Brain and Behaviour – S2

PSYC 304

Kamensek

Announcements

1. Reading club assignments (3A and 3B) due tomorrow (don't forget your tweets too)!
2. Midterm 3 is on Tuesday next week
   - Topics: motor systems, vision & action lecture from Ray, learning and memory, Sleep (all topics except the "behavioural studies in humans" section starting on slide 77), attention and executive function from Gloria, consciousness & attention.
   - A short answer question will come from Ray's lecture.
   - 2 multiple choice questions will come from Gloria's lecture.
   - Exam will be the exact same format as the previous 2 tasks
3. HSP credits – I have a report from term 1. These are used towards your total (you don't have to redo your 3 credits in term 2).

Consciousness

Learning objectives

1. Provide a reasonable definition of consciousness, and name the neural networks and structures that, when activated, may play special roles in coordinating conscious states
2. Discuss the impediments to the scientific study of consciousness, distinguishing between the “easy” and “hard” problems of consciousness, and speculate about the role of free will in understanding consciousness.

Consciousness

Attention and awareness

- are behavioral and experiential manifestations of consciousness but are not synonymous with consciousness.

Consciousness

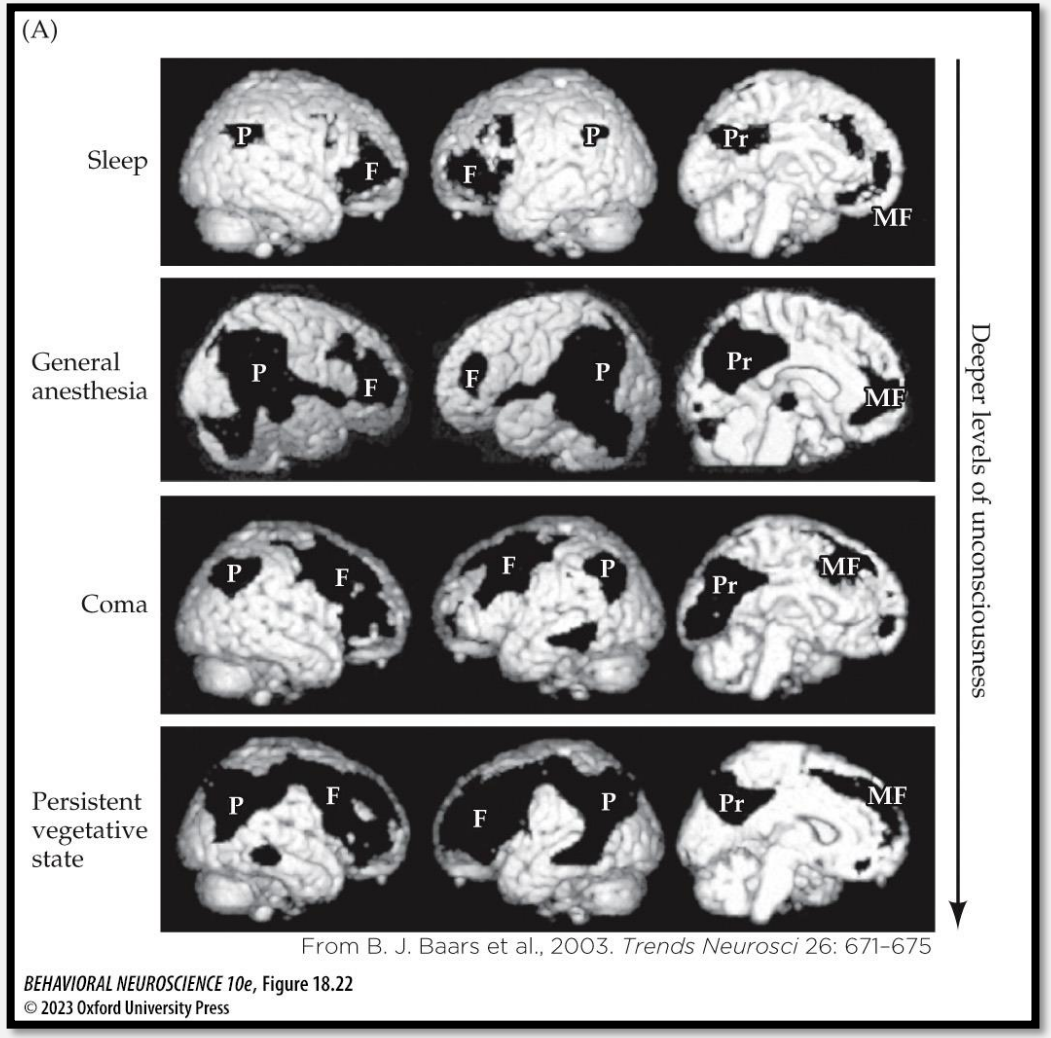
Consciousness

Default mode network:

- a circuit of brain regions that are active when the brain is introspective and reflective, and relatively deactivated when attention is directed to external events.
- Overlaps in fMRI maps suggest reliance on the frontoparietal network, as well as medial frontal cortex and cingulate.
- Dysfunction may contribute to various high-level cognitive problems.
- Same network observed in many animal models (proof of introspective mental activity?)

Consciousness

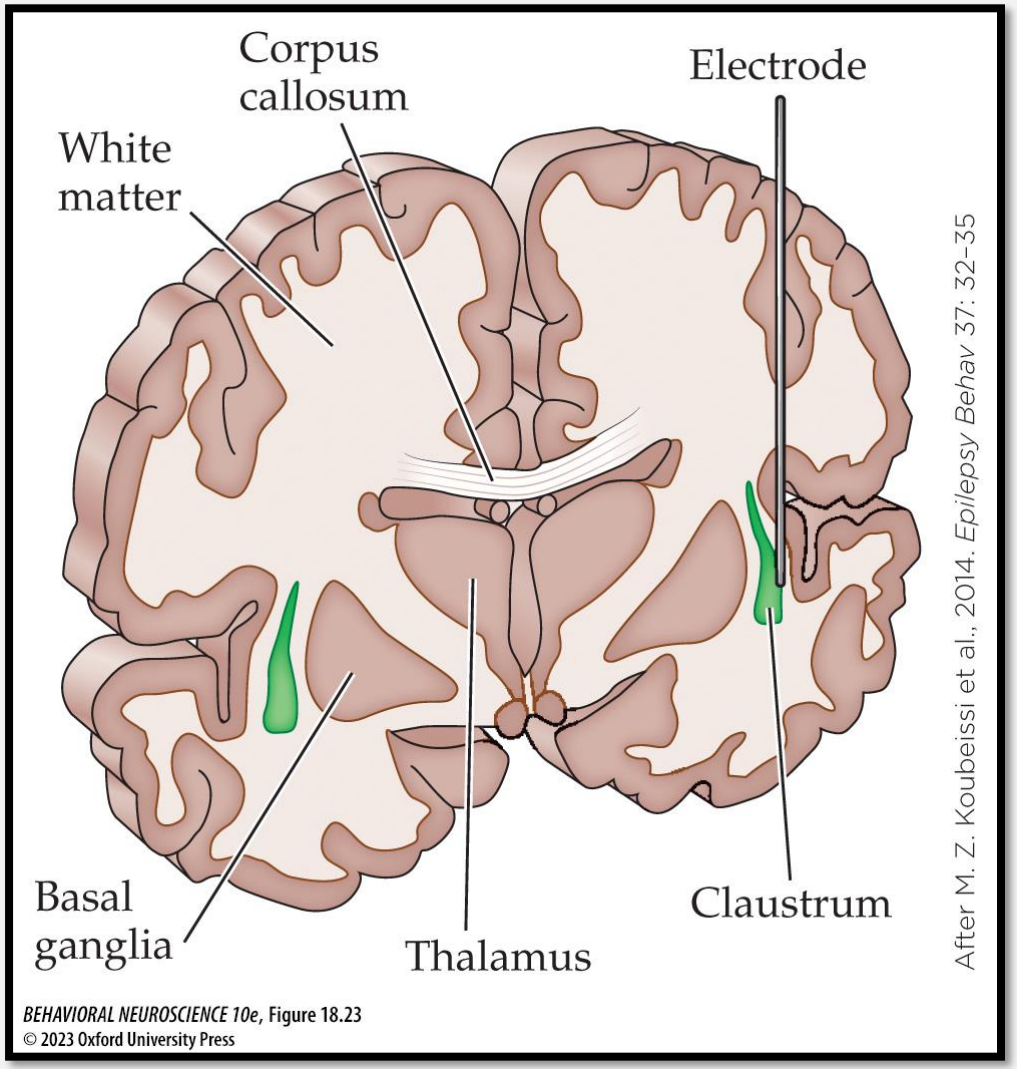
- Using fMRI, researchers have devised maps of cortical areas that appear to be deactivated in unconsciousness.
- Overlap in these maps suggests shared reliance on a frontoparietal network.
- The **claustrum** may play a critical role in generating the experience of being conscious. It has reciprocal connections with virtually every area of cortex.



Consciousness

Claustrum

- may play a critical role in generating the experience of being conscious. It has reciprocal connections with virtually every area of cortex.
- Cortical on/off switch – passing current through the claustrum leads to a temporary loss of consciousness that is regained when stimulation is stopped



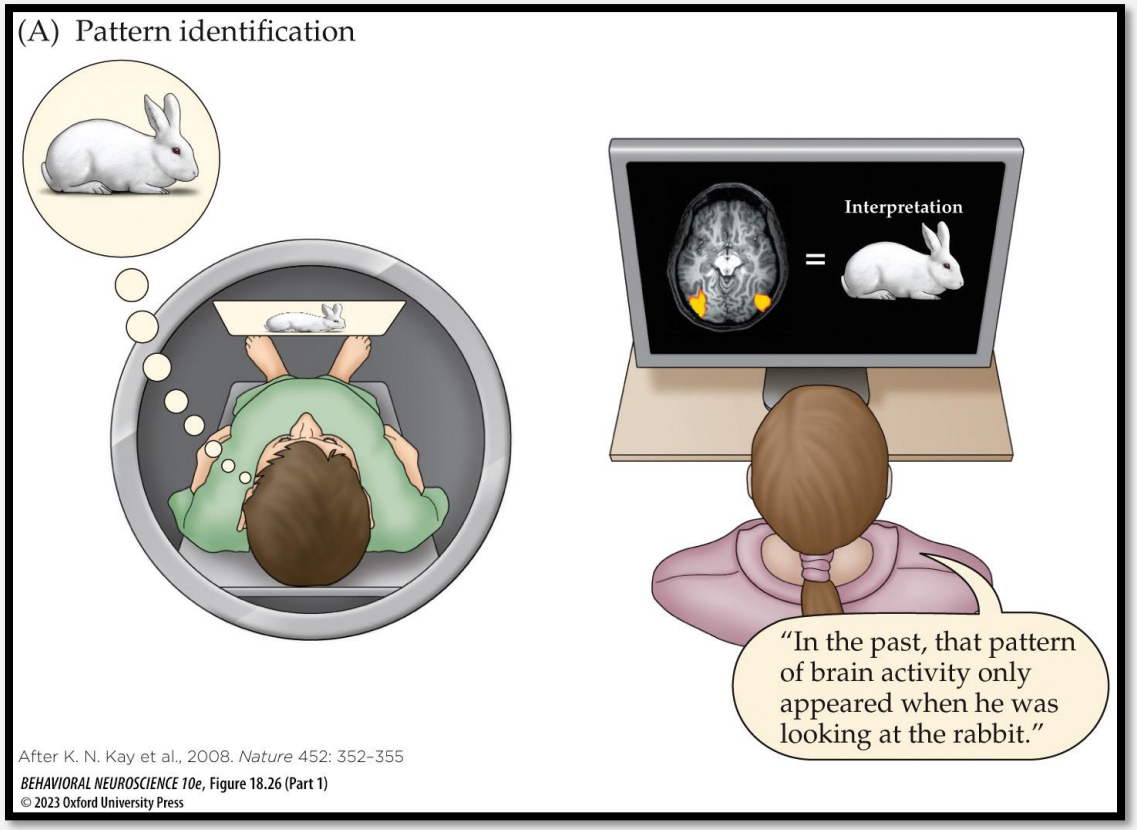
Consciousness

Cognitively impenetrable functions:

- basic neural processing operations that we can't experience through introspection.

The easy problem of consciousness:

- understanding how patterns of neural activity create specific conscious experiences.
- Computers can learn patterns from fMRI and identify the scenes or objects being viewed.



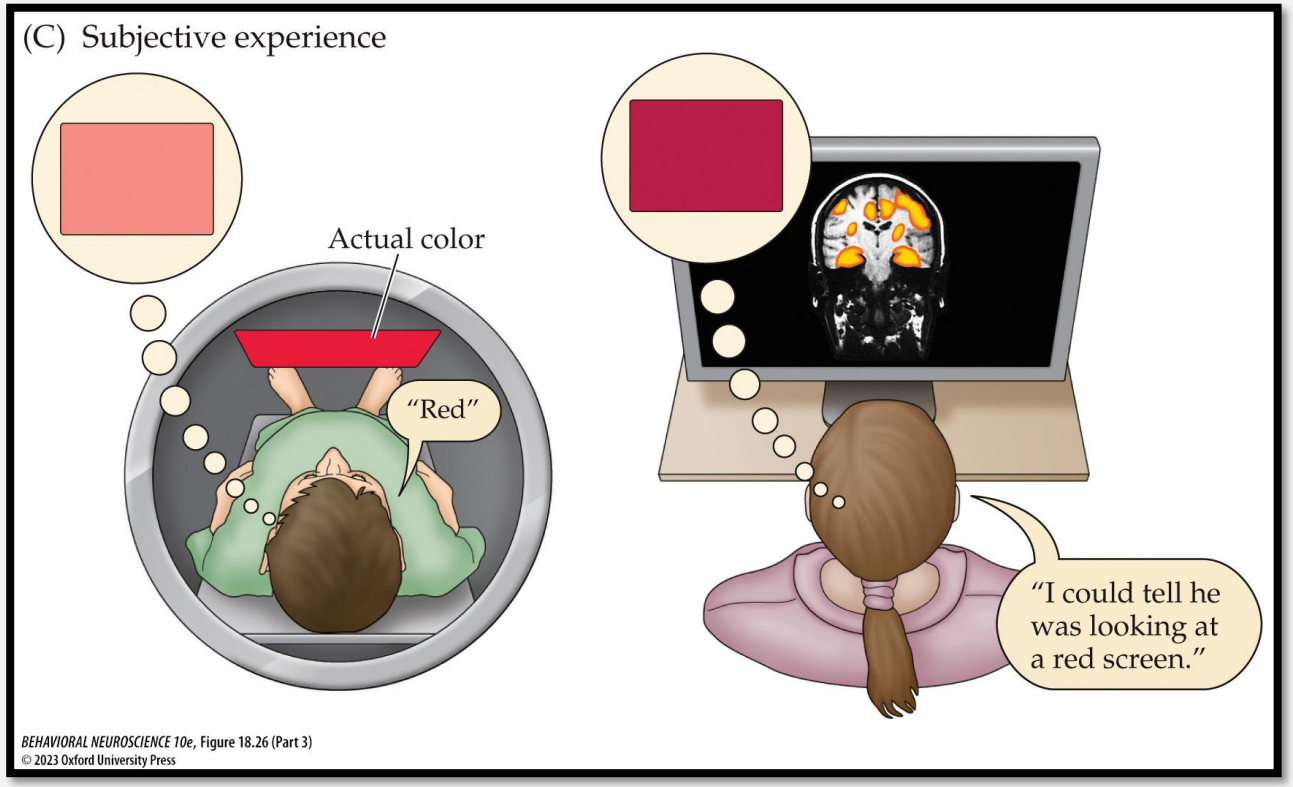
Consciousness

The hard problem of consciousness:

- understanding the brain processes that result in a person's subjective experience of the contents of consciousness.

Qualia

- purely subjective experiences of perceptions, impossible to communicate to others.
- At this point we can't even conceive of a technology that would make it possible to study qualia.



Consciousness

Our subjective experience of consciousness

- is connected to free will, or feelings of agency.
- Intentions to act yield selective fMRI activations.
- The conscious experience of making a decision appears to occur much later than the neural activity of making a decision, as seen in fMRI.

Attention

Learning objectives

1. Define selective attention, with examples, and contrast overt and covert attention.
2. Discuss the limits on attention as revealed by divided-attention tasks and compare early-selection and late-selection models of attention.
3. Distinguish between voluntary and reflexive attention and describe a classic experimental design for studying each.
4. Describe the use of focused attention to search for particular objects, using feature search or conjunction search, and discuss the binding problem
5. Explain how event-related potentials (ERPs) are measured, and name and describe the main ERP components as they relate to auditory versus visual attention.
6. Contrast and compare the auditory N1 effect, the visual P1 effect, and the N2pc component.
7. Describe experimental evidence that selective attention to stimuli enhances neural activity in the brain regions processing the stimuli.
8. Describe research that shows three different ways that attention affects the activity of individual neurons in sensory systems

Attention Selects Stimuli for Processing

Attention (*selective attention*):

- process of selecting or focusing on one or more stimuli for enhanced processing and analysis.

Vigilance:

- the global level of alertness of the individual.

Overt attention:

- directing our senses and our attention toward the same target.

Covert attention:

- shift focus of visual attention, e.g., in peripheral vision.

Attention Selects Stimuli for Processing

Cocktail party effect

- selectively enhanced attention to filter out distracting stimuli.

Attention Selects Stimuli for Processing

Dichotic presentation:

- simultaneous delivery of different stimuli to both ears at the same time.

Shadowing:

- task requiring focused attention on one ear and repeating what is heard, while receiving stimuli in both ears.
- Subjects can report little about the stimuli heard in the non-attended ear.

Attention Selects Stimuli for Processing

Inattentional blindness

- can occur in a complex shadowing task using two sources of visual stimuli.
- Subjects fail to perceive non-attended stimuli, even if very obvious.

Attention Selects Stimuli for Processing

- **Divided attention tasks** show that attention is a *limited* resource and it's very difficult to attend to more than one thing at a time.
- Our **attentional spotlight** shifts around the environment, highlighting stimuli for enhanced processing.
- It's an adaptation share with other species; helps us extract important signals from a noisy background.

Attention

This attentional bottleneck

- works as a filter to select only the most important stimuli for processing.

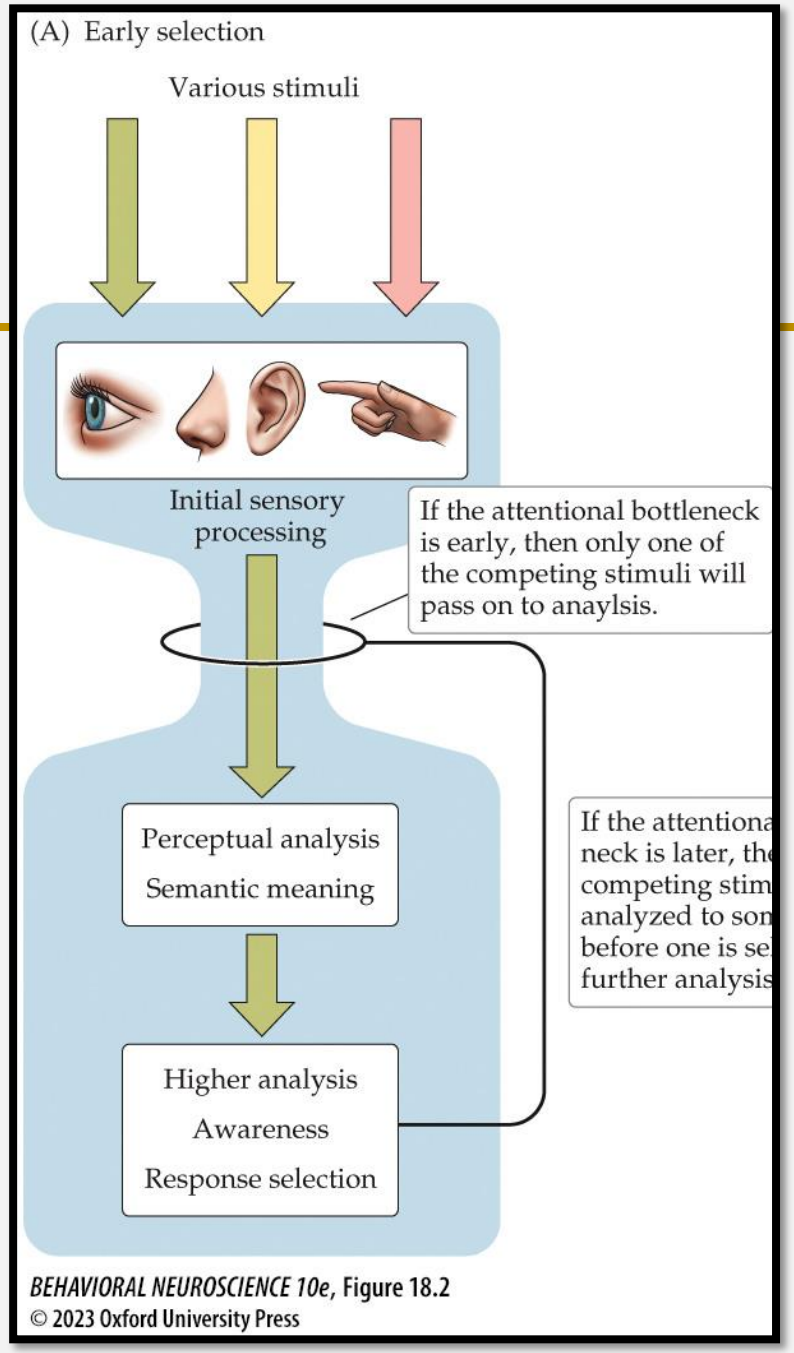
Early-selection model:

- unattended information is filtered out right away, at the level of the initial sensory input.

Late-selection model:

- filtering only after substantial analysis has already occurred.

Many models contain both mechanisms.



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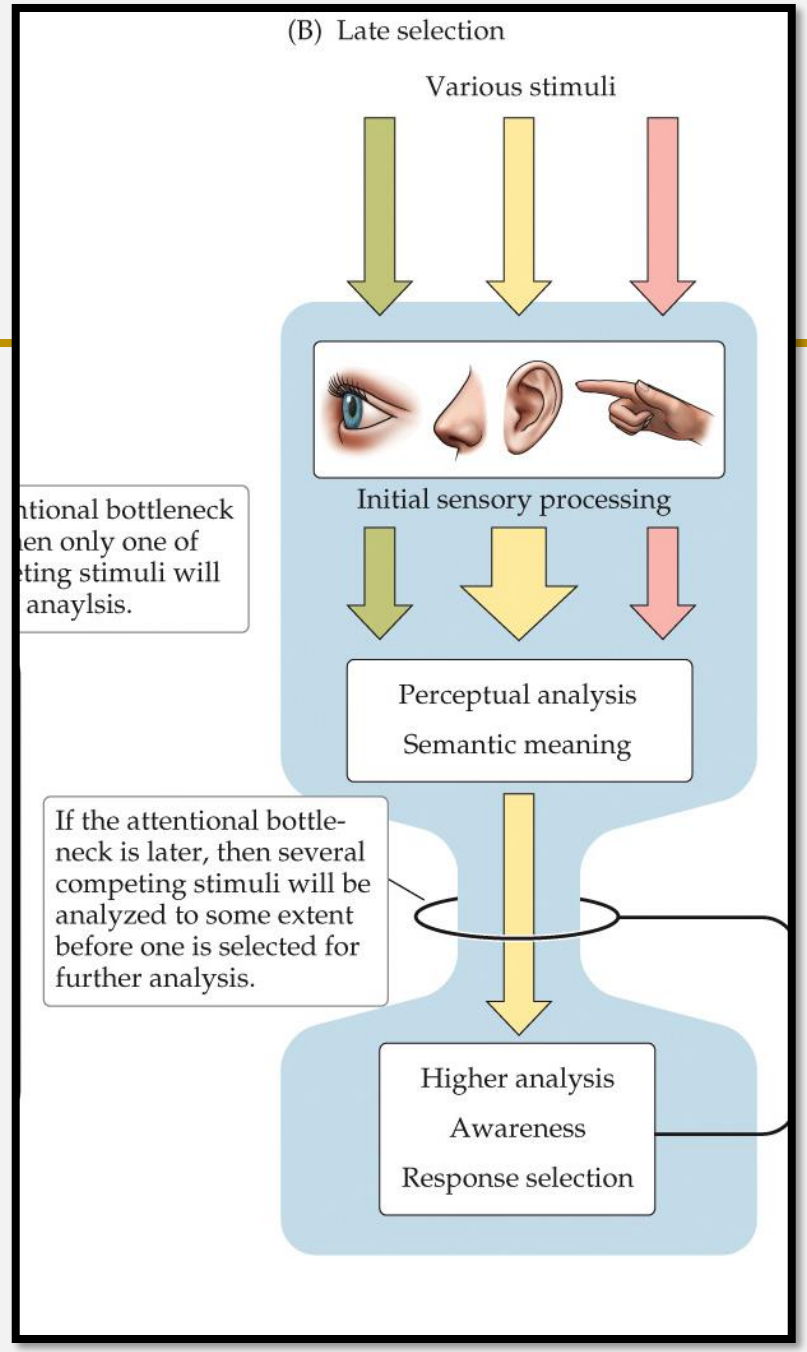


Attention

Perceptual load:

- immediate processing challenge presented by a stimulus.
- When we focus on a complex stimulus that requires a lot of perceptual processing, no resources remain for use on competing unattended items (early selection).
- When we focus on simpler stimuli, there is enough resource for processing of other stimuli (late selection).

Attention deployment

- Attention is continually rebalanced between early and late selection, according to the difficulty of the task at hand.

Sustained attention task

- single stimulus must be held in the spotlight for length of time.
- *Stimulus cuing* tests test reaction time to stimuli by first presenting a cue to the location of the stimulus.

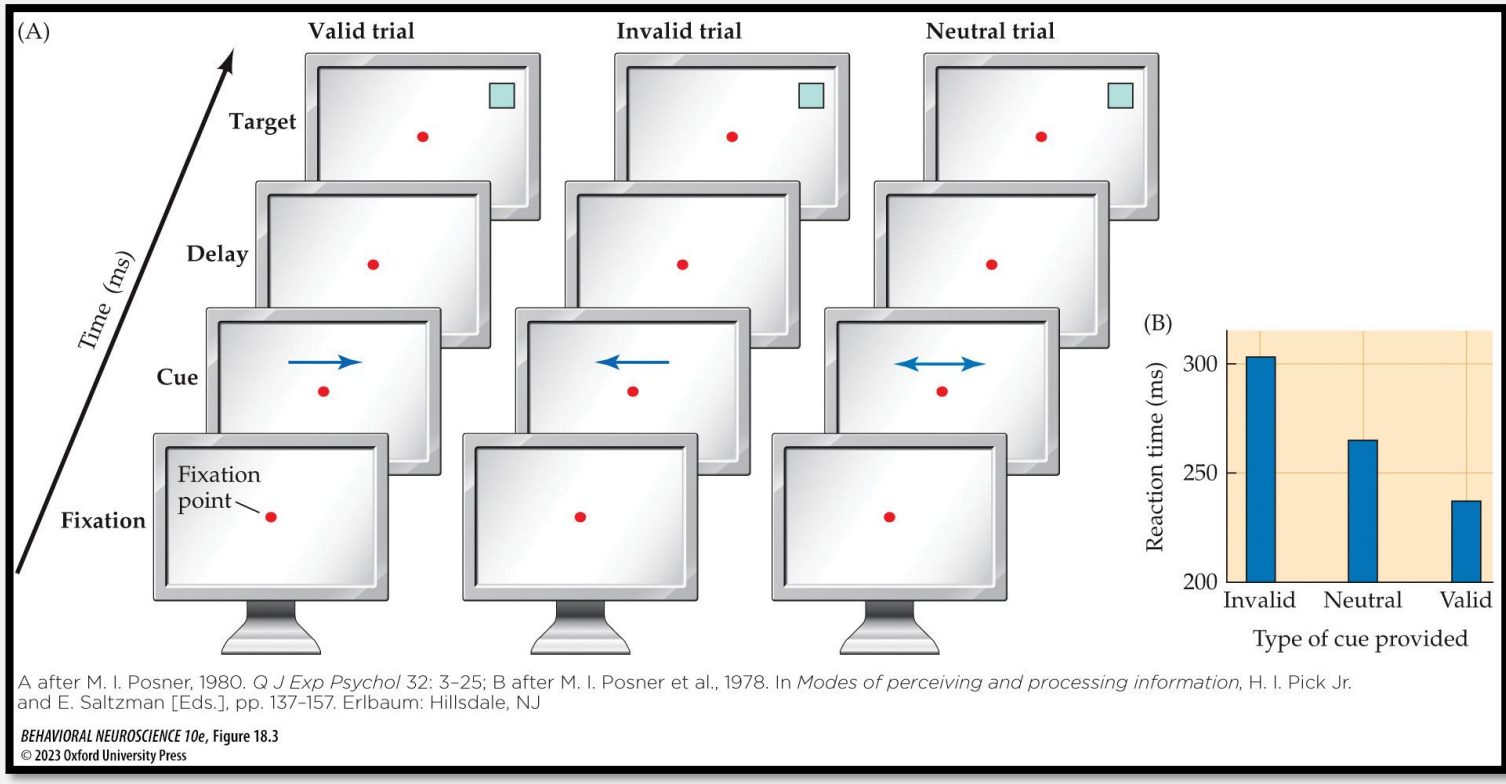
Attention deployment

Voluntary attention:

- (*consciously controlled, top-down*) attention shifts that come from within according to our interests and goals.

Symbolic cuing task

- measures voluntary attention: measures reaction time to a stimulus that is preceded by a hint or cue.
- The cues presented may be valid, invalid, or neutral.

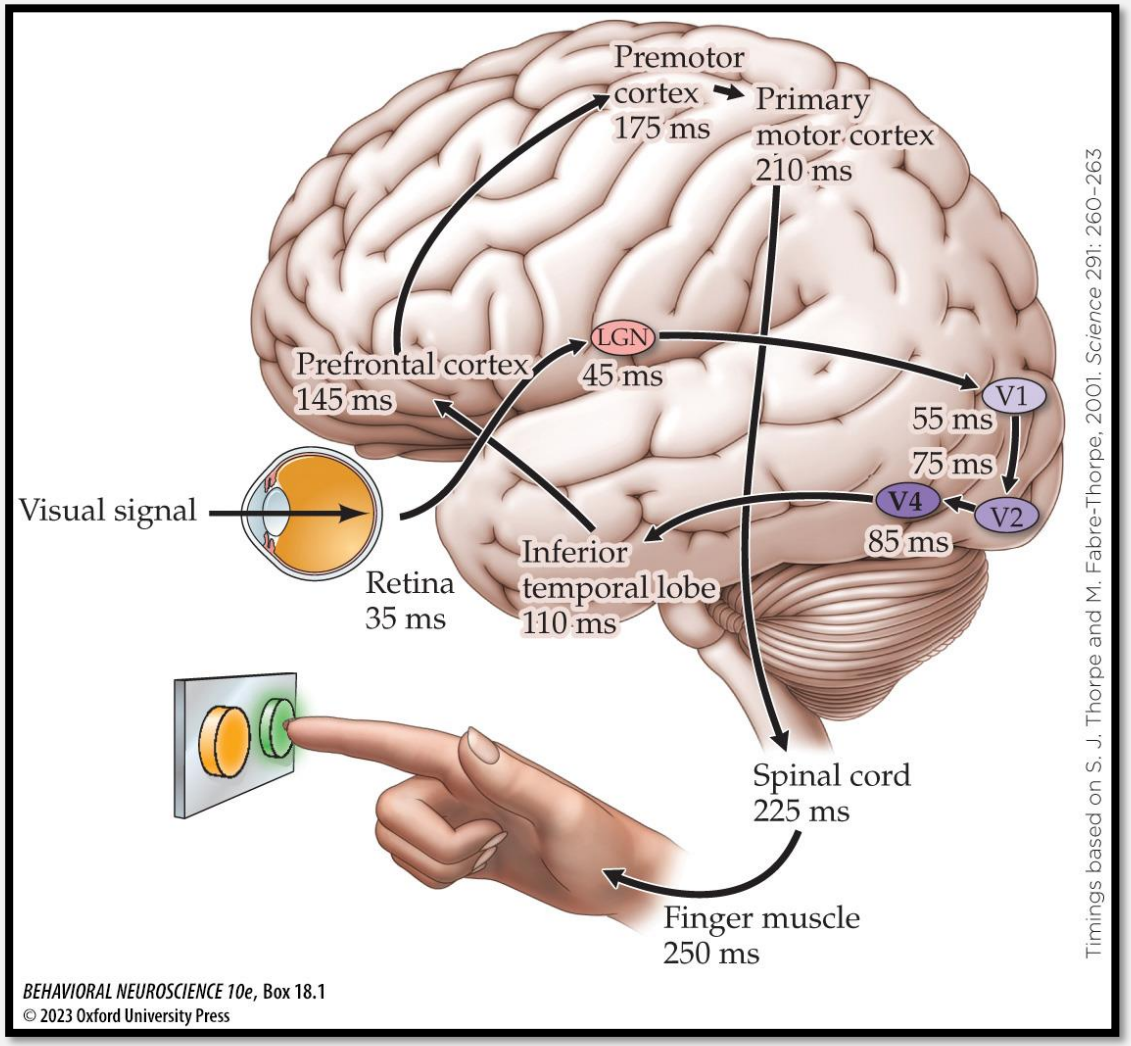


A after M. I. Posner, 1980. *Q J Exp Psychol* 32: 3–25; B after M. I. Posner et al., 1978. In *Modes of perceiving and processing information*, H. I. Pick Jr. and E. Saltzman [Eds.], pp. 137–157. Erlbaum: Hillsdale, NJ

BEHAVIORAL NEUROSCIENCE 10e, Figure 18.3

Attention deployment

- Simple reaction time tests ask subjects to make a single response.
- Choice reaction time tests present alternatives and subjects have to choose among them.
- The delay between stimulus and response varies depends on the neural processing needed.



Attention deployment

Reflexive attention:

- involuntary reorientation toward a sudden or important event.
- In this bottom-up process, attention is captured and controlled by sensory inputs from lower levels of the nervous system.

Attention deployment

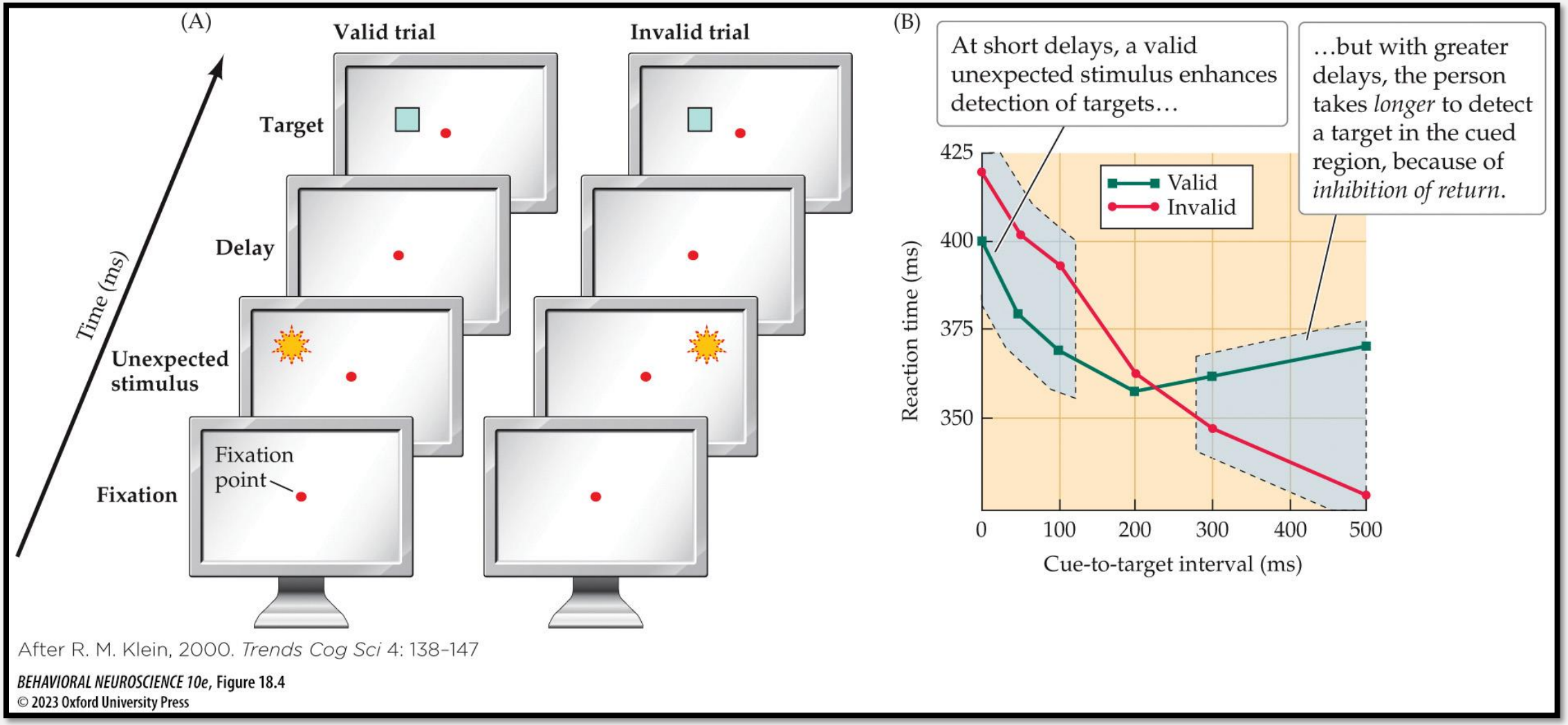
Peripheral spatial cuing task:

- measures effects of reflexive shifts of attention on stimulus processing.
- A simple *task-irrelevant* sensory stimulus (often a flash of light) is presented in the location to which attention is to be drawn.

Inhibition of return:

- longer intervals (200 ms or more) between cue and target interfere with processing of valid cues.

Inhibition of return

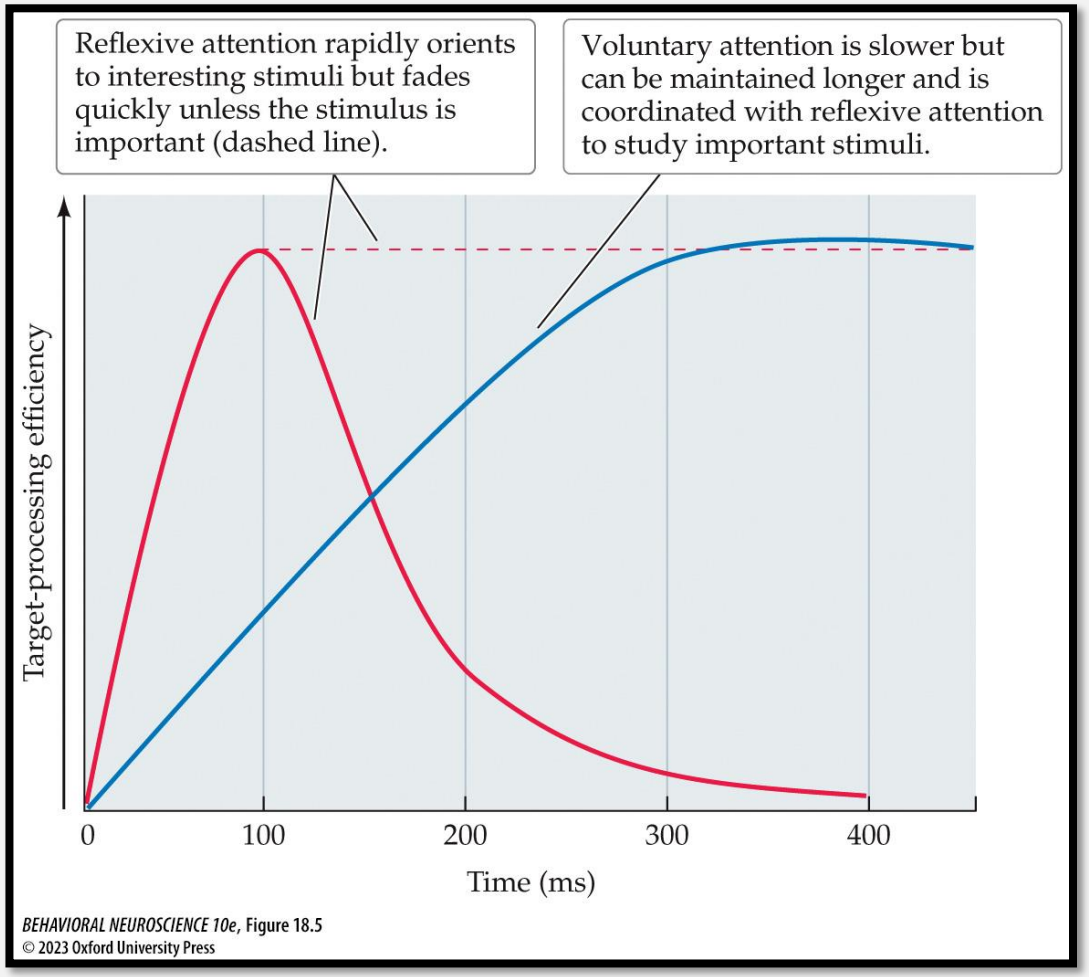


After R. M. Klein, 2000. *Trends Cog Sci* 4: 138–147

BEHAVIORAL NEUROSCIENCE 10e, Figure 18.4

Attention deployment

- **Reflexive** and **voluntary** attention normally work together.
- Effective cues for reflexive attention may involve multiple sensory modalities: e.g., a sound coming from a particular location can improve the *visual* processing of a stimulus that appears there.



Attention deployment

- Neuroscientists look at how selective attention modifies brain activity and the mechanisms of attention.

Challenge

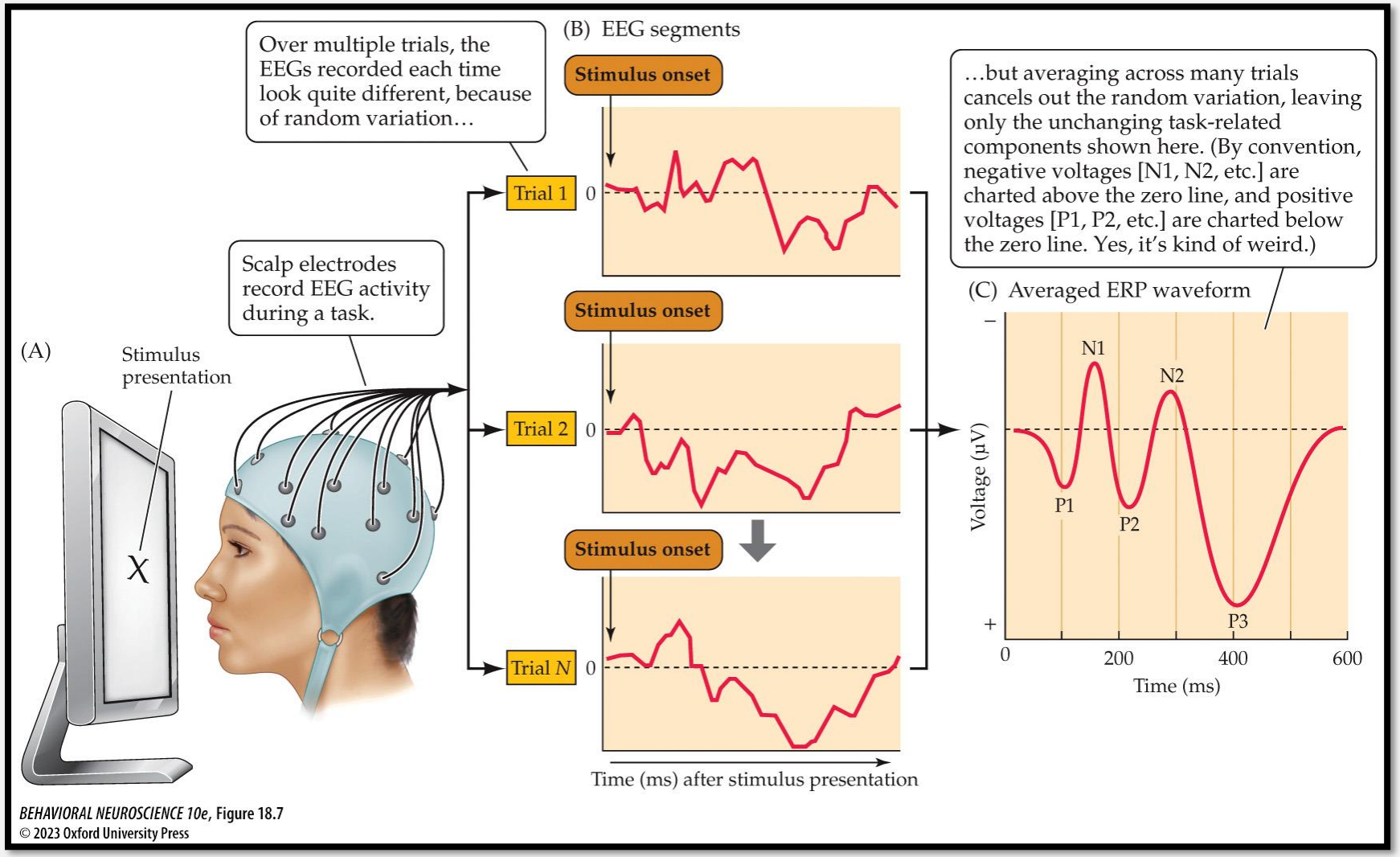
- Experimental techniques must address both
- **Temporal resolution**—ability to track brain changes in the brain that occur quickly (electrophysiological approaches).
- **Spatial resolution**—ability to observe detailed brain structure (brain imaging).
- Do you remember the names of two techniques that could be useful for each challenge?

Targets of Attention

Electroencephalogram (EEG)

- Multiple simultaneously active networks, regional differences in timing of activity, and individual variation in firing of neurons all contribute to a real-time EEG.
- Participants do repeated trials of an activity and EEGs are averaged to produce an **event-related potential** (**ERP**).
- ERPs reveal regional changes in brain activity much faster than brain-imaging techniques.

Event-Related Potentials (1)



BEHAVIORAL NEUROSCIENCE 10e, Figure 18.7

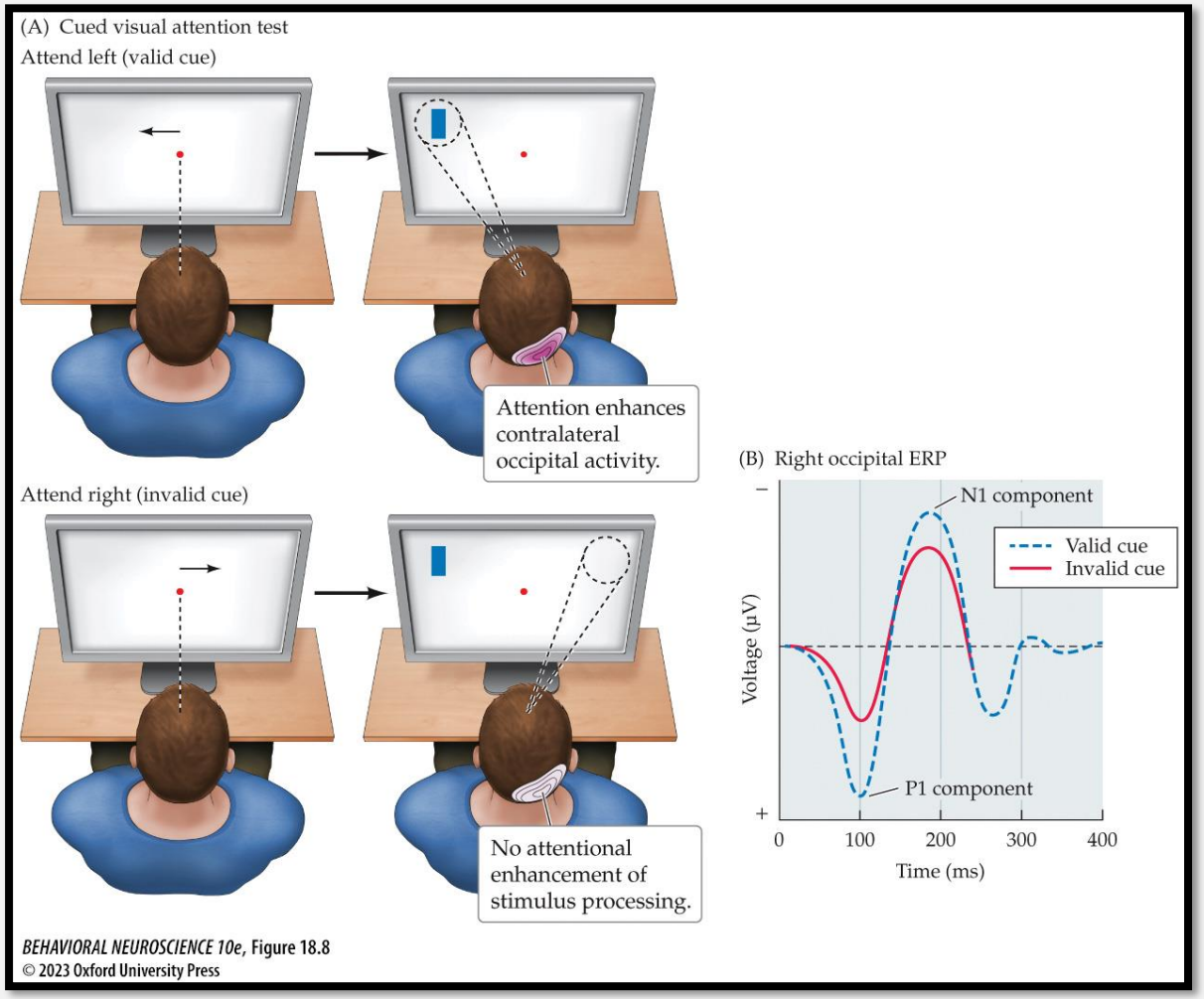
Targets of Attention:

Auditory stimuli

- In dichotic tone trials, ERPs for attended stimuli were larger in amplitude than for the unattended stimuli (**N1 effect**).
- Auditory attention enhances later ERP components—the **P3 effect** is associated with late attentional selection.
- May be a marker of consciousness.

Targets of Attention

- Attention to visual stimuli results in ERP data collected over the contralateral occipital cortex.
- P1 is a positive wave that occurs 70–100 ms after stimulus onset.
- **P1 effect**: a large increase in amplitude of P1 after attended stimuli compared with P1 for the same stimulus when attention is directed elsewhere—attentional bottleneck.



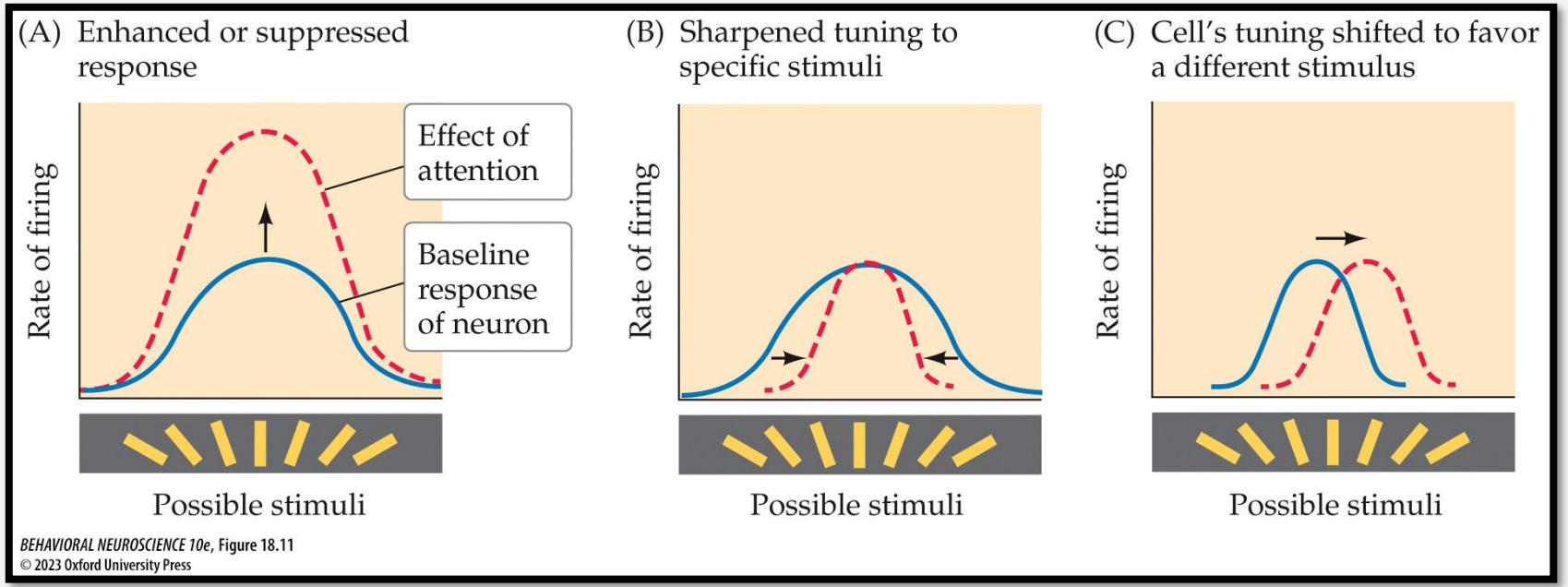
Targets of Attention

- Spatial resolution of EEG is poor, so researchers use PET and fMRI to confirm the location of activity in response to attention.
- Use EEG timing to observe specific locations of activity
- PET and fMRI studies confirm that a general consequence of attention is an enhancement of activity of the brain regions that process key aspects of the target stimuli.
- Activity in anatomical regions corresponds to location of attention and shifts when attention shifts.

Targets of Attention: Attention Alters the Functioning of Many Brain Regions

Attention may alter the function of individual neurons in three ways:

- Enhance or suppress responses
- Sharpen tuning of cortical neurons
- Induce a shift in tuning of the cell



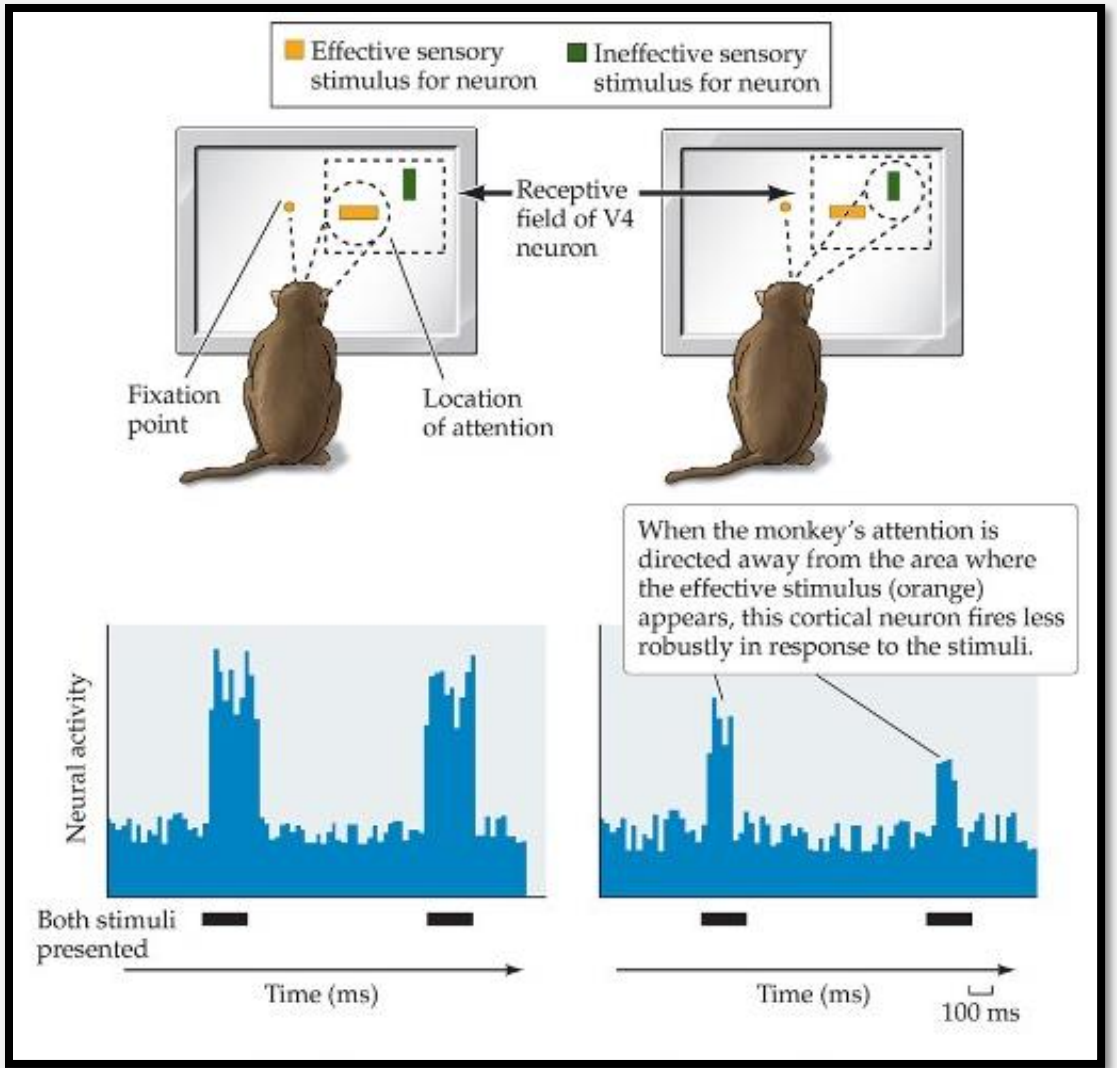
BEHAVIORAL NEUROSCIENCE 10e, Figure 18.11

Targets of Attention

- Early research demonstrated that shifting attention can change the firing rates of visual cortex neurons.

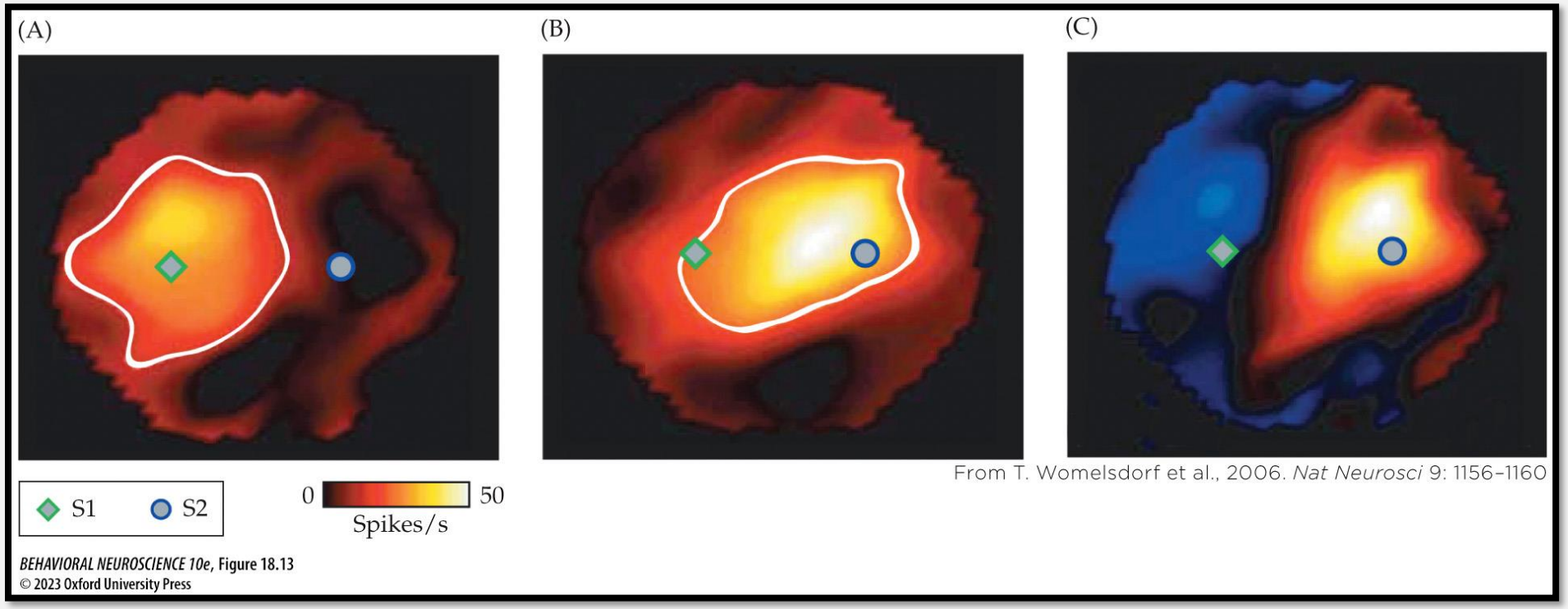
Method

- Train monkey to covertly attend to a stimulus within the receptive field of a specific neuron (with rewards)
- Observe firing patterns when that cue is shown with a distractor
- Have monkey switch attention to the non-rewarding distractor



Targets of Attention

- Shifts of attention between cued locations cause shifts in peak sensitivity within a receptive field map of one neuron.
- Attention can also apparently cause the overall size of receptive fields to shrink, sharpening the receptive field.



Reading club -

This slide is to write notes about the reading club articles