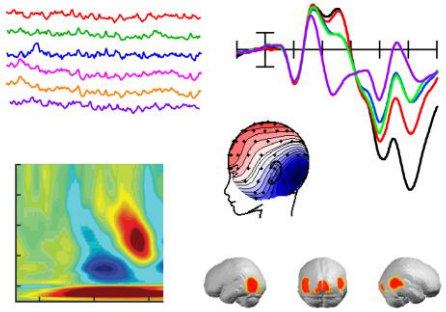
Empirical support for a multi-stage model of conscious perception

Michael Pitts[1], Gennadiy Belonosov[2], Rony Hirschhorn[2], Oscar Ferrente[3], & Liad Mudrik[2]

[1]Reed College, Portland OR, USA
[2]Tel Aviv University, Tel Aviv, Israel
[3]University of Surrey, Guildford, UK

SCALPLAB
Sensation Cognition Attention Language Perception



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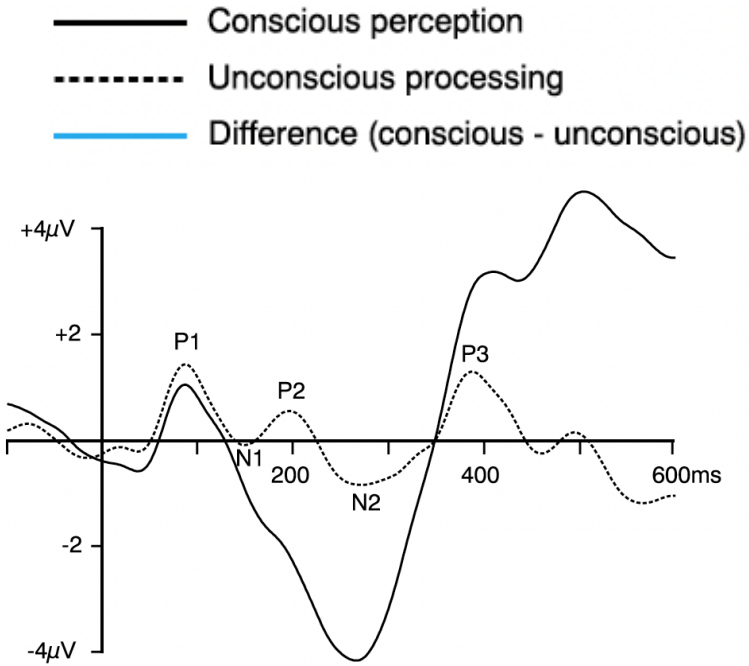
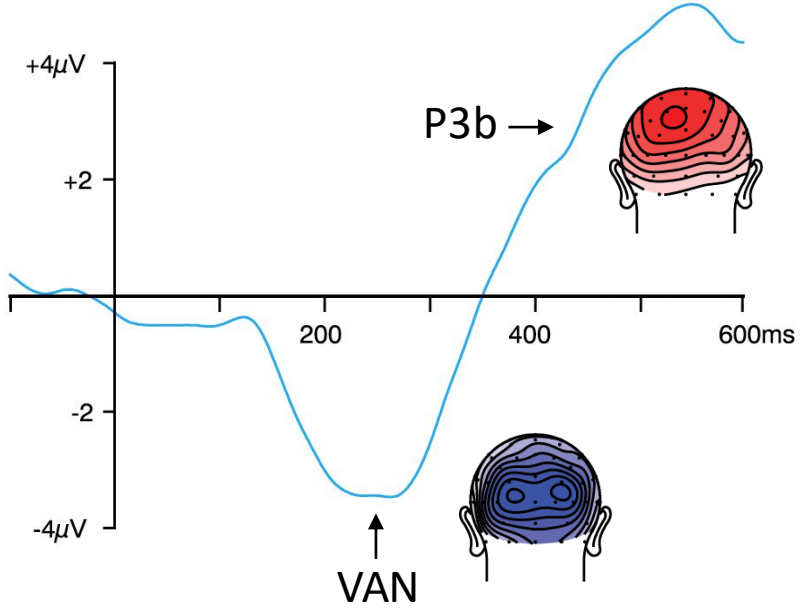
ASSC 2026

EEG experiments with trial-by-trial reports





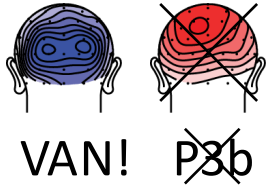
"visual awareness negativity"

reviews:
Dembski et al. (2021); Koivisto & Revonsuo (2010); Förster et al. (2020)

EEG experiments with “no-report” conditions

Brendan Hutchinson

- Registered-report meta-analysis of VAN & P3b
  - 117 published studies (1999-2025)
  - 377 effect sizes for VAN; 259 for P3b



- Main results:
  - **VAN**: indexes a processing stage **necessary** for conscious perception
  - P3b: report-related processing, <u>not necessary</u> for conscious perception

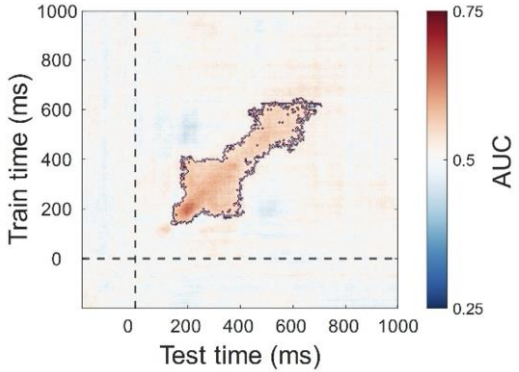
- But, are neural events indexed by VAN sufficient?
  - some evidence for VAN in “unseen-unseen contrasts”

Hutchinson et al. (2026)

Other clues that VAN is necessary but not sufficient

- Sources of VAN ➔ occipital-temporal cortex, but contributions from PFC found in several no-report fMRI/iEEG studies
  - Hatamimajoumerd et al. (2022)
  - Kronemer et al. (2022)
  - Cogitate et al. (2025)
  - review: Panagiotaropoulus (2024)

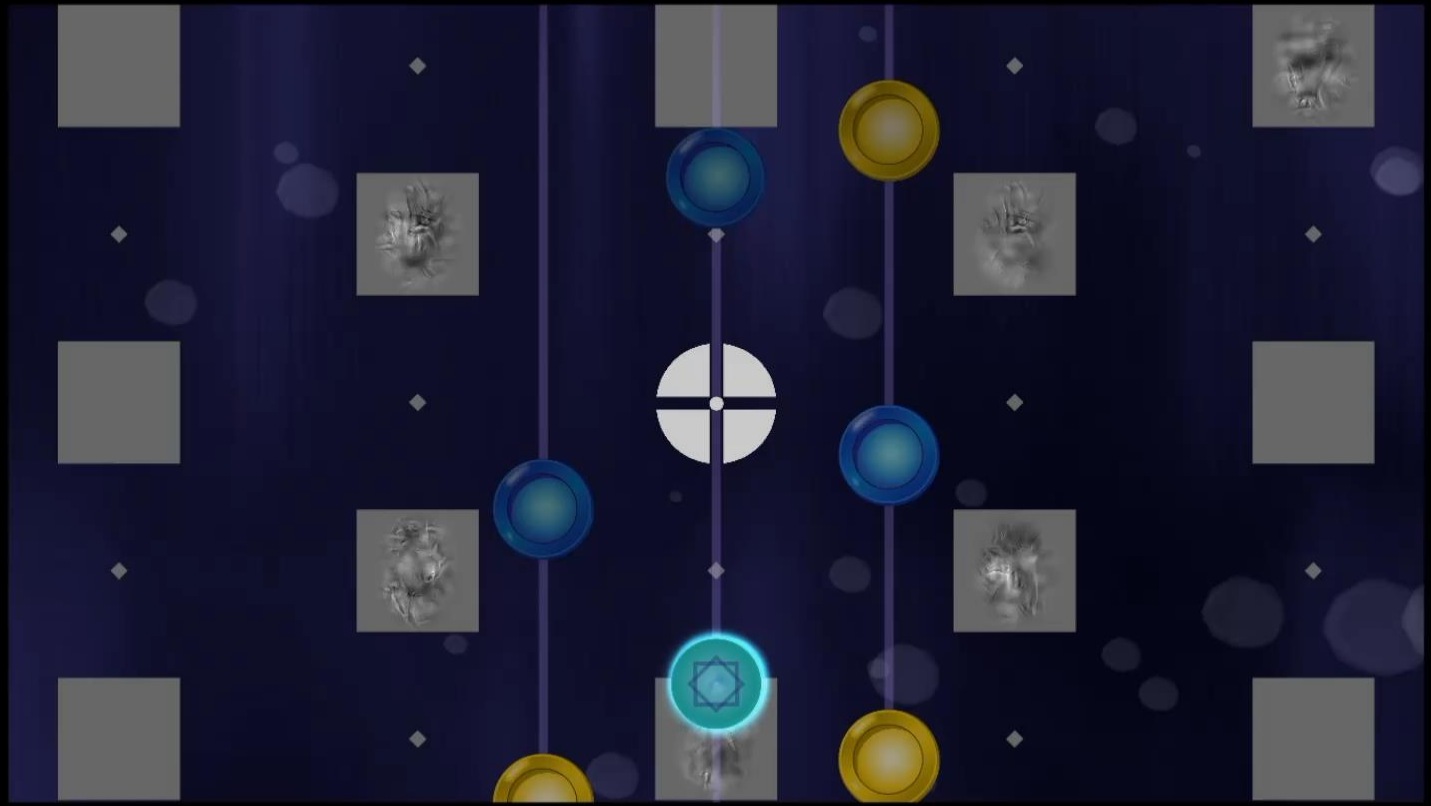
- Decoding in no-report extends beyond timing of VAN
  - Hutchinson et al. (2024)
  - Hutchinson et al. (bioRxiv)

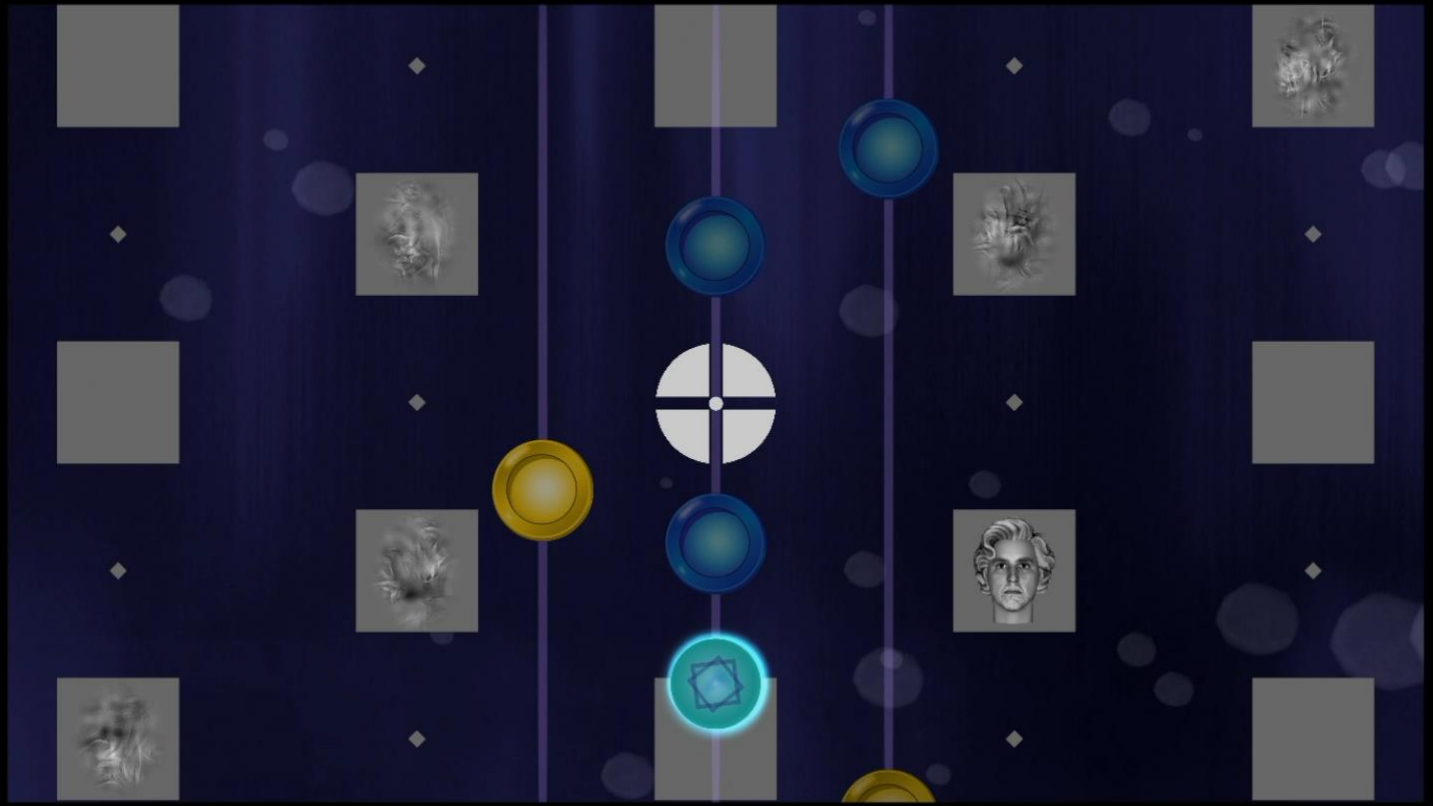


Cogitate Experiment 2

- Simultaneous MEG & EEG (N = 63)
- fMRI (N = 76)

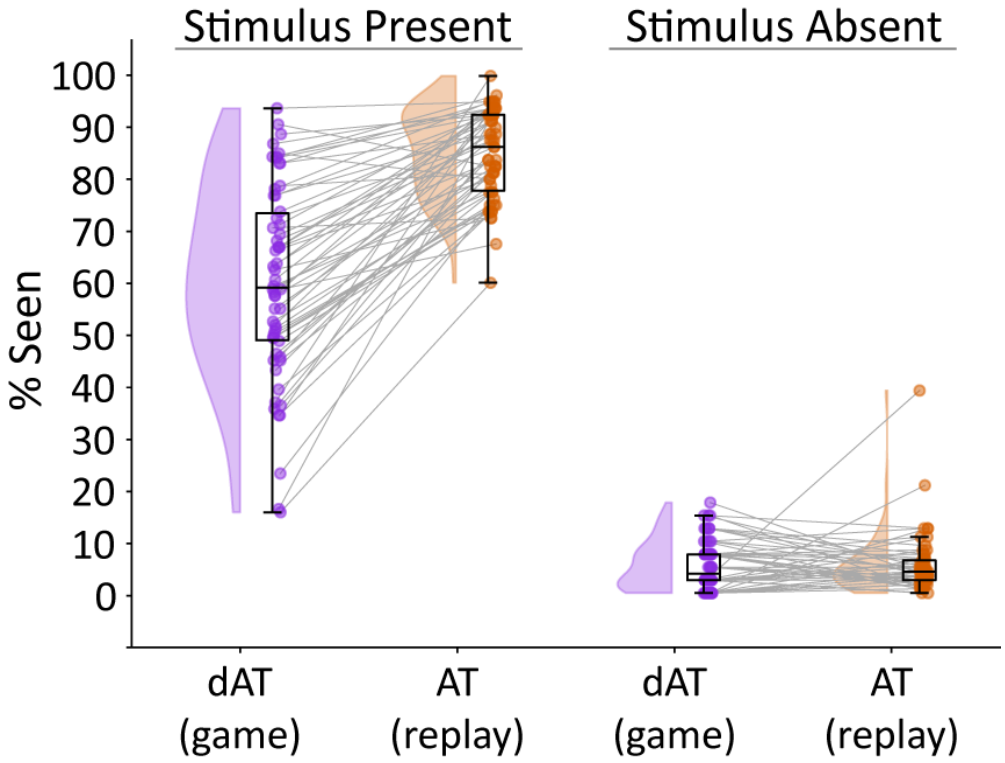
- Experiment design goals:
  - salient, unmasked stimuli (to get strong/clean neural responses)
  - task-irrelevant stimuli (to avoid contamination from P3b)
  - trial-by-trial reports (to validate seen/unseen status)





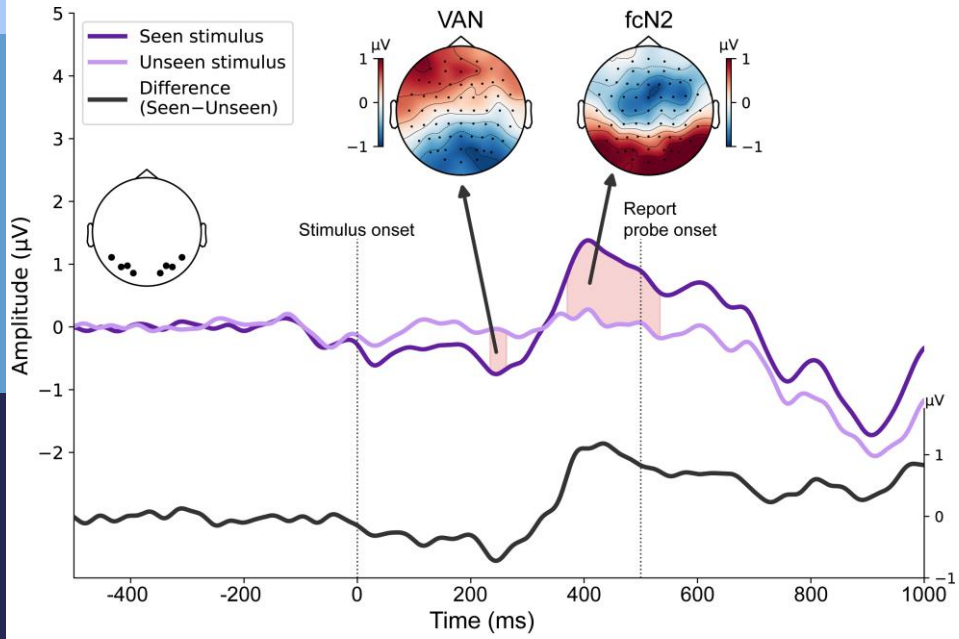
- Duration = 500ms (250ms full size/contrast, 250ms shrink/fade)
- Stim presented every ~3-6s
- Awareness probed every ~9-18s
  - 160 stimuli, 40 blanks
- Task conditions:
  - distracted attention (dAT): primary task = play video game
  - full attention (AT): replay of game shown, task = detect faces/objects

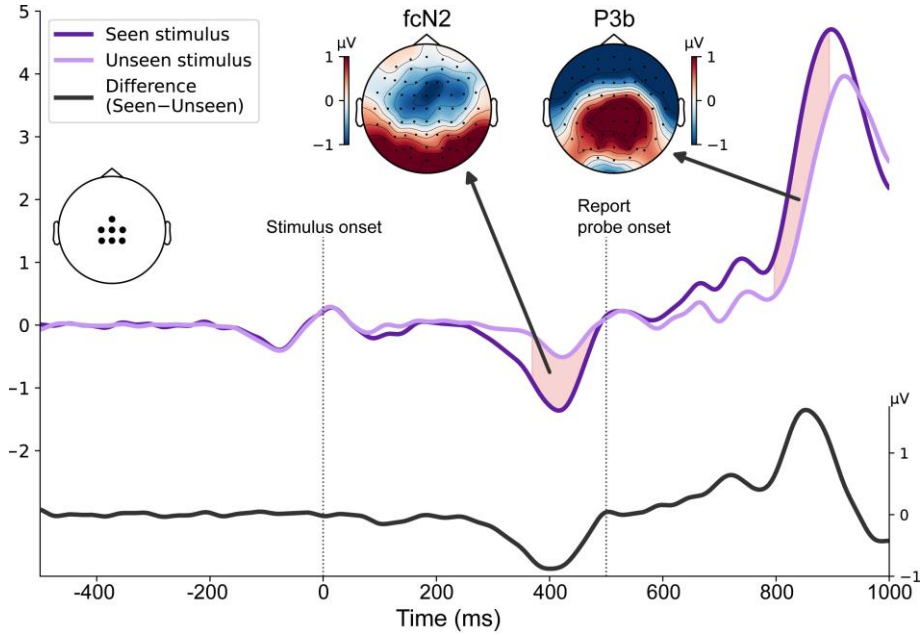
Behavioral results



Hirschhorn et al. (in prep)

EEG results

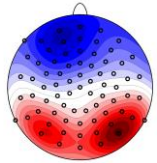




Belonosov et al. (in prep)

Additional evidence

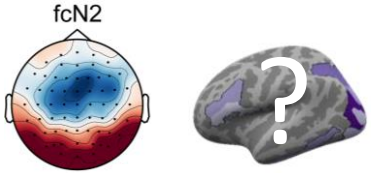
- fcN2 present in at least 6 no-report studies…
  - Liu et al. (2026) – inattentional blindness
  - Cohen et al. (2024) – backward masking
  - Sun et al. (2023) – inattentional blindness
  - Dellert et al. (2022) – attentional blink
  - Sergent et al. (2021) – stimulus degradation
  - Schlössmacher (2021) – inattentional deafness
- Also present in re-analyses of older datasets:
  - e.g., Shafto & Pitts (2015)



400-600ms

Open questions

- Where are the neural generators of the fcN2?



- What process might the fcN2 reflect?
  - global playground (Sergent et al., 2021)
  - perceptual reality monitoring (Lau, 2022)
  - attention schema (Graziano, 2022)
  - predictive coding (Hohwy & Seth, 2020)
- Does the fcN2 challenge any theories?
  - recurrent processing (Lamme, 2020)
  - integrated information (Tononi et al., 2016)
- Could the fcN2 be another task-related confound like P3b?
  - i.e., a yet-to-be-identified “no-report-task confound”?

Conclusions

- IF the fcN2 is a genuine NCC, along with the VAN, they might <u>together</u> index the "minimal *set*" of neuronal events "*jointly* sufficient" for a given conscious percept

- 2-stage model:
  - VAN = potentially phenomenal content
  - fcN2 = minimal cognitive access (not necessarily "global")
  - conceptual argument: Mudrik et al. (2026) *TICS*

- Growing evidence that *something else* has to happen after the stage indexed by VAN… lots of experiments left to do!

COGITATE


Xuan Cui


Matthias Ekman


Oscar Ferrante


Urszula Gorska-Klimowska


Simon Henin


Rony Hirschhorn


Aya Khalaf


Alex Lepauvre


Ling Liu


Pablo Oyarzo


David Richter


Zvi Roth


Yamil Vidal


Sharif Kronemer


Niccolò Bonacchi


Praveen Sripad


Diptyajit Das


Fatemeh Taheriyan

TEMPLETON WORLD
CHARITY FOUNDATION

ACCELERATING RESEARCH on Consciousness


Marcelo Armendariz


Katarina Bendtz


Tara Ghafari


Dorottya Hetenyi


Jay Jeschke


Csaba Kozma


David Mazumder


Stephanie Montenegro


Alia Seedat


Abdo Sharaf


Shujun Yang


Hal Blumenfeld


Floris de Lange


Sasha Devore


Ole Jensen


Gabriel Kreiman


Huan Luo


Sylvain Baillet


David J Chalmers


Radoslaw M Cichy


Francis Fallon


Theofanis Panagiotaropolous


Melanie Boly


Stanislas Dehaene


Christof Koch


Giulio Tononi


Tanya Brown


Michael Pitts


Liad Mudrik


Lucia Melloni


Gennadiy Belonosov
Xuan Cui
Matthias Ekman
Oscar Ferrante
Urszula Gorska-Klimowska
Simon Henin
Rony Hirschhorn
Aya Khalaf
Alex Lepauvre
Ling Liu
Pablo Oyarzo
David Richter
Zvi Roth
Yamil Vidal
Sharif Kronemer
Niccolò Bonacchi
Praveen Sripad
Diptyajit Das
Fatemeh Taheriyan
TEMPLETON WORLD
CHARITY FOUNDATION
ACCELERATING RESEARCH on Consciousness
Marcelo Armendariz
Katarina Bendtz
Tara Ghafari
Dorottya Hetenyi
Jay Jeschke
Csaba Kozma
David Mazumder
Stephanie Montenegro
Alia Seedat
Abdo Sharaf
Shujun Yang
Hal Blumenfeld
Floris de Lange
Sasha Devore
Ole Jensen
Gabriel Kreiman
Huan Luo
Sylvain Baillet
David J Chalmers
Radoslaw M Cichy
Francis Fallon
Theofanis Panagiotaropolous
Melanie Boly
Stanislas Dehaene
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Michael Pitts
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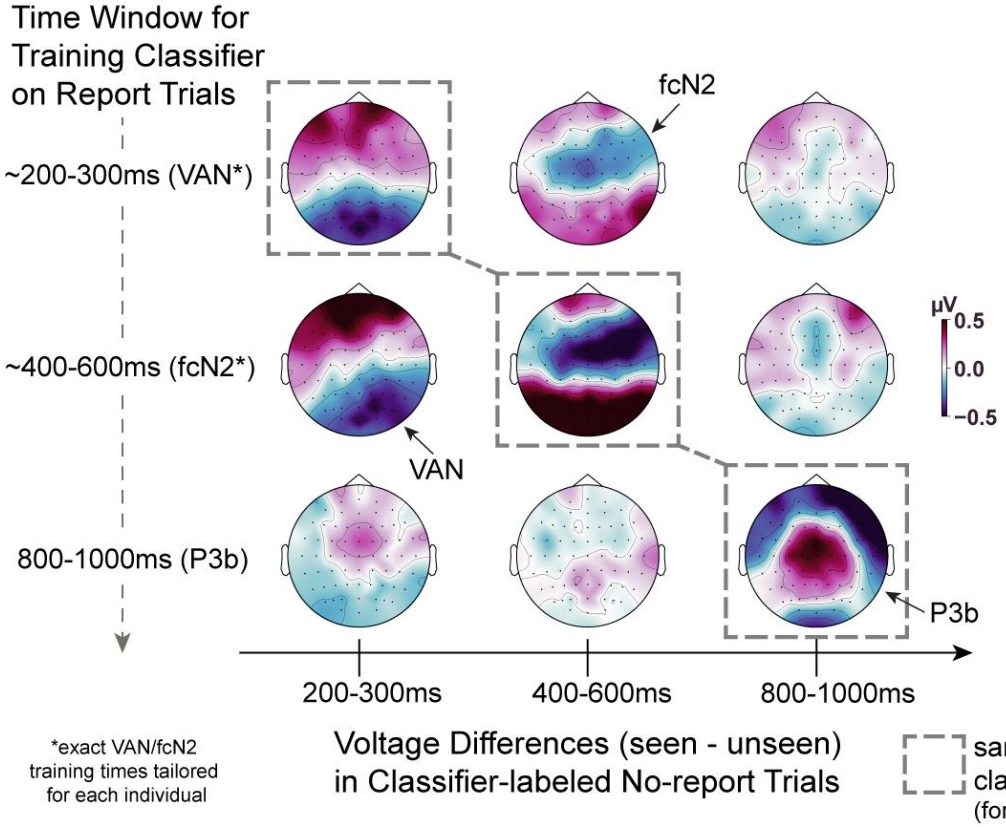
Lucia Melloni

Additional EEG results: unprobed trials

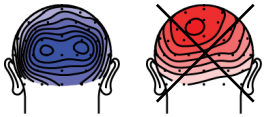
Belonosov et al. (in prep)



Classifiers were trained to distinguish seen-vs-unseen in probed trials using restricted time-windows for training.

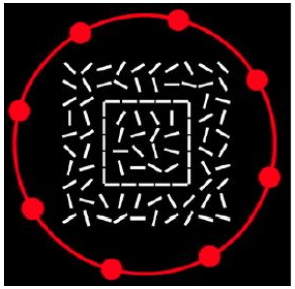
The trained classifiers then labeled unprobed trials as seen or unseen, and we compared the two at all times.

VAN & fcN2 appear to always show up as a pair of effects, while P3b was totally absent in unprobed trials.

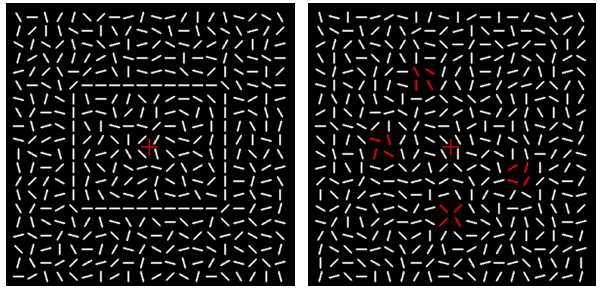


A few key no-report EEG experiments

results: VAN! ~~P3b~~



Pitts, Martinez, & Hillyard (2012)

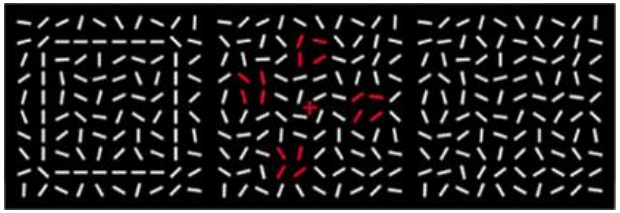


Pitts et al. (2014)

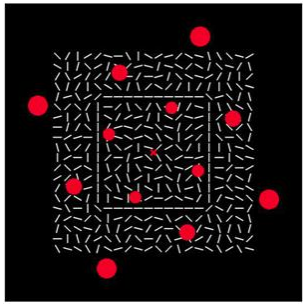
Shafto & Pitts (2015)

Schelonka et al. (2017)

Inattentional Blindness



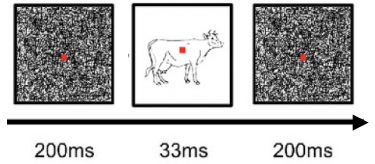
Harris, Dux, & Mattingley (2020)



Schlossmacher et al. (2020)

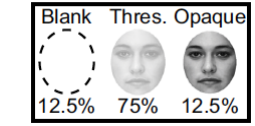
Masking

Cohen et al. (2020)
He et al. (2026)



Stimulus Degradation

Kronemer et al. (2022)
Sergent et al. (2021)



Why did Cogitate Exp 2 take 8+ years to complete?

- 2 years to develop the experimental design and pilot test it (2018-2019)
- 2 years to collect data (2020-2021), due to covid-related delays
- 2 year pause to focus on Cogitate Exp 1 analyses (2022-2023)
- 2 years to get Exp 1 published (2023-2024), thanks to some minor complications (IIT pseudoscience controversy)
- finally, in 2024-2025 we were able focus all efforts on analyzing Exp 2 and writing up the results!
- plan to publish 3 papers on Exp 2 in 2026-2027