

The Information Capacity of Visual Experience at a Brief Glance

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Background

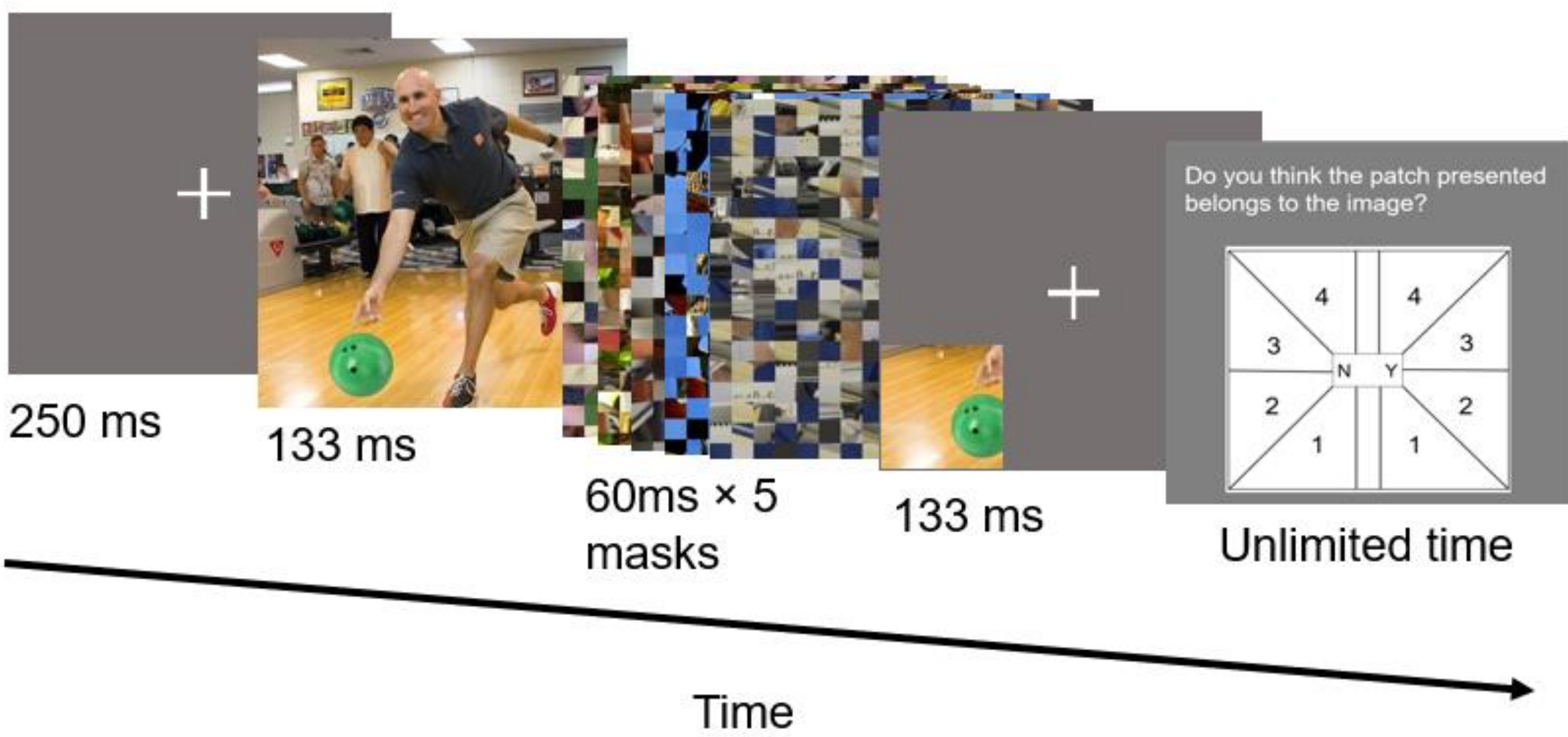
- ❖ Based on information theory, the informativeness of our visual experience is defined by the ability to differentiate between what is seen and what is not seen.
- ❖ Early experiments reported information rate of **~40 bits/second**.
- ❖ Using natural images and many response alternatives (present/absent concepts), information rate can reach **1500 bits/second**.

Aim

- ❖ To capture the information transfer rate based on phenomenal consciousness, by using **patches of images** as response opportunities.
- ❖ To examine whether the informativeness of visual perception is limited by its detailedness (a.k.a resolution).

Methods

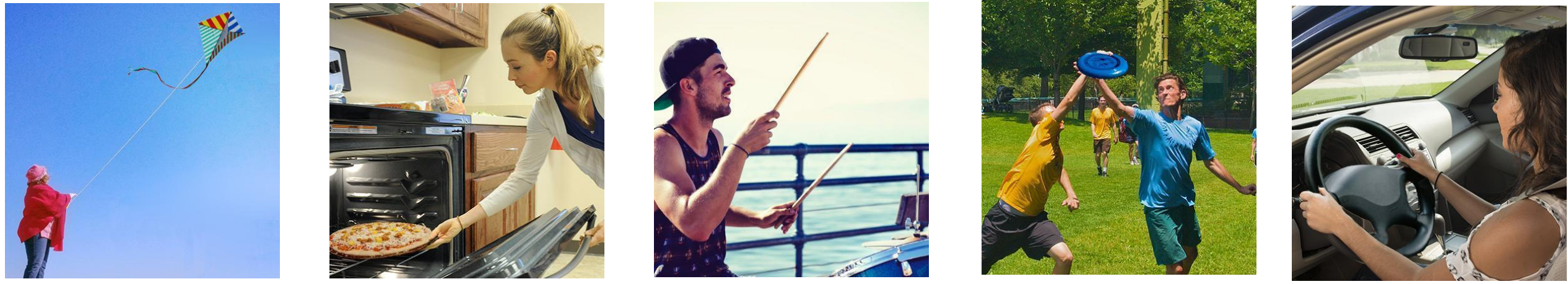
- Participant (N = 15) judged whether each of 20 image patches was a part of a briefly-viewed image.
- Patches were either present in the image, modified by replacing an original object with the novel one, or randomly-selected from a different set of images.
- For information rate estimation, randomly-selected absent patches were unique within-trial, across-trial, and across-subjects



Test patches

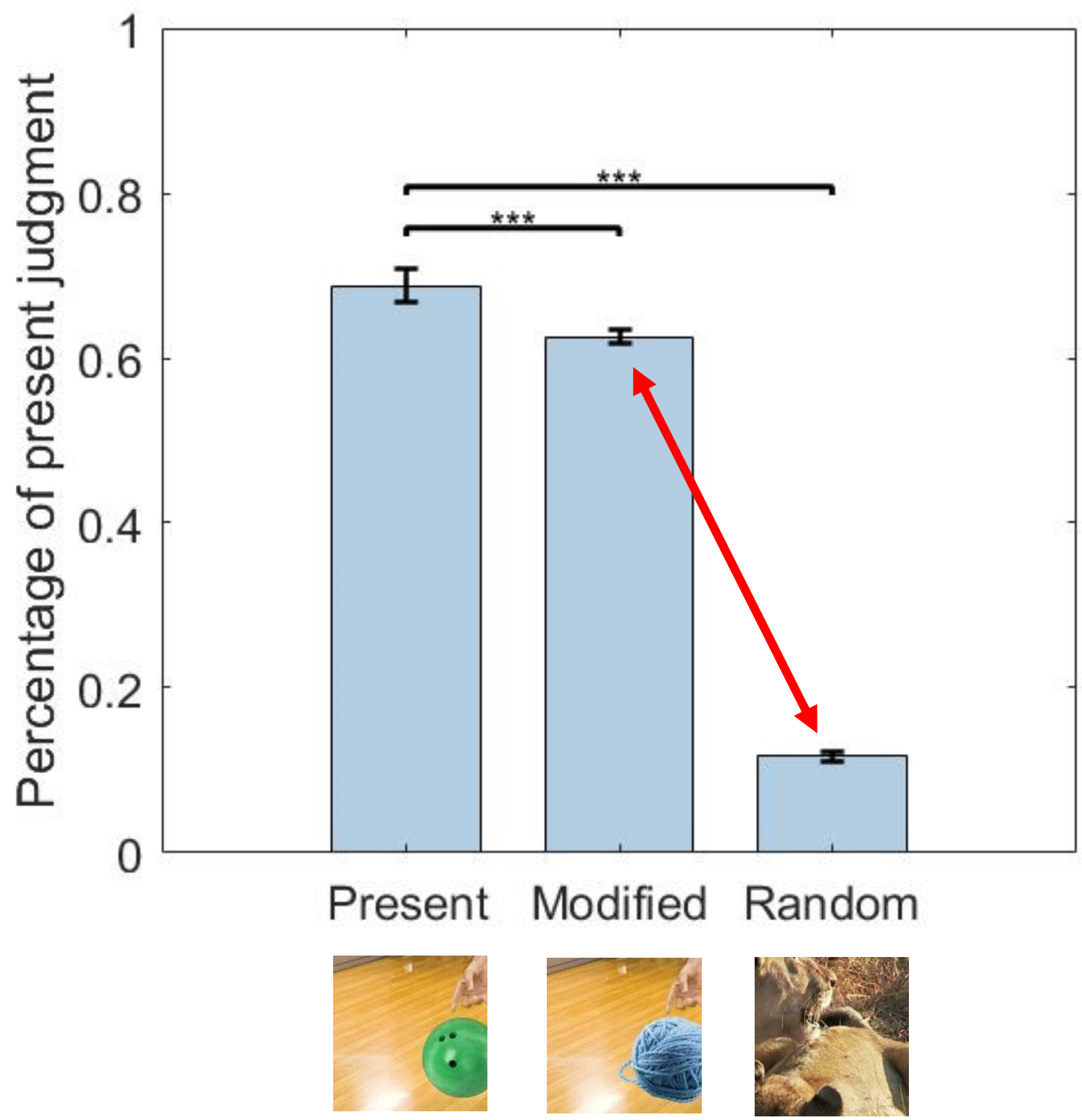
Observer	Present	Modified absent	Randomly-selected absent
1			... to the 15th
2			... to the 15th
⋮	⋮	⋮	⋮
15			... to the 15th

Sample images



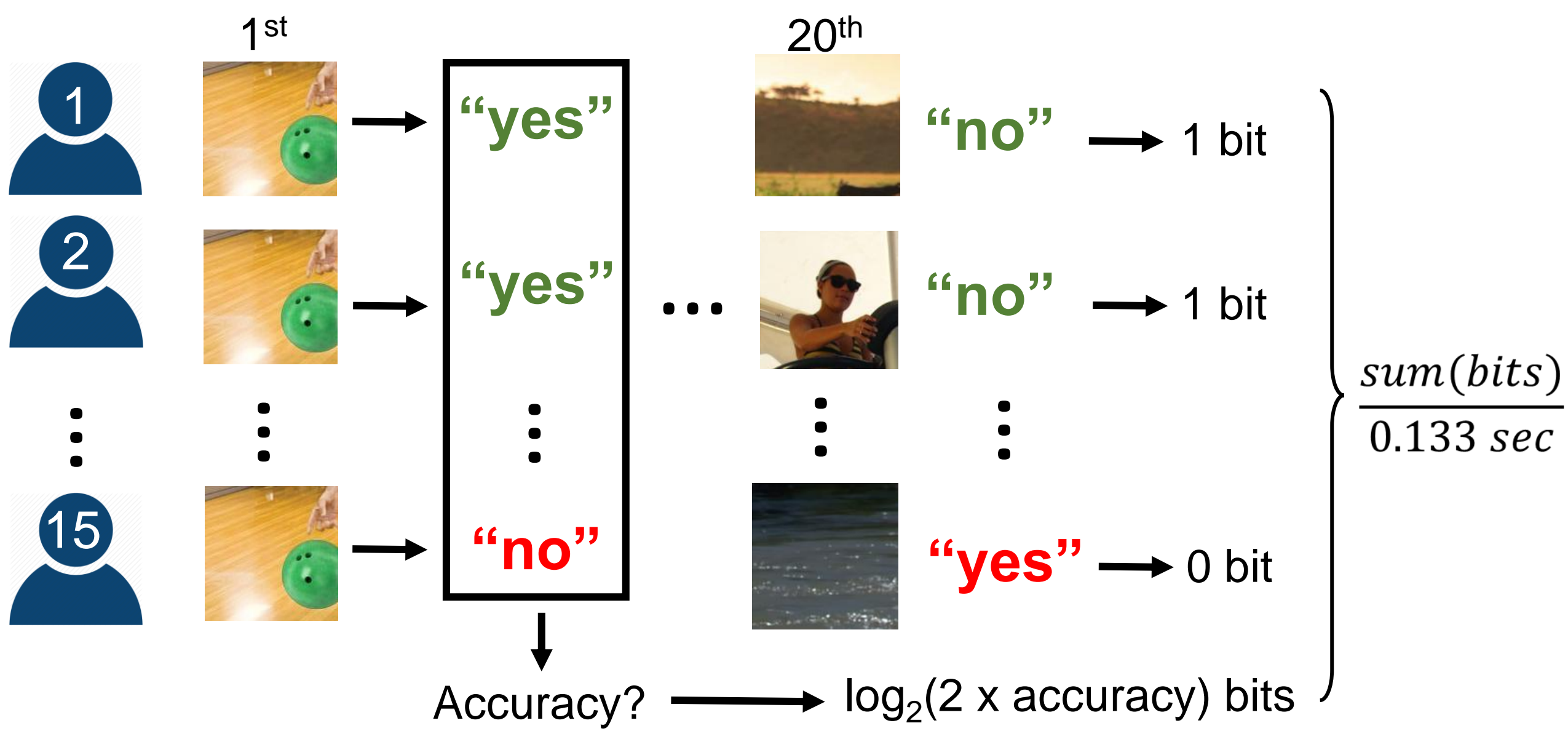
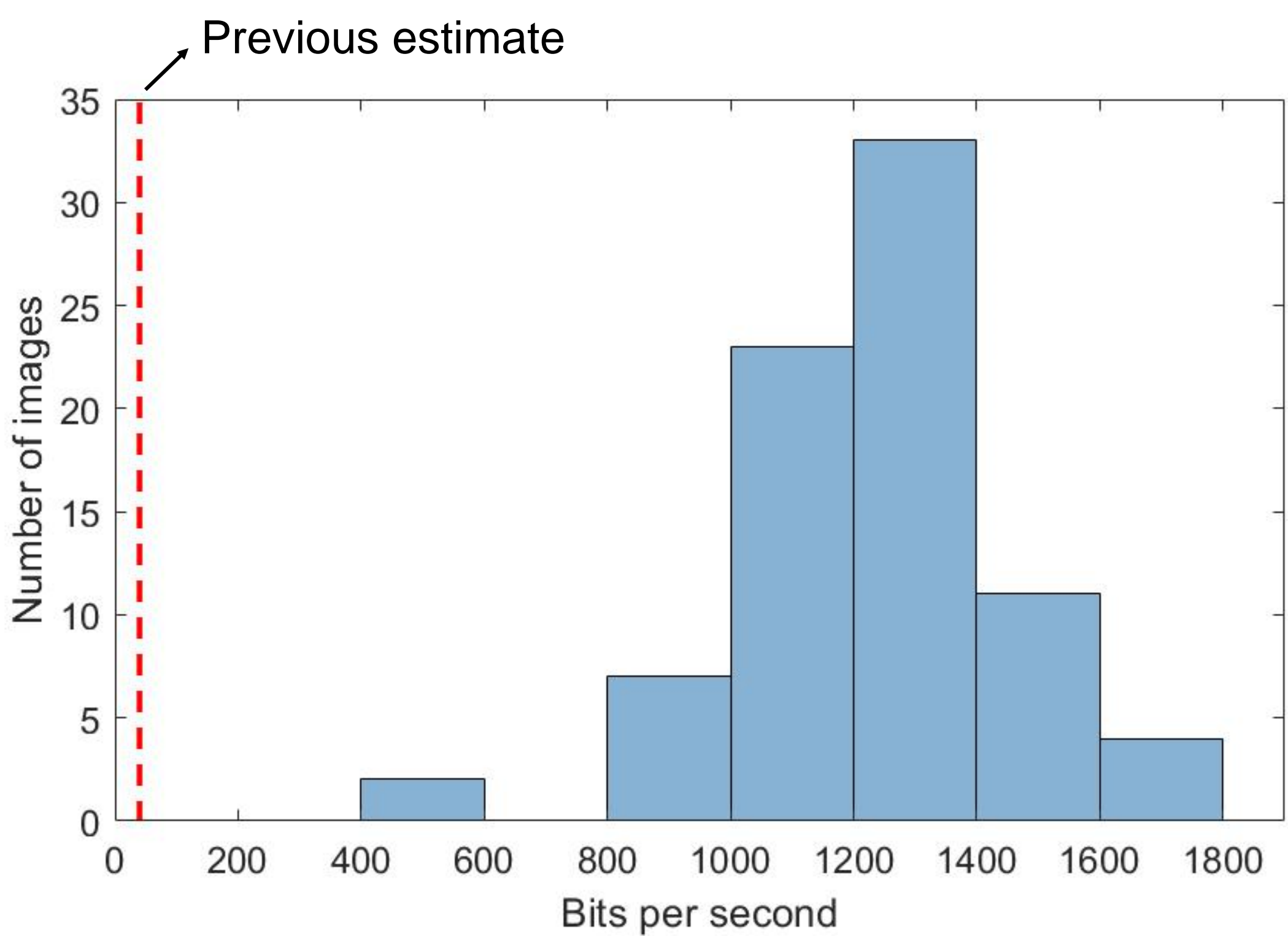
Discrimination accuracy

- Discriminability between seen and unseen, when they are perceptually-similar (present v.s. modified absent), and perceptually-different (present vs. randomly-selected absent)
- Performance decay for fine-grained differentiation



Information transfer rate

- Information transfer rate of each image = sum of transfer rate of each **unique** patch / presentation time (0.133 second)
- Based on information theory, one accurate patch judgment = $\log_2(2 \text{ response alternatives}) = 1 \text{ bit of information}$



- information transfer rate for all 80 images are much higher than previous estimate of 40 bits/second
- On average, information transfer rate for each image was **1241 bits/second**

Information rates of other modalities		
Language	Eyes (neuronal information flow)	Internet (NBN)
39 bits/sec	10^7 bits/sec	$2.5 \times 10^7 \text{ bits/sec}$

Discussion

• A brief glance is highly informative:

- Participants were highly accurate in discriminating present vs. randomly-selected absent patches, culminating in **1200 bits/second** of information transfer. This is likely to be a lower-bound estimate, as we only sampled a limited number of absent contents.
- **Informativeness as limited by the resolution of visual perception**
 - Participants were less accurate in differentiating present vs. modified absent patches. Therefore, a brief glance is not detailed, and fine-grained differentiation is difficult.

• Future directions

- Control for the perceptual differences between what is seen and what is not seen (e.g. present and absent patches to differ in only colour, spatial frequency, etc)
- Investigate what accounts for the variance in information transfer rate in different images
- Increase the number of absent patches, and explore the upper bound of information transfer (if there exists one)