DÉPARTEMENT D'ÉTUDES COGNITIVES

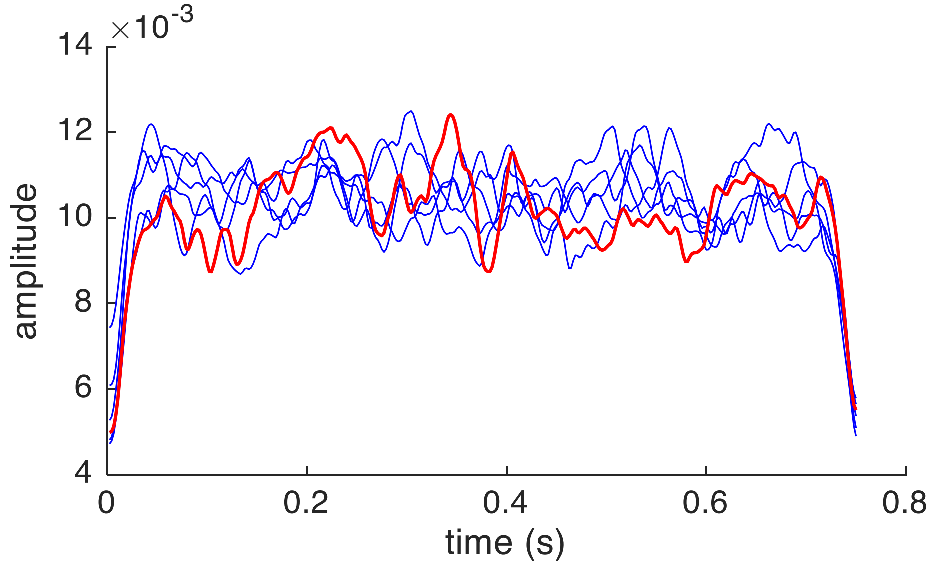
# Unveiling internal representations of temporal modulations with the revcorr approach

Emmanuel Ponsot & Léo Varnet

ARCHES meeting 2020

# Intrinsic fluctuations and revcorr

- Part of the deleterious effect of a steady noise on AM perception is due to the confusion of useful modulations in the signal with **intrinsic envelope fluctuations** arising from the filtering of noise into cochlear critical bands [Dau et al., 1997, 1999]
- **Reverse correlation (*'revcorr'*)** techniques are particularly suitable for exploring the effect of noise on perception [Ahumada & Lovell, 1971; Varnet et al., 2013].

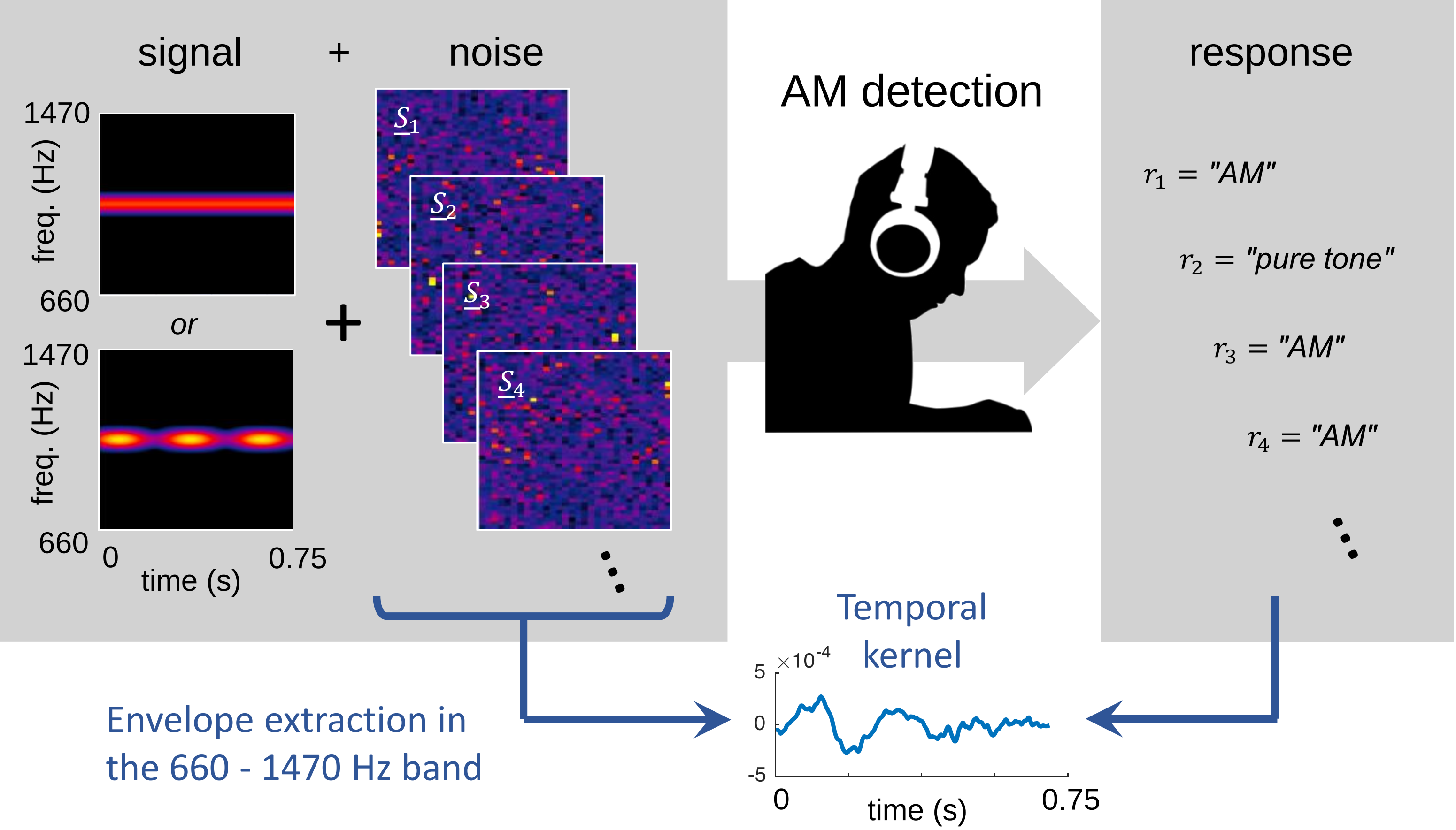



*Envelopes for 6 realizations of a white noise, band-filtered in the 660 - 1470 Hz band*

→ using the revcorr method to probe internal representations of AM by relating intrinsic envelope fluctuations with the response of listeners on a trial-by-trial basis.

# Method

**Target signals**:
Pure tone vs. 4-Hz AM
Duration = 0.75 s
Carrier frequency = 1 kHz
Fixed AM phase




**Task**: yes/no task
in white noise (-10 dB SNR).

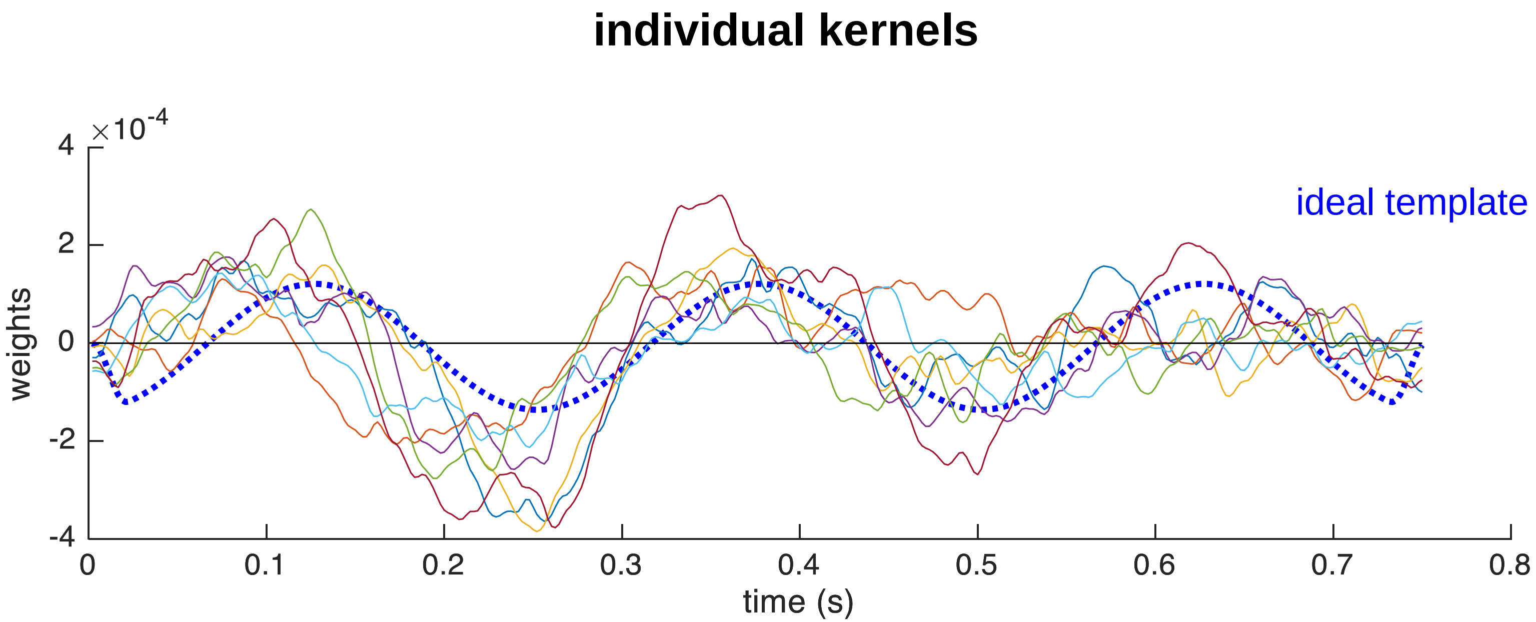
Modulation depth (m) adapted continuously during the experiment to ensure a correct response rate of 75%.

**Participants**: 6 NH listeners + 1 expert participant with only one NH ear.

# Temporal kernel

(= Pattern of intrinsic envelope fluctuations of the noise which is consistently associated with a ‘AM’ response)

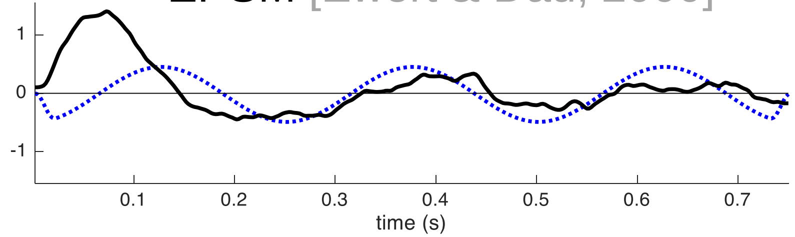
- Similar pattern for all 7 participants
- Strong 4-Hz component, in phase with the AM target



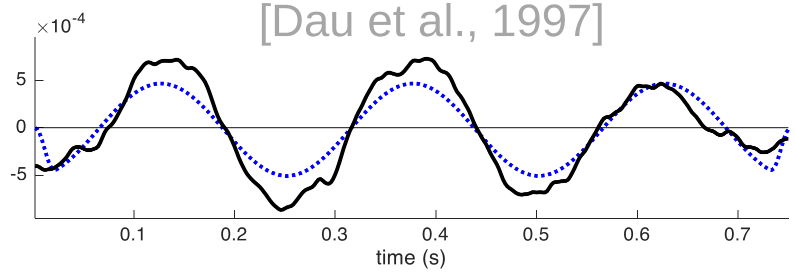

When the noise intrinsic envelope shows a strong 4-Hz component, it is more likely to be confused with the AM target to be detected.

# Temporal kernels for PEMO and EPSM

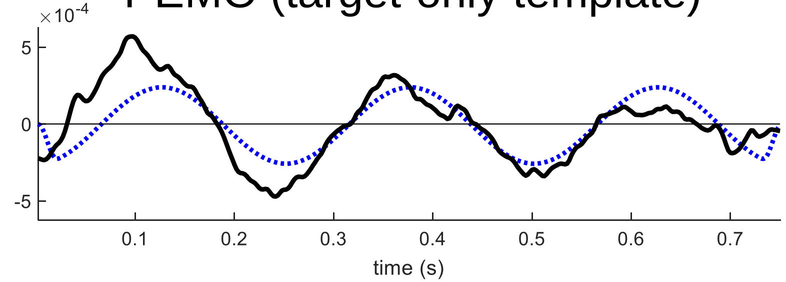
EPSM [Ewert & Dau, 2000]



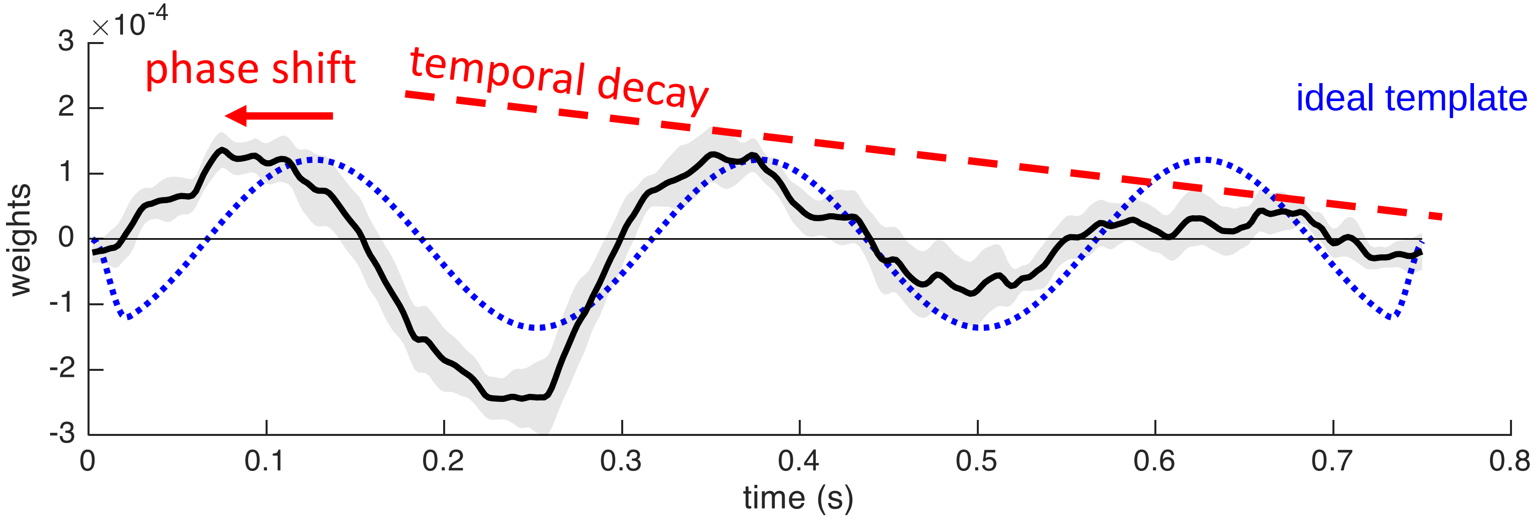

PEMO (difference template)
[Dau et al., 1997]




PEMO (target-only template)



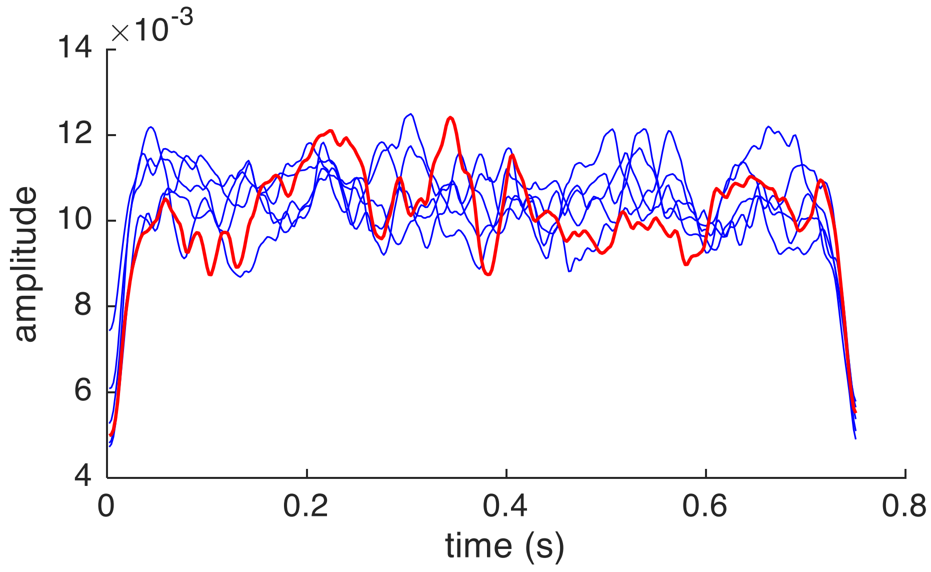

**mean kernel across participants**




Only PEMO with target-only template can correctly reproduce the human temporal kernel for this task.

# Iterim conclusions

- Direct illustration of the effect of steady noise on AM perception: at a given SNR, some realizations have a greater influence than others depending on the exact temporal intrinsic fluctuations.




*Envelopes for 6 realizations of a white noise, band-filtered in the 660 - 1470 Hz band*

- The revcorr technique can be used to **probe internal representations** in real and simulated listeners.
- In conjunction with a model of auditory system, allows us to unveil the **decision strategy** of a listener.

# Characterizing spectro-temporal modulation processing using reverse-correlation

Emmanuel Ponsot

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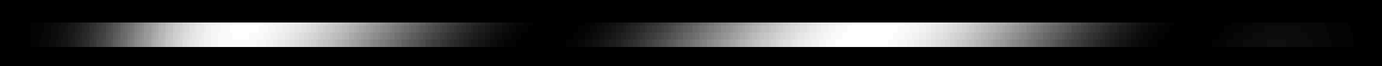
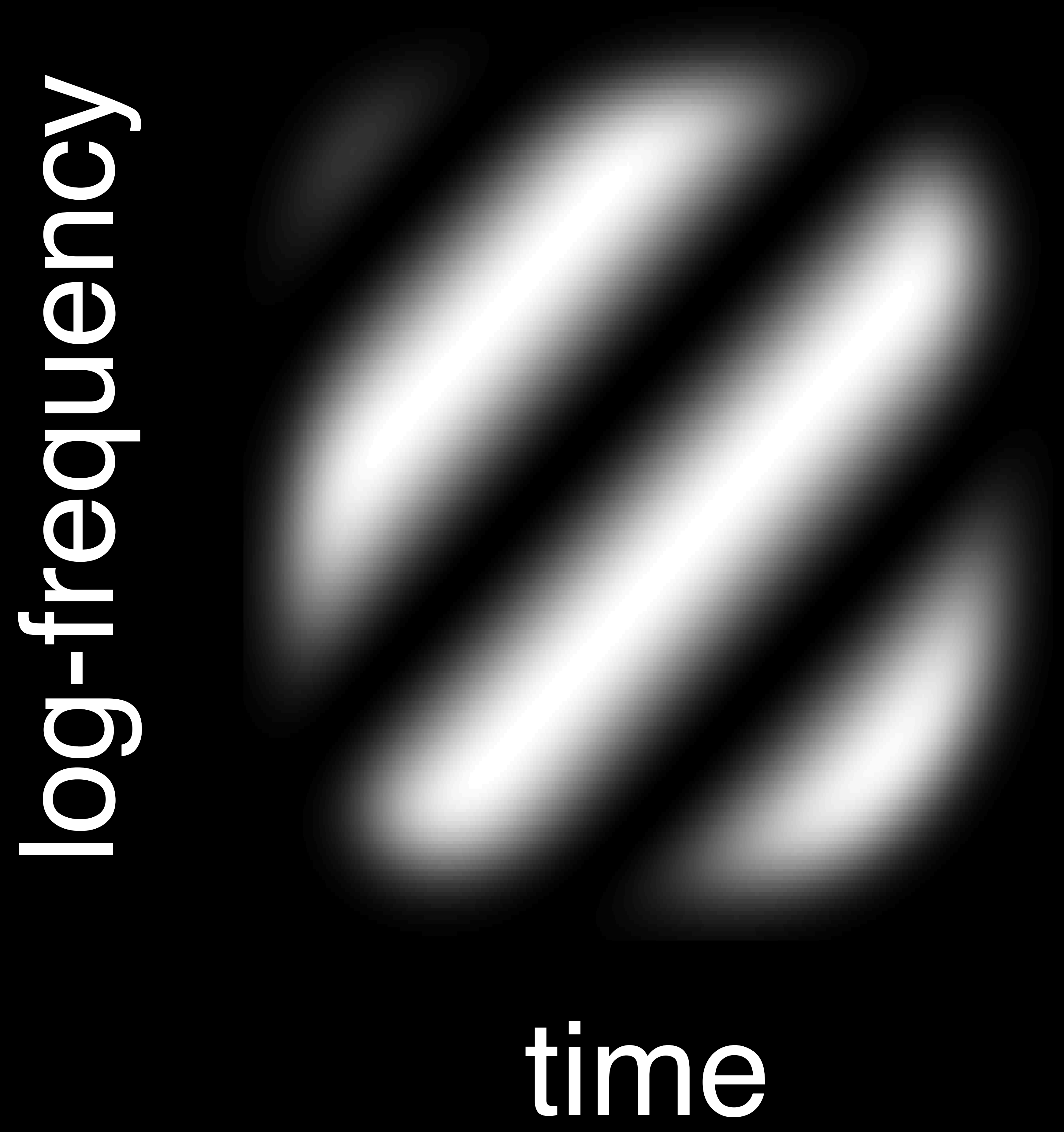
# Temporal Modulation

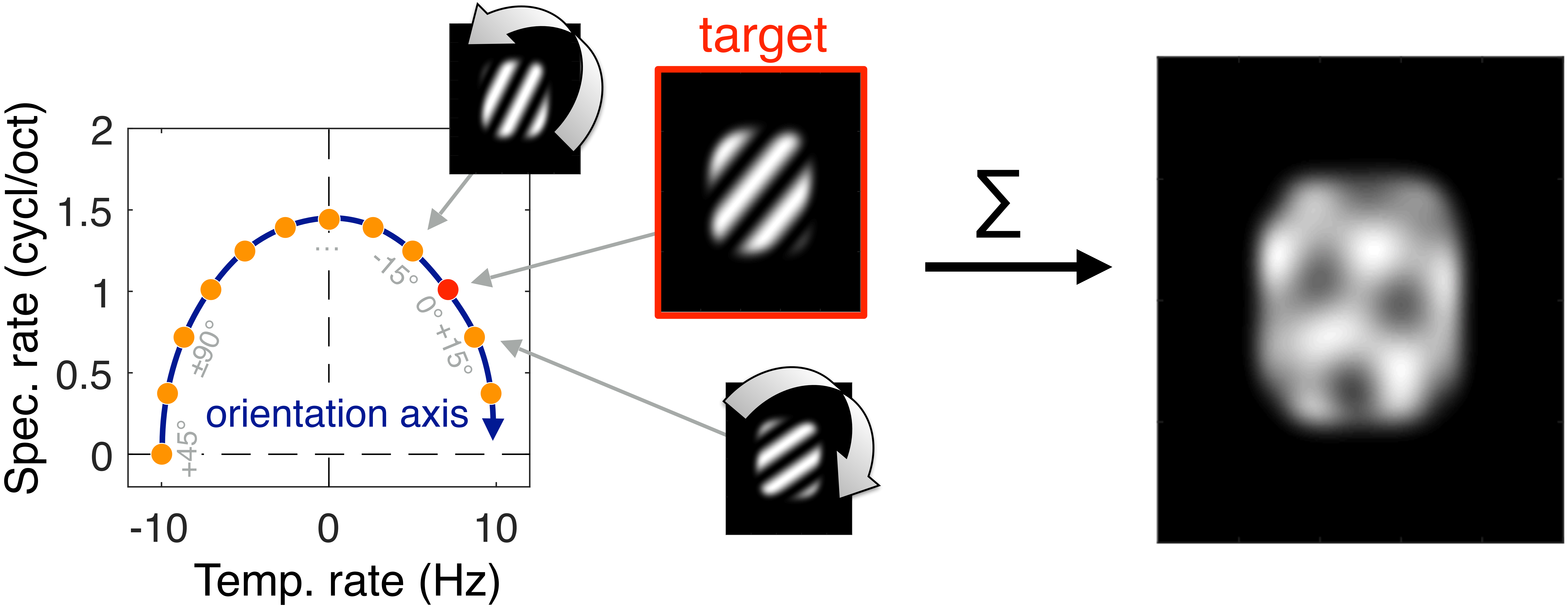


time

# Spectro-Temporal Modulation

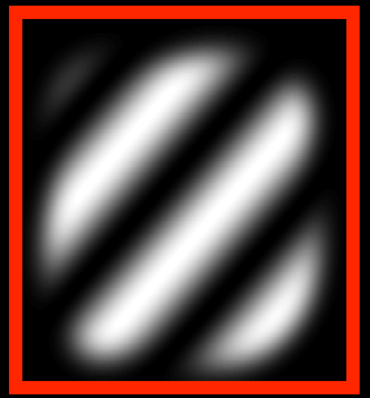


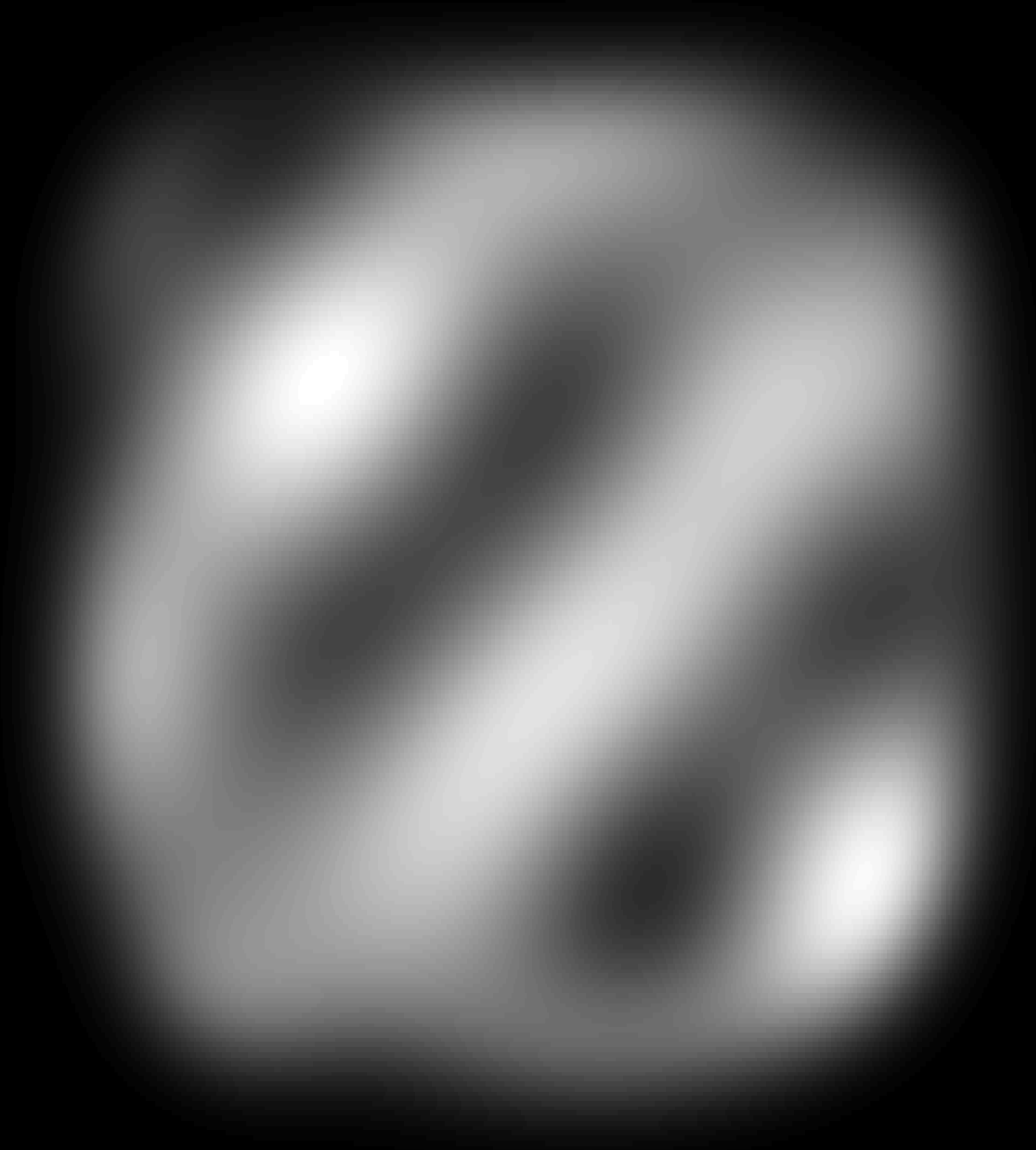
# Generation of “orientation noise”



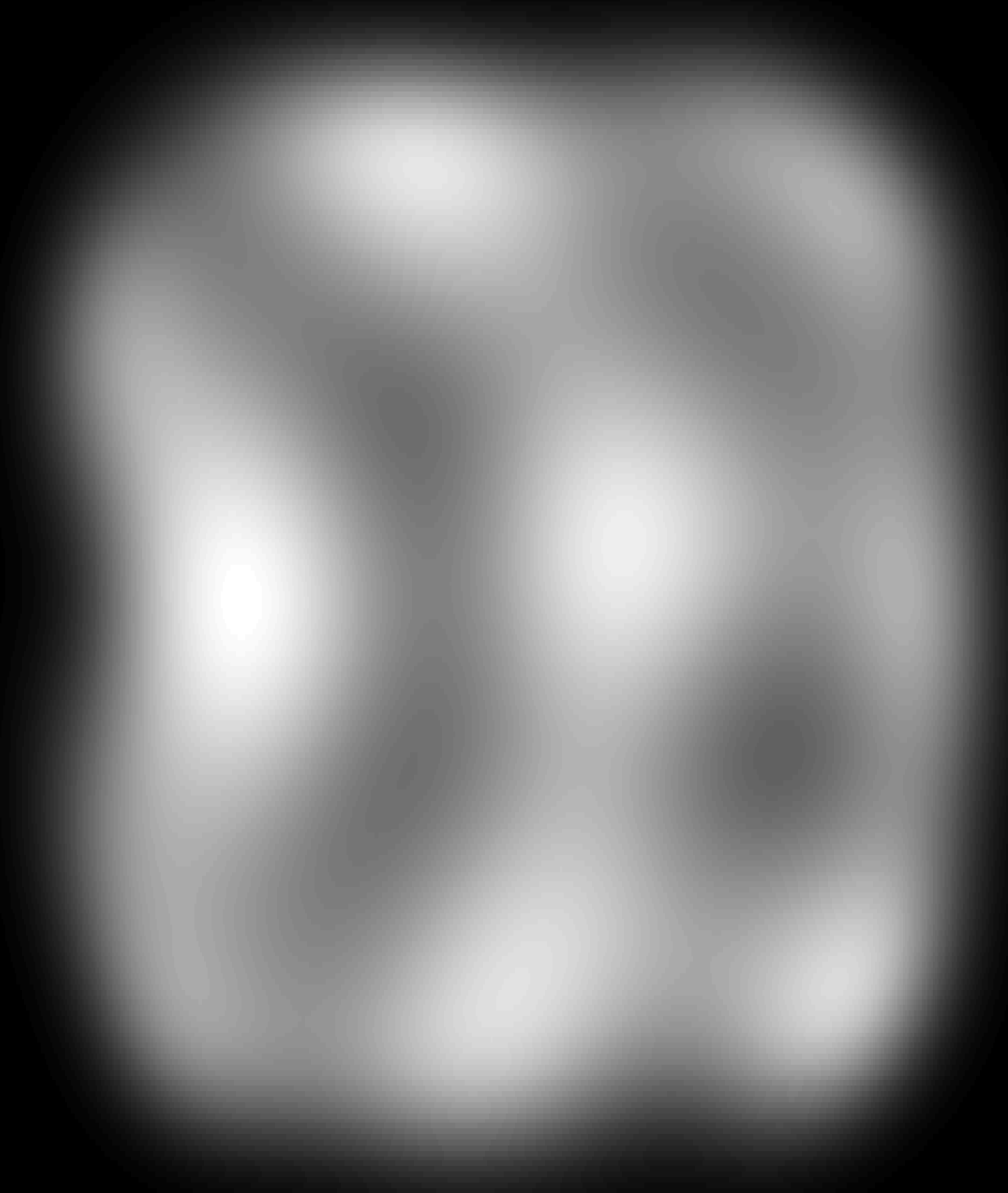

Ponsot et al. *Trends in Hear.* (in press)

# STM detection in “orientation noise”





vs



target + orientation noise

orientation noise

# Methods

Participants:

- 10 YNH (< 25 dB HL), 7 OHI (mild to moderate SNHL)

Stimuli and Task:

- Target [±7 Hz; 1 cycl/oct] / carrier [600 Hz-3.4 kHz] / Duration 250 ms
- Stimuli presented monaurally at 75 dB SPL
- 2IFC detection task with trial-by-trial feedback

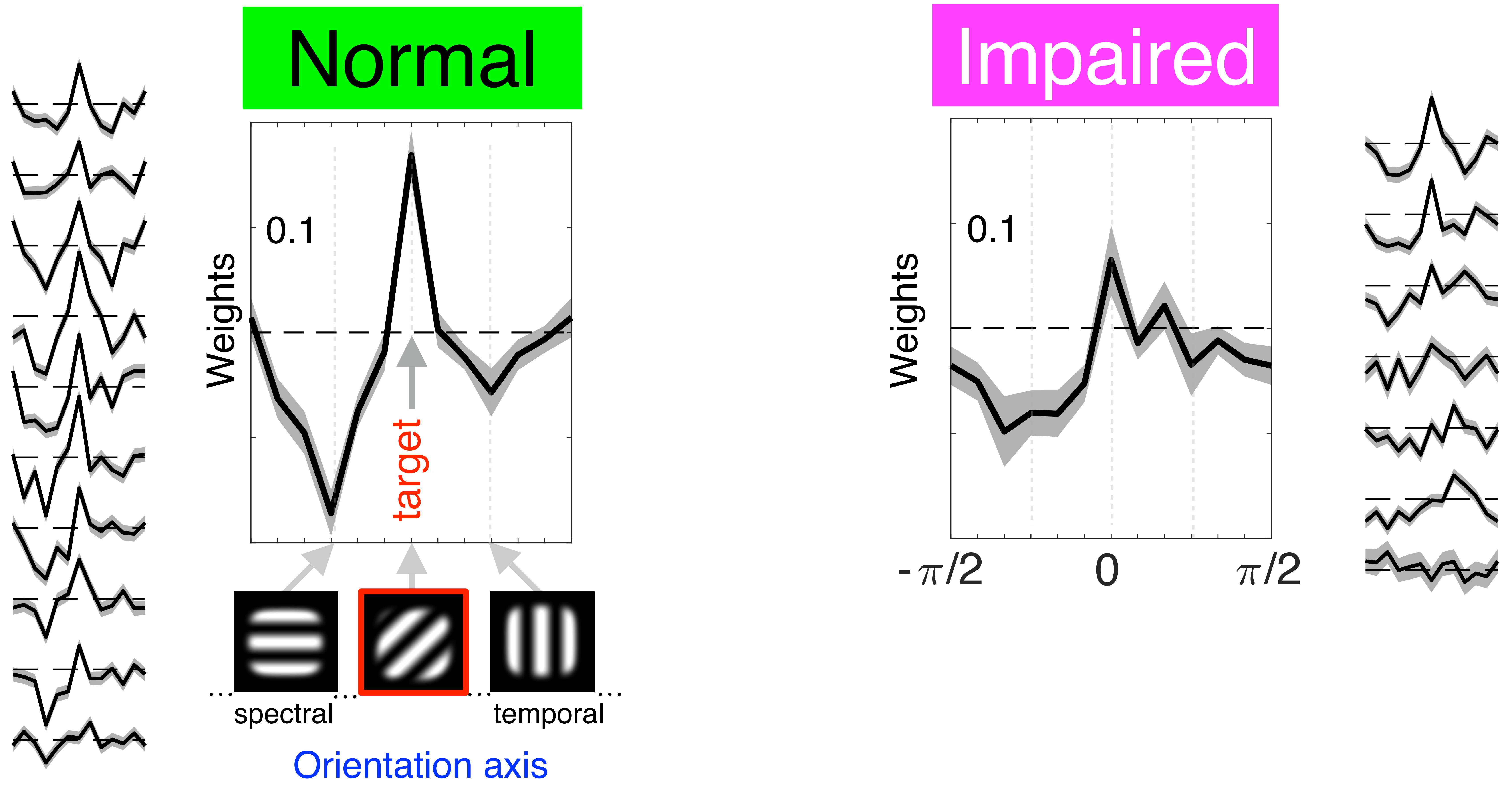
Procedure:

- Find SNR leading to *d'* ~ 1
- Five 1-hour sessions —> 5000 trials/participant

Analysis: reverse correlation: perceptual filters projected on the orientation axis

Ahumada & Lovell, *JASA* (1971)

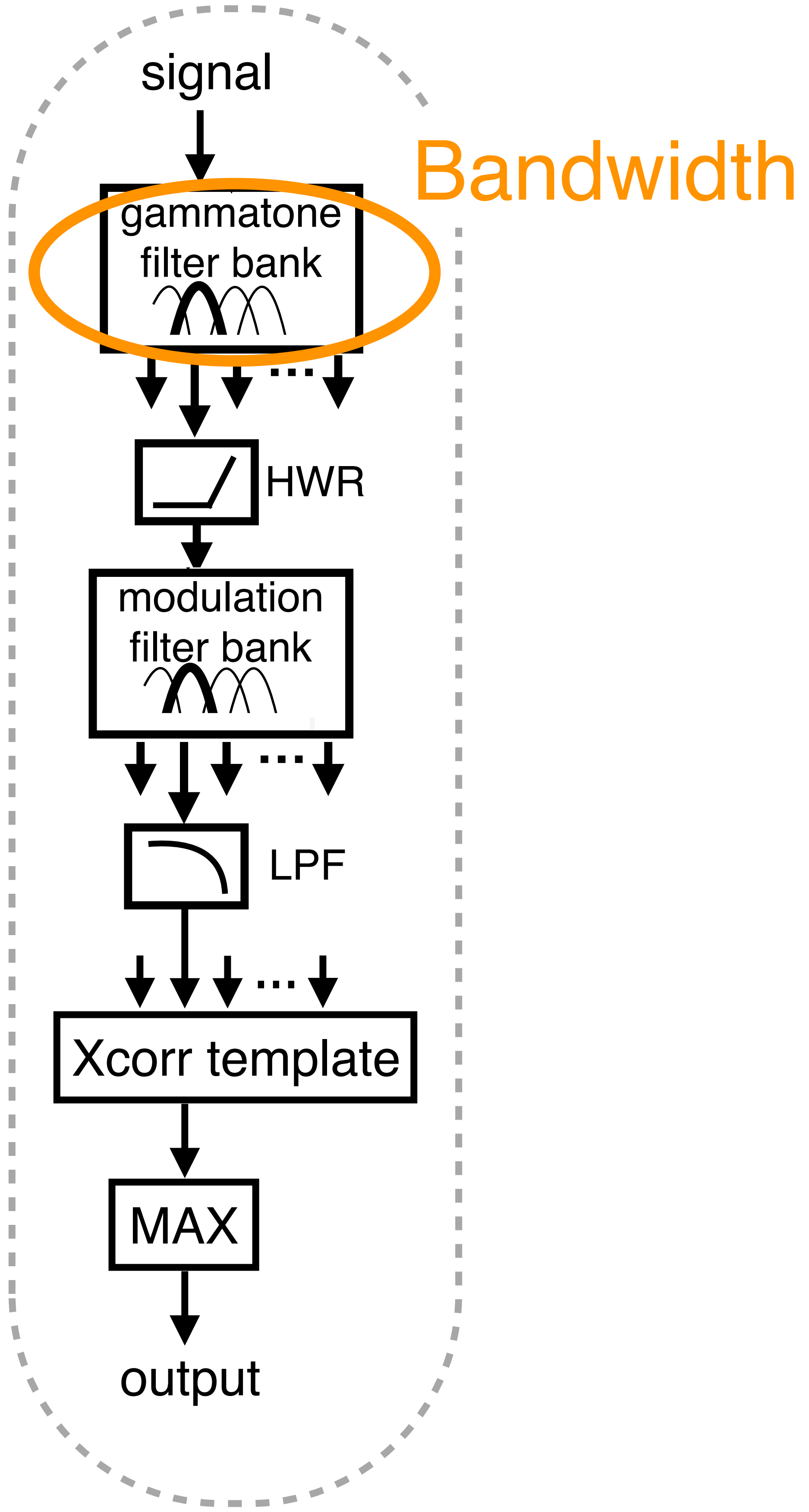
# Perceptual filters for STM detection




Ponsot et al. *Trends in Hear.* (in press)

# Can a modulation-filterbank model (± broader cochlear tuning) account for these data?

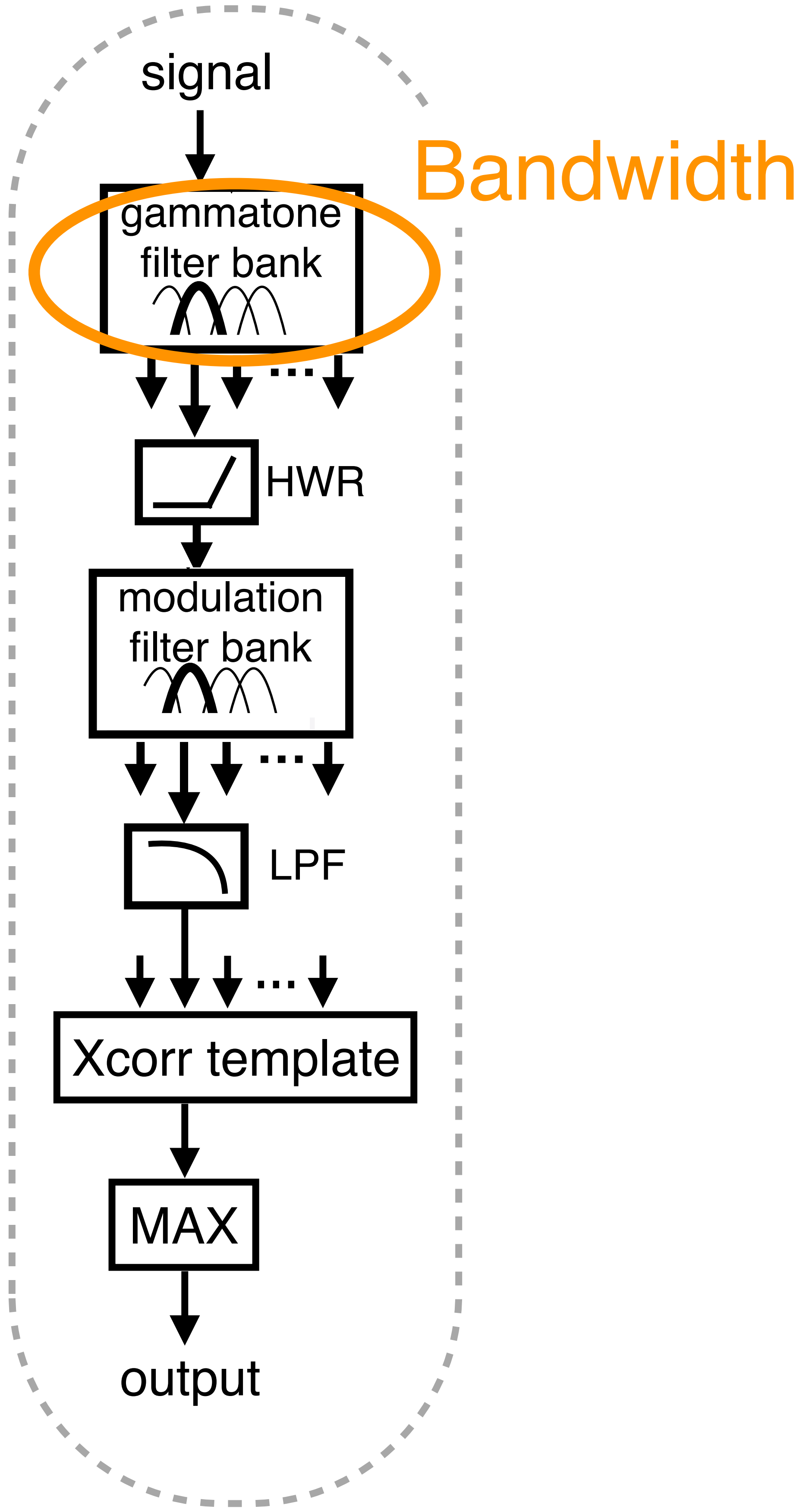
~ PEMO model

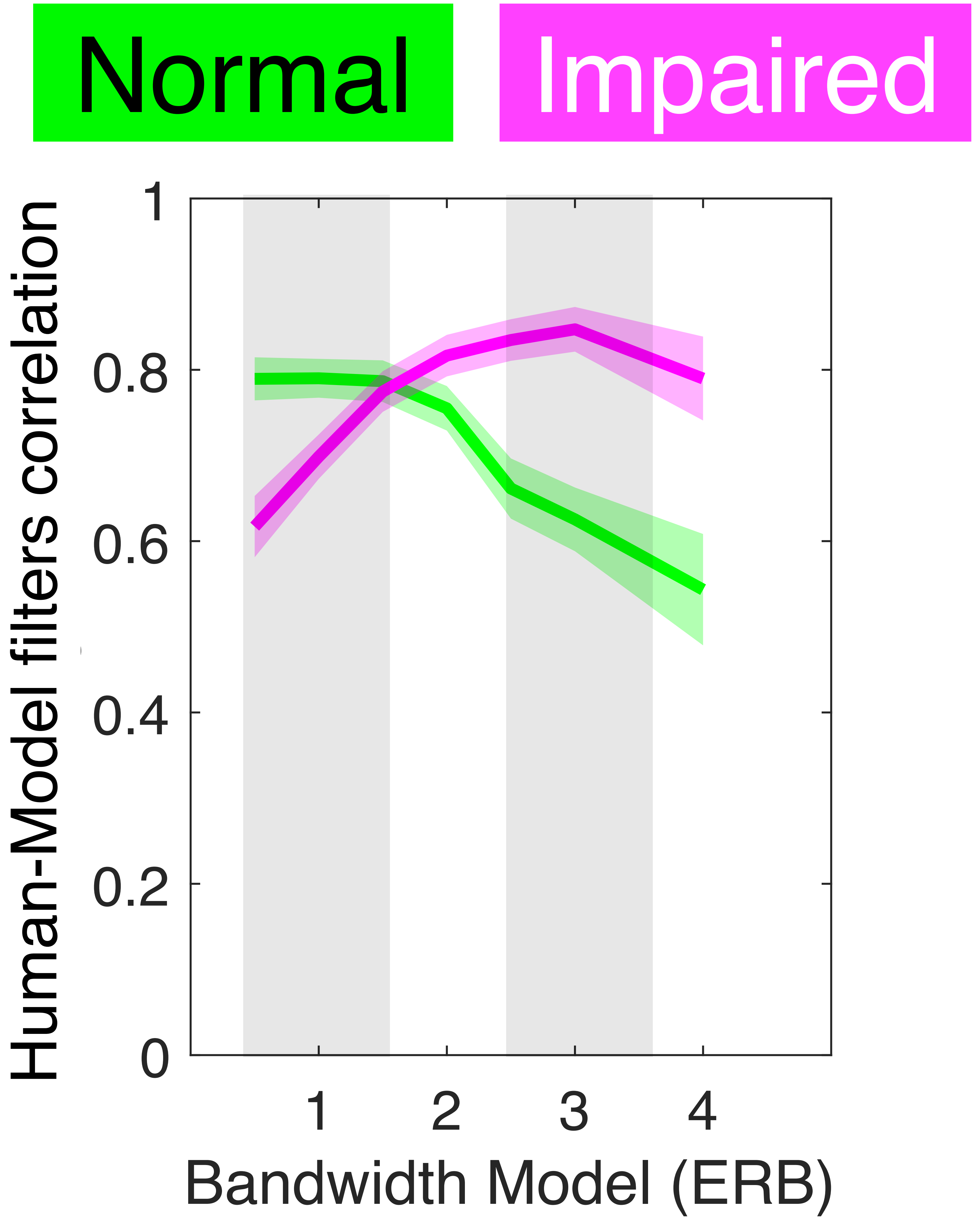



Dau et al. *JASA* (1997)

# STM detection is on average well accounted for by a modulation-filterbank model

~ PEMO model




Ponsot et al. *Trends in Hear.* (in press)

# Discussion

- Revcor on humans <u>AND</u> models: a single framework to characterize auditory processing of complex signals

- Understand interindividual differences in terms of latent model parameters?