

# Polyrhythms

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Cogs 401

# What, why, how

- Perception and experience of polyrhythms; Poudrier work
- Oldest form of music except voice; some of the most satisfying music; rhythm is important in almost every type of music, polyrhythms esp. in world music
- Demos, role of rhythm in music, Poudrier work on detecting perturbations in polyrhythms

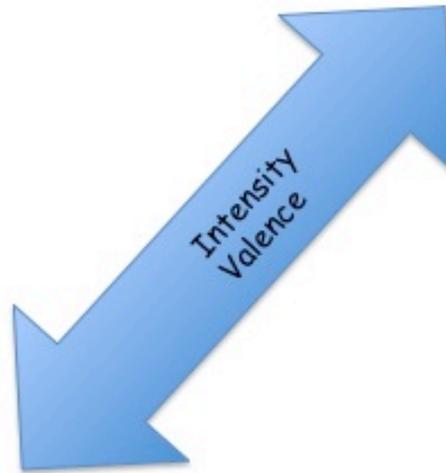
Fidali, Poudrier, Repp, 2013, Detecting perturbations in polyrhythms: effects of complexity and attentional strategies. *Psychological Research*, 77, 183-195.

Poudrier, Repp, 2013, Can musicians track two beats simultaneously? *Music Perception*, 30, 369-390.

# Demonstrations

- Hand slap demo
- <https://www.youtube.com/watch?v=haGWi5lTibI>
- Swanson and friend
- [https://www.youtube.com/watch?v=rrEqNTyMF\\_A&list=RD8cXHkDH1l0Y&index=2](https://www.youtube.com/watch?v=rrEqNTyMF_A&list=RD8cXHkDH1l0Y&index=2)

# Music, dance, emotion



# Meter and phrasing

- Meter: metronomic patterns of accentuated beats
- Phrasing: structured temporal organizations of musical “shapes” – can be irregular
- Pink Panther theme makes wonderful use of phrasing to sometimes accentuate and sometimes undercut the meter
- <https://www.youtube.com/watch?v=HhHwnrlZRus>

# What is a polyrhythm?

- Monorhythm – Viennese waltz
- <https://www.youtube.com/watch?v=iwdWE-X2vRI>
- Polyrhythm
- Ladzepko (1)
- <https://www.youtube.com/watch?v=yK42w0H8rSU>
- Pop/bass
- <https://www.youtube.com/watch?v=CtZ74JdxCt0>

# Polyrhythm production

- Focus on difficulty of execution
- Complexity of ratio is key: 2:3 is easier than 5:7
- Production is aided by conceptualization as a “sequential integrated rhythmic pattern” (“pass the dog-gone butter”)
- So things that facilitate perceptual integration, such as small separation between pitches of two streams, also facilitate production
- Practice makes (nearly) perfect

# Polyrhythm perception

- Salience of different pulses varies with ratio, pitch, speed, etc.
- Auditory stream segregation (Bregman): does the multi-pitched stream of pulses split into two or more separate streams (based on pitch separation or location)? If so, polyrhythm might not be heard but attention can be paid to either stream.
- Fission boundary: pitch separation  $< 4$  semitones integration always occurs
- Temporal coherence boundary: rapid tempo and large pitch separation: segregation always occurs
- In between?????

# Measuring polyrhythm perception

- Introduce perturbation into the polyrhythm and see whether listeners can detect it
- Example (Jones, et al, 1995): take 2:3 polyrhythm and perturb one tone in the slower (2-pulse) by  $\pm 60$  ms.
- When faster (3-pulse) was only 3 semitones higher in pitch, performance was better than either when it was 43 semitones higher or in a single-stream baseline => integration aided perception of the polyrhythm.
- Maybe explained by introduction of some shorter IOIs in the polyrhythm so perturbation was larger in percentage terms there.
- Instructions to integrate or segregate had no effect.

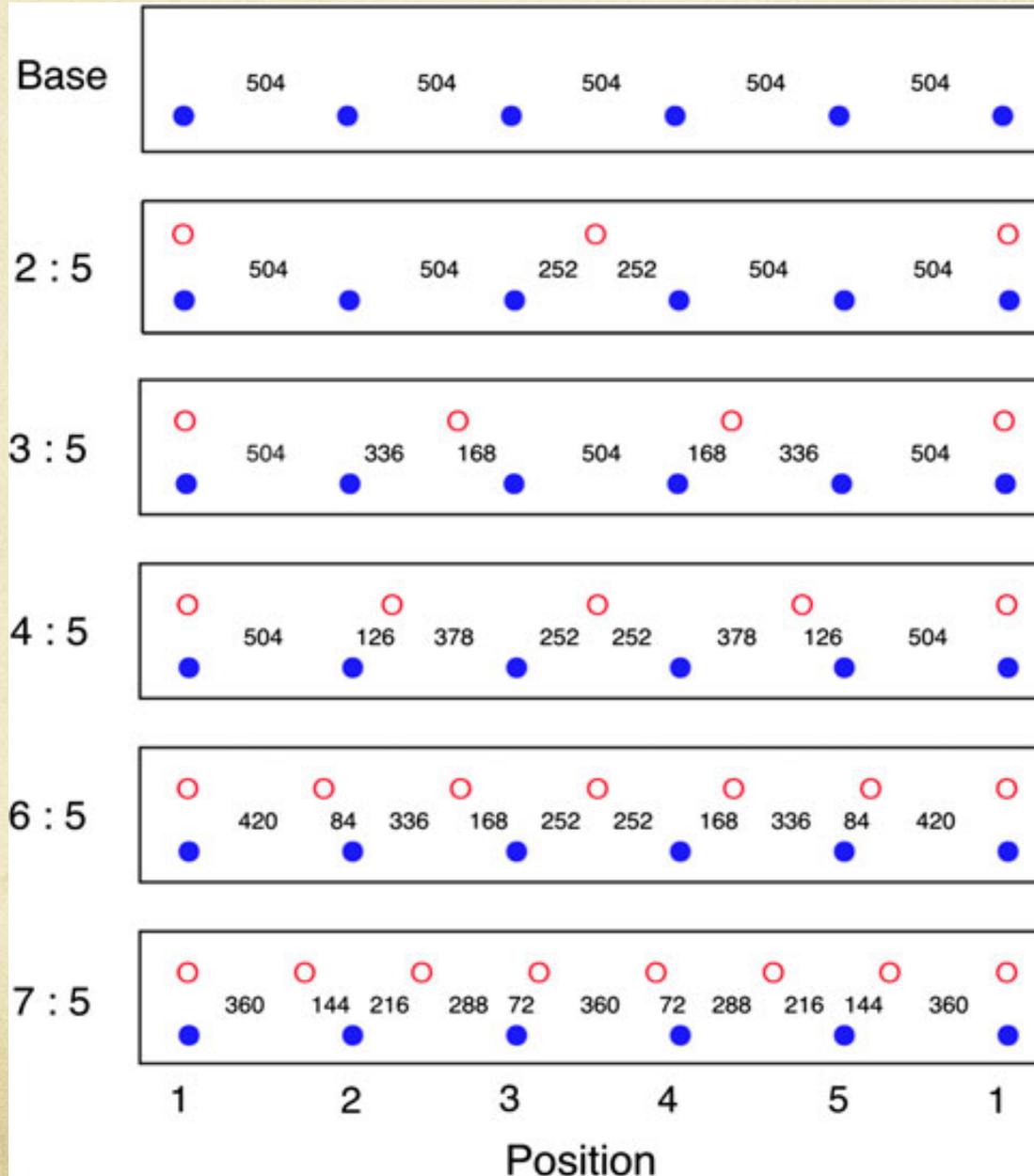
# BUT

- What about more complex rhythms? Does integration help there? They create even shorter subintervals.
- BUT:
  - More complex rhythms => more demands on memory
  - More complex rhythms => more variety of intervals, which in addition to creating more memory demands might interfere directly with detecting the perturbation (more demands on internal timekeeping).
- Will intentional segregation (paying attention to one substream) help?

# Experiment 1

- Complexity = number of pulses per cycle, and initial pulses coincide so count as only 1 pulse: 3:5 = 7; 4:5 = 8; 6:5 = 10; 7:5 = 11
- Perturbations (in tone 2,3,4, or 5) in 5-tone stream; 30 or 50 ms
- Pitch separation 1 or 7 st (note 1 < 4; 7 >4; fission boundary)
- 5-tone (baseline) stream held constant; other streams slowed or speeded to accomplish ratio

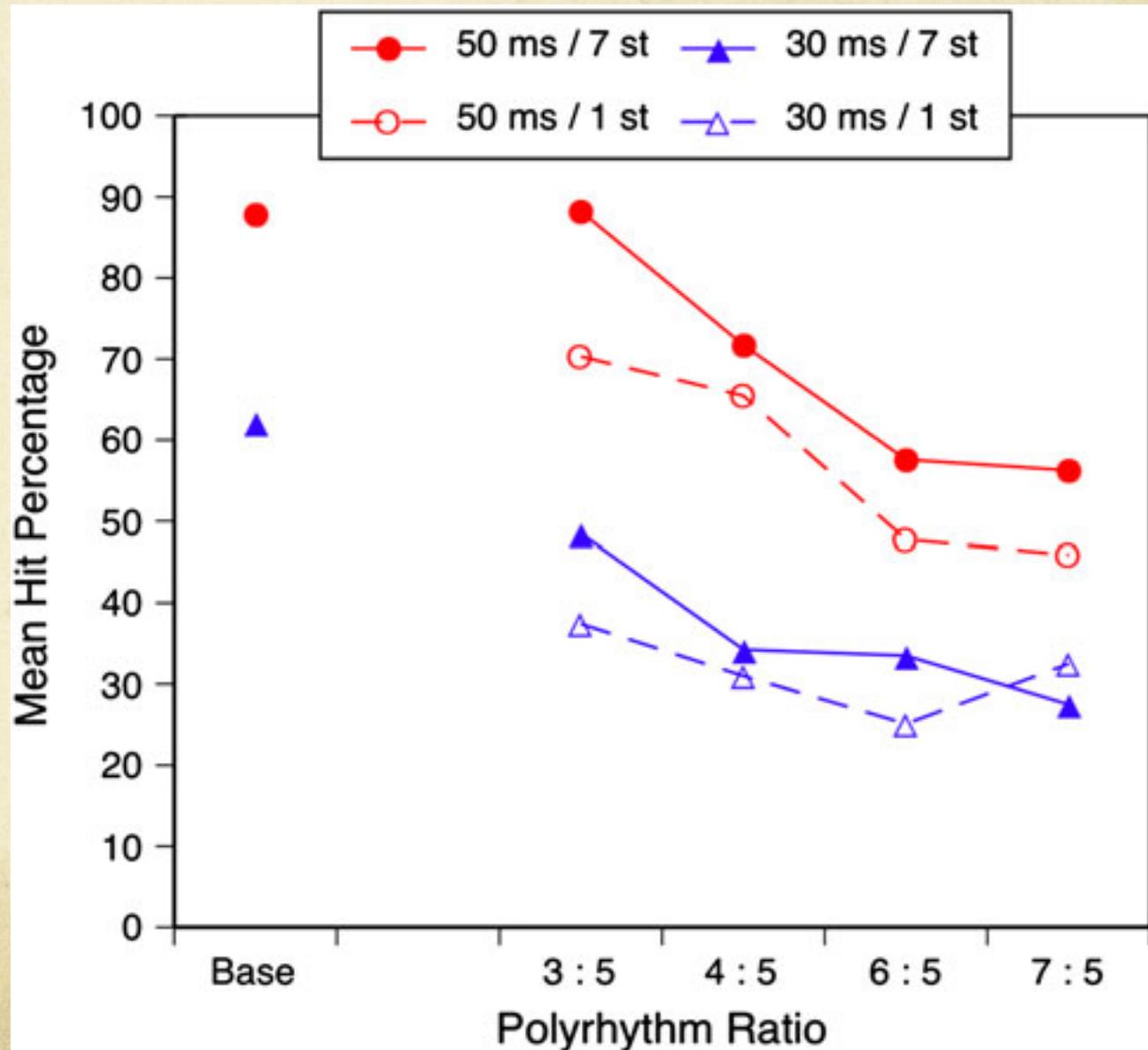
# Experiment 1



Note shorter and more variable IOIs in more complex streams

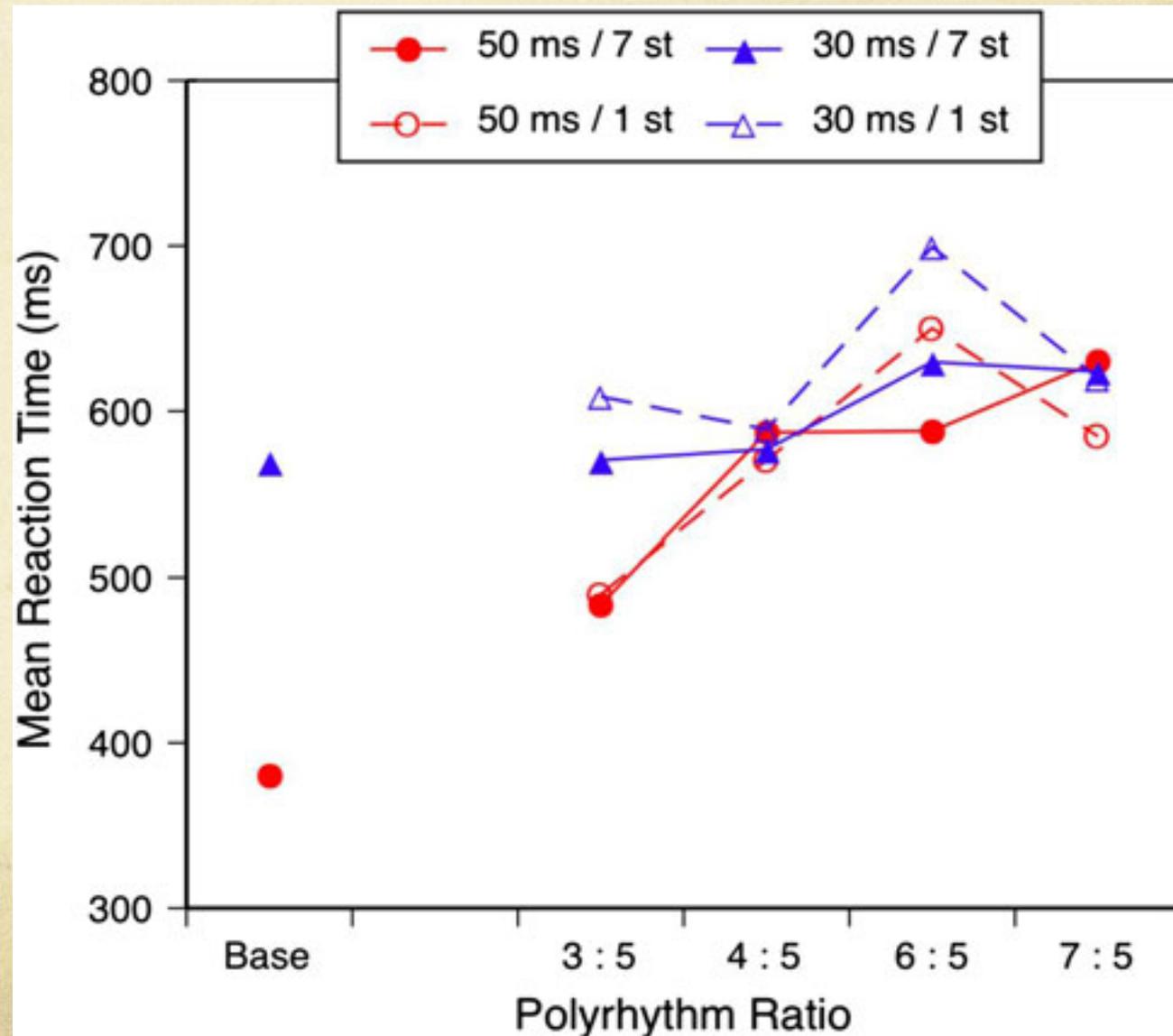
# Experiment 1 Hit Results

- Better performance on large perturbation and less complex rhythm but all pretty much below single-stream baseline
- Better performance at 7 st than at 1 st
- => integration and shorter IOIs didn't help



# Experiment 1 RT Results

- RT longer the more complex the rhythm; no effect of perturbation size or pitch separation
- All same as or slower than baseline so polyrhythm didn't help
- Complexity dominated
- No effect of selective attention

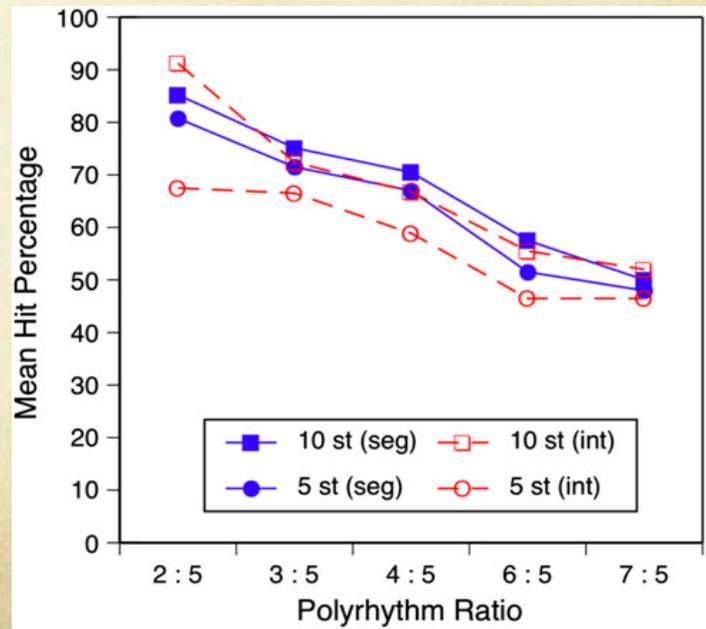
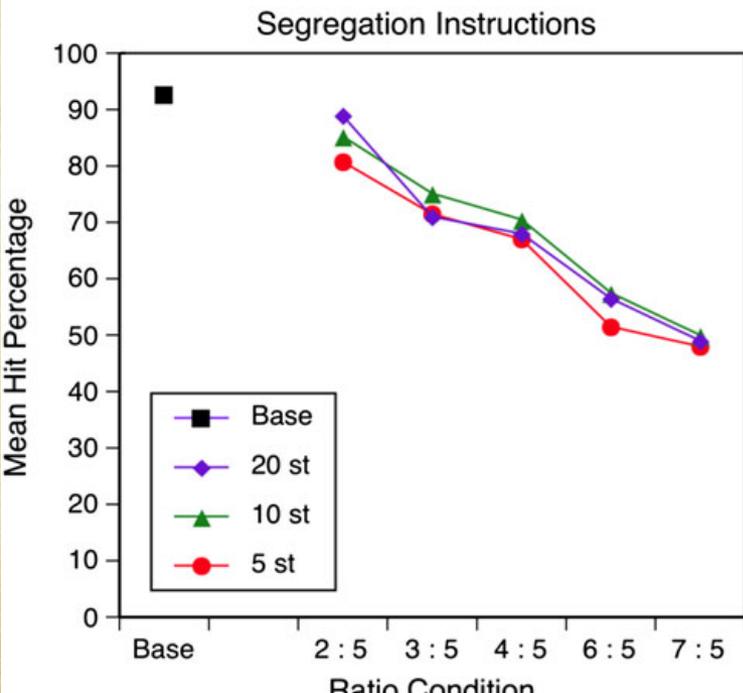
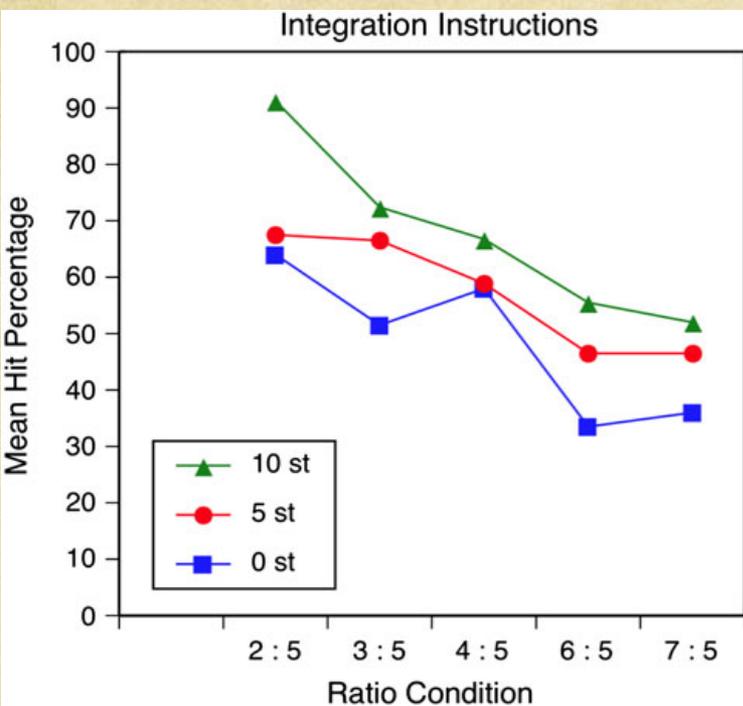


# Experiment 2

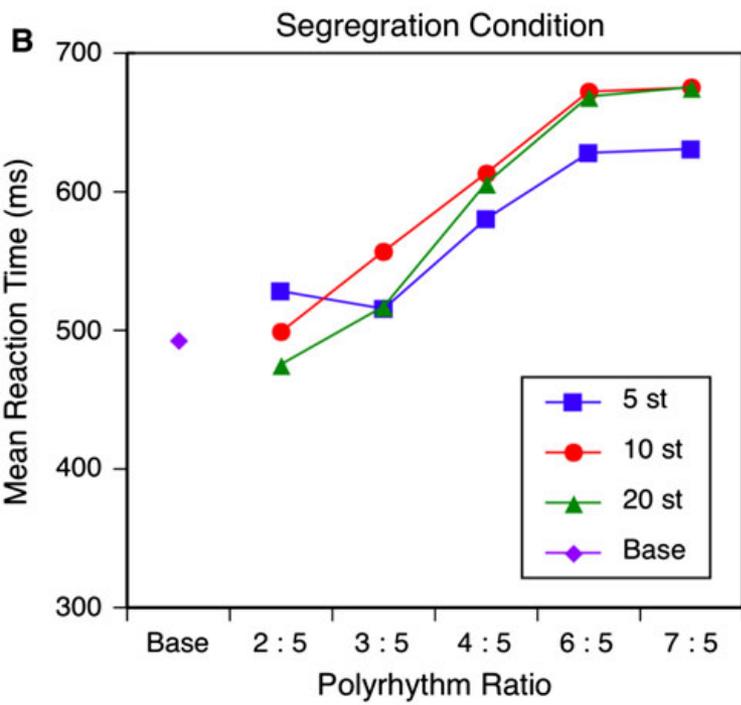
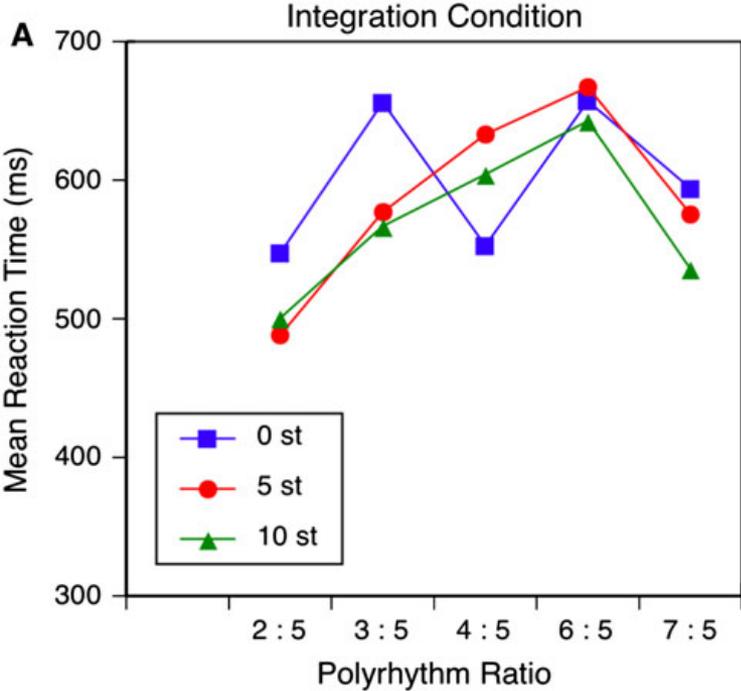
- 2:5 rhythm added
- Instructed to integrate or segregate
- 5 st and 10 st pitch separations for all
- 0 st separation also for integrate group; 20 st separation for segregate group
- If IOI duration is critical, then integrate better; if memory and variability of IOI is critical then segregate better

# Experiment 2 Hit Results

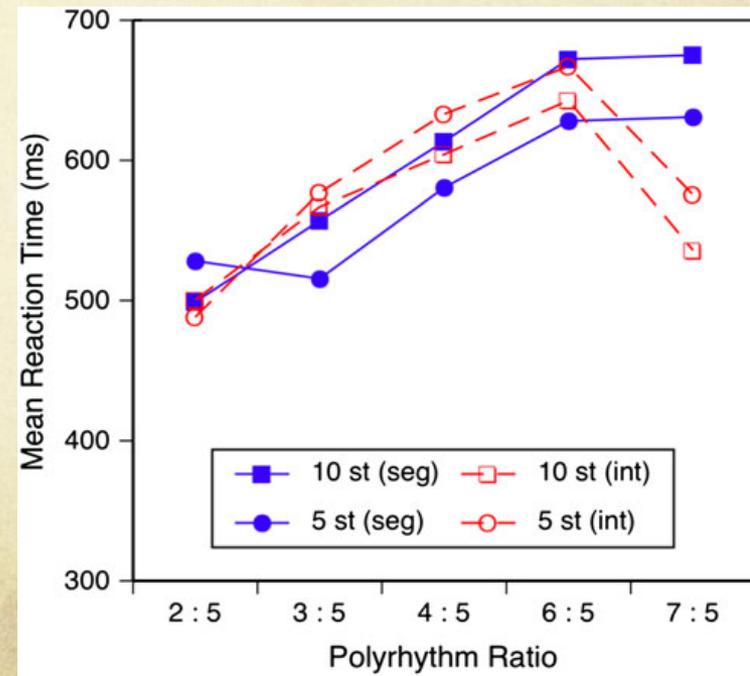
- Performance worse as complexity increased in both, and for integration worse for smaller pitch separation
- Even large pitch separation made no difference to segregation group
- All performance at or below baseline



# Experiment 2 RT Results

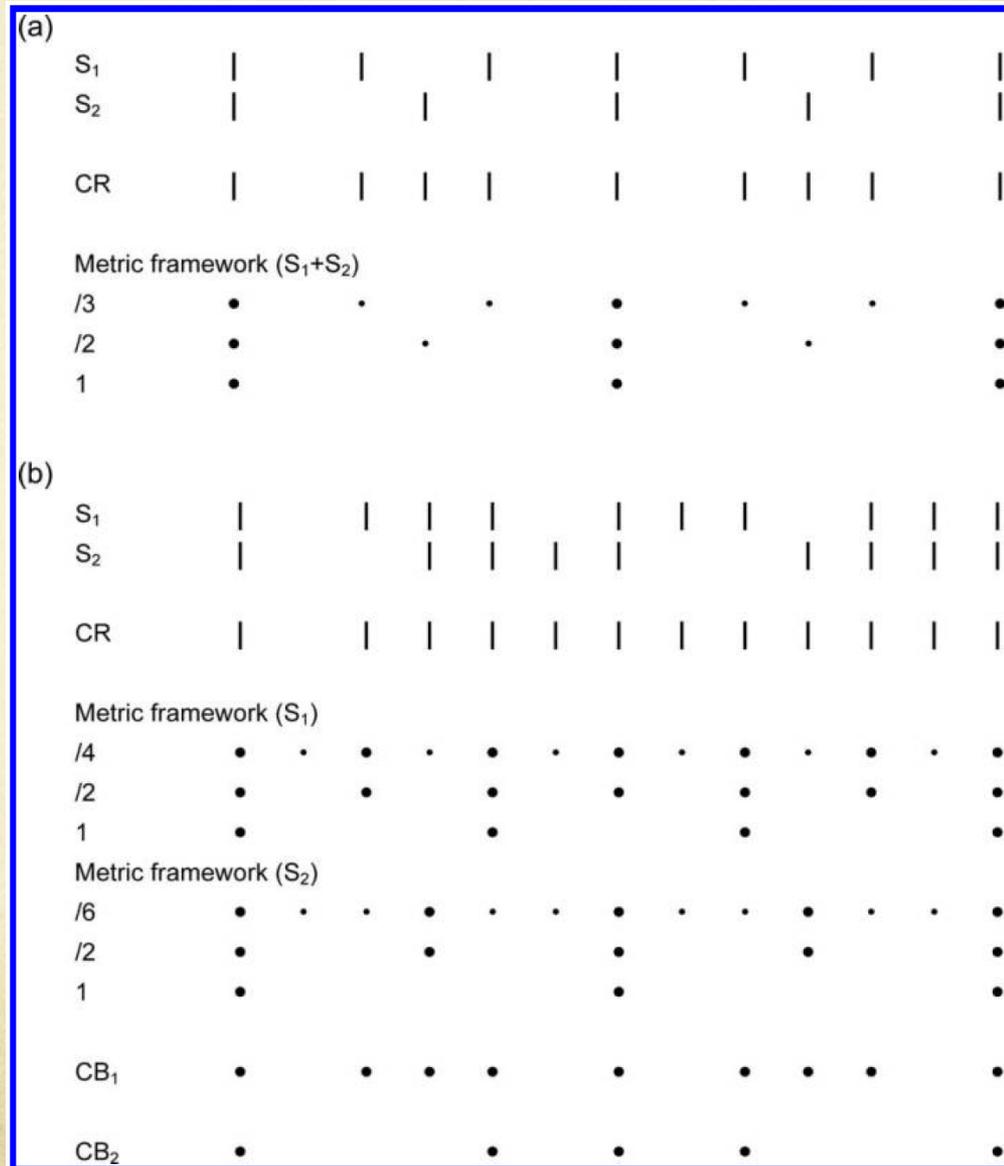


- Quadratic (INT) and linear (SEG) trends of RT with complexity
- No differences between groups on shared pitch differences except for slightly faster INT at 7:5



# More on polyrhythms

- Composite rhythm (CR)
- Metric framework
- Composite beat pattern (CB)
- Polymetric perception: simultaneous perception and tracking of two different beats



# Can musicians track two beats?

Poudrier, Repp, 2013, *Music Perception*

- Yes for simple rhythms
- Classical musicians
- 3:2 polyrhythm
- Variety of phase relations between beats
- Is the high-pitched tone on the beat?
- Selective or divided attention

(a)

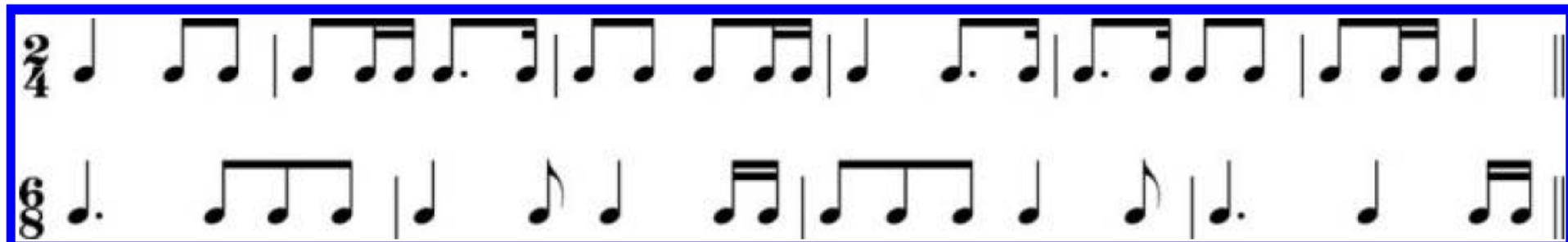


(b)



# More complex, variable rhythm

- OK in selective attention condition but basically chance performance in divided attention condition
- Difficult to perceive complex polyrhythm at once – usually done by attending separately to the two metric patterns



# Conclusions

- Only slight position effects in most complex rhythms
- Integration hindered rather than helped performance
- No large effects of instructions and especially segregation instructions did not help, even at the widest pitch separation
- Complexity of the rhythm dominated, and polyrhythms were always as or usually more difficult to perceive than the single-stream baseline.
- Selective attention used to perceive complex, variable polyrhythms