Introduction

Mental imagery, often informally described as "seeing in the mind's eye", "visualization", etc., is quasi-perceptual experience: it significantly resembles perceptual experience, but occurs in the absence of the appropriate perceptual stimuli.

Imagery is not only associated with fantasy and the imaginary, but also, and perhaps more importantly, with prototypically cognitive functions such as memory, perception,
and thought. Although imagery occurs in all sensory modes, most work in philosophy, psychology, and cognitive science has (perhaps regrettably) concentrated upon visual imagery.

1. Imagery before cognitive science

§1.1 The philosophical tradition
The classical Greek philosophers set the stage for subsequent discussions of imagery. Plato speaks (metaphorically) of an inner artist painting pictures in the soul (Philebus 39c), and suggests that memory might be analogous to a block of wax into which our perceptions and thoughts stamp impressions (Theatatus 191c,d). Aristotle endorses this wax impression model of memory, and describes this impression as a sort of picture (De Memoria 450a,b). He introduced the notion of a mental faculty of imagination, allied to perception, and responsible for producing and recalling imagery (De Anima III.iii). Aristotle was the first systematic cognitive theorist, and he gave imagery a central role in cognition. He asserts that "The soul never thinks without a mental image" (De Anima 431a 15-20), and maintains that the representational power of language is derived from imagery, spoken words being the symbols of the inner images (De Interpretatione 16a; De Anima 420b). In effect, for Aristotle, images play something very like the role played by the more generic notion of "mental representation" in modern cognitive science. This was almost universally accepted in the philosophical tradition, even by non-Aristoteleans, up until the 20th century. With certain qualifications and exceptions (most significantly the "clear and distinct ideas" of Descartes' epistemology), the "ideas" that played such a large role in philosophy and cognitive theory from the 17th through the 19th century are direct descendants of Aristotle's images. Hume, for example, explicitly identifies ideas as images (as does even Descartes in psychophysiological contexts).

§1.2 Early experimental psychology and "imageless thought"
Imagery played a large role in early experimental psychology (which, especially in Germany where it first flourished, was practiced as a branch of philosophy). Wilhelm Wundt, "the father of experimental psychology", founded the first psychological research and teaching laboratory in 1876, and imagery played essentially the same pivotal cognitive role in his theories (and those of most of his many students and imitators) that it had played for the philosophers of former ages.

However, from about 1901 Oswald Külpe and his students at the University of Würzburg directly challenged these assumptions. Experimental subjects in Würzburg were asked to provide introspective reports of the contents of their consciousness as they performed specified cognitive tasks. The introspectors (often Külpe himself, or other members of his research team) frequently claimed not to experience imagery, but rather "imageless thoughts", conscious contents without any sensory or perceptual quality. In response, Wundt sharply criticized the introspective methodology of the Würzburg experiments, whilst Titchener, Wundt's leading disciple in America, reported that in his laboratory,
similar introspective experiments always evoked imagery (not necessarily visual), producing no evidence whatsoever for conscious imageless thoughts. ("Thinking in words" is plausibly regarded as a form of auditory or vocal-kinaesthetic imagery (Paivio, 1971).)

The bitter and irresolvable controversy that arose led to a reaction by which introspective methods became thoroughly discredited amongst the majority of experimental psychologists, and the notion of mental imagery fell out of intellectual favour. J.B. Watson, who inaugurated the very influential Behaviorist movement in psychology, questioned the scientific reality of consciousness in general, and imagery in particular. Between about 1920 and 1960, imagery received minimal scientific attention. The question of the reality of conscious imageless thoughts was left unresolved, and it remains so today (Thomas, 1989; Heil, 1998; Mangan, 2001).

§1.3 Twentieth century philosophy
Amongst philosophers, few questioned the actual occurrence of quasi-perceptual experiences, and imagery continued occasionally to be discussed. However, few 20th century philosophers accorded it anything like the theoretically central position it once enjoyed. The analytical philosophy movement (that arose in the early 20th century, and that still deeply influences most English speaking philosophers) originated from the hope that philosophical problems could be definitively solved through the analysis of language, using the newly invented tools of formal logic. It thus treated language as the fundamental medium of thought, and several of the leading figures of the movement (notably Frege, Wittgenstein, and Schlick) argued strongly against the traditional view that linguistic meaning derives from images in the mind. (For a brief, though critical, summary of the main arguments see Thomas (1997a) and §3.2 below.) These arguments were widely accepted, and imagery was relegated to the sidelines of philosophy. It no longer seemed to have a vital functional role to play in the workings of the mind.

In his seminal The Concept of Mind (1949) analytical philosopher Gilbert Ryle set out to refute what he called "Descartes' Myth": the notion that the mind is somehow a special arena distinct from the physical world, populated by mental (non-physical) objects. Ryle thus vigorously attacked the notion of a mental image as a "picture in the mind", and suggested instead that what people call "imagining", "picturing in the mind's eye", and so forth, would be better understood as akin to pretending (to oneself) to see something. Ryle also questioned whether we really have a coherent, unitary concept of imagination, and it remains controversial whether imagery is really relevant to other notions traditionally associated with imagination, such as creativity (White, 1990; Brann, 1991; Thomas, 1997b, 1999).

Working in the rival phenomenological philosophical tradition, Jean-Paul Sartre (1948) also questioned the cognitive role of imagery and the notion of mental pictures. He argued that an image "teaches nothing", because any information it contains must have been put there by, and thus have already been in the mind of, the imaginer. Sartre stressed
the *intentionality* of imagery, the fact that an image is always an image *of* something (perhaps something nonexistent), but he insisted that an image is not a *thing* in the mind. Although neither Sartre nor Ryle seems to have intended to deny the reality of quasi-perceptual experience, this may not always have been clear to their audience, and their work surely contributed further to the decline of interest in imagery in both analytical and phenomenological traditions. After this, and before the rise of cognitive science, the rare philosopher who wanted to insist on the importance of imagery, perhaps even its very existence, was noticeably on the defensive (Price, 1953; Hannay, 1971; Casey, 1976).

### 2. Imagery in cognitive science

**§2.1 The imagery revival**

A revival of research on imagery was an important element of the cognitive revolution of the 1960s and 70s, contributing greatly to the rising scientific interest in mental representations. Seemingly, this revival initially stemmed largely from applied psychology research on sensory deprivation and on hallucinogenic drugs (Holt, 1964). Another important catalyst was Yates' (1966) seminal historical work on the significance of imagery *mnemonics* in Ancient through Renaissance thought. Once the powerful mnemonic properties of imagery were experimentally confirmed (Paivio, 1971), imagery could no longer be dismissed by psychologists. Interest was only heightened, during the 1970s, by the stunning "mental rotation" experiments of Shepard and his students (Shepard and Cooper, 1982), and experiments by Kosslyn (1980) demonstrating "mental scanning" and related effects. This work was taken to show that imagery is involved in visuo-spatial reasoning, and has inherently spatial properties.

**§2.2 The "analog-propositional" debate**

But how could these findings on imagery be reconciled with the functionalist, computational symbol manipulation approach to cognition that was emerging during the same period? The standard philosophical interpretation of this approach depicts cognition as the computational manipulation of representations expressed in "mentalese" (the "Language of Thought") a hypothetical, essentially language-like, representational system supposedly built into the brain (Fodor, 1975). Two rival approaches arose toward integrating the empirical findings about imagery into computational cognitive science.

Pylyshyn, in a series of influential papers (e.g. 1973, 1981), argued (in effect) that all the genuine phenomena associated with imagery (indeed, *all* truly mental phenomena) can and must be explained entirely in terms of mentalese representations. For Pylyshyn and his allies, the computational paradigm of cognitive science demands that the underlying representational reality of imagery (and of actual perceptual experience) is not picture-like, but rather a detailed mentalese *description* of a scene.

Other cognitive scientists, however, notably Shepard and Kosslyn, argued that the evidence implies that imagery must be a distinct, non-language-like form of
representation. Kosslyn, in particular, developed a "quasi-pictorial" computational theory of visual imagery, based on an analogy with computer graphics (Kosslyn, 1980). Computer graphics files store information in a compressed, non-pictorial form, but when they are displayed they are translated into a mathematical map (bitmap) of the computer monitor screen, that specifies the color at each pixel (tiny dot) on the screen itself. Likewise, suggests Kosslyn, visual information may be stored in the brain as compact descriptions, but we experience an image only when this information is used to create a two dimensional map of visual space in a special, functionally defined memory area he calls the "visual buffer". The picture in Kosslyn's theory is merely "quasi", because there is no equivalent to the monitor screen to display it. What we experience as imagery, and what is available to the cognitive processes that use imagery, is the functional picture, the mathematical map, in the visual buffer. In later work, Kosslyn (1994) identifies this "visual buffer" with the several retinotopically mapped visual areas of the brain.

"Description" and "quasi-pictorial" theorists disagreed sharply over what sorts of computational symbols, or data structures, are acceptable within cognitive theory, and which best capture the empirical properties of imagery. During the 1970s, in particular, this led to a lively and high-profile controversy, commonly, if somewhat misleadingly, known as the "analog-propositional" debate. ("Picture-description" debate would have been better. "Proposition" is jargon borrowed from philosophy, where it signifies the underlying meaning of a sentence, not, as is intended here, a descriptive "sentence" of mentalese. Furthermore, the force of "analog" in this context is hardly clear: Kosslyn, after all, models his quasi-pictures on digitized bitmaps.)

Although the leading combatants in this dispute were psychologists, and experimental evidence was frequently cited, many of the issues raised were conceptual or meta-theoretical in nature - Anderson (1978) questioned whether it was even possible to resolve the debate experimentally - and philosophers soon became involved. The very concept of mental representation seemed to be at stake. Many of the most influential articles from the heyday of this debate, by both psychologists and philosophers, are collected in two volumes edited by Block (1981a, 1981b). Description theory still finds philosophical defenders (e.g. Slezak, 1995), but Tye (1991; see also Rollins, 1989) has undermined much of its appeal with a persuasive defense of the conceptual legitimacy of quasi-pictorial arrays as a distinct form of computational representation. Furthermore, many descriptionist explanations of empirical findings seem worryingly ad hoc (Kosslyn and Pomerantz, 1977).

However, Kosslyn's (1994) declaration of victory in "the imagery debate" may be premature, even though he has certainly developed the venerable picture theory to an unprecedented level of empirical and conceptual sophistication. His (1994) recasting of quasi-pictorialism in neurological terms does little to resolve the significant problems it still faces. Pylyshyn (2002) has now launched a major counter-attack, not only restating his empirically and conceptually based objections to quasi-pictorialism, but arguing forcefully that (despite many claims and some superficial appearances to the contrary)
there is no firm evidence whatsoever to support it. Even the (much disputed) results suggesting that visual imagery experience is correlated with activity in retinotopically mapped visual cortex (e.g. Kosslyn et al, 1995) are quite consistent with non-pictorial theories (Pylyshyn, 2002; Thomas, 1999). Furthermore, quasi-pictorial theory does not parsimoniously account for a range of experimental results showing that people have difficulty, in many circumstances, in finding new representational meanings in their imagery, meanings that are relatively easily found in an actual picture (Slezak, 1995; Thomas, 1999). Also, it is unequipped to explain the fact that the experimental effects that it most directly addresses (mental rotation, mental scanning, mnemonic effects, etc.) have since been demonstrated to occur in congenitally blind as well as in sighted subjects. The blind experimental subjects apparently employ haptic (touch) imagery, but any haptic analogue of a quasi-picture would be quite unsuitable to play an equivalent explanatory role (Thomas, 1999). In addition to these empirical shortcomings, quasi-pictorialism fails to address two cardinal characteristics of imagery: its intentionality and its consciousness (see §3.2 and §3.3 below).

§2.3 Beyond pictures and propositions?
Outside the theoretical context of symbolic computationalism, in which the "analog-propositional debate" first arose, other accounts of imagery, neither pictorial nor descriptional, may become conceivable. Despite a handful of connectionist simulations of versions of quasi-pictorialism, the connectionist movement has had surprisingly little impact on imagery theory. However, more recent alternative approaches to cognition, such as "dynamical systems theory", and "situated" or "embodied" cognition, call into question the basic assumption that mental contents are to be identified with computational representations (in the sense of data structures, embodied as brain states and manipulated in the cerebral computer). Related work on both robotic and human vision (and perception in general) is converging on the idea that perception is not best understood as the processing of sensory input into a detailed inner representation - a description or depiction, of the scene before us - but rather as ongoing, directed exploratory activity (e.g. Landy et al, 1996; O'Regan and Noë, 2001). On this view, as our brains direct all the most minute details of our ongoing behavior (including the exploratory perceptual activity itself) they require a constant stream of answers to specific questions about the detailed disposition of the environment, and, instead of seeking this information in a pre-established inner representation, they deploy the sense organs, like measuring instruments, in order to obtain the answers from the environment as and when needed. In order to explain how brains coordinate this activity, we may well need to invoke data structures in the brain. However, they would not encode descriptions or depictions of the environment, but, rather, the procedures that most appropriately direct its exploration. O'Regan and Noë (2001) suggest that perceptual experience is not the experience of having a representation (a percept) in the brain, but, rather, of being engaged in ongoing perceptual exploration. In similar vein, Thomas (1999) proposes that imagery experience (and the empirical data on imagery) is best explained as arising from a sort of abortive, and largely covert, perceptual activity: a truncated "going-through-the-motions" of exploring objects or situations that are not actually there to be explored,
under the control of an appropriate procedural representation.

Meanwhile, certain philosophers broadly sympathetic to this view of imagery, and with doubts about the "standard" computational-functionalist view of the mind, have begun to revive the traditional conception of imagery as the vehicle of conscious thought, and the fundamental bearer of mental content, or intentionality (Heil, 1998, chapter 6; Ellis, 1995; Thomas, 1997a). Other recently elaborated approaches to cognition are built around closely related conceptions such as "image-schemata" (Lakoff and Johnson, 1999) and "perceptual symbols" (Barsalou, 1999).

3. Key philosophical issues

§3.1 Meanings of "imagery"
Few discussions of imagery draw a clear distinction between the claim that people have quasi-visual experiences and the claim that such experiences are caused by the presence of picture-like objects in the mind. In practice, in the literature, "mental imagery" (or "mental images") can mean any or all of at least three things:

[1] Quasi-perceptual conscious experience per se;

[2] Picture-like representations in the mind and/or brain that may be experienced as [1];

[3] Any inner representations whatsoever that may be experienced as [1].

Picture theory is so entrenched in our language and our "folk psychology" that it is only too easy to assume that when people say "imagery" they mean [2]. Far too many confident arguments about what imagery can or cannot do depend on an (often unacknowledged) assumption of pictorialism (Thomas, 1989, 1997a, 1997b).

Block (1981a-Introduction) argues that some confusions could be avoided, without prejudging the "analog-propositional" issue, if we agreed to define "imagery" as [3]. However, one can perfectly consistently maintain the reality, and perhaps even the cognitive importance, of imagery in sense [1] whilst denying the existence not only of [2] (with description theorists like Pylyshyn or Slezak), but even of [2] and [3] (with Ryle, Sartre, or Thomas: see §1.3 and §2.3 above). Defining "imagery" as [1] (as we did initially) seems to beg the fewest questions.

§3.2 Imagery, intentionality, and mental representation
Nearly all philosophers accept that imagery has intentionality: the characteristically mental property of being of, about, or directed at some object (real or imaginary). In this regard, mental imagery proper may be distinguished from superficially similar but non-intentional phenomena such as afterimages and phosphenes. This philosophical concept of intentionality is only distantly related to the notion of doing an action intentionally (i.e.
on purpose), but it is very closely related to the notion of meaningful representation. To say that an image is *of* a lion is to say that it *represents* a lion. But how is it possible for anything to have this property of intentionality, this power of being able to represent things? This is perhaps the most fundamental problem in the philosophy of cognition, and the answer we give to it will profoundly affect what sorts of cognitive theories we think are workable.

Most philosophers before the 20th century held that mental images formed the basis of the mind’s power to represent things, and probably assumed that images represent their objects because they *resemble* them: an image of a lion, like a photograph of one, *looks like* a lion. However, consider two photographs of Leo. Each photo resembles the other more than either resemble the lion (both photos are small, rectangular pieces of card, similarly marked, and neither is carnivorous or furry), yet we would normally want to say that they represent Leo, and *not* that they represent each other. Of course, a photograph of Leo does resemble him, when the right aspects of resemblance are considered, but in this regard Leo equally resembles the photograph. We are unlikely, however, to want to say that he represents *it*. In order for resemblance to play a role in representation, the relevant aspects of resemblance have to be recognized, and the resembling object has to be *used* (or, at least, *taken*) as a representation. But surely, before a cognitive system can recognize or use the relevant aspects of resemblance between a photograph (or an inner *quasi-picture*) and an object (or a percept), it must already be able to represent the picture and its object, and their various features, to itself. The mind’s power to recognize resemblance seemingly depends on its power to represent things, rather than vice-versa.

From related arguments, Fodor (1975) concludes (with the analytical philosophy mainstream) that mental images do not possess their intentionality intrinsically. Rather, they derive it from that of another, supposedly more fundamental, form of representation. For Fodor, an image (a *quasi-picture*, he assumes) of a lion represents a lion not because it resembles a lion, but, in effect, because our minds attach a mentalese caption to it saying "LION". It is not that the resemblance is not real, or cognitively useful, but that (contrary to traditional views) mentalese, not imagery, is the fundamental form of representation and the source of intentionality. This line is apparently accepted by Tye (1991) in his philosophical exegesis and defense of quasi-pictorialism. Of course, those like Pylyshyn, who hold that imagery *consists of* mentalese, also ground the intentionality of imagery in that of mentalese.

It is worth noting, however, that, despite strenuous philosophical efforts over the last quarter century, no generally acceptable theory of the source of the representational power of mentalese is forthcoming, and, indeed, none may be possible (Horst, 1996; Cummins, 1997). We might do without the rather extravagant hypothesis of mentalese if the intentionality of imagery could be derived from that of ordinary spoken language (Kaufmann, 1980). However, this would seemingly require an account of the intentionality of ordinary language that avoids reliance upon any appeal to the intentionality of the mental. The prospects for that seem poor. It would also apparently
imply that animals and babies have no intentionality: that, in effect, they have no minds.

But just because the resemblance theory of representation fails, it does not necessarily follow that the intentionality of imagery is not intrinsic. After all, resemblance theory was only ever intended to apply to pictorial theories of imagery. If imagery is conceived of as a form of directed perceptual activity (see §2.3), rather than as an inner representation, perhaps its intentionality might be understood as rooted in the inherent goal directedness of action. Such an approach still awaits detailed articulation, however, and would presumably require an account of the intentionality of action that did not root that in the intentionality of representations.

§3.3 Imagery and consciousness
According to most cognitive scientists, mental images are mental representations (pictorial or otherwise) that have their existence as brain states. How could we be conscious of such things (as we clearly can be conscious of imagery)? It seems unlikely to be in virtue of any intrinsic characteristic of the relevant brain state, for brain states are nothing but patterns of excitation of neurons, and excitation of neurons is nothing more than electro-chemistry: the movements of certain molecules and ions, polarization and depolarization of membranes, and so on; quite ordinary physical processes that go on outside of brains, and even, quite frequently, within brains, without producing consciousness.

Perhaps, then, such representations are not conscious because of any properties they have intrinsically, but, rather, we are conscious of them inasmuch as our minds access and extract information from them. This is a quite traditional idea embodied in the idiom of "the mind's eye", and it found its clearest philosophical expression in Descartes' (1664) account of imagery, wherein the image is presented as a small physical picture formed deep within the brain (at the pineal gland), from where the immaterial conscious soul is able to apprehend it directly. Nearly all cognitive scientists (and contemporary philosophers) firmly reject such explanatory invocations of the supernatural. Nevertheless, Kosslyn, the leading contemporary quasi-pictorialist (§2.2), sometimes writes of a "functional mind's eye" inspecting and interpreting his quasi-pictures. If this is nothing supernatural, however, but just more brain activity, more electro-chemistry, (as Kosslyn clearly holds) then it is not at all clear that it helps us to understand how we could be conscious of a quasi-picture (or, come to that, a mentalese description) in our brain. (Indeed, Kosslyn does not claim that it does.)

Some philosophers do hold that consciousness of mental states arises from their being themselves represented within the brain by "higher order thoughts," and a "mind's eye" account of image consciousness would presumably fit this mold. However, the higher order thought theory has not gained widespread acceptance for a number of reasons (Lycan, 2000). It probably captures not so much the distinction between conscious and non-conscious states as that between those experiences that flit through consciousness unremarked, and those that are remarked, and perhaps thereby become remembered
and/or reportable. Furthermore, it relies on the availability of a suitable account of the intentionality of the states in question, which may not be forthcoming (§3.2).

It might be objected that, this is all just a special case of the notorious, unsolved "hard problem" of consciousness: We just do not know how to explain conscious experience scientifically, so why should it especially concern us that we cannot explain it in the context of imagery? But although we can perhaps legitimately pass over the "hard problem" in some areas of cognitive theory, we cannot, in good faith, ignore it here. It is of the very nature of imagery to be conscious (or, at the very least, potentially conscious), and, very arguably (Külpe notwithstanding), all conscious experiences are imagistic, either perceptual or quasi-perceptual. The apparent intractability of the "hard problem" just may owe something to entrenched misconceptions about the nature of imagery.

Glossary

analog-propositional debate  
at its height during the 1970s, but still unresolved today, this was essentially a dispute over what sorts of computational data structures, quasi-pictorial arrays or "propositional" descriptions, might be able to model the experimental and experiential characteristics of imagery.

description theory  
also (misleadingly) known as "propositional" theory, the view that imagery consists of descriptions encoded in a language-like computational representational format.

intentionality  
the property, possessed by many (perhaps all) mental states, of being about, of, or directed at something (the something in question need not necessarily exist). Physical things used by people as vehicles of communication, such as pictures and written or spoken words, are also often said to bear intentionality, but this is usually understood to be derivative, dependent upon the mental intentionality of the users.

mnemonic  
a mental technique used to improve memorization of otherwise hard to remember material. Many of the most effective and most widely used mnemonics involve imagery.

perceptual activity theory  
the view that the experience of imagery arises from the covert enactment of exploratory perceptual actions of the specific type that would occur during actual perceptual exploration and identification of the things being imagined. On this view, images are not appropriately modeled by computational data structures.
phosphene
a visual sensation caused by non-optical stimulation of the retina or optic nerve (e.g. the mechanical stimulation of rubbing the eyes).

quasi-pictorial theory
the view that visual mental images are appropriately modeled, computationally, as two-dimensional data arrays functionally equivalent to pictures.

retinotopically mapped
refers to the way in which several visual processing areas of the brain, most notably the primary visual cortex (V1), are structured as (rather distorted and low resolution) maps of the light sensitive retina upon which light is focused at the back of the eye. Adjacent regions of the visual cortex correspond to adjacent areas on the retina such that, during vision, the two-dimensional spatial pattern of excitation of the cortical neurons corresponds topologically to the pattern of illumination falling on the retina.

References


Horst SW (1996) *Symbols, Computation and Intentionality: A Critique of the Computational Theory of Mind*. Berkeley, CA: University of California Press. This work is not cited in the published encyclopedia entry. Unfortunately, I was unaware of Horst's work until after the encyclopedia went to press. I have added the citation here because I think that Horst demonstrates, very convincingly and with much more depth and thoroughness than does Cummins (1997), why the intentional contents of the mind cannot simply be data structural representations in the brain. (That is not to say that such data structures do not exist.) The citation to Cummins (1997) is retained, because Cummins provides a particularly clear and succinct refutation of the popular causal theory of intentional content, and of the associated mentalis hypothesis. Cummins has greatly influenced my (and, apparently, Horst's) thinking about these issues. - N.J.T.T.


In reality (journals frequently being well behind with their publication schedule) this appeared in print after the publication of the Encyclopedia of Cognitive Science, so it was cited as "in press" in the version published in the encyclopedia. Pylyshyn's reply to the BBS commentators is also well worth reading (as are many of the commentaries). My own commentary on Pylyshyn's target article is also available.


Further Reading


Please post comments & new link suggestions to the discussion board:
(I may post a reply and/or send back email, as appropriate.)

or you can email me.

Return to Home Page:
*Imagination, Mental Imagery, Consciousness, Cognition: Science, Philosophy & History.*

Last revised: April 24, 2003.