

# Uses of Humdrum

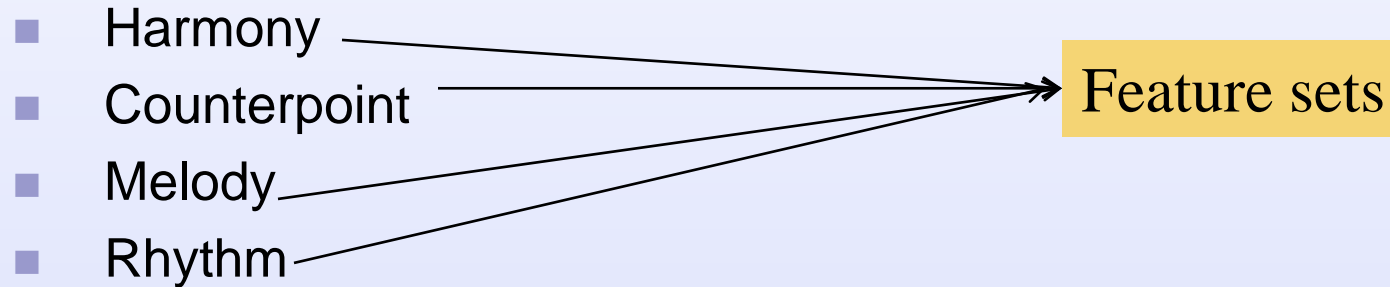
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Overview

# Traditional categories of music analysis

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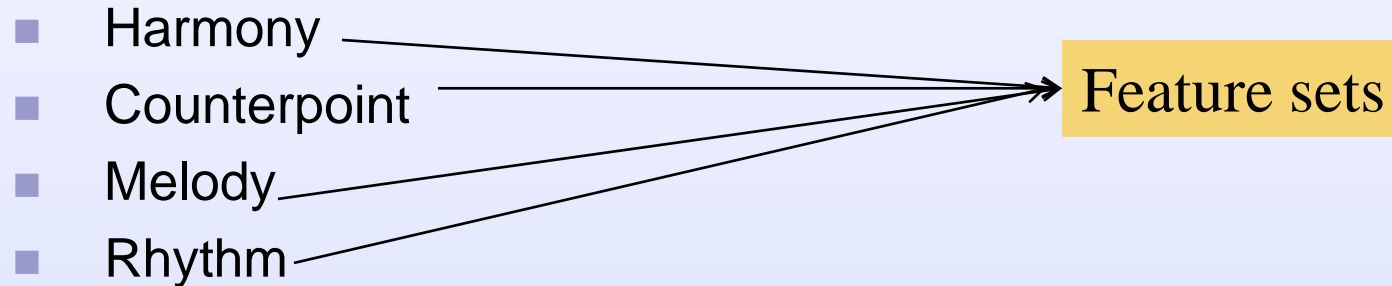
## □ Traditional means of analysis



# Traditional categories of music analysis

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## □ Traditional means of analysis



**Humdrum** = Toolset

**\*\*kern** = encoding format

# >>Manual processes in music analysis

## Riemann analysis

## Schenkarian analysis

Agmon, Conventional Harmonic Wisdom

Ex. 6

LEVEL 1: T — S — D — T

LEVEL 2: T D T T D T T D T

## Root analysis

Blair Johnson, MTO (2012)

first, last, highest, lowest: (014)

# Perspectives on music analysis: 1-2

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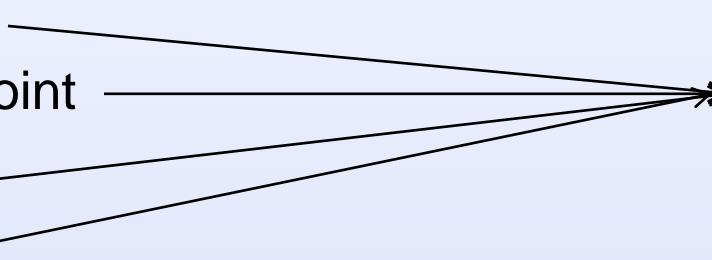
## □ Traditional (*theoretical, historical*) means of analysis

- Harmony

- Counterpoint

- Melody

- Rhythm



Feature sets:  
**Results related to score**

## □ **Statistical** (*systematic*) approaches

Feature sets: results reported in tables, charts, graphs  
**Disembodied information about music**

## □ **Audio-based** analysis

# More approaches to analysis

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- Procedures imported from other disciplines
  - Often *procedural* or *structural*
  - Borrowed from
    - Linguistics
    - Mathematics
    - Computer science
    - Engineering
- Cognitive and perceptual studies
- Performance-based analysis
- Data visualization

# Generation of new works

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- Flip side of analysis (work of David Cope)
- Emphasis on form/genre
- Emphasis on style/authorship
- Idiomatic writing for specific instrument

# Other legitimate projects

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- ❑ **Data translation**, enrichment
- ❑ **Linking symbolic data** with MIDI, audio, structured data
- ❑ **Style evaluation**
  - generation as proof of general concept
  - **Attribution** studies (e.g. Josquin Research Project)
- ❑ **Deep-learning/convolutional-network** (AI) analysis
- ❑ Generative approaches to new music



# Algorithmic generation: 12-bar blues

Exercise: Simple 12-bar Blues in F

phrase 1

phrase 2

phrase 3

Improvise over the 12 bars using notes from this blues scale

Francesco Giomi, c. 1988

Is repertory highly  
**patterned**?

# Phrase families (centonization)

- Panos Mavromatis (2006)
  - N.B. Lerdahl-Jackendoff touch

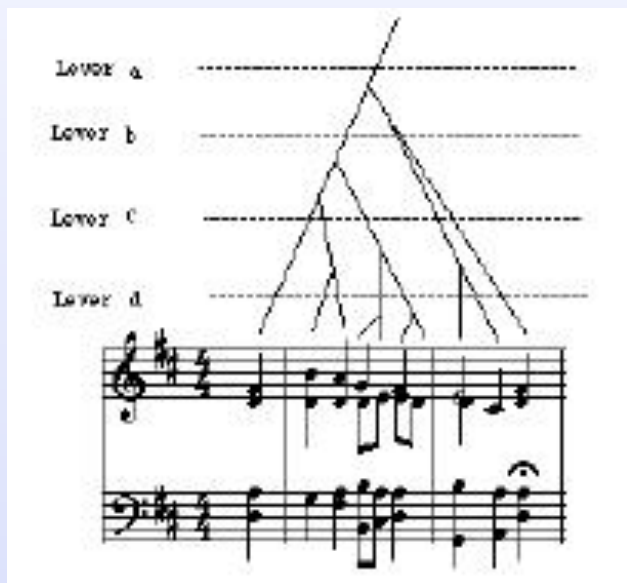
## Linguistic orientation

The image shows a musical score for Echos 1, illustrating a phrase family with formulaic variation. The score consists of 8 staves, each with a melody line and Greek lyrics. Brackets above the staff mark the family's opening and closing formulas. The lyrics are in Greek and represent a traditional form of centonization, where phrases are combined to create new meanings.

Figure 3. A Phrase family in Echos 1, illustrating formulaic variation. Brackets above the staff mark the family's opening and closing formulas.

# Hierarchical systems: Lerdahl-Jackendoff

Generative theories  
of musical grammar (1984)



Harmonic Structure	T	T	D	D	T	T	D	D	T	T	D	D	T	D	T
Motif Structure	a		a'		b		c		a		a'		b'		c'
Phrase Structure	A				B				A				B'		

# Linear systems (species counterpoint)

## Two-Voice Analysis

Vincentino: *L'artico musica* Vol. 4



A musical score for two voices (treble and bass clefs) in G major. The treble staff contains a melody with figured bass notation below it: 5, 6, 8, 2, 3, 3, 5, 3, 5, 3, 2, 8, 7, 5, 4, 3, 5, 4, 3, 3, 3, 3, 8, 6, 5. The bass staff contains a simple harmonic accompaniment.

Several systems

Pedagogical orientation

Answer (Contrapunctus III)



A musical score for a single voice (treble clef) in G major. The melody is highlighted with a red box, indicating it is the first countersubject of the AOF.

First Countersubject of the AOF

## Three-Voice Analysis

Robert Kelley

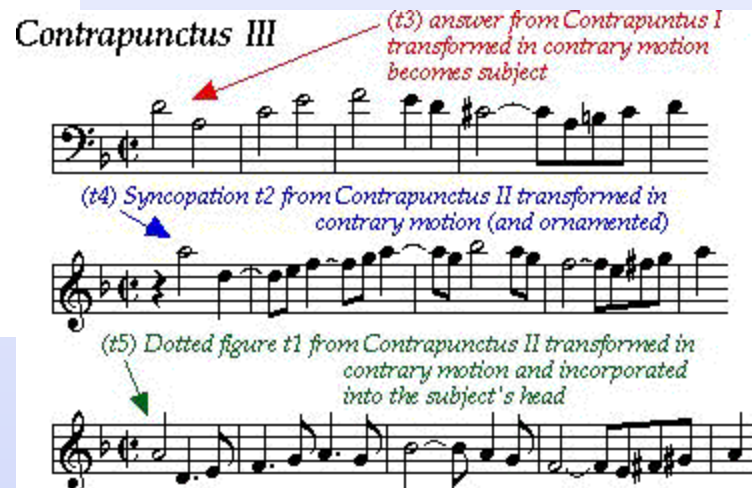


A musical score for three voices (A, T, B) in G major. The lyrics are: Ec - ce Do - mi - num nos - ter cum vir - tu - te ve - ni - et. The score includes figured bass notation below the bass staff: 5, 6, 3, 5, 6, 3, 8, 5, 3, 2, 3, 8, 2, 3, 3, 6, 6, 3, 2, 3, 3, 5, 4, 8, 6, 7, 3, 3, 6, 5, 3, 3.

# Imitative systems (18<sup>th</sup>-century counterpoint)



Timothy Smith, NAU



## Music-theory applications



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# **Sample Projects, Random Order**

# Generative chorale variations

- Dominik Hörnel (2005): Pachelbel
  - Keyboard elaboration generated from chorale melody



The image displays a musical score for a chorale variation. The top staff is a vocal line in G major, 4/4 time, with the lyrics: "Al - le Men - schen müs - sen ster - ben, al - les Fleisch ver - was - da le - bet, muß ver - der - ben, soll es an - ders". The bottom staff is a keyboard elaboration, featuring a complex, flowing melody in the right hand and a simpler, harmonic accompaniment in the left hand. The key signature is one sharp (F#) and the time signature is 4/4.

## Chorale elaboration

# Rhythm, Meter, Tempo (performance)

Simon Dixon, Gerhard Widmer, Walter Göbl (2004)

## Comparative performance analysis

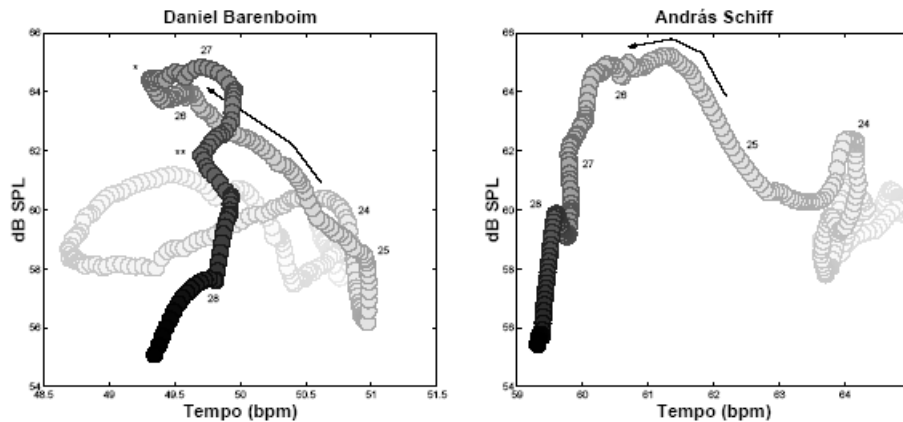


Figure 4. Expression trajectories over the last bars (mm. 24–28) of the Mozart piano sonata K. 279, second movement, first section, as played by Daniel Barenboim (left) and András Schiff (right). *x* axis: tempo in beats per minute; *y* axis: dynamics ('loudness') in decibel. The darkest point represents the current instant (third beat of m. 28), while instants further in the past appear fainter.



# Computational perception

MACHINES | By Michael Byrne | Oct 9 2016, 11:00am

## Computer Scientist Publishes Manifesto for Expressive Algorithmic Music

A new five-year research project aims to understand how humans compute music.



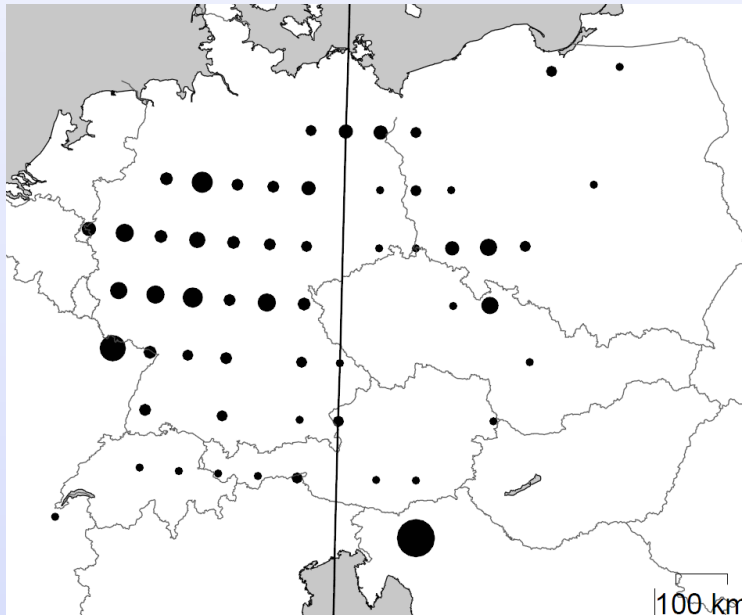
Gerhard Widmer, *Motherboard* (2016)

[https://www.youtube.com/watch?v=EJn\\_88Ru7w4](https://www.youtube.com/watch?v=EJn_88Ru7w4)

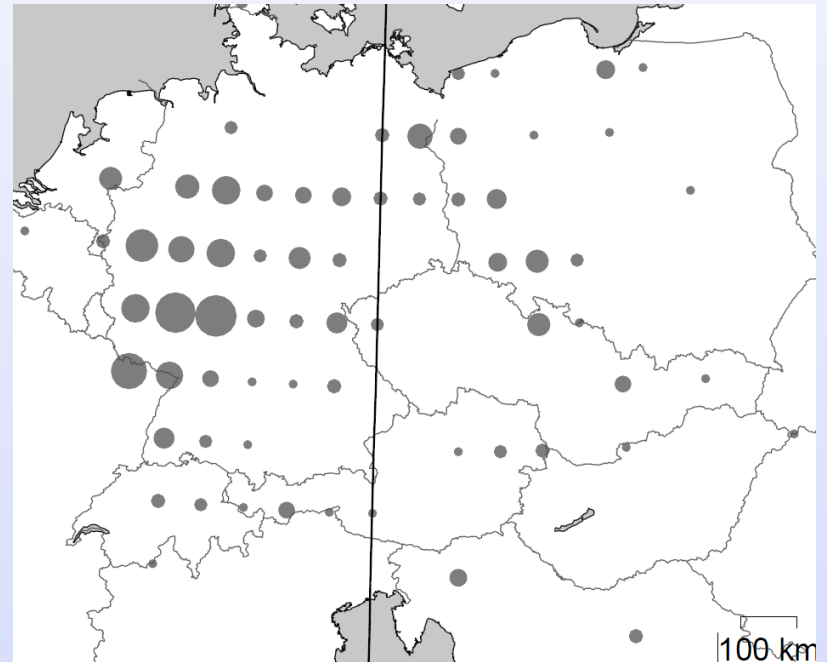


# Geospatial mapping of musical features

- Bret Aarden (1998), from EsAC data



Minor mode



Triple meter

# Tabla drumming

Parag Chordia: bol processor (2006)

## Non-Western repertoires



*Dhene ghene dhene ghene nage tak dha ne dha  
na ge tak 'dha ne dha 'dha ketetake kitetake*

+ dhenegene dheneghene taketake dha ne  
dha kite takedha kitetake dha

+ kr dhin na kitetake dheneghene  
na kite ta dhe te dha

+ gerenage na kite ta dhe te  
kitetak gerenage na kite ta

+ dha

dha nagetake dha ne dha  
dhet ta kitetake ta

natete dhet kitetak gerenage  
ta gadigene dha kitetak

dha ta gadigene dha  
dhe te dha ta gadigene

```
8.0 2.0 0.0 -36 0.0 0.0 -1.0
t 2 6 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dha
t 2 21.582 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 28.26 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 36.058 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04kr
t 2 42.722 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dhe
t 2 53.824 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 60.502 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dhe
t 2 101.5 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 108.178 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 114.856 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04kre
t 2 124.474 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dhe
t 2 136.696 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 143.374 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04dha
t 2 154.476 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
t 2 158.914 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04re
t 2 163.632 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04ki
t 2 167.468 0.0 1.0 1.03245 0.0 0.0 0.0 0.0 0.0
_04te
```

# Haydn-Mozart Quartet Quiz

(machine learning/information theory)

## The Haydn/Mozart String Quartet Quiz

Can you tell the difference between the musical styles of Haydn and Mozart?

This website tests how well you can distinguish between the string quartets of these two composers. You will listen to randomly selected movements composed by either [Mozart](#) or [Haydn](#). Then, you will choose the composer you think wrote the music you have just heard.

Digital scores for the quartet quiz have been provided by the [Center for Computer Assisted Research in the Humanities](#) at Stanford University. Click the start button below to answer some questions about your musical knowledge and then start the quiz...

start

- [View current identification statistics](#)

Brought to you by Craig Sapp and Yi-Wen Liu, Stanford University.



or ...



Yi-Wen Liu,  
C. Sapp (2002-04)  
-**entropy study (EE)**  
[[qq.themefinder.org](http://qq.themefinder.org)]

# Themefinder (melodic search)

□ Huron, Kornstädt,  
Sapp, et al. (1996)

themefinder.org

Similarity studies

[Take the Quartet Quiz.](#)

Repertory	<input type="text" value="Classical"/>	? type of music to search
Pitch	<input type="text"/>	? A-G, sharp=#, flat=- e.g. C E- G F#
Interval	<input type="text"/>	? maj=M, min=m, aug=A, dim=d per=P, fifth=5, up=+, down=-. e.g. +m9 -P8 +M3 P1
Scale Degree	<input type="text"/>	? do=1, re=2, mi=3, fa=4, so=5, la=6, ti=7 (mode insensitive). e.g. 34554321
Gross Contour	<input type="text"/>	? up=/, down=\, unison=-. e.g. //\ - / or uudsu
Refined Contour	<input type="text"/>	? up step=u, up leap=U, down step=d, down leap=D, same=s. e.g. uUDsdu
Location	<input checked="" type="radio"/> beginning of theme only, or <input type="radio"/> anywhere in theme	?
Key	<input type="text" value="Any"/>	?
Mode	<input type="text" value="Any"/>	?
Meter	<input type="text"/> / <input type="text"/>	?

# Computer methodologies in music search

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- ❑ Music geohash —————→
- ❑ Counterpoint/surfacing crawling
- ❑ Musical structure discovery via deep-learning algorithms (2016)
- ❑ Currently runs ETLeap (data extraction, transformation, loading)



# Melodic search in big data

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- Sapp, Liu, Selfridge-Field (ISMIR, 2004)

Search effectiveness in large musical databases:

<http://ismir2004.ismir.net/proceedings/p051-page-266-paper135.pdf> (100,000 musical incipits)

- Sapp, Shanahan:

Rhythmic search in 1m+ incipits [RISM musical incipit database]

# Studies comparing analytical tools

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- Claire Arthur  
MEI Proceedings (2015)
- Compares, Humdrum, MEI
- Johanna Devaney, Hugh Gauvin (Springer Verlag, 2016)
- Advocates extensions to Humdrum and MEI



# Stanford-related studies

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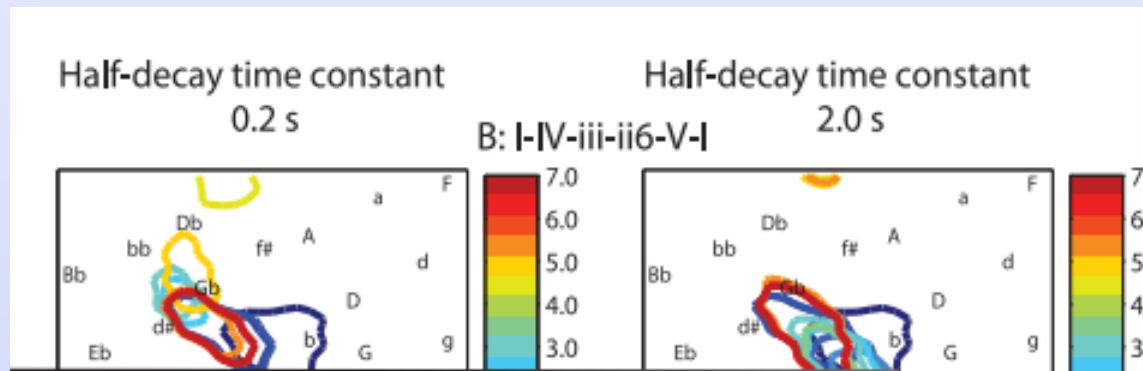
LSJUMB (Stanford Band) repertory study

□ <https://youtu.be/16Fvy3qXeaM?t=56>



# Outside users: Neuromusicology

- Carol Krumhansl: Tonal, harmonic understanding
  - Their physiological correlates
- Petr Janata: specific-key perception
  - Neural correlates



# Neuromusicology: movement/gesture

- Petri Toiviainen
  - Spatial-temporal music cognition
  - Perceived similarity and spontaneous dancing



- Ari Patel
  - Avian perception of rhythm
  - [Snowball, the dancing cockatoo](#)



Please watch the video and then answer the questions on the right. When you are satisfied with your responses, click SAVE to save your answers.

**SAVE ANSWERS**

1) These dancers are interacting with each other  
Strongly disagree ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Strongly agree

2) These dancers are dancing similarly to each other  
Strongly disagree ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Strongly agree

3) Is one of the dancers leading and the other following?  
☐ The green (left) dancer is leading ☐ The blue (right) dancer is leading ☐ Neither dancer is leading

4) How would you describe the way this dancers are moving and interacting? Further comments? (optional)

