Perceptual organization & attention: relationship and neural architecture

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Acknowledgements
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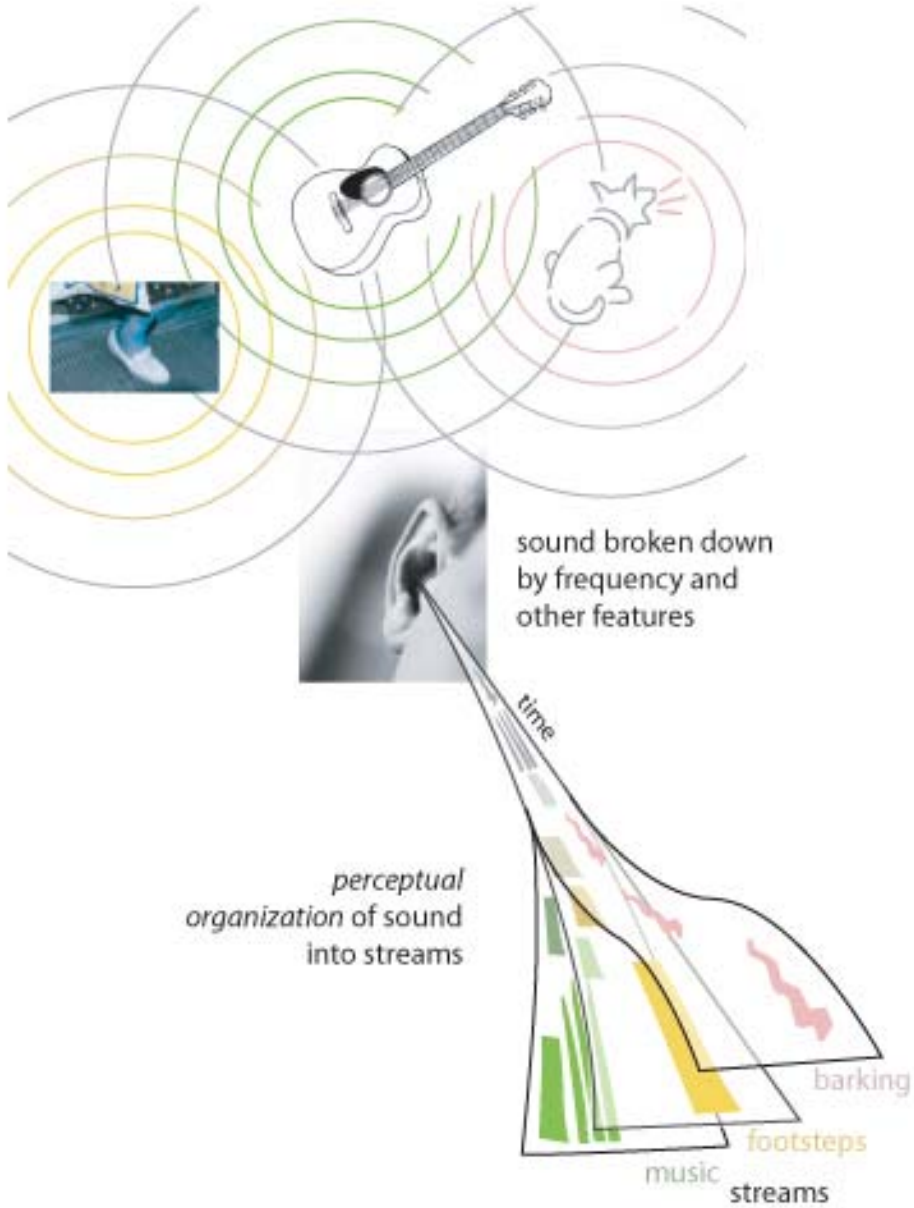
Auditory scene analysis

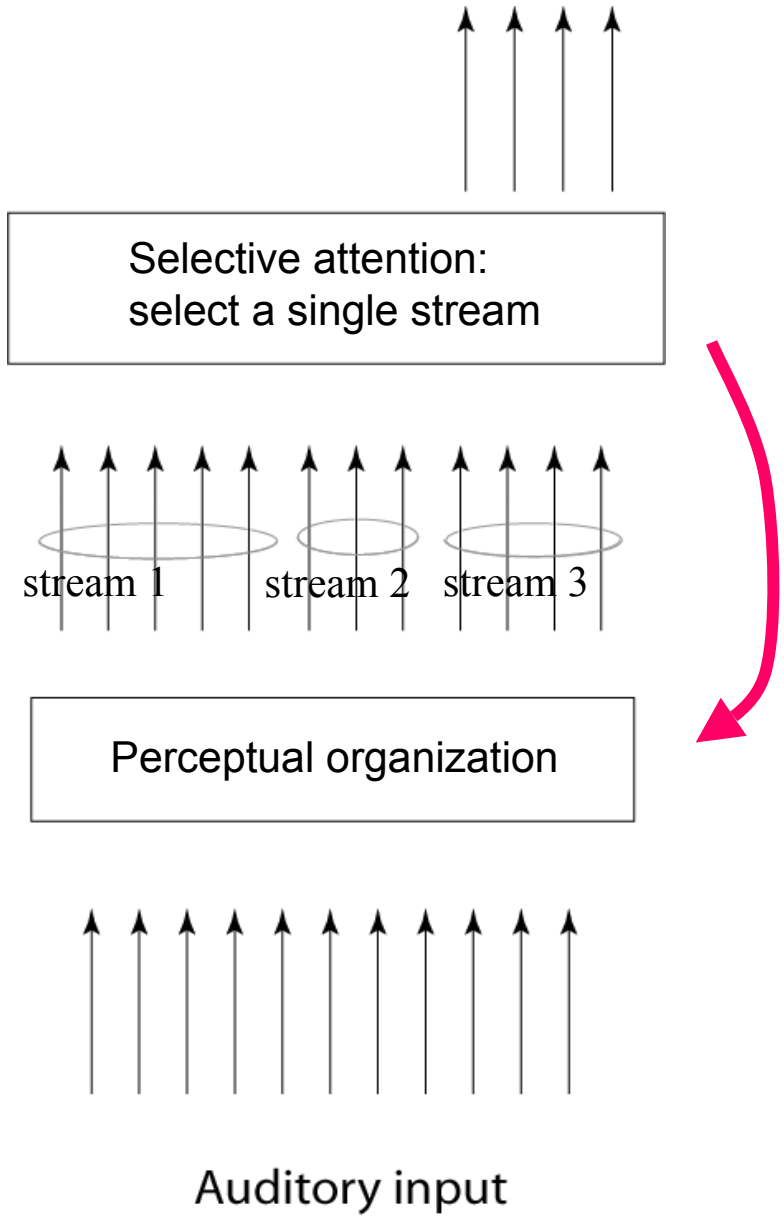
- Important process in the human auditory system
  - affects pitch, timbre, rhythm
  - ability to selectively attend to part of the scene
- Clinical importance
  - autism
  - dyslexia

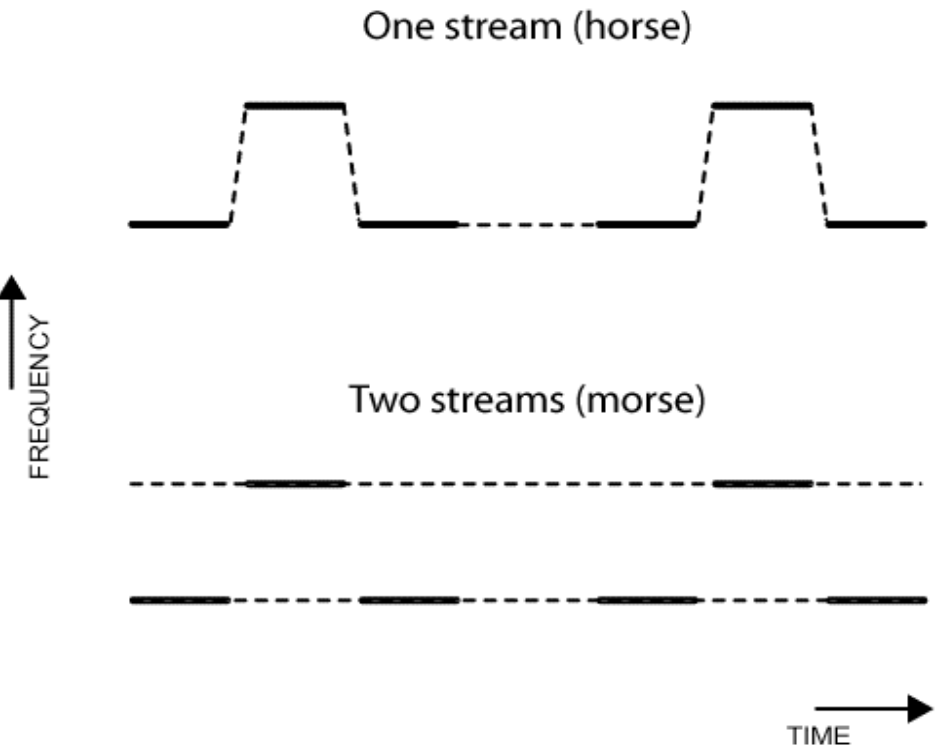


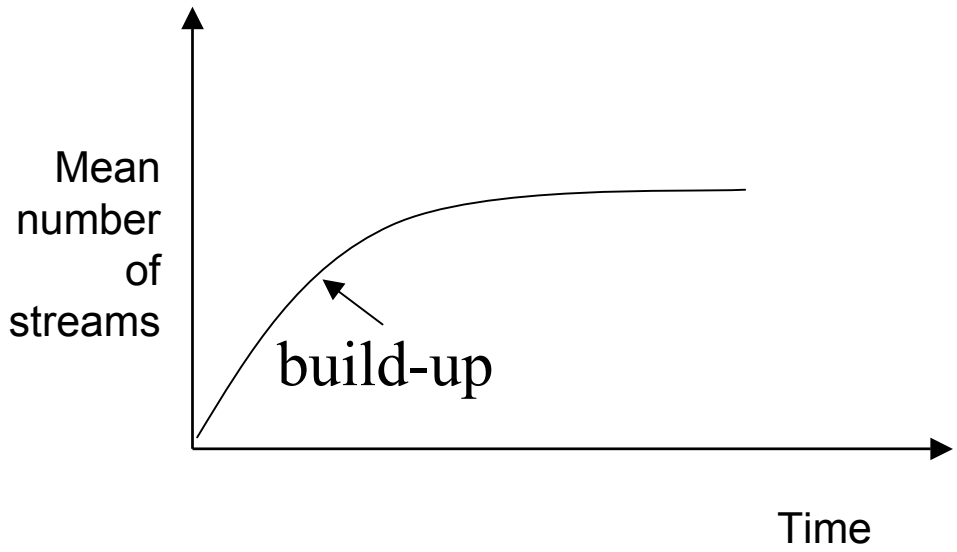
How do selective attention and perceptual organization interact?

Selective attention: use prior knowledge of target source

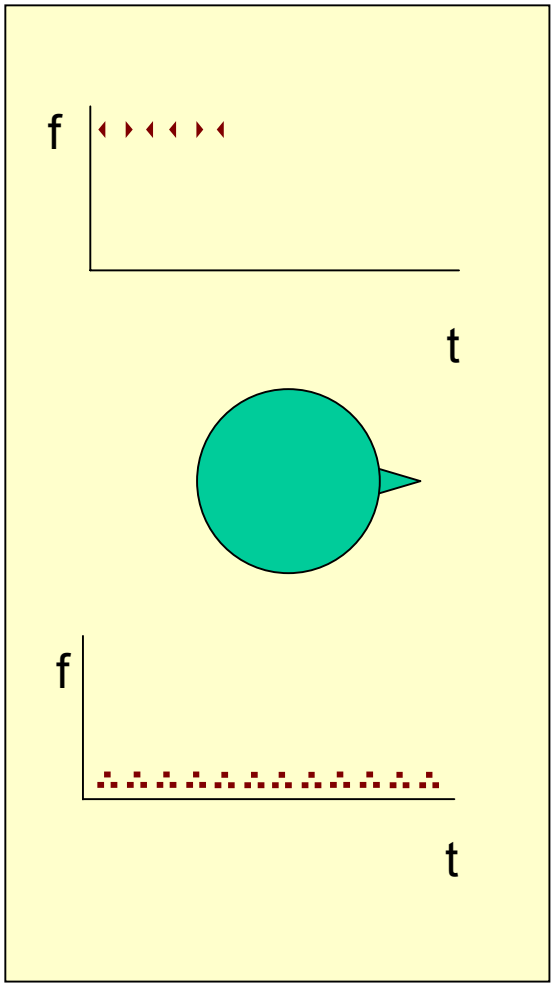
Perceptual organization: use regularities of sounds in the world to group their parts together



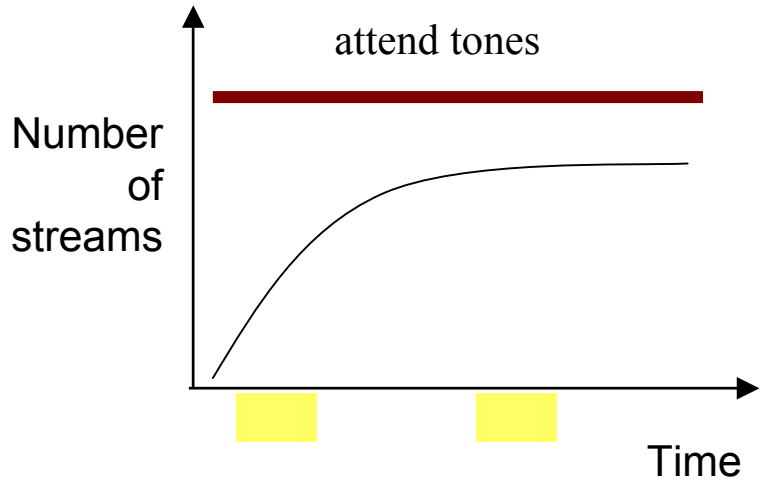




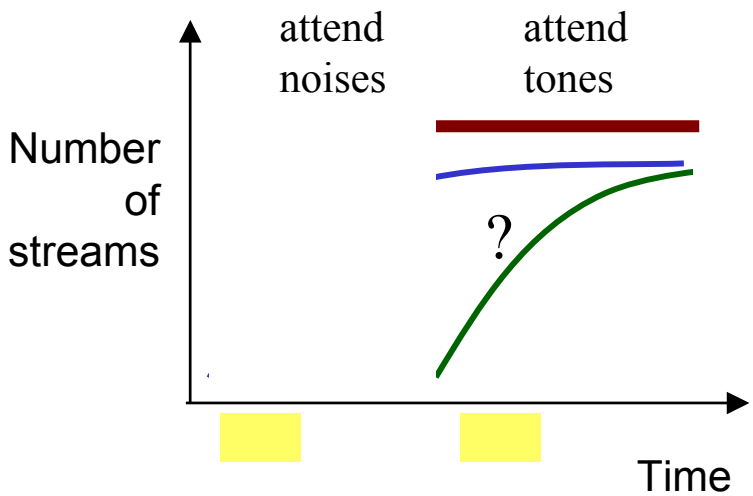
Is the amount of build-up affected by attention?



Cond 1: attend tone triplets througout

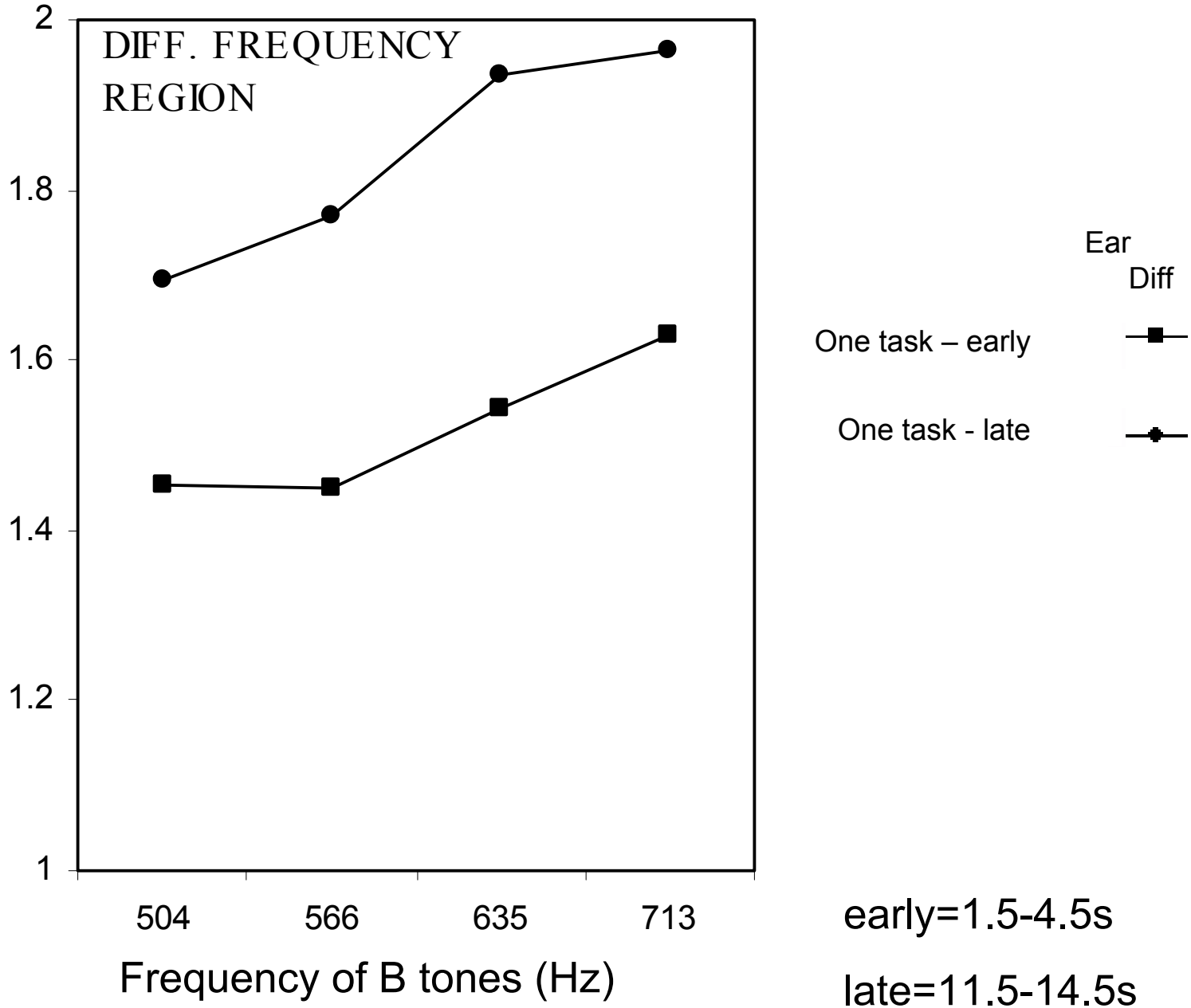


Cond 2: attend to tones in second half



20 s long; early=1.5-4.5 s; late=11.5-14.5s

Exp 1



early=1.5-4.5s

late=11.5-14.5s

Cusack, Deeks, Aikman & Carlyon (2004); Carlyon, Cusack, Foxton & Robertson (2001)

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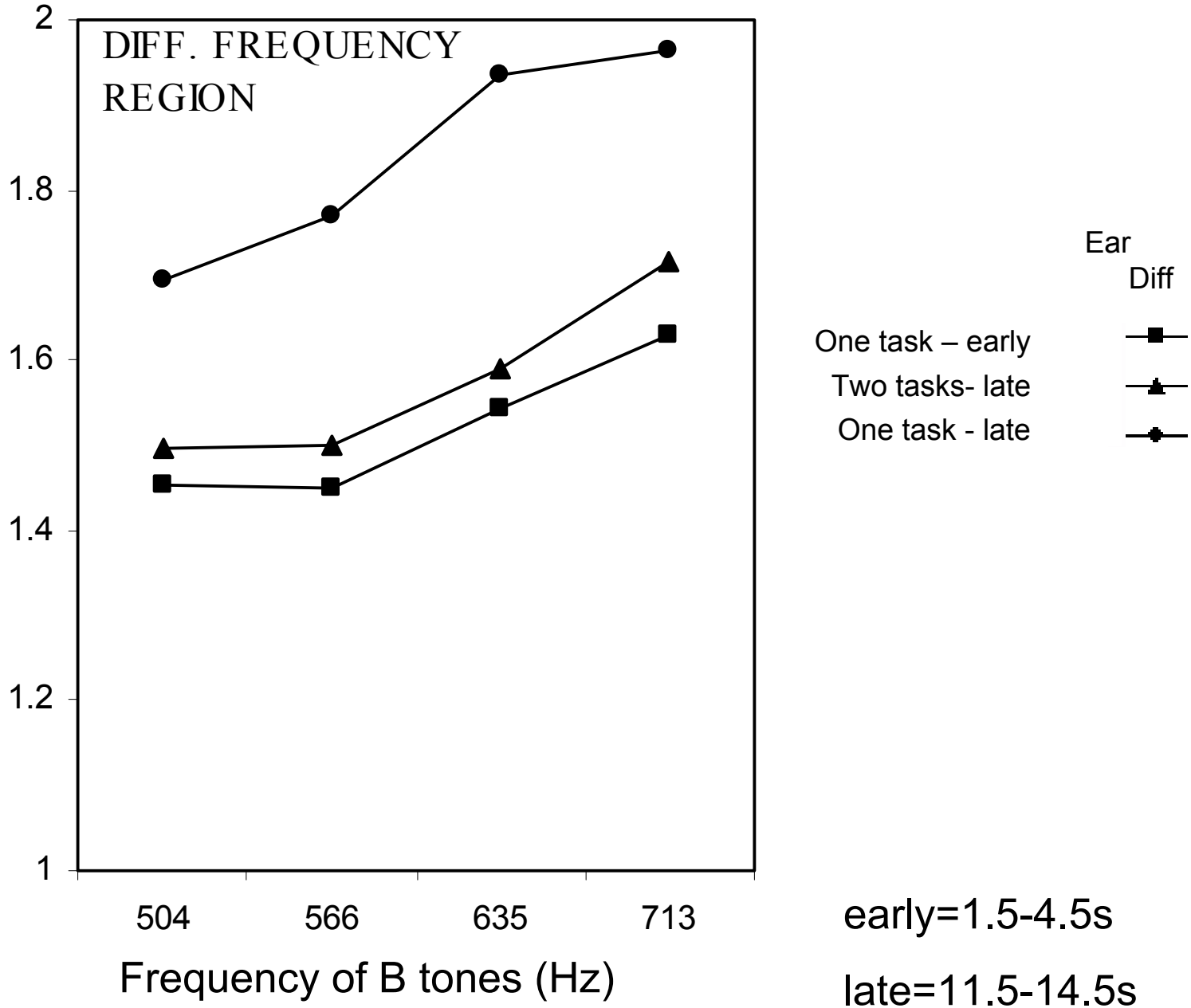

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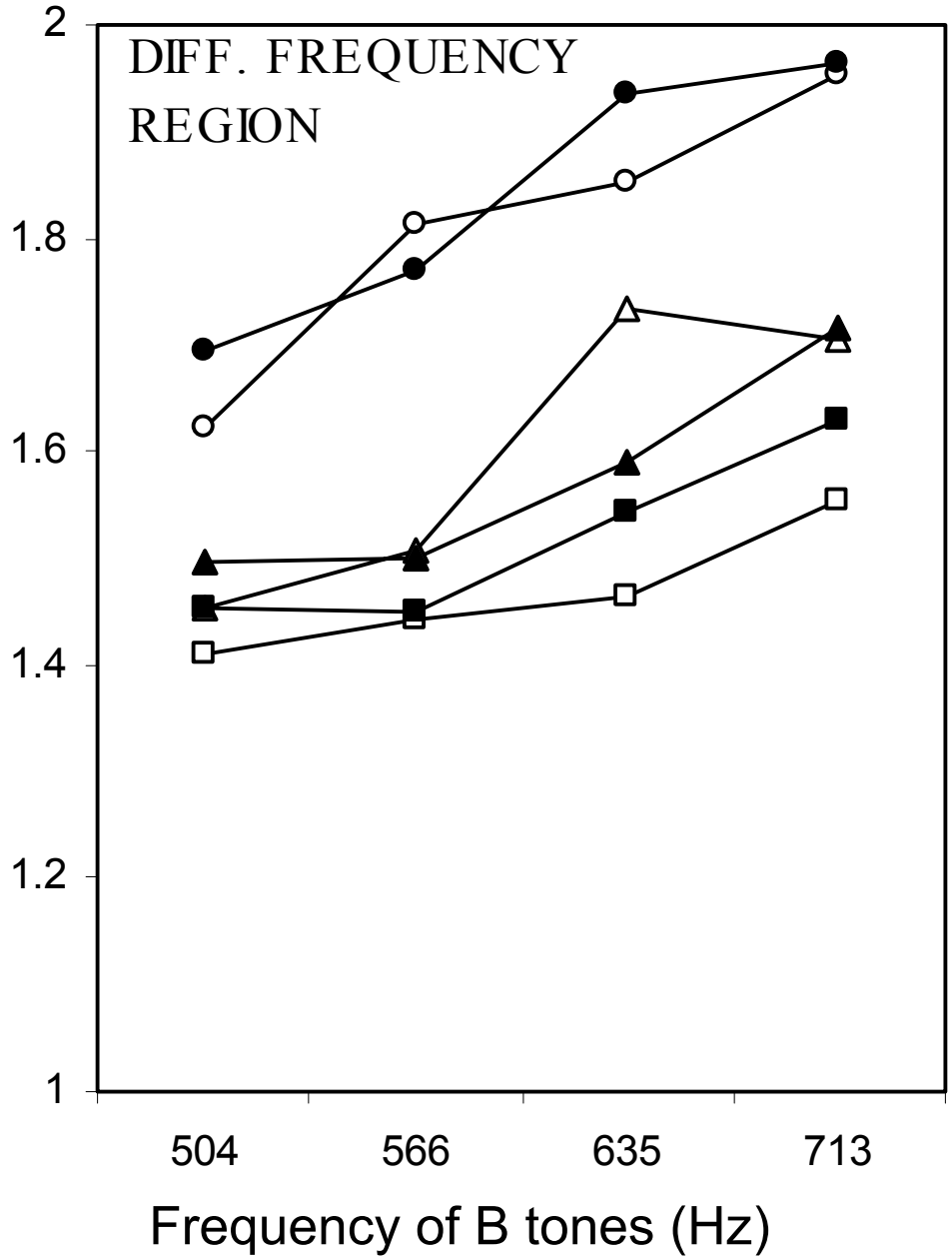

early=1.5-4.5s

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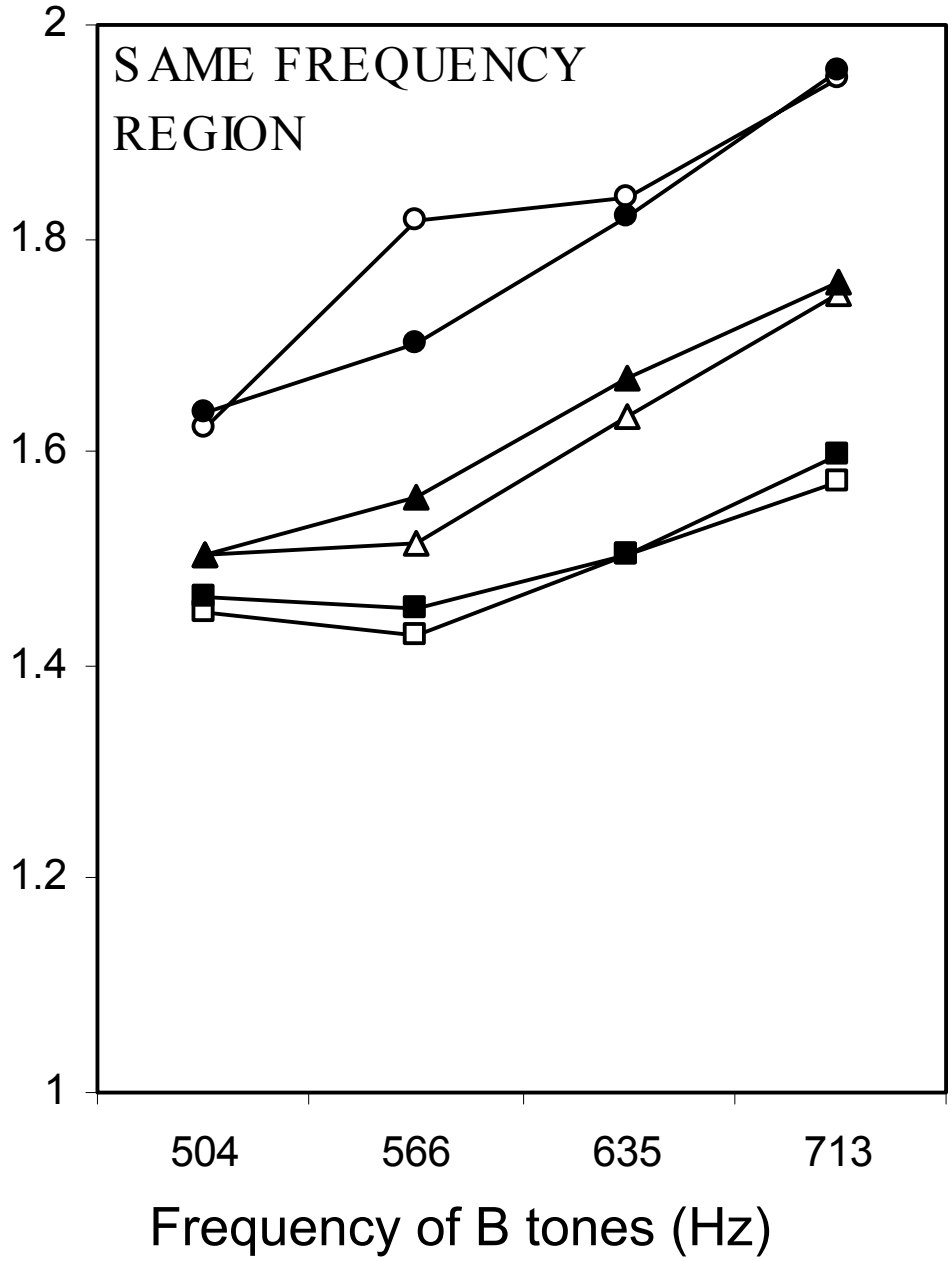
Cusack, Deeks, Aikman & Carlyon (2004)

Exp 2



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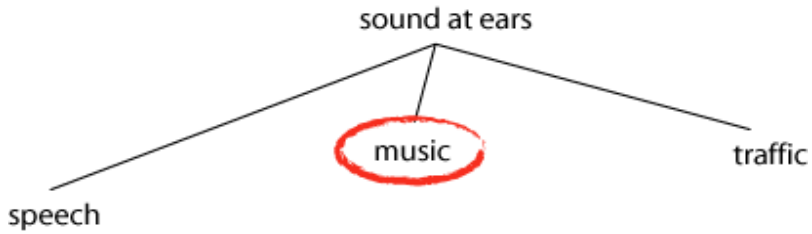
Cusack, Deeks, Aikman & Carlyon (2004)

Hierarchical decomposition model



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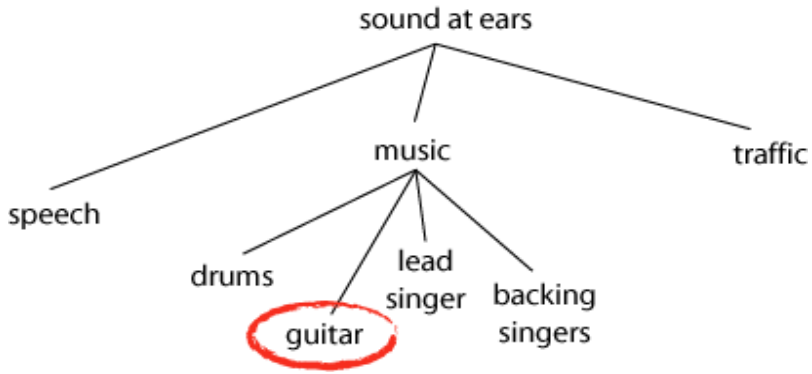

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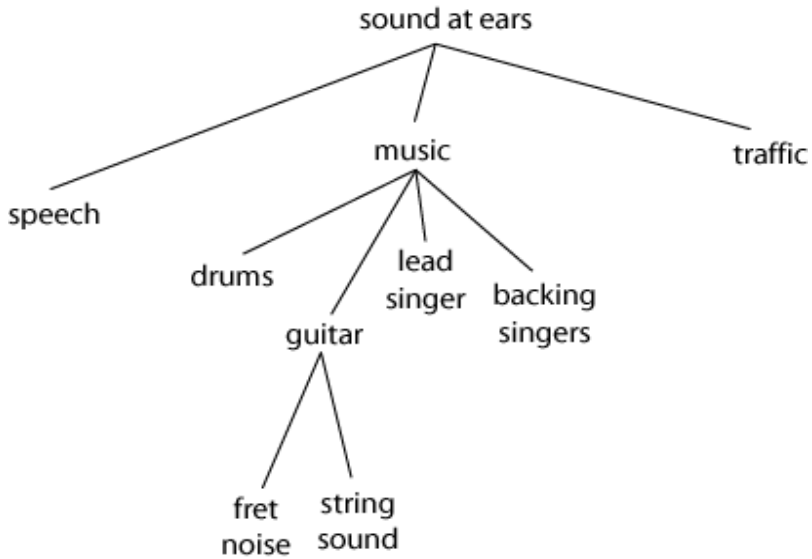
Hierarchical decomposition model



Cusack, Deeks, Aikman & Carlyon (2004)

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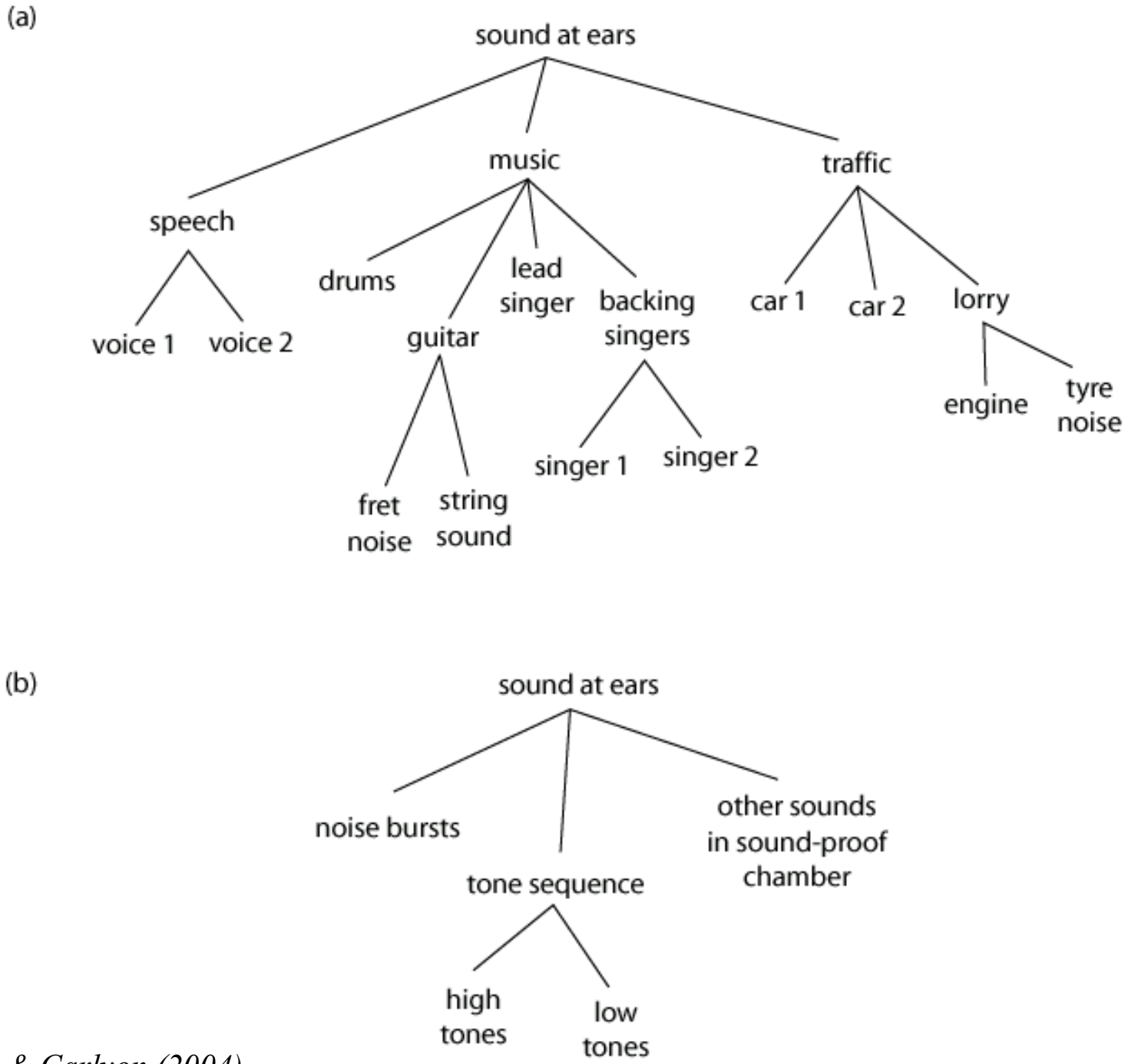


Cusack, Deeks, Aikman & Carlyon (2004)

Hierarchical decomposition model in vision

grouping

selection

grouping

selection

grouping

Towards a neural model: Integrated Competition

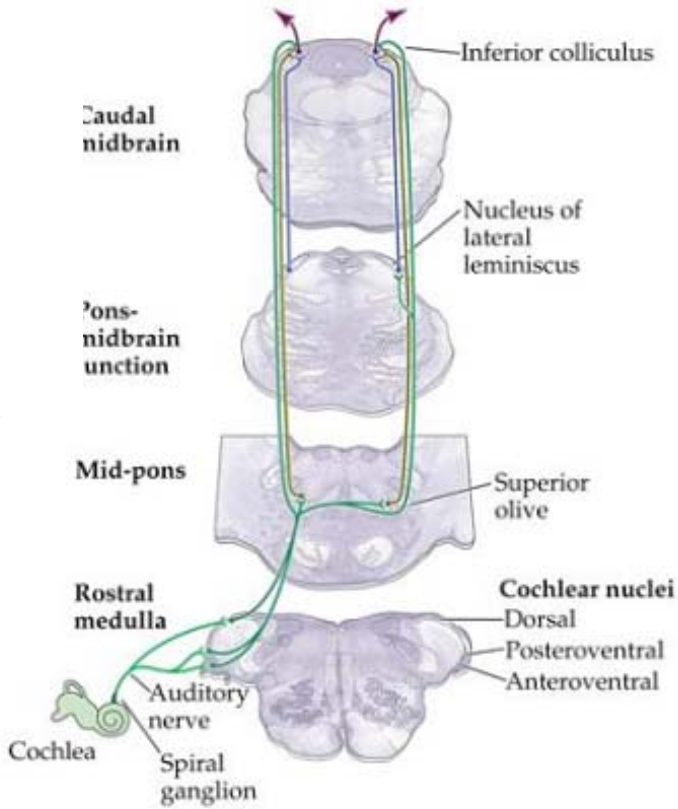
- Integrated competition model of visual attention (Duncan, 1996) explains a range of behavioural and physiological data
- Visual features are extracted in a range of brain regions
  - e.g., orientation, colour, movement
- COMPETITION for attention within each region
  - activity evoked by target objects is enhanced & by distractors is suppressed
- Activity level then INTEGRATED across different regions, so that all of the features of the attended targets are well represented

Integrated competition in perceptual organization

- Perceptual organization within each level
  - the representation of each sound element COMPETES for grouping with others
- This perceptual organization is then INTEGRATED across the different levels

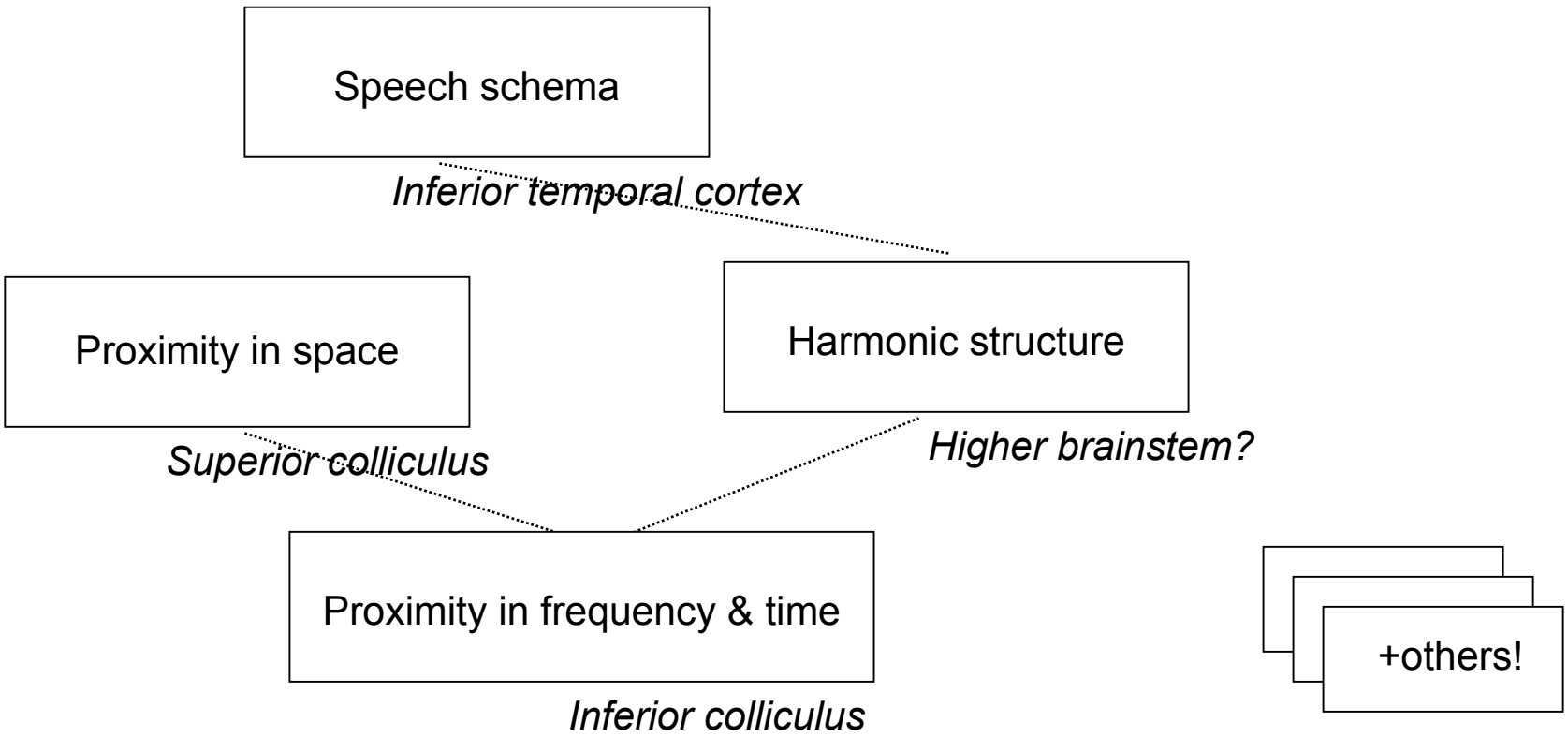
Information involved in perceptual organization best represented at many different levels

CUE	BEHAVIOURAL EVIDENCE	BRAIN REGION
frequency	Hartmann & Johnson	cochlea
ear	1991	inf. colliculus
ITD	Rogers & Bregman 1998	sup. colliculus
pitch	Vliegen & Oxenham 2001	higher brainstem?
timbre	Cusack & Roberts 2000; Roberts, Glasberg & Moore, 2002	auditory cortex?
learnt represents.	Scheffers 1983	inferior temporal

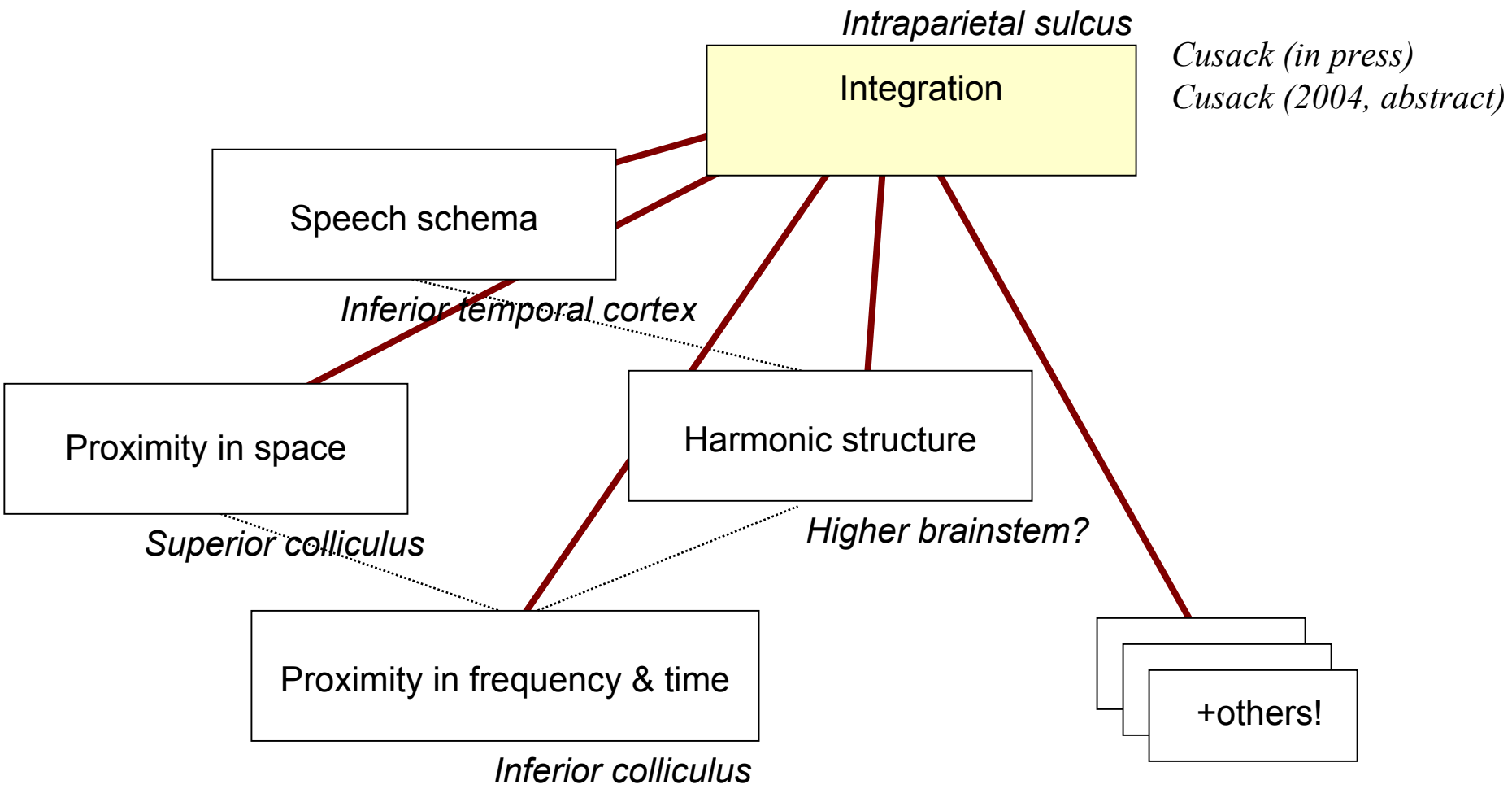


Cusack & Carlyon (2004)

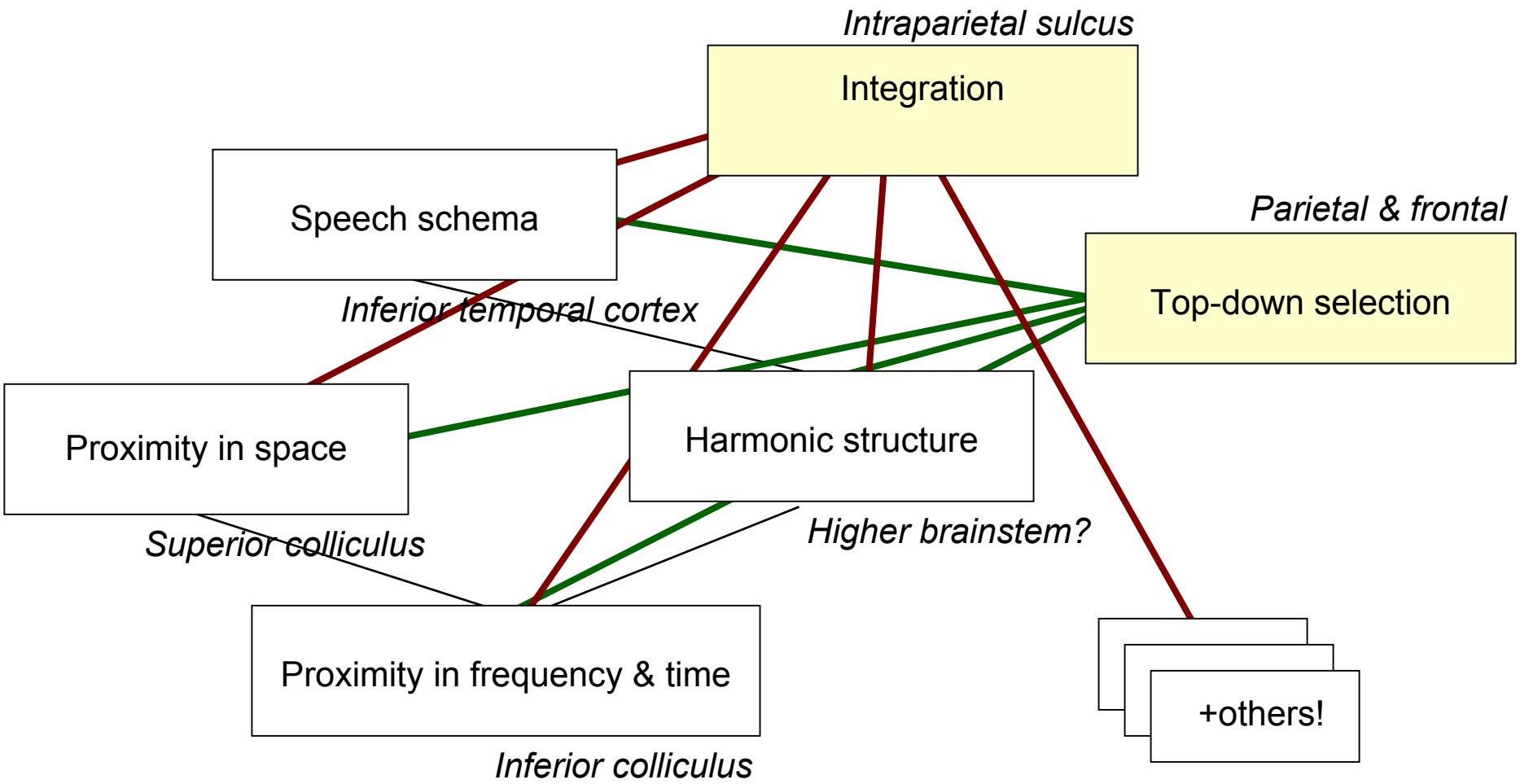
Integrated competition in perceptual organization



Integrated competition in perceptual organization



Integrated competition in perceptual organization



Summary

- Unattended sounds do not show a build-up of streaming, even if in same ear and frequency region as sounds being attended
  - consistent with hierarchical decomposition model
- Integrated competition of attention & perceptual organization could elegantly model these effects
  - consistent with a range of behavioural and physiological data
  - intraparietal sulcus may play a role in integration across regions