Pre-print of:

*Visual Arts Research*, (University of Illinois) 28:1 (55), 2002, pp.38-52.

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# An Explanation for Normal and Anomalous Drawing Ability and Some Implications for Research on Perception and Imagery

**Abstract:** The aim of this paper is to draw the attention of those conducting research on imagery to the different kinds of visual information deployed by expert drawers compared to non-expert drawers. To demonstrate this difference I draw upon the cognitive science literature on vision and imagery to distinguish between three different ways that visual phenomena can be represented in memory: structural descriptions, denotative descriptions, and configural descriptions. Research suggests that perception and imagery deploy the same mental processes and that the drawing of one's imagery would require the simultaneous deployment of these very processes. I reason that drawing a picture of one's imagery is not possible. I hypothesize that when required to draw a picture from memory, both expert and non-expert drawers access their denotative description of the object (stored in memory) rather than their imagery (structural description stored in memory). I then suggest how my hypothesis could be tested and if accurate, how this finding would impact upon the design and interpretation of experiments on imagery when drawing is involved. I also suggest why the constraints that perception places upon the simultaneous deployment of imagery appear not to cause the same constraints in autistic savant drawers and visual agnosia patients.

# An Explanation for Normal and Anomalous Drawing Ability and Some Implications for Perception and Imagery

## The relevance of drawing abilities to cognitive science.

Visual perception is a complex process. This fact is not obvious to anyone except perhaps the vision scientist. After all, we look around and see objects in a way that suggests that perception is effortless. According to vision theorists, however, a lot needs to go on in our visual brains in order for this to happen. It might seem effortless, but this is because what goes on in the visual brain is automatic, mandatory and non-conscious. Consider that the only information that hits the retina is variations in light intensity. Somehow the visual system constructs a description of an object which the cognitive system can recognize and label and to which it can attach meanings and connotations.

Various kinds of drawing ability can be studied in order to augment understanding of the various ways that humans can mentally represent knowledge about the world. This is how many cognitive scientists, including those cited in this paper, approach the study of drawing.[1] The human perceptual apparatus does not present infinite possibilities though. According to the evidence from cognitive science, perception of the world is constrained by various perceptual processes. However, the fact that artists have been able to create such a variety of ways of representing objects in the world attests to the plasticity of the perceptual system. The perceptual system is constrained in that it is made up of a number of modules, each of which is designed for a particular task. The system's plasticity can be explained by the many ways that perceptual modules can be selected, combined and exploited in the course of perceiving an object. Artists can contrive to create visual displays, which deploy unusual combinations of such modules in the perceiver. [2]

Drawing lends itself most readily to the study of perception because it is taken to be the art medium the use of which is least dependent on artistic conventions; or at least, can be. According to Julian Hochberg, writing in 1972, "the efficacy of line drawings can tell us something about the ways in which we perceive and encode the world itself, not only about the art of pictorial representation" (pp.71-2). David Marr was to take the same approach to drawing in his groundbreaking *Vision* (1982). Marr reasoned that the ease with which we recognize objects denoted by both stick figures and outlines, in spite of the paucity of information they provide, suggests that they represent a stimulus by which the visual system normally encodes the visual image.[3] The groups of people whose drawing under certain conditions have been studied by cognitive scientists include not only the groups discussed in this paper, but also patients with damage to other quite specific parts of the brain due to stroke, other calamity or illness.

The concern motivating this paper, is that while cognitive scientists study various drawing abilities in order to find out about how perception works, they may be erroneously assuming that drawing in each of the three kinds of cases examined here, deploys the same mental processes. This assumption is also seen in explanations for expert drawing according to which expert drawers have better eye-hand co-ordination or have more practice, children's drawings being taken as inept attempts at realism. On the contrary, the evidence I present (from art educators, developmental psychologists and cognitive scientists) suggests that expert drawers deploy different visual information than non-expert drawers. If I am right, this aspect of expert drawing procedure has implications for the design and implementation of research on imagery.

**Three kinds of visual information.**

In the following discussion I will introduce five key terms which together make up the parameters of my explanatory framework. These are "imagery", "structural description"[4], "denotative description", "configural description" and "schematic drawing". These terms are taken from the cognitive science literature on perception and imagery; and are based on the generally accepted representational model of vision, which began with the computational theory of vision developed by David Marr (1982); and whose developments since then are very nicely summarized by Martha Farah (2000). The awkwardness of the terms I use is a reflection of the difficulty of matching the kinds of information that the visual system processes with language, given that we are normally only conscious of the visual phenomena as objects in the world. However, before object recognition can take place, a number of processes need to operate. I adopt the framework of vision developed by computational vision research, focussing on those aspects relevant to an explanation of drawing ability. While I do not assume anything that is incompatible with the literature I cite, my contribution is that in applying the available evidence on vision to the explanation of drawing ability, I highlight aspects of drawing ability overlooked by those who use drawing for their imagery research.

In this paper I will only be concerned with three kinds of information which are involved in visual processing; only one of which involves conscious semantic information (the denotative description). These three kinds of information are relevant to the explanation of drawing ability. The initial mental visual construction, the one upon which all higher level processes involved in visual recognition depend, I will refer to as the structural description. When we focus on just the visual information of an object such as the lines, shapes, forms etc, we are accessing this mental description; the visual system's structural description of the object.[5]

Recognition of the object requires an additional kind of process. To recognize the object, the structural description needs to be brought under a tighter, more streamlined description. Only those features of the structural description, which are needed to recognize the object as one of a class of objects, would be needed here. That is, for example, if the class was of tables, then those features, which allow us to recognize all the different varieties of table as a part of the one class of tables, would be salient. This kind of mental description has been called the denotative description because it denotes a member of a class. The kind of information involved in the denotative description is semantic information: that is, literal or discursive information.[6] The denotative description of an object is based on our concept of the object, which in turn is determined by the function, or role of the object in our use of, or interaction with, it.

When we see, then, we are experiencing the world through a highly sophisticated visual construction. The construction of the structural description is automatic, non-conscious and mandatory. That is, the assumptions and so on that the system applies in order to achieve this process are hard-wired, although they require the right environmental triggers at the right stage of development in order to develop normally (otherwise they would atrophy). The content of the semantic information (the denotative description), on the other hand, is learnt.[7]

We can store both kinds of information in memory. The memory of the structural description constitutes what is referred to in the cognitive science literature as "imagery". This is an important point as I will be skipping between "imagery" as opposed to the denotative description in memory throughout my discussion. "Imagery" is, by stipulation, the memorized structural description of objects (Peterson, Kihlstrom et al, 1992). If you conjure up a mental image of Notre Dame or your best friend or whatever, you are deploying imagery. The process of accessing imagery involves three steps. We must retrieve it from memory. We then need to store it in something like a visual buffer while we scan and inspect it (Farah, 1984). Once we have retrieved an image we need to be continually refreshing it as it quickly fades (Kosslyn et al., 1983).

The third kind of visual information that the brain can process about an object is the configural mental description. A configural description is a mental apprehension of the spatial relations between objects or parts of an object. Configural descriptions carry information about spatial interrelations between the component parts of an image. Perhaps one could think of it as the perception of a pattern. In order to see a pattern, one does not focus on the elements themselves. Instead, it is as if one apprehends a rule that governs the relations experienced between the elements.[8] The psychological reality of this experience is supported by neural studies (Kosslyn and Rabin, 1999). That is, there is a pattern of neural firings that correspond to the perception of global visual relationships. According to Kosslyn and Rabin (1999) there are two visual systems, the ventral and the dorsal. The ventral stores shape descriptions while the dorsal stores configural, spatial information. The experience of configural properties is more abstract than simply conjuring up an image of an object; and is more closely associated with our notions of aesthetic form or unity. However, in the cognitive psychology literature on 'imagery' that draws upon studies involving subjects in drawing their imagery, it is commonplace for the structural description and the configural description to be conflated. [9] In this paper, I do not discuss the role of the configural description in drawing, except in passing, such as when I refer to the expert drawer's initial stage in the drawing procedure. However, it is important in imagery research to make this distinction because, for example, the information needed for discerning top-bottom orientation would seem to be configural rather than structural; whereas in the literature, this configural description is referred to as imagery.[10] Important to my hypothesis is not that perception cannot operate simultaneously with access to memories of configurations (which as far as I know is not the case). One should be able to draw from one's memory of configural descriptions. Drawing one's memory of global patterns of an object or scene does not deploy the same processes as attempting to draw a picture of one's imagery. Imagery, as it is a memory of the structural description, includes information about surface properties and small details. The claim I will be defending is that perception cannot operate simultaneously with access to imagery. Consequently, conflating the configural with the structural description may undermine the usefulness of research on imagery.

The important point about these three ways of representing visual information in memory is that they are based on the neurological structure of the brain. That is, there are distinct pathways which, through various brain imaging techniques and clinical studies, have been shown to underpin processes akin to the structural, semantic and configural encoding of information (Farah, 2000). These three distinct pathways do not just represent the same information differently. Instead, they pick up different kinds of information about the one object. This feature of the interaction between perceptual mechanisms and the object perceived gives rise to what is referred to in the philosophical literature as the various aspects of an object.

How does this distinction between structural, denotative and configural descriptions help us think about and understand various drawing abilities? If there is evidence to support the idea that these three mental descriptions of any one object or scene can operate as distinct systems, then we have a basis for explaining expert and non-expert drawing ability.

Martha Farah's research (1984, 2000) on the neurological basis of mental imagery suggests that long term visual memory and imagery retrieval are part of an imagery system which is distinct from other memory and reasoning processes (1984, 2000). This suggests that skills or deficiencies concerning imagery (retrieval of structural description of object from memory) could occur independently of the ability to recognize or name an object.

Further research by Farah suggests that imagery shares certain processes with perception, and these research findings are also borne out by the clinical and scanning research conducted by others (Chambers and Reisberg 1985; Pinker and Finke 1980; Posner and Raichle 1994). This would suggest that both imagery retrieval and inspection would inhibit the simultaneous perception of objects and vice versa because both deploy the same operations and hence both processes can't operate at the same time. Stephen Kosslyn and Carolyn Rabin (1999) have found just that. Furthermore, they have found that perceiving an object takes precedence over the inspection of imagery. This means that one needs to disengage one’s attention from the perceived object, if one is to inspect one’s imagery of the object. If one tries to do both at once, which drawing from memory onto a surface would require because one needs to observe the lines one draws, perception will always dominate. It would follow that one cannot draw one's imagery. When one attempts to draw from memory, one must be drawing upon a mental description of the object other than the structural description; unless one can draw without looking at the paper/surface. In sum, the evidence from the cognitive scientists mentioned above supports the idea that when one attempts to draw imagery (structural descriptions retrieved from memory), one’s attention to the shape or lines as they emerge on the page would deploy perceptual processes and these would dominate at the expense of imagery inspection [11.]

The terms "expert" and "non-expert" drawers is derived from the cognitive psychological literature on drawing (Verstijnen, Van Leeuwen, Goldschmidt, Hamel & Hennessey.1998 & 2000). The context in which this distinction is used is to differentiate between those people who can draw realistically from life and can do so by conscious choice; and all the rest (novice sketchers who are referred to as non-expert drawers). Art educators generally recognize that expert drawers attend to perceived objects in terms of lines, shapes, textures and their relative positions, proportions, and tones when they draw realistically. The underlying explanation for this strategy, I would suggest, is that expert drawers access and draw their structural description of objects, a description automatically processed in the course of perception but one that most people have no cause to consciously access. The explanation for non-expert drawers, on the other hand, would be that they draw their denotative description of the object, whether the object is within their sight range or not. For example, if they draw a table, they will be inclined to represent the table as a parallelogram with four legs of equal length protruding from one side. This is a representation of the fact that a table needs to be flat and horizontal in order to support objects. To achieve the latter, its legs need to be of equal length. This is the kind of information about tables that we use to recognize a table. It is the denotative description of a table.

So far my claims regarding the processes deployed by the expert and non-expert drawer are ones which, while they should be brought to the notice of imagery researchers, are ones that have been made a number of times elsewhere. The further claim I wish to make and defend in this paper will emerge from a comparison between three categories of drawing: (1) realistic drawing by the mature artist; (2) schematic drawing by children and by adults untrained in drawing; (3) realistic drawing by autistic savants and by patients with left parietal brain damage.

The comparison between the procedures deployed by the three groups of drawers suggests that those with normal brain functioning are unable to inspect [mental] imagery while actively perceiving their drawing as it emerges on the page. In order to draw a remembered image, they need to access their denotative description instead. Hence, when drawing from memory, the story for expert drawers reverts to one similar for non-expert drawers. On the other hand, those in our third group seem not to exhibit this interference from perception when inspecting their imagery in the process of drawing. It is as if they do not focus on what emerges on the page (while they draw) but rather give full attention to their imagery.

**Perception, imagery and the expert drawer**

Now having set up the framework within which this discussion will unfold, I will begin to examine the procedures and strategies deployed by the expert drawer compared to those apparent strategies deployed by the other groups within my study. We will find that by applying this understanding of vision and imagery (which emerges from the research I have cited) to expert and non-expert drawing abilities, not only do we notice aspects of drawing ability which have gone unnoticed previously, but we also notice some problems in the way that drawing is used in imagery research.

Consider that to translate three dimensions onto a two-dimensional surface, the expert drawer usually begins the process by first grasping the overall shapes and their relative positions within the scene (the configural description). She does this by closely observing the scene in front of her and drawing directly from this. If she wants a very faithful rendition of the scene, she will not draw from memory. She will focus her attention on the lines, textures, shapes and forms that she can see. Drawing from memory usually results in a more schematic interpretation.

For a realistic result in drawing, the general configuration of the perceived scene or object is set down first. In order to establish the main shapes and their relative positions, the main axes of the shapes and their overall volumes in relation to other objects in the field will be gradually built up. The expert drawer focuses on the parts of these axes, capturing the deviations from their major orientations. The "axes" refer to the imaginary central line of any shape or form, which is drawn first in order to provide the skeletal frame upon which one can then build up the figure, keeping the proportions in check. That is, around these axes, cylinder-like forms are constructed. Then the expert drawer can shift her focus to capture the surface details. She usually intermittently checks the emerging pictorial image by matching what she has drawn with her concept of the objects involved (her denotative description of the objects). When she does this, she is aware of a change in her focus. At such times the expert drawer may decide to modify some aspects of the drawing to accentuate some of the object's characteristics in line with this concept. For example, when drawing a portrait, she may decide to accentuate the contrast between the darks and lights of the eye of a person she is painting in order to create the effect of a more piercing stare; or she might decide to soften the outlines of the face to create a more gentle overall effect. Her decisions will depend upon the personality traits of her sitter, which she wishes to emphasize. Such changes might augment the artist's interpretation of her sitter, even though in her purely visual study of the person, these characteristics were not obvious. For many years I was a portraitist, both as a symbolist/expressionist painter and as a more conservative painter of commissioned works. I was always intrigued to find that portraits, which included more of my interpretative inclusions, provoked the strongest positive response of recognition from the sitter's friends and relatives; (my interpretative touches were not self-indulgent flourishes, but genuine attempts to draw out something unique about the sitter). The point here being that while the focus on line, form, shape and texture on its own is possible and necessary for the portrait painter, the recognition of the resulting object draws upon other kinds of information such as the denotative information with all its attached connotations.[12]

When expert drawers draw from memory, however, their drawings take on a more stereotypical and schematic look than their drawings from life. This supports the hypothesis that expert drawers cannot draw from a memory of their structural description of the object (imagery). I am suggesting that when expert drawers draw from their visual memory of an object, they access the denotative description of the object and translate this into visual form. This restricts the drawer to those features of the object for which she has concepts. On the other hand, drawing from life allows the perceptive drawer to capture nuances, which are normally unavailable in one's denotative description of it. If one knows in advance that one will want to draw an image of an object from one's memory of it, one can consciously translate more of the visual components of the object into a denotative description while perceiving the object. This will at least make the drawing from memory more detailed.

Lorna Selfe (1995: p.228) approvingly quotes from Freeman (1980) regarding the skills required in order to draw in perspective. According to Freeman, the expert drawer learns to draw in perspective in a systematic way. What she learns involves the kind of semantic knowledge, which we have referred to as encoded in a denotative description. I beg to differ on this point. The kind of learning referred to by Freeman is necessary for those who need to translate three-dimensional designs in the head into drawing on a two-dimensional surface. They need this semantic knowledge about perspective because they can't draw their imagery directly; they can only draw their imagery via their denotative description of it. However, for those who draw from life, such knowledge can be a hindrance rather than a help. One needs to suspend such semantic knowledge in order to draw from life. All one needs in order to draw in perspective from life, is the ability to focus on one's structural description: in the words of the drawing teacher, one needs to focus on what is in front of one's eyes. The systems developed by Renaissance designers were an articulation of the kind of drawings that were emerging from artists who were learning to suspend the kind of thinking (a focus on one's denotative description) which inhibits drawing from life. These drawing systems were of use to architects who need to be able to draw designs that they conjure up in their heads; without being limited to copying various combinations of sketches they have made from life.

**Denotative descriptions and schematic drawing**

If you were to draw a picture applying what you knew about perspective to a cityscape, you would likely achieve a very schematized version of perspective. The things in our world rarely line up side by side with their sides parallel to each other as is implied by the way academic painters (in the manner referred to by Freeman) apply perspective. For those with no such learned systems at their disposal, the functional aspects of the object dominates in their drawing of it. As described earlier, the denotative description of an object is based on our concept of the object, which in turn is determined by its function or role. The example I gave earlier of a drawing of such a description was of a table as a parallelogram with four parallel vertical oblongs of equal length. This is in fact how children will normally draw a table 'from life' and from memory, as will adult non-expert drawers with perhaps some concessions made by the latter to what they know about perspective. The more the denotative aspects of an object intervene in one's attention when drawing an object, the more schematized and stereotypical the pictorial image will appear.

Children, under the age of eight or nine, typically draw a schematized interpretation of the object. That is, they draw the aspects of the object that are salient in their conceptual understanding of the object. To use the language of the drawing teacher, schematized drawing exhibits what the drawer knows about the object, not what she sees. In the psychological literature on drawing, this is often referred to as intellectual realism as opposed to visual realism.

Elementary school teachers find that prompting young children to think about and remember their involvement and experience of the object, is a more effective way to increase the richness and complexity of their drawings than simply drawing the children's attention to the perceptual characteristics of the object. Young children and non-expert adult drawers do not deviate from the dynamics of the function of perception (which is, presumably, to be able to quickly recognize objects); that is, the conceptual or denotative aspect of the object dominate their attention. To understand this through an evolutionary frame, consider this scenario: if you were confronted with a tiger and your first response was to take note of the patterns on the fur, you would not live long enough to have descendents to whom you could transfer your aesthetic tendencies. Perception has evolved to pick up on those features that lead to quick recognition of food, mate, collaborator and predator; and to inform action appropriately. A similar way of thinking about it is expressed by Lorna Selfe (1983: p.189), according to whom, the first symbols or schemata to appear in children's drawing reflect the symbolization process involved in their language development; a process which is universal in normal children. Schematic drawings then, whether they are purported to be observational drawings (drawn of an object directly perceived) or not (drawn from memory), involve drawing from a memory of the denotative description of the object.

If one sets up a still life for young children, one can observe that after the first inspection of the object, the child will set to work hardly glancing in the direction of the figure or still life again. Non-expert adult drawers, who draw schematically, will persist in intermittently inspecting the object placed in front of them, but they are unable to suspend their engagement in the object's denotative description in memory, which is what they in fact draw rather than the view of the object in front of them.

There is an exercise that many art teachers use to assist the change in focus required for the shift from schematic drawing to realistic drawing (Edwards). It involves attempting to copy a line drawing of an object, which has been turned 180 degrees (or upside down). The idea is that to draw realistically, one needs to focus on an object as simply an array of lines (or tones or textures) in a particular relation to each other rather than on what the sum of the lines represent.[13] Perhaps for the beginning artist, this assists their attentional shift from the denotative aspect to the structural aspect.

The various examples above suggest that non-expert drawers draw from their denotative descriptions whether they purport to be drawing from a perceived object or from their memory of the object. This does not show that they do not have structural descriptions. From the understanding of vision presented in this paper, it must be clear that not all the processes involved in the perception of an object need involve conscious awareness. It is likely that we can store some of this information in memory without ever having been conscious of it. For example, it could well be possible that non-expert drawers store the structural description of objects in memory without ever consciously attending to this structural description. (Furthermore, this is not a claim inconsistent with them having consciously accessed their spatial, configural imagery.) Drawing in a realistic way may require access to processes which, during the course of normal perception, we have no need to access. Conversely, the more schematic a drawing style is, the more it is the result of semantic knowledge which is the kind of information we access in the normal course of object recognition.

**The autistic savant drawers**

The autistic savant drawing phenomenon[14] presents a different profile regarding both the developmental stages of non-autistic children's drawing and the drawing procedures followed by expert and non-expert drawers. First, consider that the autistic savant drawer does not display the developmental trajectory of children without autism. The non-autistic child starts at uncontrolled scribbling, progresses through controlled scribbling to naming of scribbling to making geometric shapes that she later combines into aggregates which develop into schematized versions of objects. Then, if the cultural conditions promote it, in some cases, the child shifts into attempting realistic representations by about eight or nine years old (Kellogg 1970)[15]. If the normal child is a precocious artist, she will still develop through these stages, only at a faster pace. The autistic savant drawer, on the other hand, begins to draw realistic images, seemingly from the moment he or she can control the pen or pencil.[16]

Of the two examples I discuss in this paper, the autistic child artist known in the literature as Nadia began to draw realistically at about 2-3 years old with no former scribbling or schematic drawing (Selfe 1983); while an autistic man, referred to as E.C by Laurent Mottron and Sylvie Belleville, began drawing at 7-8 years old with apparently no former scribbling or schematic drawing (1993). The absence of evidence of the developmental stages in drawing in autistic savant drawers is typical of the autistic savant drawing phenomenon generally according to Selfe who has observed a number of autistic savant drawers (Selfe 1983; 1995). In any case, the very possibility of someone drawing realistically without first working through the schematic stages of drawing suggests an interpretation regarding the relation between schematic drawing (intellectual realism) and realistic drawing (visual realism). It suggests that it is not a matter of systematic development from schematic drawing to realistic drawing. The autistic artist phenomenon suggests that realistic line drawing deploys operations which are not dependent upon having first deployed the operations involved in schematic drawing.[17] Secondly, it suggests that realistic line drawing is a reflection of the kind of encoding that our visual system engages in, in order to process the visual field. The idea is that this encoding is present whether we consciously access it or not. Learning to draw realistically, on this account, is learning to access this kind of encoding.

The third key point is that, unlike the procedure used by the expert drawer intent on capturing a realistic representation of a scene, the drawings of these two autistic savant drawers were not built up gradually, from basic shapes. They did not develop the pictorial representation from an overall configuration to more detailed aspects, as is the procedure followed by the expert drawer. Instead, the autistic savant drawer, usually favoring a biro or pencil, draws an image from end to end, sometimes drawing off the page or ending abruptly at the page's border. According to Selfe (1995):

> She [Nadia] set down lines as if she were swiftly tracing round an outline, moving here and there, until the figure emerged to the astonishment of the onlooker. Unlike all young artists, her production did not appear to be governed by the previously drawn lines but by a very strong image of the finished product. (199)[18]

A fourth notable peculiarity of the autistic savant drawer, given my reference above about what happens to the drawing of expert and non-expert normal drawers when they draw from memory, is that the autistic savant drawer who draws realistic representations of objects, draws these from a memory of the object [19.] In Nadia's case, these were drawn often from a memory of book illustrations. Intriguingly, these were often drawn from angles other than the angle projected in the illustration. Golomb refers to this as interpretation on Nadia's part (1992: p.254) and Selfe argues that this feature of Nadia's drawing defies explanation (1995: p.213). However, Marr (1982, p.35)) reported on research on patients with agnosia[20] who through damage to the left parietal segment of the brain (usually through stroke) could draw a three dimensional view of an object from various angles when only shown a picture of one view of the object from a foreshortened angle. Interestingly, and relevant to our discussion here, is that these patients could not recognize the object or say what it was used for. They were unable to recall any semantic information about the object. These patients could only have been drawing the object from memory because they were only shown the object from one very restricted view of it. As they could not access semantic knowledge of the object, my conjecture is that they drew their structural description. It is reasonable to conclude, therefore, that Nadia's ability to draw objects from memory from various viewpoints reflects a feature of the imagery system in the brain. Furthermore, the way she drew as described by Selfe above (1995) suggests that when she drew she managed to keep her imagery in mind by not focussing on (not perceiving) the paper in front of her.[21]

Let's see if our other case study corroborates this conclusion. Laurent Mottron and Sylvie Belleville videotaped E.C drawing objects from memory. Before one taping they showed the final component of a flute, seen backwards, to E.C. for 15 seconds, then took it away and asked E.C to draw it. They found that:

> instead of drawing complete parts one after the other, that he generated contiguous lines irrespective of their positions in parts. ... E.C. drew the flute outline only when he came upon a component contiguous with the body of the flute (1993: 297).

They compared this to the procedure used by the normal expert drawer (not noting whether the expert drawer relies on memory or observation) and found that the latter started by constructing the outline of the flute in order to capture the overall shape and then proceeded to the juxtaposition of various parts (as documented earlier in this paper). They noted that in both cases the final production was excellent in terms of photographic likeness. According to Mottron and Belleville, E.C.'s drawing procedures and characteristics are comparable to those of other autistic savant drawers with exceptional drawing ability presented in the literature (1993: 306) [22.] The information provided by Lorna Selfe, regarding Nadia's drawing procedure, concurs with this (1977: 9-10 & 1995: 199-200).

Mottron and Belleville varied the above experiment by asking E.C to copy and recall two different and familiar objects a number of times, so that they could see whether the order of segments drawn would be repeated or not. This would test the possibility that there was some kind of hierarchy at work in E.C.'s drawing procedure that was not obvious to the researchers. However, the results proved otherwise. They found that:

> E.C. showed a randomized order of feature production on both copy and recall conditions. Only 20% of the transitions made [moving from one feature of the drawing to the next] were repeated. In contrast, normal controls, as was hypothesized, exhibited very rigid recall sequences. The same sequences were indeed repeated on 90% of the transitions (1993: 298).

E.C's drawing procedure sounds similar to Nadia's. He drew the flute shape from end to end as if tracing lines one after the other rather than building them up. He did not seem to be responding to his previously drawn lines.

It would have been instructive for our purposes here, had the experimenters taken particular note of the difference in the drawings of both the non-autistic artists and the autistic artists when they both drew from memory compared to their output and procedures when drawing from observation. Selfe reports that most autistic children's drawing (other than those identified as autistic savant drawers) develops through the same trajectory as non-autistic drawers only at a pace consistent with their mental age rather than their actual age. Apparently Nadia sometimes drew in a more schematic way, such as when she drew trains (Golomb, 1992: p.257). The similarity between the realistic drawings of the autistic savants and those with left parietal brain lesions reported by Marr, suggests that the autistic savant drawers' ability may be caused by a condition not restricted to autistics; nor shared by all autistic children. Selfe reports that Nadia's language ability was very limited (1995) and the fact that those with left parietal brain lesions could not access semantic knowledge from memory suggests that when accompanied with this unusual fluency in drawing, the cause of the language deficit is a severing of the link between structural and semantic internal modules;[23]such that the former dominates consciousness at the expense of the latter. Expert drawers, on the other hand, may have learnt to suspend semantic knowledge in order to access their structural descriptions.

As Wing and Gould explain, autism is a difficult condition to identify in terms of symptoms because it is very common for those deficits associated with autism[24] to be accompanied by deficits not normally associated with autism. In addition, there are varying degrees of these symptoms. However, the fact that there are cases of autistic people like Stephen Wiltshire who draw realistically and have advanced language development is no more an affront to my explanation than the fact that mature artists have normal language ability. However, it would be interesting to learn the extent to which Wiltshire draws from memory. Some of his drawings in Selfe (1983) look like they are executed by mental procedures not divorced from semantic content, even though his later drawings of buildings are more a record of structural descriptions. This kind of development is in keeping with the normal development seen in non-autistic artists.

**Conclusion**

Two things I have wanted to argue: drawing realistically requires suspension of semantic knowledge (not a new claim)[25]; and drawing from structural description is only possible in direct observation; and impossible from memory (new claim) unless the drawer draws without looking at the page. The drawing procedure as described by Selfe in relation to Nadia (1995: p.199) and as described by Mottron and Belleville in relation to E.C., suggests that when these children drew on a page, they did not focus on the page, but kept their imagery in their mind's eye; something, the rest of us would need to train ourselves to do. Otherwise, children and adults other than the autistic savants (and presumably other than those with left parietal lesions) focus on the page and the lines as they emerge, and lose access to their mental imagery. When this happens the only alternative is to access semantic knowledge of the object in order to build up an image of it; which is much more cumbersome than drawing from observation, and results in a schematic depiction of the remembered image.

Unless a person is trained or trains oneself as an expert drawer, drawing from the direct perception of an object will not succeed in diverting one's attention away from the denotative aspects of the object. Consequently such a drawer will make a schematic drawing. Furthermore, those for whom it is usual to draw their memory of an object in a schematic way do not experience the interference between imagery and perception because schematic interpretations (denotative descriptions) do not deploy the imagery system as such. Such drawers happily retrieve their denotative descriptions while perceiving their emerging drawings. As they may never have drawn their structural description when drawing from life, they would not experience the drawing from memory as a different kind of focus to drawing from life. By comparison, expert drawers attend to the structural aspects of the perceived object at the expense of denotative aspects; only reverting to the denotative description when drawing from memory because the imagery system (structural descriptions) cannot operate simultaneously with perception.

It would be illuminating to ascertain more precisely what the relation between drawing from life and drawing from imagery is in the autistic savant and visual agnosia cases. The literature discusses this aspect in a rather incidental manner. The experimenter would need to control for the possibility that the autistic savant may still be drawing from their imagery even when they are asked to draw from observation; just as other young children and untrained adults draw from memory, albeit their denotative description, when they are asked to draw from observation. This can be ascertained by observing how often and how closely the drawer studies the perceived object.

A number of experiments could be conducted with both expert drawers and non-expert drawers, asking them to describe the strategies they use when they draw from life and when they draw from imagery. Particular note should be taken of the difference in these accounts between those who draw realistically and those who struggle to capture a realistic image. The former should be more conscious of a mismatch between their imagery and the strategies they deploy to draw an image of the remembered object as compared to the strategies they deploy to draw from observation. The non-expert drawers, on the other hand, as they draw from the denotative description even when they draw from life, might not be able to distinguish between drawing the denotative description as opposed to drawing the structural description, as they may never have experienced the latter.

If my hypothesis were correct, drawing from the stored denotative description (semantic content) instead of from imagery, would be less obvious to those drawing a construct made up of a few lines from memory.

This is the typical content of imagery research, and it consists of components that can easily be translated into a denotative description. The switch to the denotative description would be more obvious to the expert drawer when attempting to draw more complicated imagery, such as, say, imagery of Notre Dame or a relative or friend. Of course, if my hypothesis is correct, the need to draw the denotative description rather than imagery (the structural description) would not be detectable by non-expert drawers who had never experienced the difference between drawing the structural description and the denotative description, having only ever experienced the latter. Consequently, the interference between perception of the emerging drawing and imagery would need to be tested using people who can draw realistically from observation of the perceived object.

Finally, researchers need to test separately for perception and memory of objects as compared to perception and memory of the relations within/between objects (the configural spatial properties like balance, closure and other relations between interrelated components of a scene).[26]

The upshot of the hypothesis presented in this paper, is that the nature of imagery cannot be ascertained by studying the drawings made by subjects who draw their memories of previously shown images/objects. Researchers need to take into consideration the possibility that there is more than one kind of mental description of visual information, not all of which are accessible when drawing from memory.

1. The underlying assumption of course is that drawing style can be separated from drawing conventions, Nelson Goodman on the necessarily conventional nature of art notwithstanding. That this is possible is the framework of this paper. It will not be argued for here, suffice to direct you to certain works that argue for this directly. Hochberg (1972) is such an example. In addition, research by Warrington and Taylor (1973) on left parietal damage, discussed in Marr 1982, indirectly demonstrates that drawing style can be separated from convention, and instead reflects aspects of the visual system. An overview of related research can be found in Farah, 2000, pp.92-101. Furthermore, Willats illustration of the interface between primary (optical) and secondary (conventional) geometry (1997), attests to the possibility and likelihood of styles of drawing ranging from those which reflect the human visual encoding (structural description) to those which rely more on conventional norms (denotative description).

2. This idea is examined in detail in relation to artistic style in J. A. McMahon (forthcoming) "Perceptual Constraints and Perceptual Schemata: The Possibility of Perceptual Style", *Journal of Aesthetics and Art Criticism*.

3. See also Donnelly et al (1998); Hayward (1998); and Lawson et al (1999).

4. The word "description" is used, not to link it with a discursive-type encoding but rather to avoid connotations of actual pictures in the head. "Description" is understood to be a generic term for "mental encoding or mental representation".

5. The standard model of visual perception within a representational theory of mind involves early levels of visual processes, which consist of the separate but parallel processing of line, color, shape and movement. See David Marr (1982); or for a very introductory text see Part II of Ilona Roth and Vicki Bruce (1995); for recent overview of research see Farah (2000).

6. While the structural and denotative can be distinguished as separate processes (Farah, 1984), they interface and possibly interact as supported by the close proximity of their neural bases in the brain (Farah 1984).

7. This is a very brief and simplified version of the understanding of vision that underpins recent work on vision in cognitive science. All the research on vision, cited in this paper, is based on this kind of model of vision.

8. My way of articulating this is derived from J. Taylor (1964) *Design and Expression in the Visual Arts*. New York: Dover; quoted in J. Hochberg (1972), p.68.

9. For example, see Anderson & Tore (1993).

10. That such a separation of the visual experience from semantic content is possible see Peterson, Kihlstrom, Rose & Glisky (1992); and Farah (2000).

11. Perception and imagery share a common visual buffer according to Farah, 1984, p.249. They also share all other processes except what Farah calls an image generator (2000, p.275-281). What this means is that in a person with intact perception but unable to conjure up imagery, the explanation given is that the image generator is damaged. If my hypothesis is correct, this generator

does not allow simultaneous inspection of imagery with perception (and this is supported by Kosslyn and Rabin, 1999). I suggest how this might be tested in the conclusion to this paper.

12. Navon's findings (1992) suggest that imagery of an object uses a viewer-centered frame and imagery of people uses an object-centered frame; an interesting possibility with implications for my hypothesis here but not one I pursue in this paper.

13. Pariser suggests that drawing may have less to do with one's "internal representation" of the object and more to do with knowing what moves to make. But his examples to demonstrate this point involve children making schematic drawings, not drawings from life in the full sense as described in this paper (1981: pp. 24-5).

14. The presence of any kind of savant ability in autistics has been estimated at 1 in 10; as such, exceptional drawing ability is fairly unusual. However, its very possibility is significant for the hypothesis presented here.

    The identification of the deficits which lead to a diagnosis of autism have been difficult to isolate because autism is often seen in cases where a patient has many unconnected deficits. However, the triad of impairments, which were identified by Lorna Wing and Judith Gould (1979), are generally accepted as indicating a classic case of autism. These impairments are: a pathological social impairment; impairment of verbal and non-verbal communication; and an impairment of imaginative abilities.

15. See Golomb (1992) for a discussion of various versions of this developmental trajectory.

16. Golomb questions whether we can assume that there was no drawing development in the case of the autistic savant Nadia (1992: pp.260-62) but Selfe believes the data supports this (1995) and the case reported by Mottron and Belleville (discussed shortly) also supports this view.

17. The trajectory of drawing development in non-autistic children suggests the dominance of language based concepts in normally functioning perception in humans. A shift into realistic drawing for adults would be a re-deployment of selected perceptual strategies.

18. The autistic savant drawer favors line drawing. Color seems to hold little interest (Selfe 1977: 9, 19-20; and Mottron & Belleville 1993: 287, 290, 306). These aspects of their drawing and their young age, strongly suggests that their drawing is not a result of having absorbed pictorial conventions. A convention absorbed by non-autistic children at a very early age is the placement of one's pictorial image in relation to the size and edges of the page.

19. This point is usually ignored in the literature on realistic drawing in autistic savants. See Kellman (1996); Milbrath & Siegel (1996); Charman & Baron-Cohen (1993); and Eames & Cox (1994).

    Charman & Baron-Cohen acknowledge the absence of a consideration of this issue (1993: 179). Selfe (1995: p.199) records this point; Arnheim (1992, p.158) marvels over this; while Golomb (1992: p.254) lingers on this point, in order to set the basis for a comparison with non-autistic children's drawing procedures. None of these authors use this point as a significant factor in explaining the autistic savant drawing phenomenon.

20. "Visual agnosia" is a blanket term for a wide array of visual disorders affecting object recognition, in which elementary visual functions such as acuity and visual fields are grossly intact. See Farah (2000) p.92-101.

21. It would be relevant to learn more about the drawing procedure of those with left parietal lesions.

22. In reference to this claim, they cite Hermelin & O'Connor 1990; O'Connor & Hermelin 1987; Selfe 1977 & 1983.

23. The need to suspend semantic knowledge of objects when drawing realistically is supported by Phillips, Hobbs, and Pratt (1978) and Lee (1989).

24. See fn.14 above

25. See Snyder & Thomas (1997) and Pariser (1981).

26. I would like to thank Michael Davis for his research assistance, which was funded by an Australian Research Council Small Grant (2001), and awarded to me by the University of Canberra,.

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