

Mental Iconicity Seminar

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## W7: Symbolic Representation in Perception

2.17.25

### Is there symbolic representation in perception?

**Perceptual pluralism:** perception enlists different formats of representation. (Green, Quilty-Dunn)

**Perceptual monism:** perception enlist only iconic representation. (Burge, Block)

**Green + Quilty-Dunn:** "The empirical evidence seems to indicate that object files do not represent in an iconic format. We think the evidence supports the hypothesis that object files represent in a propositional format."

**Burge:** "This train of reasoning seems to me a *reductio* of their conception of iconicity and their conception of how representation takes place in pictures and perception. The fact that various properties are iconically represented in a package in perception does not begin to show that they cannot be remembered iconically to different degrees."

### The architecture of visual perception

**Light, retina, and cortex.** Light is reflected in straight lines from the environment into the eye. Vision begins when this light is sensed by the retina. The resulting package of optical information is ultimately processed by the visual cortex.

**The Inverse Problem.** The function of vision is to answer the question: what scene in the environment most likely caused this retinal image? This is an inverse problem because it seeks to invert (or trace backwards) the causal process of light reflecting from the scene to the eye.

**Vision as unconscious inference to the best explanation.** According to the prevailing view: vision solves the inverse problem by making a series of unconscious inferences. Something like: *if the incoming light forms pattern X, then there must be a cube there*. Such inference almost always abductive: it reasons from evidence (e.g. optical) to explanation (e.g. environmental shape). Such reasoning is ampliative, in the sense that it adds information to the premises to derive the conclusion; contrast this with deductive reasoning, which only eliminates information.

**Stages of visual processing.** Visual processing is thought to take places in many stages, starting from (i) primitive analysis of the retinal image; through (ii) edge, shape, color, and motion representation; and ending up with (iii) object perception and finally (iv) categorization.

### Object files

(based on Green and Quilty-Dunn 2021 (GQD), illustrations from Pylyshyn 2006)

**The core idea.** “An object file is generally characterized as a representation that (i) sustains reference to an external object over time, and (ii) stores and updates information concerning the properties of that object.” (2)

**Two functional roles:** object files must fulfill the two functional roles of (i) *index* (tracking an individual object) and (ii) *description* (storing features of the object).

**Evidence 1: Multiple object tracking (MOT).**

“In the MOT task, a participant is presented with a set of objects, and some of these objects are flashed on and off in order to mark their status as targets. After this, all of the objects move randomly about the screen for some period of time. At the end of the trial, the participant is typically asked, of a single object, whether that object was a target, or she is asked to report all of the targets. Most MOT studies have suggested that perceivers can reliably track up to about four objects, after which performance declines rapidly”

**Key point:** subjects can track an object in MOT even if the object changes features (e.g. color, shape, orientation, size).

**Evidence 2: Object-specific preview benefit (OSPB).**

“A participant is shown a pair of objects on screen, and preview features (usually letters or numerals) briefly appear on those objects. After the preview features vanish, the objects move to new locations. Finally, a test feature appears, and the participant is asked either to categorize it to report whether it is the same as either of the preview features. A number of studies have shown that under these conditions, participants’ reaction times are faster when the test feature matches one of the preview features (a case of general priming) and are even faster when it appears on the same object on which that preview feature initially appeared (Kahneman et al. [1992]; Noles et al. [2005]). This latter effect is known as the ‘object-specific preview benefit’ (OSPB).”

**Evidence 3: Visual short-term memory (VSTM).**

“In VSTM studies, participants are briefly presented with a display of objects called a sample array, and asked to remember one or more features of those objects. The sample array then vanishes, followed by a blank screen or mask for a brief period of about one second, called the retention interval. Finally, during the testing period, the participant makes a response that indicates how accurately or precisely she encoded features of the objects in the sample array.”

“An important study due to Luck and Vogel ([1997]) has been taken to support the view that VSTM stores object representations. Luck and Vogel asked participants to memorize either the colours, the orientations, or both the colours and orientations of a sample array of line segments. They found that change-detection accuracy in each of

these conditions was essentially the same. In each case, participants could reliably recall about three to four objects, after which performance sharply declined. Luck and Vogel took this to suggest that VSTM is limited in the number of object files that can be simultaneously stored, but that there is no cost to encoding multiple features in the same object file. According to Luck and Vogel, once a file has been opened for an object, we can store both the colour and the orientation of the object just as easily as we can store its colour alone.”

**Summing up.** There are a limited number of “files” in memory that appear to track objects, but each file can store multiple features, and these features can be updated and change over time.

### **Are object files iconic?**

#### **Two signatures of iconicity:**

“**ICONICITY:** Every part of the representation represents some part of the scene represented by the whole representation.”

“**HOLISM:** Each part of the representation represents multiple properties at once, so that the representation does not have separate vehicles corresponding to separate properties and individuals.”

Contrast sentences and pictures.

**Evidence 1: separability of index and feature representations.** Object files track objects through changes; challenges holism.

“There is strong reason to believe that these indexes are syntactically separate from any feature representations used to attribute features to the object. For example, indexes are plausibly maintained across changes in the feature representations held in an object file.”

#### **Evidence 2: abstractness of feature representations.**

“Gordon and Irwin ([2000]) showed an OSPB for categories like FISH, even when the preview stimulus was the word ‘fish’ and the test stimulus was a picture of a fish. Results like this suggest that object files explicitly represent abstract features.”

#### **Evidence 3: separability of feature representations (independent forgetting).**

**Differentiation.** “Since icons are holistic and therefore lack separate symbols for separate features, an iconic representation of the low-level features of an object should not allow independent encoding of separate low-level features. A prediction of the mixed-features model, then, is that object files should not represent, say, the colour of an object without also representing its shape and orientation.”

**Experimental paradigm.** “There is strong evidence in favour of independent forgetting. Fournie and Alvarez ([2011]) used a continuous-report task in which

participants first viewed an array of five triangles of various colours and orientations (Figure 2). Then, in the test period, participants performed a colour response followed by an orientation response, or vice versa.”

**Results.** “Fougnie and Alvarez examined ‘guess trials’, in which the subject’s degree of error in indicating an object’s colour or orientation was more than three standard deviations away from the target value. The mixed-features model would predict that participants should either remember both features together or forget both features together. However, Fougnie and Alvarez found that colour guess trials and orientation guess trials were only weakly correlated. Specifically, subjects retained information about colour in more than 40% of orientation-guess trials, and retained information about orientation in more than 30% of colour-guess trials”

**Conclusions.** “These results show that participants often fail to store information about the orientation of an object in VSTM while storing information about its colour, and vice versa. Representations of low-level perceptible features must therefore be able to come apart and be stored separately, exactly as the mixed-features model denies.”

**Conclusion on format.** “The empirical evidence seems to indicate that object files do not represent in an iconic format. We think the evidence supports the hypothesis that object files represent in a propositional format.”

### **The structure of object files**

**Single-slot model.** “All the features of an object, regardless of category, are entered into a single memory store. On this proposal, the capacity limit on parallel feature storage— if there is one— applies to an object file as a whole.”

**Multiple-slot model.** “Features from different categories are entered into their own category-specific slots within a file. In addition to countenancing a limit on the number of object files that can be concurrently stored, this view allows that separate feature categories may have their own object-specific capacity limits.”

**Evidence.** “On balance, then, the evidence indicates that features from the same category compete with one another to a much greater degree than features from different categories, even when the features are integrated into the same object. This finding is hard to explain on the single-slot view, but is predicted by the multiple-slots view, since the latter holds that separate feature categories have separate slots within an object file.” (22)

### **Burge’s reply**

**Iconic perception is *a priori*:** “This train of reasoning seems to me a reductio of their conception of iconicity and their conception of how representation takes place in pictures and perception. The fact that various properties are iconically represented in a

package in perception does not begin to show that they cannot be remembered iconically to different degrees."

**Format monism:** "Green and Quilty-Dunn, 'What is an Object File?', make much of the supposed non-iconicity of memory index files. Anaphoric or, alternatively, tracking applications in memory—in index files—that derive from referential applications in perception may or may not have a 'symbol' that effects the reference. Such a symbol's occurring would not prevent perceptual memory from being iconic. Memory files always contain more than the referential index. They contain attributives. Perceptual attributives in memory that guide a perceptual memory file remain iconic. The file cannot represent without some, perhaps changeable, attributional guidance. Since iconic representations can have non-iconic, even symbolic elements, presence of a symbol in memory files would not prevent them from being iconic."

### **Pictorialism G+QD**

"The proponent of the mixed-features model may make a final retreat and claim that each individual feature is represented iconically. However, it is unclear how the colour of a triangle might be represented iconically without specifying its shape and orientation. Indeed, Kosslyn et al. ([2006], p. 11) stress that the contents of icons must be in some sense 'picturable', and there is no remotely intuitive sense in which one can picture the colour of a triangle separately from its spatial features"

### **Reframing the object file debate**

**Orders of representation.** Representations exhibit orders of complexity.

**First-order** representations are contentful but have no contentful constituents.

**Second-order** representations are contentful and have first-order constituents.

**Examples:**

**Words** are first-order representations. **Sentences** are second-order representations.

**Discourses** are third-order representations.

**Circles** (in an Euler diagram) are first-order representations. **Arrangements of circles** are second-order representations.

**Iconicity and symbolism at different orders.** A representation may be iconic at one order and symbolic at another.

**Example:** a seating chart is like a map, exhibiting second-order iconic structure; but its component parts are names, first-order symbols.

**Is perception iconic?** This question is too simplistic. Perception could be iconic at some orders of organization and symbolic at others, or it might mix iconic and symbolic elements. We should not assume (by conceptual necessity) that all

perceptual representations are iconic.

**Object files are not propositional.** GQD argue that object files are not iconic, and conclude that they are propositional. Yet object files lack a number of “propositional” features, including: arbitrary domains, recursively extensible structures, and logical operators.

**Object files are second-order symbolic.** Let’s replace the iconic/propositional divide with the iconic/symbolic divide. Object files are *symbolic*, and specifically, they are *second-order symbolic*. But not all second-order symbolism is recursive and propositional. (Compare: menu items!)

### **Semantics of object files**

What would be the semantic rules for object files?

$[[\langle \alpha, \theta_1, \theta_2, \theta_3 \rangle]]_c = \text{the state of affairs such that:}$

$\exists x: x = [[\alpha]];$

$\text{color}(x) = [[\theta_1]];$

$\text{shape}(x) = [[\theta_2]];$

$\text{orientation}(x) = [[\theta_3]];$

$\text{location}(x) = f(c).$

### **Notes:**

This is a second-order semantics.

The sequence and structure of the object file plays no role in explaining the determination of content— the structure does not appear in

The (crucial!) issue of location is not dealt with here.

**Diagnosis.** This looks like a case of second-order symbolism.

**Features representations: open question.** This leaves open the question of whether first-order feature representations are iconic. Not much of the evidence surveyed by GQD shed light on this question.

**Diagrammatic feature representations:** GQD assume that if features are represented iconically, they do so an ensemble, in the style of a picture. They overlook the possibility, that individual features are represented iconically, in the style of a diagram.

**Proposal:** My working hypothesis is a form of perceptual pluralism.

**X-order: global iconicity in the format of perception.** This is the overall spatial organization of the visual field— I’ll argue in the next few weeks that it is iconic. (See also Clarke.)

**X-1 order: local symbolism in the format object files.** Object files are assigned locations within the visual field, so occupy the X-1 order. Object files are second-order

**X-2 order: micro iconicity in feature representation.** Features are assigned to slots within object files, so occupy the X-2 order. These feature representations are typically iconic.