Information Processing: From Data to Solutions

Research Methods and Design

Professor Michelle Levine
Psychology Department
Barnard College

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Today's Agenda

- **Experimental Research**
  - Why do we do research?
  - How do we conduct research?
    - Scientific method
    - Potential control problems in experimental designs
    - Ethical responsibilities
  - A case example from my research

Rational Empiricism

- **Empiricism:**
  - gaining knowledge through observation
  - **Empirical questions:**
    - questions that can be answered through systematic observations and experiences
- **Scientific method:**
  - rules and techniques of observation that minimize errors allowed by simple observation

Scientific Method

- Steps to the scientific accumulation of knowledge:

1. Begin with a question (usually prompted by theory) and form a *testable hypothesis*.
2. Gather evidence.
   - Hypothesis *confirmed vs disconfirmed*
3. Make findings public & therefore open to scrutiny.

Theory → Testable Hypothesis

- **Theory:**
  - an idea or set of ideas that describe a particular event, process, or behavior

- **Testable Hypothesis:**
  - prediction that is formulated in such a way that observations are able to confirm or disconfirm

Gathering Evidence

- **Observational studies**
  - observe the world as it is
- **Case studies**
  - one person is studied in depth
- **Surveys**
  - gather self-reported attitudes, opinions or behaviors

- **Today we will focus on:**
  - **Correlational research**
  - **Experimental research**

What VS Why

- **Correlations:**
  - Do changes in a variable link to change in another variable?

  - If two variables are correlated, what does this tell us?

Correlation & Causation

- 3 possible relationships:
  - A causes B
  - B causes A
  - Some other factor causes both
- Problem of directionality
- Problem of third variable

Causation

- Cannot make causal inference, unless:
  - A and B occur together with regularity
  - A precedes B in time
  - Theoretical explanation exists
  - Other explanations can be ruled out

- Experiments clarify causes and effects by:
  - Manipulation and randomization

Manipulation

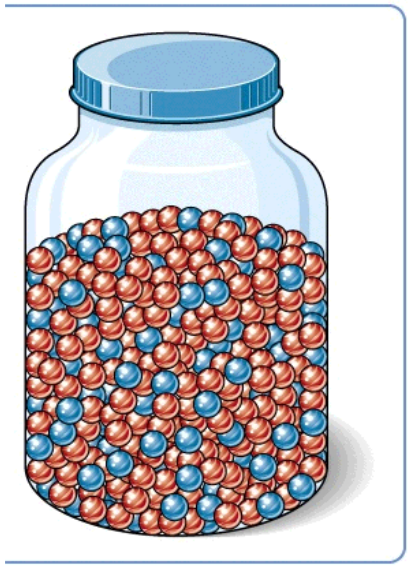
- **Manipulation:** manipulate some variables, control for others
  - **Independent variable:** variable manipulated to measure its effect on the dependent variable
  - **Dependent variable:** variable measured/ recorded

Defining Variables

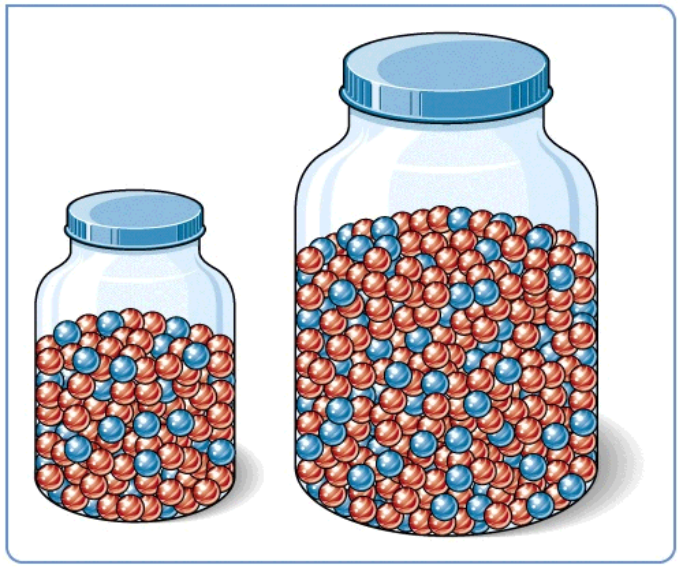
- **Operational definition:**
  - defining variable in concrete terms
    - Easy to measure physical properties
      - E.g., “distance”
    - Not so easy to measure psychological properties
      - E.g., “happiness”
- Reliability
- Validity

Randomization

- **Random sampling:**
  - each member of a population has an equal chance of inclusion into a sample (unbiased sample)



What is the fastest way to know about the marble color ratio in the jar?



Blindly transfer a few into a smaller jar and count them.

Randomization

- **Random sampling:**
  - each member of a population has an equal chance of inclusion into a sample (unbiased sample)

- **Random assignment:**
  - to experimental group vs control group
    - to different experimental groups
  - (between-subject design vs within-subject design)

Ethical Responsibility

- Institutional Review Board (IRB)
- Confidentiality
- Informed Consent
- Deception
- Debriefing

Institutional Review Board (IRB)

- Formal process for evaluating the ethics of a proposed research study
- Protects research participants (and researcher)
- Required whether research funded or not
  - Sometimes eligible for *expedited review* or *exemption*

- http://www.columbia.edu/cu/irb/

Confidentiality

- Participants must consent to have any information disclosed to a third party
  - This includes for data analysis purposes, presentations, every*thing*
- Any exceptions must be explicitly stated to participants
- Participants' names and any other identifying information remain anonymous
  - an ID number is assigned to each participant
  - then only the ID numbers are used throughout experiment and data analysis

Informed Consent

- Every participant must sign an agreement to take part in the study
- For most cases, informed consent is obtained before the participant begins the experiment
- Key components:
  - Must provide as much information as possible about what is involved and any potential risks
  - Assure participant that they may revoke consent at any time

Debriefing

- At the end of the experiment, the researcher
  - Explains the experiment's purpose, design and educational objectives
  - Describe manipulations not discussed in consent form
  - Answer any questions

My Research

- Methodologies from cognitive psychology, linguistics and computer science
- One area:
  - What communication cues are necessary for different types of coordinated action?
    - Face-to-face versus computer-mediated settings
  - The following line of my research looks at *music*
    - Often (metaphorically) compared to language:
      - Scripted language = notated sections
      - Conversational interaction = jazz improvisation

Musical Coordination

- Musicians playing together mutually influence each other (two-way coordination)
- Unlike playing along with a recording (one-way coordination)
- How do they do this?

Two-way Coordination

- Musicians coordinate on (at least)
  - Timing
    - Attacks (entrances) and cut-offs
    - Tempo (speed) and tempo changes
    - Rhythm and meter
  - Dynamics (volume) and dynamic change
  - Expressive features
  - Conceptualization of piece

Competing Lore on What it Takes to "Be Together" Musically

- Being in the same PHYSICAL space is essential
  - E.g., recording studio booths and headphones spoil *real* togetherness
- Being able to SEE each other is essential
  - E.g., blocked sightlines spoil coordination
- Close LISTENING to partner is what is most essential
  - Doesn't matter whether you can see your partner or not

Research Questions

- What are the types of information (auditory, visual, physical) needed for particular musical moments?
- Hypothesis:
  - Different coordinated musical moments have a different set of demands and affordances.

Method

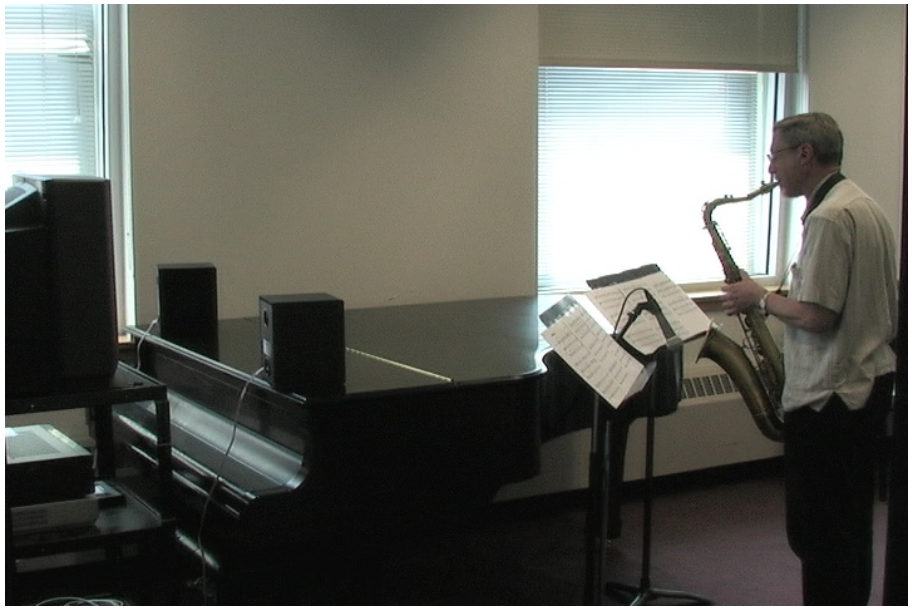
- 30 pairs of NYC jazz pianists and saxophonists rehearse and perform the same piece
  - In the same physical space **(FTF)**
  - In separate spaces but with real-time video and audio connection **(video-mediated)**
  - In separate spaces with only audio connection **(audio-mediated)**

Musical Piece

- Jazz bebop style
- Specially commissioned for experiment composer Mark Limacher
- Notated and improvised sections
- Sections with piano as lead and sections with saxophone as lead
- Metrical and tempo shifts
- Measurable entrances within an ongoing rhythm and after pause that disrupts rhythm (fermata)

Setup: FTF

Setup: Video- and –Audio-mediated



- Two soundproof rooms connected by cable
- Monitors and speakers where partner would be
- Cameras and mics project video and audio to partner in other room

What Video-mediated Partners Saw on Monitor

Design

- 2 Rehearsals
  - 10 minute solo rehearsal
    - Each partner in own room
  - 10 minute joint rehearsal, either
    - FTF
    - Video-mediated
    - Audio-mediated
- 3 Performances (full run-throughs)
  - Performance 1: always same mode as joint rehearsal
  - Performances 2 and 3: counterbalanced across remaining 2 modes

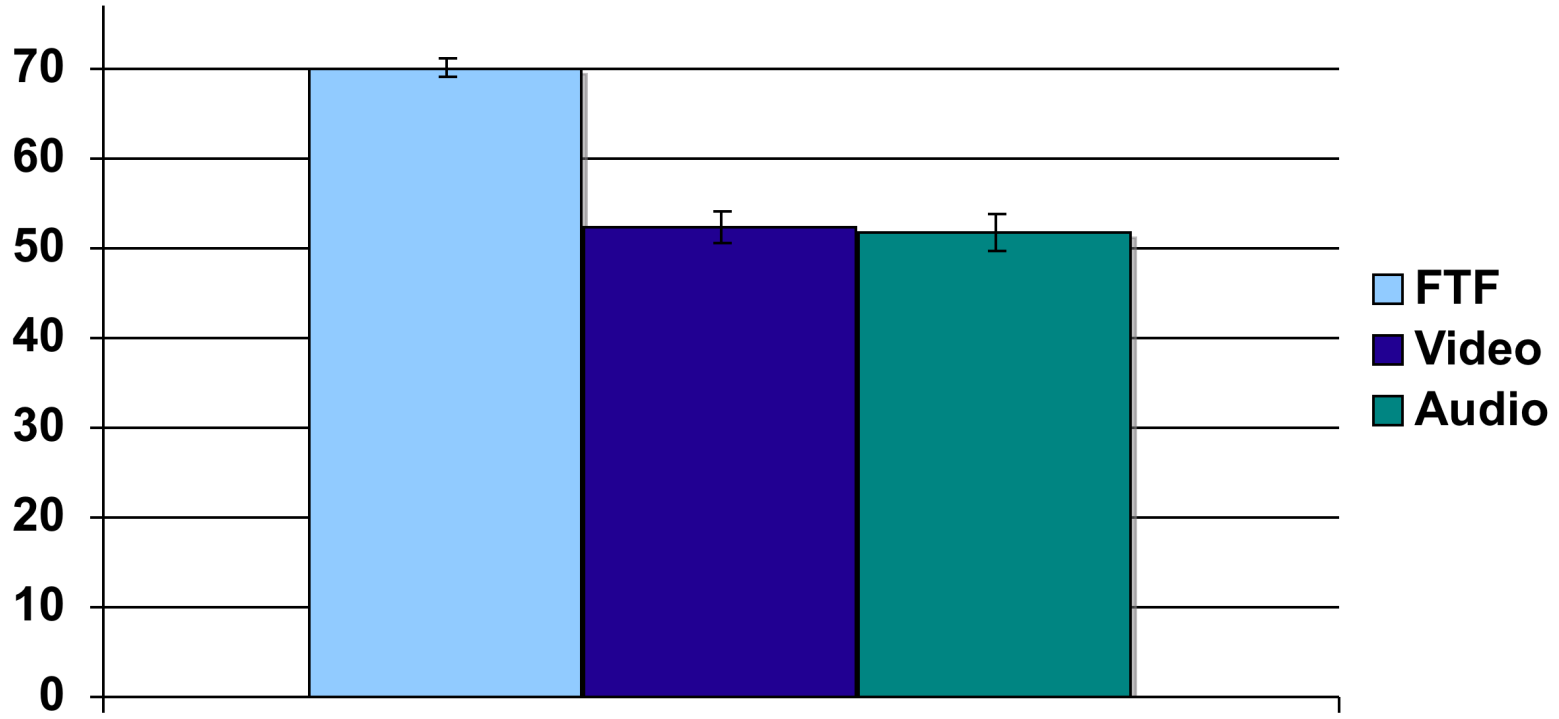
Post-Experiment Questionnaire

- 11 questions (7-point scale)
  - Performers rated *same room*, *2 rooms video*, and *2 rooms audio* on, e.g.:
    - "How quickly did you adjust to the experience?"
    - "How well could you concentrate on performing?"
    - "What was your overall comfort level?"
    - "How strong was your sense that you were in the same place as your partner?
- Questions taken from Presence questionnaire (Witmer & Singer, 1998) and previous studies measuring presence (Barfield & Weghorst, 1993; Dinh et al., 1999; Slater et al., 1996)

Questions for Analysis

- How do visual and audio affordances affect:
  - **feelings of copresence?**
  - quality of coordinated performance?
  - quality of improvised solos?
- Which moments of notated musical coordination are particularly affected by mode?

Reported Feelings of Copresence
(questionnaire composite score)



Notable Individual Variability

- 6 (of 60) players did not rate FTF as feeling more copresent
  - (4 ranked audio as more copresent, 2 video)
- 21 players ranked audio as more copresent than video
- 27 players ranked video as more copresent than audio

Notable Variability Within Pairs

- Partners didn't necessarily agree in their ratings of copresence
  - 20 pairs produced different rankings (10 the same)
  - 11 pairs who agreed that FTF ranked first differed in their ranking of audio and video

What Explains Rankings?

- Some reported preferring audio because
  - video distracting
  - audio forces you to focus more
- Some reported preferring video because
  - more natural
  - easier to cue the last note
- Some reported that it didn't matter because
  - they didn't know the piece well enough to be able to use visual partner cues

Questions for Analysis

- How do visual and audio affordances affect:
  - feelings of copresence?
  - **quality of coordinated performance?**
  - **quality of improvised solos?**
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Method of Analysis: Expert Ratings

- Subjective measures on the sound files collected
- 3 jurors
  - Faculty members at The New School for Jazz and Contemporary Music
  - Performing musicians
  - Have been on hundreds of juries (evaluation committees)
- Blindly evaluated audio (in random order) of each performance
  - Uninformed of experimental setup

JURY FORM

Disc: _____

Track #: _____

ENSEMBLE	EXCELLENT		ABOVE AVERAGE		AVERAGE		BELOW AVERAGE		POOR	
Unity of ensemble sound	10	9	8	7	6	5	4	3	2	1
Interplay between piano and sax	10	9	8	7	6	5	4	3	2	1
Dynamics	10	9	8	7	6	5	4	3	2	1
Rhythmic vitality	10	9	8	7	6	5	4	3	2	1
Artistic Success	10	9	8	7	6	5	4	3	2	1

IMPROVISED SOLOS	EXCELLENT		ABOVE AVERAGE		AVERAGE		BELOW AVERAGE		POOR	
SAX										
Appropriate to composition	10	9	8	7	6	5	4	3	2	1
Coherence	10	9	8	7	6	5	4	3	2	1
Creativity/originality	10	9	8	7	6	5	4	3	2	1
PIANO										
Appropriate to composition	10	9	8	7	6	5	4	3	2	1
Coherence	10	9	8	7	6	5	4	3	2	1
Creativity/originality	10	9	8	7	6	5	4	3	2	1

OVERALL ASSESSMENT	EXCELLENT		ABOVE AVERAGE		AVERAGE		BELOW AVERAGE		POOR	
SAX	10	9	8	7	6	5	4	3	2	1
PIANO	10	9	8	7	6	5	4	3	2	1
Ensemble	10	9	8	7	6	5	4	3	2	1

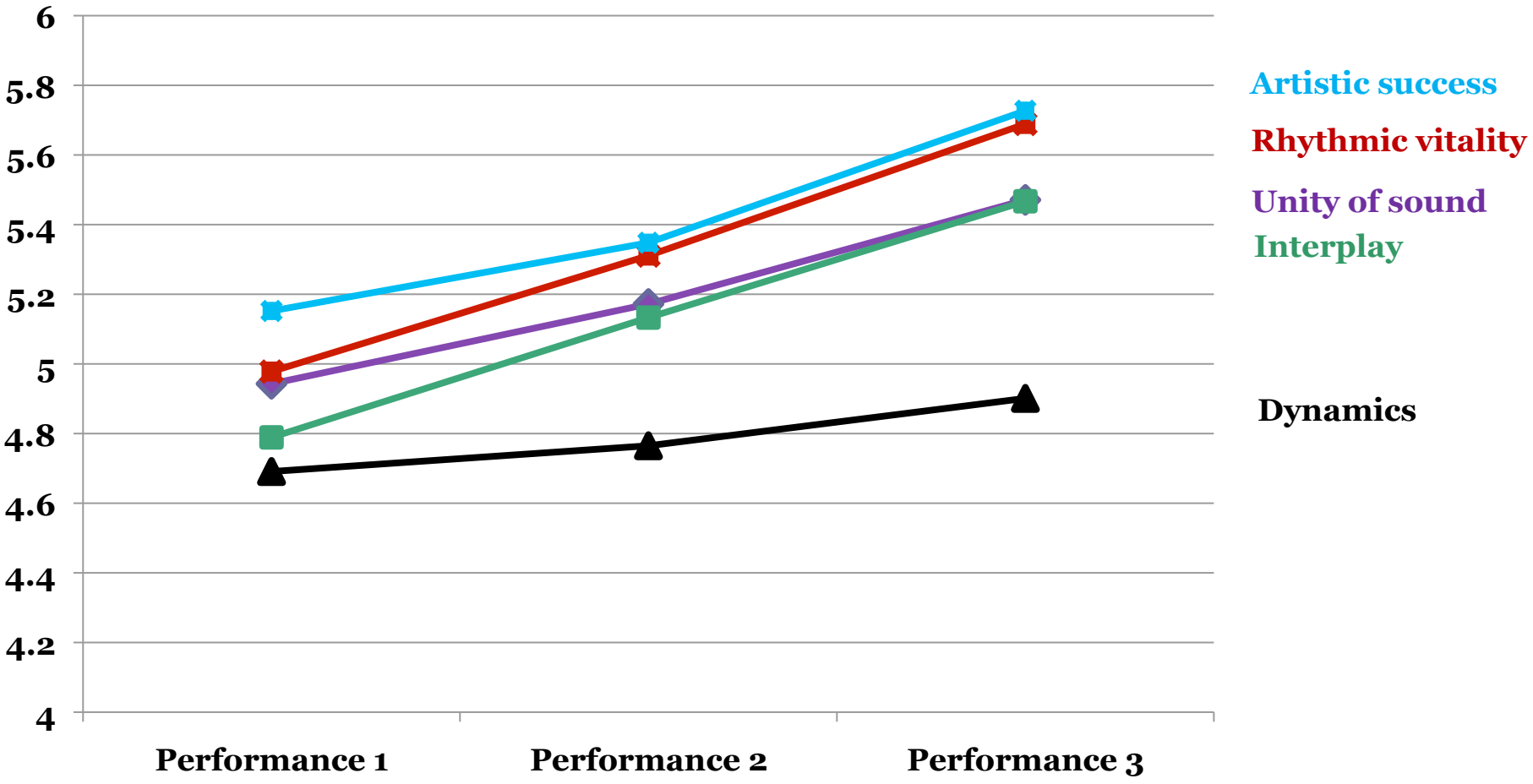
ADDITIONAL COMMENTS: *(please use the back of the sheet if you need more room)*

Jury Member Signature:_____

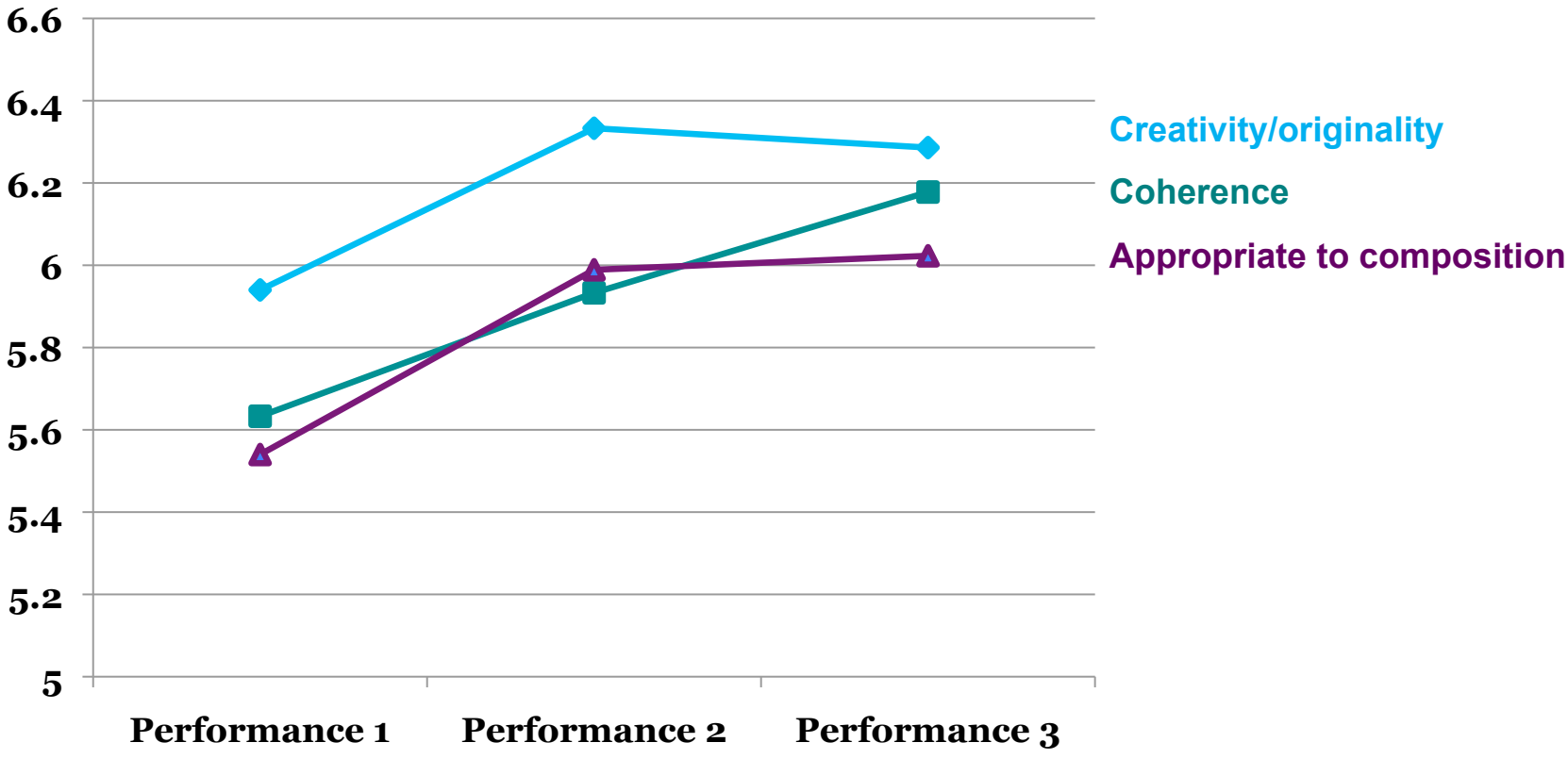
Predictions: Practice Effect

- Quality of ensemble and improvised solos should improve over performances (regardless of mode), if experience with the piece allows for
  - More coherent, appropriate, and creative "composition"
  - Better support FROM partner
  - Better support FOR partner

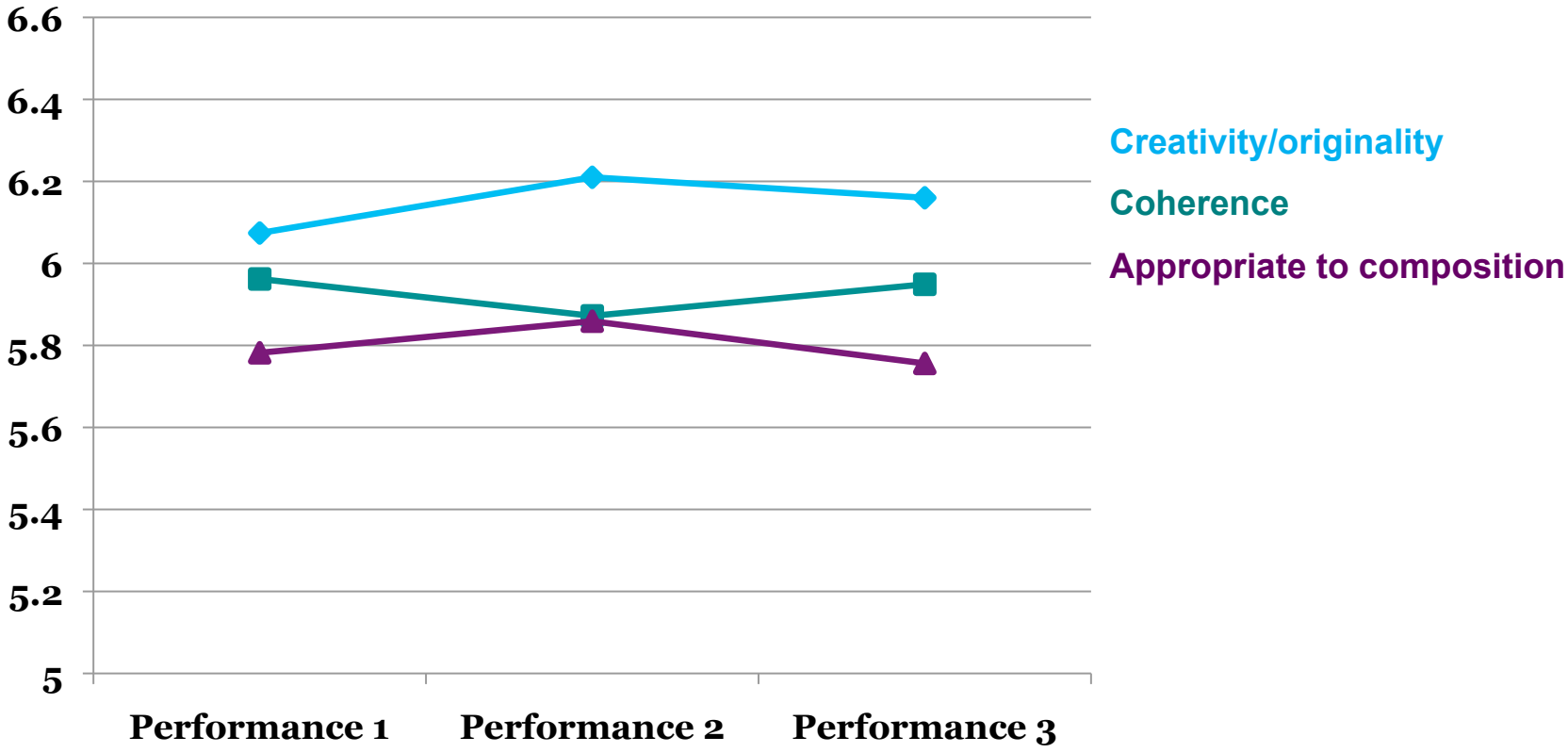
Practice Effects
(ensemble ratings)



Practice Effects
(saxophone solo)



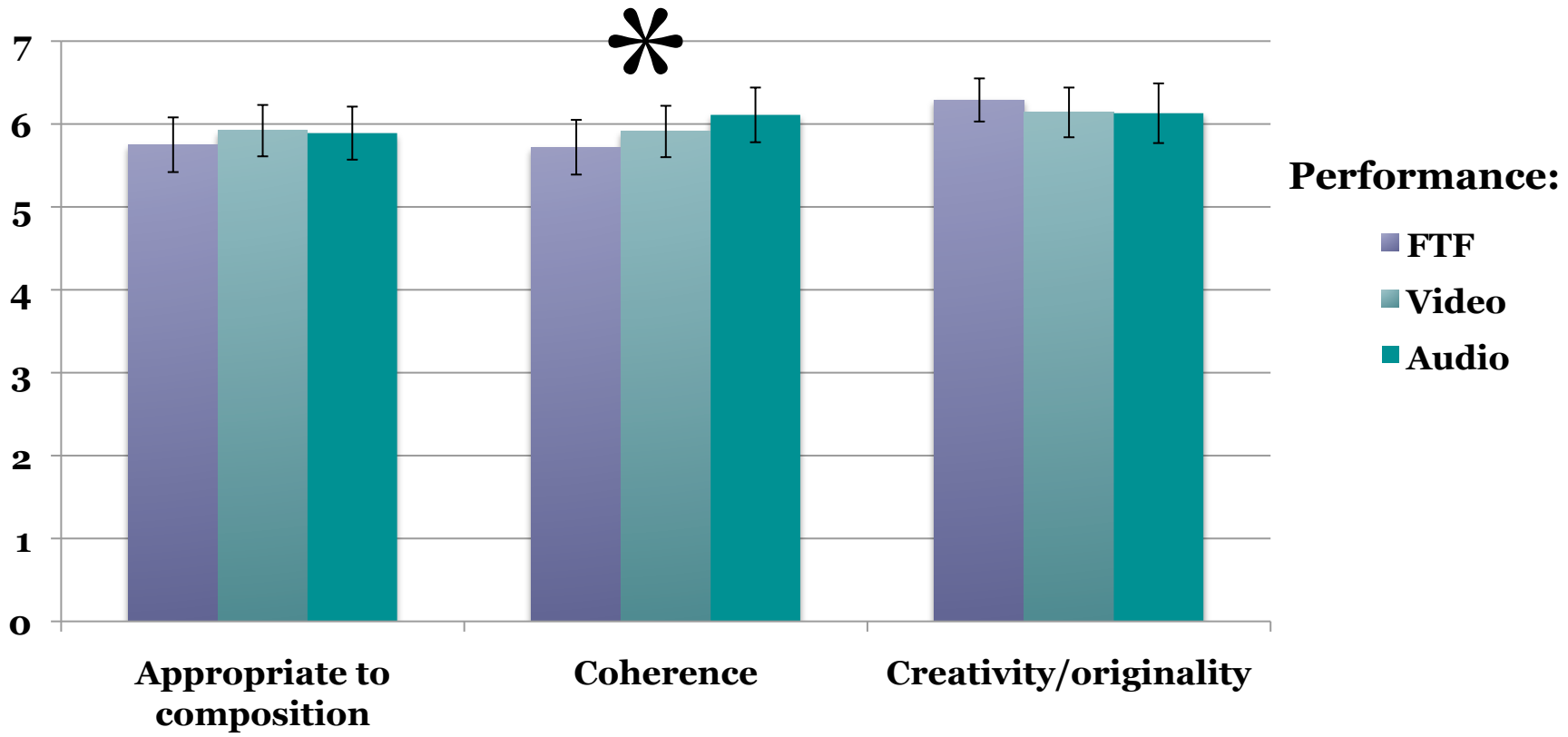
Practice Effects
(piano solo)



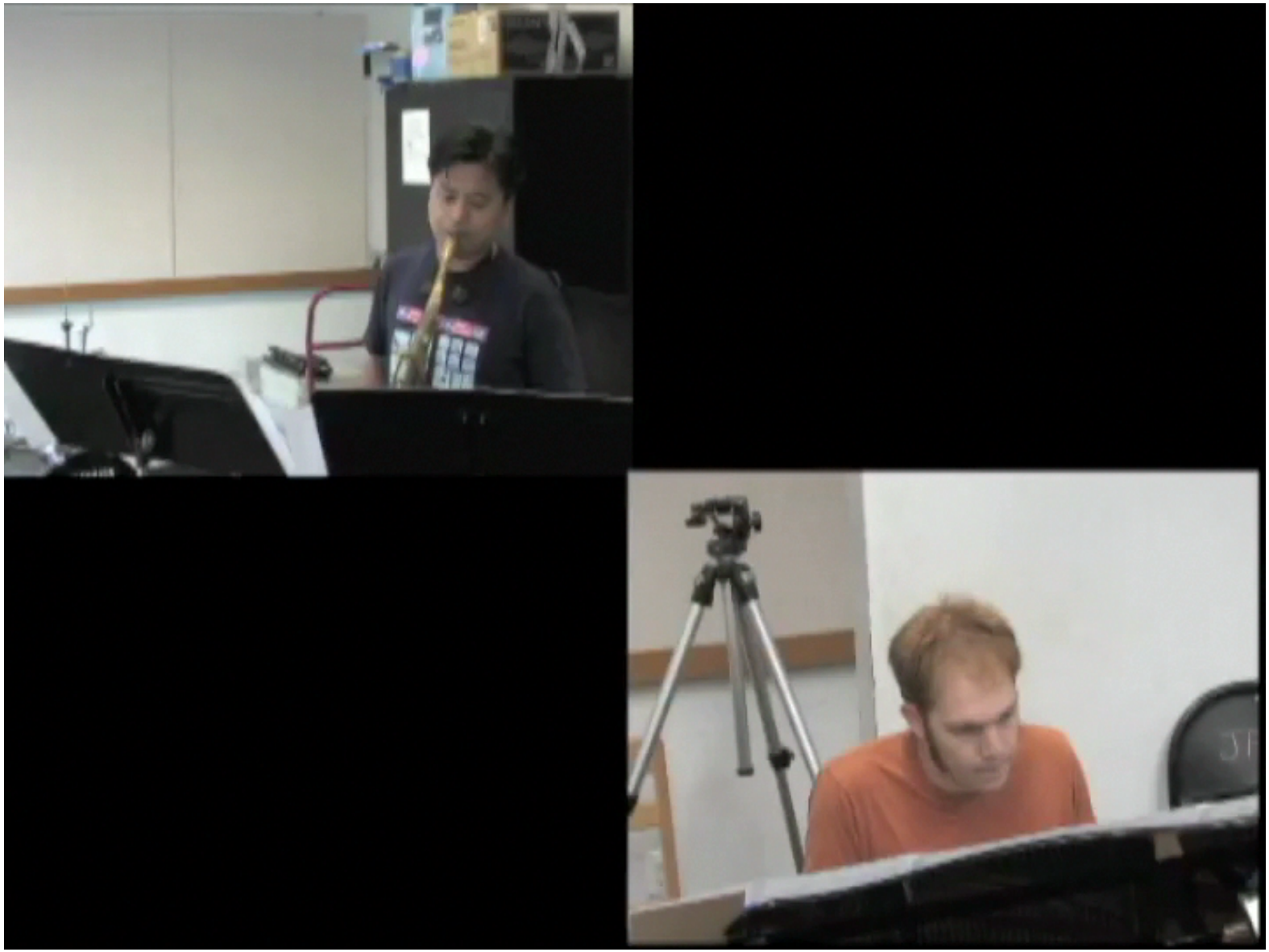
Expert Ratings (Cont'd)

- Juror ratings on the *whole piece* indicate
  - **NO GLOBAL MODE EFFECTS**
- Juror ratings on the *piano solo* indicate
  - **NO MODE EFFECTS**
- Juror ratings on the sax solo indicate…

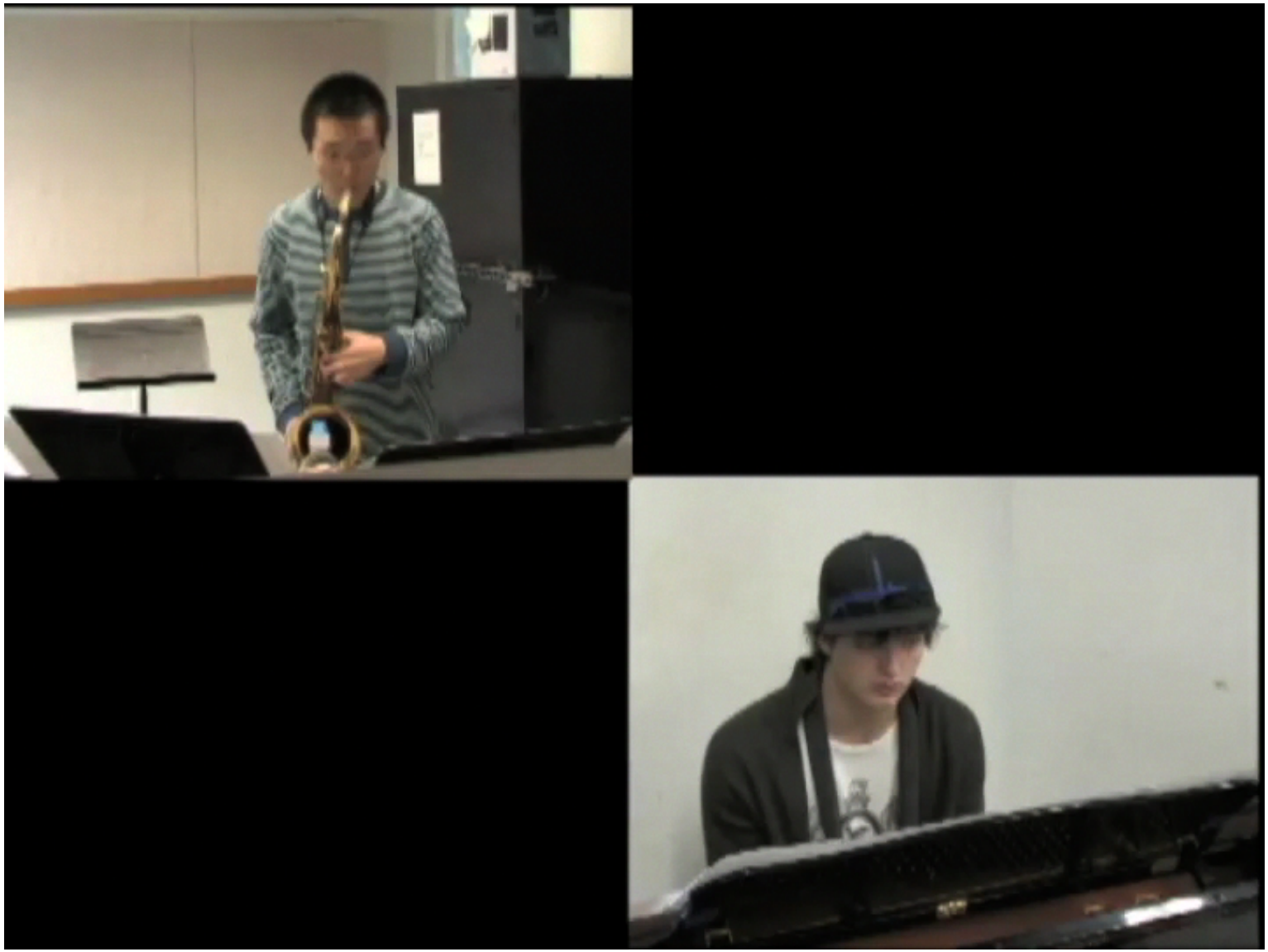
Performance Mode and Quality of Sax Solos



Highly Rated Improvisation



Poorly Rated Improvisation



Improvised Sax Solo is Interdependent

- Examples highlight the extent to which rhythm (piano) provides the foundation for what front line (sax) does
- Although in common parlance the sax improvisation is a “solo,” the soloist needs the right partner(s) in order to shine

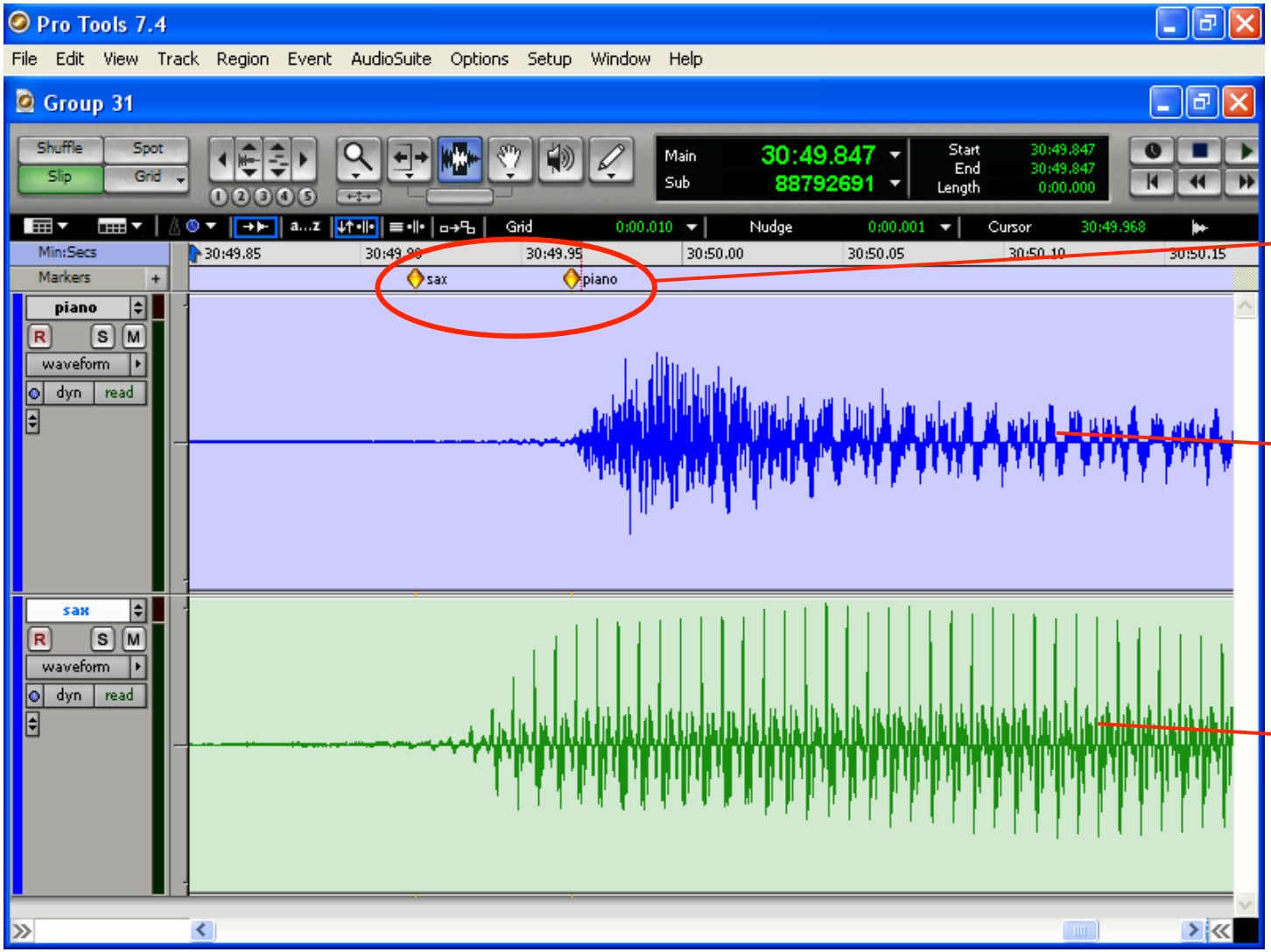
Partner as Distracting in Two-Party Improvisation

- Consistent with view that audio mode reduces distraction and thus facilitates better improvisation in two-party improvisation
- Consistent with evidence from other domains that people look away more from partner while answering more difficult questions (e.g., Doherty-Sneddon, et al., 2002; Glenberg, Schroeder, & Robertson, 1998)
- And, not surprisingly, no effect of partner view in one-party improvisation

Questions for Analysis

- How do visual and audio affordances affect:
  - feelings of copresence?
  - quality of coordinated performance?
  - quality of improvised solos?
- **Which moments of notated musical coordination are particularly affected by mode?**

Measuring Coordinated Attacks



MARKERS

(label points of attack)

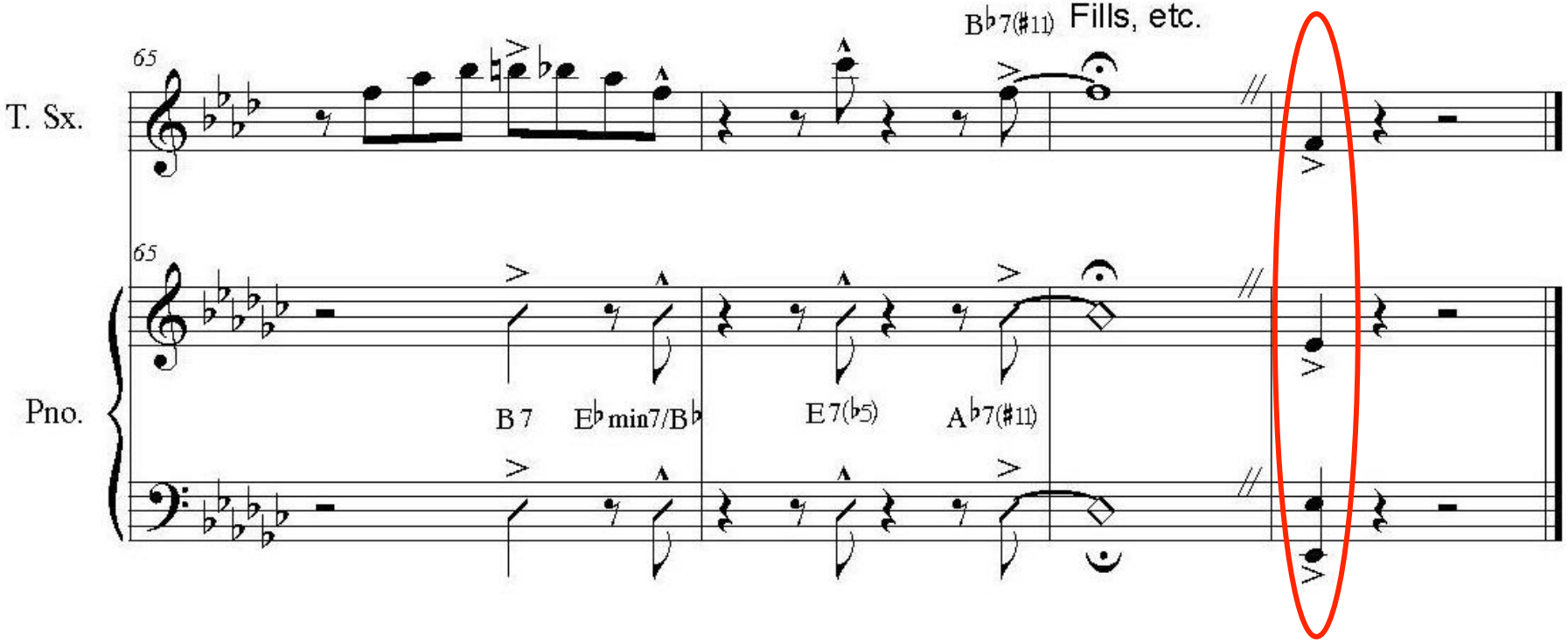
piano

sax

Sampled Attacks

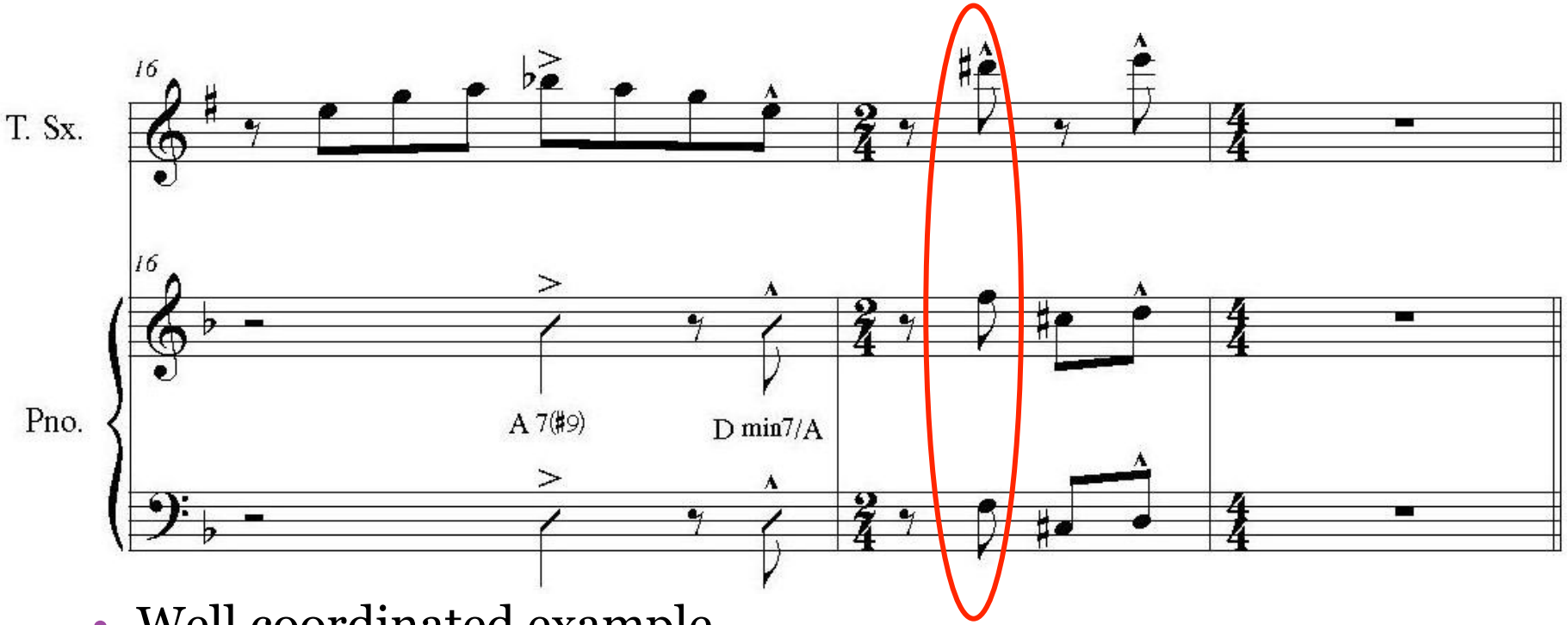
Within ongoing rhythm		
	Both continuing	6 (of 30)
	Sax rejoins piano	6 (of 7)
	Piano rejoins sax	6 (of 20)
	After rest for both	6 (of 6)
After fermata		
	(Final chord)	1 (of 1)

Example of a Point of Measurement
(final note of piece)



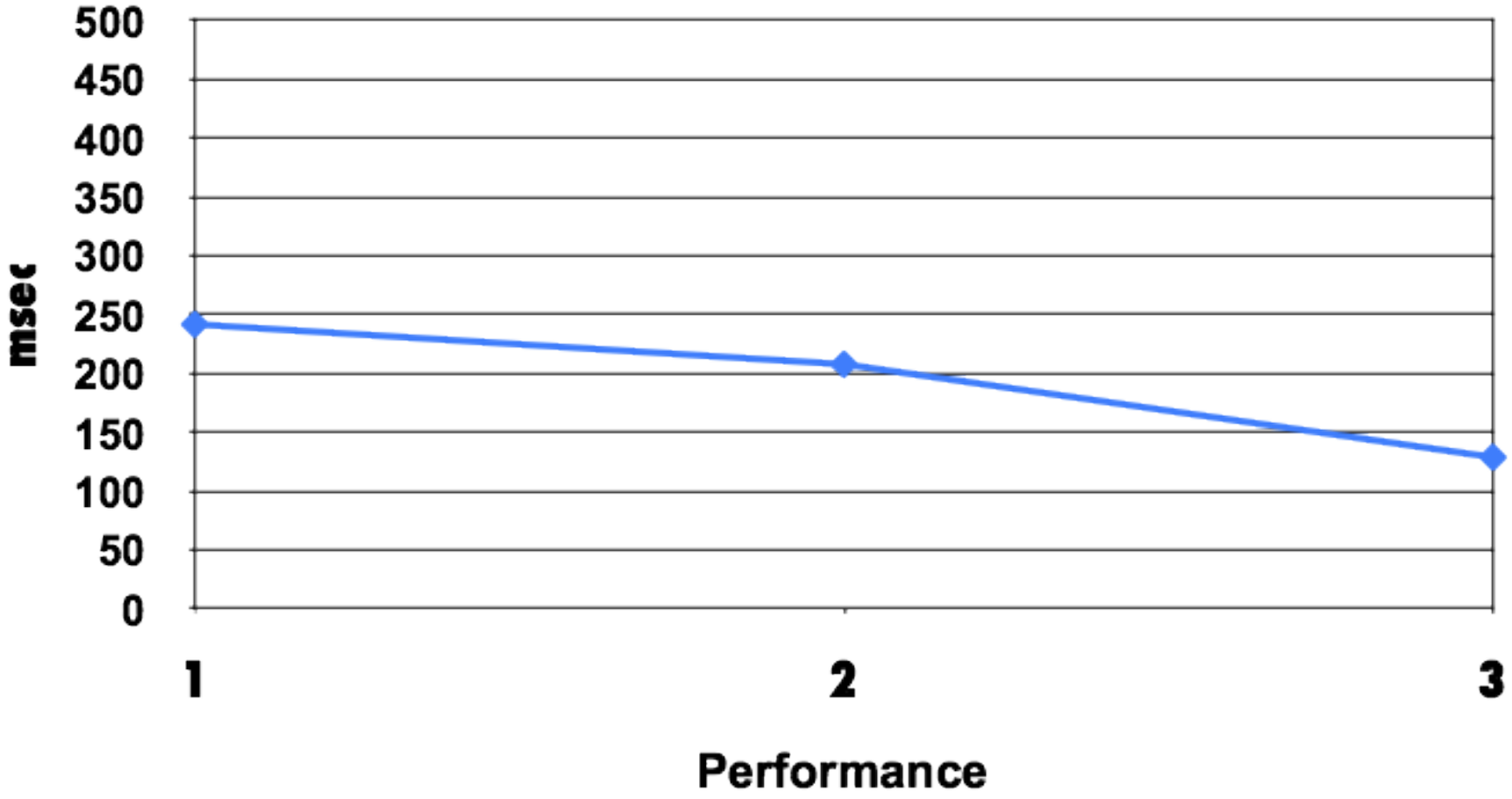
- Well coordinated example
- Poorly coordinated examples

Another Example
(note in ongoing rhythm)

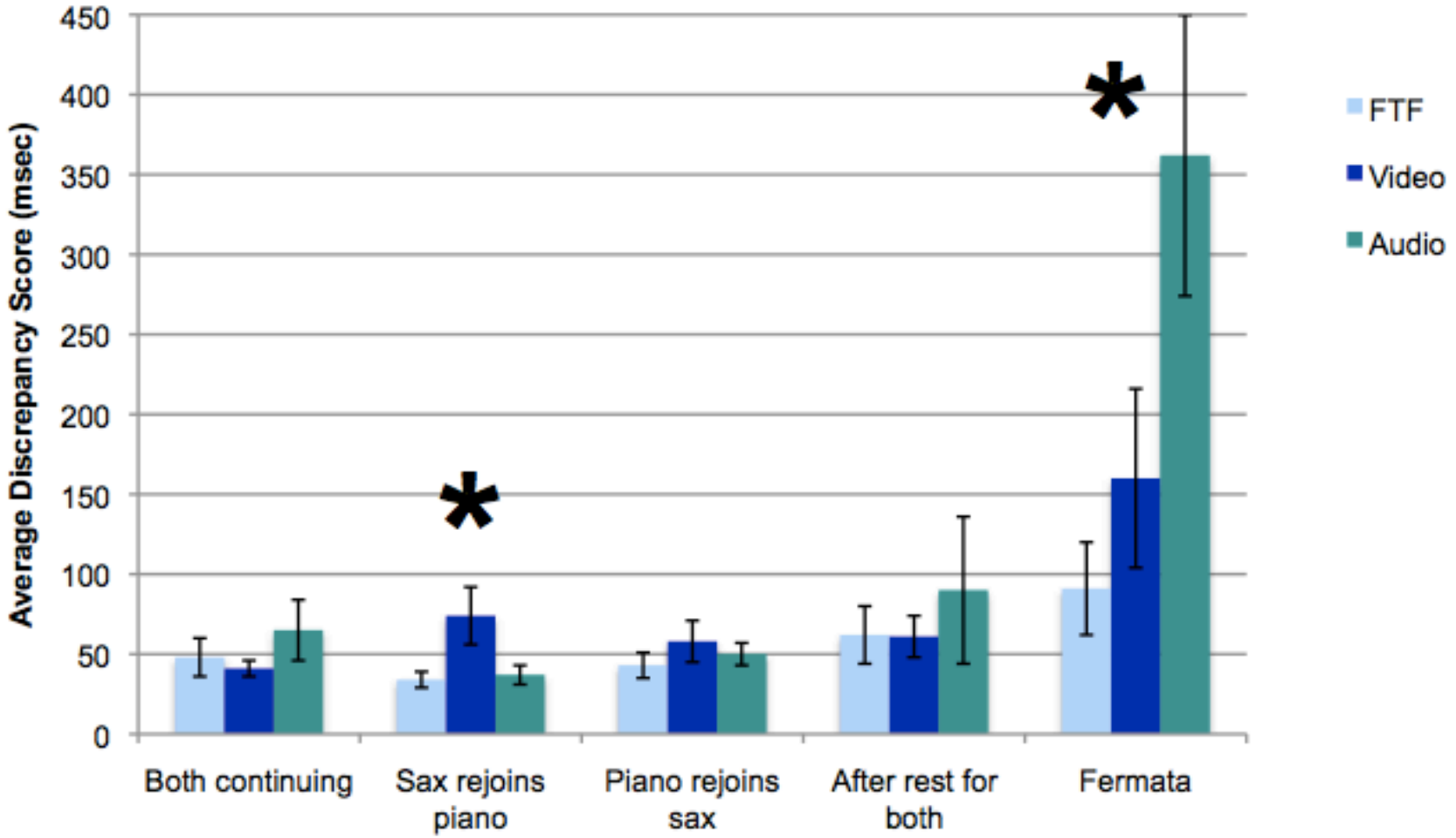


- Well coordinated example
  - In context
  - Isolated
- Poorly coordinated example

Practice Effect
(overall discrepancy)



Mode & Musical Moments

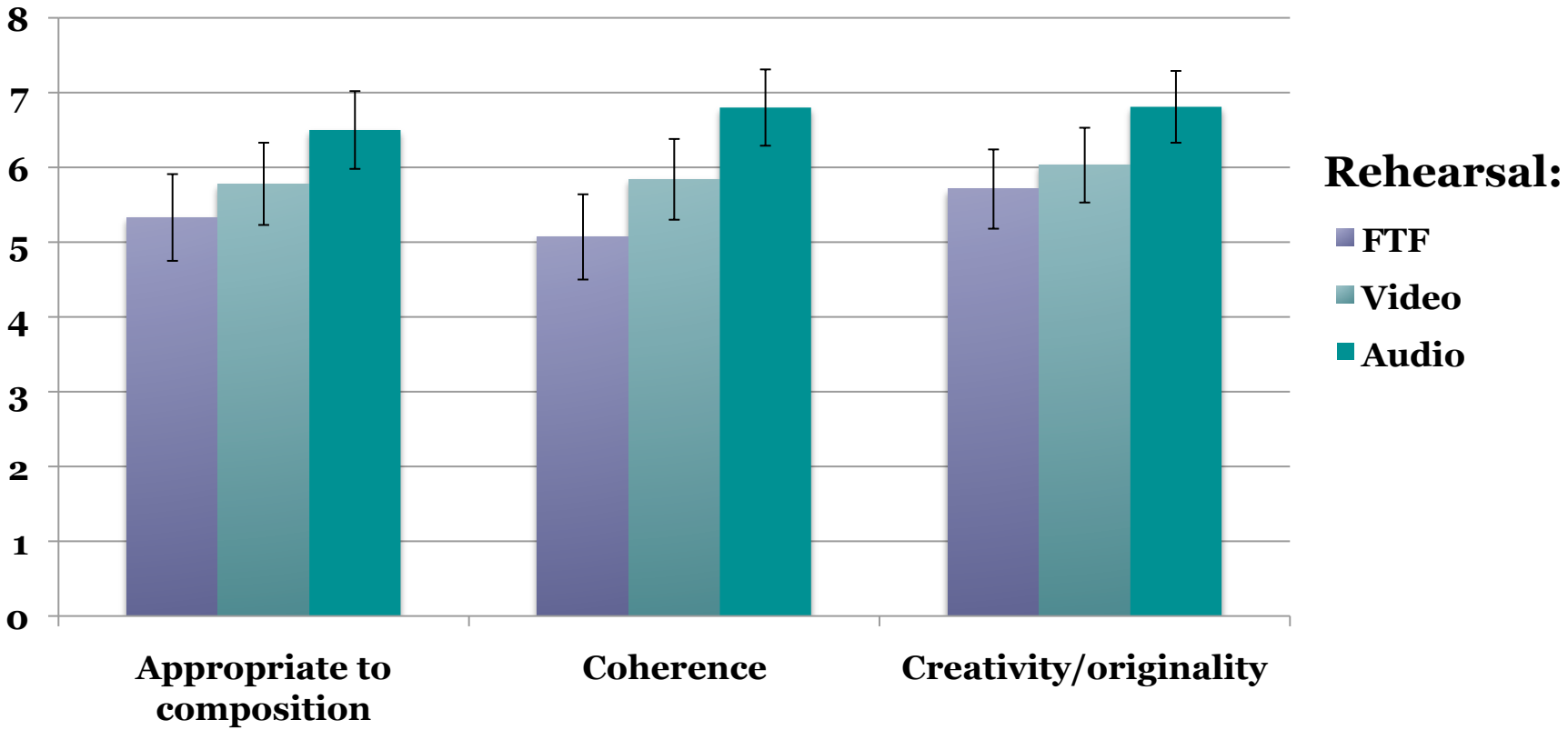


Benefit of Audio-Only?

- Very different story for two-party solo *and* notated parts of piece than for one-party solo
  - At certain moments, seeing partner improves coordinated accuracy

- This lead us to ask:
  - Do we see a benefit of audio-only that carries over into subsequent performances?
    - That is, does *rehearsing* in audio-only mode lead to better performance across all modes?

Rehearsal Mode & Quality of Sax Solos



Desirability of Audio-Only?

- For several decades younger jazz performers have rehearsed with recordings
  - Jazz teachers note, anecdotally, that this can make them ill-prepared for fully responsive two-way coordination
- Do performers *prefer* not to see their partner?
- Do they report being less distracted by their partner in audio-only?

Anecdotal Evidence

- From post-experiment debriefing:
  - “Looking at people doesn’t matter because jazz in time…so with jazz in time you need to just listen.”
  - “Audio is the most important thing. Video helps more because you can see the hands moving etc. but when it’s just audio you listen harder because it’s crucial…”

Emerging Picture

- Impact of being able to see partner is different at different musical moments
  - Not particularly helpful or necessary
    - within an ongoing rhythm
    - during a piano solo (one-party improvisation)
  - Very useful
    - at section changes
    - for coordinating coming in at the same time without established rhythm
  - Possibly distracting
    - during high-complexity task like sax solo

Ongoing Investigations

- Eye gaze
  - To what extent do partners look at each other during notated parts versus improvisations?
  - Does improvisation by musicians who close their eyes differ?
- More generally:
  - How exactly does rhythm partner (in this case, pianist) set the stage for what the other person (in this case, saxophonist) does?
  - To what extent is influence one-way?

- Even more generally:
  - Can the cues be incorporated, or possibly enhanced, in virtual environments for music-making?

Questions? Critiques? Confounds?