When auditory mismatch negativity ***deviates*** from simple probabilistic inference.

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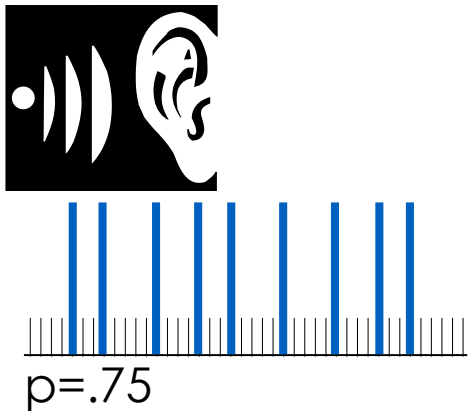
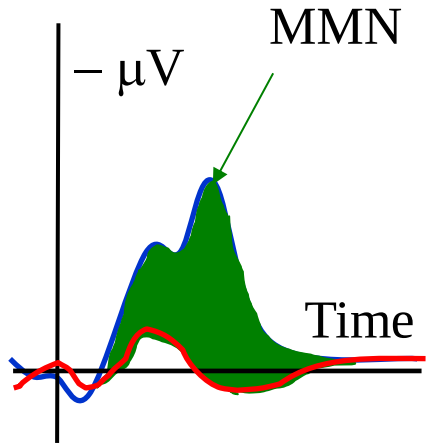
PRIORITY RESEARCH CENTRE:
TRANSLATIONAL NEUROSCIENCE AND MENTAL HEALTH

Mismatch Negativity (MMN)





Prediction Model

continue

Deviations

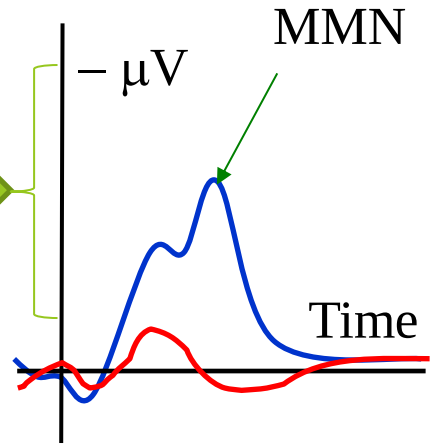
MMN

MMN = prediction-error signal

Elicitation = Model based on probabilistic inference is active.

MMN = Confidence-weighted prediction-error

Amplitude =
Modulated by confidence in the model.



Elicitation = MODEL IS ACTIVE

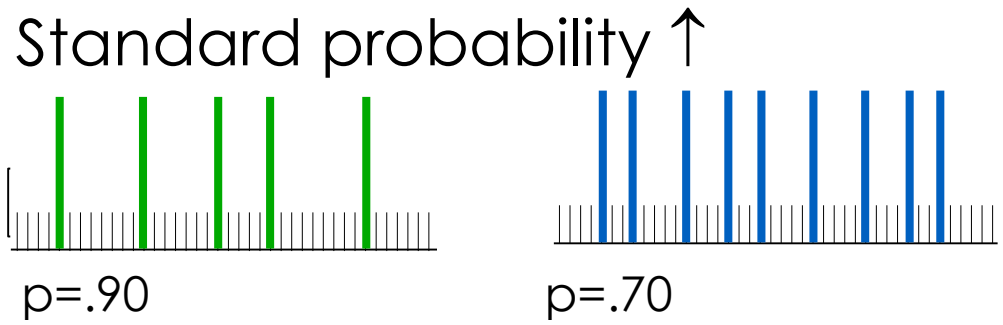
Probability & transition statistics

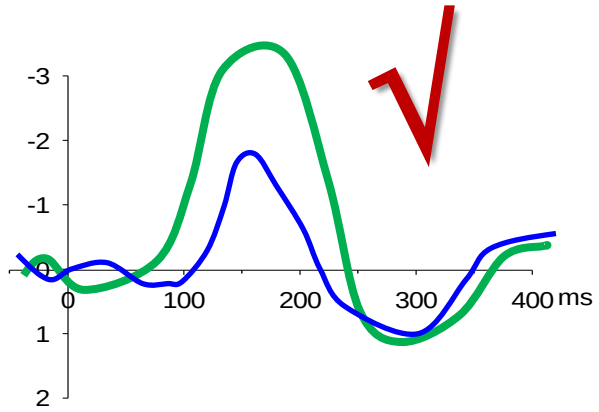
- Good account of **what** you will predict and **when** you will see MMN

Confidence is complex:

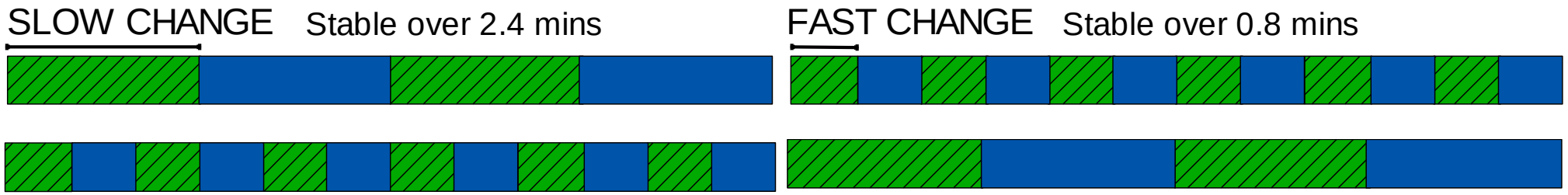
- Sensitive to **model stability**.
- Subject to order-driven **"first impression" bias**.
- Is modulated by not just local but **super-ordinate sequence patterns**.

THE QUESTION: What affects confidence?





THE DESIGN: Multi-timescale paradigm



Equal # of two sounds:	30ms & 60ms
Alternate probabilities:	Standard p=0.875, deviant p=0.125
Interval onset-onset:	300ms
Hypothesis:	Slow MMN > Fast MMN

Why do we have order-driven bias?

Weighted First-Impression

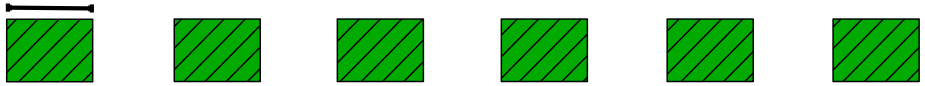
X = probable sound = predictable
Y = rare sound = unpredictable
C = confidence (stability/precision)

SLOW CHANGE Stable over 2.4 mins

C= HIGH

BIG MMN

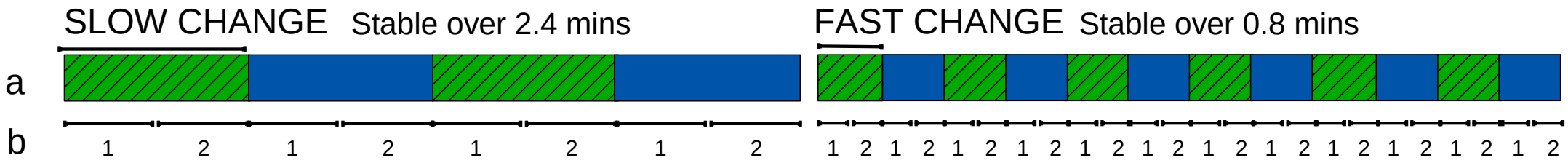
FAST CHANGE Stable over 0.8 mins



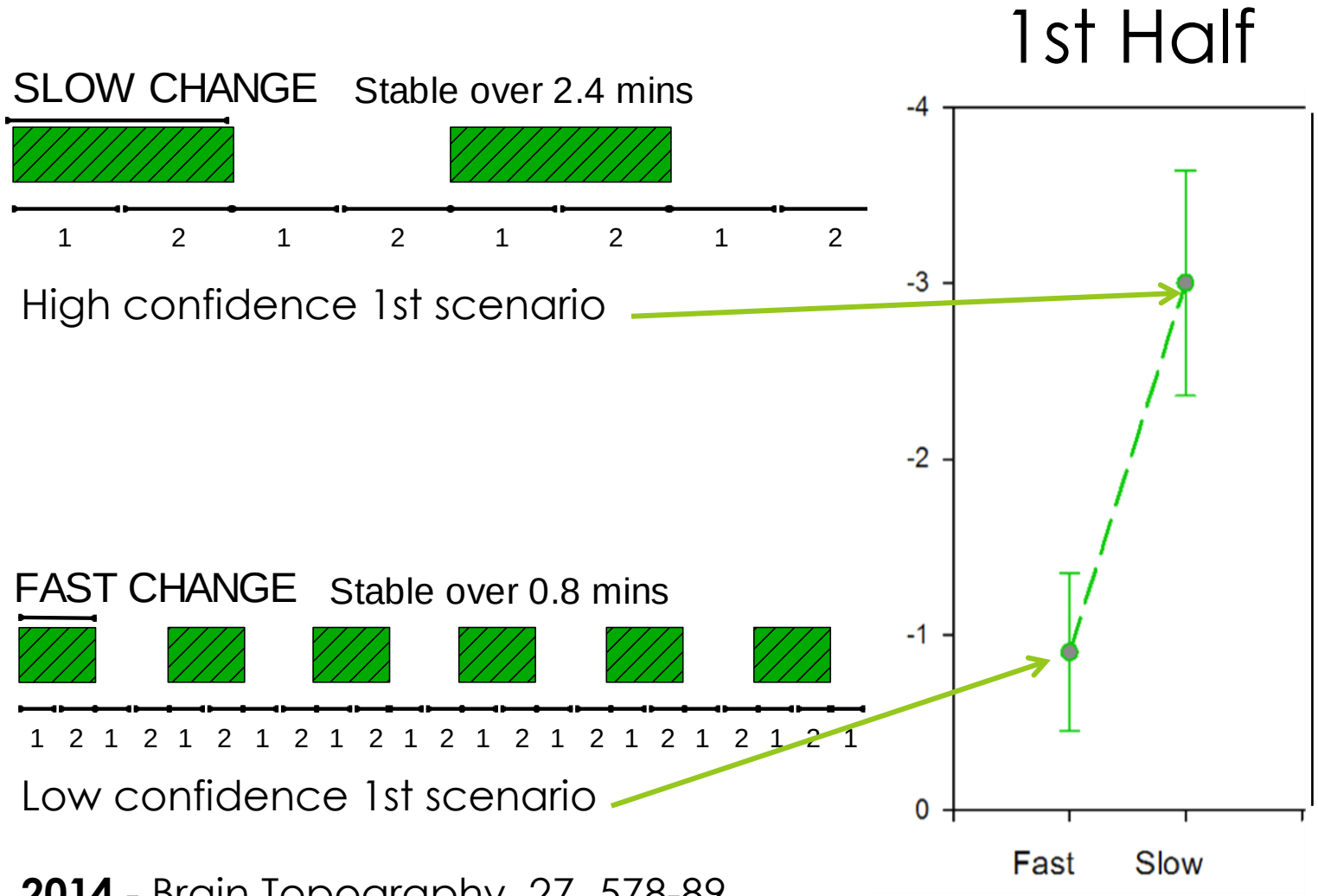
C= LOW

SMALL MMN

Evidence at transition points

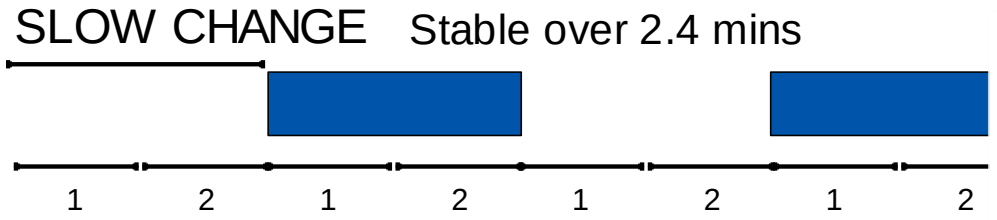


Transition Points

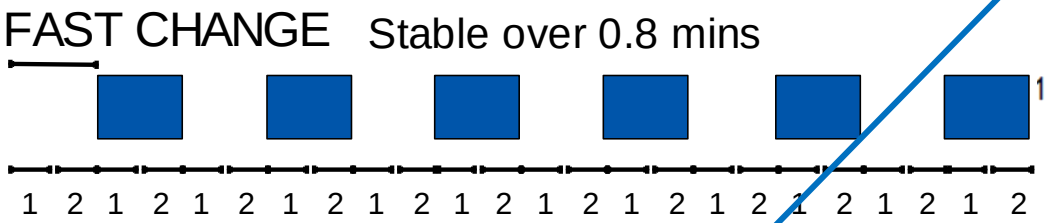


2014 - Brain Topography, 27, 578-89.

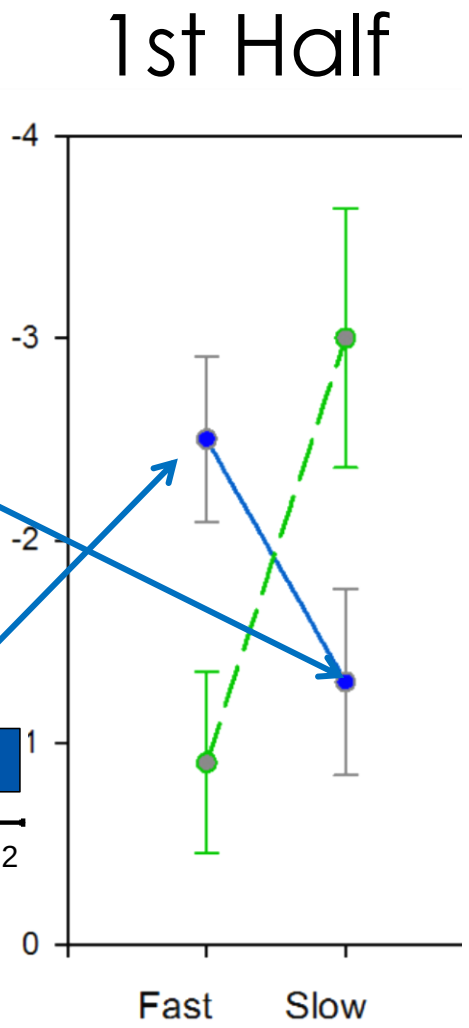
Transition points



High confidence 1st scenario
Suppressed confidence in reversal



Low confidence 1st scenario
Minimal impact on reversal



2014 - Brain Topography, 27, 578-89.

Weighted first impression is not enough…

Learning super-ordinate pattern or pattern of errors?

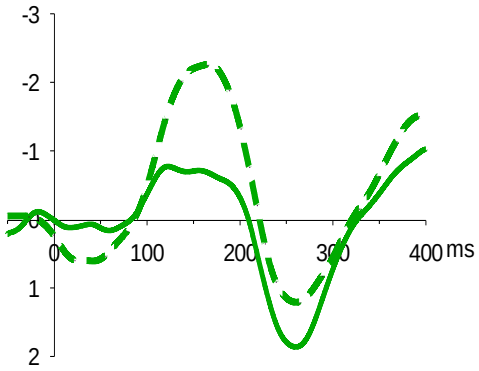
High confidence

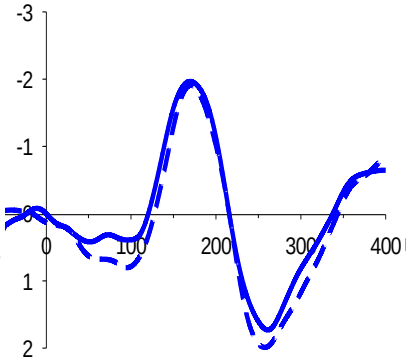
Low confidence

Slow

>

Fast

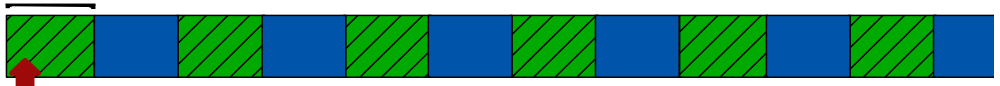




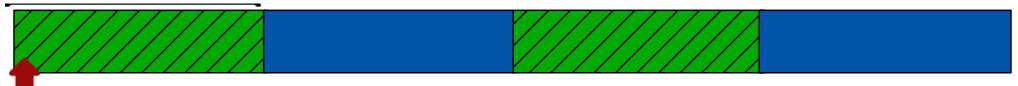
Slow

≤

Fast



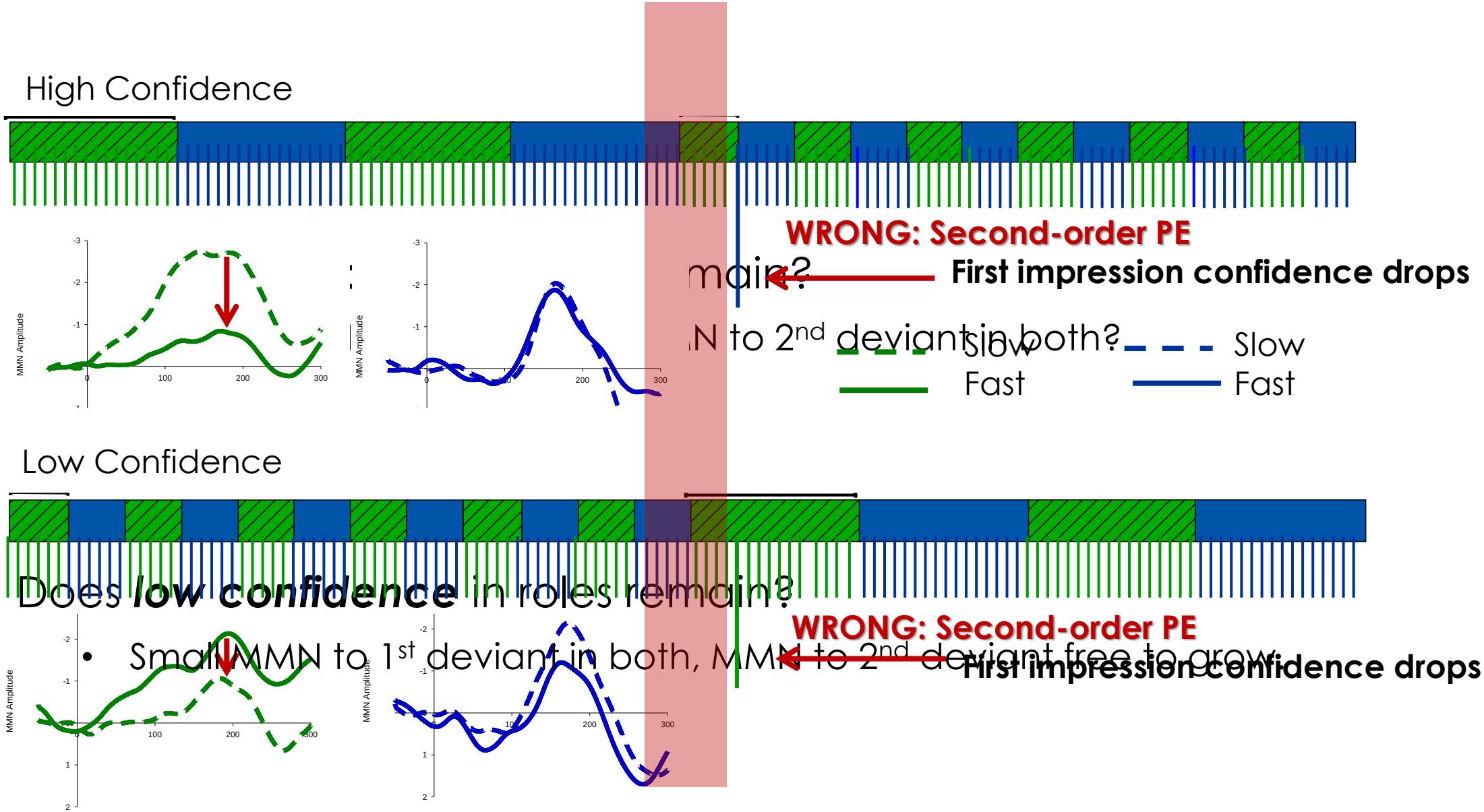
Low confidence



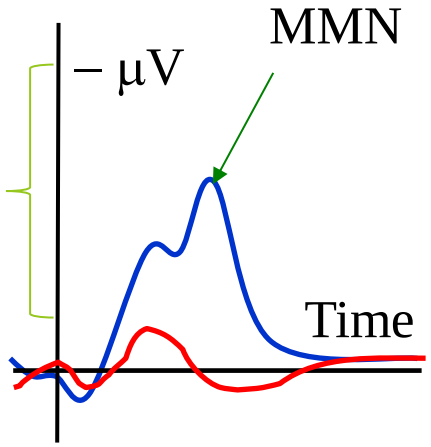
High confidence

Mullens, Damaso et al. in prep

What if we remove the gap?



TAKE-HOME MESSAGE



Amplitude of MMN

- Not governed by transition statistics alone
- Subject to ***order-driven bias***/heuristics……why?
- Modulated by predictions based on ***super-ordinate*** structure
- Operating over a long timescale and subject to learning

= A very sophisticated relevance-filtering system

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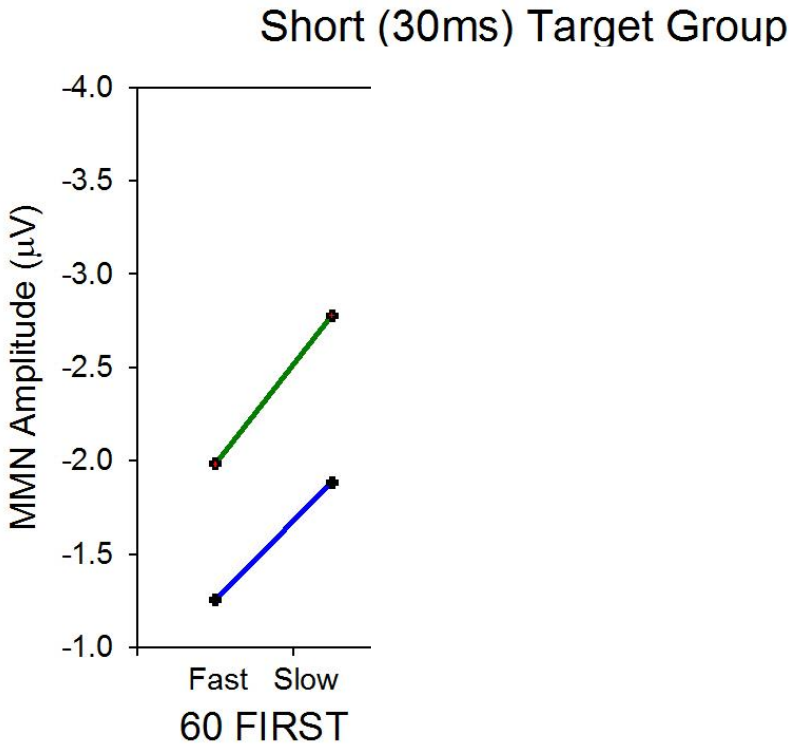
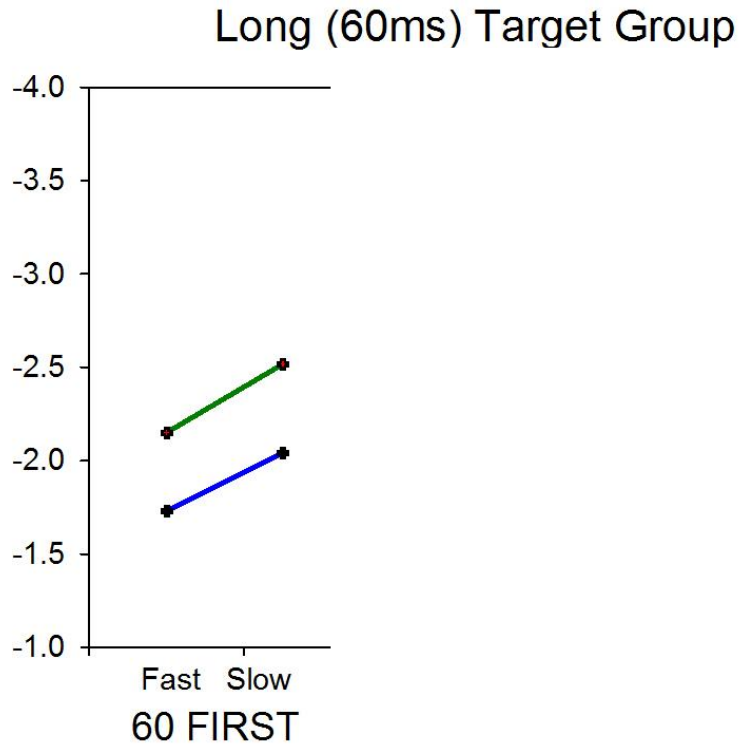
NHMRC Project Grant Application 1002995

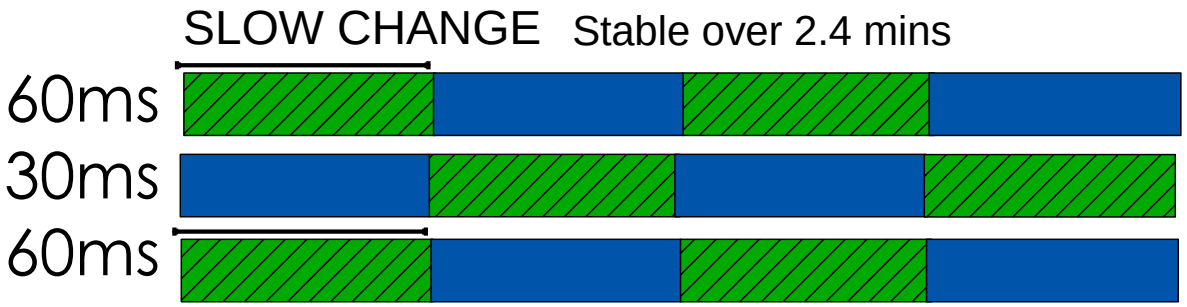
Published Data

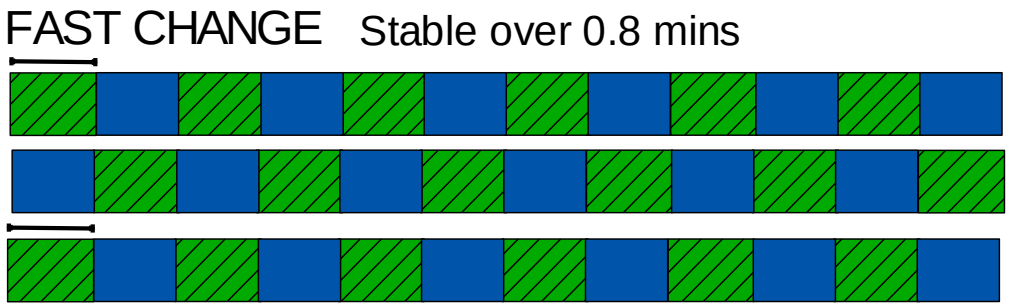
2011 - Neuropsychologia, 49, 3399-3405.
2013 - Journal of Neurophysiology, 109, 99-105.
2014 - Brain Topography, 27, 578-89.
2014 - Psychophysiology, 51:437-45.
2014 - Frontiers in Auditory Cognitive Neuroscience.

60ms
30ms

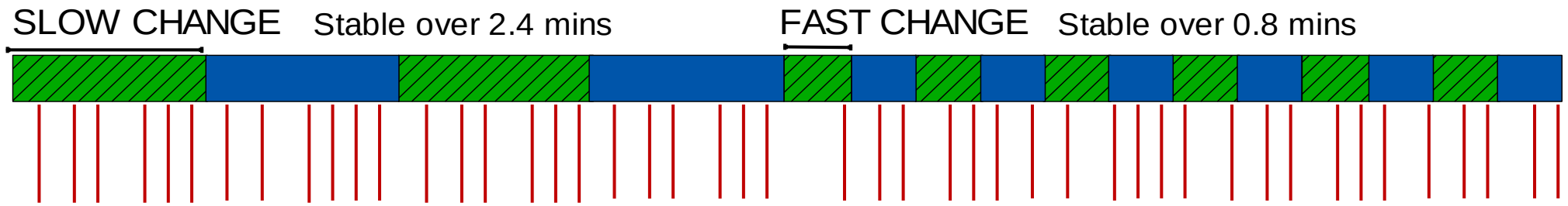

Short (30ms) Target Group
MMN Amplitude (μV)
-4.0
-3.5
-3.0
-2.5
-2.0
-1.5
-1.0
Fast
Slow
60 FIRST


Long (60ms) Target Group
-4.0
-3.5
-3.0
-2.5
-2.0
-1.5
-1.0
Fast
Slow
60 FIRST


SLOW CHANGE
Stable over 2.4 mins
60ms
30ms
60ms


FAST CHANGE
Stable over 0.8 mins

What if we prevent 1:1 mapping?



30ms = probable sound = predictable/redundant?
60ms = rare sound = unpredictable/important?

p=0.75 = 30ms 1000Hz, p=0.125 = 60ms 1000Hz, **p=0.125 = 30ms 1500Hz**

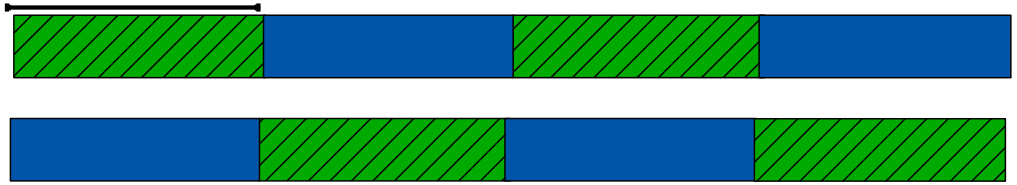
p=0.75 = 60ms 1000Hz, p=0.125 = 30ms 1000Hz, **p=0.125 = 60ms 1500Hz**

Property of 30ms belongs to ***common and rare*** tones.

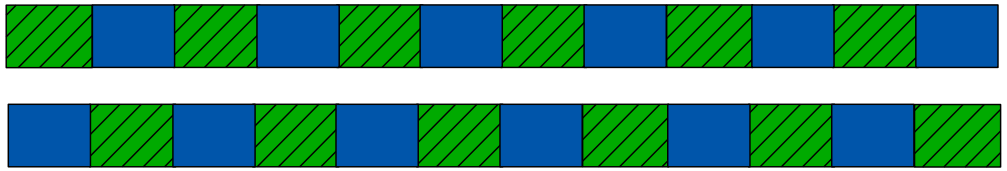
Should disrupt the bias because…
No unambiguous mapping of duration to relevance.

What if we add another sound?

SLOW CHANGE Stable over 2.4 mins



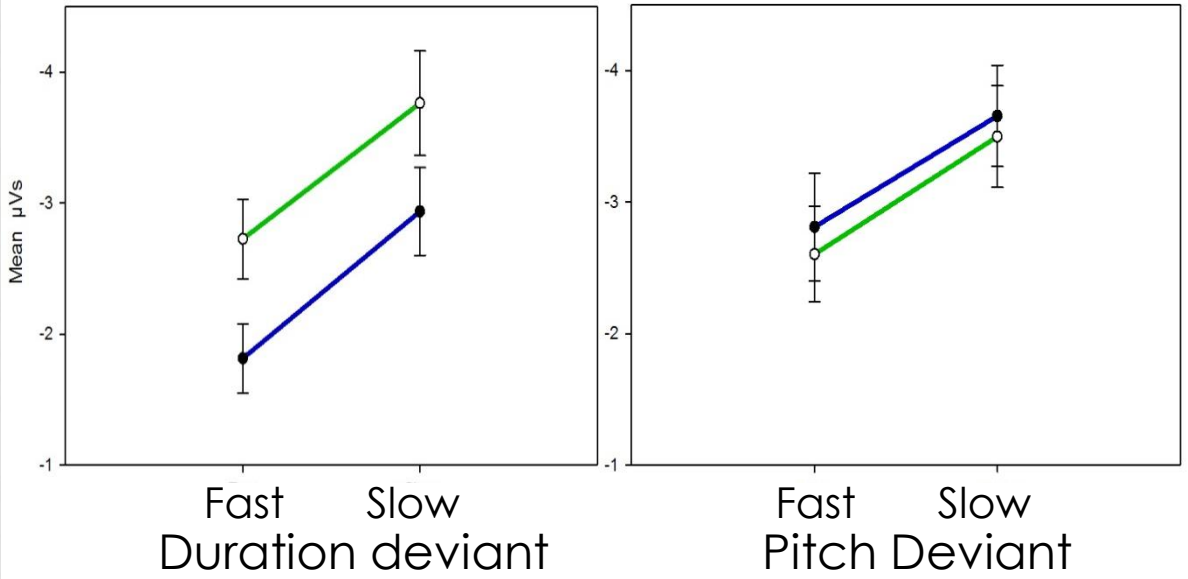
FAST CHANGE Stable over 0.8 mins



Order 1

X

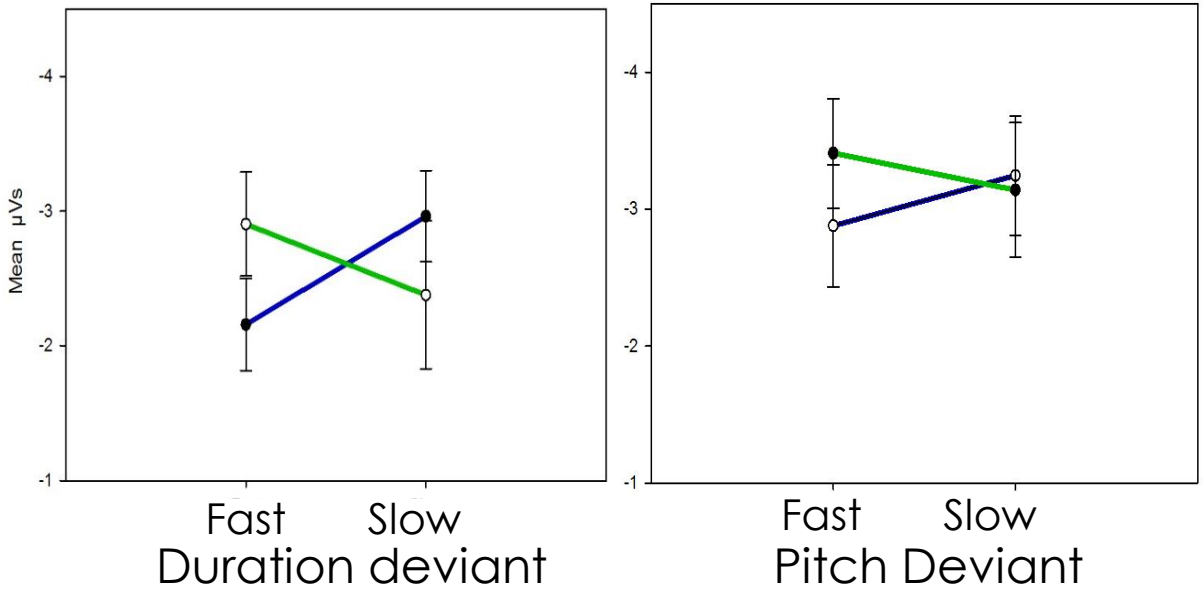
Slow > Fast both



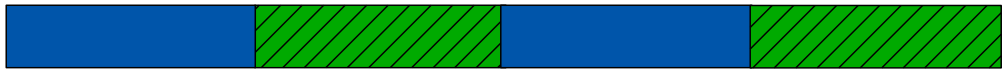
Order 2

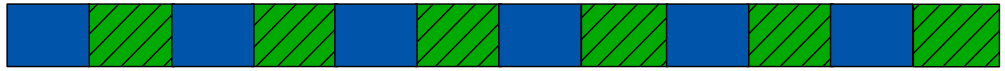
√

Slow > Fast 1st deviant only



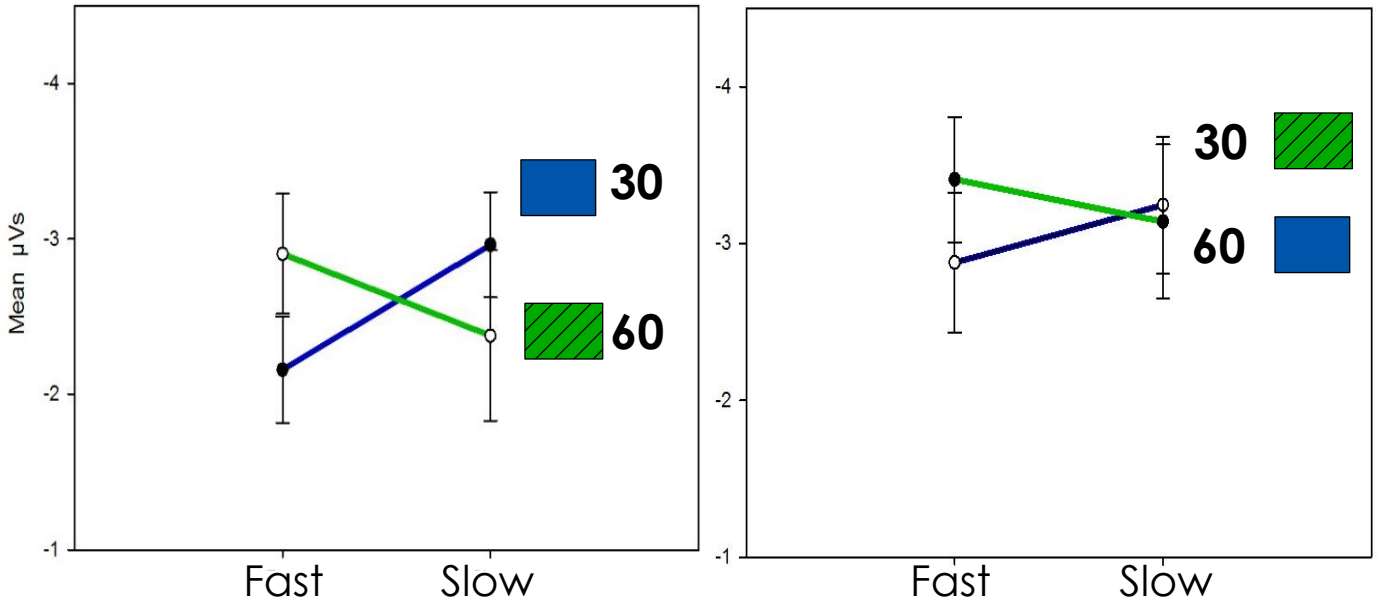
What if we add another sound?





MMN to a deviation *in pitch*
is being modulated
by *sound duration*
(a non-error property)

30ms in length Slow > Fast ***60ms in length*** Slow < Fast



pitch deviant

pitch deviant