Neural coding and the anticipation of complex visual stimuli

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Overview

Some neurophysiology

Responses to pairs of stimuli

Responses to sequences > 2

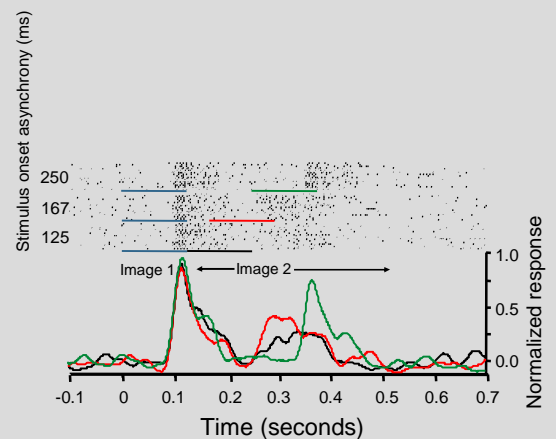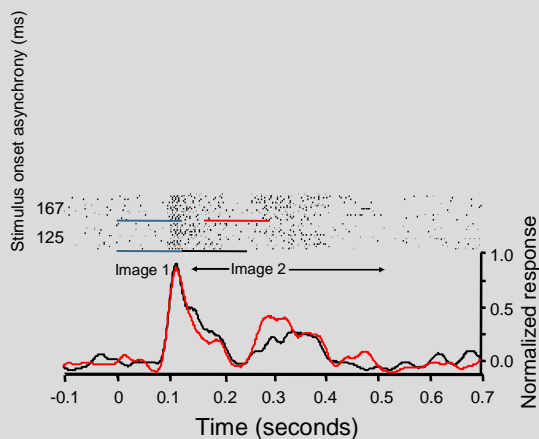**Modelling the neurophysiological data**
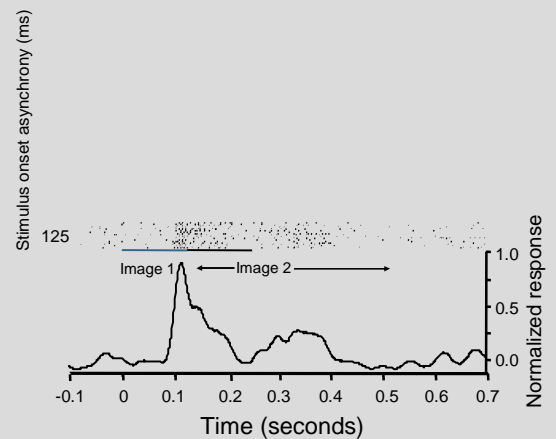
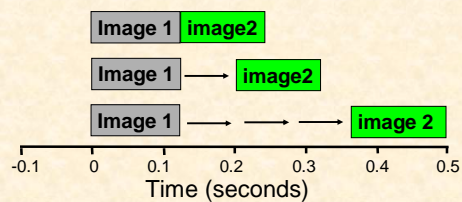Building the model from data (pairs)
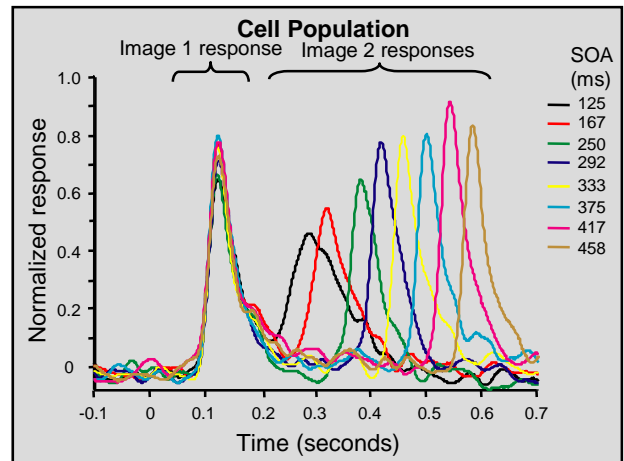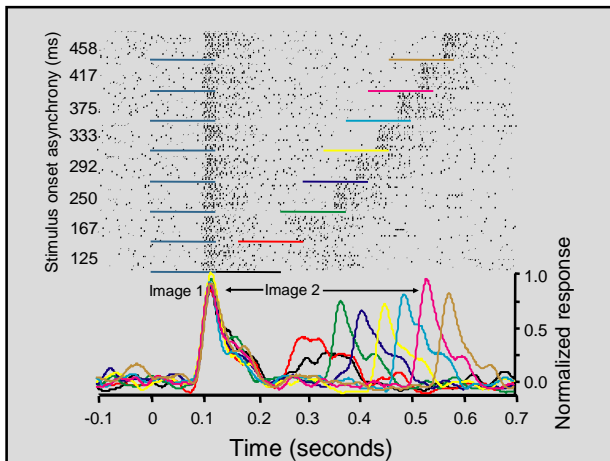
Testing the model against data (sequences >2)

Decoding the (model) data

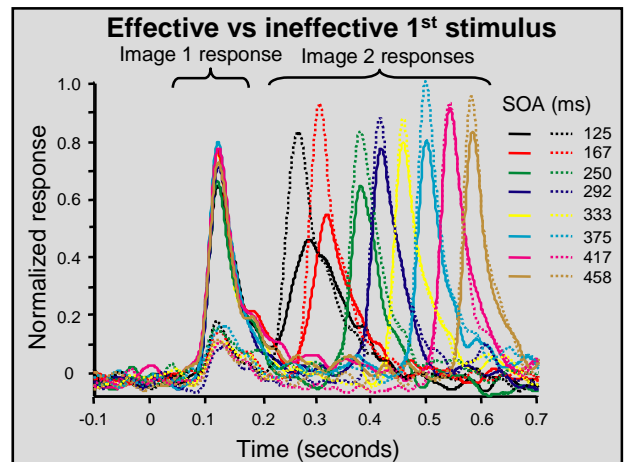Test against human psychophysical data

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Image sequences

Start simple: Test 2 images in succession
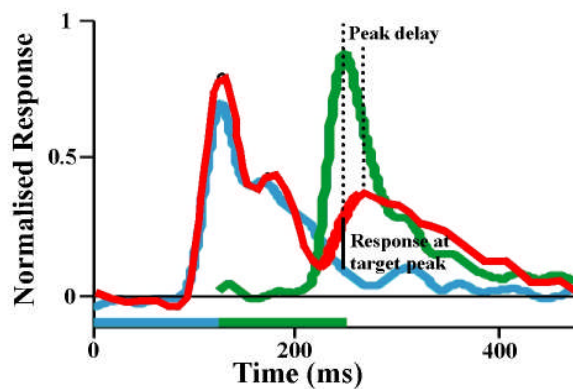
Vary stimulus onset asynchrony (SOA)

Cell Population

Image 1 response   Image 2 responses

SOA (ms)
- 125
- 167
- 250
- 292
- 333
- 375
- 417
- 458

Forward Masking

- **Does it matter what the "mask" is?**
  – Vary the masking stimulus (stimulus 1)

Effective vs ineffective 1st stimulus

Image 1 response   Image 2 responses

SOA (ms)
- 125
- 167
- 250
- 292
- 333
- 375
- 417
- 458

Measuring forward masking

Peak delay

Response at target peak

Effective vs ineffective mask

Average Response   Resp at target peak   Peak Delay

Stimulus onset asynchrony
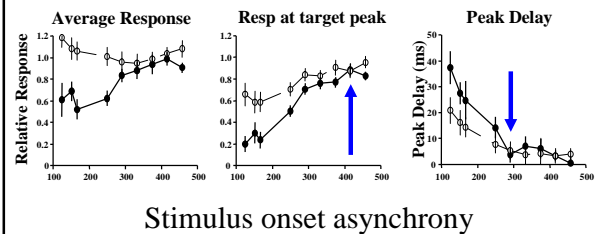
Forward masking

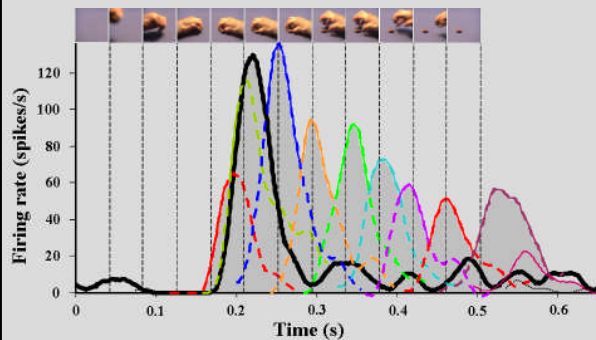- **Two effects (different time courses?)**
  - Decrease in magnitude (at SOA < 400ms)
  - Delay of the peak response (at SOA < 300ms)

Masking and sequences

- **What happens with sequences > 2?**
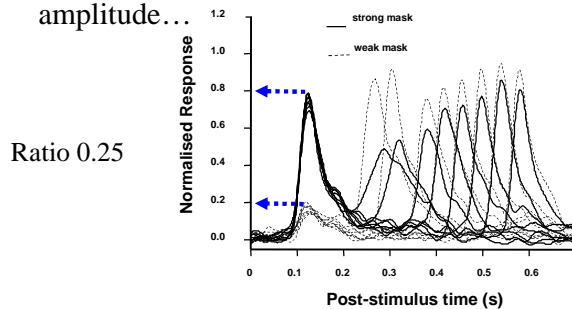
Responses to sequences

Masking and sequences

- **What happens if show a sequence of images?**
  - Do we see evidence of forward masking?
    YES (of course)
  - Do the results from the pairs explain the results?
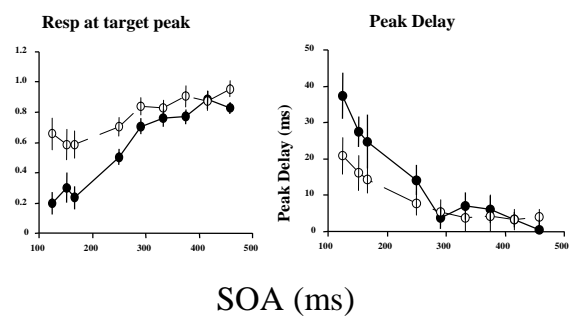 - Even when first frames elicit only small response?

Modelling forward masking

- Take the effect of stimulus response amplitude…
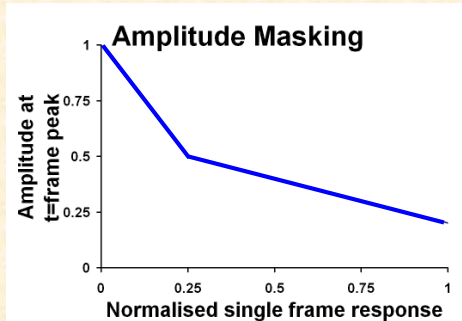
Ratio 0.25

Modelling forward masking
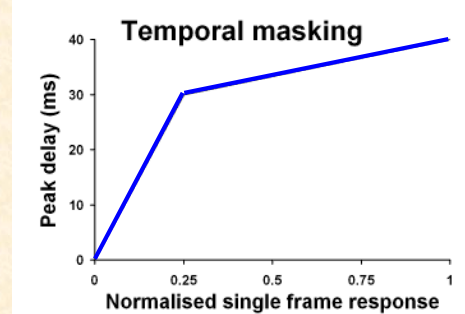
- and the observed effects of masking…

SOA (ms)

Modelling forward masking
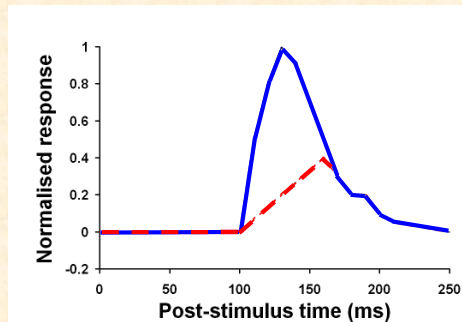
- …to generate simple amplitude and…

Modelling forward masking

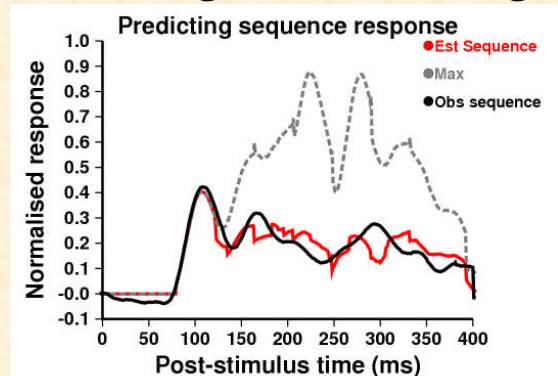- …temporal "masking functions"

Modelling forward masking

- Apply masking to responses to single frames

Modelling forward masking

Masking and sequences

- **What happens with image sequence?**
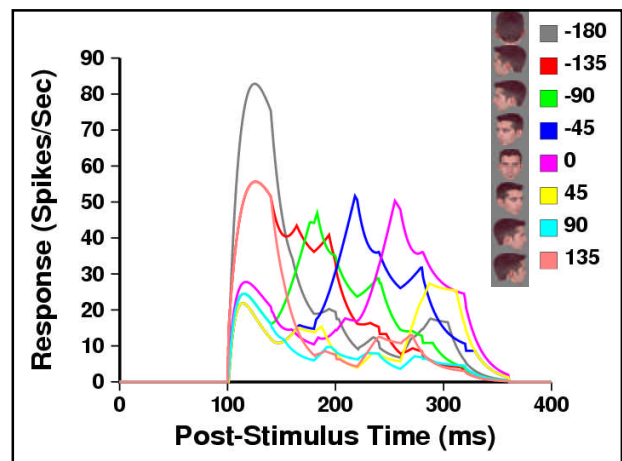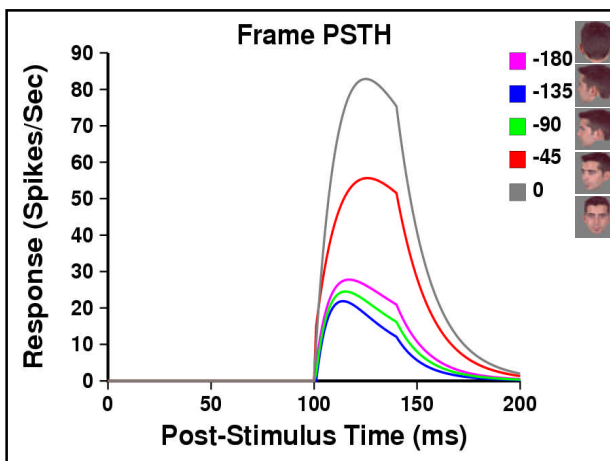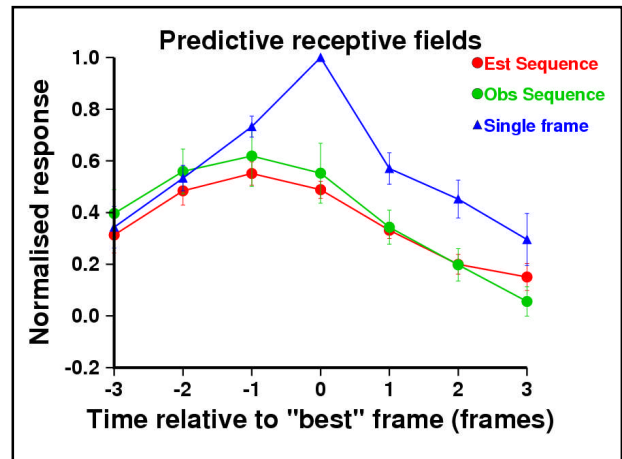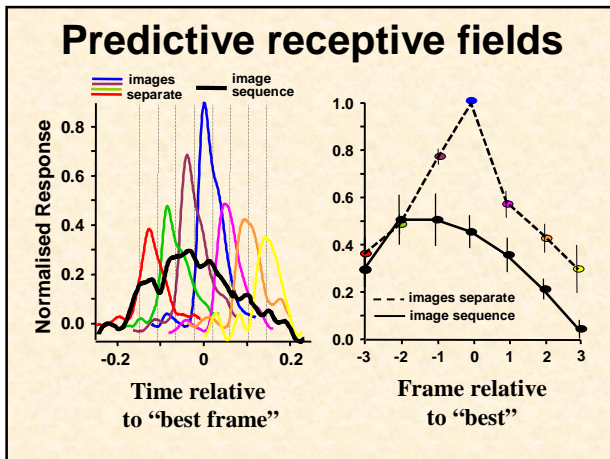 - Do we see evidence of forward masking?
    YES
  - Do the results from the pairs explain the results?
    YES

Masking and sequences

- What are the implications for perception?

Predictive receptive fields

Normalised Response

Time relative to "best frame"

Frame relative to "best"

images separate / image sequence

Predictive receptive fields

- Est Sequence
- Obs Sequence
- Single frame

Normalised response

Time relative to "best" frame (frames)

Frame PSTH

Response (Spikes/Sec)

Post-Stimulus Time (ms)

-180, -135, -90, -45, 0

Response (Spikes/Sec)

Post-Stimulus Time (ms)

-180, -135, -90, -45, 0, 45, 90, 135

Decoding

- What are the possible "decoded outputs"?
  - 8 views + 96 orders
  - All the orders except 12345 "unlearnt"
- What is the relevant time-scale?

Don't use whole sample period

Mean response across stimuli

Single frames / Sequence

Cell population

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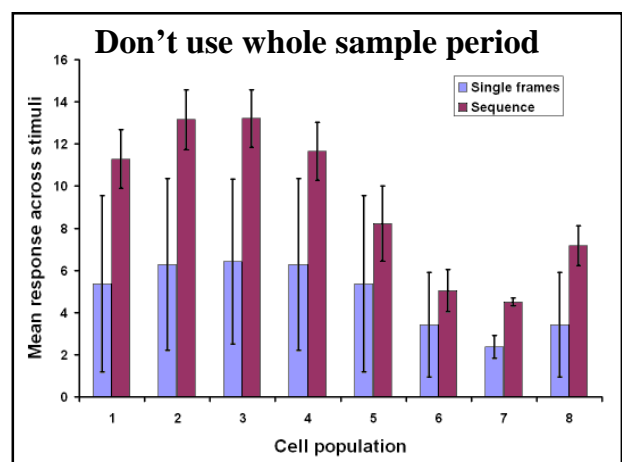
Decoding

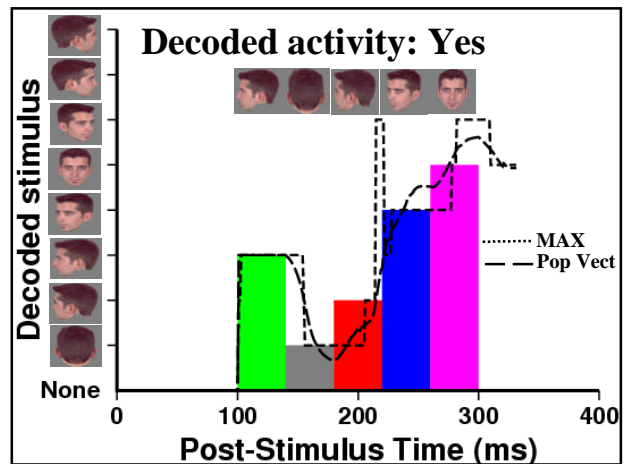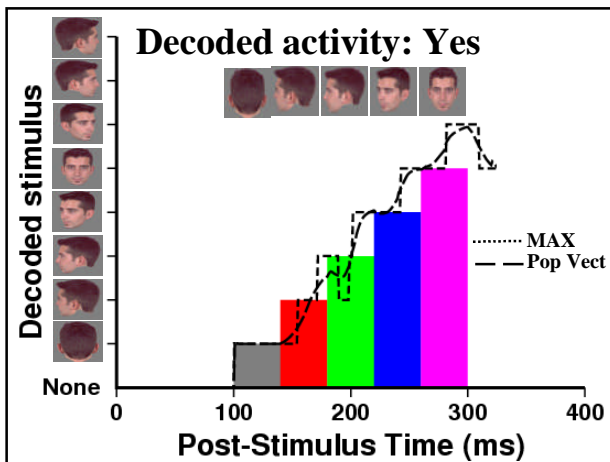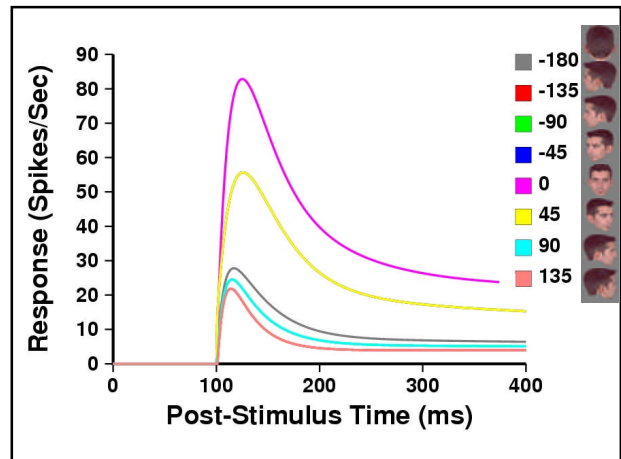- **Continuous decoding:**
  - What are the priors (Bayesian decoding)?
  - What are the means (Population vector)?
  - Used response time course to single stimulus

Decoded activity: Yes
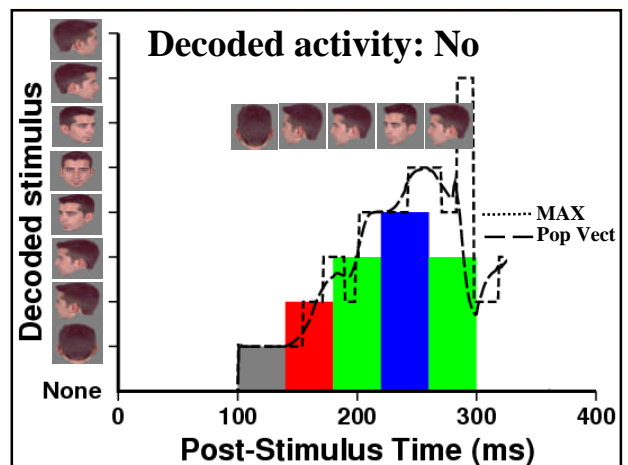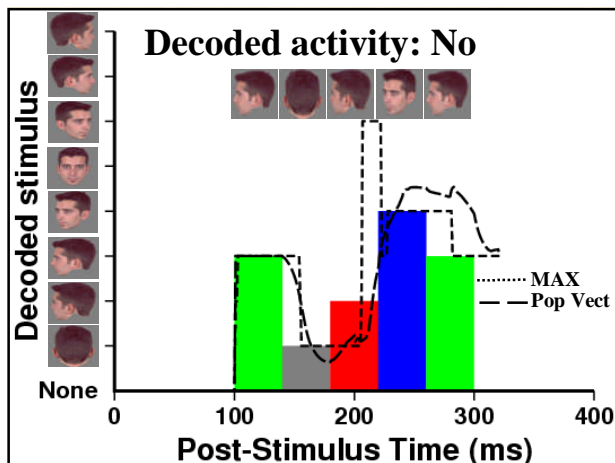

Decoded activity: Yes

Population vector decoding

- **To say target present**
  - When does the population vector exceed threshold?
  - Use length integrated over time when indicating "Target"

	12345	XXX45	XXXX5
Population Vector	244	228	210
Human RT_Y (ms)	578	634	728

Decoded activity: No

Decoded activity: No

Decoded stimulus

None

Post-Stimulus Time (ms)

········· MAX
— — Pop Vect

Population vector decoding

- **To say target absent**
  - Vector must NOT indicate "target" at any point
  - Wait until end of sequence (RT_N > RT_Y)
  - Use distance vector is from target at end

	1234 not 5	XXX4 not 5	XXXX not 5
Pop Vector	-123	-99	-94
RT_N (ms)	821	887	924

Population vector decoding

- **False positives**
  - Target absent but say yes
  - Determined by how close the vector gets to target
  - This depends on the "overshoot"
    - Number of false positives related to both RT(Y) and Accuracy(Y)

Summary

- Responses to pairs of STS neurones show forward masking
- The masking between pairs can predict responses to sequences
- Decoding of sequences fits with psychophysical data

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