Emergence of metrically structured rhythms and inter-partner coordination in joint drum improvisation

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Background

- Musical activities involve socially coordinated behavior
- Improvisation is a common form of musical behavior
- Rhythm provides temporal cues for group coordination
- Joint improvisation is spontaneous yet still exhibits highly coordinated action

Call-and-Response

Tandem
Background

● Rhythm in joint improvisation
  ○ Mutually adapting dyads of jazz pianists achieve greater temporal alignment (Setzler & Goldstone 2020)
  ○ Preschool children produce metrically organized rhythmic improvisations in call-and-response scenario (Whitcomb 2010)

● Many studies focused on experts or children

● What about musicians without improvisation experience?
  ○ What rhythmic content do they produce?
  ○ How do they interact and coordinate with a partner?
Hypotheses

Musicians without improvisational expertise can:

- **Interact** with and **adapt** during joint improvisation with an experienced partner
  - exhibit coordinated, highly synchronous action
  - implicitly adopt metrically organized rhythmic patterns
  - use different strategies between call-and-response and tandem playing

- Enjoy the joint improvisation task

- Feel more competent in improvisation over the course of a session
Methods - Apparatus

- Each participant sits across from the experimenter
- Participant and experimenter each have a MIDI device that triggers drum samples
- Each drum timbre assigned to a quadrant of the MIDI device
- The two devices used the same four drum samples, with one containing slightly detuned versions
In this task, you will be asked to improvise freely on the drum pad. There are no right or wrong answers. Think of this as a musical conversation.

Practice trading/tandem with metronome (bpm = 100)

### Trading section

**Turn 1**
- Experimenter
  - Roughly consistent tempo
  - Common rhythmic subdivisions
  - Variation in drum choice
  - Dynamics

**Participant**
- ~6-7s

**Turn 4**
- Experimenter
  - ~90s

**Participant**
- ~6-7s

### Tandem section

**Turn 1**
- Experimenter
  - Roughly consistent tempo
  - Common rhythmic subdivisions
  - Variation in drum choice
  - Dynamics

**Participant**
- ~90s
Methods - Surveys

Pre-Test Survey → Practice

- Demographics
- Musical Training
- Improvisation experience

Block 1
Block 2
Block 3
Block 4
Block 5

Trading → Tandem → Post-Block Survey

Post-Test Survey

- How enjoyable was that experience?
  - Trading (5 pt. likert)
  - Tandem (5 pt. likert)
- How well do you think you performed?
  - Trading (5 pt. likert)
  - Tandem (5 pt. likert)

Compared to the start of the study...
- I felt ___ “in-sync” with my partner
- I was ___ focused on listening to my partner than myself
- I felt ___ self-conscious about my playing

8 total questions about how experience changed over the course of the study
Participants

- **15 participants** (7 male, 8 female)
- 14 right-handed
- **Average age:**
  - $M = 23.33$ years, $std=5.58$
- **Years of musical training:**
  - $M = 12.67$ years, $std = 5.65$
- **Improvisation experience:**
  - $M= 3.6$ years, $std = 5.18$
Results - Inter-onset-interval (IOI)

- IOI = time between successive events
- Identifiable peaks around:
  - <5 ms
  - 160-170 ms
  - 310-320 ms
  - 485 ms*
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Experimenter

Tandem (experimenter)
Results - Inter-onset-interval (IOI)

- IOI = time between successive events
- Identifiable peaks around:
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- IOI = time between successive events
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  - 310-320 ms
  - 485 ms*
- High level of consistency across blocks for both tester and participant
Results - Inter-onset-interval (IOI)

- IOI = time between successive events
- Identifiable peaks around:
  - <5 ms - multiple pads pressed
  - 160-170 ms
  - 310-320 ms
  - 485 ms*
- High level of consistency across blocks for both tester and participant
Results - Inter-onset-interval (IOI)

- IOI = time between successive events
- Identifiable peaks around:
  - <5 ms - multiple pads pressed
  - 160-170 ms
  - 310-320 ms
  - 485 ms*
- High level of consistency across blocks for both tester and participant
  - Peak values correspond to 16th notes and 8th notes at a bpm of 90-94
  - This suggests rhythmic subdivisions and possible metric structure
Results - Inter-onset-interval (IOI)

- **IOI** = time between successive events
- Identifiable peaks around:
  - <5 ms - multiple pads pressed
  - 160-170 ms
  - 310-320 ms
  - 485 ms* - experimenter shows more structured output
- High level of **consistency** across blocks for both tester and participant
  - Peak values correspond to 16th notes and 8th notes at a bpm of 90-94
  - This suggests **rhythmic subdivisions** and possible **metric structure**
Results - Asynchrony between partners

- “Intended concurrent onset” (ICO) defined as notes played by each partner that occurred within a threshold (< 20 ms).
- ICO threshold chosen as it is approximately 1/8th of peak IOI duration (164 ms)

→ Mean asynchrony for ICOs did not change over the 5 blocks

→ The proportion of ICOs : total notes increased over the 5 blocks
Drum Timbre Distribution

How many notes were played on each of the 4 drum timbres?

→ Chi-square analysis: significant difference between Trading and Tandem

What about inter-partner dynamics?

→ Some individual participants showed imitation of the experimenter within turns

→ Potentially dependent on task–Trading vs Tandem
Enjoyment increased over the blocks

Self-perceived success increased over the blocks

→ In as short as 45-60 mins people had a meaningful musical improvisation experience
Post-Test Survey

“How much did ____ change over the course of the study?”

Participants felt substantial increases in:
- Enjoyment
- Improvement
- Synchronization with their partner
- Ability to come up with new ideas
- Complementing their partner

They recognize their role as follower rather than leader
They reported a lowering in self-consciousness (usually barrier against creative exploration)

→ Participants’ subjective experience of improvisation was positive overall, and they felt they succeeded in behaving creatively
→ They adapted to the task over the course of their participation
Discussion

● Both partners showed rhythmic **regularity** and metrical **structure**
  ○ IOI distribution is highly consistent between experimenter and participant, as well as trading vs tandem
  ○ IOI clusters around rhythmic subdivisions (peaks at 16th note, 8th note, dotted 8th note, ~90-94 bpm)

● Both partners behaved differently in trading vs tandem sections
  ○ Used different drum sounds more frequently than others
  ○ Trading: partner imitation

● Participants’ behavior and experience **changed** over time
  ○ Tandem: % notes in-sync with partner increased
  ○ Self-reported increases in enjoyment, ability, synchronization
  ○ Decrease in self-consciousness
Future Directions

● How to find/analyze **rhythmic motifs**?
  ○ Need more fine-grained metrics to assess partner interaction/adaptation
  ○ Include velocity & timbre information

● Relationship between participants’ music/improvisation **experience** and performance/survey metrics
  ○ Need more participants of varying musical backgrounds

● More constrained tasks – e.g. experimenter plays prescribed part, participant improvises
Thank you!

Questions?
Pre-Test Survey

1. What is your age?
2. What is your gender?
3. Do you play any instruments? If so, which? (None, Piano, Voice, Drums/Percussion, Guitar/Bass Guitar, Bowed String, Brass, Woodwinds, Other)
4. How many years of experience (private lessons, performance, academic study) studying music do you have?
5. Do you have experience with improvising music? How many years?
6. What styles/genres of music do you listen to the most?
7. Have you participated in a psychological study before?
Post-Block Survey

Please answer the following questions. Answer each question for the trading sections and tandem sections separately.

1. How enjoyable was your experience?  
   (Not enjoyable/Somewhat unenjoyable/Neutral/Somewhat enjoyable/Very enjoyable)  
   a. Trading  
   b. Tandem

2. Please explain the reasoning behind your rating. What did you like/dislike about the experience? (free response)

3. How well do you think you performed?  
   (Very poorly/Somewhat poorly/Neutral/Somewhat well/Very well)  
   a. Trading  
   b. Tandem

4. Please explain the reasoning behind your rating. In your opinion, what factors make for a successful duet? (free response)

5. In your view, how did this block go compared to the previous one? Did anything change?

6. Are there any particular moments (positive, negative, or otherwise) that stood out to you?
Post-Test Survey

Please reflect on your experience as a whole by rating how much you agree with the following statements. For each, consider the trading sections and the simultaneous (tandem) sections separately.

1. I enjoyed the task ____ as time went on.
   (Significantly less/Somewhat less/[no change]/Somewhat more/Significantly more)
   a. Trading
   b. Tandem

2. Please explain your responses to the previous questions. In what way did your experience change, if at all? (free response)

3. I got ____ at the task over the course of the study.
   (Much worse/Somewhat worse/[no change]/Somewhat better/Much better)
   a. Trading
   b. Tandem

4. Please explain your responses to the previous questions. In what way did your experience change, if at all? (free response)

5. Compared to the first trials, by the end of the study I felt ____ “in sync” with my partner.
   (Significantly less/Somewhat less/[no change]/Somewhat more/Significantly more)
   a. Trading
   b. Tandem

6. Please explain your responses to the previous questions. In what way did your experience change, if at all? (free response)

7. By the end of the study, it was ____ to come up with new musical ideas in the moment.
   (Significantly more difficult/Somewhat more difficult/[no change]/Somewhat easier/Significantly easier)
   a. Trading
   b. Tandem

8. Please explain your responses to the previous questions. In what way did your experience change, if at all? (free response)
8. Compared to the first trials, by the end of the study I was ____ focused on listening to my partner than on what I was playing. 
   (Significantly less/Somewhat less/[no change]/Somewhat more/Significantly more)
   a. Trading
   b. Tandem

9. Please explain your responses to the previous questions. In what way did your experience change, if at all? (free response)

10. Compared to the first trials, by the end of the study I felt that what I played and what my partner played were ____ complementary. 
    (Significantly less/Somewhat less/[no change]/Somewhat more/Significantly more)
    a. Trading
    b. Tandem

11. Please explain your responses to the previous questions. In what way did your experience change, if at all? (free response)

12. In terms of the relationship between myself and my partner, I was more of a “leader” than a “follower”. 
    (Strongly disagree/Somewhat disagree/Neutral/Somewhat agree/Strongly agree)
    a. Trading
    b. Tandem

13. Please explain your responses to the previous questions. In what way did your experience change, if at all? (free response)

14. Compared to how I felt at the start of the study, I felt _____ uncertain/self-conscious by the end. 
    (Much less/Somewhat less/[no change]/Somewhat more/Much more)
    a. Trading
    b. Tandem

15. Please explain your responses to the previous questions. In what way did your experience change, if at all? (free response)

16. Did you have any particular strategy or approach when improvising? If so, did this change at all over the course of the study? (free response)

17. Please share any other reflections, comments, or observations about your experience in the study. (free response)
Citations