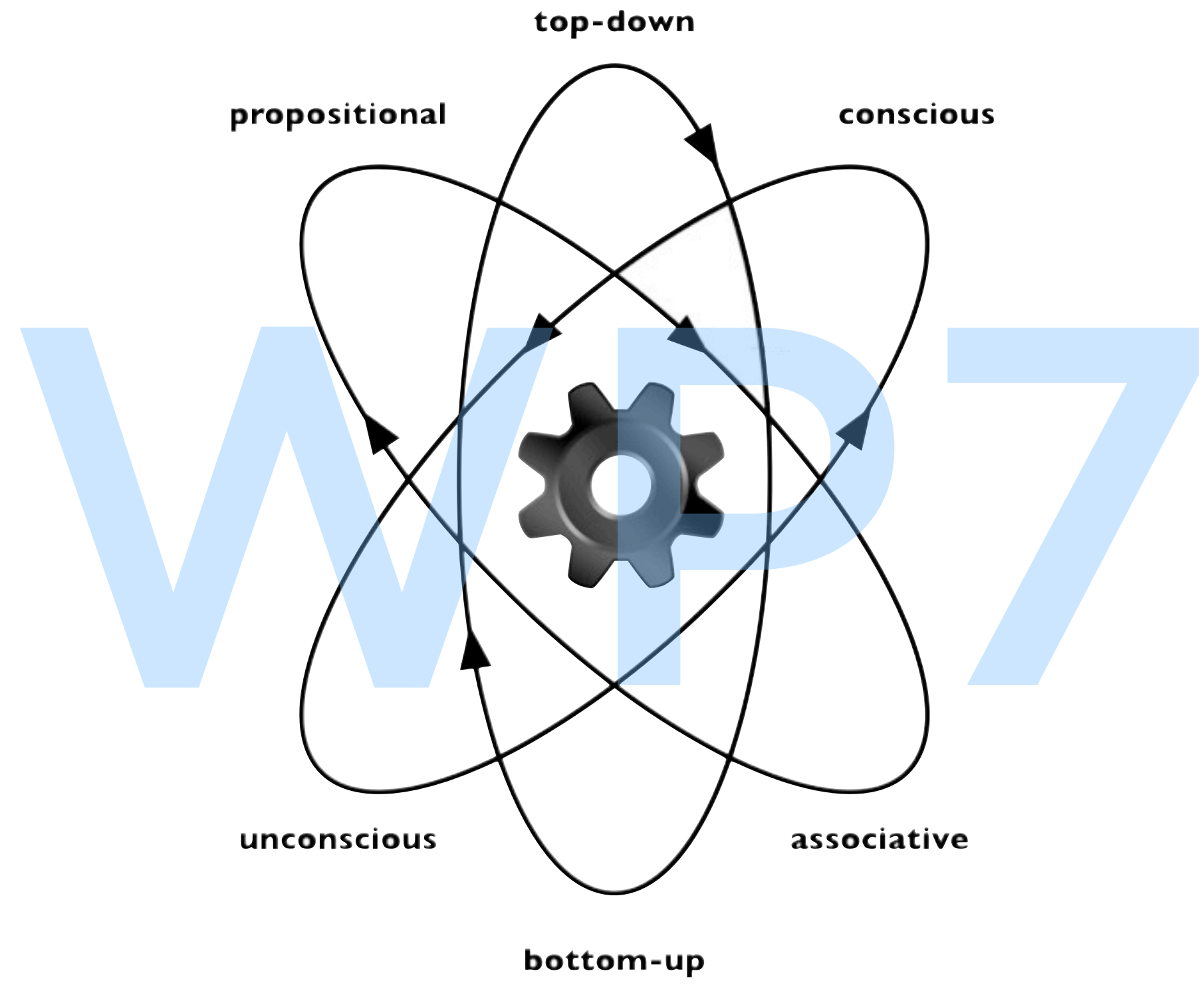


Mechanisms of awareness: "Learning to be conscious"



# Mechanisms of awareness: “Learning to be conscious”

- **Three parts:**

- **WP7a:** Quality of representation: Expertise studies (with Bruno, Guillermo & Philippe) & causal learning/associative learning studies (**Esti**, with Jan & Tom)
- **WP7b:** Metarepresentation: Metacognition, hypnosis, suggestion (with Zoltan)
- **WP7c:** Learning & consciousness: Externalizing the inner loop (**Emilie**, with Patrick)

- Repetition & masking
- Unconscious sequence learning (?)
- Unconscious associative learning (?)
- Expertise in the motor domain
- Hypnosis
- Agentivity, ownership & neurofeedback

WP7a

Quality of representation



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journal homepage: [www.elsevier.com/locate/concog](http://www.elsevier.com/locate/concog)



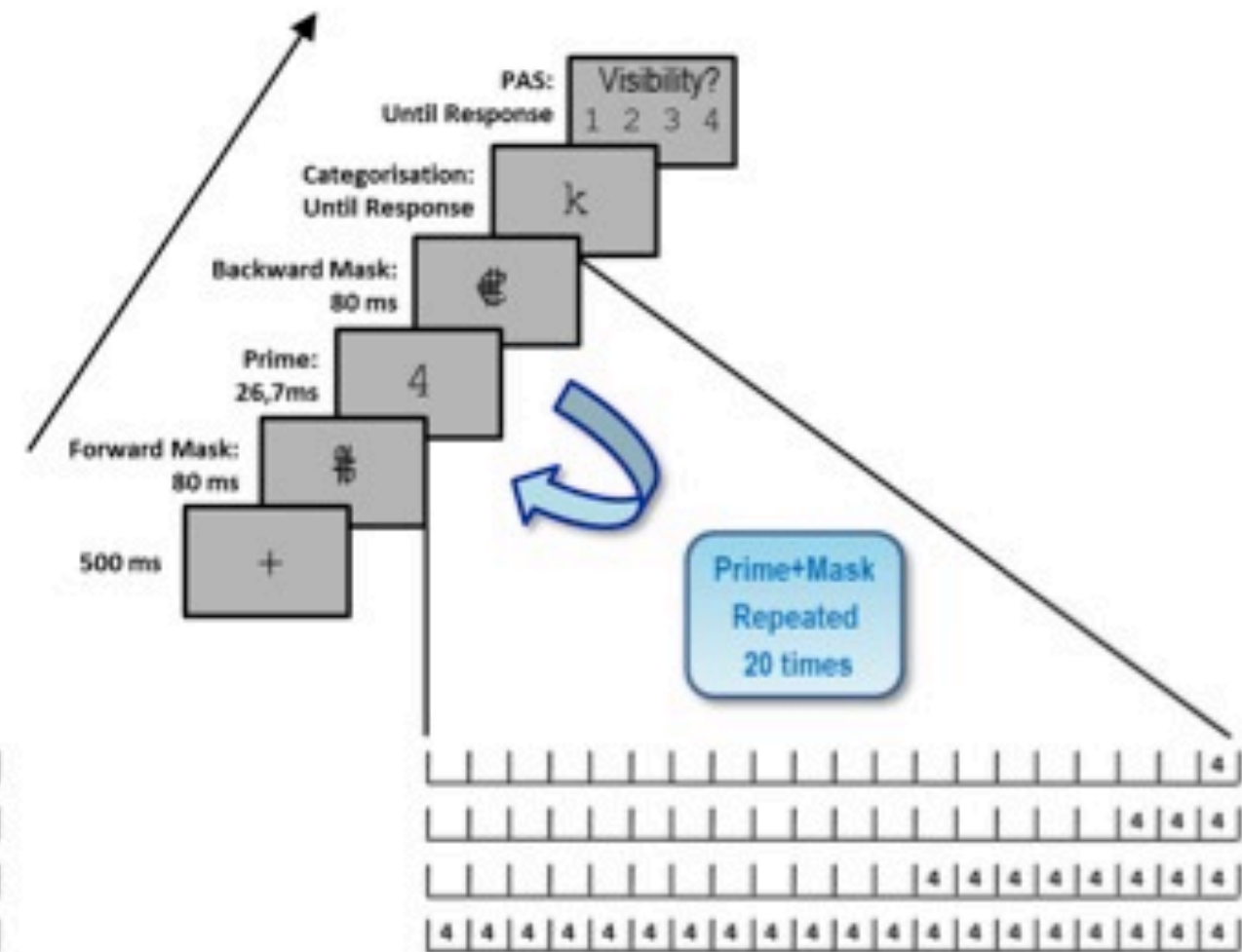
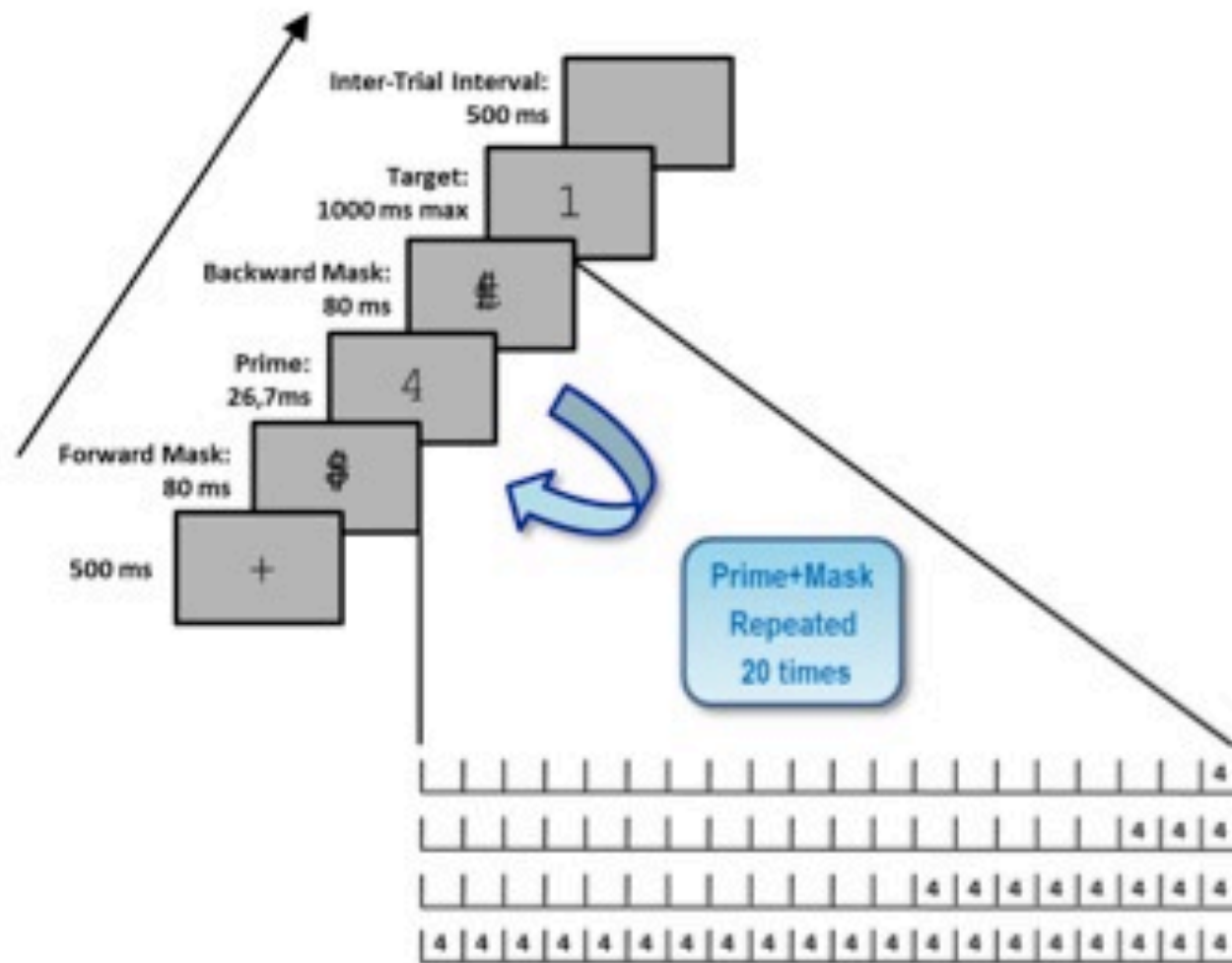
### Repeating a strongly masked stimulus increases priming and awareness

Anne Atas\*, Astrid Vermeiren, Axel Cleeremans

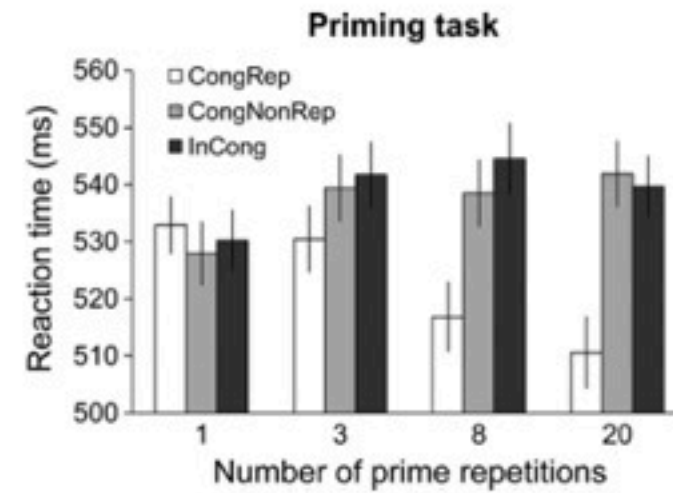
*Consciousness, Cognition and Computation Group, Université Libre de Bruxelles, Belgium  
Centre de Recherche Cognition et Neurosciences, Université Libre de Bruxelles, Belgium*



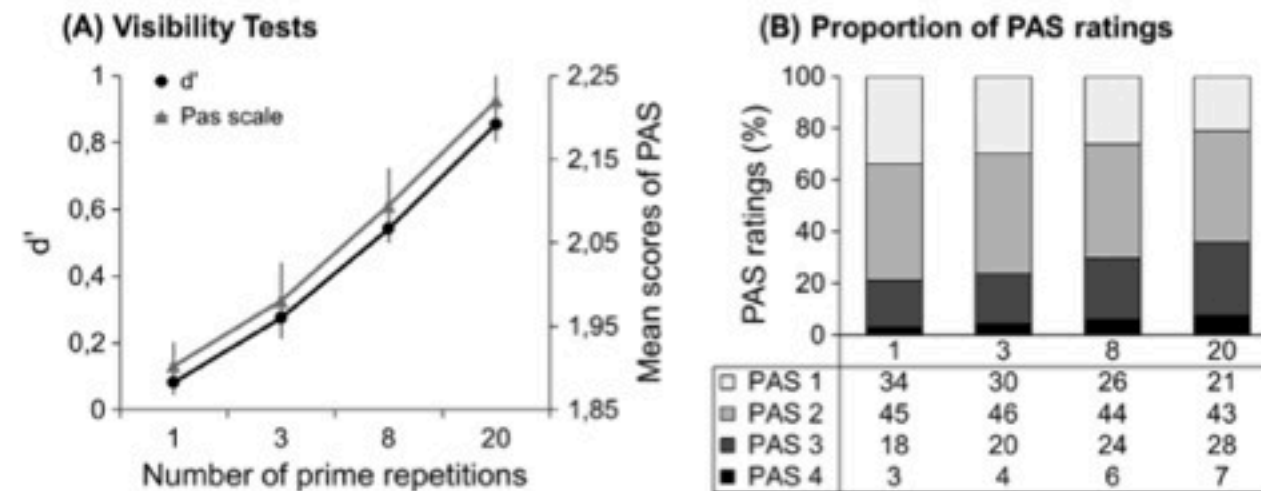
# MARCEL (1983)



# RESULTS



**Fig. 2.** Priming effect. Median reaction times were plotted separately for each condition of prime-target relationship and for each number of prime repetitions. Error bars represent one standard error of the mean.



**Fig. 3.** (A): Objective and subjective visibility performance.  $d'$  Values (gray triangle) and mean scores of the PAS scale (black dot) were plotted separately for each number of prime repetitions. Error bars represent one standard error of the mean. (B) Proportion of each PAS rating as function of the number of prime repetitions.



# **Nonconscious Learning From Crowded Sequences**

**Anne Atas<sup>1</sup>, Nathan Faivre<sup>2,3</sup>, Bert Timmermans<sup>4</sup>,  
Axel Cleeremans<sup>1</sup>, and Sid Kouider<sup>2</sup>**

<sup>1</sup>Consciousness, Cognition, and Computation Group, Centre de Recherche Cognition et Neurosciences, Université Libre de Bruxelles; <sup>2</sup>Laboratoire de Sciences Cognitives et Psycholinguistique—Centre National de la Recherche Scientifique, École des Hautes Études en Sciences Sociales, and École Normale Supérieure; <sup>3</sup>Biology Division, Computation and Neural Systems, California Institute of Technology; and <sup>4</sup>School of Psychology, King's College, University of Aberdeen

Psychological Science

XXXX 1–7

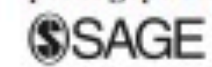
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DOI: 10.1177/0956797613499591

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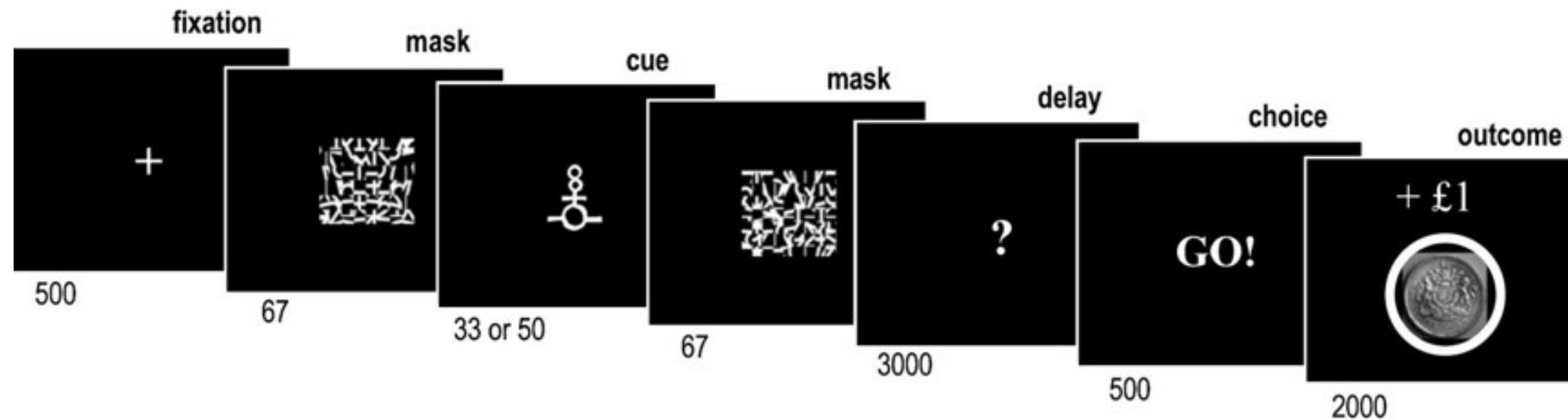
# Nonconscious Learning From Crowded Sequences

Anne Atas, Nathan Faivre, Bert Timmermans,  
Axel Cleeremans, and Sid Kouider



# Pessiglione et al., 2008:

## Instrumental Conditioning with Monetary Reward



One masked stimulus followed by a reward and another by a punishment

**Go** = Risky choice

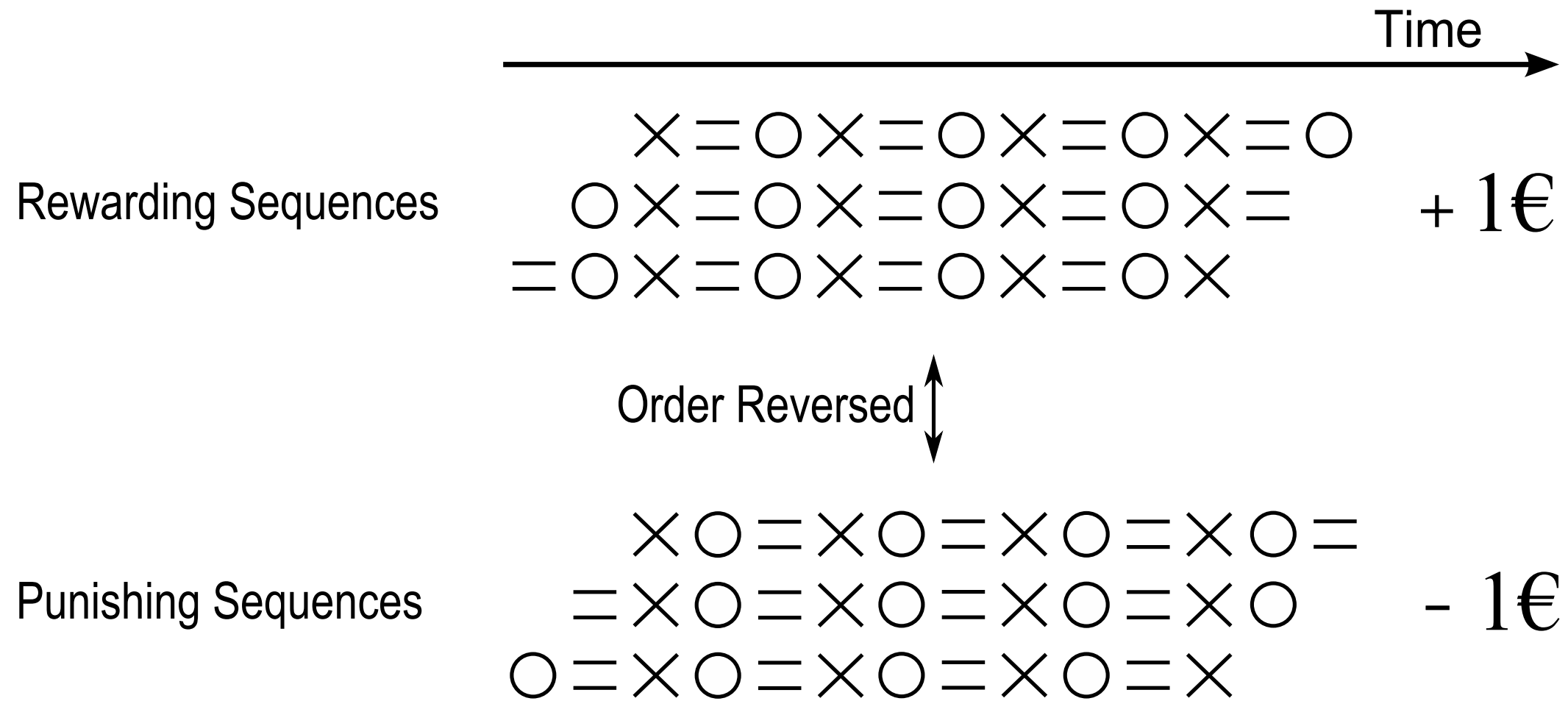
➔ Outcome : + €1 or - €1, depending on the specific masked stimulus

**No-Go** = Safe choice

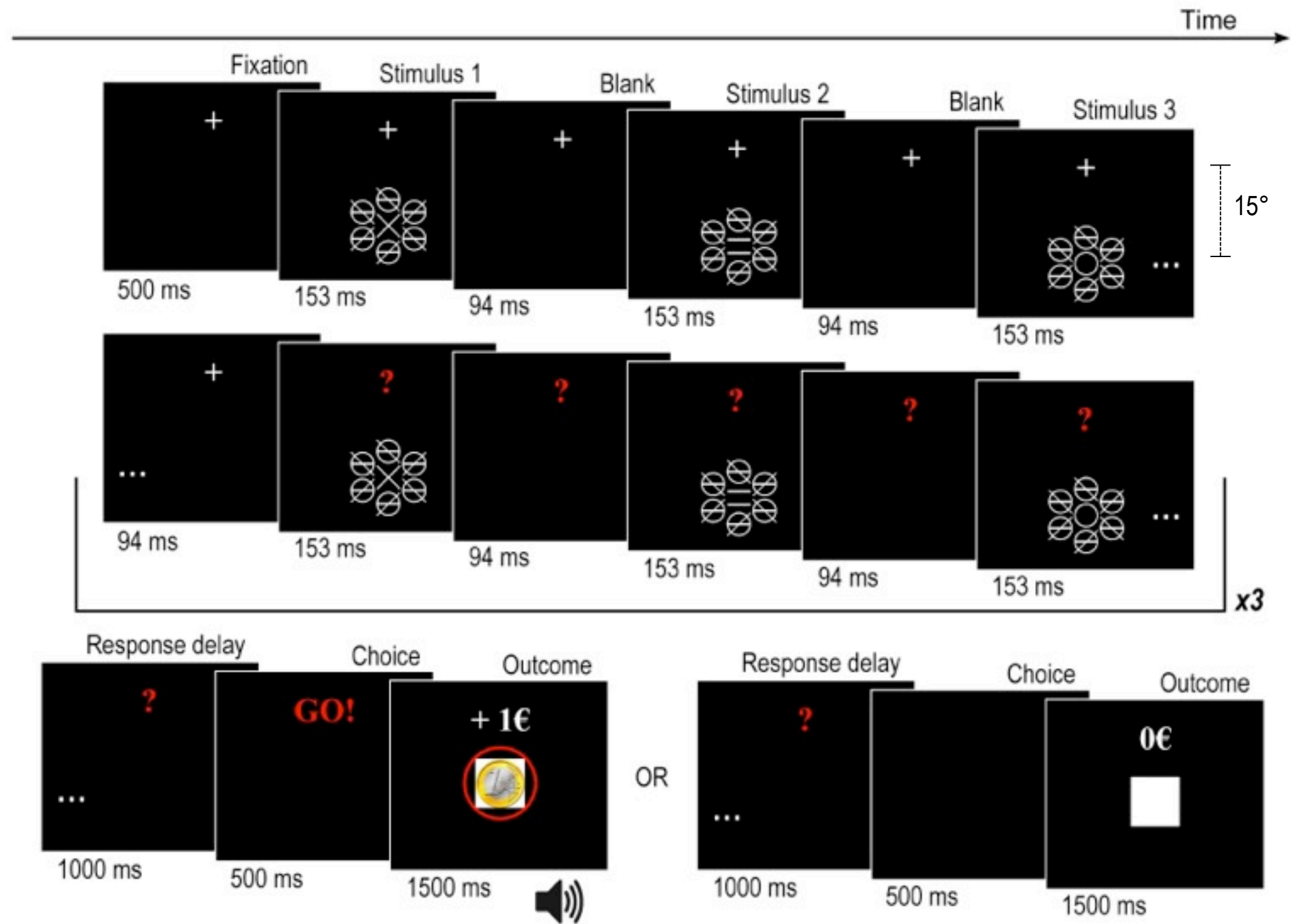
➔ Outcome : € 0 all the time

**Learning** = Go resp. rate of the rewarded cue > Go resp. rate of the punished cue

# The sequences



# The learning task

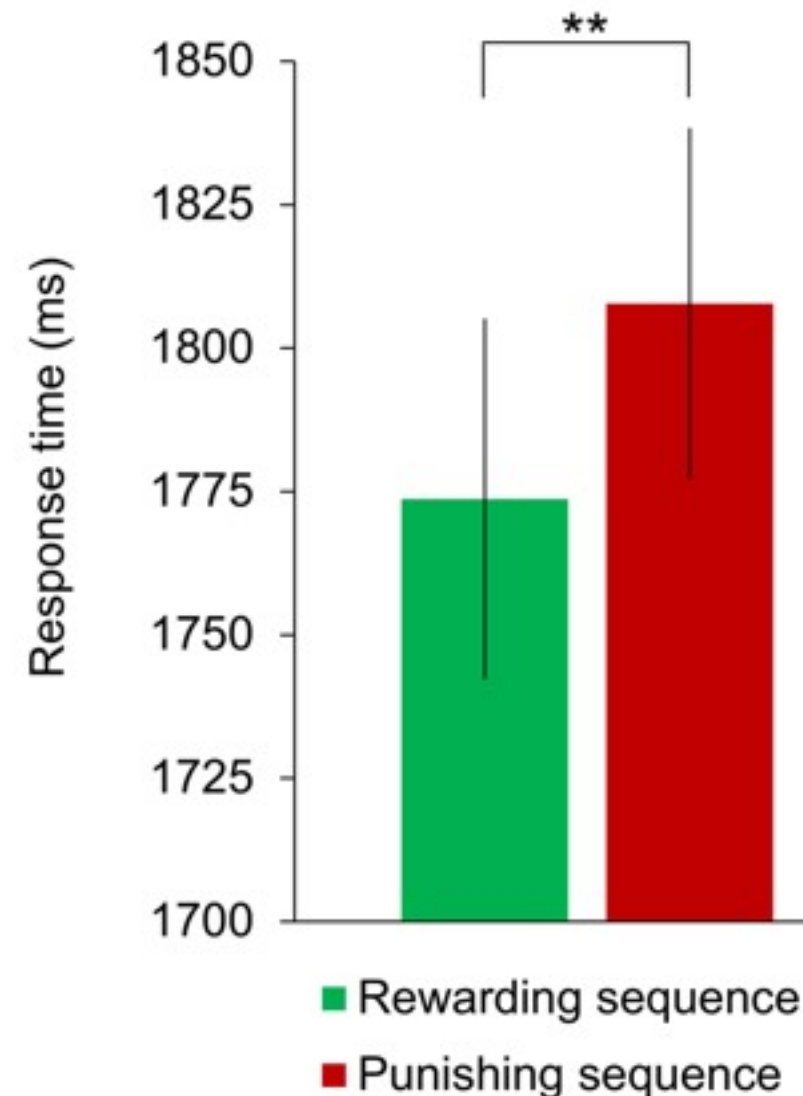
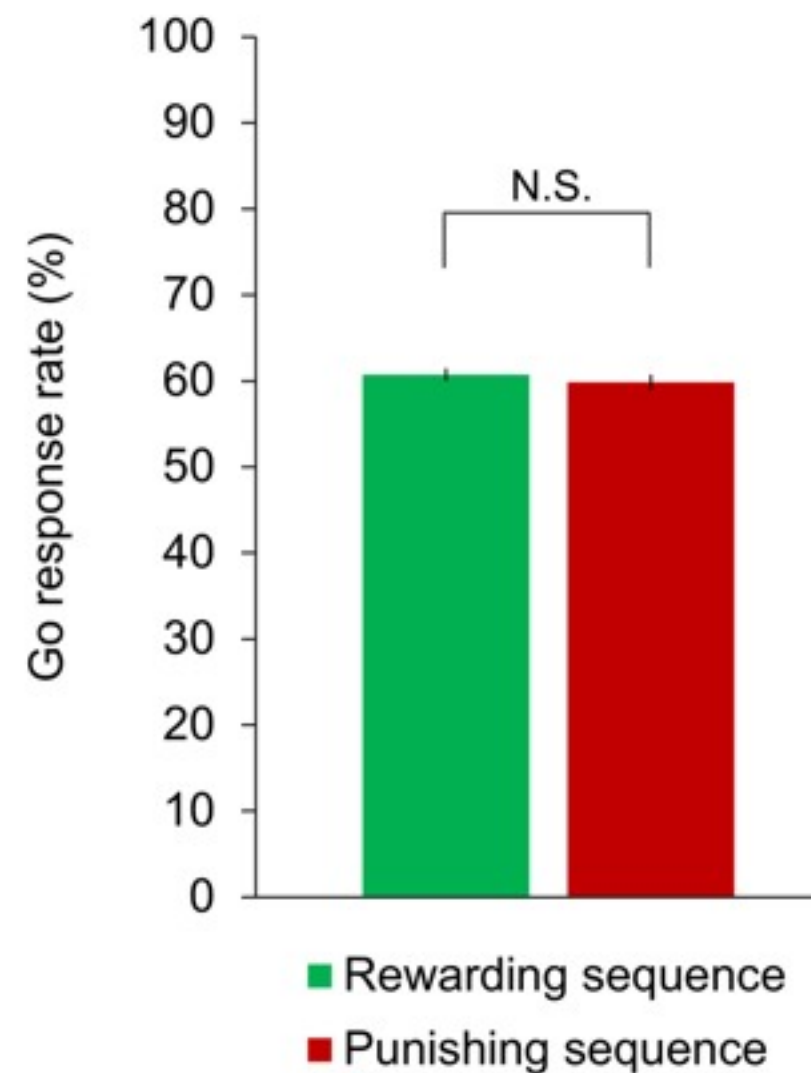


**No learning on decision =**

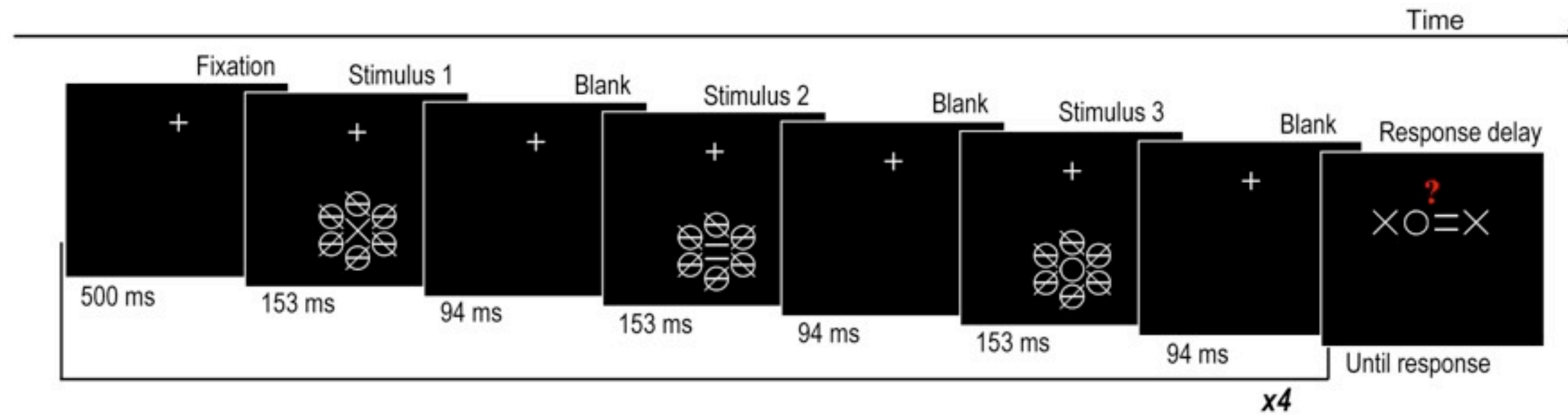
Go resp. rate of the rewarding sequence = Go resp. rate of the punishing sequence

**BUT learning on RTs (for Go responses only) =**

RTs of the rewarding sequence FASTER than RTs of the punishing sequence

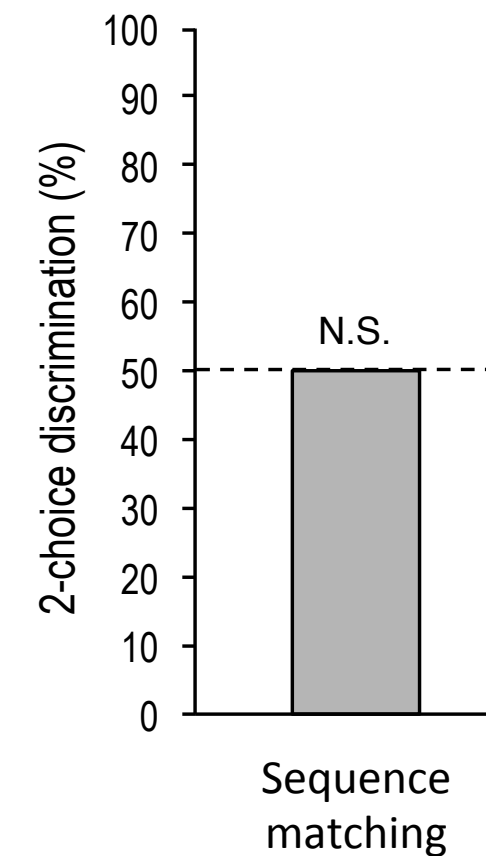


# The awareness test



Question: Does the invisible sequence contain or not this visible succession of 4 shapes?

Yes (right button) No (left button)



# Conclusion

Participants can become sensitive to the sequences of crowded symbols that are not consciously accessible

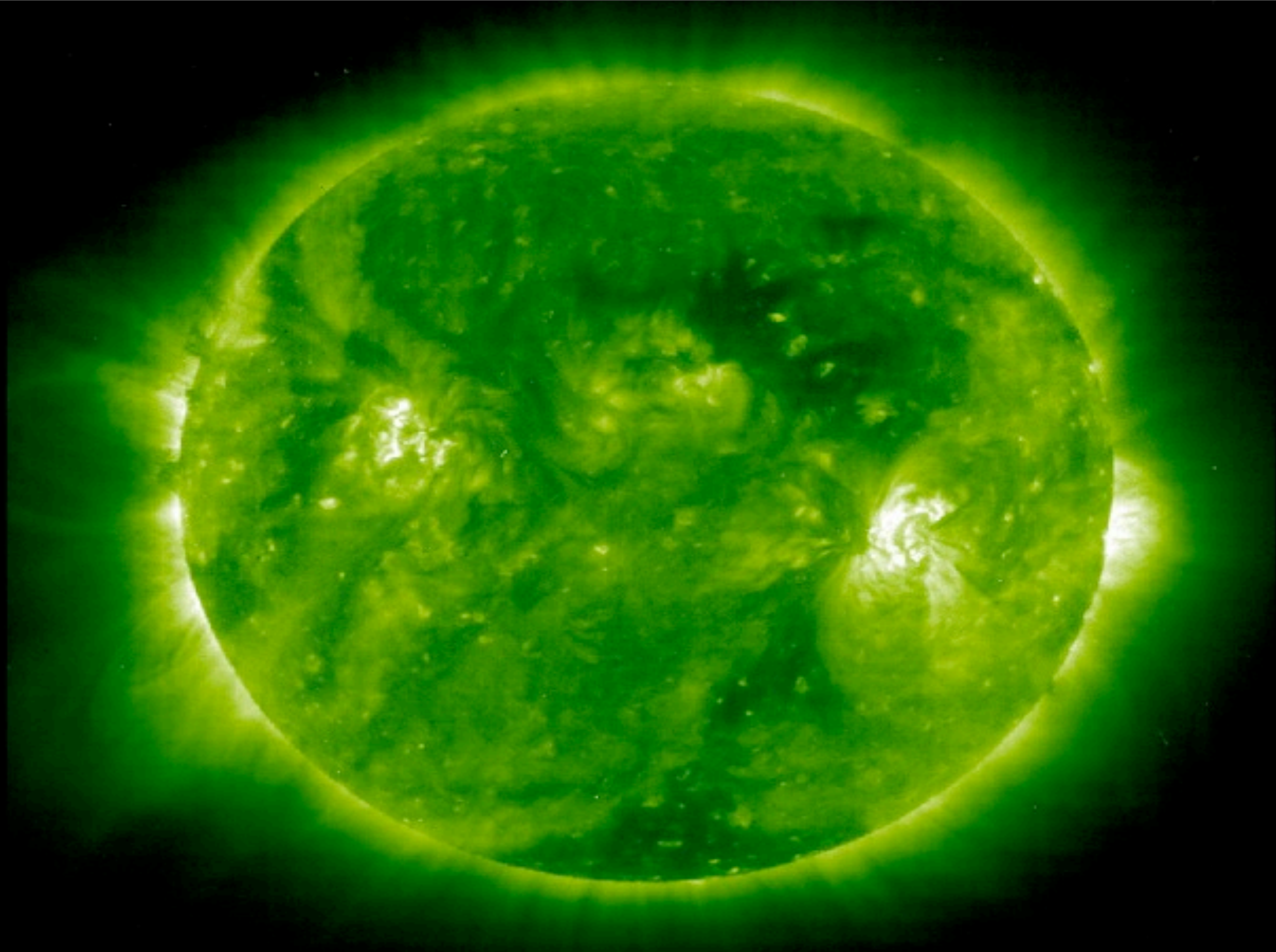


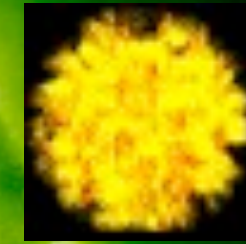
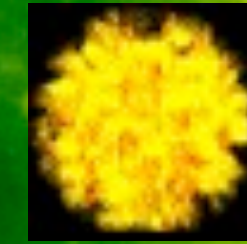
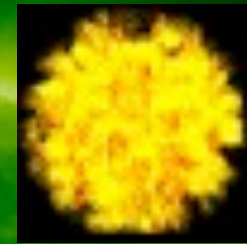
# Associative learning

- To contribute to the debate between associative and inferential theories of associative learning by:
  - (1) documenting possible dissociations between the behavioural expression of associative learning and its accessibility to awareness (metaknowledge)
  - (2) exploring the extent to which these two aspects of associative learning are independent processes
  - (3) exploring how behaviour and awareness change over time..

# Method

- 10 Blocks
  - 4 trials A: cue A +
  - 4 trials B: cue B +/-
  - 4 trials C: cue C-
- 2 questions after each block
  - Have you done better to prevent Martians invade us?
  - How did you do to successfully prevent the Martians invade us?







# SHIELD!!

Continue barpressing?



YES: INVASION

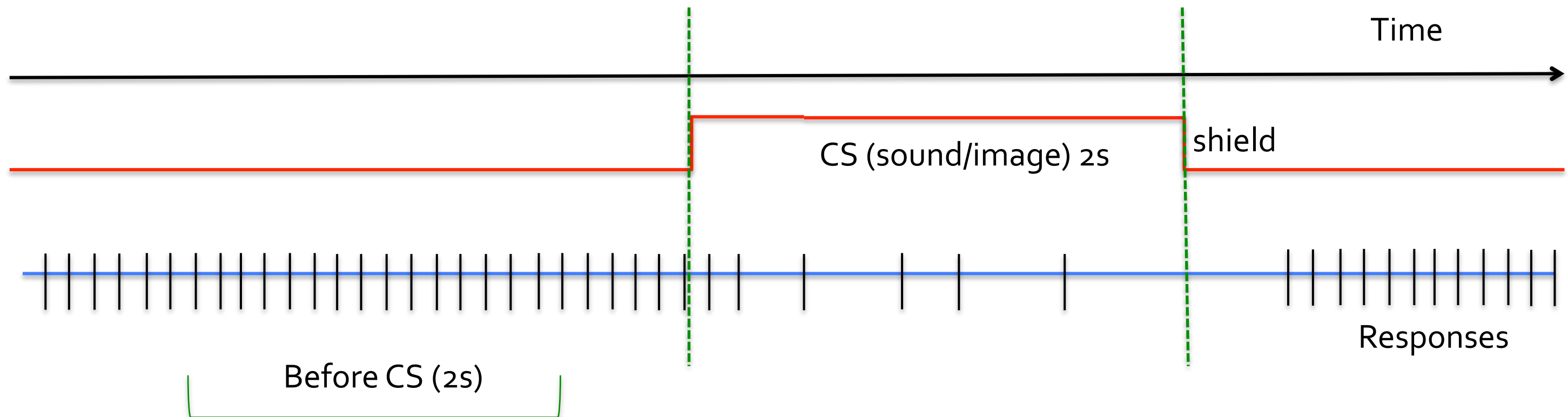
NO: nothing

# Measure: suppression ratio

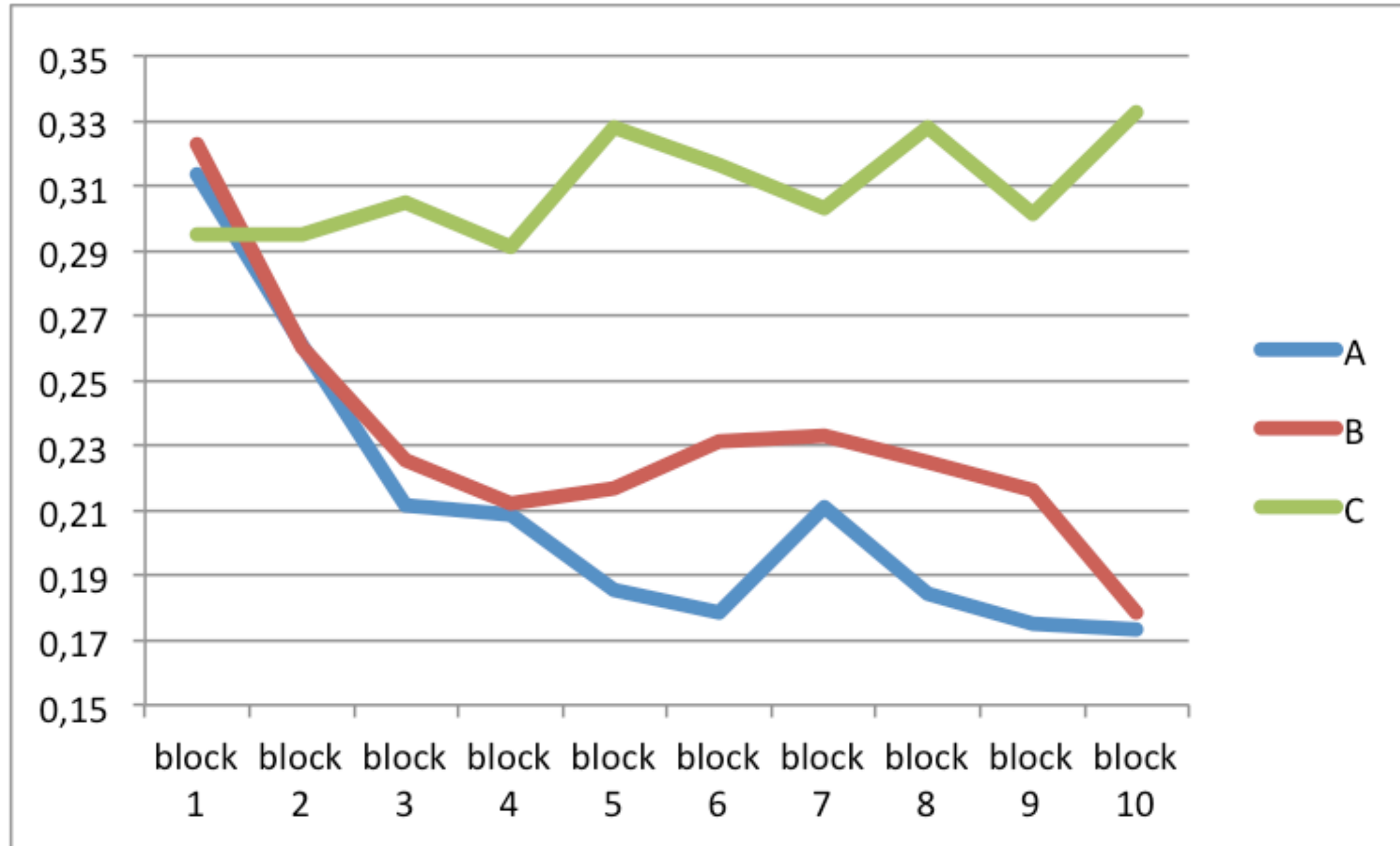
- Measure: suppression ratio

Responses during CS

Responses during CS + before CS



# Results: Suppression ratio 4



# Verbal Report vs Behaviour

Visual

Subject	Learn? $A < c$	Verbal
1	No (0.5; 0.5)	No
2	Yes (0; 0.167)	Block 7 / block 9: strategy better not respond when a cue is presented
6	No (0.33; 0.29)	Block 1: cues do something, block 3 he thinks it is random...
8	No (0, 0)	Block 8 : he knows that cues do something
9	No (0,0)	Block 1 cues do something / block 4: strategy better not respond when a cue is presented
12	Yes (0; 0.475)	Block 1/ block 4 difference between cues
13	Yes (0.08; 0.5)	Block 1 :strategy better not respond when a cue is presented / block 2 difference between cues
15	Yes (0; 0.54)	Blok 5: messages
18	No (0.5; 0.475)	No



# CORRELATES OF THE ACQUISITION OF A MOTOR EXPERTISE WITH EXTENDED PRACTICE (fMRI STUDY)

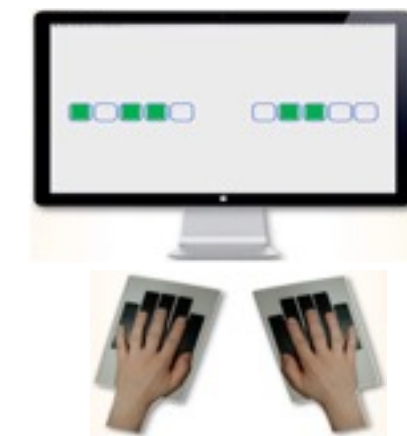
## AIM

Contribute at the better understanding of motor learning expert acquisition in healthy subjects  
Study of the neural correlates of chunking information process

## HOW TO DO IT?

Using a multiple-Choice Reaction Time task adapted from Seibel, 1965

- The task is composed by 10 keys, one per finger that allow a total of 1024(-1) different combinations ([video](#))
- Participant were asked to reproduce as fast as possible the combinations (stimuli) appearing on the screen.  
Stimuli are **Randomly** presented!
- Participants accomplished a total of 25 sessions (+/- 1 hour/ session)
- fMRI scan was presented on 5 learning sessions (**fMRI: Sessions 1-2-4-9-25**)



# SEIBEL(1963)'S 1023-CHOICE RT TASK



1: Stimuli

## Participants

- A total of 12 Subjects ( 8 F, 4 M) were selected in a personal interview

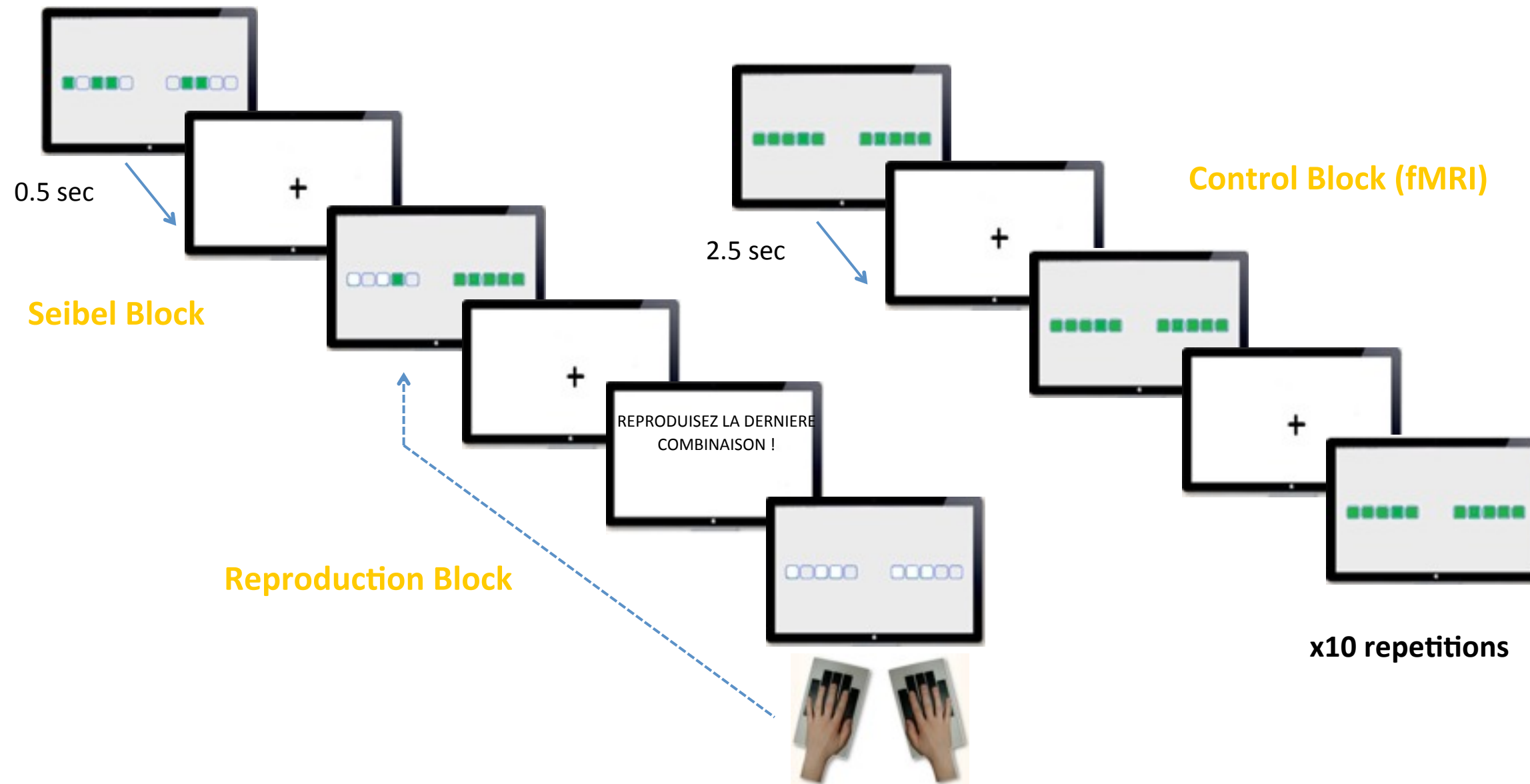
fMRI compatible

No musicians or experienced typists

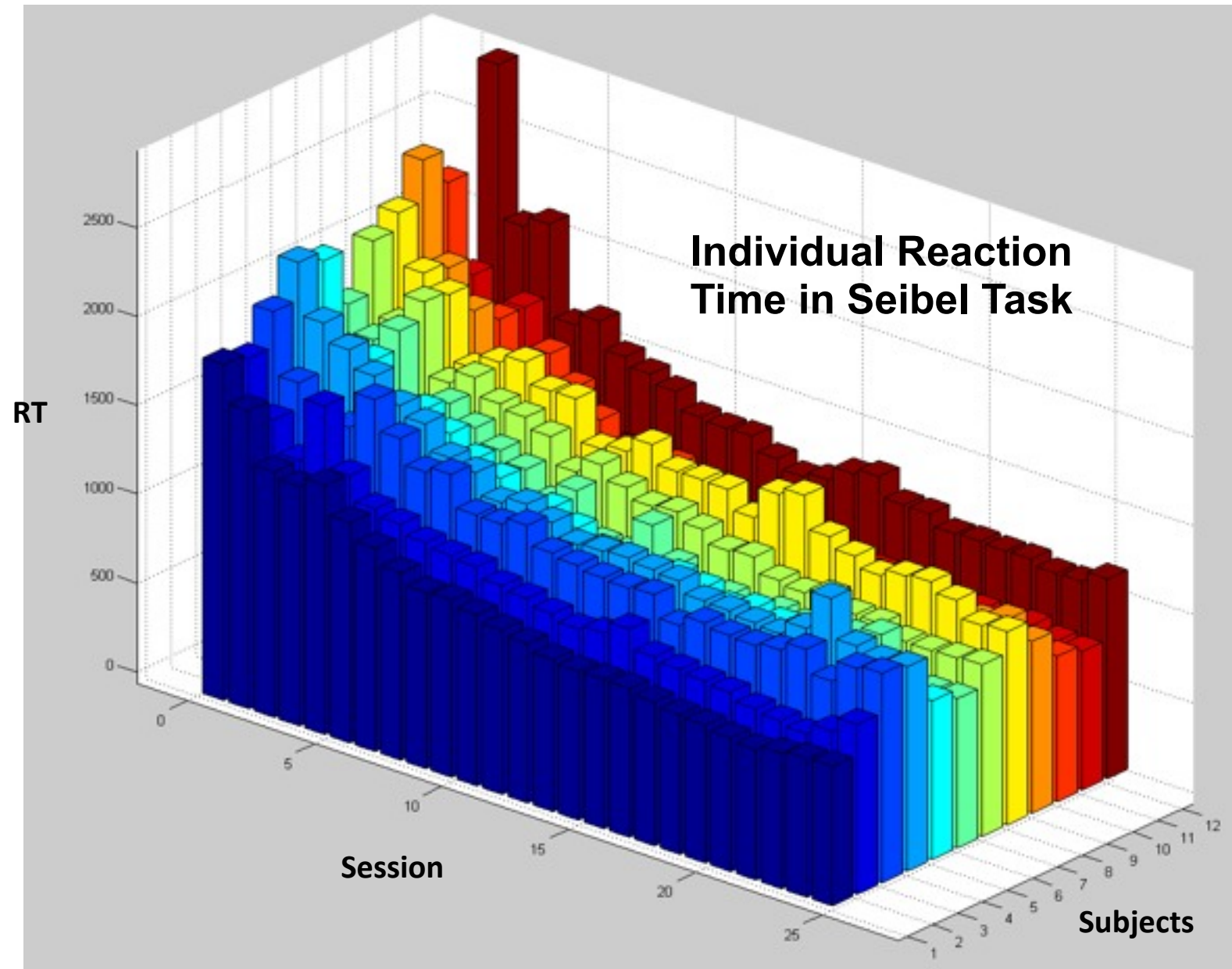
Right-handed

- Age average of 26,47 +/-2,07
- All learning sessions were performed at the same time ( to avoid circadian effects)
- Participant schedules were measured by wrist actimetry throughout the experiment

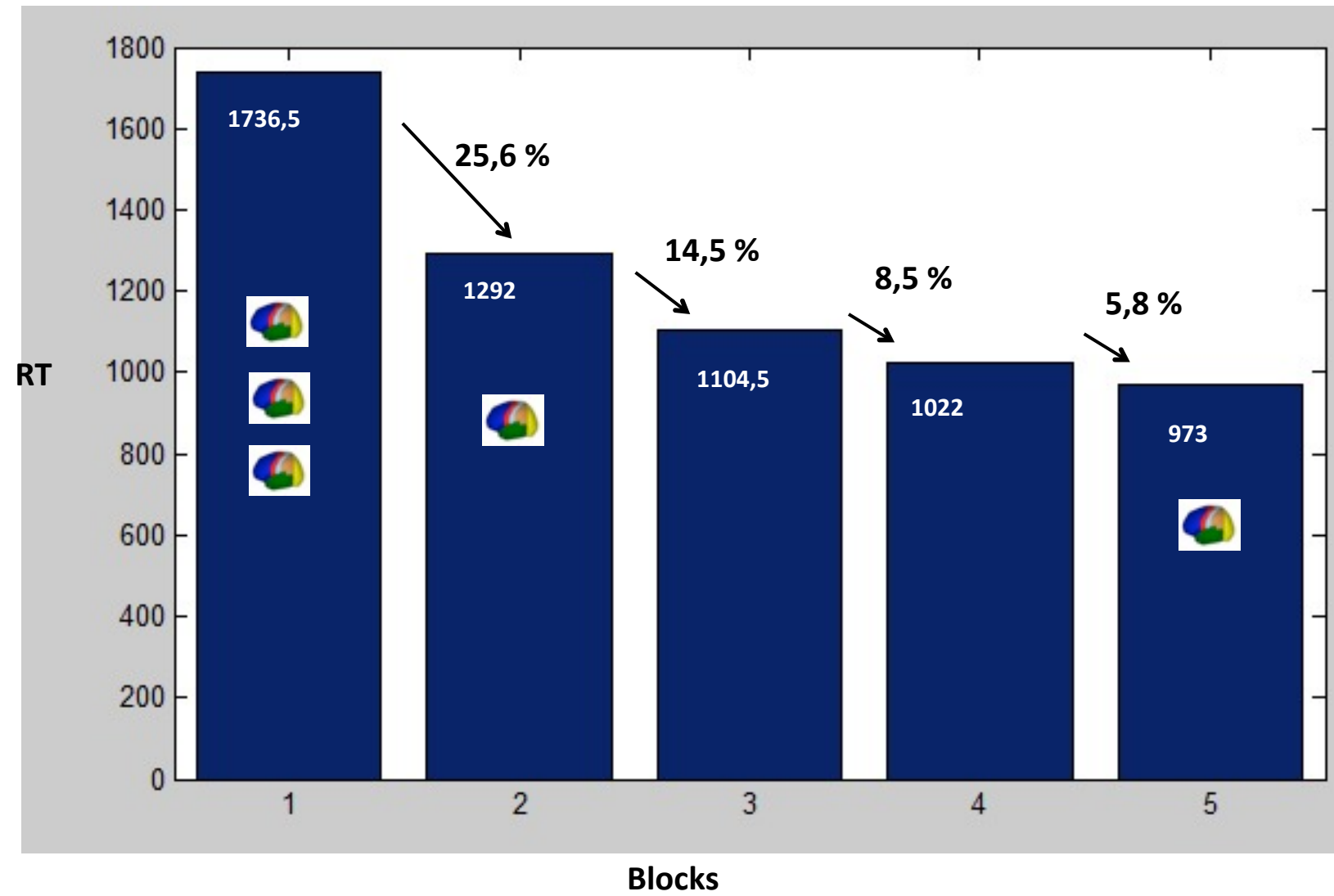
# Experimental Design



# Individual Reaction Time Distributions

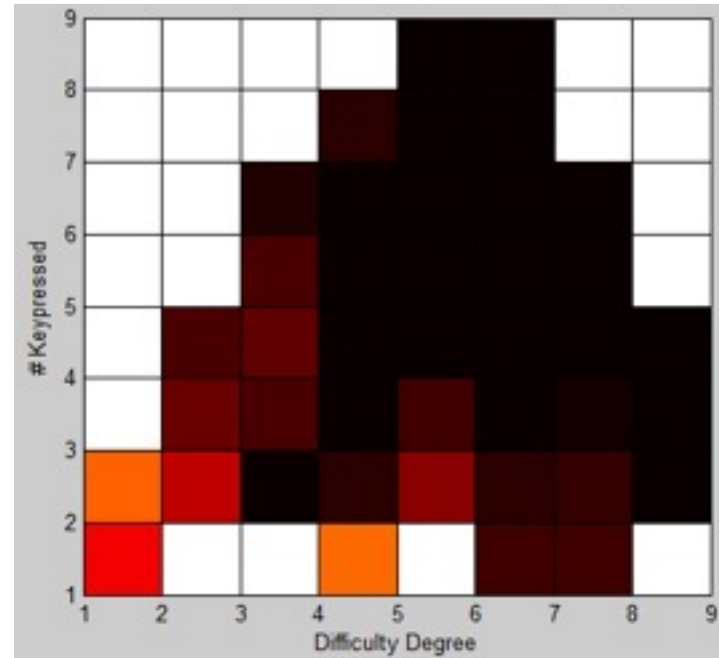


## Global Reaction Time / Block

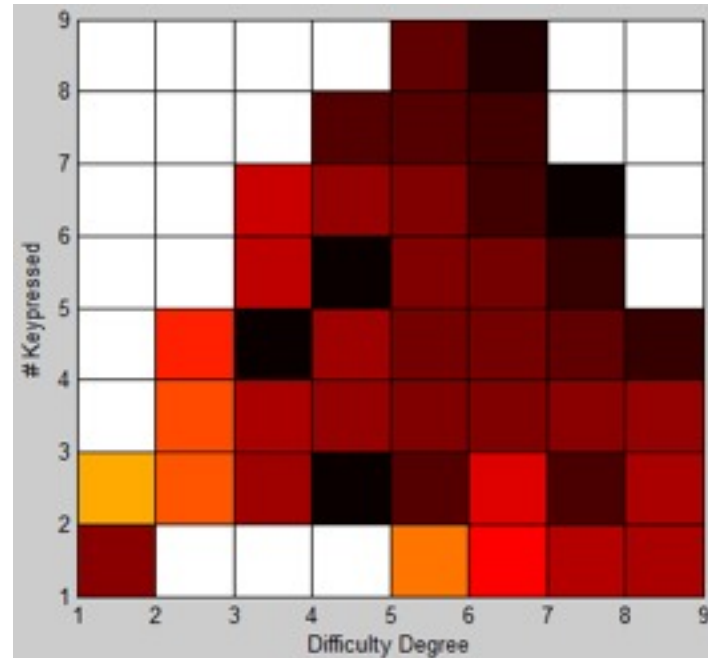


 = fMRI Testing

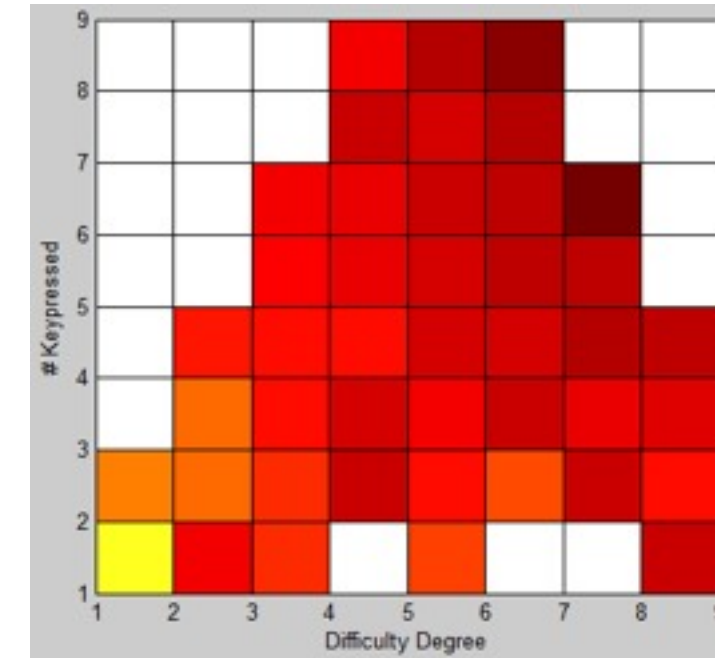
# Reaction Time distribution between number of finger and complexity



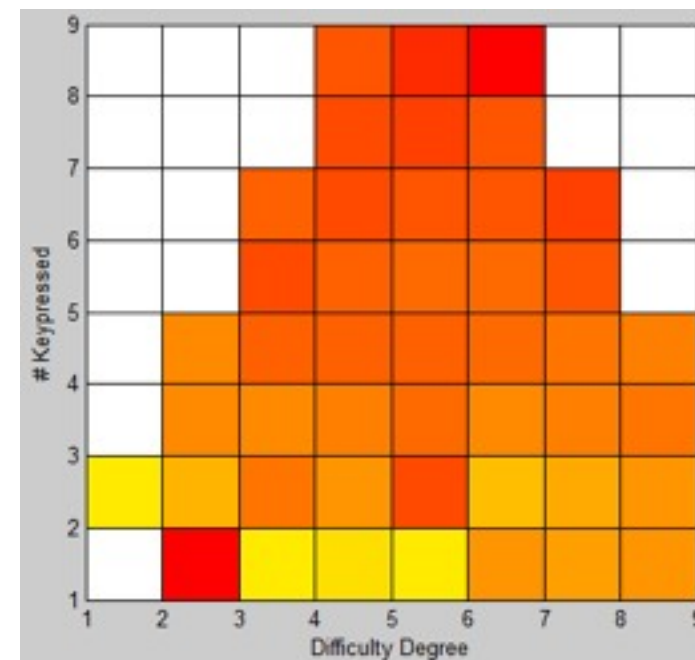
SS1



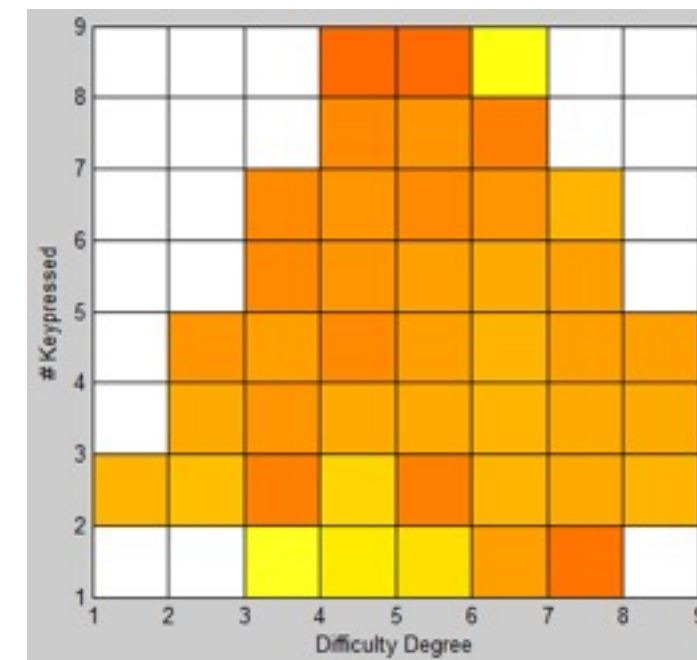
SS2



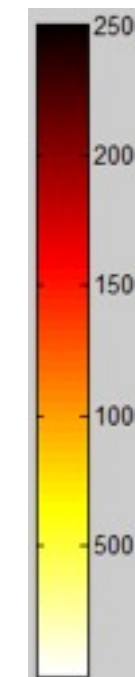
SS4



SS9

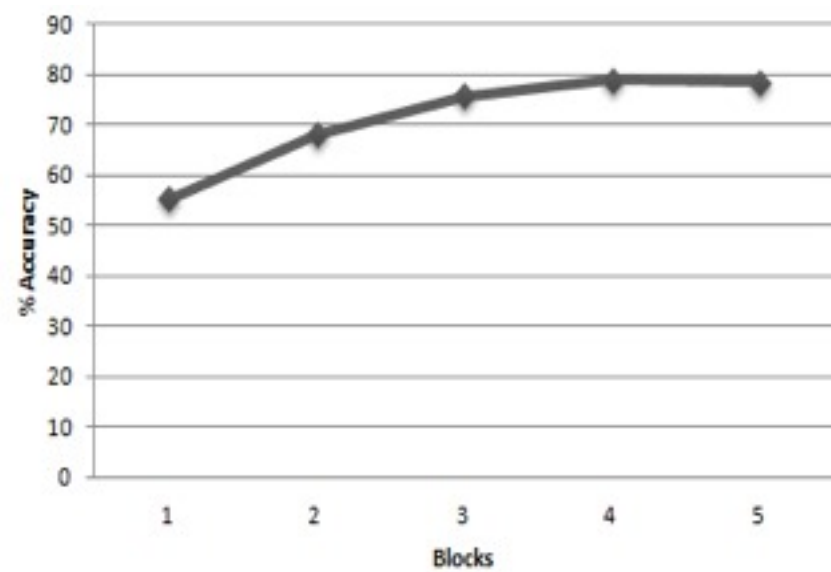
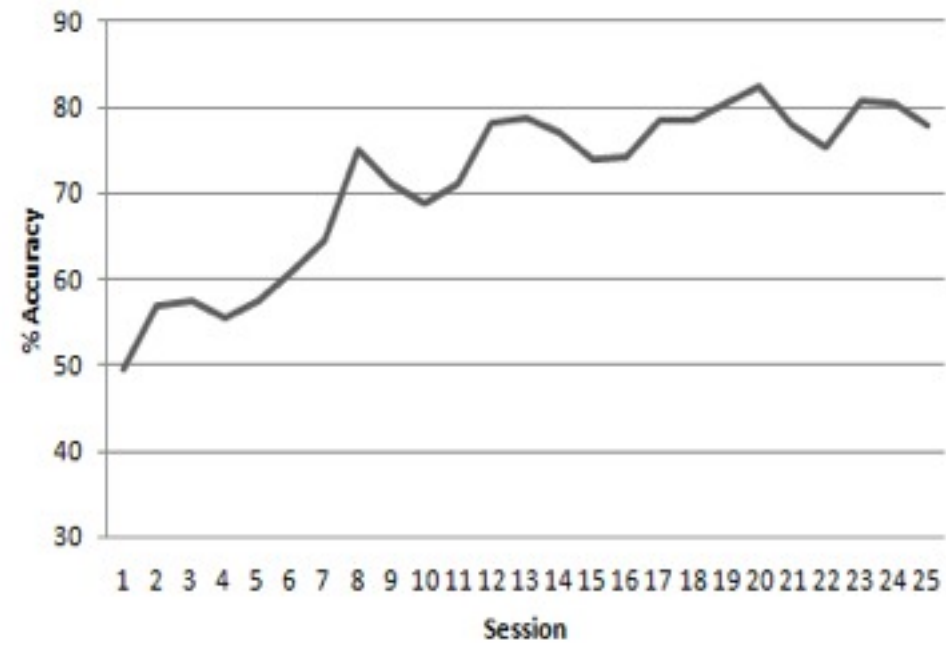


SS22

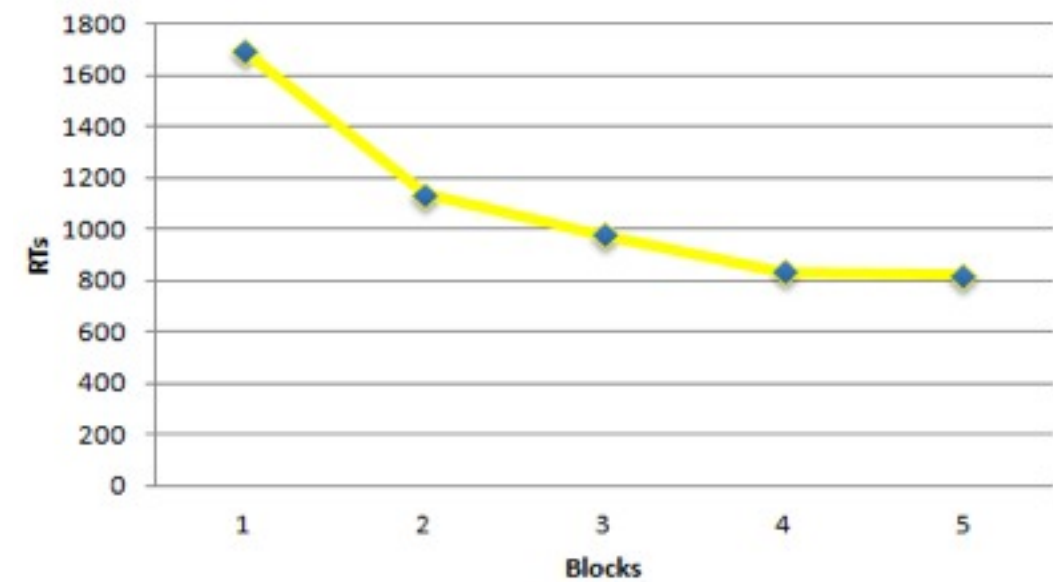
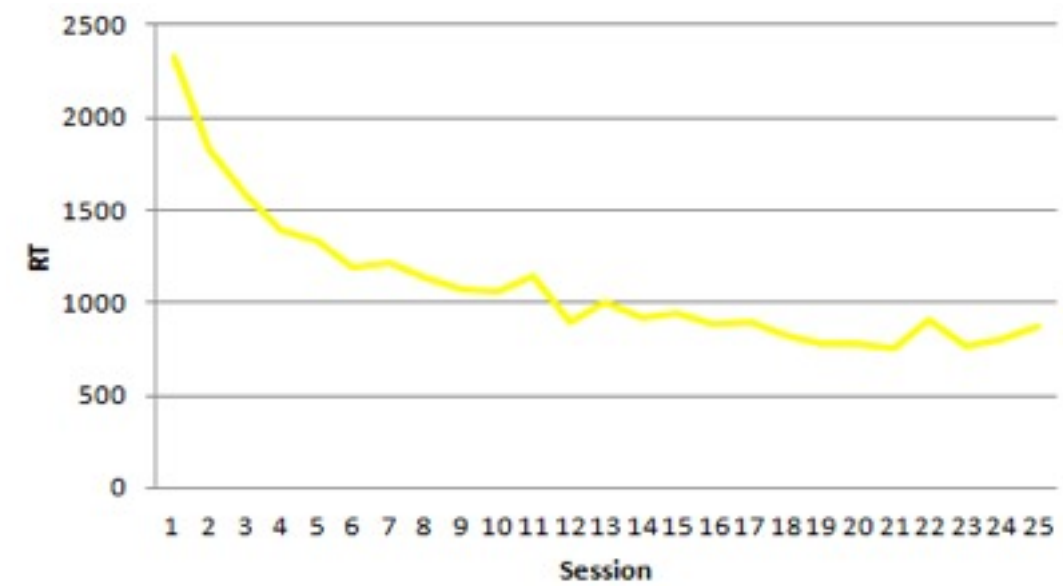


# Performance achieved during the "Reproduction task"

% of Correct responses ( combination reproductions)



RT employed to select the correct response





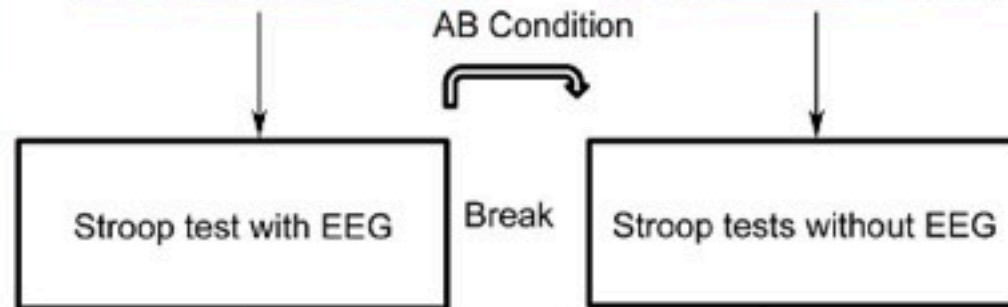
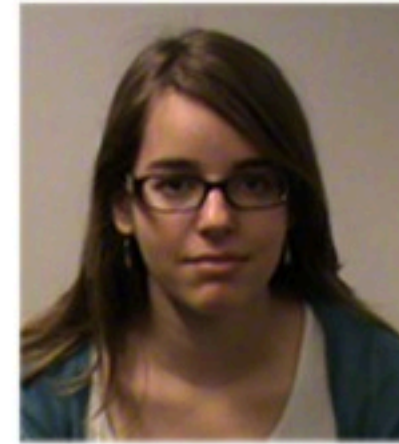
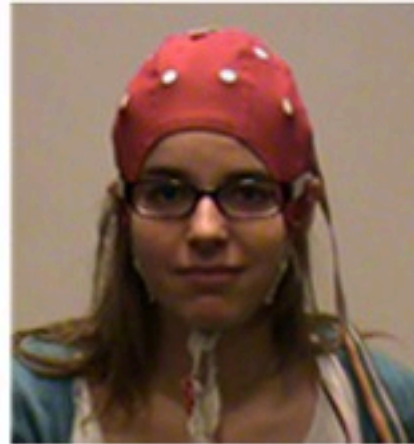
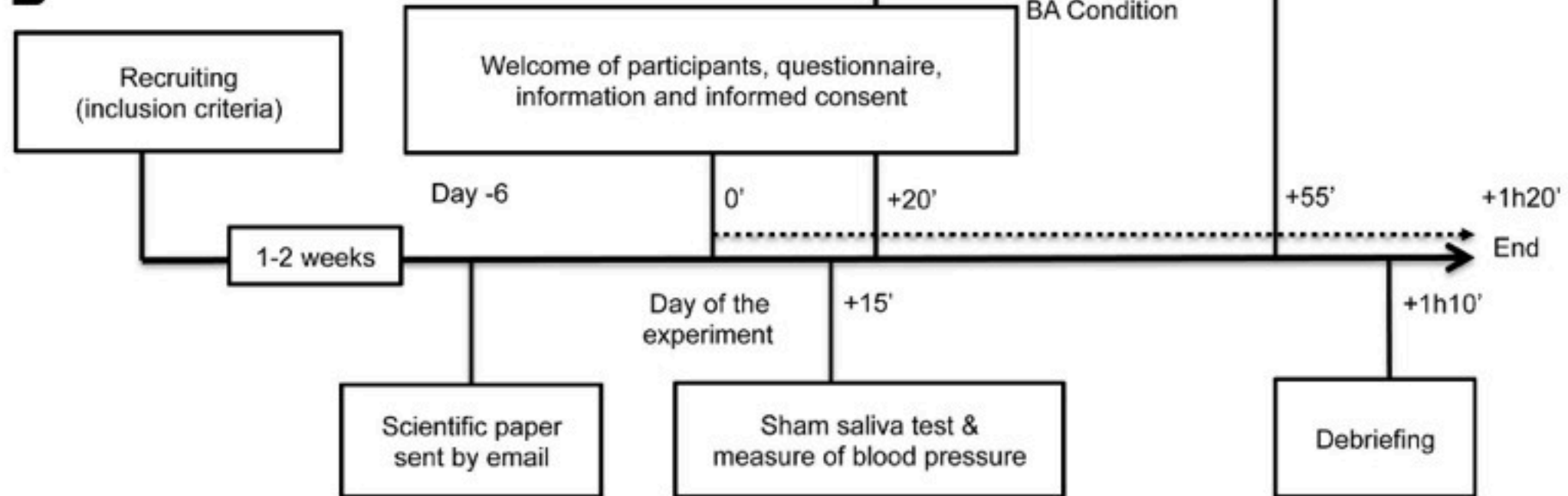
WP7b

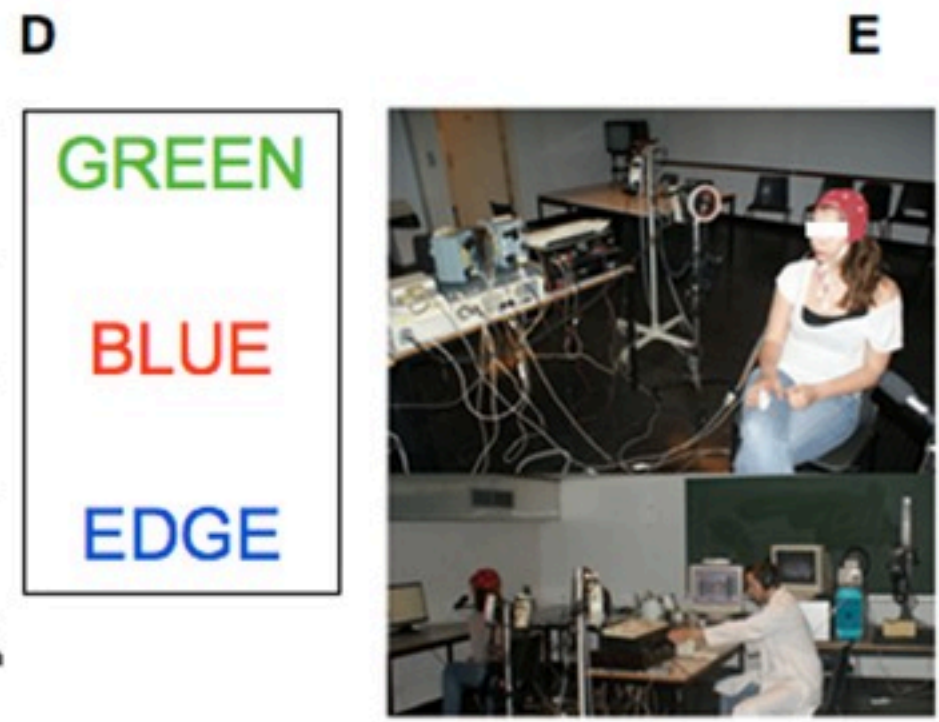
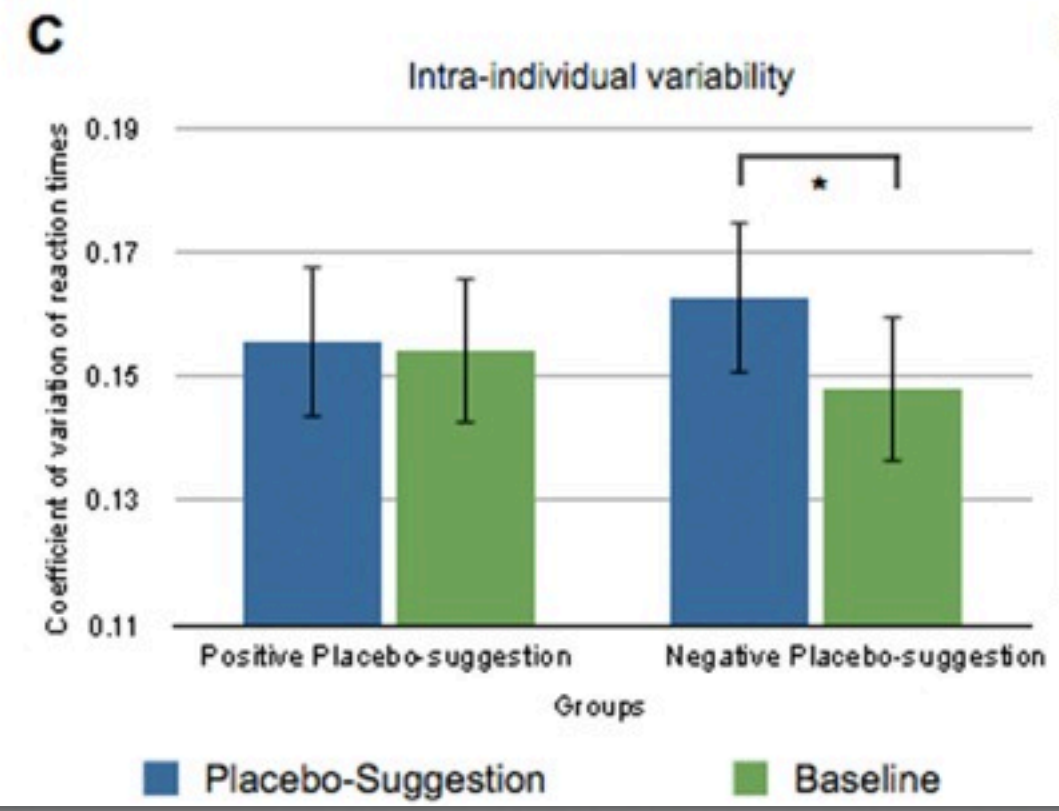
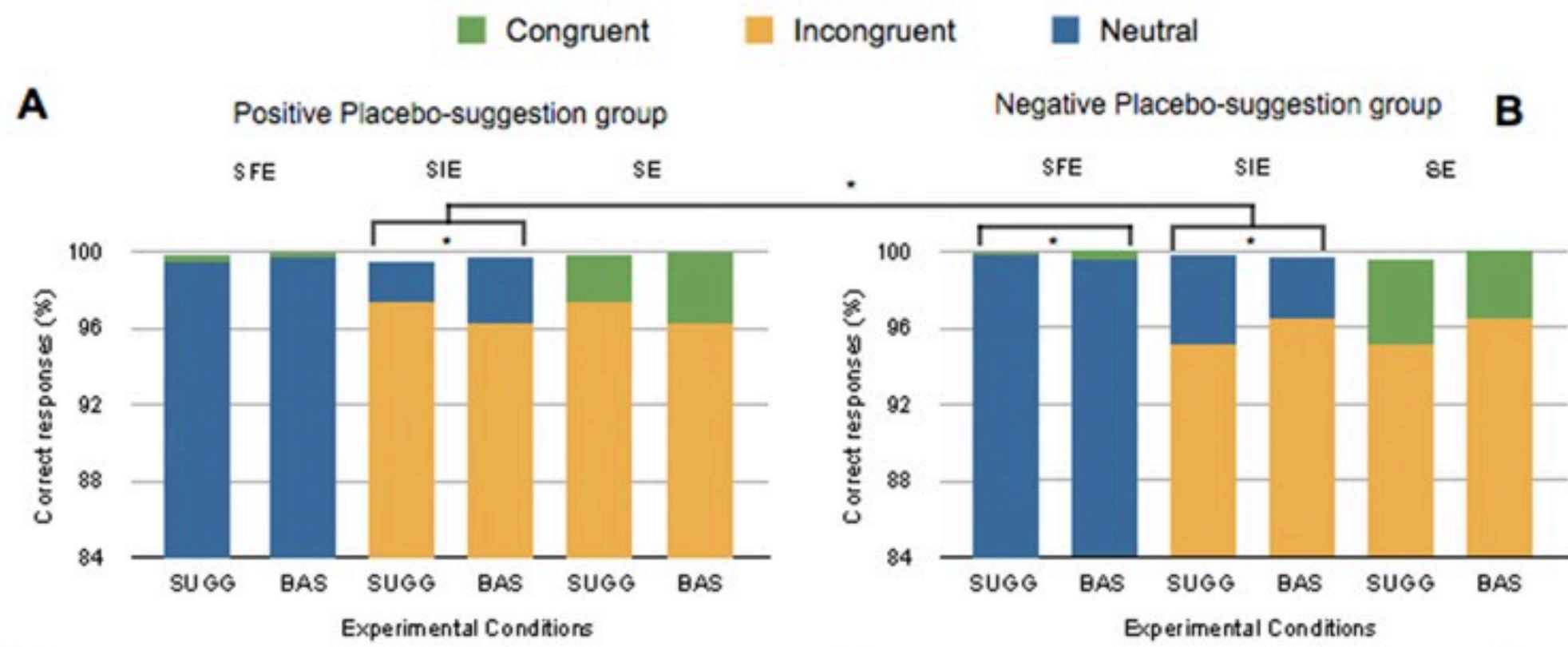
Metarepresentation

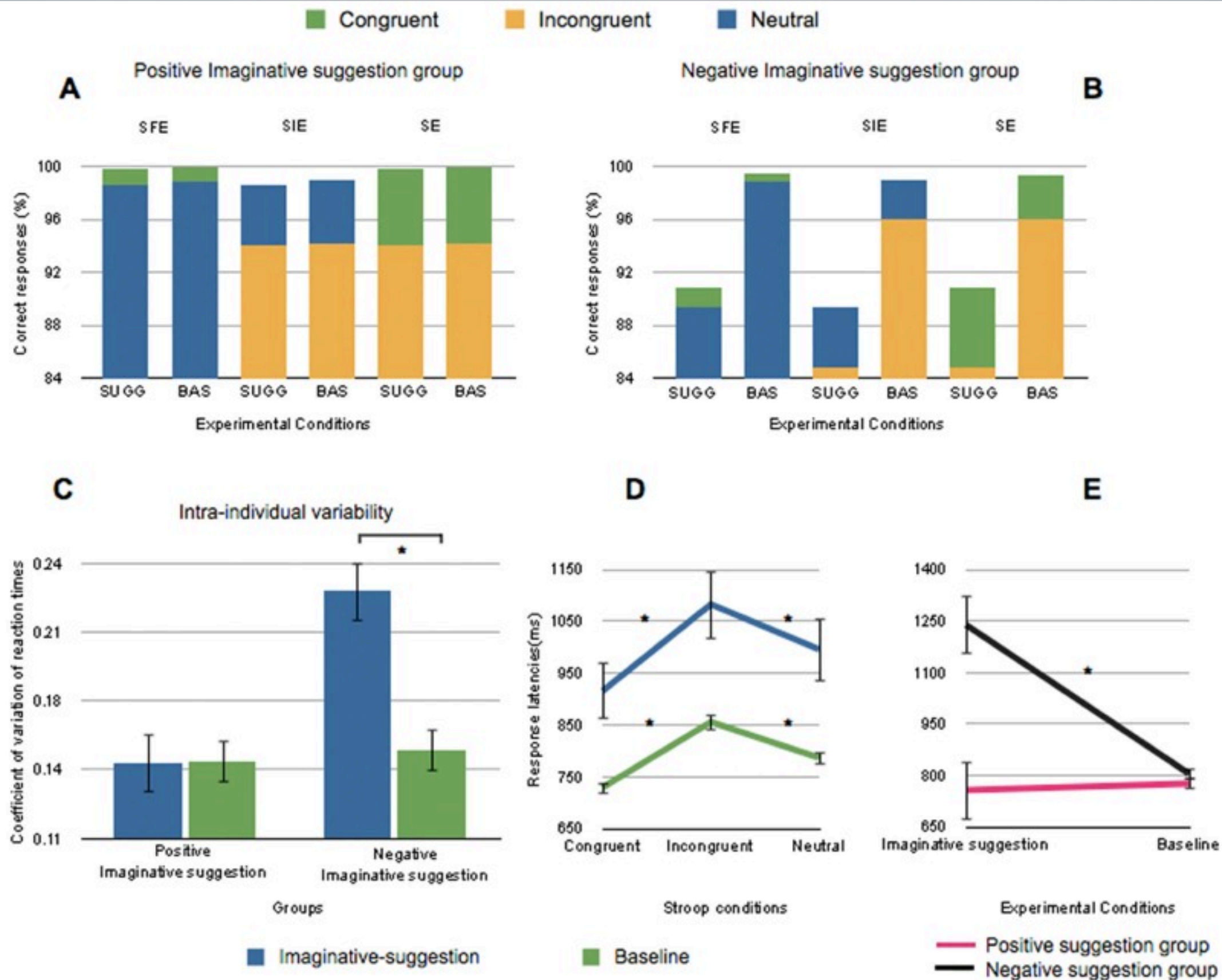
# Placebo-Suggestion Modulates Conflict Resolution in the Stroop Task

**Pedro A. Magalhães De Saldanha da Gama<sup>1,5,6\*</sup>**, **Hichem Slama<sup>2,3,4,5,6</sup>**, **Emilie A. Caspar<sup>1,5,6</sup>**, **Wim Gevers<sup>2,5,6</sup>**, **Axel Cleeremans<sup>1,5,6</sup>**

1 CO3 - Consciousness, Cognition & Computation Group, Université Libre de Bruxelles (ULB), Brussels, Belgium, 2 UNESCOG - Research Unit in Cognitive Neurosciences, Université Libre de Bruxelles (ULB), Brussels, Belgium, 3 UR2NF - Neuropsychology and Functional Neuroimaging Research Unit, Université Libre de Bruxelles (ULB), Belgium, 4 Department of Clinical and Cognitive Neuropsychology, Erasme Hospital, Université Libre de Bruxelles (ULB), Brussels, Belgium, 5 CRCN - Center for Research in Cognition & Neurosciences, Université Libre de Bruxelles (ULB), Brussels, Belgium, 6 UNI - The ULB Neurosciences Institute, Université Libre de Bruxelles (ULB), Brussels, Belgium

**A****B**





W P 7 C

Learning to be conscious

- rubber hand
- BCI & neurofeedback:
  - If awareness depends on learning, then we should observe a change in the temporal gap between RP and W judgement in a Libet design involving learning to control a BCI to move an artificial effector
  - We should likewise observe effects of making (real or fake) EEG activity available to people as they perform the Libet task





# DISCUSSION

