Technical Issues in Naive Sense Datum Theory.

John M. Nicholas

Dept. of Philosophy
University of Western Ontario

Draft 004 22 July 2012

Comments Invited; Please don't quote yet
Originally "Exercises in Naive Sense Datum Theory", presented at University of Hertfordshire's Phenomenal Qualities Project final conference, 31 March 2012. Proceedings to be published by O.U.P. Paul Coates and Sam Coleman (eds).

> It might or might not prove in the end logically possible to escape from dualism – without giving up realism; but there were at least strong reasons for wishing to escape from it. ... Its theory of knowledge granted you no access to the reality in which you believed and about which desired to know. The craving to *possess* your object, to meet it face to face, instead of being limited to reports from it given by deputies whose credentials were perhaps dubious, had not been effectually extirpated from the human mind by the cause of reflection which had led to dualism
>
> To think dualistically all the time puts, at the least, a considerable strain upon the human mind; and it was natural to seek relief from that strain .[1]

1. PRELIMINARIES: WHAT'S THE PROBLEM WITH SENSE DATUM THEORY?

There is probably no better explanation of why we would want to resist the implications of the Sense Datum Theory (SDT) than Lovejoy's account, given above. The fact is that sense datum theory, or, just to start with, the view that experienced colours reside in sensations rather than in the world outside our bodies, is hard to come to terms with intellectually and emotionally.

On the intellectual side, If they trouble to comment on it at all at any length, contemporary philosophers typically rehearse four strategic arguments in their rejection of sense datum theory (SDT).[2] (1) SDT is committed to dualism which is scientifically or naturalistically unacceptable; (2) SDT implies a 'veil of the appearances', and thus scepticism about the world beyond the sense data, which is contrary to epistemic intuition; (3) arguments from illusion and hallucination, the alleged core arguments in favour of SDT are unsound; and; (4) SDT implies an 'homunculus', sometimes conceived of as a locus 'where it all comes together', meaning perceptual, affective, intellectual and executive functioning. The SDT's supposition of an homunculus implies a vicious infinite regress, it is said.

(1), (2), and (3) are either false or irrelevant. Something in certain respects like (4), but a lot weaker may be plausible. SDT implies neither dualism nor skepticism. SDT is grounded in inductive, not deductive, reasoning. Soundness was never plausibly on the cards for SDT, any more than it is for the great majority of credible scientific theories. SDT does not imply an infinite regress. I'll say more about the alleged implication to dualism, and the alleged homunculus regress below.

*

My goal in this paper is to examine where the difficulties of implementation lie in adopting the theory which proposes that sensations are the bearers of colour attributes and that they are in the brain. I do not claim that these problems are intractable, and I do not take them to discredit NSTD. They are the technical difficulties which must be coped with in articulating a view that is widespread in a number of scientific communities, but is not accessible from an experimental or observational investigative platform at present. While colours are the focus of our discussion, I propose that as colours go, other sensory attributes will follow. My policy will be to pursue Naivete, to make explicit the most simple ways in which SDT could be realised. 'Naive' Sense Datum Theory (NSDT) is a cousin of Direct Realism, and adopts where possible some of its simplicity; it is a direct realism. My secondary intent here is to argue that the possibility of the existence of a neural 'place where a lot, if not it all, comes together' has been discredited by *neither* scientific *nor* philosophical considerations. I will argue that common arguments against the case are not yet decisive. In addition, I will outline difficulties which some alternatives to STD face. My argument here is not so much that *Naive* SDT is true (though I find parts of it credible) but that it is a live contender which deserves further scientific examination. I shall make a start by introducing what I take to be a useful heuristic viewpoint for understanding what is essential to SDT.

*

Prichard's Diagnostic: consider the hostile critique of Russell's SDT by H.A. Prichard. I believe that it offers a valuable exploratory instrument and diagnostic tool, and it suggests a convenient terminology. Prichard's was not a complaint against sense data, but against Russell's associated doctrine that awareness of sense data constituted *knowledge by acquaintance*. He insisted that acquaintance constituted no such thing, but he did allow that it is typically accompanied by the false belief that our sense data are the things outside us which we see. As he stated it (1950, p.61)

> … there is the possibility that we can perceive something without *apprehending* its character at all, and if so it might be possible that when seeing something we, so to say straight off *mistake* it for something else, and that in particular what we call seeing bodies, instead of consisting in seeing colours and judging them to be bodies on the strength of the apprehension of them as colours involved in seeing them, consists in seeing colour and without apprehending them as colours at all mistaking them for bodies.

Prichard was right, I think, in entertaining the idea that we make this mistake. In fact, the possibility that we may commit this error seems to apply whether or not we apprehend colours *as* colours, but I will not explore that issue here. However, following Prichard's lead and other clues, I propose that, when we ask '[w]hat is that which when we are said to see a body we see and mistake for a body?', I say that the answer is *a sense datum* or *an array of sense data*. Call it the "Phenomenal Array".

SDT proposes that the Phenomenal Array – what is given to us in experience at any particular time – is spatially located in the physical space of the brain in some or other volume or surface.[3] Our mistaken belief that the Phenomenal Array is the world outside our bodies does not lead us into much trouble on a day to day basis, apart from in the Philosophy seminar. In fact, it is a sign of sanity in sense datum theorists (never mind the rest) that outside the seminar room and away from the desk, they proceed as if Direct Realism were true. It's a serviceable belief and functions well because Natural Selection has made that possible. It is unlikely that many, if any, other animals share this mistaken belief, if only because they have no opinion at all on the ontology of the Phenomenal Array.

Prichard's point was, as I shall put it, that we mistake our Phenomenal Array for the 'Visual Field'. The expression 'Visual Field' is used in conflicting ways in different specialty literatures. In this paper, it will denote the array of distal stimuli, outside our bodies, which contribute to our seeing them. It is part of the environment. Using this terminology permits a simplification of the differences between major positions, and in a way that is relatively free of narrow theoretical commitments. It allows a more natural formulation of the doctrine of Direct Realism than by the usual appeal to *lack of mediation in perception* so that Direct Realism does not have to define itself in terms of Indirect Realism.

- Direct Realism: the (visual) Phenomenal Array is the Visual Field.
- SDT: the Phenomenal Array is not the Visual Field, and is likely part of the brain, or in a non-physical domain.
- IR: the Phenomenal Array is the intentional content of our (visual) experience
- Disjunctivism: the Phenomenal Array is either the Visual Field or something else (?).

Many readers may judge that Prichard's Diagnostic is wrong. When SDT asserts that 'the Phenomenal Array' is what we mistakenly take to be the Visual Field, they will deny that it is a mistake. Despite that disagreement, I believe, it picks out sufficiently well what I am referring to by the expression. A Direct Realist, for example, will understand the expression '(visual) Phenomenal Array' to denote the assemblage of surfaces of distal stimuli visible to them at any given time at which they are aware of it. Of course, that is a little rough; it leaves out floaters, phosphenes, afterimages, migraine 'castellations' and the like, which are not outside our bodies and do not really count as distal stimuli.

*

Does SDT imply immaterialism? Prichard's Diagnostic also prompts a useful viewpoint on the usual complaints against SDT, particularly – that it implies immaterialism or dualism. If we mistake our sense data for external objects, and we judge that external objects bear the properties which our sense data do, then it is implausible that the attributes of sensations are not physical. It is certainly a rush to judgement. For when we mistake 'what it's like' for attributes of objects in the external world, we have no sense of anomaly when we also attribute physical variables to them. We see a yellow tulip, and do not doubt for a minute that it instantiates not only qualia (*per hypothesis)* but also momentum, energy, gravitational mass, electric charge, and so on. There is nothing non-physical, as of the current state of physics, in qualia that we perceive in their *intuitabl*e character. Otherwise, we could never comfortably identify the P*henomenal Array* as the external world, while taking the external world to be physical. Qualia are not alien; they are the properties which we believe we see the physical world to have. If we did discern those attributes to be non-physical, then presumably Direct Realists and Disjunctivists would be Dualists, too. But none of us need be dualists, at least on the grounds that there is something 'spooky' about qualia as experienced. Further, if it is very hard to conceive of how atoms and molecules can give rise to colours, sounds, tastes, and bodily sensations the difficulty afflicts Direct Realists and Disjunctivists as much as it does Sense Datum Theorists. They too have Hard Problems, though theirs are in the physics of external bodies, while ours are in the psychology of brains.

*

Does SDT imply a homunculus regress? Gareth Evans has given an economical account of 'the homunculus fallacy' as (Evans, Gareth, 1985, p. 397)

> when one attempts to explain what is involved in a subject's being related to objects in the external world by appealing to the existence of an inner situation which recapitulates the essential features of the original situation to be explained … by introducing a relation between the subject and inner objects of essentially the same kind as the relation existing between the subject and the outer objects.

The homunculus fallacy is inextricably linked in the philosophical literature with the notion of the 'Cartesian Theatre' which in both neural and psychological terms is where things (all?) come together. An inner viewer makes possible the sight of a person. Daniel Dennett has been the most vigorous opponent of this profound philosophical vice, and he has influenced the terms in which researching scientists frame their literature (Dennett 1991).

The prominent neurologist, Antonio Damasio has declared himself for Dennett's position. He has observed (1994, p. 94):

> Somehow it stands to reason that what is together in the mind is together at one place in the brain where different sensory aspects mingle. The usual metaphor has something to do with a large Cinemascope screen equipped for glorious Technicolor projection, stereophonic sound, and perhaps a track for smell too. Daniel Dennett has written extensively about this concept which he dubbed the "Cartesian Theater," and has argued persuasively, on cognitive grounds, that the Cartesian Theater cannot exist. I too, on neuroscientific grounds, maintain that it is a false intuition.

Such a "Theatre" invokes inner projectors and images requiring a viewer in the brain whom we should suppose to have vision in the same way as does the person whose vision is to be explained. Such a conception would satisfy Evan's criterion for the homunculus fallacy. It is not required by the Sense Datum Theory.

Although SDT does not imply a regressive homunculus, some exponents of SDT have *elected* to propose versions of the theory which seem to invite this criticism. Consider Frank Jackson's fundamental "analytic thesis" (Jackson 1977, p. XX):

> … that to *see* a reasonable-sized, opaque material object is to *see* something distinct from that object, the relevant immediate object of perception (whatever the ontological status of the latter may turn out to be).

This is outer seeing explained by inner seeing. What has motivated Jackson and other Sense Datum Theorists to invoke inner and outer seeing is the attempt to avoid the alleged skeptical difficulties of inference and interpretation associated with the "Veil of the Appearances". If seeing sense data somehow can be properly said to *constitute* seeing external things, then we have a semblance of directness of perception, at least in our talk. However, because there is another, direct solution to that problem, Probability as the Guide to Life, I see little to be gained from forcing the language to do the job indirectly. It has the scent of Theft, rather than of Honest Toil. However, that strategy is merely an option and not an essential part of SDT. It is not an option that should be taken up.

All that SDT requires, acknowledging a slight deformation of common usage, is that a perceiver is 'consciously aware' of only the sense data. The perceiver 'sees' the distal stimulus, and derives information in the process of detecting it. The 'awareness' of sense data is only part of a modular element in a larger functional structure which constitutes the 'seeing'. One is aware of sense data; one sees distal stimuli. One does not see sense data; one is not aware of distal stimuli. There is no first step into a regress, and Evans' criteria for the homunculus fallacy are not satisfied.

2. PRELIMINARIES: WHY BELIEVE THAT THE PHENOMENAL ARRAY IS IN THE BRAIN?

While philosophers are generally dismissive of SDT, large numbers of vision scientists, neurologists, physicists, colour theorists, and the *Commission internationale de l'éclairage* have adopted the view that the bearers of colours are brain-based sensations or percepts, not objects external to the body. If representation is at issue, then, in perception, we have representation *by* colours not representation *of* colours. What grounds compel us to take sensations, percepts, or sense data, rather than the relevant external objects to be the bearers of colours? I take these three considerations to be decisive:

i: To attribute colours to distal stimuli would be to add an 'idle wheel' to the explanation of colour vision. We have well-established ideas about what the contributions of distal stimuli are to the process of colour and other vision, and they do not include the generation of colours (i.e. those attributes that at the very least conform to the structure of colour similarity spaces etc) at those distal stimuli. Stimuli which characteristically cause us to see, say, red, may as well be plaid for all that it would contribute to the visual process. Given the redundancy of colour in our scientific understanding of distal stimuli, we have no particular reason to attribute colours to them. However, as F.H.Bradley rightly pointed out to Bertrand Russell, SDT does not prohibit the existence of colours in physical things other than living brains, even if not experienced. SDT does not insist that colours only exist if someone or something is conscious of them.

ii: Colours have particular properties and relations (similarities, unique/binary character, variability with frequency of uniqueness by subject, ...). Distal stimuli have no physical grounding for those attributes (Nassau 2001).

iii: In addition to partially understanding why the roles of light sources, transmissive media, and reflecting surfaces in causing colours and their vision are exhausted by their generating luminance spectra, we also partially comprehend how colours are produced – in or at the brain. Consider Jameson's and Hurvich's representation of a subject's (Jameson's) chromatic response functions (1958, p. 551).

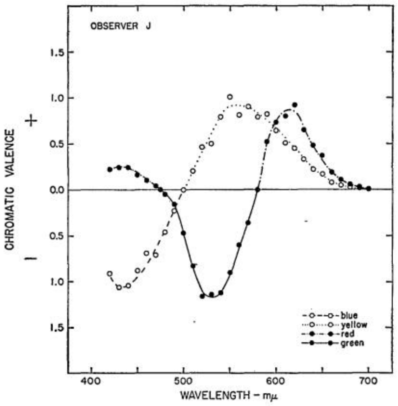

Fig. 5. Chromatic response functions. Observer *J*.

Fig. 1

For a given subject, it represents the weighting of chromatic components, R, G, B, Y, in binary hues in terms of energies delivered to the retina. Other things being equal, each frequency in the spectral hues will yield a characteristic *binary* hue with relative weightings for R/Y, Y/G, G/B, and B/R as dictated by the given curves. The curves are empirically determined by hue cancellation, assuming (1) that there are two parallel chromatic opponent channels, RG and BY, and (2) that the measure of a given opponent is given by the (energy) intensity of its complementary that is required to annihilate it. In those special cases where each of one pair of opponents takes a zero value, there appears a *unique* hue which is one of the complementaries from the second opponent pair. If red and green are annihilated, then either unique blue or unique yellow will appear depending on wavelength.

The Hurvich and Jameson Opponency Model is, admittedly, a preliminary and imperfect model of hue formation, but it is an important first step in our understanding of the calculus of the generation of hues – behind the retina. Direct Realists may be troubled by the locus of hue formation being in the brain, not in the distal stimulus. Intentionalist Representationalists may be troubled by the process being the formation of the hues themselves not the formation of symbolism to serve as the vehicle for intentional content.

5. FIRST TECHNICAL ISSUE: WHERE IN THE BRAIN IS THE PHENOMENAL ARRAY?

Naive SDT supposes that there is a unitary site in which multi-modal binding or co-location of sensory attributes is distributed in space and made available to awareness and attention, in a unitary way. Does such a notion hold up?

We saw earlier how Damasio acquiesced to Dennett's 'cognitive grounds' against the Cartesian Theatre. He also had *neurological* grounds against it. What he had in mind was the theory that "the components provided by different sensory portals end up being displayed together in so-called multimodal cortices, where the most detailed and integrated representations of reality are achieved." Notably in the case of vision, it is tempting to suppose that the retino-geniculo-striate pathway should assemble a visual framework in the occipital lobe and then fill in details in a feed-forward 'cascade' through the association cortices, perhaps ultimately targeting the anterior temporal and frontal cortices, and also the hippocampus. Relatively enlarged neuronal receptive fields anterior to the occipital lobes, and increased multimodality reinforce that impulse (Driver and Noesselt, 2008; Macaluso, 2006; Macaluso and Driver, 2005; Macaluso, Frith, and Driver, 2002)[4] . However, Damasio has stated (1992, p.208)

> ... there is no neuroanatomical structure in the cerebral cortex to which signals from all the sensory modalities that may be represented in our experience can converge, spatially and temporally. The entorhinal cortex and the hippocampus might be candidates for the sort of "integrative" role but they do not pass the necessary anatomical tests. Also, we know for certain that they cannot do the job because patients in whom such structures are destroyed bilaterally ... do not have a disturbance of consciousness in the sense discussed...". ... The prefrontal cortex, another region associated with consciousness in the minds of most people that have ever thought about the brain, is an even less adequate candidate than the entorhinal cortex for the "integrative" locus underlying a Cartesian Theater. It provides many anchor points for signals hailing from various sensory streams and from the motor system, but there is no single site to which "representations" can cohere spatially and temporally. Extensive bilateral ablation of prefrontal cortices in humans does not preclude basic consciousness, although, again, we have argued that the highest levels of self-consciousness are not possible within these structures.

The 'traditional' view identified by Damasio is one which reinforced a supposition that consciousness, plausibly the summit of our evolutionary development, should be linked with new brain, cortex and neo-cortex. Damasio's arguments are largely aimed at cortical candidates. But perhaps such a view is gratuitous 'cortico-centrism'. In addition, perhaps Damasio is setting the bar too high for consciousness. Why must we suppose that our awareness of and attention to the Phenomenal Array should also be the locus of motor operation, presumably meaning executive control?[5] Might its portfolio be merely sensory?

In the light of the issue of cortico-centrism, the development of Damasio's own thought has been intriguing. Parvizi and Damasio (2001) have proposed a *constitutive* role for the (sub-cortical) ascending reticular formation in mammalian consciousness. Two classes of evidence motivate them. The first is that damage to the upper brainstem causes coma and vegetative state. The second is that the reticular formation conditions "wakeful and attentive states" (p. XX). They observe:

> Such evidence supported a general account of the relationship between brainstem and consciousness that can be summarized as follows: (a) the brainstem contains the reticular formation which is the origin of the ascending reticular activating system; (b) the engagement of the ascending reticular activating system activates the cerebral cortex; (c) the process of activating the cortex underlies wakefulness and attention; and (d) wakefulness and attention are indispensable constituents of consciousness, or, as some might say, constitute consciousness.

Further the authors distinguish two problems in investigating consciousness. The first is the problem of understanding how the brain yields a "mental pattern" in any sensory modality. They loosely describe such mental patterns as "images".[6]

> This first problem of consciousness is the problem of how we form a temporally and spatially unified 'movie-in-the-brain', a metaphorical movie, of course, with as many sensory tracks as the brain's sensory systems. Solving this first problem in neuroscientic terms consists of discovering how the brain makes neural patterns in its neural circuits and turns those neural patterns into the explicit mental patterns of the whole range of possible sensory images, which stand for any object, any relationship, concrete or abstract, any word or any sign."

However, they deny that there is any "homunculus", preferring to have the "owner and observer" of the "movie" appear as a character.

Damasio seems to suppose that the limits within which the metaphor of the internal movie theatre applies exclude any audience for the movie. There is no explicit guide to the employment of the metaphor, but it is not unnatural to suppose that he conceives of something like a screen, even if without a viewer. If that is right, then NSDT may be onto something. The surprise is that Damasio has sidestepped his own arguments against a cortical screen and proposed a sub-cortical one.

*

Are there Less Naive, Consciousness Archipelagos? Naive Sense Datum Theory implies that there is one place in the brain where, if not everything, at least an appreciable number of things, particularly sensory ones, come together. What is 'Naive' about the view is that the one place is the locus of the unitary phenomenology we experience, ranging from the extreme left of the Phenomenal Array to its extreme right and so on, all in one.

Less Naive proposals, too, give credence to the brain's sustaining arrays of phenomena to which we can apply awareness and attention, thereby constituting our experiences. They insist, unlike Naive SDT, that there is no *unitary* cerebral locus which captures phenomenal presentation. The work of Semir Zeki and his collaborators on the cortical localization of dedicated processing for particular sensory attributes in the extrastriate cortex has led Zeki to promote a doctrine of "microconsciousnesses". He conceives of the distribution of elements of consciousness in a neural archipelago as opposed to in a unitary site. The functional specialization of V4 and V5, provide Zeki with what he calls the 'cornerstone' for a theory of multiple microconsciousnesses. The separation or autonomy of the input paths, the differential consequences of lesions in the respective areas (achromotopsia in V4, akinetopsia in V5), and the autonomy or 'juxtaconvergence' of outgoing paths to other areas, point, according to Zeki, to the conclusion that "the consciousnesses of elementary visual attributes are distinct from one another" (Zeki 19XX, p. XX).

Zeki's microconsciousnesses are very surprising, because it is very hard to conceive of a phenomenology which comes in only one modality at a time. He justifies his view by appeal to the functional segregation by modality in the extrastriate cortex, a double dissociation argument[7] on V4 and V5, and, likely, an over-interpretation of Riddoch Syndrome – a variety of blindsight.

Zeki and Bartels have written:[8]

> ... a lesion in one area does not invade and disable the perceptual territory of the other. Thus an akinetopsic patient sees colours consciously even though unable to perceive and be conscious of (fast motion). By contrast, an achromatopsic patient is unable to perceive and be conscious of colours but is able to see and be conscious of visual motion effortlessly. Hence consciousness of these elementary visual attributes are distinct from one another and I speak of them as 'microconsciousnesses'. ... One conclusion from the clinical evidence is that a microconsciousness for colour or visual

> motion is generated at a distinct processing site, and *therefore* that a processing site is also a perceptual site.

Zeki's conviction that there can be disjoint consciousnesses of instances of single modalities of perception is an alien notion for those who experience a phenomenology of the usual kind, and it is certainly alien to NSDT. NSTD implies a unitary Phenomenal Array, not an Archipelago of Arrays, respectively devoted to colour, motion, figure, orientation, sound, somatic sensation. Zeki's position is influenced by his analysis of the cases studied by Riddoch[9] in World War I, of victims of severe cortical blindness, and by his and Dominic ffytche's research (Zeki and ffytche, 1998) with a contemporary subject, G.Y., who had a substantial scotoma resulting from damage to the primary visual cortex. All the subjects were able to detect motion, and allegedly motion alone, in their scotomata.

The key matter is that "... one feature of the syndrome of residual motion vision as described by Riddoch is the crude ability to detect motion within the hemianopic field, *without being able to assign any other attribute to the moving object or stimulus*."[10] Riddoch himself wrote (1917, p. 17) that his patients claimed that awareness was of motion only. All the subjects were "quite sure that neither shape nor colour can be attributed to [the movement]." Zeki and ffytche (1998, p. 26) reported:

> For Patient 1, 'The 'moving things' have no distinct shape, and the nearest approach to colour that can be attributed to them is a shadowy grey'. For Patient 2, 'The 'moving something' had neither form nor colour. It gave him the impression of a shadow'. Patient 3 could detect the movement of feet in the street '. . . though they had no shape'; Patient 4 '. . . declared he could distinguish no object . . . but he knew that something had moved through his blind field', while Patient 5 said, 'They [the moving objects] don't appear to have any colour or shape. They look like shadows. Sometimes I can tell if the moving things are white'.

They also reported temporal changes in the blindfield description of their contemporary patient G.Y. The patient's initial reports in 1980[11] and 1993 were of movement in a shadow, not unlike when one shuts one's eyes while looking out of a window and then moves one's hands back and forth. It was 'dark and shadowy'.[12] In 1996, he reported experiencing 'a black shadow moving on a black background', allowing that 'shadow' was "the nearest I can get to putting it into words so that people can understand".

At first sight, this provides a precedent for the cases which Zeki insists are of consciousness of a single attribute of a single sensory modality in isolation from all others. Zeki and ffytche observed from their fMRI studies of G.Y. that the variability between the patient's aware and unaware conditions in response to motion stimuli went with some discernible neural variation. They concluded that the transition from the unconscious to the conscious awareness of motion varies with the level of activity in area V5, and reasoned that if V5 were required to relay to some 'master integrator' then activity should have been discovered also at that ulterior site. No such cortical activity was detected.

Zeki and ffytche *did* see activity, but it was in the *medulla* not the cortex. Their educated guess was that the activity was in the ascending reticular formation although the resolution of their fMRI did not permit precise confirmation of that.[13] There is no hint that subcortical activity might be linked to a 'master integrator'.

Zeki has not proposed a compelling picture. There are several difficulties. The first is that he offers no explicit reason for saying that the specializations for motion and for colour in V5 and V4 are conscious. The second is that the reports of Riddoch's patients and of G.Y. do not really fit the claim. Their descriptions are not unequivocally unimodal. Movement was indeed perceived neither determinate shape nor figure differentiated from ground, but anyone who has woken in the night and contemplated the vagueries of their visual presentations while their eyes are closed will be familiar with motions that are barely discernible because of the vagueness of forms and marginal apparent contrast. But there are shapes as well as movement. There may not have been chromatic hues, but greyscale differences marginally discernible over threshold would suffice to allow the distinction between one black on another black.[14] The third is that Zeki's "micro-consciousnesses" are preparatory for other multimodal and narrative levels of consciousness whose relations to them are only vaguely specified. Surely, for the higher levels some assembly is required out of the *phenomenal* "micro-consciousnesses", and, mysteriously, it will have to be at a distance.[15]

We saw that Damasio gave relatively detailed arguments against there being a neural place where things come together – but restricted his discussion more or less to the cortex. Parvizi and Damasio side-stepped those arguments by promoting the contribution of the sub-cortical ascending reticular formation as constitutive of consciousness. Zeki, too, has sidestepped those arguments while preserving consciousness in the cortex, but at the cost of things not coming together. How the semblance of unitary assembly which grounds NSDT's Naivete is achieved is not discussed.

*

Is there a decussation problem? Whether or not one embraces an archipelago model such as Zeki's, there is in any case a glaring need for assembly at a distance. It is due to the separation, for each sensory modality, of substantially distinct streams assigned to different *cortical hemispheres*. With that comes the division of sensory targets into rough halves which are represented in the cortex contralateral to it. Where relevant the same applies to subcortical structures. This is the problem of decussation.

Vision provides a dramatic case. After stimulation of the retina, projections via the optic nerves are segregated at the optic chiasm. This occurs in such a way that the projections from the right retinal hemifields of both eyes, 'nasal' for the left and 'temporal' for the right, which capture the left visual field, project to the right side of the brain. Similarly, the left eye's temporal hemifield and the right eye's nasal hemifield project via the optic chiasm to the right brain.[16] The main projections are to the primary visual cortex, via the dorsal lateral geniculate nucleus (LGNd) of the thalamus, commonly referred to as the retino-geniculate-(striate)-cortical pathway. We may see evidence of the character of this division in Roger Tootell's well-known image of one side of a primate primary visual cortex, derived from an image stabilized on the retina by a micro-projector on a contact lens (Tootell, Silverman, et al., 1982). Only about half of the target is captured by the contralateral striate cortex.

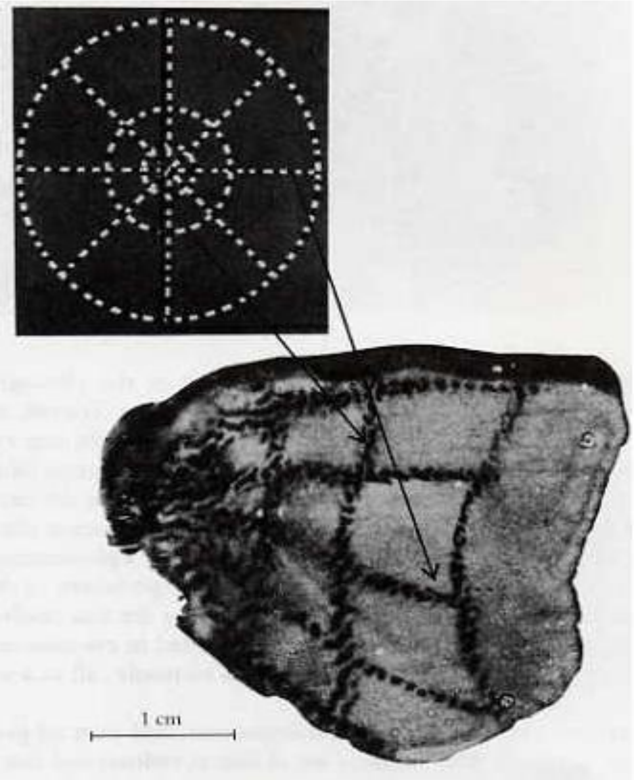

Fig. 2

This division of the Visual Field into two near halves, overlapping at the central meridian roughly one and a half degrees of apparent arc at the central meridian where the retinal hemifields overlap is held in common between the two cortices – cannot be more important for the Naive Sense Datum theorist. For if we assume that there is a unitary neural site in which the visual, auditory and somatosensory sensory inputs are brought into registry, so that our phenomenology may be taken at face value, there has to be substantial processing which can recombine the divided halves. We may ask what does the corpus callosum contribute to the unification of the two halves to make up the Phenomenal Array? Here the preliminary answers are tantalising but incomplete. Peculiarly, the primary visual cortices are *almost* completely 'acallosal'; for the most part, they lack connections via the corpus callosum. The exception is a set of spatiotopically ordered reciprocal connections between the interfaces of V1 and V2 in each cortex, and these are exclusively of the central meridian by which the two hemifields overlap . Clearly, there is communication between left and right visual cortex, but it is not at all clear how exactly it is to be useful.[17] The connection is simple in that it is 'homotopic', so that projections are between mirror-image structures left and right. However, if I'd like to know how my new jacket will look, I would hope that my tailor would be more informative than just telling me how well the buttons on the right side match with the button holes on the left side. Clearly, if the Naiveté of NSDT is to be vindicated, some additional operations will be required so that the two full halves of the Phenomenal Array can be brought into proper juxtaposition.

Because the corpus callosum is not a good candidate for the locus of assembly, we entertain the idea the the whole assembly is in one side. If this were the case, there would likely be idiosyncratic pathologies would reflect the failure to link up the halves appropriately. There are pathologies, cf the lack of registry between the left and right eye. But that is not the right issue. On the other hand, hemianopia and hemineglect have the right properties in relation to the segment of the Visual Field from which assembly failure would screen us of. Further, the well known asymmetry of the hemispheres in this regard, favours the right parietal cortex as the locus, since right parietal lesions with left visual field loss of competence is the statistical paradigm.

*

Are superposed laminar maps the key? Some philosophers think it useful to point out that having a representation of a spatial array of objects does not require the representation to be a spatial array of representations of the respective objects. However, while it is not required, it is at least optional, and taking up the option is not at all a philosophical error or fallacy. The brain frequently elects for it. It widely uses retinotopic and spatiotopic maps, as well as other topographical representations (Sherman and Guillery 2006, ch. 9). Consider first the very remarkable employment of cerebral spatial mapping: that of the lateral geniculate nuclei of the dorsal thalamus. In a striking example of what Zeki has termed 'juxtaconvergence', magnocellular, parvocellular, and koniocellular pathways from retinal hemifields in both eyes project through the layers of the LGNd, and are brought into tight registry. The congruence of the retinal maps in the respective layers is so precise that target mappings are aligned, as one author put it, “like one of the toothpicks in a club sandwich” (Walls, 1953, cited in Sherman and Guillery, ibid., p. 327).

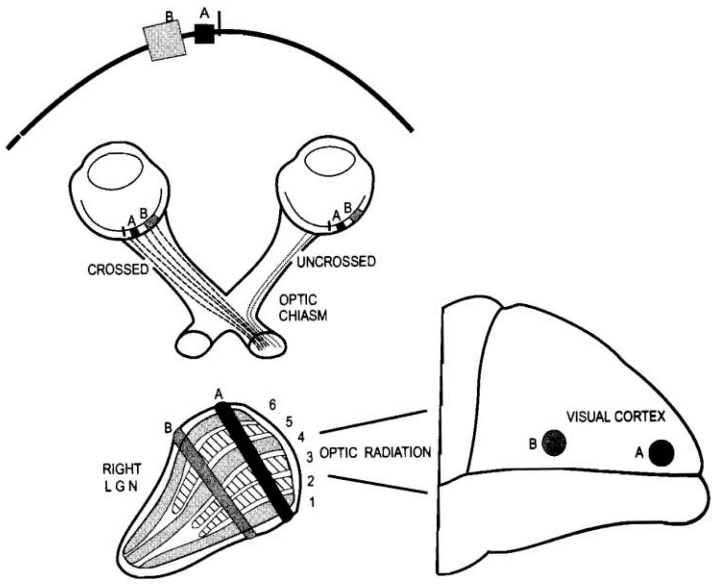

Fig. 3

Why the LGN does this, and specifically what function is achieved by this remarkable alignment is not understood, but we can see that the brain *can* do it and *does* do it. While this example makes the point of principle, it is not multimodal in the respects that we are looking to match with the Phenomenal Array. Three (six counting the contributions from both eyes) neural channels passing through LGN carry information about distinct attributes which are all visual only.

Now consider the superior colliculi. Each colliculus has the wide range of modalities we are looking for, and, like the lateral geniculate nucleus employs the device of careful alignment of laminar structures to bring different dimensions of sensory experience into close registry – one of the key elements of the Naive SDT to which I give some credence. Unlike the LGN, the superior colliculi offer a wider synthesis. Laminar structures bring into registry retinotopic, somatosensory, and auditory spaces. This is arguably what is required for the entire Phenomenal Array.

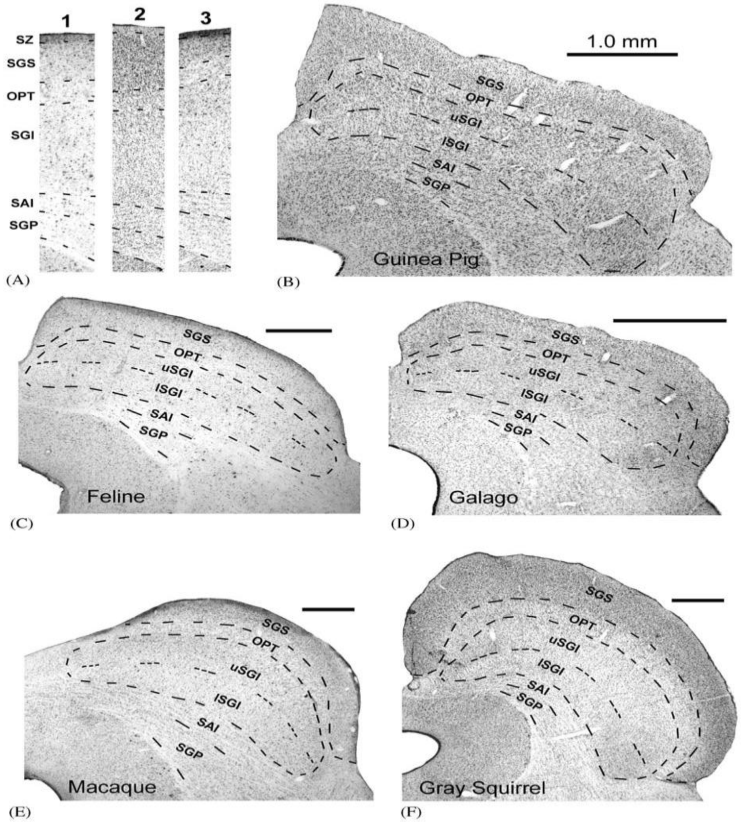

Fig. 4

In 1996[18], Sprague observed that cats whose primary visual and extrastriate cortex had been removed on one side unsurprisingly lost the capacity to detect and orient towards targets in the contralateral visual field. After the removal of the contralateral superior colliculus or after sectioning of the anterior commisure which connects the two superior colliculi, those competences returned, very surprisingly.

This seeming redundancy of the cortex may appear to be a blow against those who propose cortical sites for neural correlates of consciousness, or at least those of core consciousness. The Sprague Effect, together with the more or less normally conducted lives of decorticated rodents, arguable signs of consciousness in hydranencephalic human infants devoid of much or all cortex, and the striking preservation of consciousness and functionality of patients subject to partial decortications (while conscious!) prompt Bjorn Merker to propose that the resources for consciousness lie subcortically rather than cortically.[19]

Merker focuses on the superior colliculus (SC), which is one of the most studied sites in the brain. Conventionally, SC is understood to be a lynchpin in the brain's system for orientation of the head, the eye, and in the appropriate mammals, the ear. Importantly, it contributes to the regimentation of saccades. It takes early delivery of information from the optic tract and is remarkable for its capacity for 'intermodal integration' which, Merker proposes, serves to remedy some of the profound complexities which arise for animals like us which have mobile receptor arrays, like our eyes and cats' and dogs' ears.

The crucial structure in this locus is what Merker calls the 'selection triangle' which embodies the interaction of target selection, motivational state, and ultimately the selection of action. In terms that an advocate of SDT can only warm to, Merker proposes that the "conscious mode of function" associated with SC grounds the interactions in the selection triangle in "the general form of a *neural analog reality simulation*". He envisages (p. 76)

> an analog (spatial) mobile "body" (action domain) embedded within a movement-stabilized analog (spatial) "world" (target domain) via a shared spatial coordinate system subject to bias from motivational variables, and supplying a premotor output for the control of the full species-specific orienting reflex.

In addition, in terms reminiscent of Prichard's Diagnostic, Merker emphasizes 'the synthetic nature" of "what we typically take to be physical reality itself". This synthetic scene has a coordinate system "lodged in the head representation of the simulated analog *visual* body, say in close proximity to its analog eye region". He judges that

> [t]here is reason to believe that the implicit "ego center" origin of this coordinate space is the position that we ourselves occupy when we are conscious, and that the

> analog body and analog world of that space is what we experience as and call our tangible, concrete body and external world ... 72
>
> In its peculiar nesting of a body inside a world, around an ego-center in a shared coordinate space subject to motivational bias, this interface possesses the essential attributes of phenomenal consciousness. 73

But is this consciousness for real? Given that we are considering the prospects for Naive SDT, could the superior colliculus be the locus of the Phenomenal Array? It is certainly true that SC has the capacity to bind visual, auditory, and somesthetic projections, so it meets the necessary condition of multimodality. In addition, SC achieves multimodality by the superposition of laminae corresponding to the respective modalities. That is to say, it does it by assembling spatial maps and bringing them into registry – a difficult task, given that different modalities come from sources with different metrics. Consequently, we can see in SC the resources for a spatial Phenomenal Array, which may even include colour in a coarse-grained way[20].

There are difficulties. First, due to decussation, there are two superior colliculi, left and right, connected by the callosal anterior commisure. Is one SC the unique locus of the whole Phenomenal Array? If not, then how are the two approximate halves of the sensory fields brought into registry? Second, what confidence do we have that in decorticated cats, the functionality of the gaze and visual orientation is not an unconscious system as the dorsal stream is understood (Goodale and Milner, 2004) to be? The cats are not in a position to report on their experience. Further, one human subject who may well have been an instance of the Sprague Effect, suffered initial disruption of his visual system not from lesions to the visual cortex but to the pre-frontal cortex.[21] He could report the restoration of some degree of the lost functionality, and thereby demonstrate his consciousness, after coincidentally a cyst invaded his left superior colliculus. Because primary and extrastriate cortices were intact, we cannot preclude the possibility that his consciousness derived from the cortical level, and the cats and mice who function semi-normally without cortex do so without any phenomenology.

7. SECOND TECHNICAL ISSUE: IS THERE ROOM FOR VOLUMINOUS SENSE DATA?

Must the Phenomenal Array be a simulacrum of the (seen) external environment? If it is, then it may well be expected to be *three-dimensional*. There are limits to this. There is no plan or side elevation view of our environment with us in it. It is not so much Super Mario as Doom that sets out the phenomenology, dictated initially by our retinocentric perspective. A 3D Array is not an implausible start, because we preserve, in our Naivete, what is reasonable to take from Direct Realism. Direct Realists have no problem on that front. The DR Phenomenal Array is the trivial simulacrum; it *is* an array of parts of the world itself, and it is, accordingly, spatially three-dimensional. There is plenty of volume in the world for the facing surfaces that we see. But the brain is a tighter space.

Let's consider a simple, if artificial, visual experience. Figure XXXX is a Julesz random dot stereogram which illustrates the role of parallactic disparity in generating three dimensional vision. This essay does not come with a stereoscope, so I leave the figure as an autostereogram. Sometimes the middle target is seen as below the surround, and sometimes above.

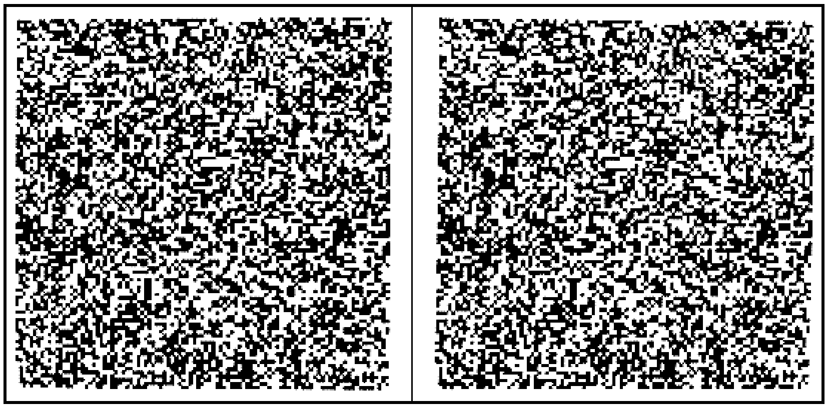

Fig 5

Suppose then that there is a cerebral volume in which the components of the Phenomenal Array are segregated into separate planes. Because most reports of this figure recognize only two spatial planes, we have a relatively simple model of how the appearance is constituted. While natural scenes, on the other hand, might be supposed to have many more planes in which there are visual presentations, here there would be only two occupied planes at a time. Some viewers find this figure to be ambiguous. Sometimes the centre square is nearer and sometimes farther away than the surround. What is required for a cerebral site to be able to support distinct phenomenal planes like these simple examples? Given NSDT's Naive commitments, we should say that we have a region of the brain in which two planar phenomenal figures are constructed at a time. Three planes are implicated if the figure is ambiguous for a given subject. Then, the centre square vanishes from the nearest occupied plane in the region, and reappears in a plane behind that of the surround.

Immediately we have a technical issue – either a difficulty or something instructive. Consider first the simple hypothesis that the generation of the planar surround and detached planar square are surface effects of some neural array, made available to the awareness and attention of the subject. Then there should be a neural array to yield the centre square when it is in front of the surround, as well as one for the surround. However, when the forward square vanishes and is replaced by the remote square, the space appears empty all the way through the middle of the surround until we attend to the remote square.

Following a long tradition, let's call the assumed region of the brain in which these presentations are made the 'Sensorium'. Such a Sensorium will rarely if ever be full, in the sense that it is everywhere occupied by elements of the Phenomenal Array. In the case of the random dot stereogram, it is mostly empty. This is instructive because it points to the Sensorium's being sufficiently densely occupied with neural structure that elements of the Phenomenal Array can be generated anywhere within it. If that is so, then we learn something about the capacities of awareness and attention. They are insensitive to certain classes of neural arrangements, as for example, the inactive neural array which initially yielded the near centre square. Such an insensitivity should not be confused with transparency in optical media, but there's probably little harm if, metaphorically, we say that the relevant neural arrays are 'invisible' to awareness and attention. This scenario seems to suggest that sometimes activated neural arrays generate elements of a Phenomenal Array to which awareness and attention respond and other times, not suitably activated, they are 'invisible'.

Perhaps we should say, given the above assumptions, that the neural underpinnings of the elements of the Phenomenal Array are *always* 'invisible' to awareness and attention. It is striking that, if what we are aware of is a volume in the brain, then we do not experience something like the graphical representations of structures of neurons that we see in neurology texts or in Ramon y Cajal's exquisite drawings, even allowing for the fact that the living cells have not been stained. What we are aware of is very different in character from those complex discrete structures. Perhaps it is not the neuronal arrays themselves that constitute the Phenomenal Array.[22]

*

Is the Phenomenal Array Two-Dimensional? NSDT may have an option, however, which would avoid the difficulty of 'invisible' neural structures. It is to assert that we are mistaken in our judgments that the Phenomenal Array is deep. It is two-dimensional. This is a highly counter-intuitive view and, no doubt, for many readers preposterous. I think that it is not, and that it is sufficient for the details of our phenomenology. First, note that at any given fixation only the segment of the Phenomenal Array corresponding to the foveal region of the retina offers the sharply delineated figure-ground separations and occlusions characteristic of focused vision. The foveal region contributes to the Phenomenal Array roughly 1-2 degrees of apparent arc, which is about the area of the tops of two thumbs held together at arm's length. Only a very small portion of the Phenomenal Array is so tidily formed at each fixation. The antidote to that is, of course, that we re-fixate relentlessly. Of course, figure-ground and occlusion properties are not the only properties characteristic of depth perception, but I propose that they are the decisive ones. Let's see what the crucial variables are in the different responses one has to (a) and (b) in Fig 6.[23]

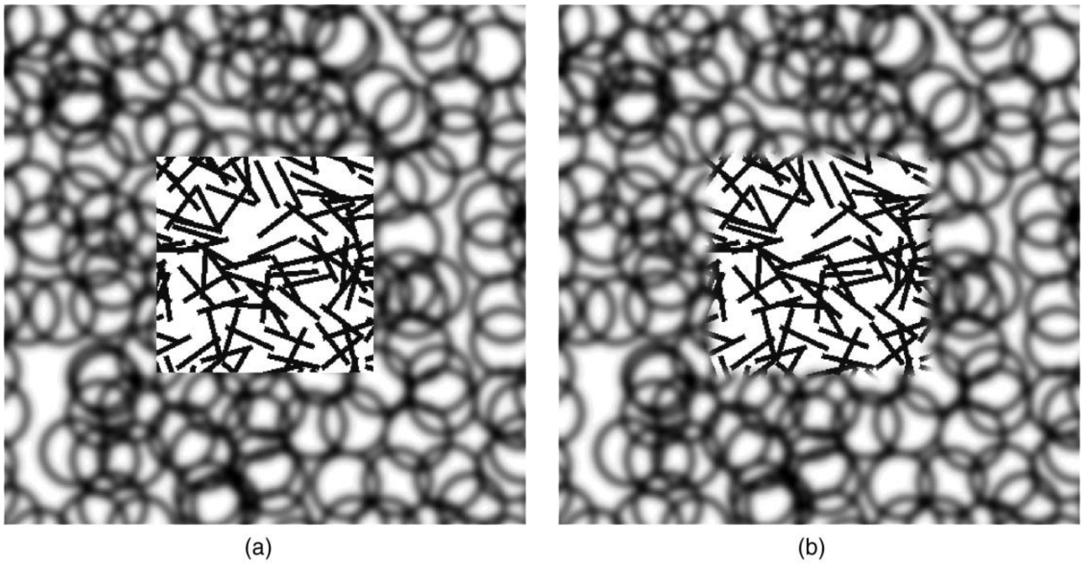

Fig 6

There are several attributes in play here. One is surface blur, and the central square and the surround differ in blur. Another is edge blur. We see, typically although not without exception, the centre square in (a) in front of the plane of the surround. In (b), we seem to be focused on the inner square behind the outer plane. Why? The crucial difference does not depend on colour, texture gradient, stereopsis, or even surface blur (that is held constant), but on which of the inner objects owns the sharp boundary. In more natural targets, many other factors enter into the formation of the Phenomenal Array and its apparent depth structure. In addition, movement introduces parallactic variation which, like stereopsis within relatively near distances, dominates other cues. Stereopsis permits quantitative estimates of depth, as does accommodation, but I propose that the net effect in the construction of the phenomenology is no different in principle from the static case given in the figure. Quantitative estimates of depth arising from parallax in movement does not result in the depth of perception of depth per se, but in the appropriate rate of displacement of the distant surface against a foreground target.

Even if the Phenomenal Array were 3D, its appearance would be indistinguishably replicated by a 2D surface with the appropriate combination of sharp contours, contour blur, surface blur, texture gradients, and luminance variation in the foveal zone. Having the production of colours, say, on a surface rather than in a 3D volume in the brain reduces the need for remote neurological influences in the formation of sensations, and is conformable to the brain's efficient use of *laminar* structures in the cortex generally, and in 'binding' devices such as the superior colliculus and the lateral geniculate nucleus.

If this proposal is correct, which I am sure many readers will doubt, then our judgments that we see depth in the Phenomenal Array might be counted as an extreme sort of Stimulus Error: we allow our phenomenological reports to be biased by what we know to be true of the world outside us.

[9] CONCLUSION.

I have attempted to sketch a simple sense datum theory. It is not propelled by epistemological or metaphysical bells and whistles, like foundationalism or logical atomism, but rather by what I take to be plausible in the light of scientific evidence. I have not argued from illusions and hallucinations, although they have their place as empirical evidence. As I have presented it, the sharp end of the argument is the difficulty of reconciling the properties of colours with the physical properties of distal stimuli.

Most neurological arguments against there being what I have called the Phenomenal Array, as Naively conceived, a unitary array addressed in unitary fashion by awareness and attention, aim at cortical versions of the thesis. However, cortical models are not the only available ones with promise (though like all models, with difficulties). Sub-cortical models are not without promise. I conclude with the proposal that the Phenomenal Array might plausibly be taken to be two-dimensional. Intuitively this is implausible at first. I believe that further reflection will undermine the (Grand) Stimulus Error of allowing phenomenological reports to be biased by our knowledge of what is true outside us. That would be helpful in avoiding difficulties in understanding why we can be aware of the Phenomenal Array, but not of neural structures juxtaposed with it.

REFERENCES

Anastassiou, C. A., R. Perin, et al. (2010). "Ephaptic coupling of cortical neurons." *Nature Neuroscience* 14(2): 217-224.

Barbur, J.L., et al. (1993), 'Conscious visual perception without V1. ', *Brain,* 116, 1293-302.

Bouman, M. A. and Walraven, P. L. (1957), 'Some Color Naming Experiments for Red and Green Monochromatic Lights', *Journal of the Optical Society of America,* 47 (9), 834-39.

Damasio, A. R. (1989a). "The Brain Binds Entities and Events by Multiregional Activation from Convergence Zones." *Neural Computation* 1: 123-132.

Damasio, Antonio R. (1990), 'Synchronous activation in multiple cortical regions: a mechanism for recall', *Seminars in the Neurosciences,* 2, 287-96.

Damasio, A. R. (1992). "The Selfless Consciousness." *Behav Brain Sci* 15(2): 208-209.

Damasio, A. R. (1994). *Descartes' error : emotion, reason, and the human brain.* New York, Putnam.

Dennett, D. C. (1991). *Consciousness explained.* Boston, Little, Brown and Co.

Driver, J. and T. Noesselt (2008). "Multisensory interplay reveals crossmodal influences on 'sensory-specific' brain regions, neural responses, and judgments." *Neuron* 57(1): 11-23.

Goodale, M. A. and A. D. Milner (2004). *Sight unseen : an exploration of conscious and unconscious vision*. Oxford ; New York, Oxford University Press.

Huemer, Michael (c2001), *Skepticism and the veil of perception* (Lanham, Md.: Rowman & Littlefield Publishers).

Jackson, F. (1977). *Perception : a representative theory*. Cambridge Eng. ; New York, Cambridge University Press.

Jameson, Dorothea and Hurvich, Leo M. (1955), 'Some Quantitative Aspects of an Opponent-Colors Theory. I. Chromatic Responses and Spectral Saturation', *Journal of the Optical Society of America,* 45 (7), 546-52.

Lovejoy, Arthur O. (c1930), *The revolt against dualism : an inquiry concerning the existence of ideas* (Chicago: Open Court).

Macaluso, E. (2006). "Multisensory processing in sensory-specific cortical areas." *Neuroscientist* 12(4): 327-338.

Macaluso, E. and J. Driver (2005). "Multisensory spatial interactions: a window onto functional integration in the human brain." *Trends Neurosci* 28(5): 264-271.

Macaluso, E., C. D. Frith, et al. (2002). "Directing attention to locations and to sensory modalities: multiple levels of selective processing revealed with PET." *Cereb Cortex* 12(4): 357-368.

Manzoni, T., P. Barbaresi, et al. (1989). "The callosal connections of the primary somatosensory cortex and the neural bases of midline fusion." *Exp Brain Res* 76(2): 251-266.

Marcel, Anthony J. (1998), 'Blindsight and shape perception: deficit of visual consciousness or of visual function?', *Brain and Language,* 121, 1565-88.

Marshall, Jonathan A., et al. (1996), 'Occlusion edge blur: a cue to relative visual depth', *Journal of the Optical Society of America,* 13 (4), 681-88.

Mather, G. and Smith, D. R. (2000), 'Depth cue integration: stereopsis and image blur', *Vision Res,* 40 (25), 3501-6.

Merker, B. (2007), 'Consciousness without a cerebral cortex: a challenge for neuroscience and medicine', *Behav Brain Sci,* 30 (1), 63-81; discussion 81-134.

Prichard, H.A. *Knowledge and Perception: Essays and Lectures* (Oxford: Clarendon Press).

Riddoch, George 'Dissociation of Visual Perceptions Due to Occipital Injuries, with Especial Reference to Appreciation of Movement.'' *Brain* 40, 15-57.

Santhouse, A. M., D. H. ffytche, et al. (2002). "Functional Imaging of the Mechanisms Underlying the Bilateral Field Advantage." *Neuroimage* 17(2): 680-687.

Sherman, S. Murray and Guillery, R.W. (2006), *Exploring the thalamus and its role in cortical function* (Cambridge, Mass.: MIT Press).

Sprague, J. M. (1966), 'Interaction of cortex and superior colliculus in mediation of visually guided behavior in the cat', *Science,* 153 (3743), 1544-7.

Tootell, R. B., M. S. Silverman, et al. (1982). "Deoxyglucose analysis of retinotopic organization in primate striate cortex." *Science* 218(4575): 902-904.

Tootell, R. B., J. D. Mendola, et al. (1998). "The representation of the ipsilateral visual field in human cerebral cortex." *Proc Natl Acad Sci U S A* 95(3): 818-824.

Walls, G. L. (1953). The Lateral Geniculate Nucleus and Visual Histophysiology. *University of California Publications Physiology*. Berkeley, California, University of California**:** 1-100.

Weddell, R. A. (2004), 'Subcortical modulation of spatial attention including evidence that the Sprague effect extends to man', *Brain Cogn,* 55 (3), 497-506.

Weiss, S. A. and D. S. Faber (2010). "Field effects in the CNS play functional roles." *Front Neural Circuits* 4: 15.

White, B. J., et al. (2009), 'Color-related signals in the primate superior colliculus', *J Neurosci,* 29 (39), 12159-66.

Young, M. P. and Scannell, J. W. (2000), 'Brain structure-function relationships: advances from neuroinformatics', *Philos Trans R Soc Lond B Biol Sci,* 355 (1393), 3-6.

Young, M. P., Hilgetag, C. C., and Scannell, J. W. (2000), 'On imputing function to structure from the behavioural effects of brain lesions', *Philos Trans R Soc Lond B Biol Sci,* 355 (1393), 147-61.

Zeki, S. and Bartels, A. (1998), 'The asychrony of consciousness', *Proc Roy Soc B,* 265, 1583-85.

Zeki, S. and ffytche, D. H. (1998), 'The Riddoch syndrome: insights into the neurobiology of conscious vision', *Brain,* 121, 25-45.

Zeki, S. (2001). "Localization and globalization in conscious vision." *Annu Rev Neurosci* **24**: 57-86.

---

[1] See Lovejoy, 1930, p. XX. In the quotation ‘dualism’ denotes the sense datum theory.

[2] See Huemer, 2001.

[3] I have excluded the traditional option dualistic non-physicality, on the grounds of the vagueness and ambiguity of the conceptualization. “Non-physical” is unhelpfully ambiguous and can, for example, be satisfied by the physics that is yet to come. I see no reason to deny that accounting for consciousness might require our appealing to ‘neo-physical’ variables which are commensurable with what is true in current physics. We should not insist that to count as physical something must be reducible to currently held physics, only that it can be incorporated into a common framework with it. For example, with a little historical idealization, electrostatic central forces (Coulomb forces) did not have to be reduced to mechanical theory in order to count as physical. Charge was introduced as a new fundamental property with an appropriate force law and contributed characteristic energies to combined mechanical and gravitational systems perfectly functionally.

[4] The cited papers highlight the areas of multimodality which appear in the extrastriate cortex. Further, they completely undermine the proposal of a unidirectional, feed-forward cascade after primary sensory contribution. There are important feedback circuits in play, in some cases from multimodal sites to primary unimodal ones, and, in others, between unimodal ones.

---

[5] Regardless of the problematic standing of the experiments of Benjamin Libet, and more recent work suggesting the same drift, it is perhaps appropriate that a Naive approach to the Phenomenal Array does not take it for granted that the locus of sensory experience is the very locus of decision making rather than of the perception of decision making.

[6] I suggest that such a terminology is infelicitous. If we start with paradigm cases of images such as paintings or photographs, then an image is an external artefact which produces in the viewer visual 'mental patterns' appropriately similar to those which would be produced in the viewer by the subject matter of that image. The definition of 'image' presupposes the concept of 'mental pattern'.

[7] Mathematical simulations by Malcolm Young and his colleagues raise some important questions about the decisiveness of double dissociation arguments in the case of cortical functions. See Young and Scannell, 2000, pp.3-6. See also Young, Hilgetag, and Scannell, ibid., pp. 147-61.

[8] Emphasis added.

[9] See Riddoch 1917.

[10] Ibid.

[11] Barbur 1993.

[12] In 1994, G.Y. highlighted a 'feeling' rather than an unequivocal visual experience.

[13] Zeki and ffytche, ibid.

[14] See Bouman and Walraven 1957.

[15] Zeki has not ignored the issue of how phenomenal microconciousnesses are to be assembled into bound percepts. Without adopting a 'terminal perceptual station', he supposes (Zeki, 2001, p. 75.) that nodal sectors of distant subsystems can have their activity bound in a process of non-hierarchical multistage integration. He explicitly envisages the binding as an 'integration between different perceptual correlates" and sets out conditions which should contribute to this integration: an enabling system such as the ascending reticular formation, thresholds of activity, reciprocal activation and deactivation, and more (Ibid., pp, 78-80.) Discussion of these proposals is impossible within the confines of this paper.

[16] See Figure 3.

[17] Tootell, Mendola, et al. (1998) have identified ipsilateral visual field maps which 'begin' approximately where the contralateral representations 'end' in the extrastriate cortex (p. 819). They accept that 'communication across the interhemispheric "seam" in higher visual areas presumably is related to the construction of a *unitary visual percept*, uniting the two hemifield maps present in the lower-tier areas" (p. 822, emphasis added). Similar conceptualizations have appeared in discussions of somatosensory cortical areas. Thus, Manzoni, Barbaresi, et al. (1989) have described in mammals the predominance in the primary somatosensory area, SI, of neurons with receptive fields of the roughly mid-line axial and paraxial trunk, with little or no representation of peripheral limbs. In the simplest model that they discuss, the corpus callosum permits "a unitary body representation generated by fusing together two somotototopically matching maps, one of the contralateral hemibody mediated by thalamo-cortical input and one of the ipsilateral hemibody replicated by the corpus callosum" (p. 251, emphasis added). Mid-line fusion serves to reduce noise in the primary somatosensory and visual cortices. This, I presume, is reflected in the 'bilateral field advantage' in vision which accrues to the bilateral neurons devoted to the central meridian (Santhouse, ffytche, et al. (2002)).

[18] See Sprague 1966.

[19] See Merker 2007.

[20] See White et al. 2009.

[21] See Weddell 2004.

---

[22] Electric fields might starting candidates to explain continuous expanses in the Phenomenal Array, particularly in the light of the recognition of the influence of ephaptic potentials on synchronization in ambient neurons. See Weiss and Faber, 2010, and Anastasiou, Perin, Markram and Koch, 2010.

[23] See Marshall et al. 1996. See also Mather and Smith 2000.