Information Processing: From Data to Solutions

Research Methods and Design

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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 $\rightarrow$ 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*

Confidentiality

• Participants must consent to have any information disclosed to a third party
  ▫ This includes for data analysis purposes, presentations, everything

• 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?

• Which moments of notated musical coordination are particularly affected by mode?
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

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<tr>
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<td>Interplay between piano and sax</td>
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## IMPROVISED SOLOS

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<td>PIANO</td>
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## OVERALL ASSESSMENT

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**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

![Bar chart showing performance ratings for sax solos in different modes: FTF, Video, and Audio. The chart includes metrics for appropriateness, coherence, and creativity/originality.]
Highly Rated Improvisation
Poorly Rated Improvisation
Improvised Sax Solo is Interdependent

- Examples highlight the extent to which rhythm (piano) provides the foundation for what frontline (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

<table>
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<th>Within ongoing rhythm</th>
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<tbody>
<tr>
<td>Both continuing</td>
<td>6 (of 30)</td>
</tr>
<tr>
<td>Sax rejoins piano</td>
<td>6 (of 7)</td>
</tr>
<tr>
<td>Piano rejoins sax</td>
<td>6 (of 20)</td>
</tr>
<tr>
<td>After rest for both</td>
<td>6 (of 6)</td>
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<table>
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<tr>
<th>After fermata</th>
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<tr>
<td>(Final chord)</td>
<td>1 (of 1)</td>
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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

![Bar chart showing average discrepancy scores for different musical moments.](chart.png)
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

![Bar chart showing the comparison of different rehearsal modes (FTF, Video, Audio) for different aspects of sax solos: Appropriate to composition, Coherence, Creativity/originality.](image-url)
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?