

stage, and still only at a whole organ level, significantly limiting the refinement of treatment options.

Two kinds of “memory images”: Experimental models for hallucinations?

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Abstract: Collerton et al. postulate that in a variety of different clinical conditions, hallucinations are derived from object schema lodged in long-term memory. I review two new experiments in which *memory images* can be easily triggered in neurologically intact subjects. These examples of making visible items in memory may provide experimental models for genesis of hallucinations.

Collerton et al. have abstracted from a variety of clinical entities some common traits of hallucinations and have proposed a plausible theoretical framework to account for the circumstances in which these images most often arise. Yet, at the core of their model, the location and physiological nature of the *schematic images* that feed hallucinations remain uncertain.

Are hallucinations akin to the images evoked by electrical stimulation of sites in the temporal lobe (Penfield & Perot 1963)? Or are they derived from more widely distributed networks, including the prefrontal cortex? Discovering how those visual images arise from memory is especially difficult because hallucinations arise unpredictably. Perhaps fMRI or pharmacological analyses of hallucinations would be advanced by studying analogous phenomena in a reliable and safely evoked manner in a laboratory setting. I review here two novel “memory image” phenomena, which might provide useful models for hallucinogenesis.

About 30 years ago I experienced remarkable intrusions of well-formed images at bedtime: the vivid replay of neuron waveforms that I had seen during hours of microelectrode recording earlier that day. Recently, I asked several visual scientists for such anecdotes and netted six recollections similar to my own. Three persons recalled seeing at night sharp images of patterns on computer screens, used earlier that day for psychophysical tests of experimental subjects. One man, driving home in the early morning, nearly swerved his car to avoid colliding with such an apparition. Naturalistic phenomena also appeared. One man, who had spent the afternoon picking avocados, was treated to an array of green blobs at night. Another saw images of swimming fish after a sporting day, and another recalled images of tree branches picked up while helping his tree-surgeon father.

This last individual is now a neuroanatomist and sometimes sees dendritic trees at bedtime. I lately discovered that very similar anecdotes were recounted by Hanawalt (1954), but the phenomenon appears not to have been systematically studied until recently. These recurring images appear similar to the dream intrusions studied by Stickgold et al. (2000) in volunteers who played a video game for several hours and witnessed the same specific images recurring at night. Another experiment form that lab (Merabet et al. 2004) may provide a safe method of increasing receptivity to those recurring images, as the blindfolding of volunteers for only 48 hours led to a high incidence of hypnagogic imagery.

Next, I present data from my own experiments on a rare visual phenomenon as an experimental analogue to the proto-objects postulated by Collerton et al. to be the source of hallucinated forms. About 1% of the academic population may experience *visual persistences* (VPs): vivid positive afterimages of single objects lasting for 15 to 30 seconds after brief fixation and eye closure (Ingle 2005). Although VPs are formed from just-seen objects or drawings and are not derived from long-term memories, new unpublished experiments reveal that certain VPs can reliably trigger *memory images* (MIs). This happened routinely when each of 5 subjects (including myself) formed a VP of an uppercase letter ro-

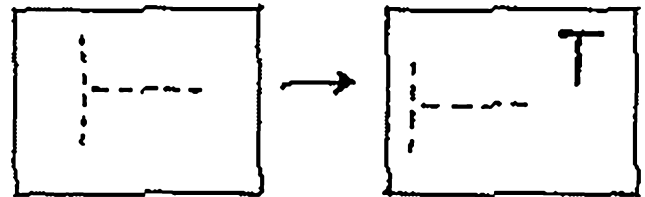


Figure 1 (Ingle). Fixation of a dashed sideward *T* leads to a *visual persistence* (VP) of the unfamiliar pattern. Within 2 or 3 seconds, a *memory image* (MI) of an upright *T* appears on the same index card.

tated 45 degrees from the vertical. Within 2 or 3 seconds, the VP of the sideways letter rights itself. One does not see the letter rotate, but the upright orientation suddenly replaces the first image. This intrusion from memory of the “canonical” orientation occurs as well with numerals and small faces (photos or schematic drawings).

A second example of substitution of an MI for a VP occurs when sideways letters or faces are used to create VPs. After the brief delay, the subject sees two images: the same sideways VP plus the upright MI. Two persons, tested with letters, saw the upright MI overlap with the original VP, whereas three others saw the MI set just to the right of the original VP (Fig. 1). We then found that these MIs are not all simply rotated versions of the VP. First, when the letter (e.g., a sideways *T*) is made of dashed lines, the upright *T* is seen with solid lines. Second, when the sideways letter is of a less familiar color (purple or yellow-green) the upright letter appears black or grayish. Yet, a familiar ink color (red) is duplicated in the upright MI. These phenomena invite further experiments to determine how much viewing of a given color, line-texture, or font may be necessary for that feature to appear in the MI.

Since the specialization of the fusiform region of temporal cortex for upright faces is now established (Yovel & Kanwisher 2004), I suggest that an analogous specialized representation for upright letters exists for humans (who read regularly) and that this representation readily intrudes upon the VP representation derived from the tilted letter. Although fMRI experiments have found some degree of localization for activations by single letters (e.g., Joseph et al. 2003), our experiments suggest that even better localization might be found by comparing responses of upright to rotated letters. As reliable as letters, numerals, and faces have been in triggering MIs, we have yet to see such effects using tilted or rotated VPs of line drawings of common objects such as fish, cars, bottles, cups, or horses. It seems likely that for these items there are not enough neurons dedicated to the identification of their canonical orientations.

Monoamines in RCVH: Implications from sleep, neurophysiologic, and clinical research

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Abstract: The role of brain monoamines may be important for the neurobiology of the alterations of visual alertness in recurrent complex visual hallucinations (RCVH). This is evidenced by sleep research, neurophysiologic, and clinical data. Hence, the mechanisms of RCVH may not be simply explained by acetylcholine underactivity only.

The novel Perception and Attention Deficit (PAD) model for recurrent complex visual hallucinations (RCVH), proposed by Collerton et al. in the target article, examines a large body of data