 1



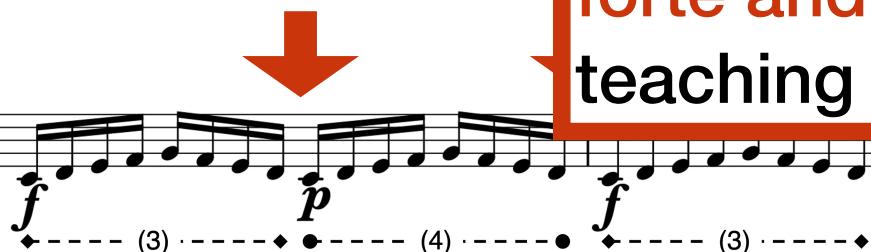


Dynamics contrast

Experiment 1

- Effective locations to teach dynamics?
- Looking at transition forte to piano (FtoP) piano to forte (PtoF)

KV-Diff: Exp 1

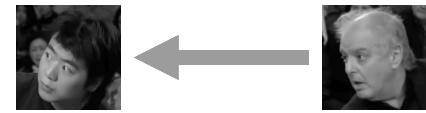


Participants exaggerated the contrast between forte and piano when teaching dynamics



Summary

Experiment 1

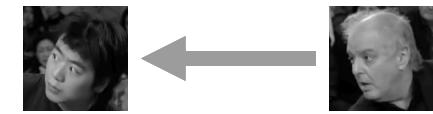


- Participants **systematically** modulated their performance for teaching purposes
- Can we generalise these findings when teaching a **more musically complex** piece?

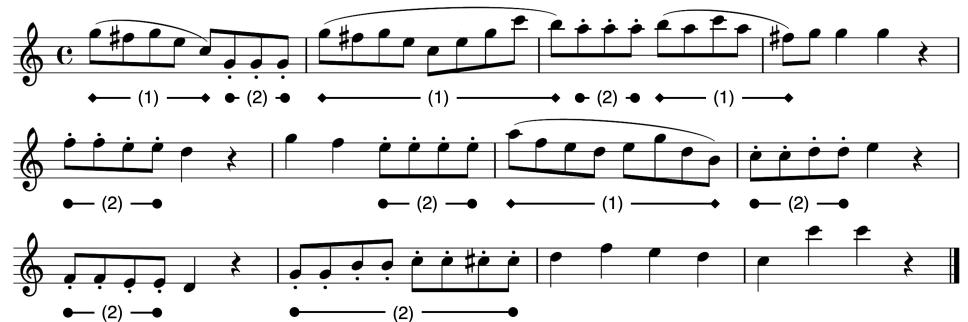
Participants and stimuli

Experiment 2

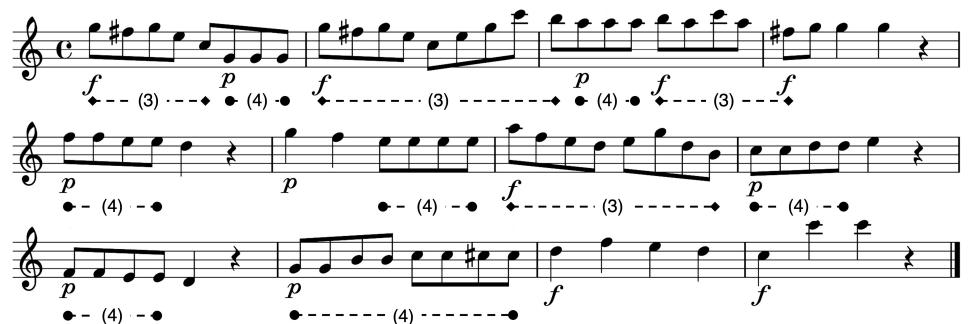
- 20 piano experts (9 female)
 - 15.65 years of practice on average ($SD = 5.67$)
- Articulation: Smoothness of sound
- Dynamics: Loudness of sound



(1) Articulation



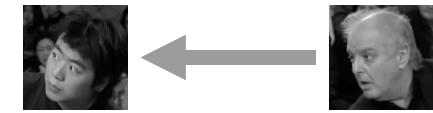
(2) Dynamics



Participants and stimuli

Experiment 2

- 20 piano experts (9 female)
- 15.65 years of practice on average ($SD = 5.67$)
- Articulation: Smoothness of sound
- Dynamics: Loudness of sound



(1) Articulation

Three staves of musical notation in common time with a treble clef. The notation consists of eighth and sixteenth note patterns. Articulation points are marked with small dots and dashes below the notes. The first staff has points (1), (2), (1), (2), (1). The second staff has points (2), (1), (2). The third staff has points (2), (2).

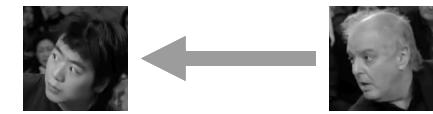
(2) Dynamics

Three staves of musical notation in common time with a treble clef. The notation includes eighth and sixteenth note patterns. It features dynamic markings: f (forte) and p (piano). Articulation points are marked with small dots and dashes. The first staff has f , (3), (4), f , (3), (4), f . The second staff has p , (4), p , (4), f , (3), p , (4). The third staff has p , (4), p , (4), f , f .

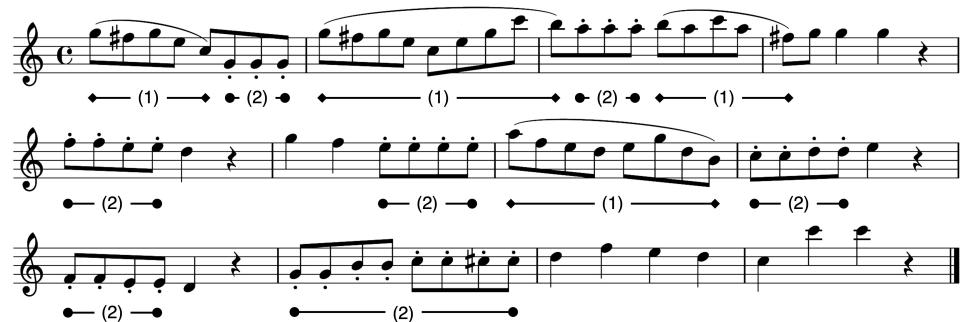
Participants and stimuli

Experiment 2

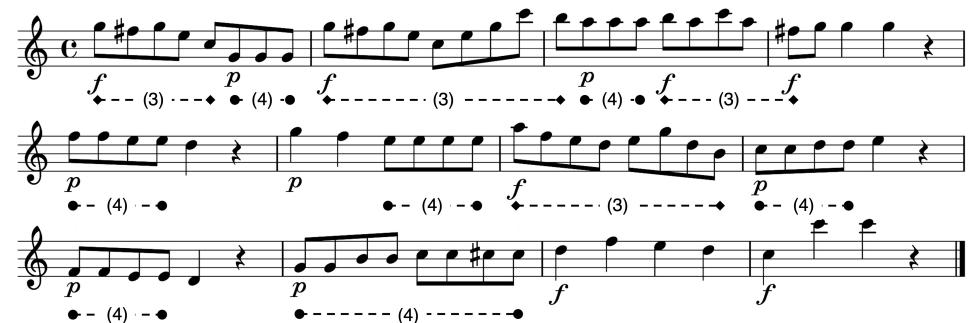
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 - 15.65 years of practice on average ($SD = 5.67$)
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(1) Articulation



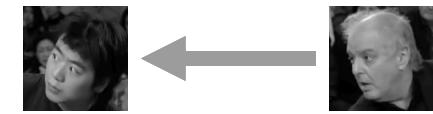
(2) Dynamics



Participants and stimuli

Experiment 2

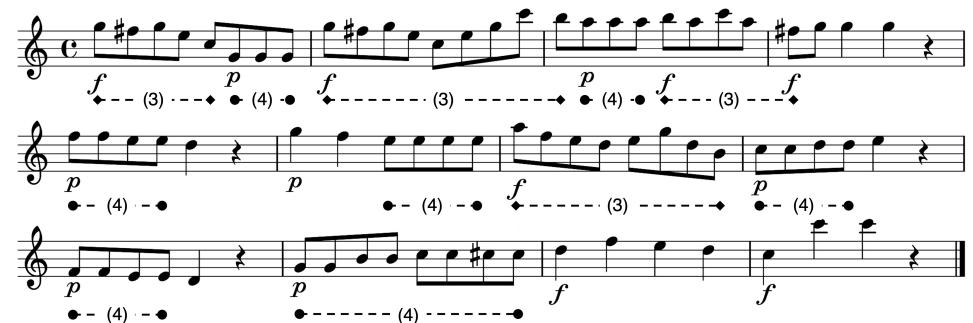
- 20 piano experts (9 female)
 - 15.65 years of practice on average ($SD = 5.67$)
- Articulation: Smoothness of sound
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(1) Articulation

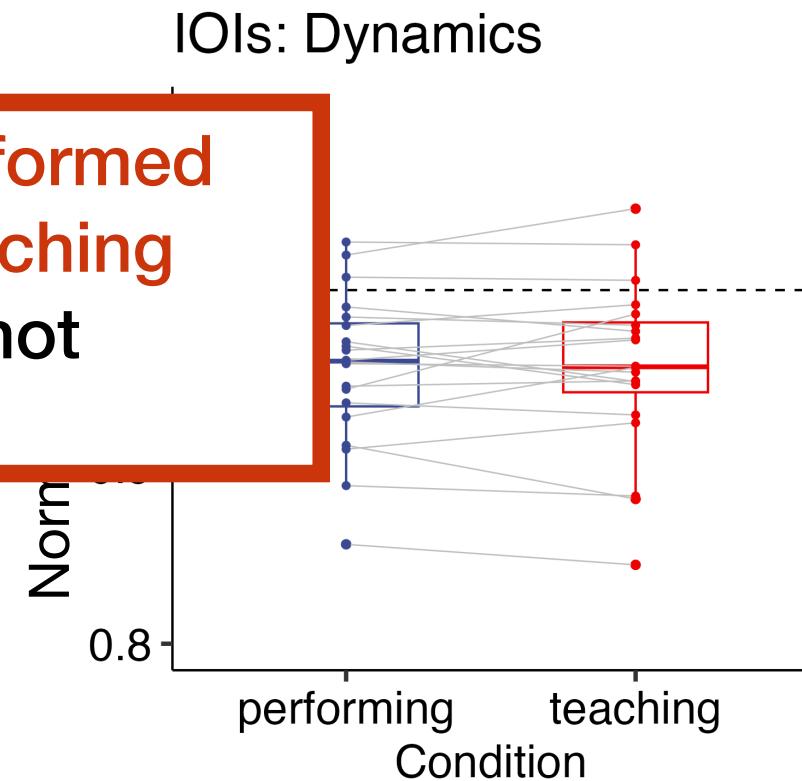
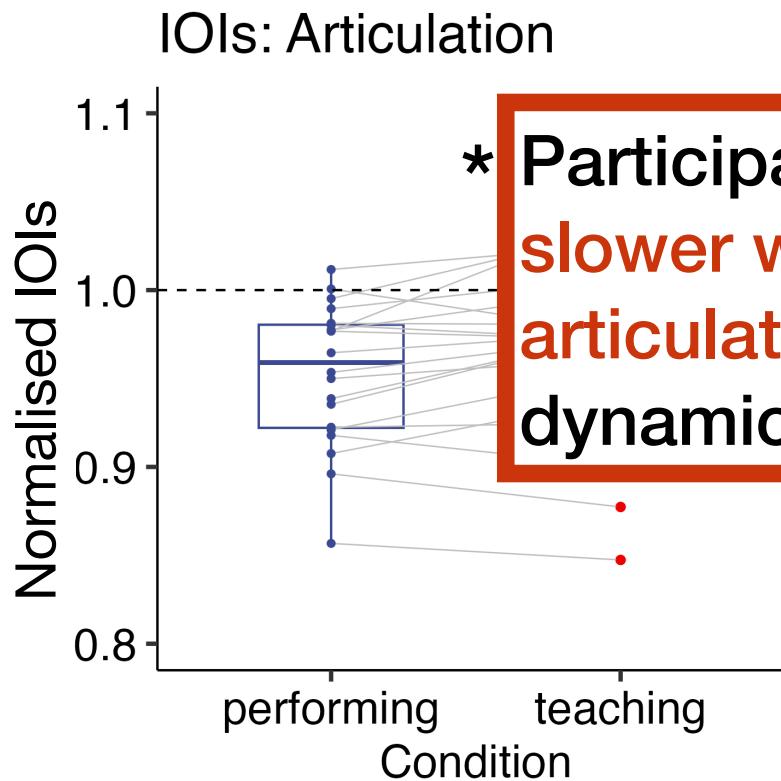
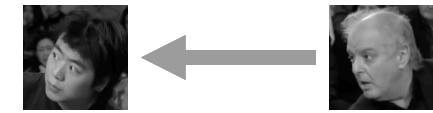


(2) Dynamics



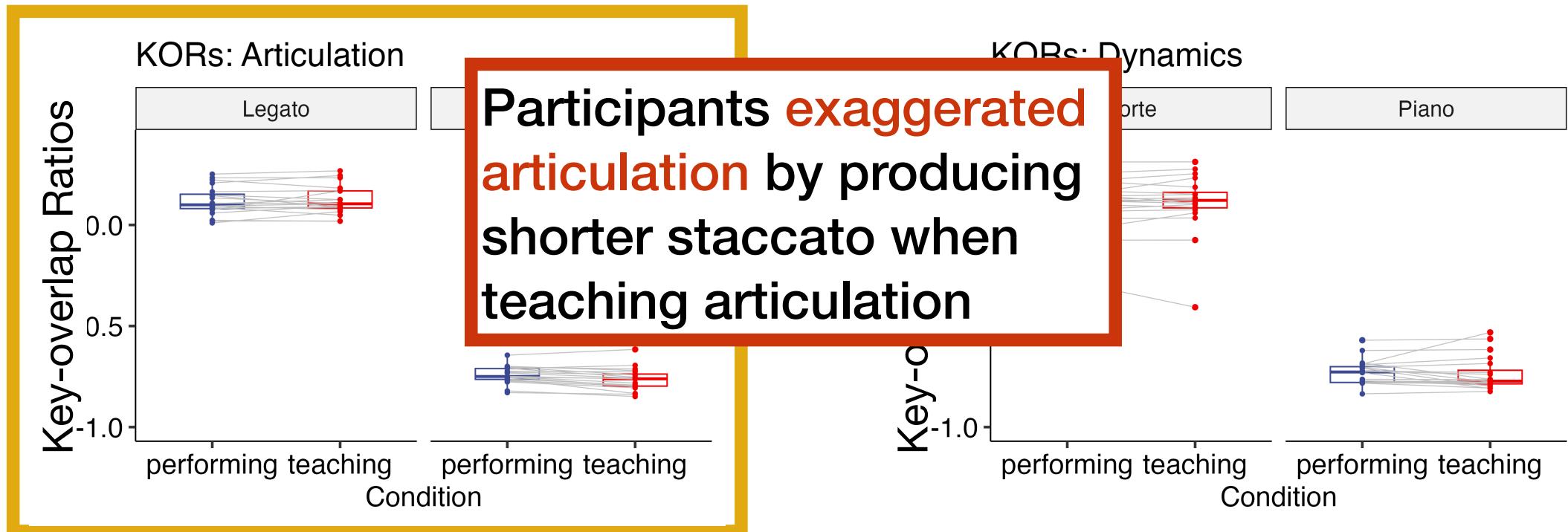
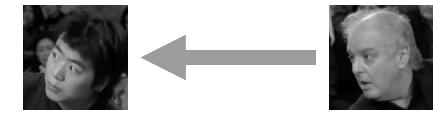
Tempo

Experiment 2



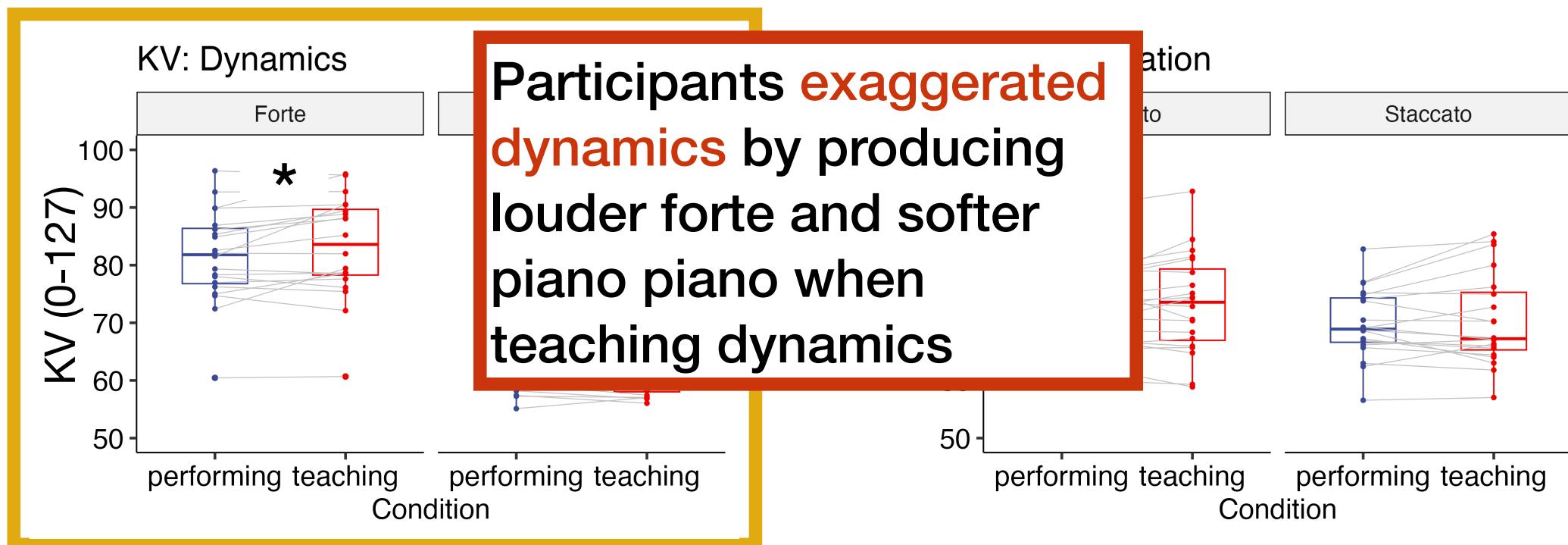
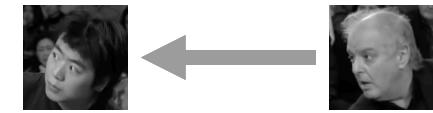
Smoothness (Articulation)

Experiment 2



Loudness (Dynamics)

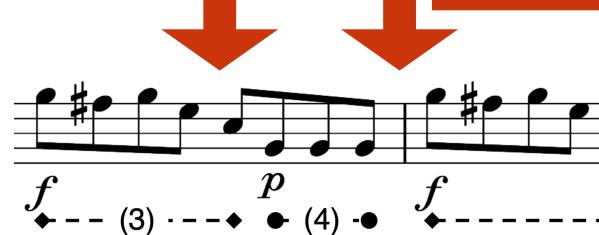
Experiment 2



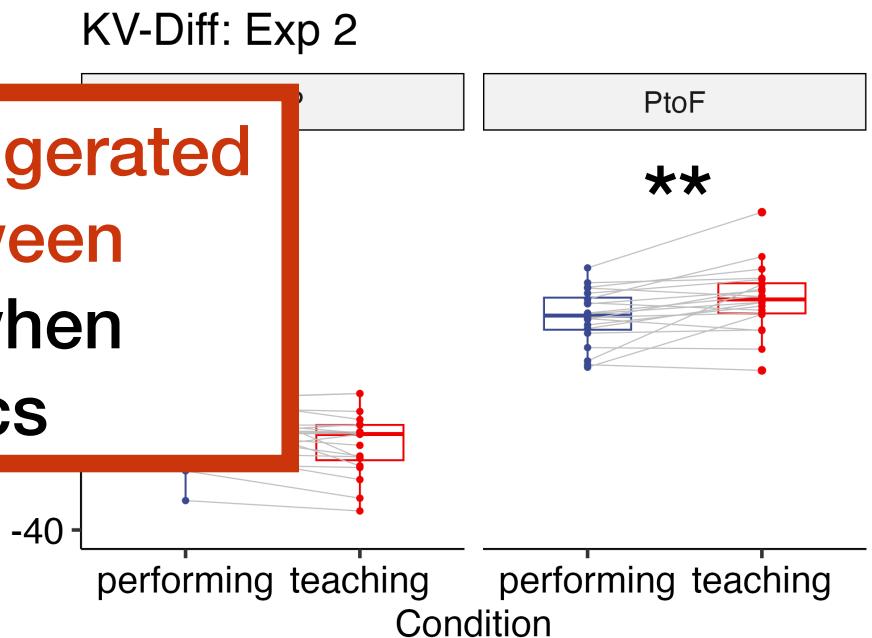
Dynamics contrast

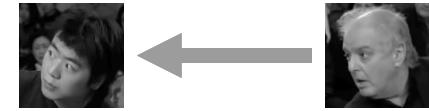
Experiment 2

- Effective locations to teach dynamics?
- Looking at transition forte to piano (FtoP) piano to forte (PtoF)



Participants exaggerated the contrast between forte and piano when teaching dynamics



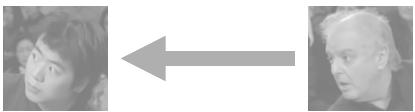


Discussion

Experiment 1 & 2

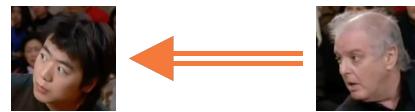
- Expert pianists **selectively highlighted relevant aspects of notated expressions**
 - Dynamics: Consistent findings for dynamics contrast
 - Articulation: No exaggeration for legato
 - Ceiling effect?
 - Slower performance only when teaching articulation
 - Changing tempo might give a different interpretation in music

Study 1



How do expert pianists **modulate** their performance **for teaching**

Study 2



How do expert pianists **adapt** their performance according to **novices' demonstrated skills?**

Study 3

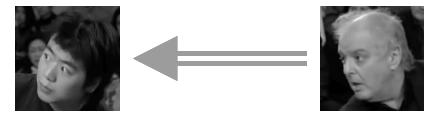


What makes musicians **infer teaching intentions** when listening to expressive performance?

Study 4



How do experts teach musical expression **in the real world?**



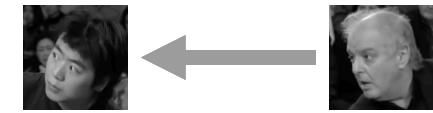
Experts' adaptation depending on novices' skills

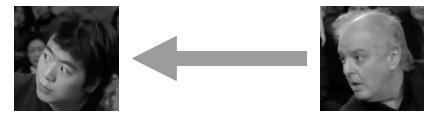
- During a skill acquisition process, experts regularly monitor novices' actions and **intervene by adapting their behaviour to novices' observed abilities** (Mermelshtine, 2017)
- Exaggeration tends to happen when novices **fail to reproduce** what experts demonstrated (Fukuyama et al., 2015)
- We investigated whether and how expert pianists teaching skills to learners **adapt their demonstrations as a function of the novices' demonstrated skills**

Participants and apparatus

Methods

- 20 piano experts (15 female)
 - 21.55 years of practice on average ($SD = 11.59$)
- A weighted Yamaha MIDI digital piano





Design & Procedure

Methods

- We generated **artificial recordings of novice piano performances** instead of recruiting actual novice pianists to obtain experimental controls (original performances were taken from **Study 1**)
 - Recordings with articulation and dynamics (ideal performance), with only articulation or dynamics, and without articulation and dynamics (poor performance)
- Within-subjects design
 - Factors: 2 Articulation (Present vs. Absent) x 2 Dynamics (Present vs. Absent)
 - 16 trials in total (2 Articulation x 2 Dynamics x 4 instances of each type)

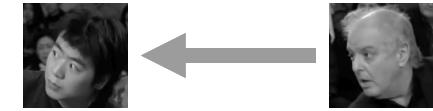
Design & Procedure

Methods

1. Listening phase:

Participants listened to a student's performance (recording)

2. Playing phase: Participants were asked to perform the piece specifically for the student



Please listen carefully to the current recording.

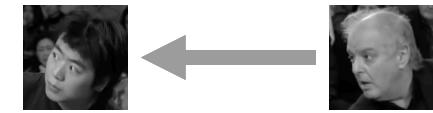
A musical score for piano in common time, treble clef, and G major. It consists of three staves of music. Dynamic markings include *f*, *p*, *f*, *f*, and *f*. Fingerings are indicated above the notes, such as 5-4-5-3-4-3-2-1 and 5-4-5-3-2-3-4-5-3-2-1-2-1-2-1.

Please play the piece below in order to teach expressive techniques for the student you just listed

A second musical score for piano in common time, treble clef, and G major, identical in structure to the first but with different dynamic markings: *f*, *p*, *f*, *f*, and *f*.

Stimuli

Artificial recordings of students



Ideal performance
(Articulation - **Present**,
Dynamics - **Present**)

Musical notation for a single melodic line in common time (C). The notes are numbered 1 through 5 above them. The dynamics are marked as follows: forte (f) at the beginning, piano (p) in the middle, and forte (f) again at the end. Fingerings are indicated above the notes: (5,4), (5,3), (1,3,2,1), (5,4,5,3,4,2,3,1), (5,4), (4,3,2,1,3), (2,1,4,3,2,1,5,3,2).

Articulation
Present

Dynamics
Present

Musical notation for a single melodic line in common time (C). The notes are numbered 1 through 5 above them. The dynamics are marked as follows: forte (f), piano (p), and forte (f). Fingerings are indicated above the notes: (5,4), (5,3), (1,3,2,1), (5,4,5,3,4,2,3,1), (5,4), (4,3,2,1,3), (2,1,4,3,2,1,5,3,2).

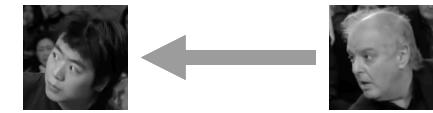
Articulation
Absent

Dynamics
Absent

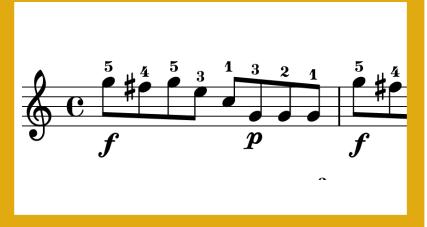
Musical notation for a single melodic line in common time (C). The notes are numbered 1 through 5 above them. The dynamics are marked as follows: forte (f), piano (p), and forte (f). Fingerings are indicated above the notes: (5,4), (5,3), (1,3,2,1), (5,4,5,3,4,2,3,1), (5,4), (4,3,2,1,3), (2,1,4,3,2,1,5,3,2).

Stimuli

Artificial recordings of students

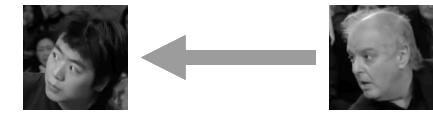


Ideal performance
(Articulation - **Present**,
Dynamics - **Present**)

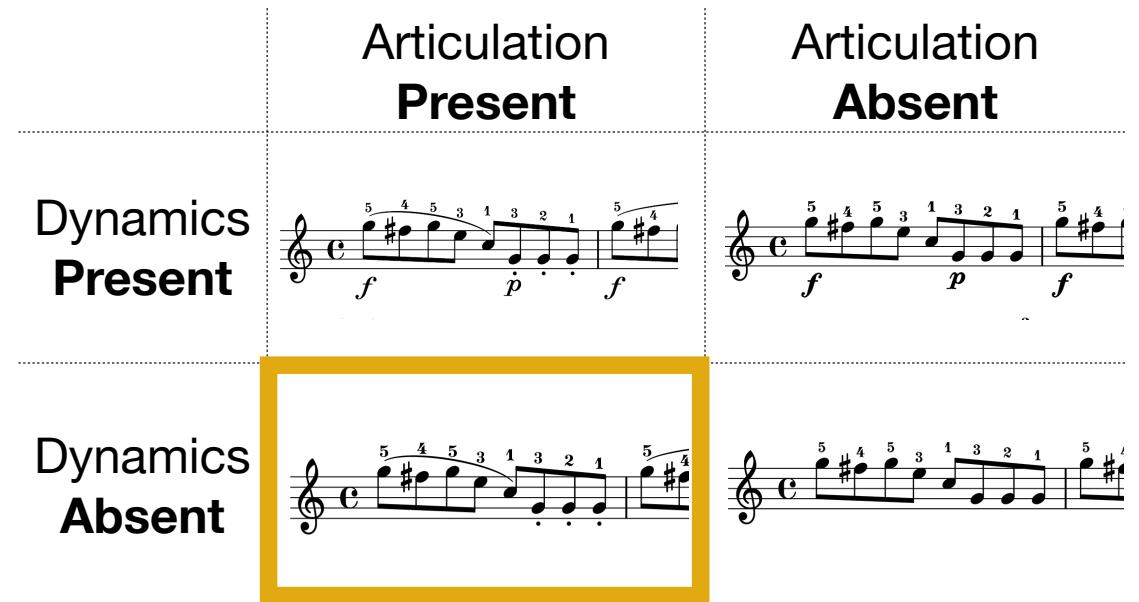
Articulation Present	Articulation Absent
Dynamics Present	
Dynamics Absent	

Stimuli

Artificial recordings of students

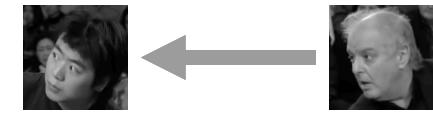


Ideal performance (Articulation - **Present**, Dynamics - **Present**)



Stimuli

Artificial recordings of students

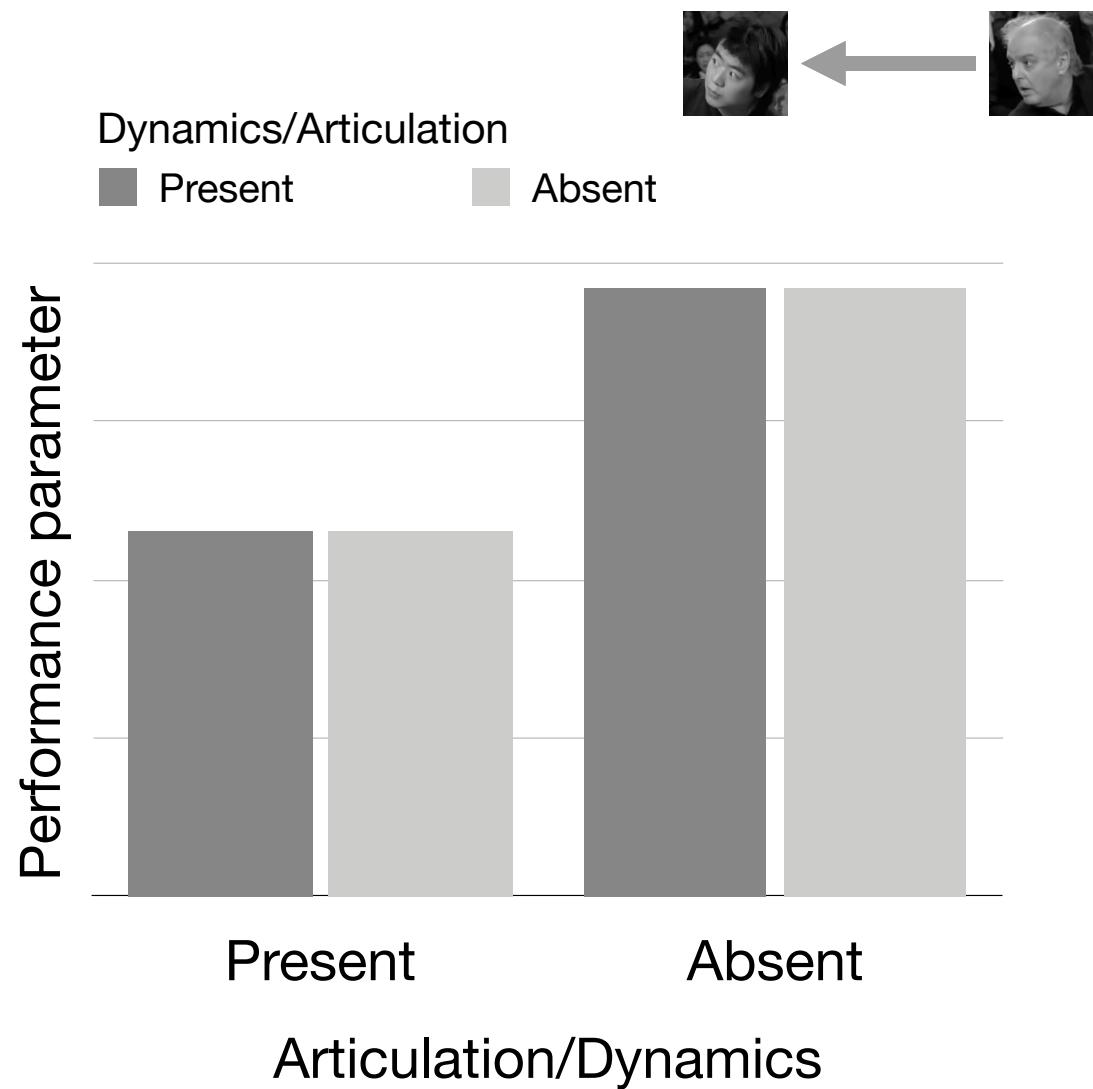


Ideal performance
(Articulation - **Present**,
Dynamics - **Present**)

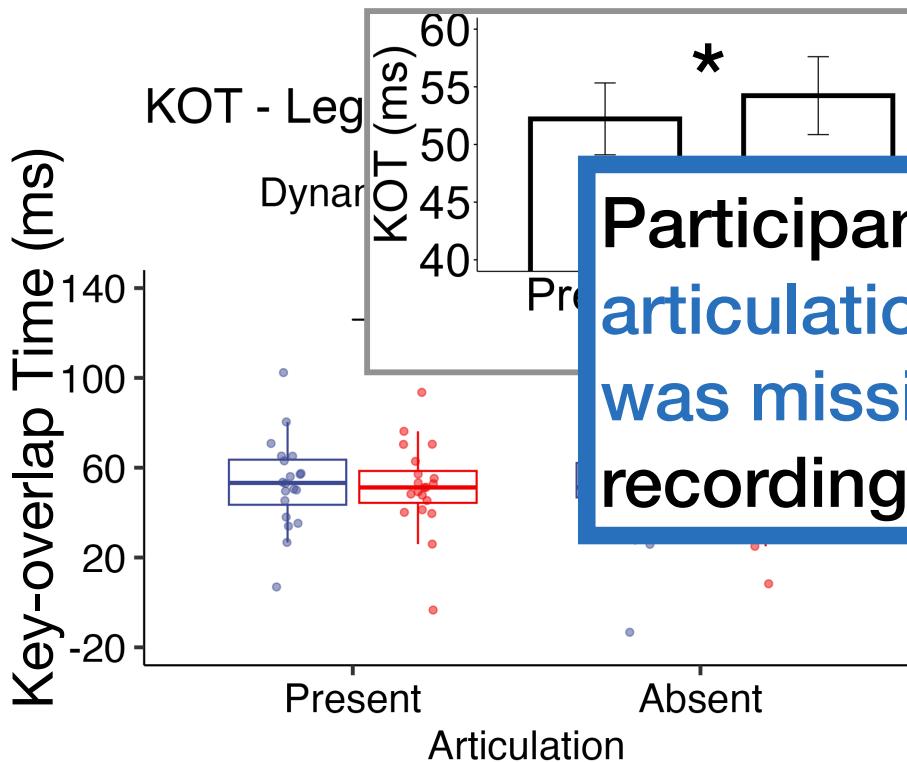
	Articulation Present	Articulation Absent
Dynamics Present		
Dynamics Absent		

Predictions

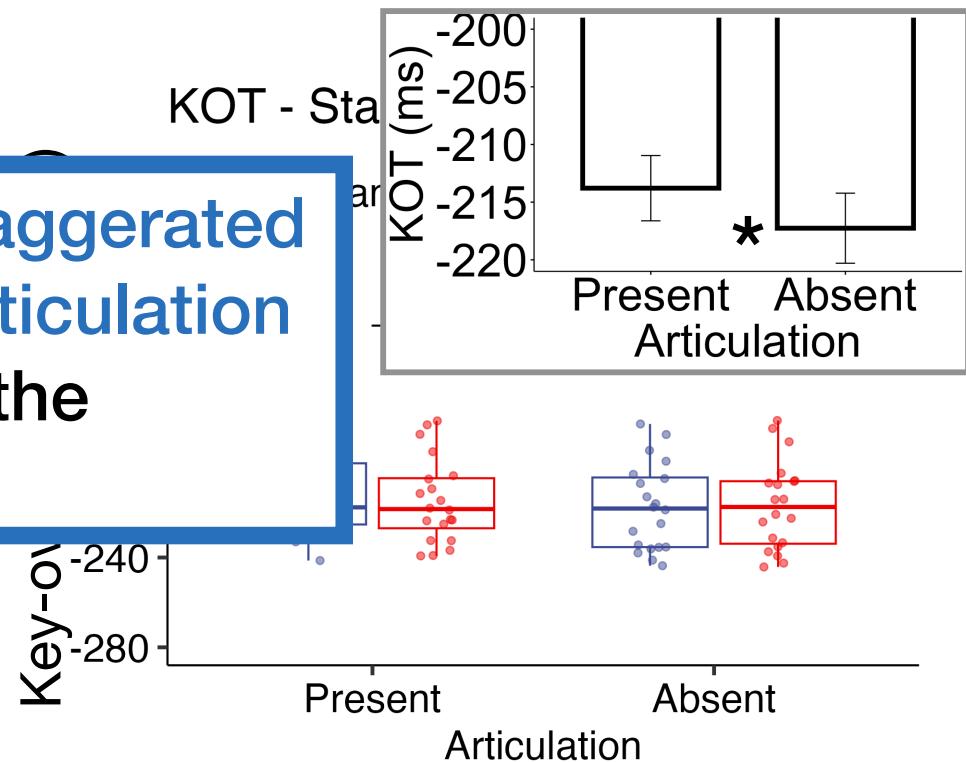
- Expert pianists would **exaggerate their performance only when specific techniques were missing** in the recordings
 - Produce **longer legato and shorter staccato when articulation was not implemented** in the recordings
 - Produce **louder forte and softer piano when dynamics was not implemented** in the recordings



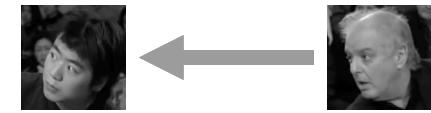
Smoothness (Articulation)



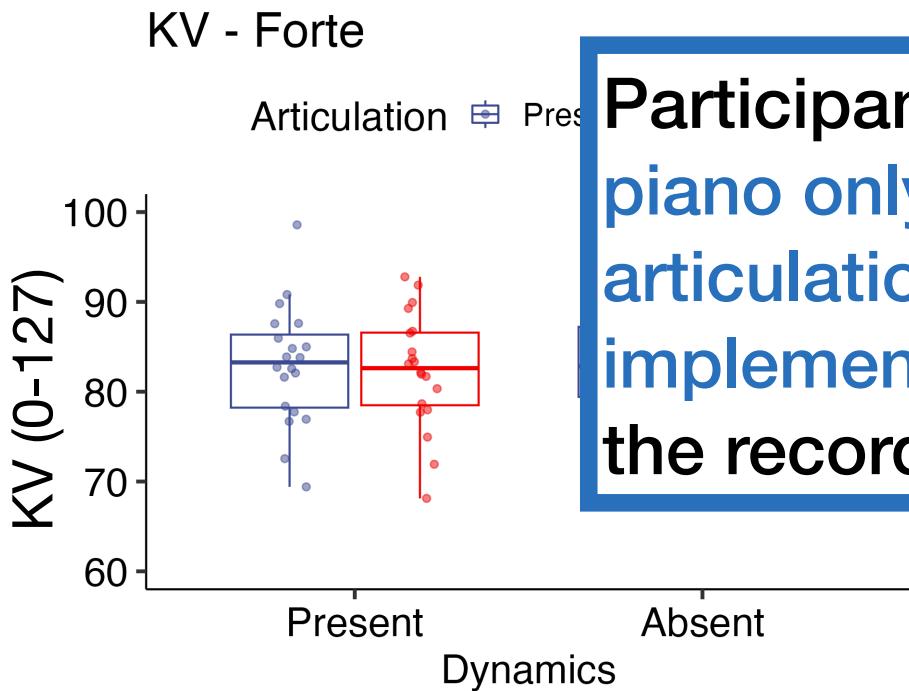
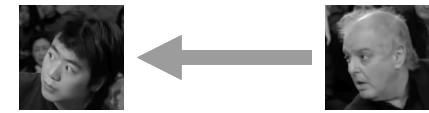
Articulation ($F(1, 19) = 5.59, p = 0.029, \eta^2 = 0.002$)



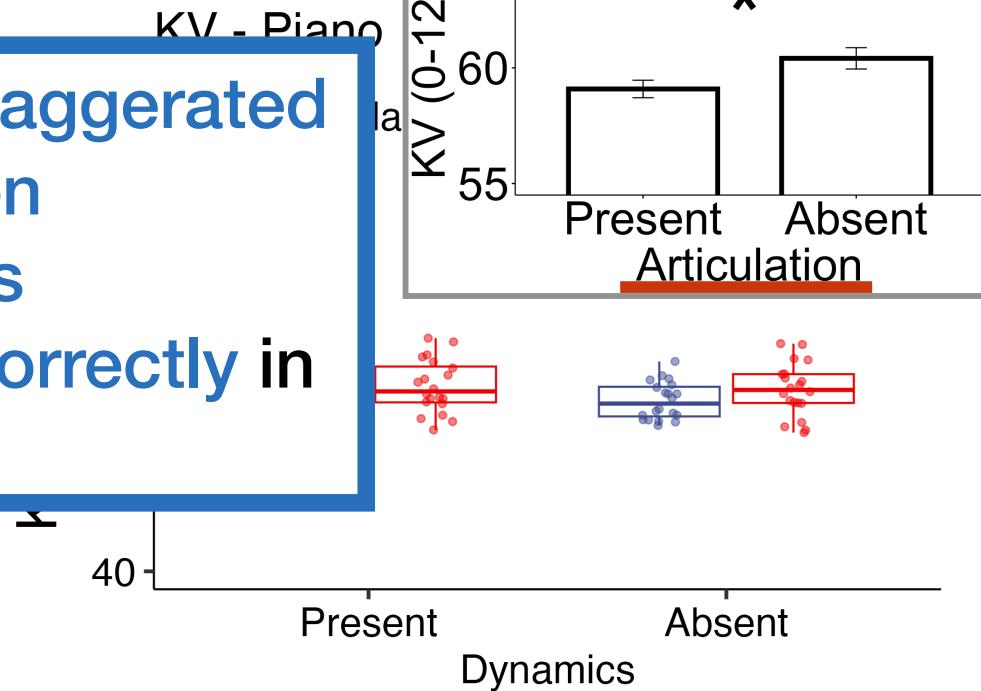
Articulation ($F(1, 19) = 4.88, p = 0.040, \eta^2 = 0.009$)

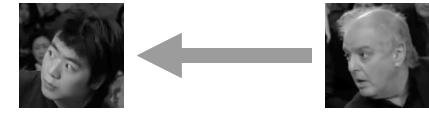


Loudness (Dynamics)



Participants exaggerated piano only when articulation was implemented correctly in the recordings

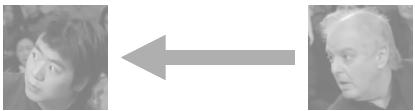




Discussion

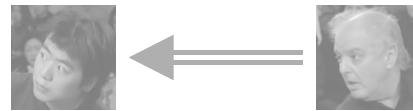
- **Systematic modulations for the smoothness of sound if articulation was missing in the recordings**
- No systematic modulations for the loudness of sound even when dynamics was not implemented in the recordings
 - Articulation was **prioritised for teaching** (e.g., Scaffolding behaviour; Zukow-Goldring & Arbib, 2007)?
 - **Identifying and focusing on the most relevant problem** for each student may be more effective to facilitate skill acquisition

Study 1



How do expert pianists **modulate** their performance **for teaching**

Study 2



How do expert pianists **adapt** their performance according to novices' demonstrated skills?

Study 3



What makes musicians **infer teaching intentions when listening to expressive performance?**

Study 4



How do experts teach musical expression **in the real world?**



Inferring pedagogical signals

- Perceiving pedagogical intentions from experts' actions is one of the fundamental components of social learning (Csibra & Gergely, 2009)
 - Infants may **recognise and make use of pedagogical cues** produced by adults (Brand & Shallcross, 2008; Fernald, 1985; Koterba & Iverson, 2009; Saint-Georges et al., 2013)
- Which performance features make listeners infer teaching intentions?
 - **Is exaggerated performance recognised as teaching performance?**

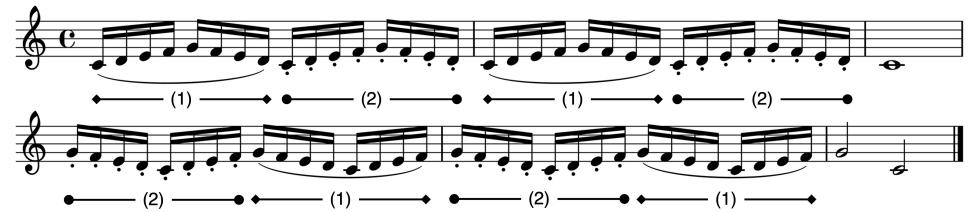


Participants and stimuli

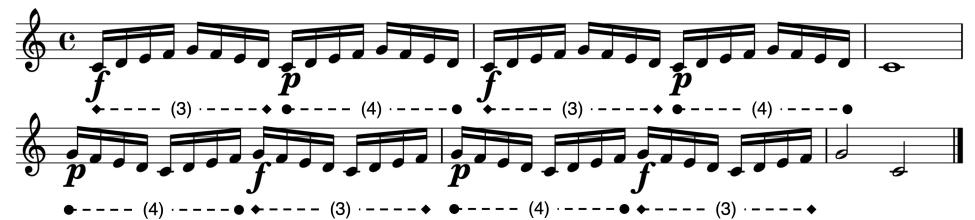
Experiment 1

- 20 musicians (13 female)
- We randomly sampled recordings from **Study 1**
 - 24 articulation recordings, 24 dynamics recordings from the teaching condition
 - 24 articulation recordings, 24 dynamics recordings from the performing condition

(1) Articulation



(2) Dynamics



Design & Procedure

- Musicians listened to piano recordings where a musical expressive technique of either articulation or dynamics was implemented
- They were asked to judge if each recording was produced for teaching or not



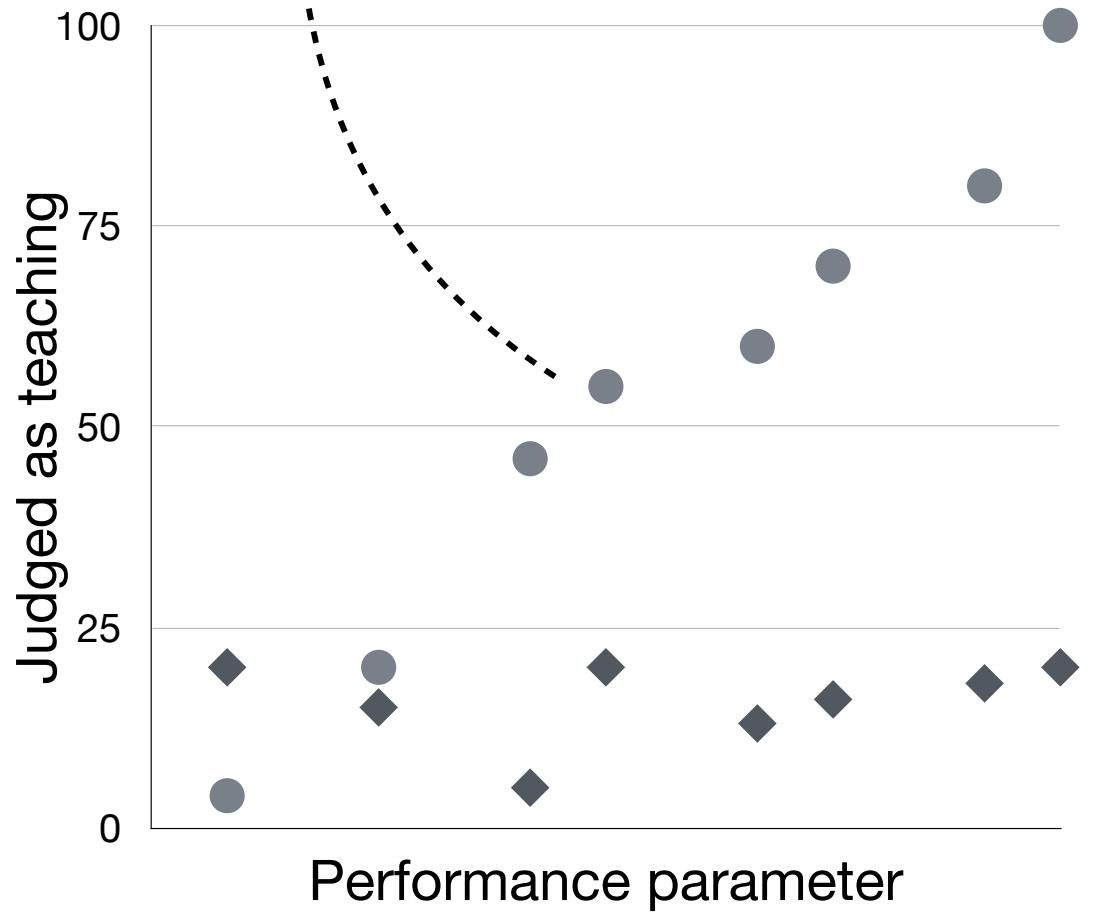
Teaching?
Yes: <Left> No: <Right>
Press <Return> to confirm

Predictions

- Pedagogical performance characteristics observed in Study 1 (e.g., **performances with exaggeration should be used to infer teaching intentions** by musician listeners)



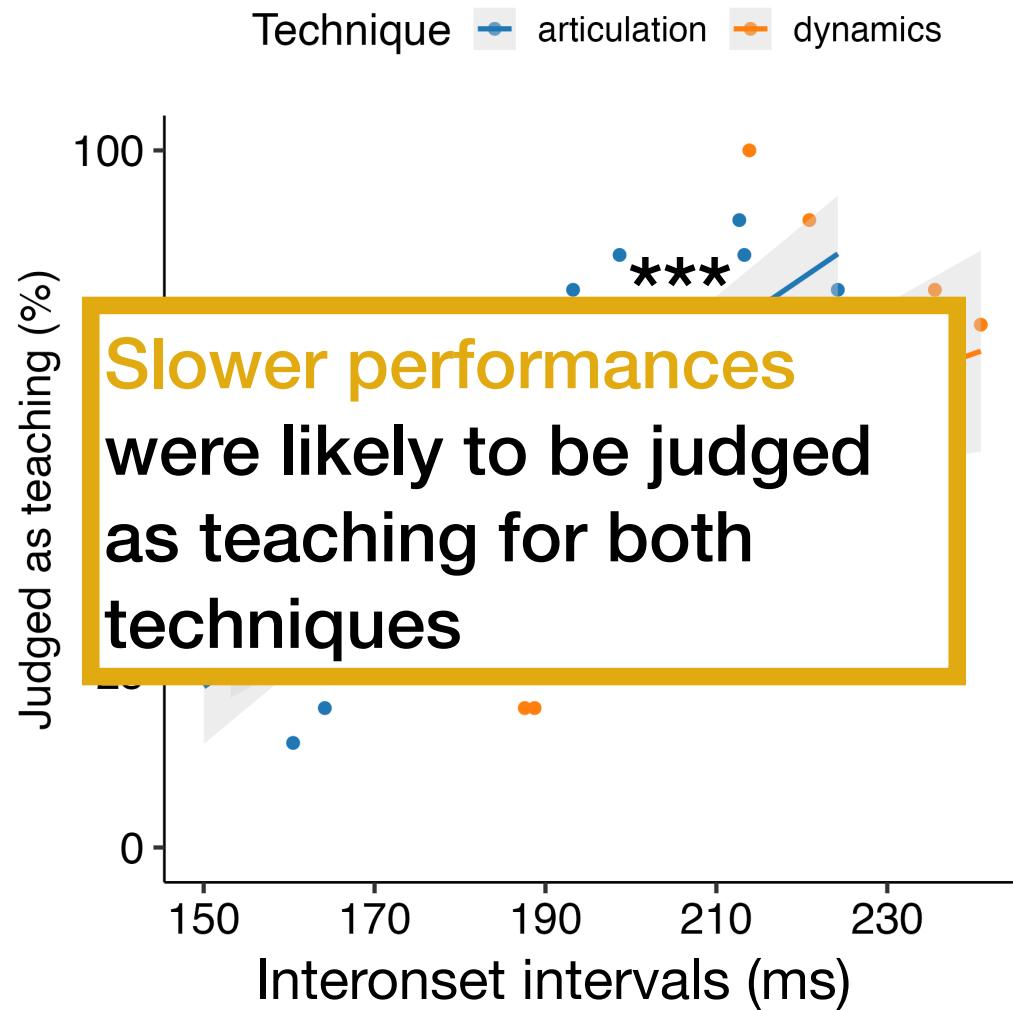
Each performance/recording





Tempo

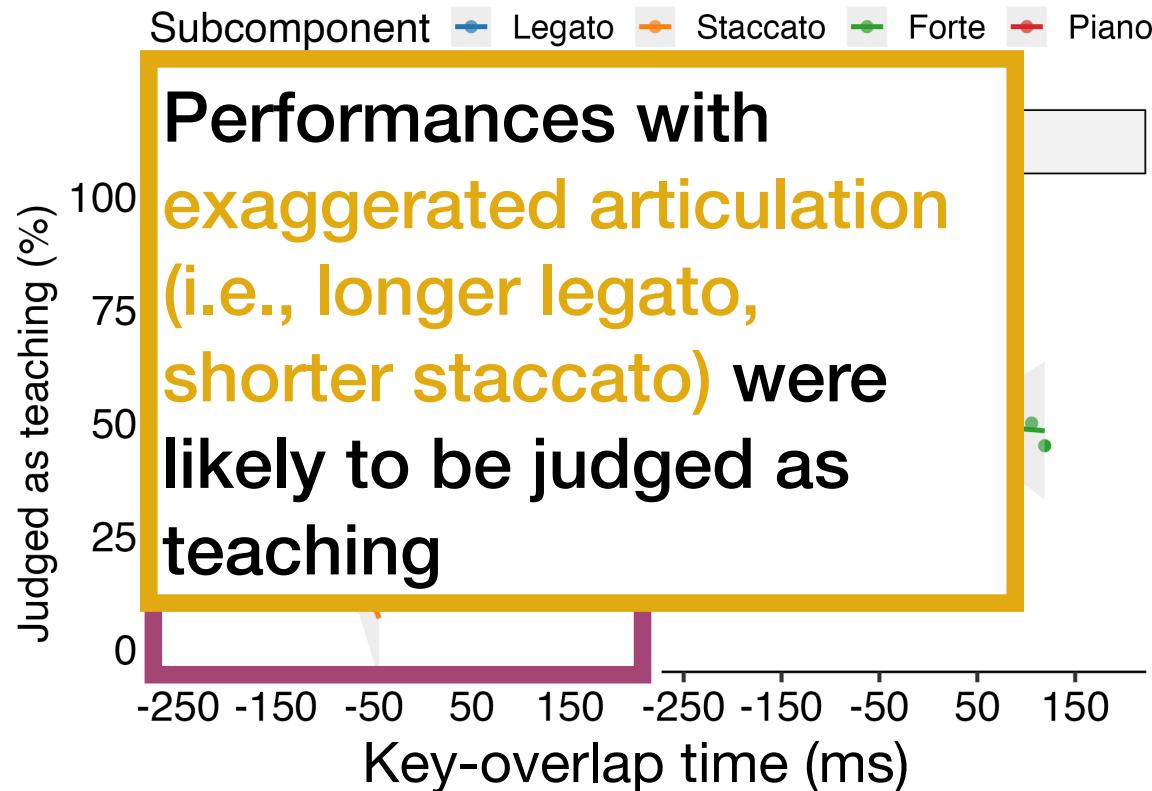
Experiment 1





Smoothness

Experiment 1

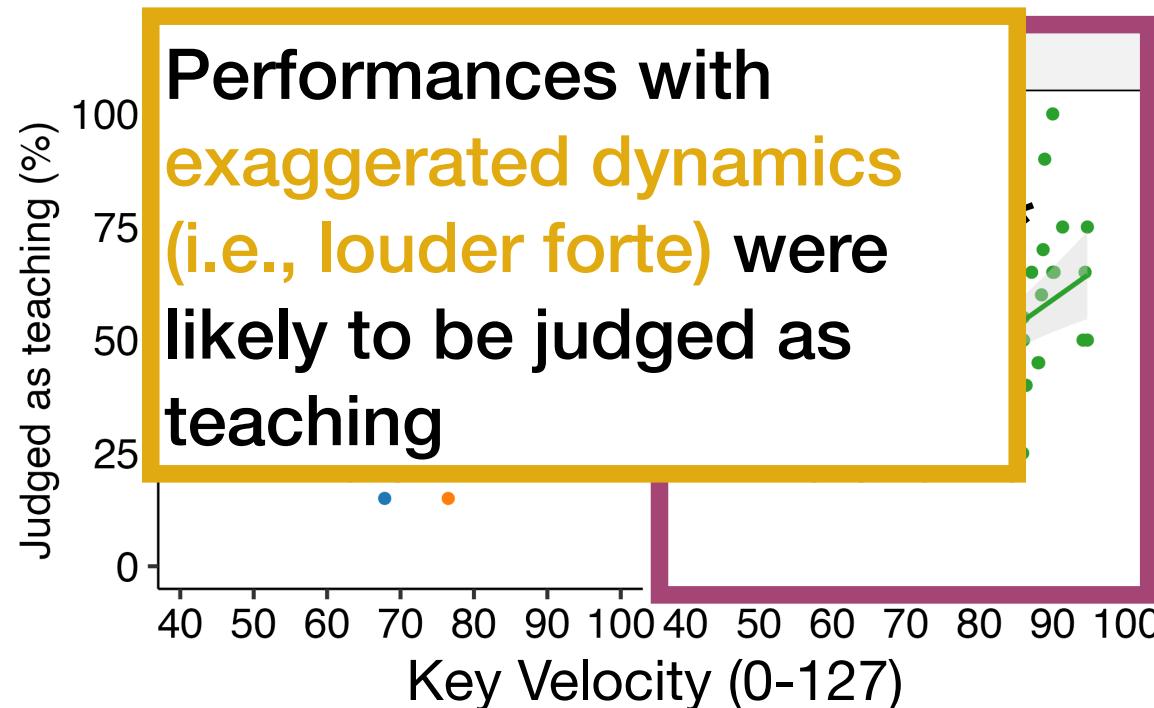




Loudness

Experiment 1

Subcomponent Legato Staccato Forte Piano

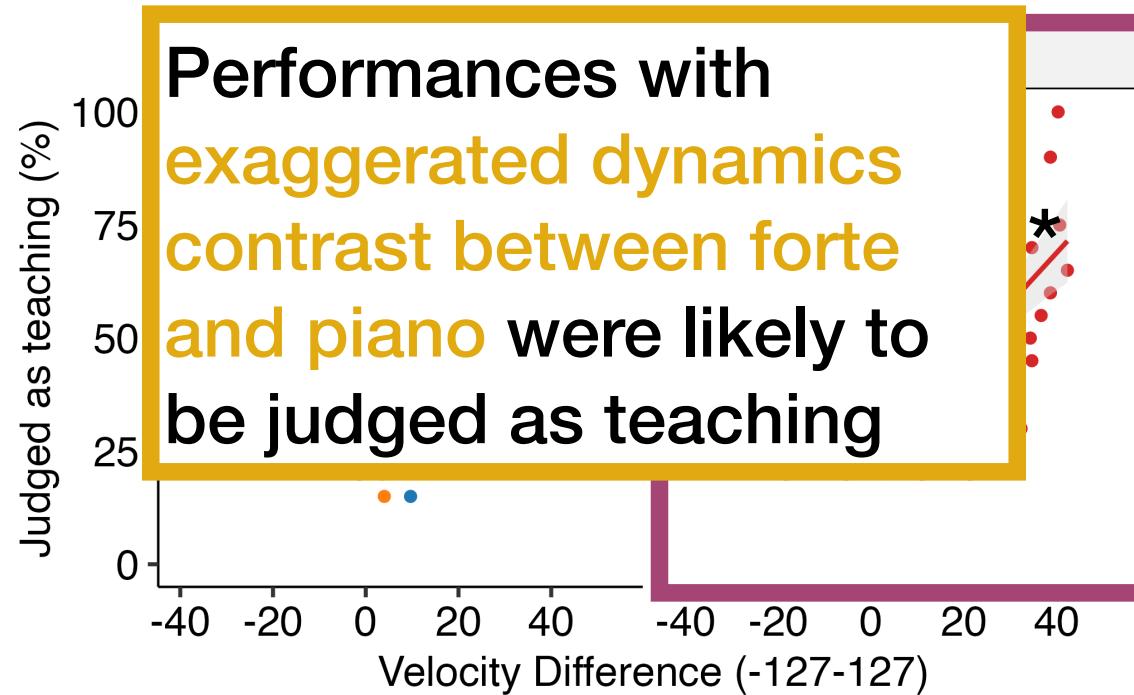




Dynamics contrast

Experiment 1

Subcomponent LtoS StoL FtoP PtoF





Discussion

Experiment 1

- **Slower performances** were judged as teaching regardless of the kind of techniques implemented
- **Exaggerated performances** (except for piano) were likely to be judged as teaching
- Can we generalise these findings when teaching a **more musically complex** piece?



Participants and stimuli

Experiment 2

- 20 musicians (10 female)
- We randomly sampled recordings from **Study 1**
 - 18 articulation recordings, 18 dynamics recordings from the teaching condition
 - 18 articulation recordings, 18 dynamics recordings from the performing condition

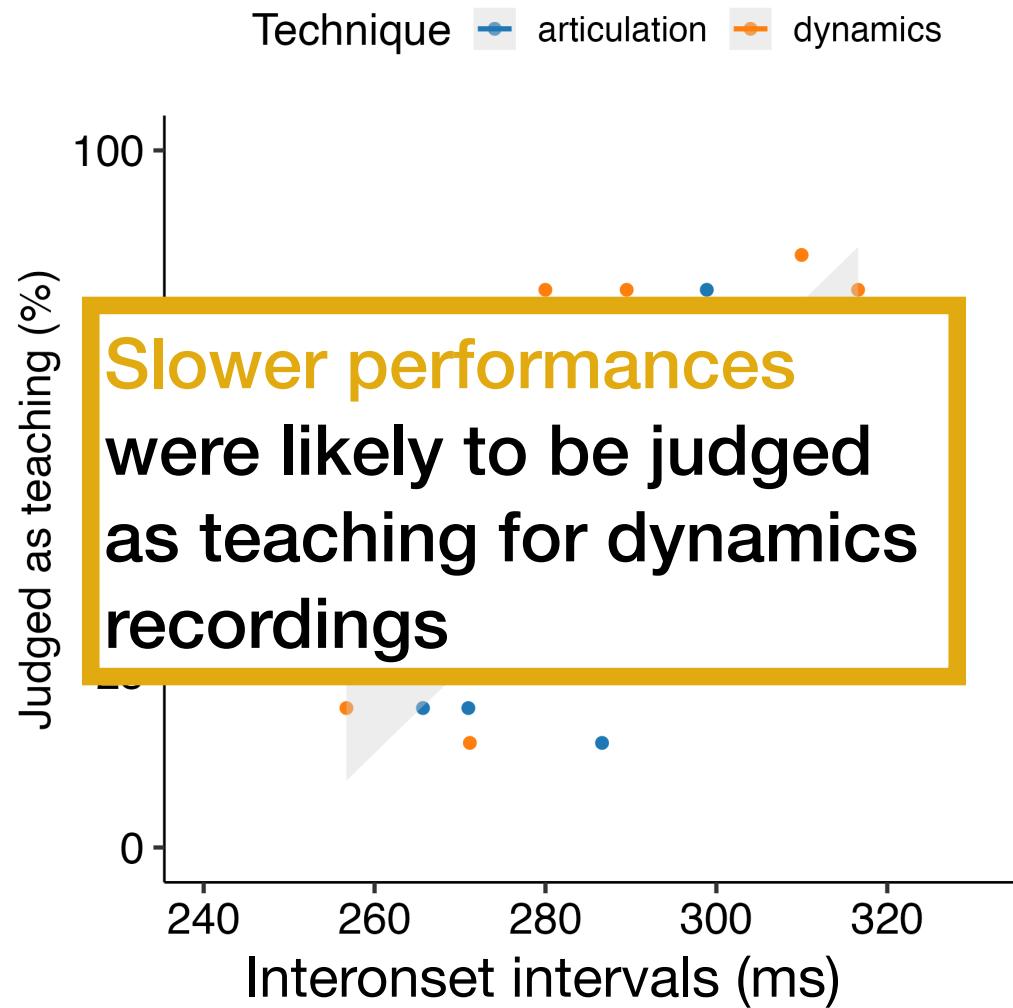
(1) Articulation

(2) Dynamics



Tempo

Experiment 2

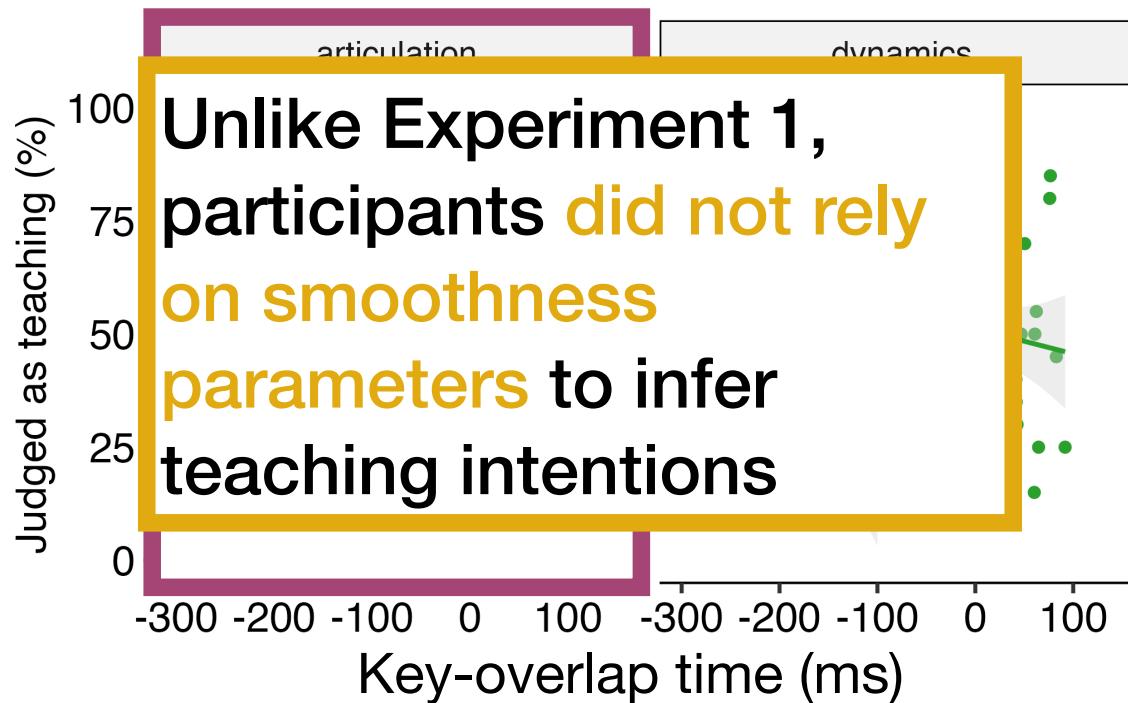




Smoothness

Experiment 2

Subcomponent Legato Staccato Forte Piano

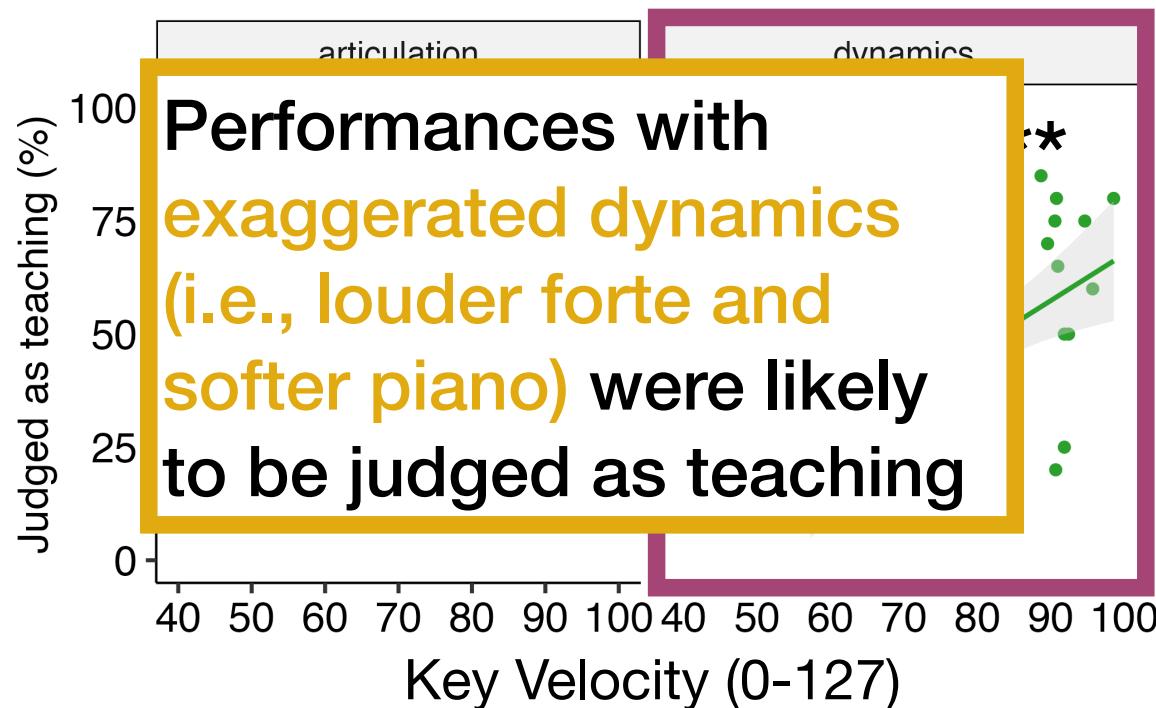




Loudness

Experiment 2

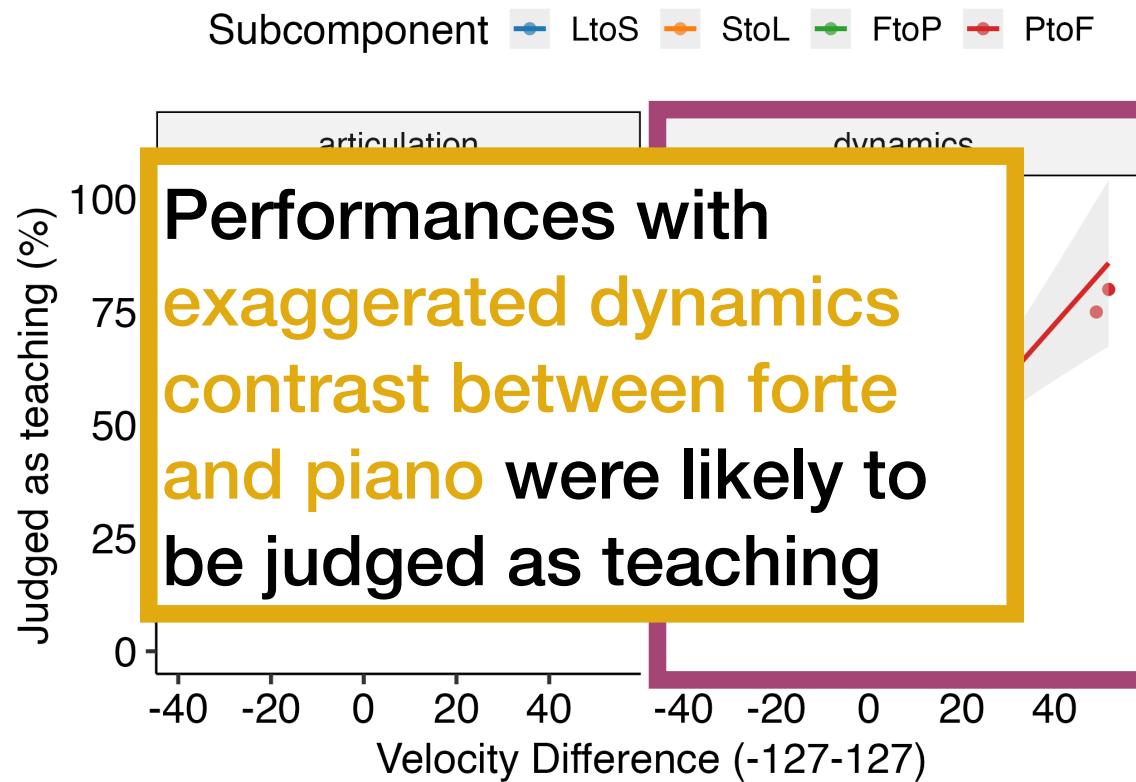
Subcomponent Legato Staccato Forte Piano





Dynamics contrast

Experiment 2



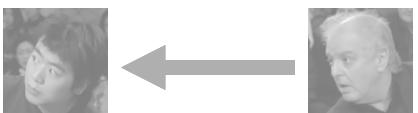


Discussion

Experiment 1 & 2

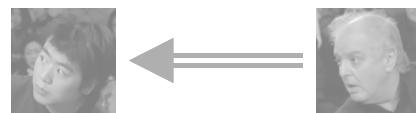
- Musician listeners can infer teaching intentions by **relying on specific performance aspects**
- **Dynamics is reliable or consistently used** regardless of the complexity of the pieces
 - Dynamics is relatively easy to perceive? (Nakamura, 1987)

Study 1



How do expert pianists **modulate** their performance **for teaching**

Study 2



How do expert pianists **adapt** their performance according to novices' demonstrated skills?

Study 3



What makes musicians infer teaching intentions when listening to expressive performance?

Study 4



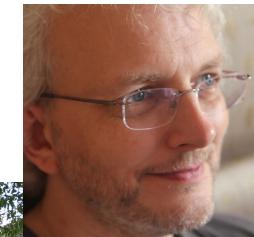
How do experts teach musical expression **in the real world?**



Exaggeration



**Martin Clayton
(Ethnomusicologist)**





Discovering musical expression

together with teachers: A qualitative approach

- How do music teachers teach musical expression in the real world?
- Semi-structured interview (e.g., DiCicco-Bloom et al., 2006)

Learning history

Teaching experience

Teaching expression

Use of
exaggeration

Cultural differences





Methods

Participants

- 6 teachers (3 piano teachers, 2 Hindustani raag teachers, 1 cello teacher)
- 2 students (1 Hindustani raag learner, 1 cello learner)
- Each interview took about one hour (in-person or online)

Exaggeration as an exploration tool

- Exaggeration is not only for teaching (signalling)

“... sometimes it's good to just experience the extreme version. And then, you balance out”

- Exaggeration might invite students to **explore and experience variability** in performance
 - Experiencing motor variability during a learning process (Dhawale, Smith & Ölveczky, 2017; Wu et al., 2014)
 - Variability in action, sound and sensation

The role of teachers

- The ability to choose suitable materials (exploration space) for each student seems to be important for teachers

“The piano teacher should know the piano repertoire very well. You should also study your students, their mentality, their temperament . . . It was something like choosing the best-ever dress from your wardrobe to offer just enough [for] them to start . . . You need to find the exact colour, you need to find the exact style [for students].”

- Provide **appropriate materials and environments** to acquire technical and expressive skills

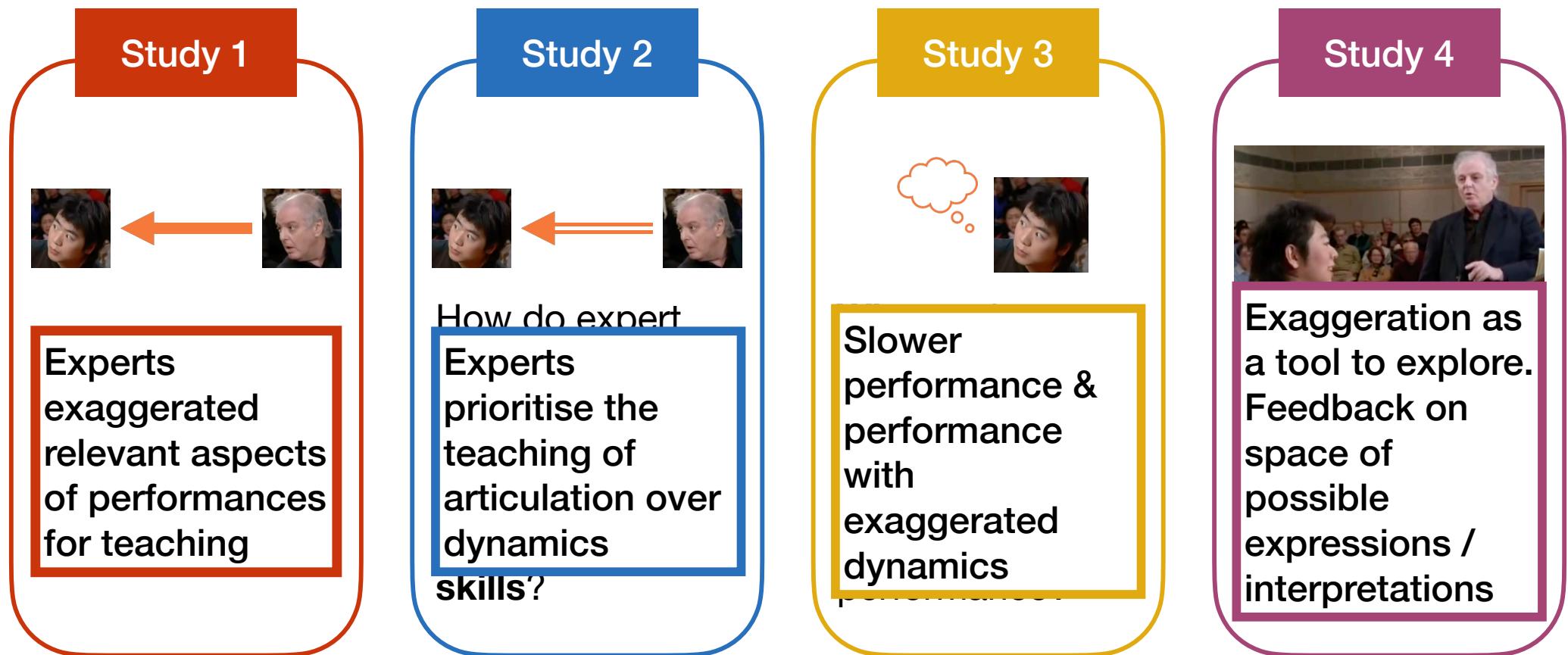
The role of teachers

- Giving feedback when students go beyond the limit of possible performance, rather than giving direct instructions and suggestions on what to do

“For adult students, I encourage them to come up with their own ideas and obviously when it’s stylistically not correct or if it doesn’t make sense, as a music interpretation, then I tell them that it’s not right.”

- **Teachers value their students’ interpretations** and let them explore first - but give some constraints (Schiavio et al., 2022)
- **Innovation needs didactic pedagogy and scaffolding**, not random trial-and-error (Legare & Nielsen, 2015)

Main findings



Discussion and open questions

Ostensive communication in skill transmission

- Pedagogical signalling (ostensive communication) is supposed to provide constraints on novices' cognitive mechanisms to **narrow down the possible goals** of observed actions (Csibra & Gergely, 2006, 2009, 2011)
- What people learn (e.g., recognise, memorise or imitate) from demonstrations may depend on how teachers demonstrate
- Generalisability
 - Diversity and similarity in music performance (e.g., Repp 1992, 1997)
 - **Which performance aspects are likely to be generalised/transmitted?**
 - **Are skills acquired through ostensive communication likely to be transmitted over generations?**

Interactivity between experts and novices

- One of the limitations of our approach is that the information flow between experts and novices was **unidirectional**
- How experts and novices could communicate was **strictly constrained**, namely only through sound
 - Musical expression as an embodied concept (Li & Timmers, 2020, 2021)
 - Various teaching methods and the age of learners (Bonastre & Timmers, 2021)
- Turn-taking vs. synchronous performance (e.g., Schiavio, Stupacher, Parncutt & Timmers, 2020; Pan, Novembre, Song, Li, & Hu, 2018)
 - **How could exaggeration be used when performing together?**

Identifying the goal of expressive performance

- Teaching is effective because **experts know how to obtain a particular goal** and modulate their demonstration so that novices are able to understand the goal efficiently
 - The **technical** component of expressive performance: generalisable, transmittable because of clear (instrumental) goals
 - Exaggeration to **highlight relevant aspects**
 - The **creative** aspect of expressive performance: the process of defining goals, the boundary of teaching and learning might be more ambiguous
 - Exaggeration as **an exploration tool**

Our findings reveal the importance of action-based communication between experts and novices through the lens of exaggeration, even when teaching seemingly complex skills such as expressive performance in music



Acknowledgement

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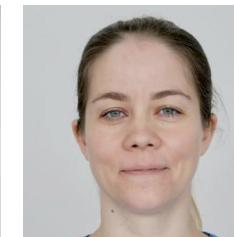
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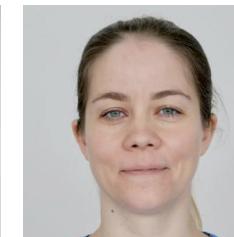
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- Central European University



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Backup slides

Study 1

Instruction

- **Teaching condition (Exp 1 & 2)**

Now, 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 to produce the piece according to the notation that you just practised.*

- **Performing condition (Exp 1)**

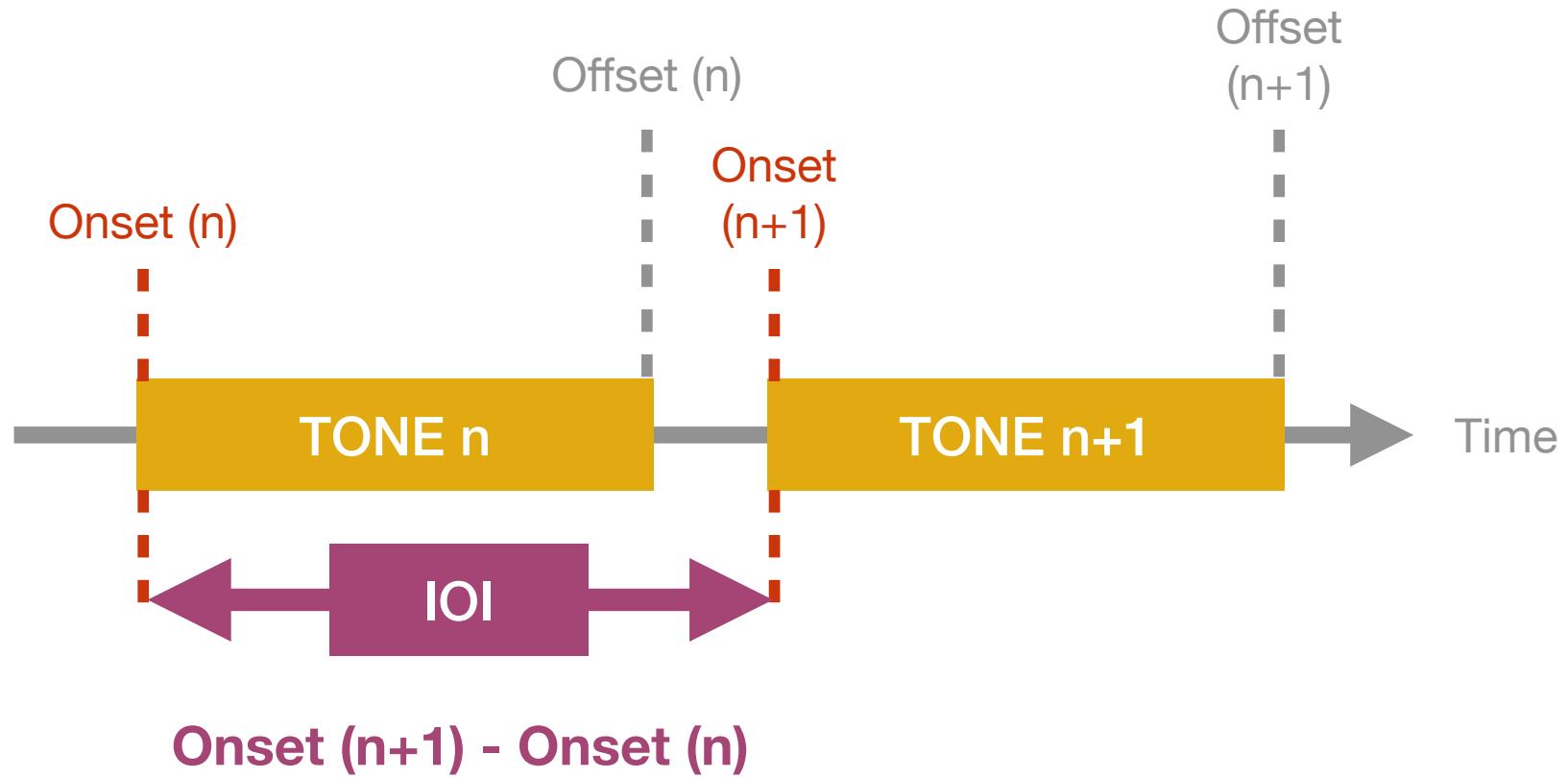
Now, play what you practised as if you were performing it to an audience. *Do your best as a performer to produce the piece according to the notation that you just practised.*

- **Performing condition (Exp 2)**

Now, play what you practised as if you were performing it to an audience. ***Perform the piece expressively with your interpretation.*** *Do your best as a performer to produce the piece according to the notation that you just practised.*

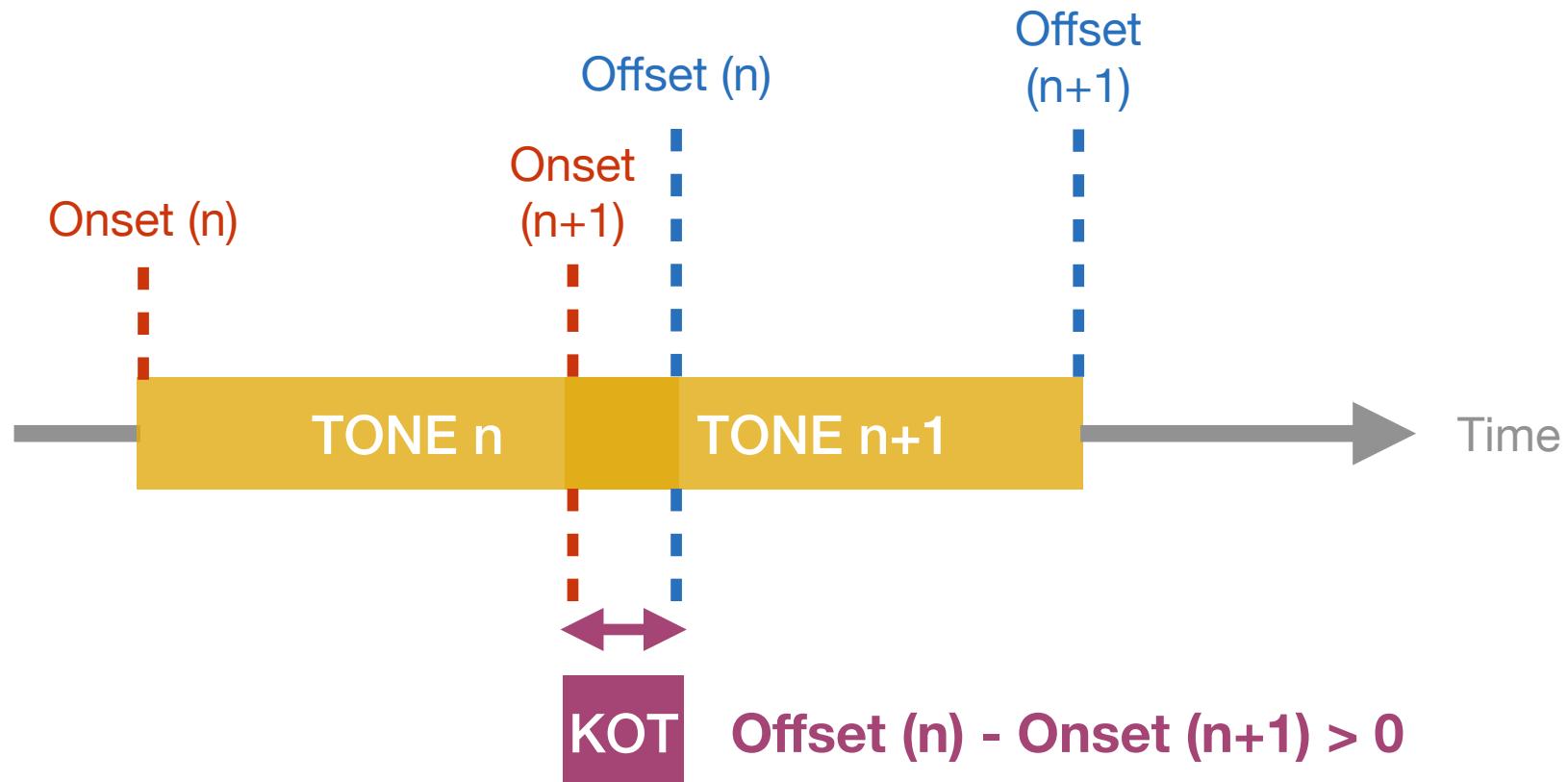
Tempo

Interonset intervals (IOIs)



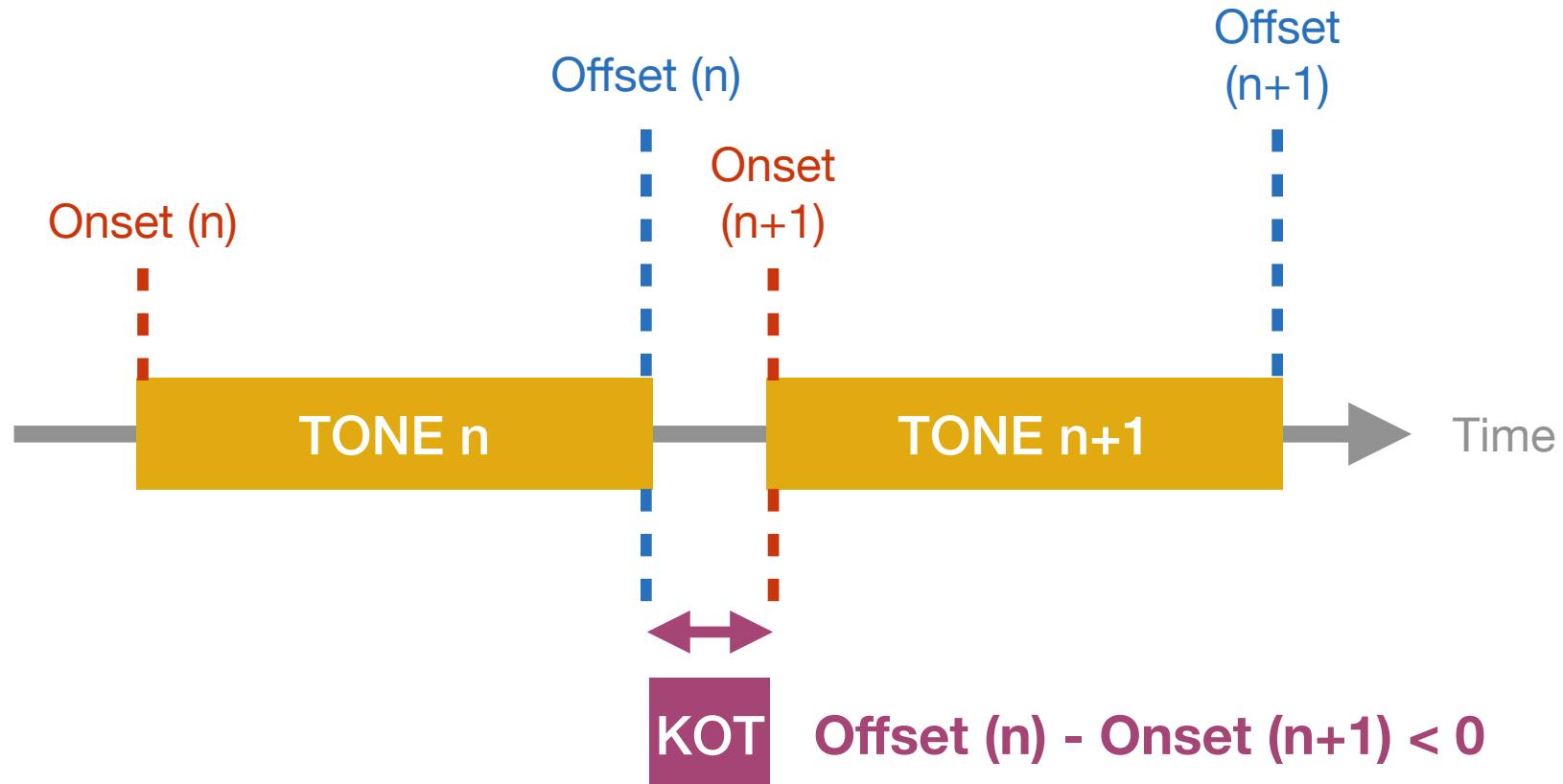
Smoothness (Legato)

Key-overlap time (KOT)



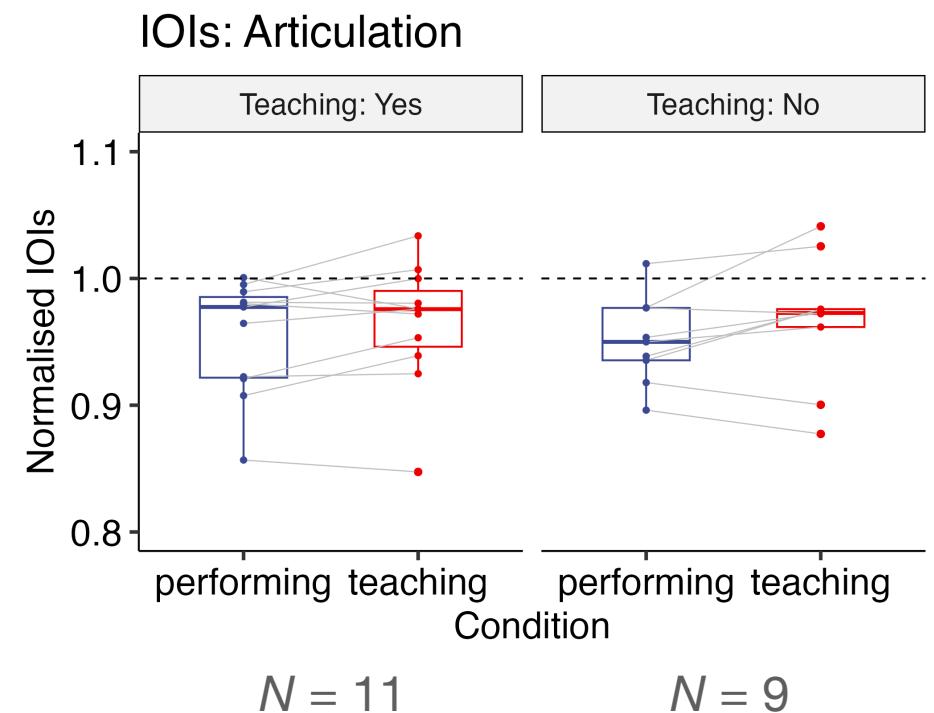
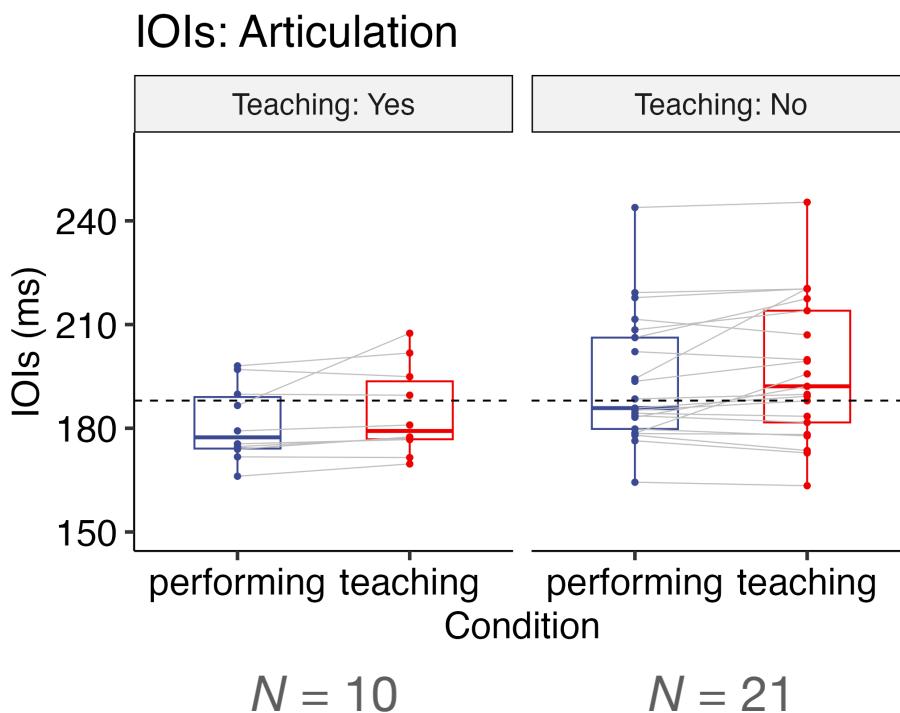
Smoothness (Staccato)

Key-overlap time (KOT)



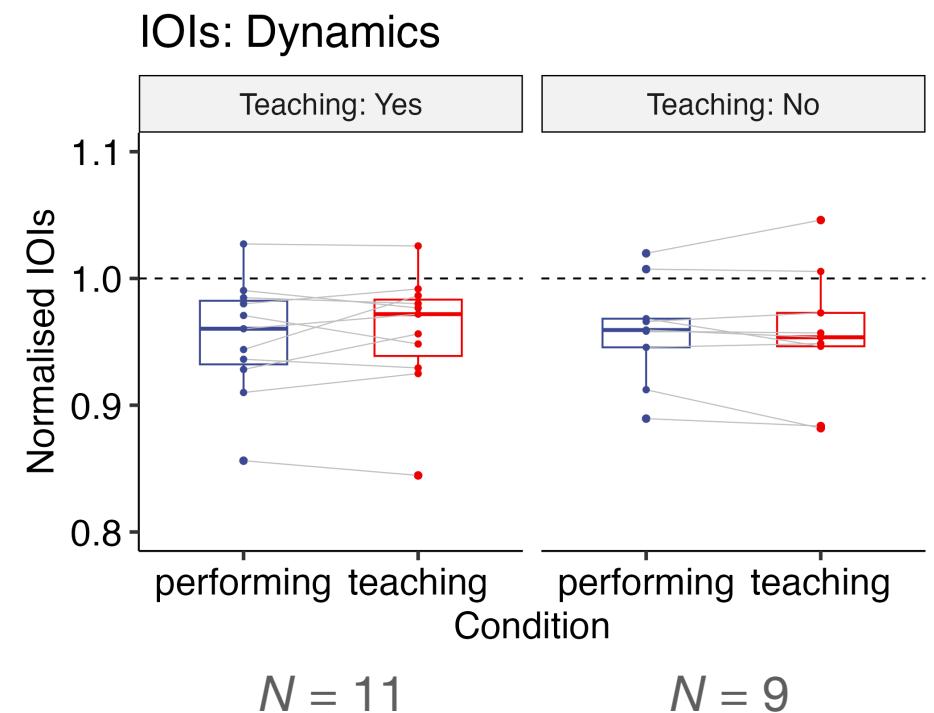
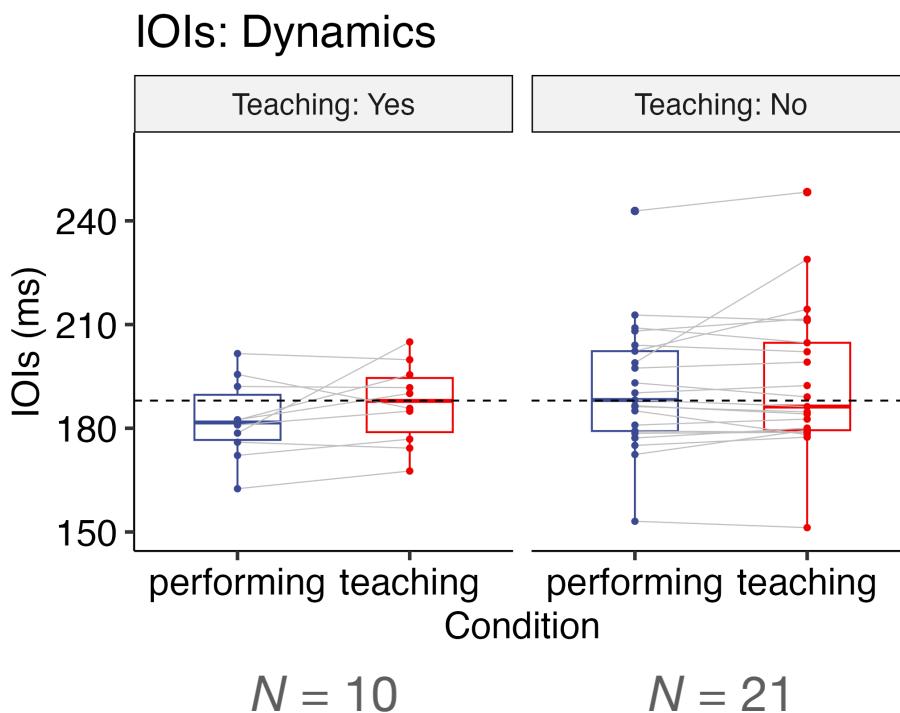
Data for teachers vs. non-teachers

Tempo (Articulation - Experiment 1 & 2)



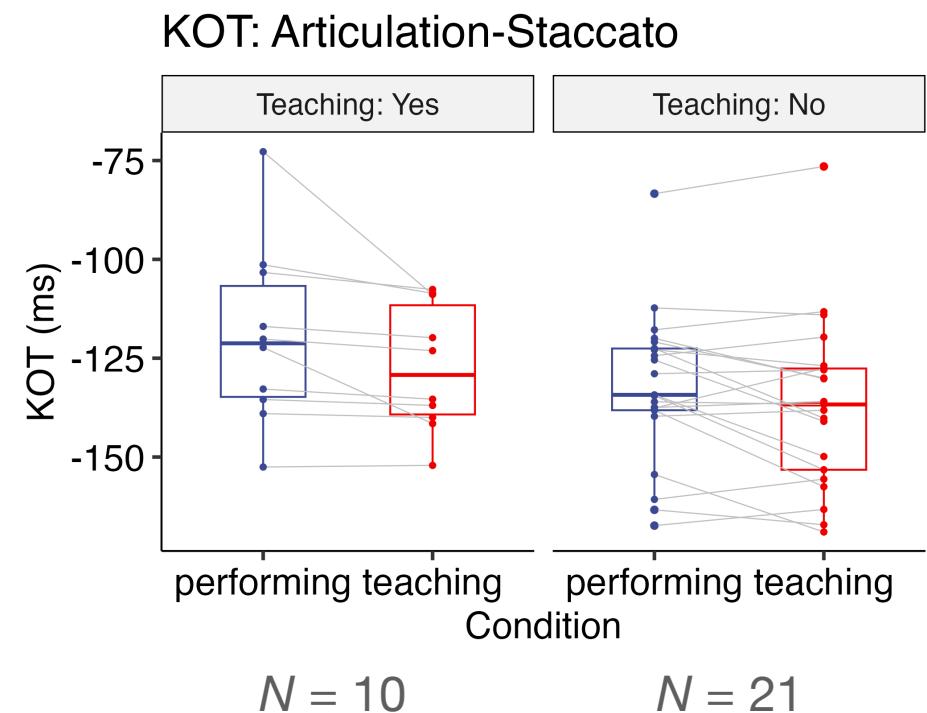
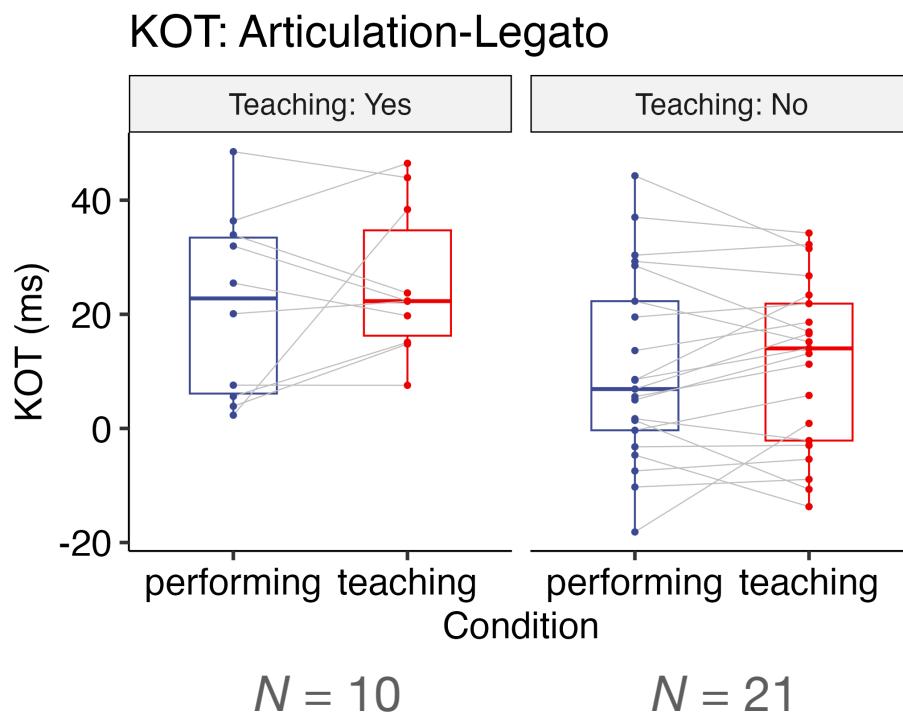
Data for teachers vs. non-teachers

Tempo (Dynamics - Experiment 1 & 2)



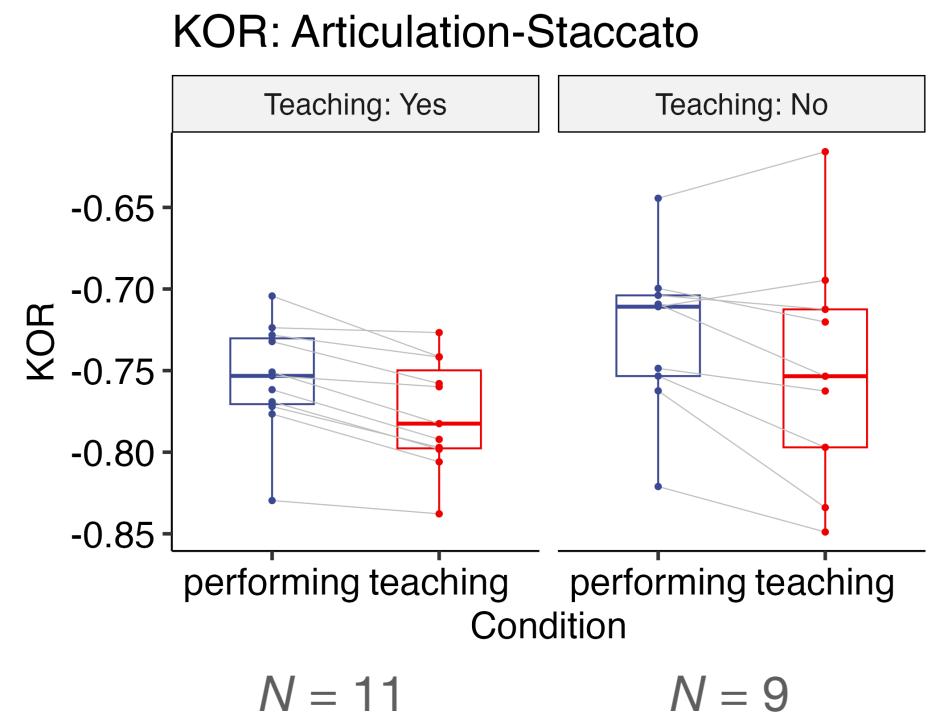
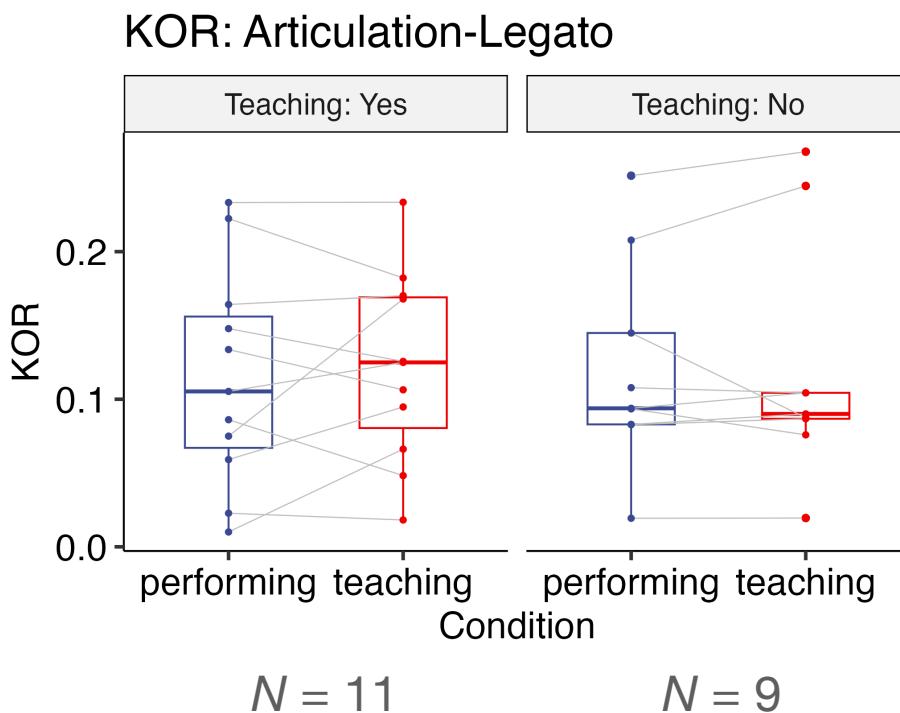
Data for teachers vs. non-teachers

Smoothness (Articulation - Experiment 1)



Data for teachers vs. non-teachers

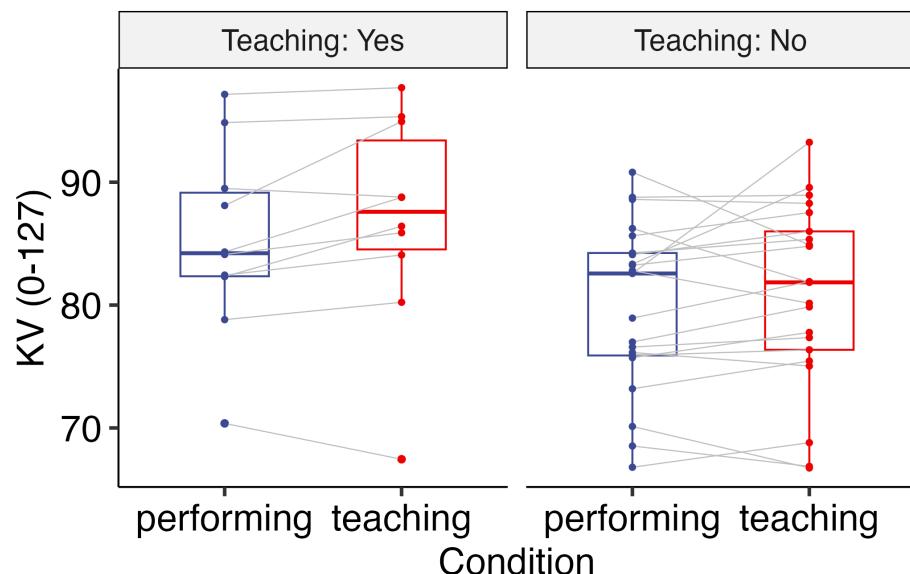
Smoothness (Articulation - Experiment 2)



Data for teachers vs. non-teachers

Loudness (Dynamics - Experiment 1)

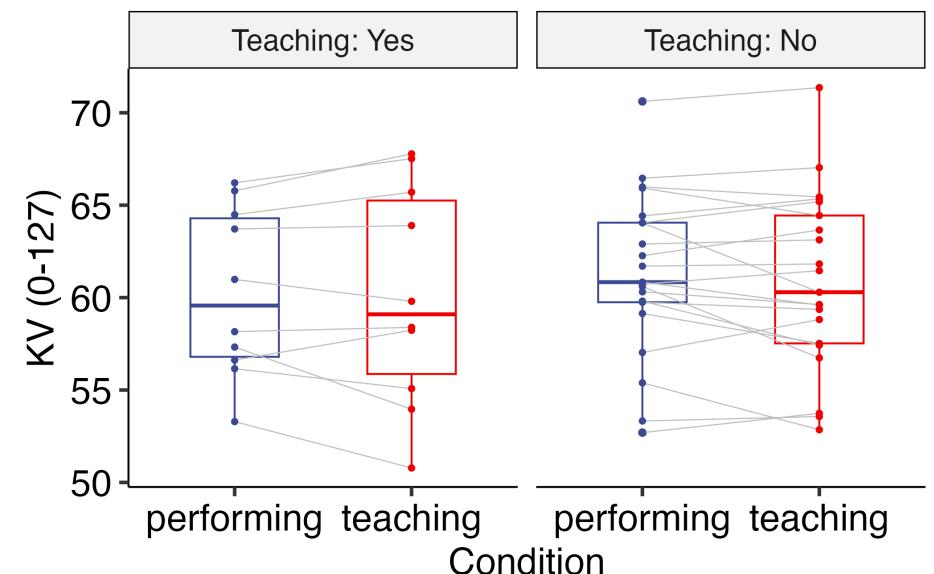
KV: Dynamics-Forte



$N = 10$

$N = 21$

KV: Dynamics-Piano



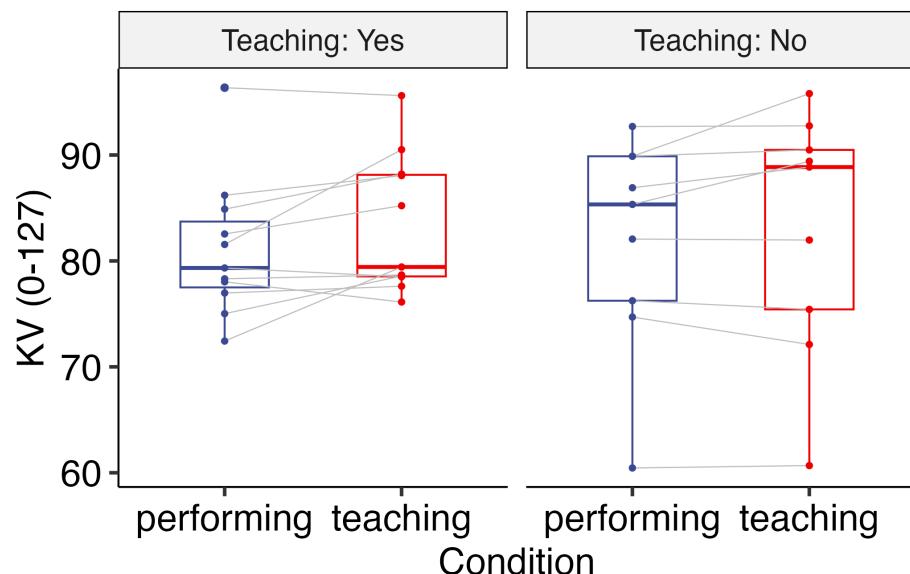
$N = 10$

$N = 21$

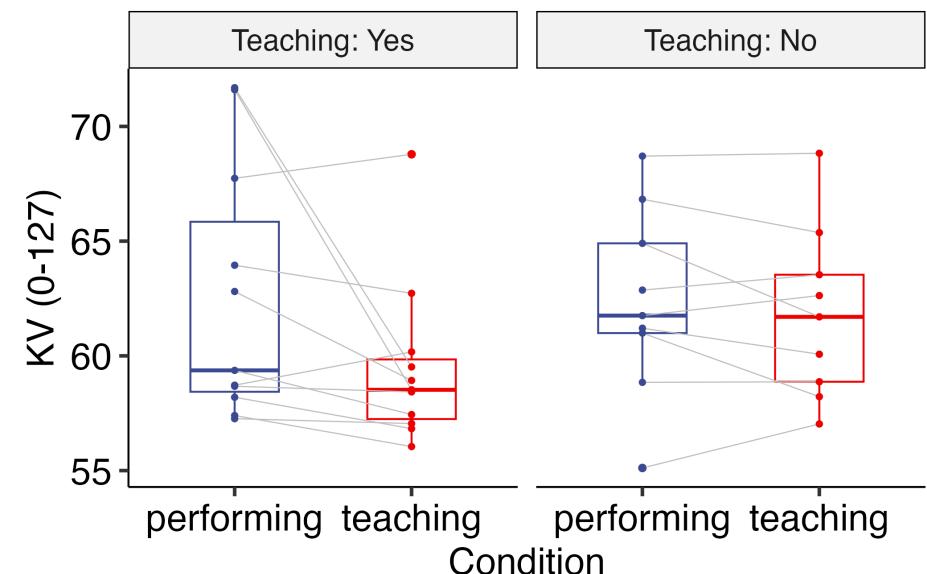
Data for teachers vs. non-teachers

Loudness (Dynamics - Experiment 2)

KV: Dynamics-Forte

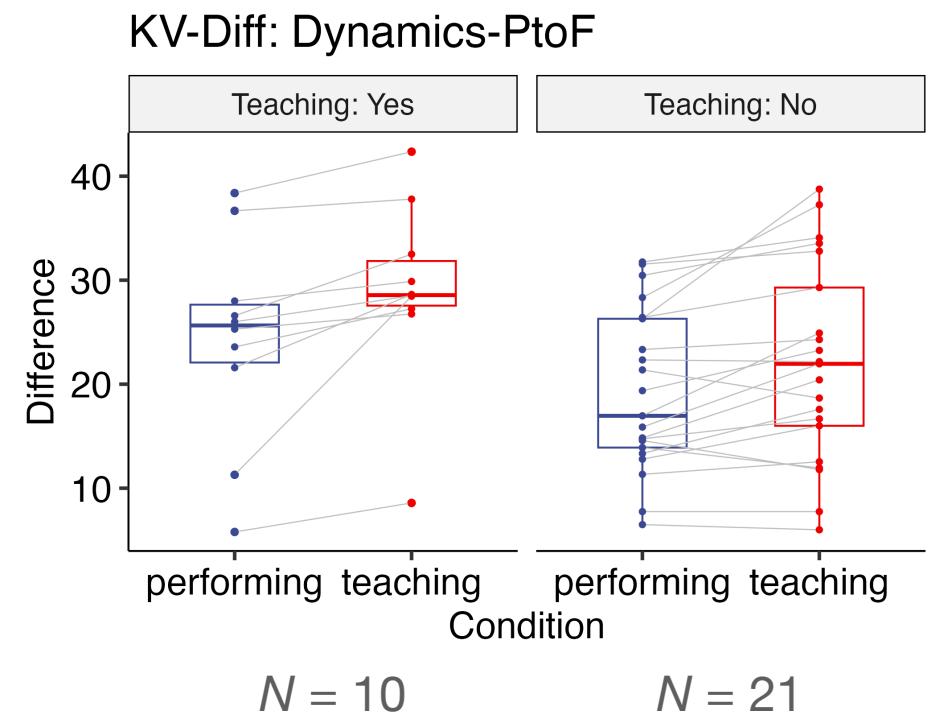
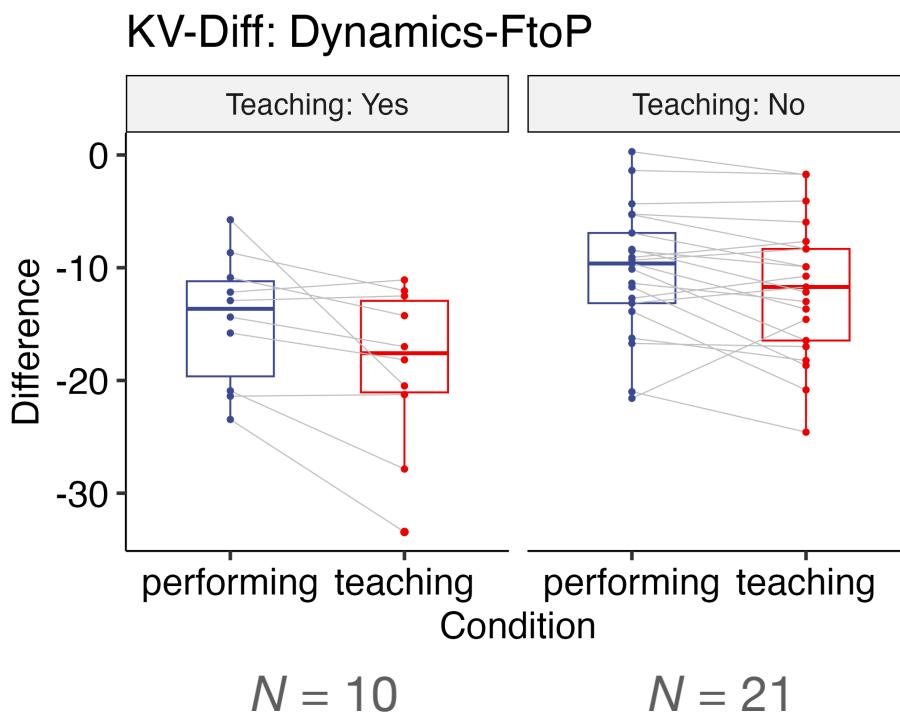


KV: Dynamics-Piano



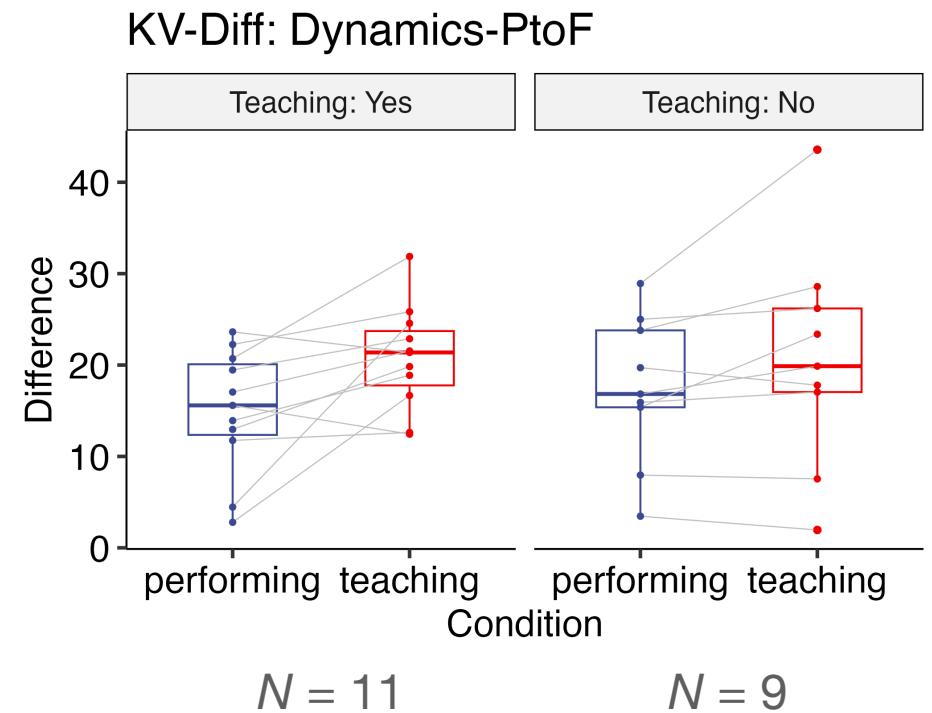
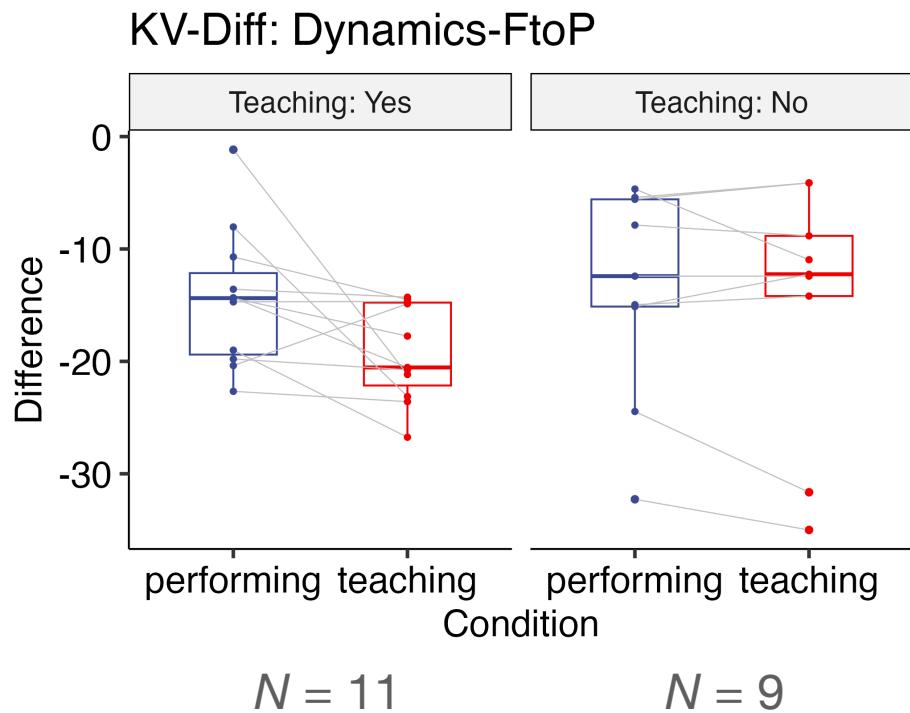
Data for teachers vs. non-teachers

Dynamics contrast (Dynamics - Experiment 1)



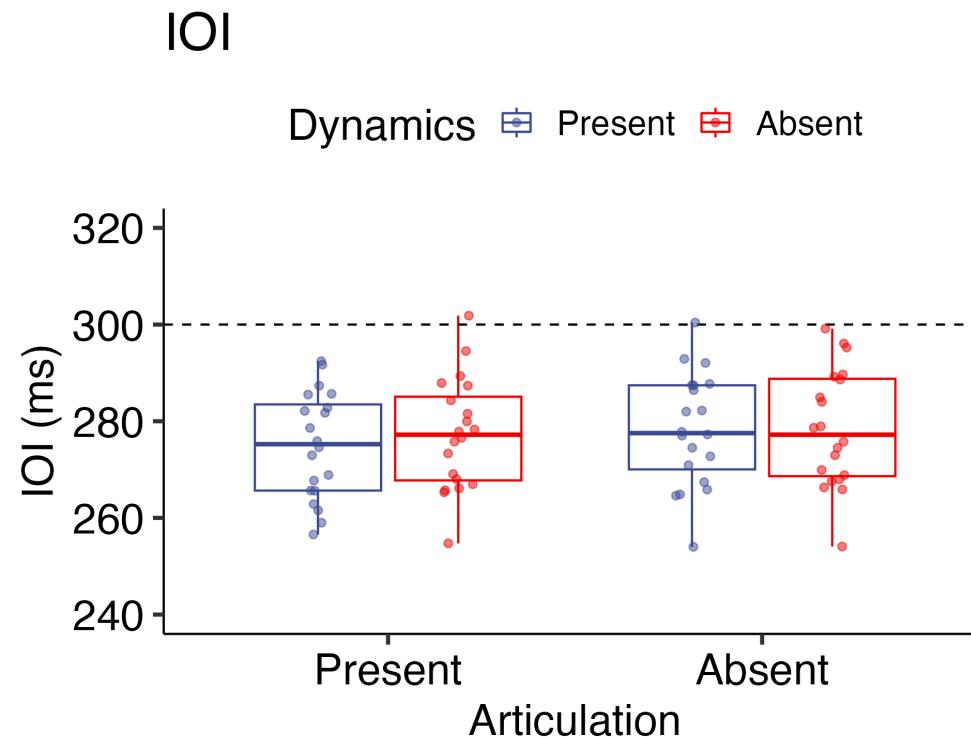
Data for teachers vs. non-teachers

Dynamics contrast (Dynamics - Experiment 2)



Study 2

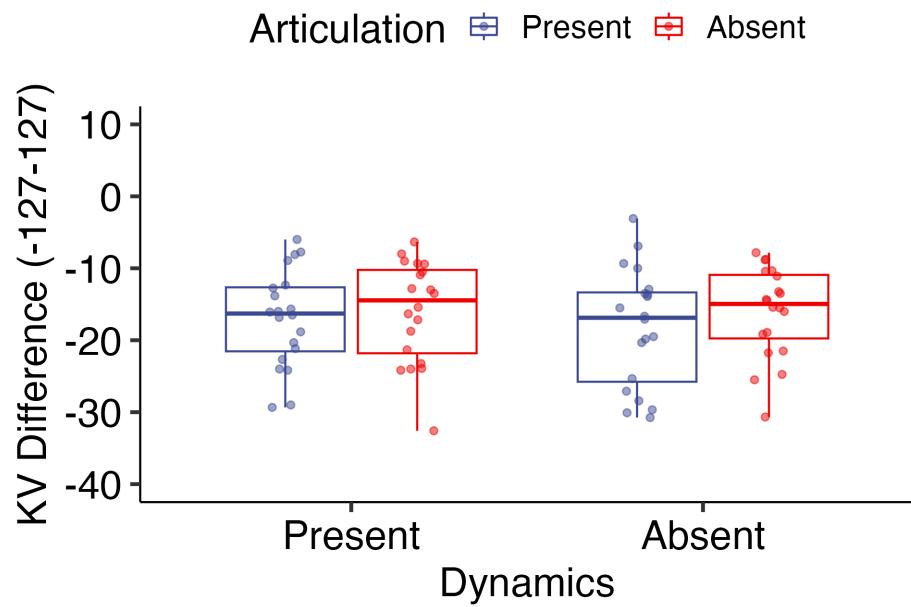
Tempo Results



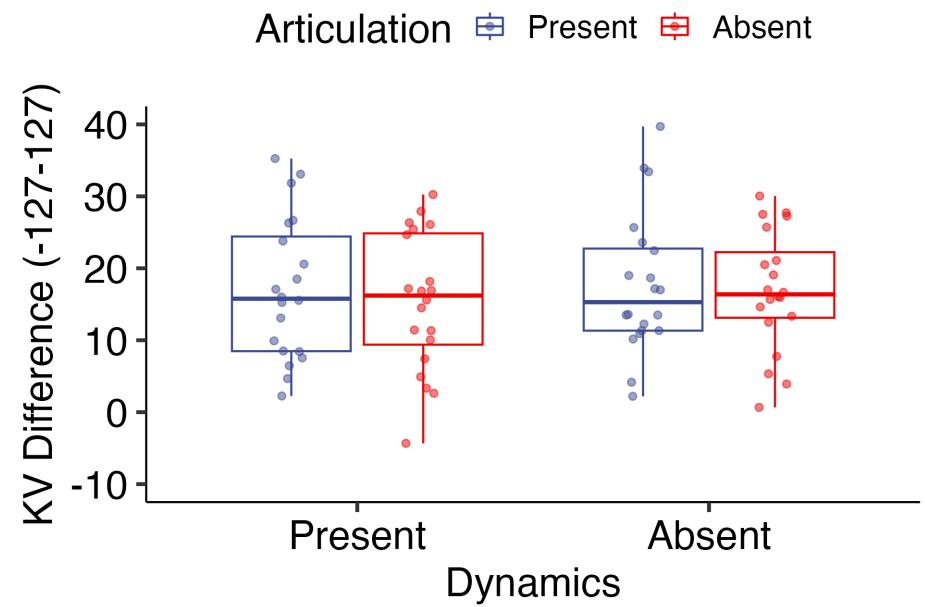
Dynamics contrast

Results

KV Difference - FtoP



KV Difference - PtoP



Study 3

Video and sound clips



Daniel Barenboim's masterclasses on Beethoven's piano sonatas at Symphony Hall, Chicago. January 2005

Sonate No. 23, “Appassionata”

3rd Movement
Opus 57

Ludwig van Beethoven
(1770 - 1827)

Piano

Allegro ma non troppo

ff p

cresc.

f

dim.

pp

sf

Kempff



Richter



Sonate No. 23, "Appassionata"

3rd Movement
Opus 57

Ludwig van Beethoven
(1770 - 1827)

Piano

Allegro ma non troppo

The musical score consists of five staves of piano music. Staff 1 shows a basso continuo line with a forte dynamic (ff) and a piano dynamic (p). Staff 2 shows a treble line with a crescendo. Staff 3 shows a treble line with a diminuendo (dim.). Staff 4 shows a basso continuo line with a piano dynamic (pp). Staff 5 shows a treble line with a sforzando dynamic (sf).