




**MUSICAL RHYTHM, LINGUISTIC  
RHYTHM, AND HUMAN  
EVOLUTION**

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## MUSICAL ABILITY – VITAL OR UNNECESSARY?

- Age-old debate, from Darwin to present
- Prevailing notion
  - Human minds shaped by natural selection for music (Patel, 99)
- Argument against
  - Music is evolutionarily irrelevant
  - Pinker: Music nothing more than “auditory cheesecake”

## TACKLING THE ARGUMENT - RHYTHM

- Patel's approach - examine the innateness of rhythmic ability in humans
  - Rhythmic ability metric - Beat Perception and Synchronization (BPS)
  - Main questions:
    - Innateness – are we born with Rhythmic ability?
    - Domain specificity – is BPS distinct enough from other abilities?
    - Human specificity – BPS in other primates, other animals?
  - First step – comparison to rhythm in Linguistics
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## MUSICAL RHYTHM VS. LINGUISTIC RHYTHM – PERCEPTUAL GROUPING

- Rhythm vital to linguistic ability, understanding – essential aspect of linguistic prosody
  - Similar characteristics
    - Mental clustering of events (phrasing), exists in both fields
    - Linguistic, musical prosody (Palmer, 246-50)
    - Use similar brain substrates
  - Fields diverge when considering meter
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## MUSICAL RHYTHM VS. LINGUISTIC RHYTHM – METER

- Meter – “hierarchical organization of beats in which some beats are perceived as stronger than others [accented]”(Patel, 100)
- Stressed beats inform sense of hierarchical prominence in music
- ‘Beats’ of speech irregular – hard to find pulse.
- Understanding of meter in music, language, subtly different



## BEAT PERCEPTION AND SYNCHRONIZATION (BPS)

- Unique to music
- Not by-product of linguistic rhythm
- Musical meter very natural to humans – experimental evidence (tapping)
- Ability to subdivide meter in music – “expectancies on periodicities at different hierarchical levels” (Patel, 100)

**Row, Row, Row, Your Boat**

E. O. LYTE

Row, row, row, your boat Gent - tly down the stream;

Mer - ri - ly, mer - ri - ly, mer - ri - ly, mer - ri - ly, Life is but a dream;

Source:  
<http://www.smart-central.com/RowRow.htm>



### INNATE BPS ABILITY

- Infant studies
  - No apparent response to ‘musical beat’
- Need developmental studies on *capacity* of infant brain to have BPS ability
- Consider infants who acquire ability to speak, yet are too young to speak
- Also need studies on non-musically trained children and adults



### DOMAIN-SPECIFICITY OF BPS

- Patients with brain damage, including acquired arrhythmia – compare impairment in distinct abilities
- Rhythmic abilities (BPS) affected with other capacities intact (e.g. pitch processing)
- Deeper question: Is there a relationship between BPS and other cognitive skills?
- BPS could be closely related to fundamental cognitive skills



## HUMAN-SPECIFICITY OF BPS

- Non-human animals cannot produce music (McDermott)
- If animal can display BPS ability:
  - How distinct/intertwined is BPS from music?
  - Is BPS a part of adaptation for music
- Irrelevant whether or not animal shows ability without prompting
- Existence of ability matters – does natural selection for music account for BPS?

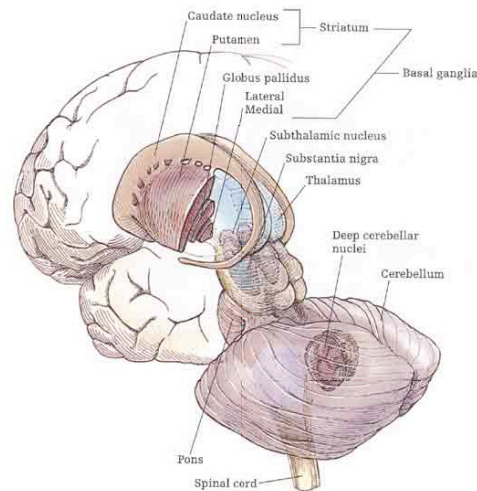


## HUMAN-SPECIFICITY OF BPS – ANIMAL CHOICE

- Hypothetical choice - Chimps, bonobos
- Close relatives of humans
- Behavior – strongly suggests BPS ability
  - Rhythmic drumming with hands, feet
  - Drumming occurs at a rate compatible with BPS studies
- Role of Basal Ganglia, may counter these points, see next slide




## THE BASAL GANGLIA AND SURROUNDING DEEP BRAIN REGIONS




## THE BASAL GANGLIA - REGION OF INTEREST

- Forms part of the distributed circuit (with cerebral cortex, thalamus) involved with gauging temporal intervals
- Accepted by Linguists and Neuroscientists as region of brain responsible for language comprehension and speech synthesis (Rodriguez et al.)
- Rhythms with regular beat (consistent meter) cause activity in the Basal Ganglia
  - Also involved with motor control
  - Controls similar functions in variety of species (includes rodents, other primates)


## THE BASAL GANGLIA - LIMITATIONS

- How does the basal ganglia respond to *auditory* input?
  - Interval timing abilities *amodal* – apply to temporal divisions in both audio and visual events
  - Humans BPS poor when exposed to temporal visual stimuli
  - Basal Ganglia alone cannot account for BPS in humans
  - There must be another reason for link between auditory input and motor output in human evolution
  - Vocal Learning may be that missing factor
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## VOCAL LEARNING – WHAT IS IT?

- Vocal learning – learning to produce vocal signals based on auditory signals heard.
  - Children use vocal learning to learn to speak
  - Very uncommon amongst other animals – could explain McDermott's assertion of 'non-musicality' of animals
  - Amongst primates, humans alone exhibit vocal learning
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## VOCAL LEARNING – WHY RELEVANT

- Has desired quality
    - A tight relationship between auditory input and motor output is *necessary* for vocal learning to succeed
  - Birds
    - Research shows that modifications to basal ganglia allows vocal learning
    - Anatomically have basal ganglia similar to humans
  - Studies may show link between strong auditory/motor relationship and BPS
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## CONCLUSION AND FURTHER RESEARCH

- Innateness of rhythmic ability
    - Linguistic ability somewhat innate
    - Rhythm – need experimentally simple tests on infants
  - Domain specificity
    - Clearly, rhythmic ability distinct from pitch detection
    - Is rhythmic ability separable from other cognitive functions?
  - Human specificity
    - Basal Ganglia responsible to some degree
    - Neural circuitry responsible for vocal learning more important
    - Other primates unlikely to show BPS ability
    - Cannot rule out non-primates having BPS ability
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