Why the eyes rotate in their sockets

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The eyes rotate in their sockets to orient high-resolution vision towards items of interest.

- The eyes are oriented with quick saccades (≈25-50 ms), and visual information is perceived during fixations (≈200-400 ms).
- Eye movements are generally motivated by strategic decisions to acquire perceptual information needed for a task.

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- For example, if you ask someone to fixate the crosshairs, he or she will execute a strategy to issue the saccades needed until it is perceived that the center of the crosshairs are being viewed in as much detail as possible.
- If you ask someone to look at the $h$, they will make strategic eye movements until $h$ is in high resolution vision.

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- Eye movements are determined by (a) predictions of how the world is organized and (b) availability functions that determine the probability that an object's feature can be perceived.
- Availability functions are influenced by:
  (a) the distance to the object,
  (b) the feature in question,
  (c) the size of the object, and
  (d) the density of other nearby objects.
Visual-perceptual availability functions

The probability that a feature can be perceived as a function of its eccentricity from the current point of gaze. Color is more available than size or shape. These values were estimated to model a particular icon search task (Kieras & Hornof, CHI 2014).

What this means for visual search in an unstructured unfamiliar visual field

In general, people can find things the fastest if they know the color of the “target”. But knowing the size and shape help, too. If people have to study the fine detail of objects, search tends to be slow.

We ran an experiment in which we presented participants with screens of 75 objects, each with a unique number, and a unique combination of color, shape, and size. The objects were randomly re-positioned for every trial. Participants were “precued” with the target object’s number, and sometimes other visual features of the target, and asked to find the target quickly. We recorded their eye movements and studied their visual “scanpaths”.

Precue: “13”

Precue: 07 purple
Visual availability interacts with cognitive strategies:

People interact with the world by executing cognitive strategies.

Cognitive strategies...
... are plans that coordinate perceptual, motor and memory processes to accomplish tasks.
... are sometimes conscious, sometimes subconscious.
... usually have a goal state.
... can be complex, such as for dual task performance.
... are compiled; stored in, maintained in, and loaded from memory; parameterized for specific tasks.

They are just like computer programs and functions.
They are well-established but under-appreciated.

(Shiffrin & Atkinson, 1969; Baddeley, 1974; Lachman et al., 1979; Rosenbaum, 1991; Reichle, 2012)

Cognitive Strategies and orienting the eyes

Look at the dot in the center. All letters should be equally available.
An object’s size interacts with the availability of other visual features of the object. In other words, object-features (such as color and shape) will remain available as the objects move away from the point of gaze provided that the objects are made large enough.

Adapted from Anstis (1974)

An object’s size

The subset of the human architecture that is used in visual tasks, and used in controlling a computer with eye movements. Missing: additional perceptual and motor processors.
A flowchart summarizing a cognitive strategy for visual search (Kiers & Hornof, CHI 2014)

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