

Modeling Social Interaction: multifrequency coordination



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Synchronization across People

*More often than not,
processes occur at different rates*





Synchronization across People

*More often than not,
processes occur at different rates*

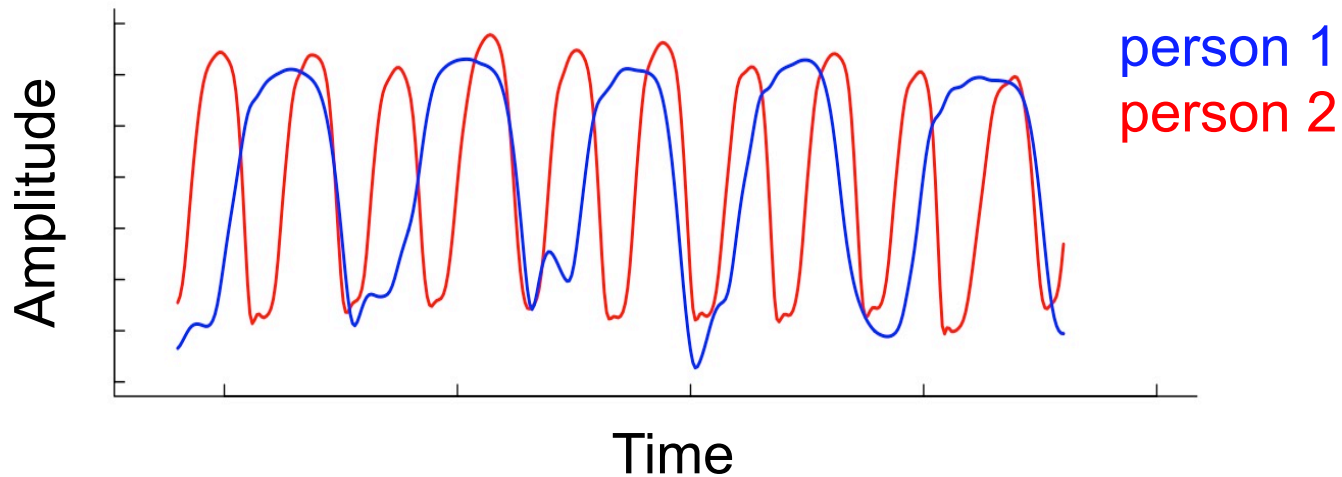
*i.e., multifrequency coordination,
frequency locking*

*Characterize those patterns with a **ratio**:*

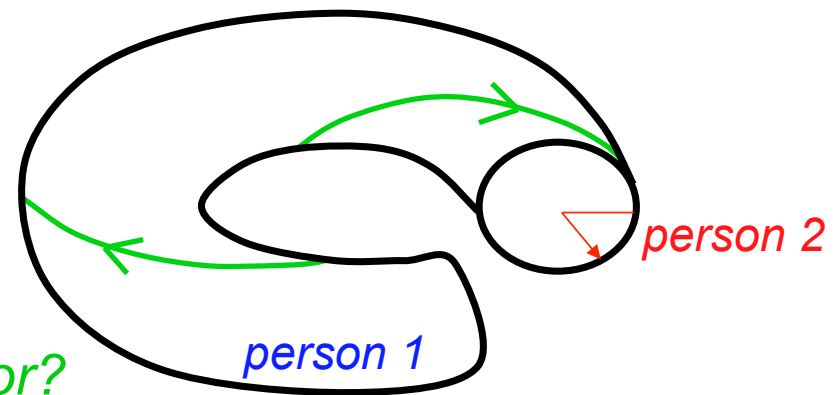
- Simple ratios: 1:1, 1:2, 1:3, 1:4, 1:5,...
- Complex ratios: 2:3, 2:5, 3:4,...



Modeling Multifrequency Coordination: two frequency resonance model



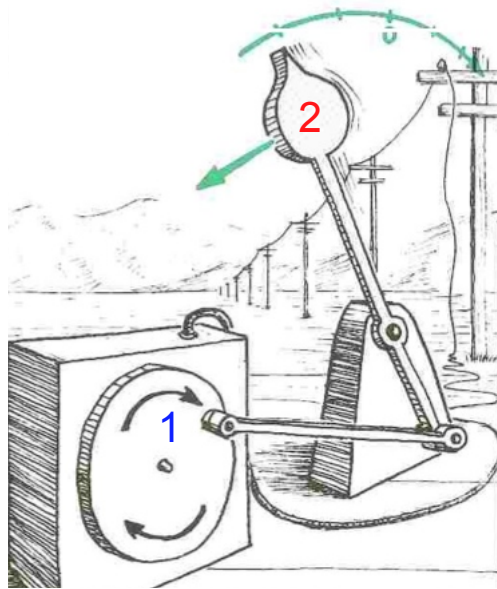
Detecting a Pattern:
*What is person 2 doing when
person 1 performs a landmark behavior?*



Glazier & Libchaber (1988)

Modeling Multifrequency Coordination

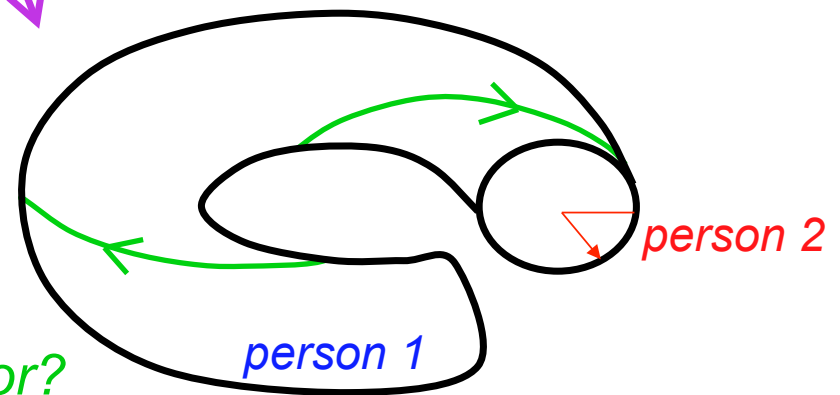
two frequency resonance model



*Strobing one oscillator
at a behavioral landmark of the other*

physical model

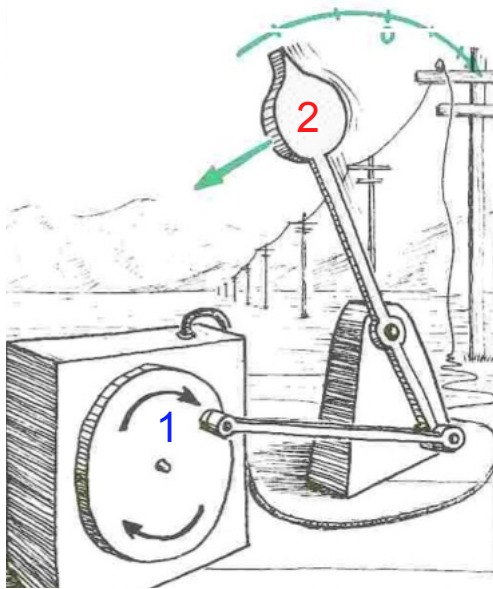
Detecting a Pattern:
*What is person 2 doing when
person 1 performs a landmark behavior?*



applied to psychology

Modeling Multifrequency Coordination

two frequency resonance model



*Strobing one oscillator
at a behavioral landmark of the other*

$$\theta_{n+1} = \theta_n + \Omega + \frac{K}{2\pi} \sin(2\pi\theta_n) \pmod{1}$$

↓ next phase angle
 ↓ current phase angle
 ↓ keeps ratios between 0 and 1

Ω

bare winding number
"required" or "intentional" ratios
ratio (0 - 1) of uncoupled frequencies
ratio when $K = 0$

K

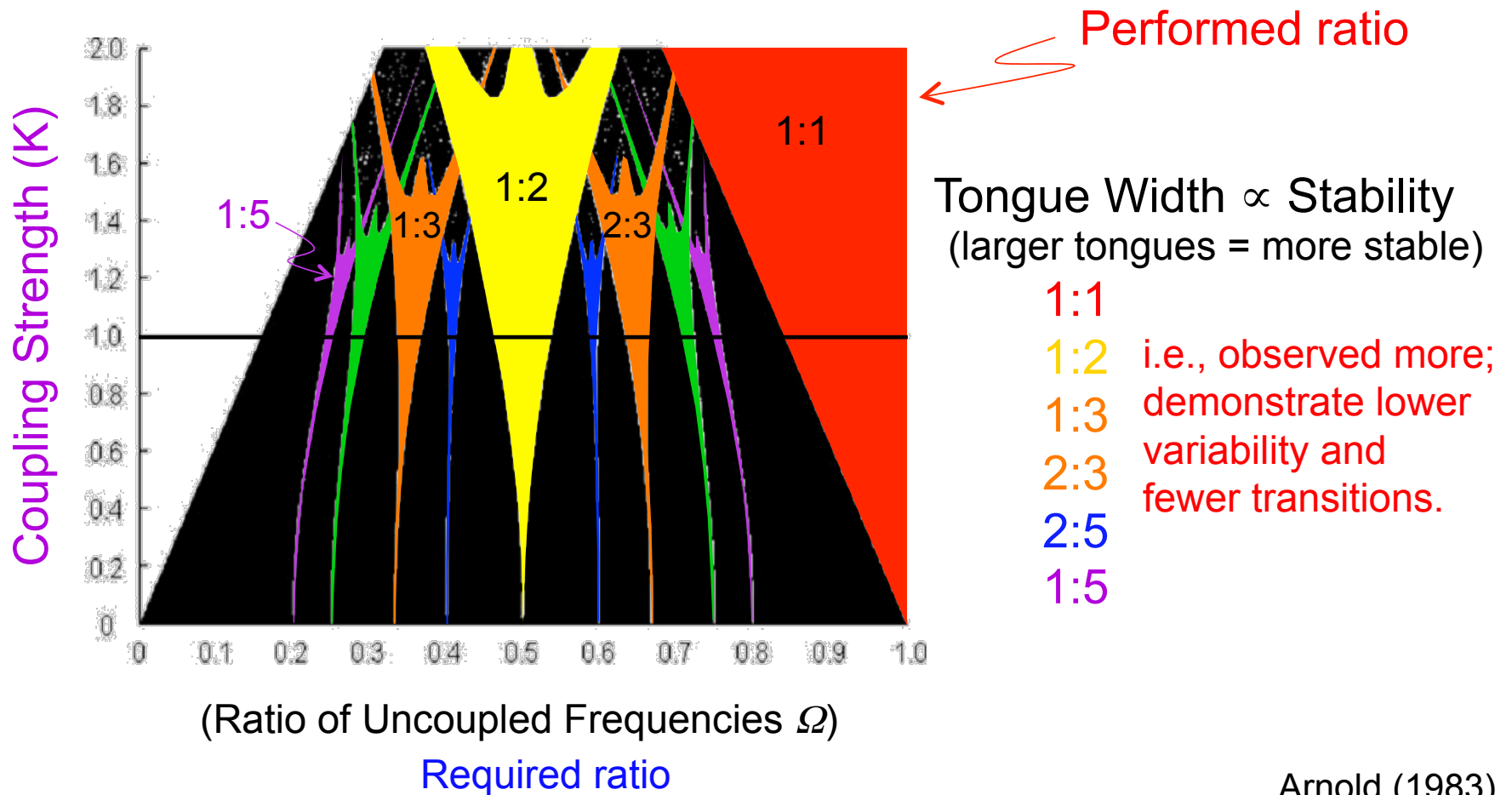
coupling strength
level of influence

Prediction: W
"winding number"

1:2, 1:3, 1:4, ...
2:3, 2:5, 3:4, 3:5, ...

Glazier & Libchaber (1988)

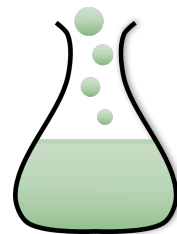
Predictions: Arnold Tongues



Arnold (1983)

Support for Predictions

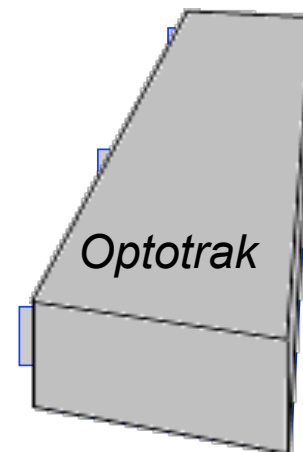
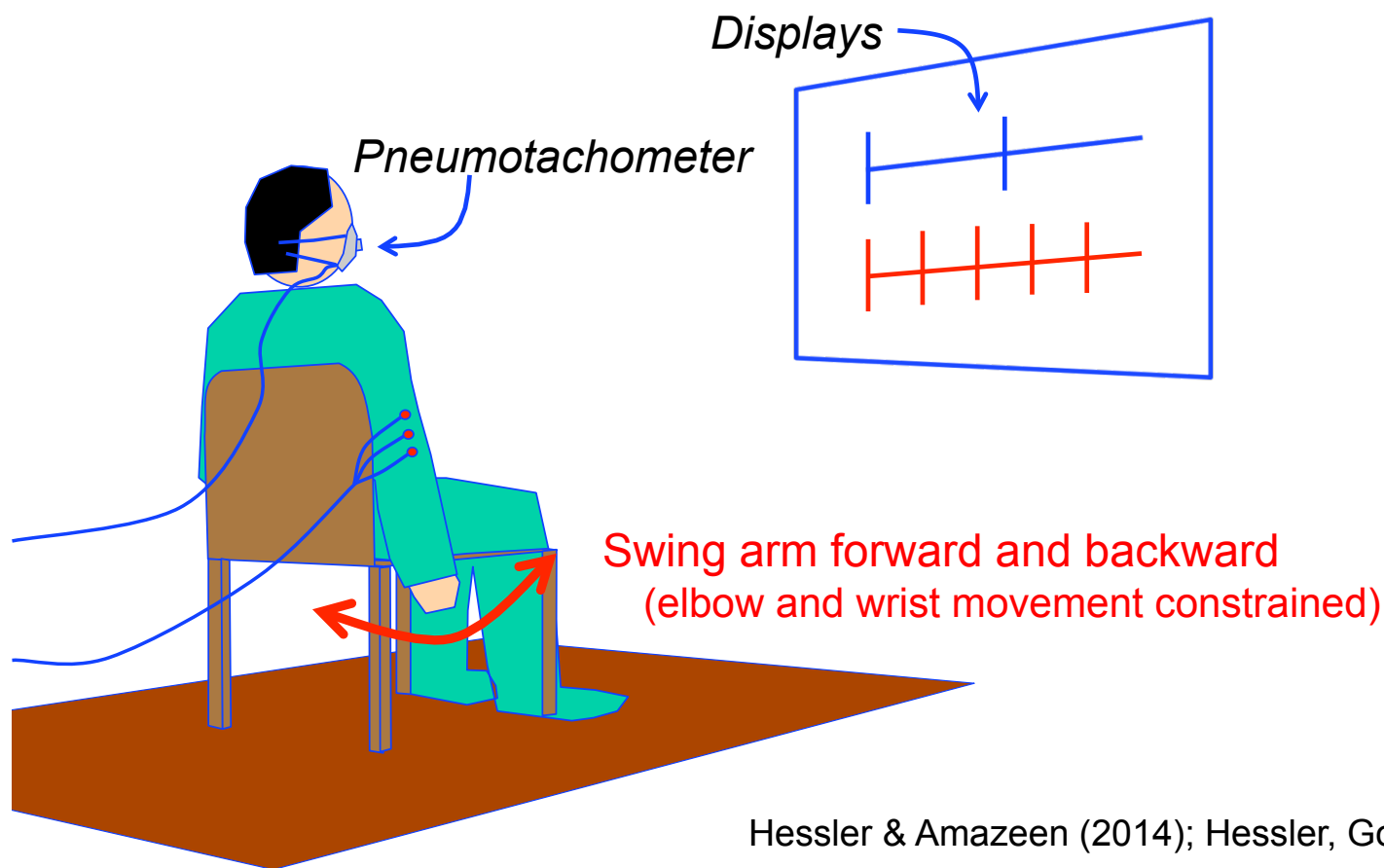
across physical – chemical – biological phenomena



Glazier & Libchaber (1988); Peper, Beek, & van Wieringen (1995)

Motor-Respiratory Coordination

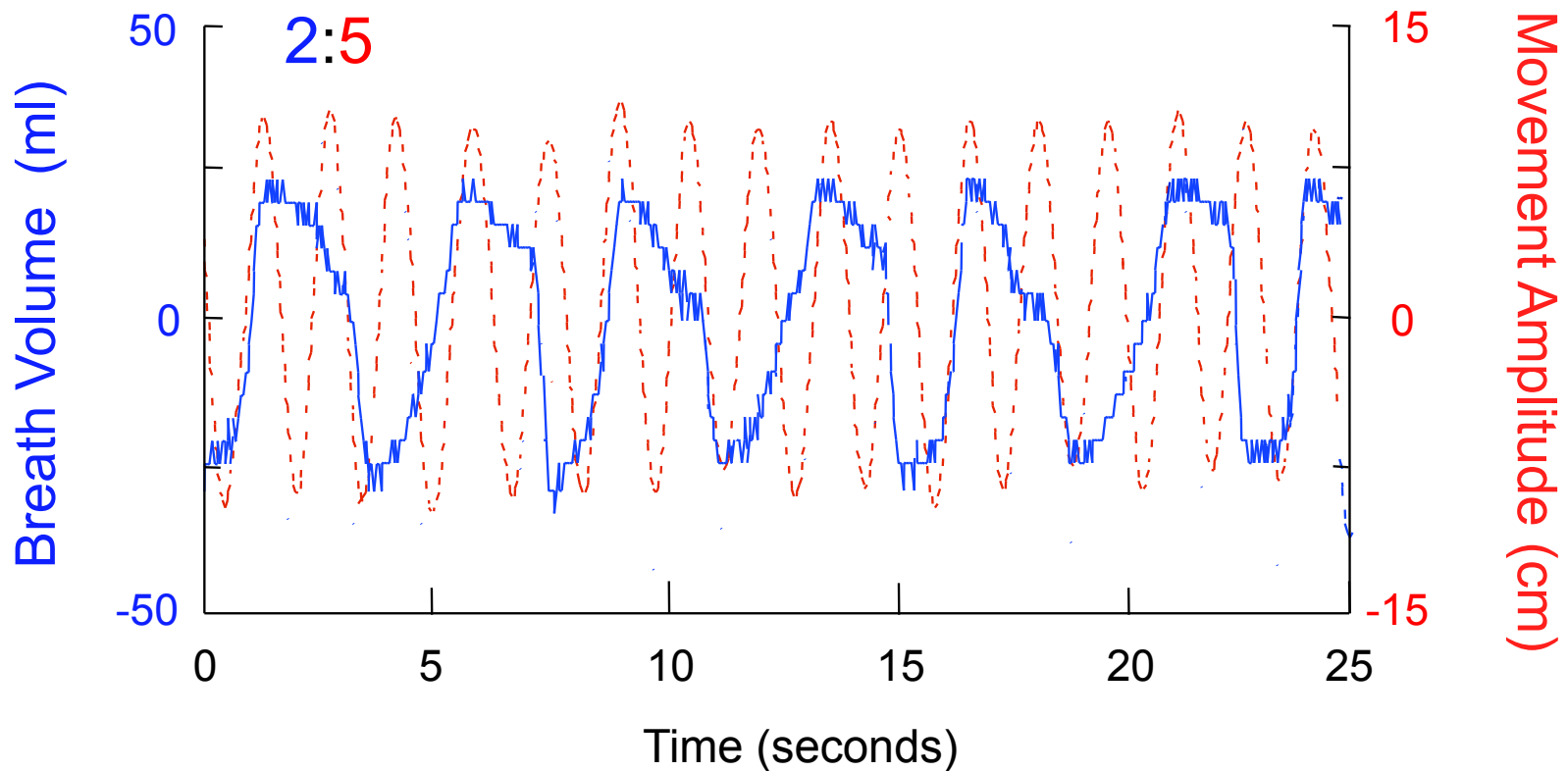
synchronization across physiological subsystems



Hessler & Amazeen (2014); Hessler, Gonzales, & Amazeen (2010)

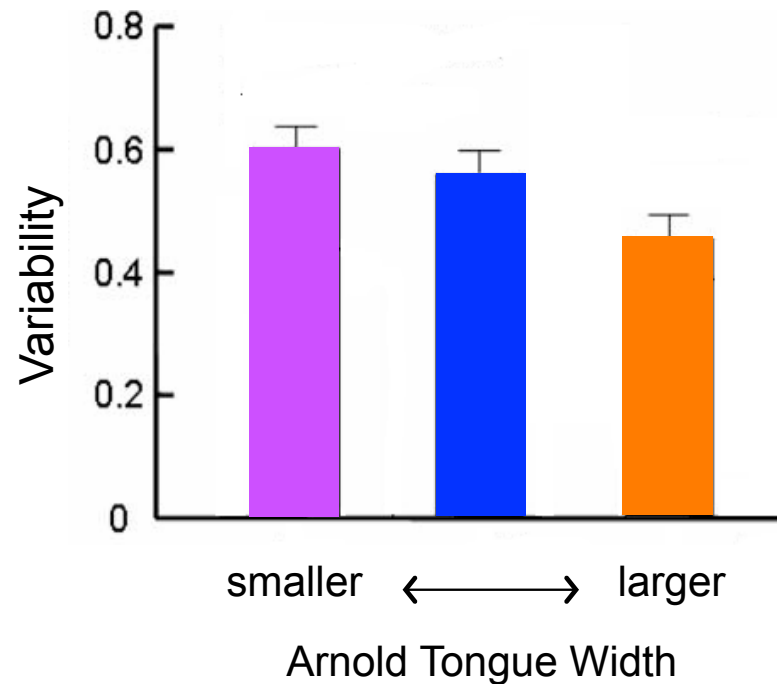
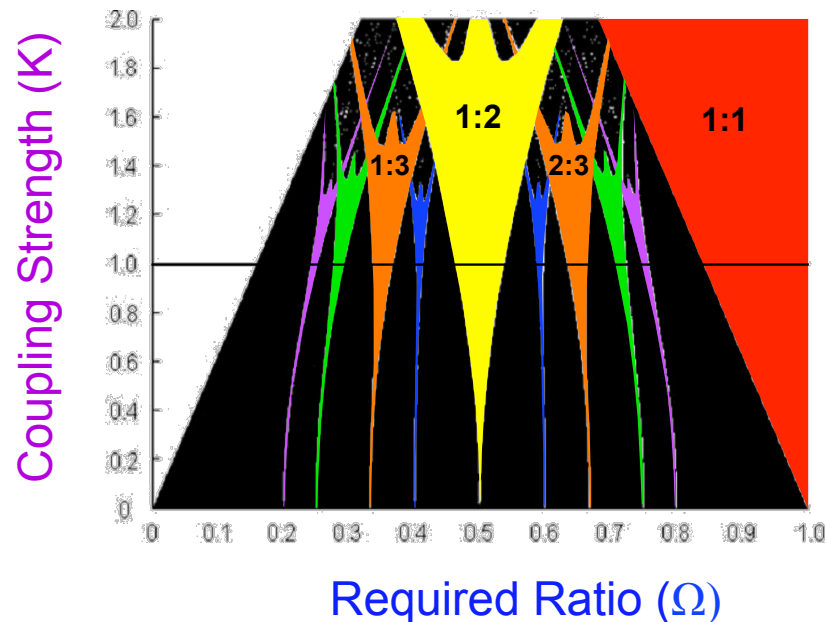
Motor-Respiratory Coordination

Raw Data



Hessler & Amazeen (2014); Hessler, Gonzales, & Amazeen (2010)

Motor-Respiratory Coordination results support model predictions



*More stable performance
for ratios occupying larger tongues*

Hessler & Amazeen (2014); Hessler, Gonzales, & Amazeen (2010)

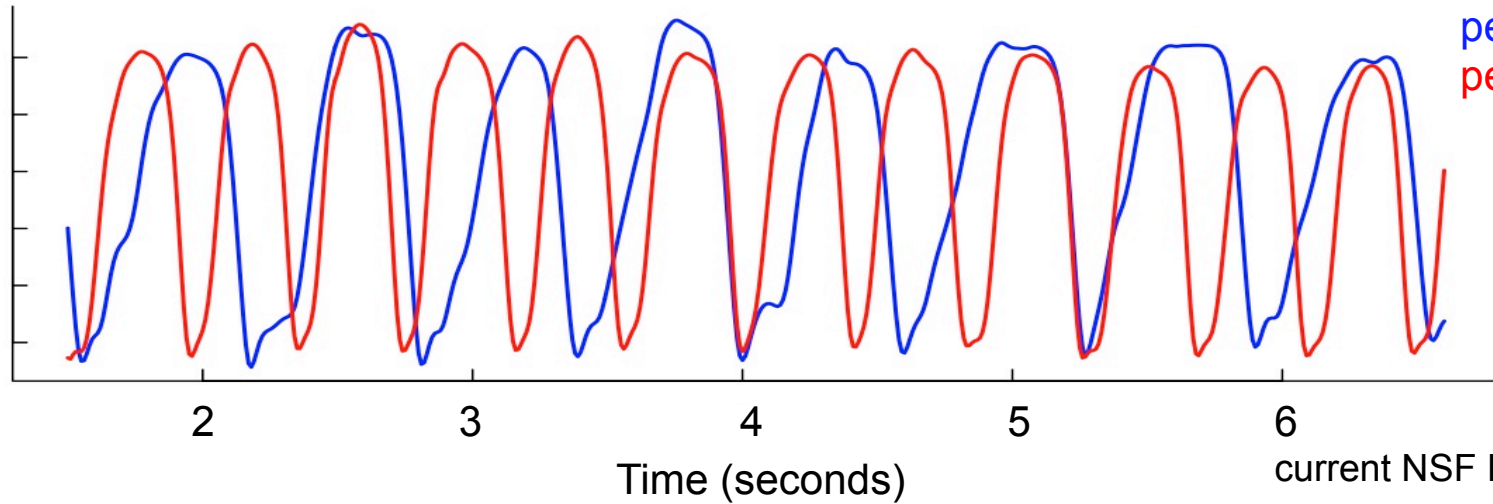
Synchronization across People

Do the same results hold across people?



2:3

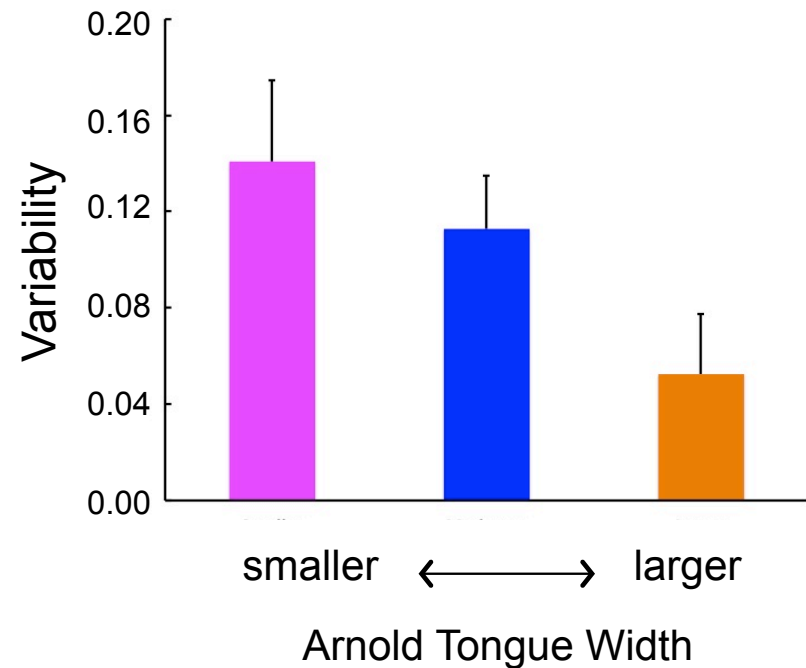
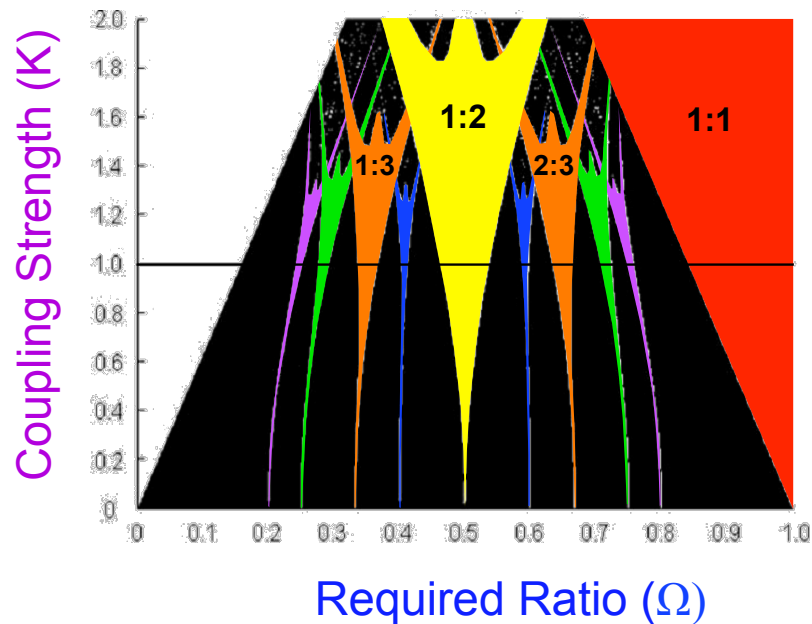
Movement Amplitude (cm)



current NSF Research

Synchronization across People

results support model predictions



*More stable performance
for ratios occupying larger tongues*

current NSF Research

Field Testing

with the National Double Dutch League



Jamie Gorman
Texas Tech University



current NSF Research

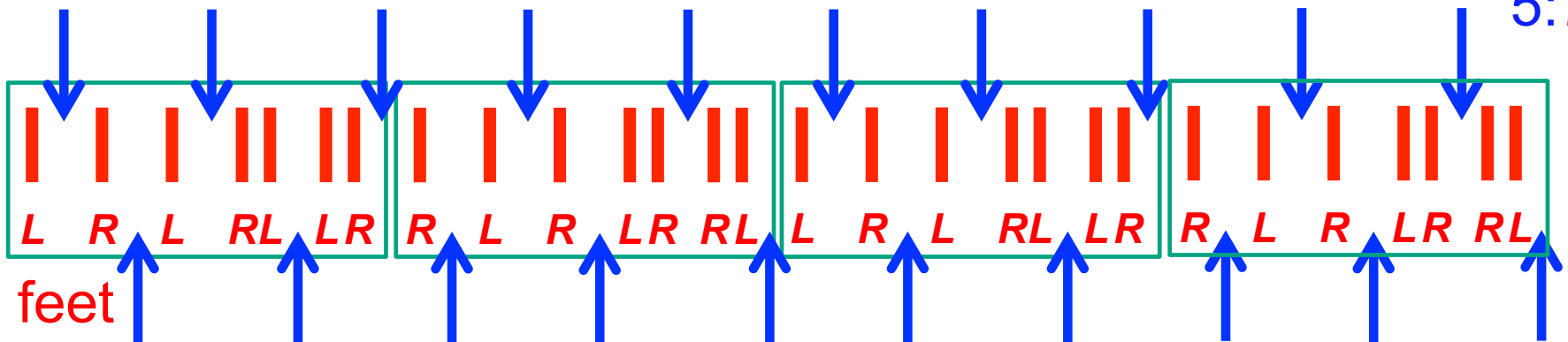
Field Testing

with the National Double Dutch League



rope

5:7



To maintain a stable complex ratio, teams alternated footfall patterns

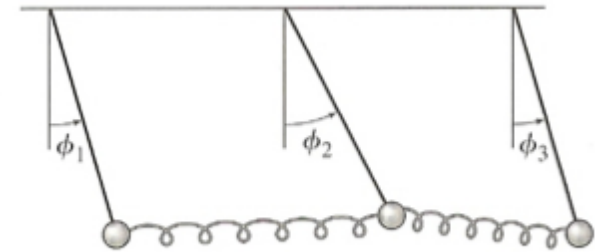
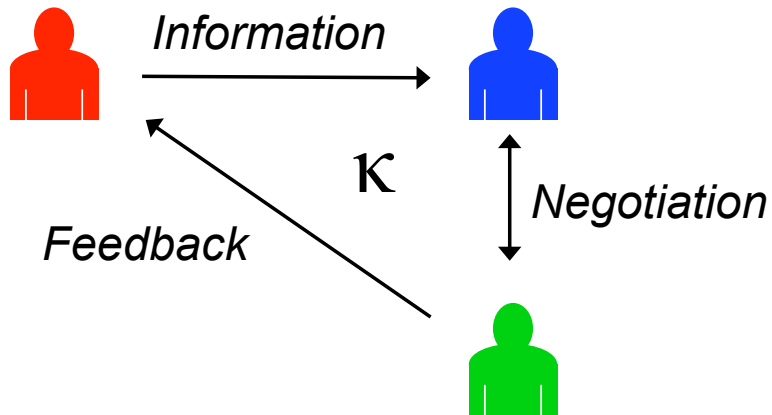
current NSF Research

beyond the dyad:

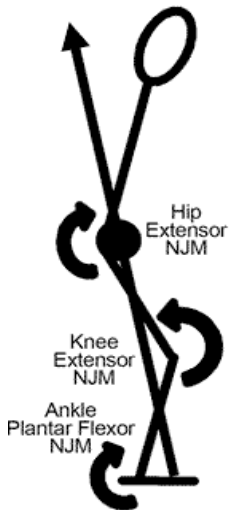
What About Groups and Teams?



create new order parameters



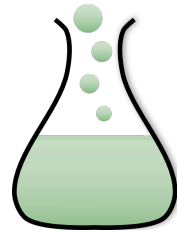
3-frequency resonance models



consider pairwise patterns

complexity models

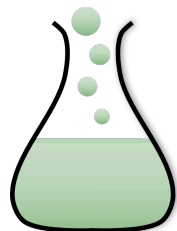
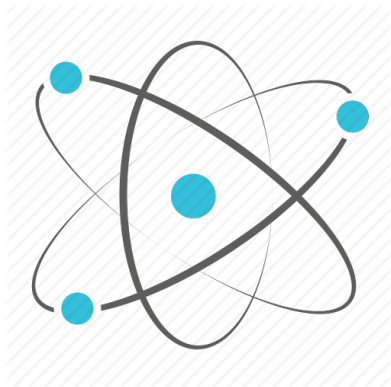




Modeling Social Interactions

Synchronization across individuals abides by mathematical principles...
and the same dynamics that apply to other natural phenomena.





Acknowledgments

Graduate and Undergraduate Students

Cameron Gibbons
Aaron Likens
Clayton Newsom
Duchess Cash

Angelica Williams-Castillo
Lauren Mehok
Lana Rogoff
Kelsey Long

Hannah Kiss
Jacob Alexander
Christina Gipson (TTU)
Lexus Castro (TTU)

Robert Buckman (TTU)
Melissa Harden (TTU)
Kaleitha Gilson (TTU)

Collaborators:

Jamie Gorman – Texas Tech University
Nancy Cooke – ASU, Polytechnic

Eric Hessler – U. Minnesota, Duluth

Sponsors:

National Science Foundation

Air Force Office of Scientific Research

Thank you for your attention.