Perceptual learning of novel sounds

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Introduction

Auditory memory

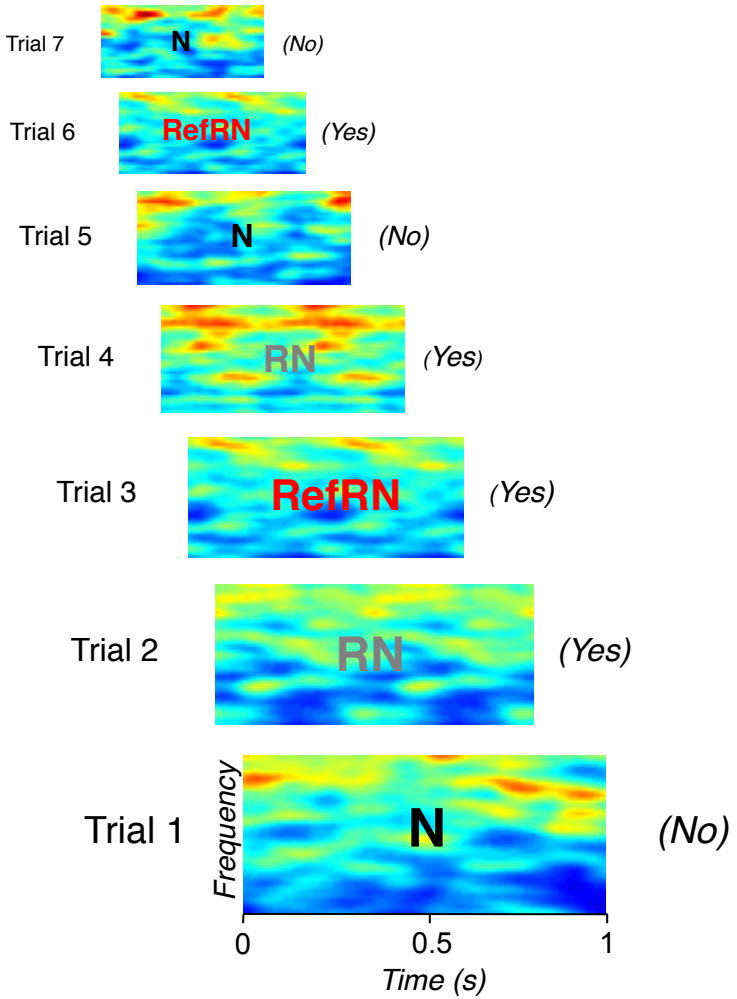
- Auditory features and sound sources associated by experience
- White noise to observe the formation of new auditory memories
  - complex
  - meaningless
  - never heard before

Memory for noise

Task

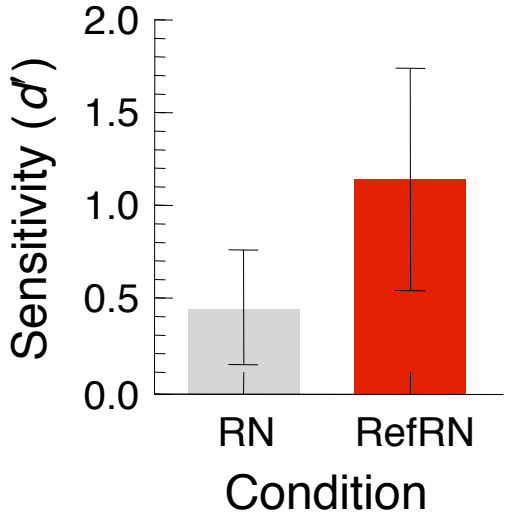
- 1s noise sample
- Repetition-detection task
- RefRN identical throughout block

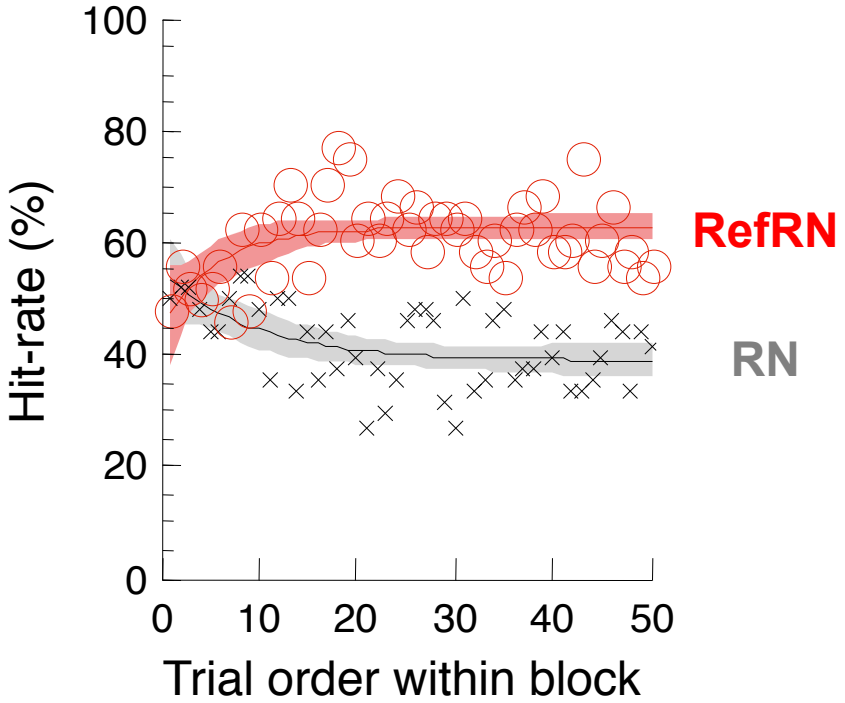
-> Improvement for RefRN=learning



Memory for noise

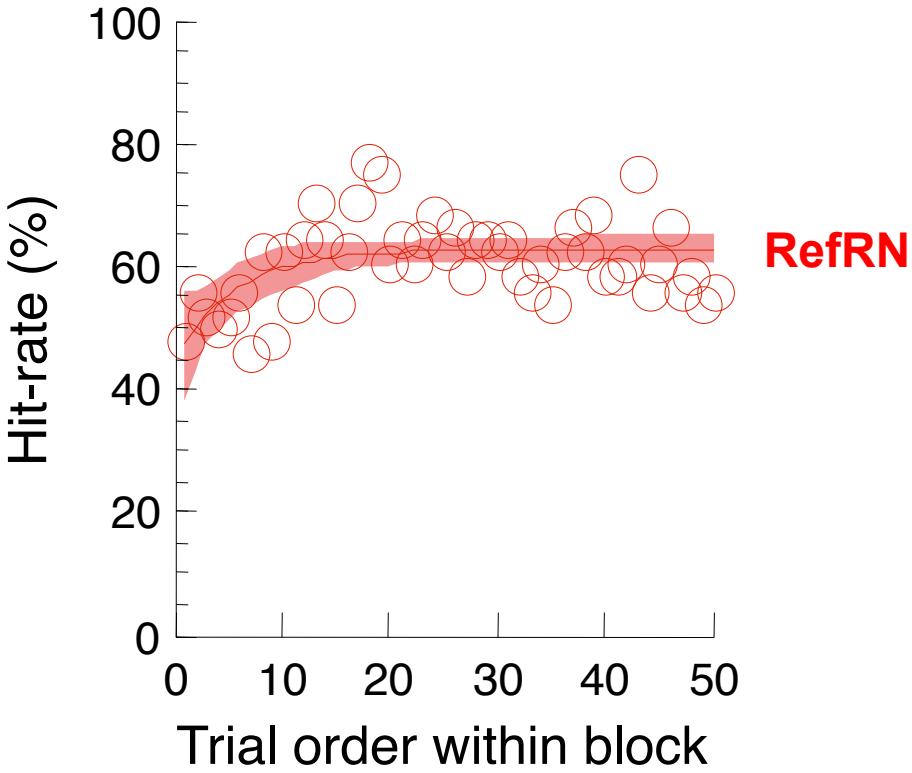
Average results





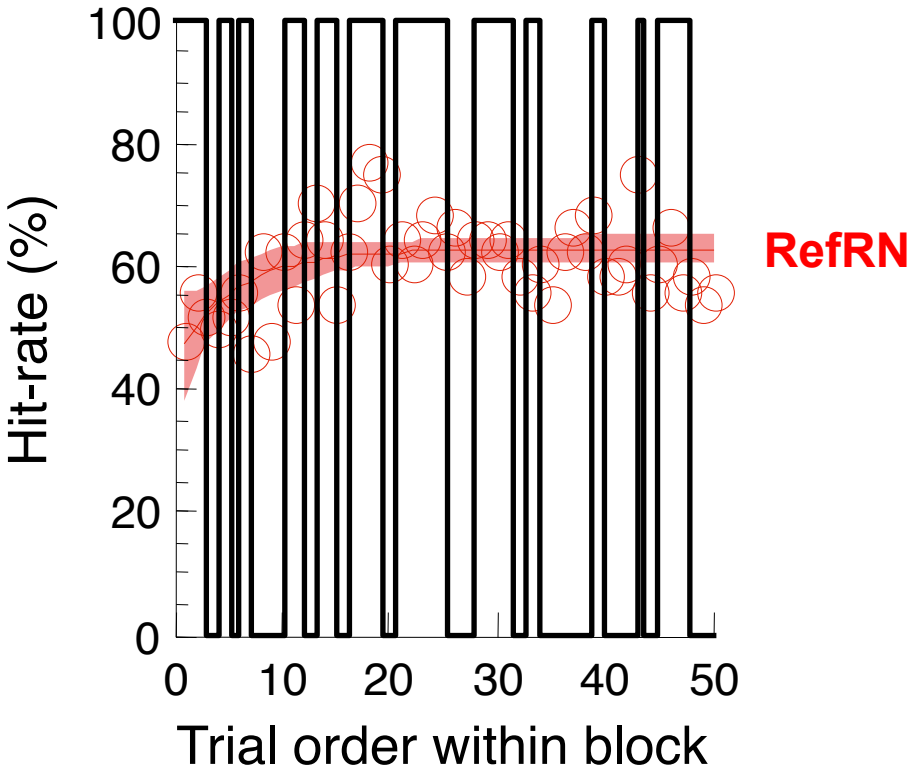
- Performance advantage for reference samples
- Due to an increase in sensitivity during the block
- Decrease for RN: criterion effect (Gorea & Sagi 2000)

Memory for noise



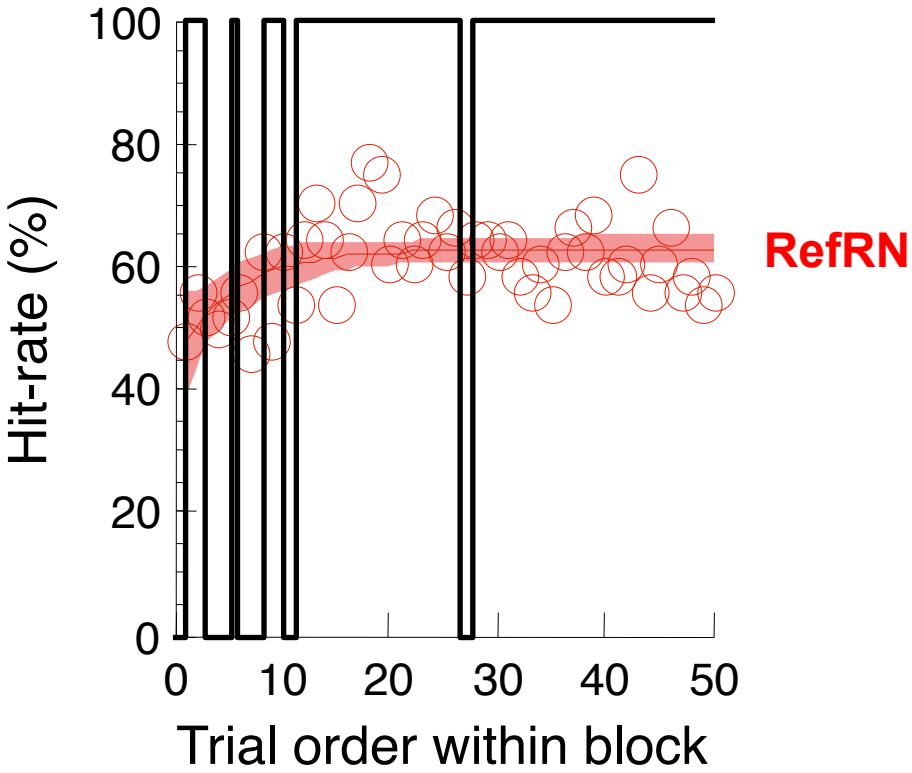
- Modest increase on average
- But inter-block variability

Memory for noise



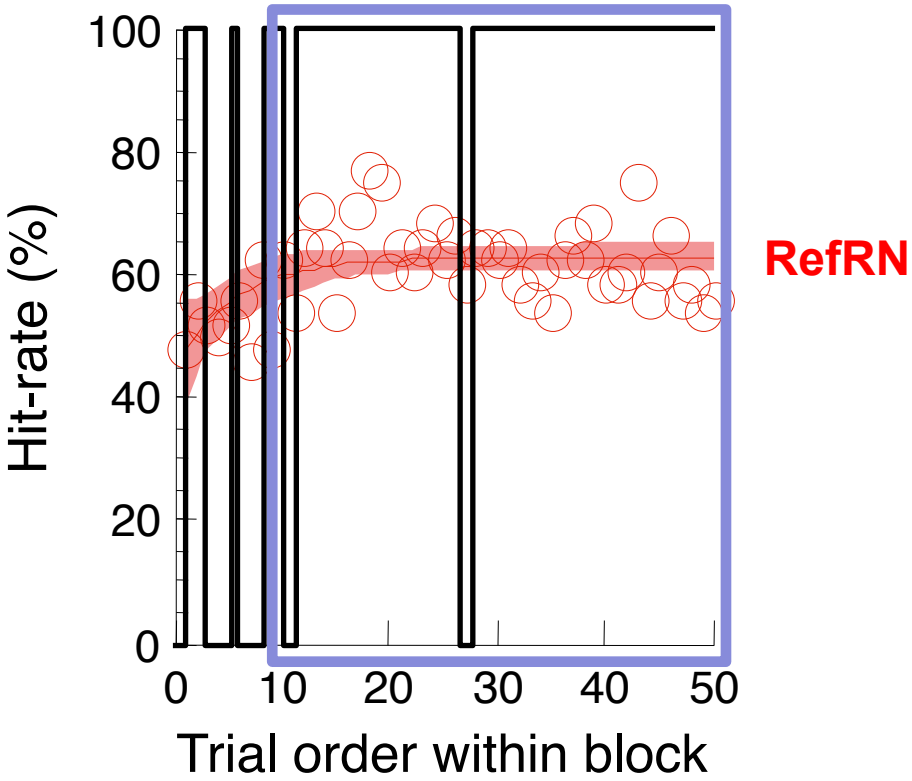
- Modest increase on average
- But inter-block variability: no learning

Memory for noise



- Modest increase on average
- But inter-block variability: almost perfect learning

Memory for noise



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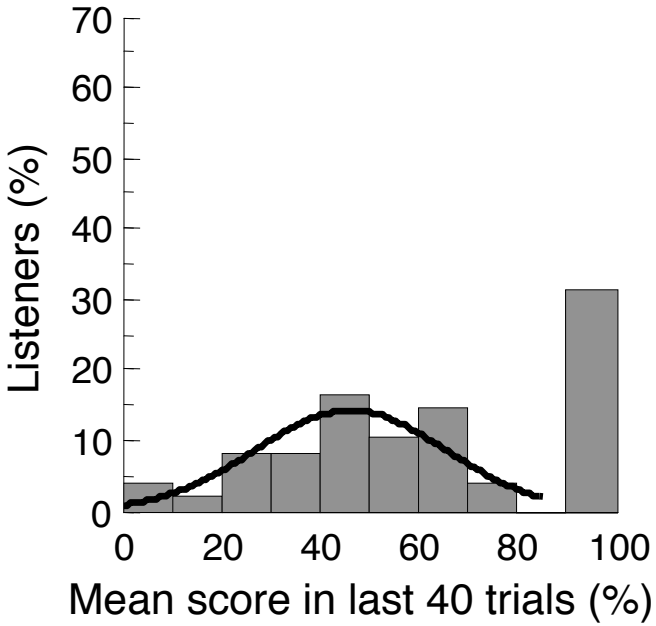
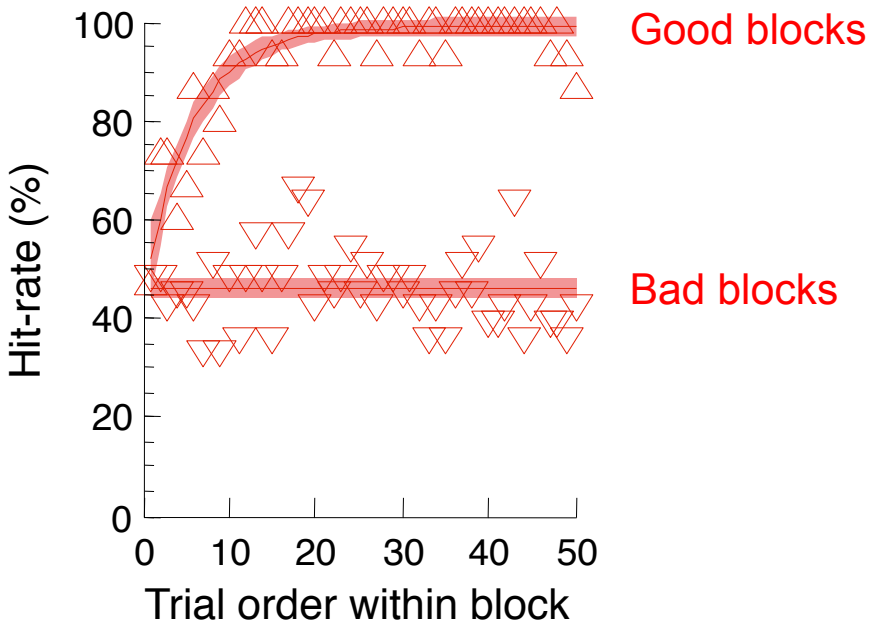
Memory for noise





- Bimodal distribution of block hit-rates
- Learning either absent, or perfect
- Half-life = 2 trials

Memory for noise

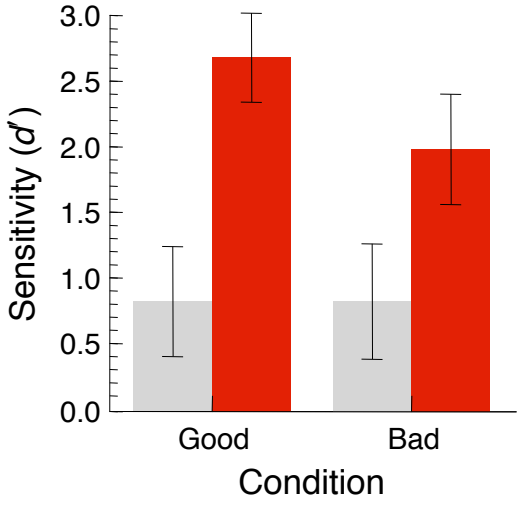
Summary so far

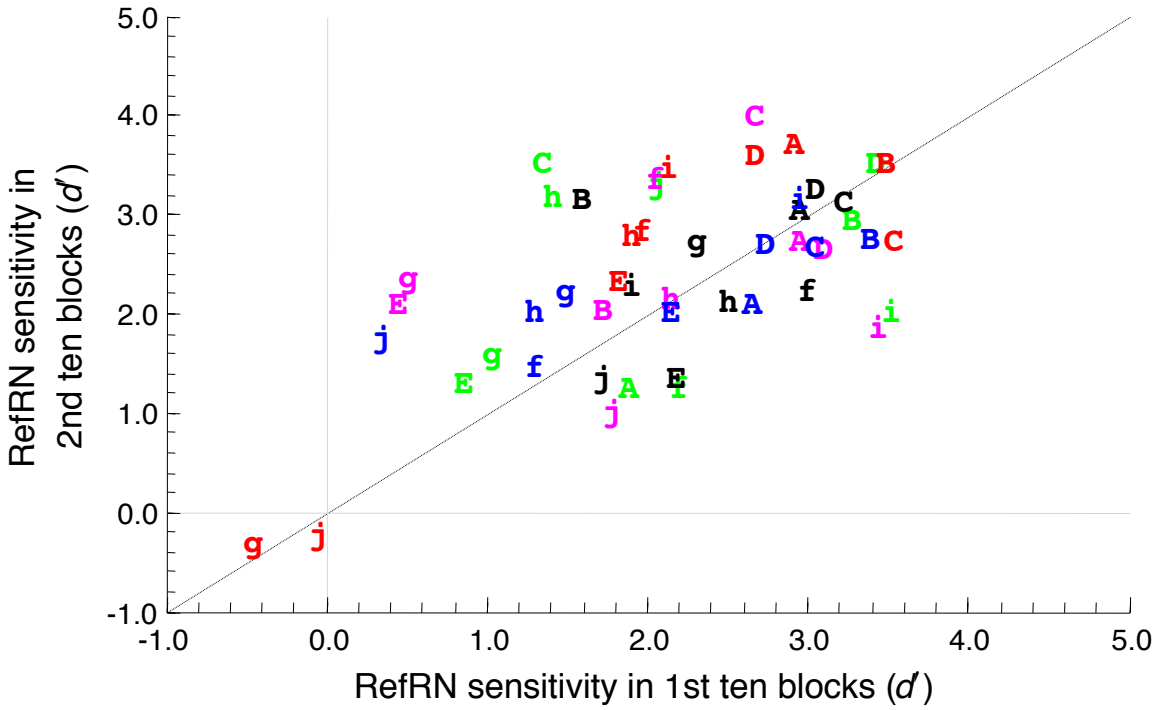
- Listeners can learn 0.5-s samples of noise
- Learning: - unsupervised
  - robust to interference
  - extremely fast

Good noise, Bad noise

- Blocks with and without learning: different noise statistics?
- New experiment:
  - 5 RefRNs from the “good” blocks
  - 5 RefRNs from the “bad” blocks
  - 2 runs per listener

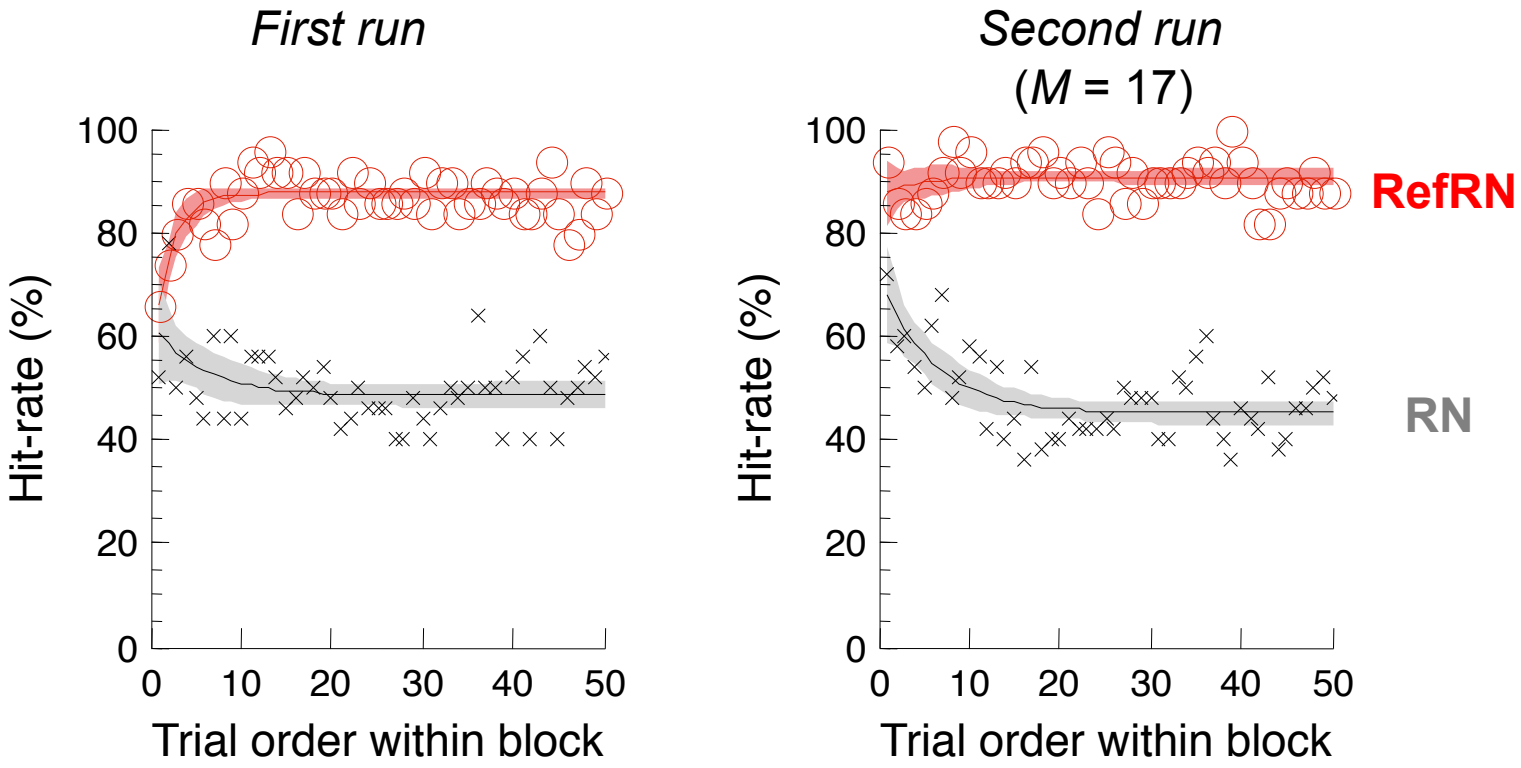
Good noise, Bad noise





- Modest difference between ‘good’ and ‘bad’ noises
- A listener-noise thing

Good noise, Bad noise



- Memories for noises retained over weeks

Memory for noise

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- Listeners can learn 0.5-s samples of noise
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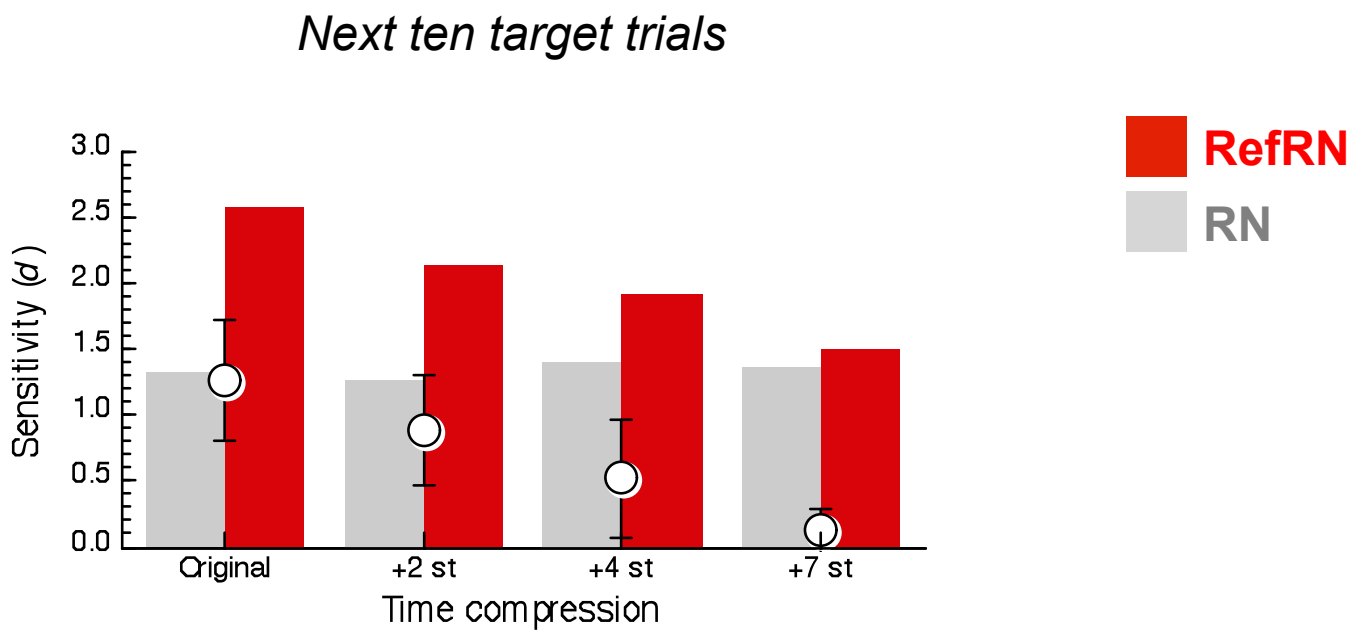
  - robust to interference
  - extremely fast
  - long-lasting

Generalisation

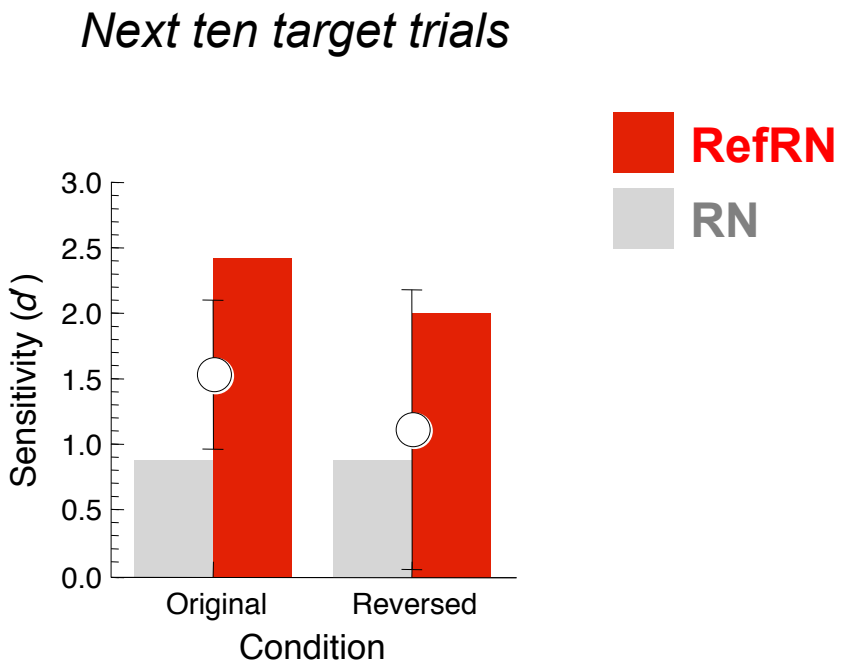
- Is exact repetition necessary for retrieval?
- New experiments:
    - Learning, then time compression (time & frequency shift)
    - Learning, then reversal

Generalisation



- Learning survives fairly large distortions

Generalisation



- No effect of time-reversal: short-duration acoustical cues?

Memory for noise

Summary so far

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  - generalises to similar sounds

Memory for noise

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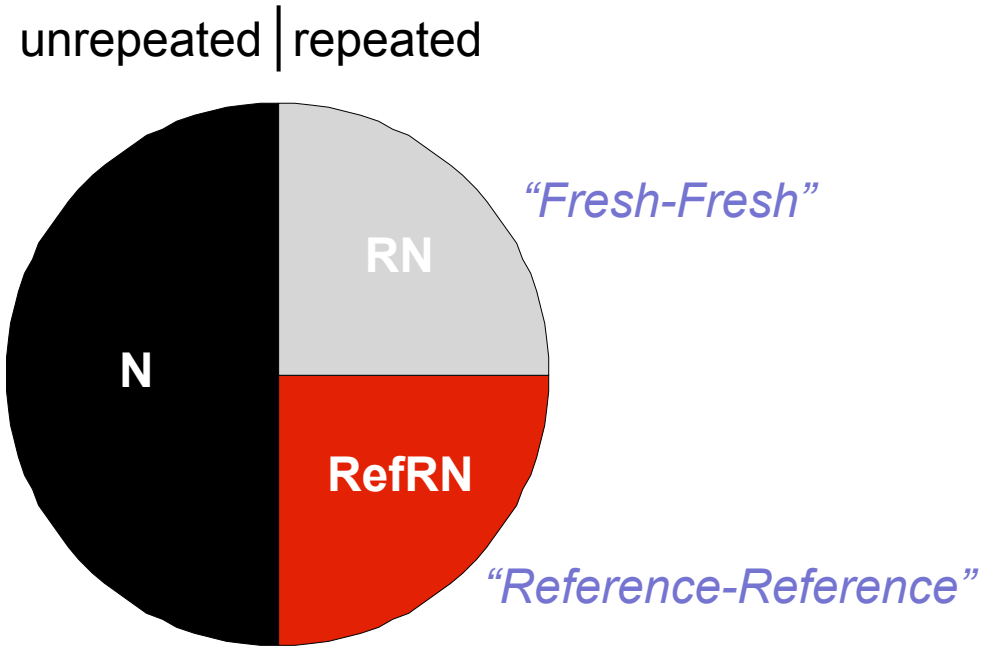
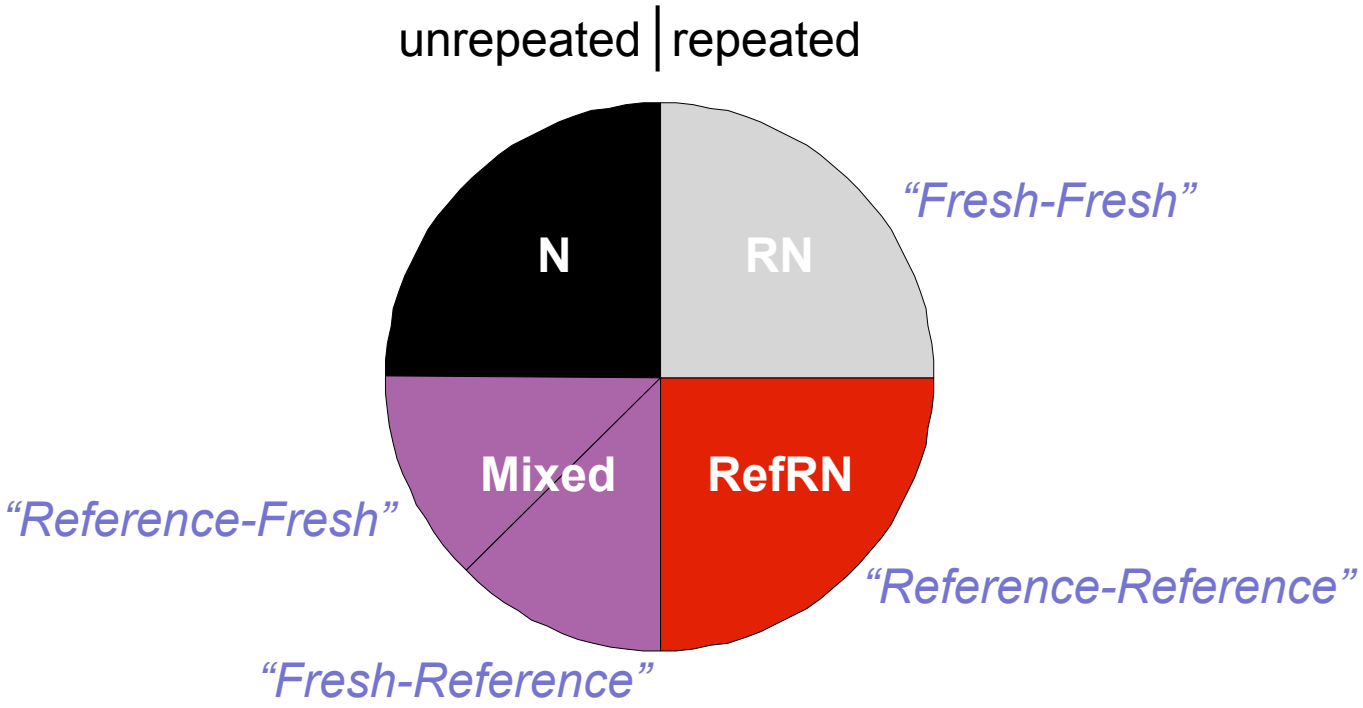
improved repetition detection or ***noise recognition***?

Noise recognition

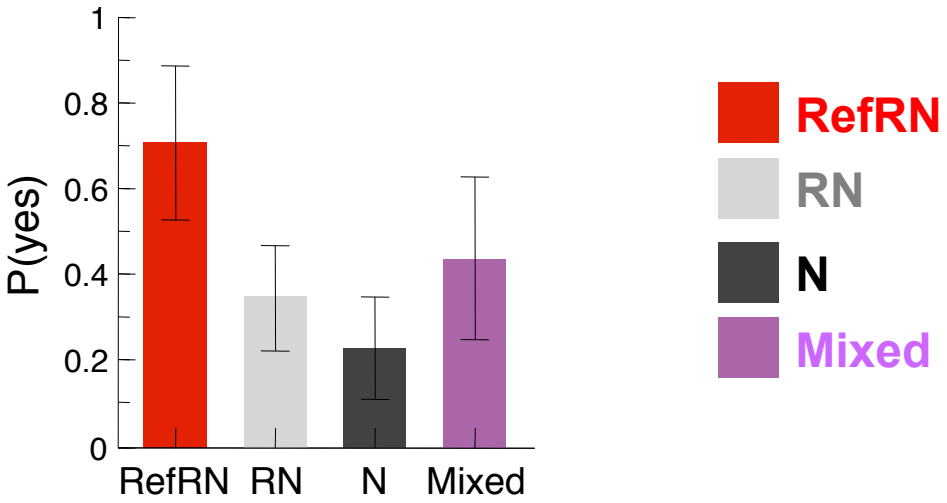


Noise recognition



- "Mixed" stimuli are unrepeated but may be recognisable.

Noise recognition



- Mixed stimuli reported as repeated!?

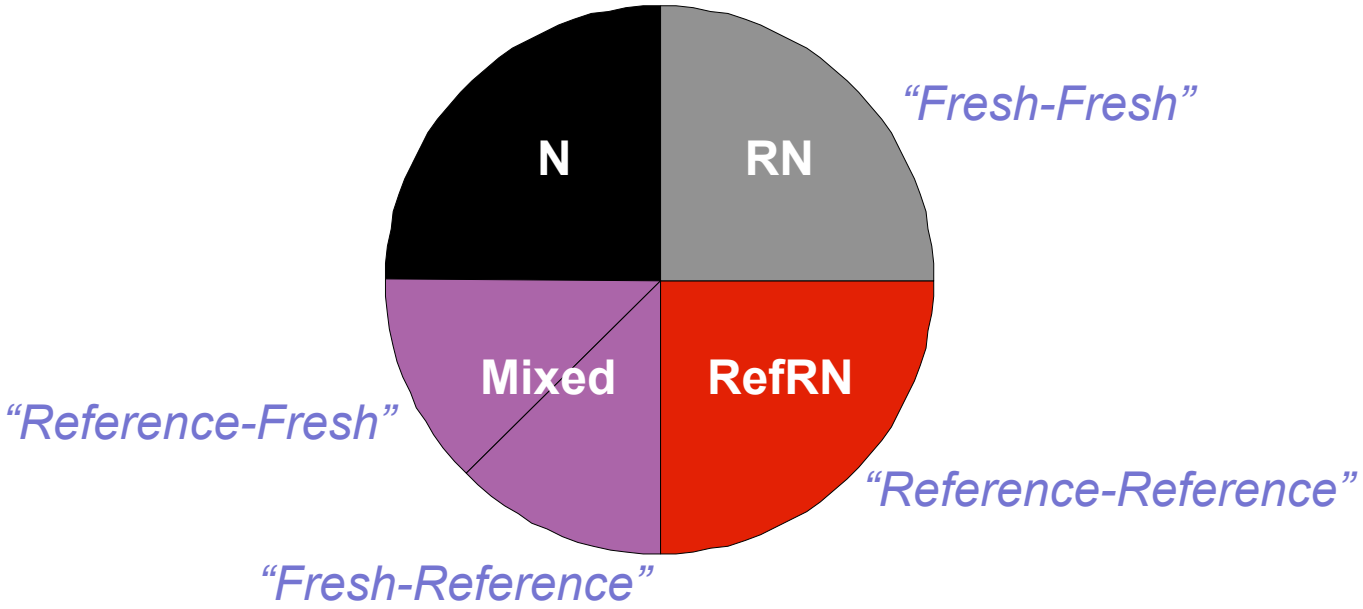
  => Listeners “cheat” with noise recognition.

Memory for noise

Summary so far

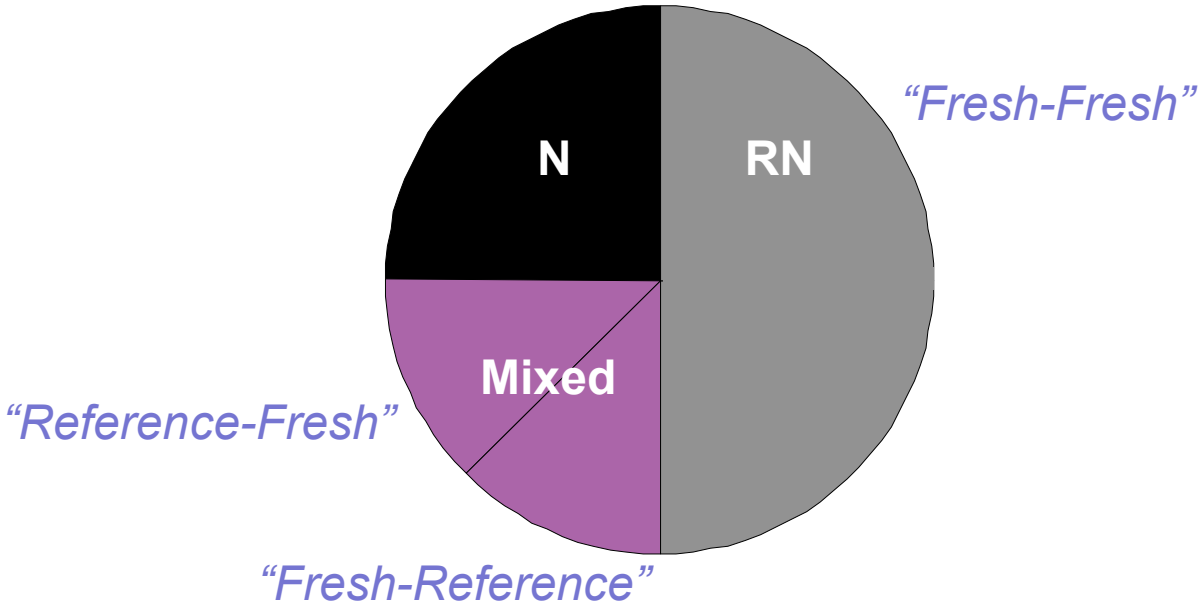
- Listeners can learn 0.5-s samples of noise
- Learning:
  - unsupervised
  - robust to interference
  - extremely fast
  - long-lasting
  - generalises to similar sounds
  - reflects noise recognition

Learning unrepeated noises



- Confusing RefRN and Mixed?
- No RefRN => no confusion

Learning unrepeated noises



- Confusing RefRN and Mixed?
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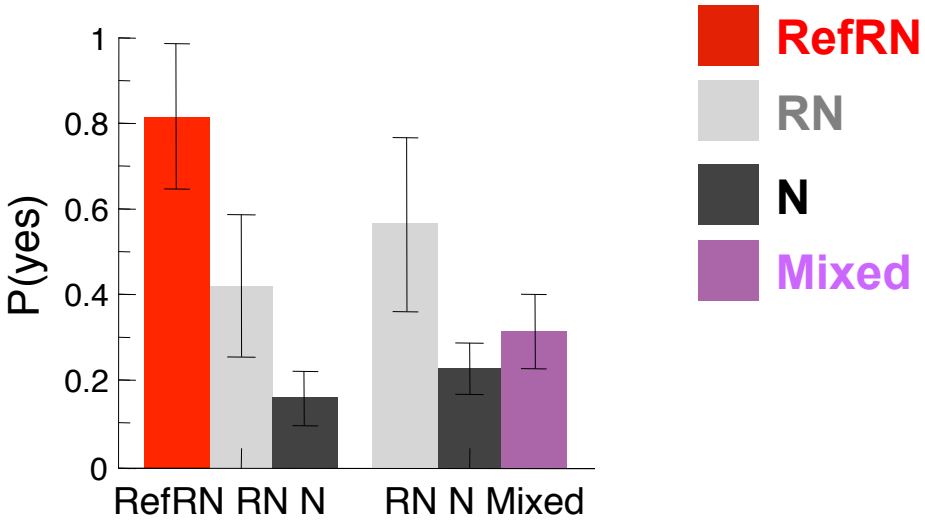
Learning unrepeated noises



- Some learning of Mixed
- Only in a few (early) blocks

Memory for noise

Summary so far

- Listeners can learn 0.5-s samples of noise
- Learning:
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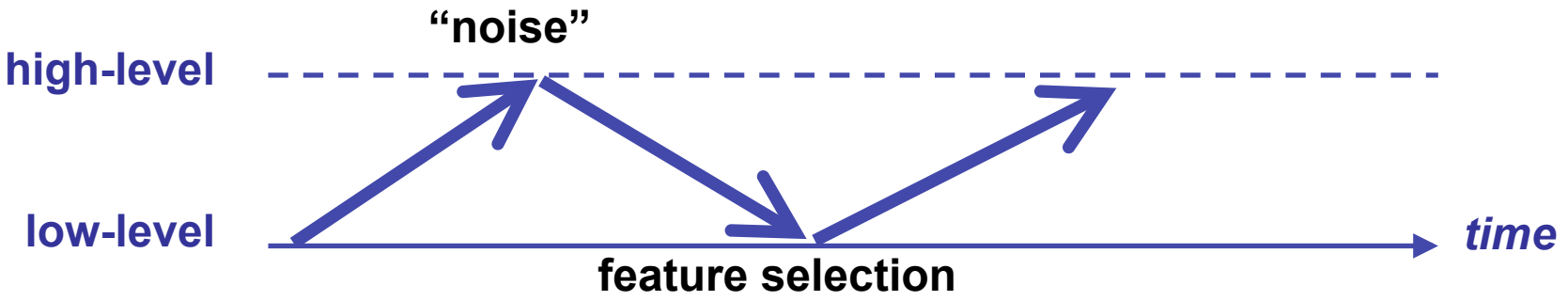
  - robust to interference
  - extremely fast
  - long-lasting
  - generalises to similar sounds
  - reflects noise recognition
  - unrepeated noises can also be learnt

Memory for noise

Neural mechanisms

- Rapid sensory adaptive plasticity (Ulanovsky et al. 2003; Atiani et al. 2009, Dean et al. 2005, Tzounopoulos & Kraus, 2009)
- How to achieve fast & stable learning of complex sounds?
- Top-down selection (Ahissar et al., 2009)



Memory for noise

Perceptual insight

Rubin, Nakayama, & Shapley (2002)

Memory for noise

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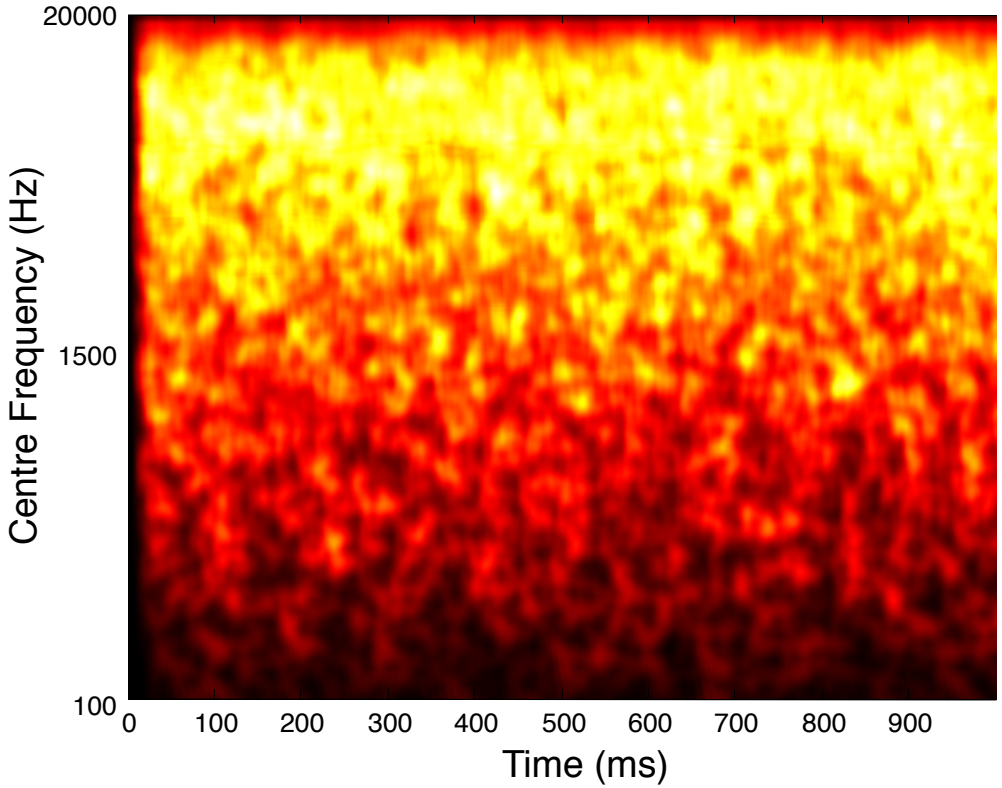
Memory for noise

Noise learning and CASA



- Multitude of acoustical features vs lack of perceptual features
- Experience changes perception
- Recognition in the absence of segregation cues?

Memory for noise

Summary

- Memory for noise as a paradigm to study auditory memory
- Learning observed has many features desirable for real-world
- Probable interplay between low- and high-level processes

- Learning:
  - unsupervised
  - robust to interference
  - extremely fast
  - long-lasting
  - over a range of durations
  - generalises to similar sounds
  - reflects noise recognition
  - unrepeated noises can also be learnt