

Reference: Baars, B.J. (2007) Attention & Consciousness. In B.J. Baars, & N.M. Gage (Eds.), *Cognition, Brain, and Consciousness.: Introduction to Cognitive Neuroscience* (225-253). Academic Press.

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BIG QUESTION: WHAT IS THE DIFFERENCE BETWEEN CONSCIOUSNESS AND ATTENTION?

Short answer: Attention implies selection; consciousness refers to being able to report accurately.

- **ATTENTION IS A SELECTION MECHANISM:**

- In everyday life, competition between lots of different systems is going on. Attention can go to inner or outer events, between perceiving and responding, and between lots of different inputs.
- Evidence points to sensory processing occurring in local areas, with activation in frontal and parietal systems only occurring when attention is needed. Some experiments have shown that prefrontal cortex can “highlight” certain visual regions.
- Attention can be voluntary or automatically allocated. Voluntary is more “top-down” and goal-driven; automatic is dictated by features of the stimulus, and is more bottom-up.

- **EXPERIMENTAL PARADIGMS**

- Selective attention is studied by auditory shadowing studies, visual flanker tasks and the Attention Network Task (ANT), a variation of the flanker task. This task separates being *alert* for a signal, *orienting* to a specific location, and *controlling* to act against expectations and use readied attentional resources. Executive attention seems to be tied to the anterior cingulate and the lateral prefrontal cortex.
- Visual search paradigms have illustrated the “pop-out” effect, which shows parallel search. This is an example of stimulus-driven attention capture. The Stroop task is used to study executive functioning, since you need to balance between a well-practiced and a novel task.

- **BRAIN BASIS FOR ATTENTION AS BIASED COMPETITION:**

- We have to balance lots of competing factors for our attention, and the attention system may work somewhat like the eye movement system; it orients itself to certain features/locations. Selective attention can increase activity in visual cortex. In this case, pre-frontal cortex can be thought of as guiding a spotlight, which shines onto the relevant area of visual cortex, increasing efficiency at that location.

- **EXECUTIVE FUNCTIONING:**

- Executive functioning can mean going against some response, like looking the opposite way of a cued direction, or maintaining attention when there is some distraction occurring. Perceptually interesting information may not require any additional attentional resources, but more cognitive tasks might require executive functioning to maintain attention.
- The authors make the point that mental effort may mostly be necessary for the beginning of tasks, but once an “onerous” task has been started, it may become engaging and no longer require mental effort. Mental effort is required to balance voluntary and automatic attention, and may need to be invoked many times throughout a particular action (i.e. after taking a break from studying). This returns to the idea of attention and neuronal competition.

- **BRAIN BASIS OF CONSCIOUSNESS**

- We can report lots of things that we do mentally, but we are generally unaware of the processes underlying it (i.e. I can read, but not monitor my saccades).
- We are constantly doing a lot of processing of sensory information, and yet we are only aware of a small amount of it at any given moment. Reading these words, you are not aware of your chair, of a small draft in the room, of the other meanings of the word “chair” (i.e. a C.E.O.), and yet, evidence suggests that all of these things are processed unconsciously, to some degree. Research has looked at comparing conscious events with unconscious counterparts to compare and contrast brain regions activated.
- Visual feature integration (i.e. binding) and binocular rivalry has been a useful paradigm for studying what features become dominant (i.e. conscious). Using macaque monkeys seeing two different things in each visual field, they found that visual cortex for conscious and unconscious stimuli was identical; however, the difference came in activation of the temporal cortex (IT and STS). Other work has also found that conscious stimuli provoke more widespread activation, and generally in “higher-level” systems. Sometimes, there is also more intense activation in relevant sensory systems.
- Sensorimotor skill acquisition also paints the same picture: when first learning a task, we must consciously attend to it. As we become more practiced, less and less conscious attention is needed, and when we become experts, we only notice something if the task goes awry (i.e. start falling off your bike). This has been found using fMRI and PET methodologies. For fMRI, the more the task deviates from what is well-practiced, the more activation occurs in the anterior cingulate and the dorsolateral prefrontal cortex.

- The widespread activation may also cause some degree of synchrony between the firing of different regions of the brain. The authors report one study that found different regions all firing around 40 Hz when responding to a visual flicker task.

Recap/take homes:

Selective attention can focus resources on critical brain areas. Selective attention and conscious integration can be thought of as rapidly alternating. The brain has many competing regions, and selective attention may be a function of applying a bias to certain regions (i.e. attending more to a cued location). However, for something to become conscious requires widespread activation of “higher-level” systems, such as frontal and parietal regions. Otherwise, if only processed locally (i.e. in visual cortex only), a stimulus may remain unconscious.