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Visual Experience and Motor Action: Are the Bonds Too Tight?[1]

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[1] This paper grew out of an invited commentary on papers by Adrian Cussins and Brian Cantwell-Smith, presented in a session on nonconceptual content at the Eastern APA, Washington , January 1998. Thanks to Adrian Cussins for encouraging me in this project and for granting permission to refer to his unpublished ms. Thanks also to various anonymous referees, to Jesse Prinz, Adrian Cussins, Brian Smith, Pete Mandik, Josefa Toribio and to my colleagues in the Philosophy/Neuroscience/Psychology Program and the Washington University School of Medicine. Special thanks to Ned Block, Martin Davies, Greg Currie and Frank Jackson for valuable exchanges concerning several earlier drafts, and to Martin Davies and Chris Peacocke for a wonderful face-to-face discussion in London. Earlier versions of this paper were entitled "Experience and Action: A Tension in the Notion of Nonconceptual Content".

Abstract/Introduction

How should we characterize the functional role of conscious visual experience? In particular, how do the conscious contents of visual experience guide, bear upon, or otherwise inform our ongoing motor activities? According to an intuitive and (I shall argue) philosophically influential conception, the links are often quite direct. The contents of conscious visual experience, according to this conception, are typically active in the control and guidance of our fine-tuned, real-time engagements with the surrounding three-dimensional world. But this idea (which I shall call the Assumption of Experience-Based Control) is hostage to empirical fortune. It is a hostage, moreover, whose safety is in serious doubt. Thus Milner and Goodale (1995) argue for a deep and abiding dissociation between the contents of conscious seeing, on the one hand, and the resources used for the on-line guidance of visuo-motor action, on the other. This 'dual visual systems' hypothesis, which finds many echoes in various other bodies of cognitive scientific research, poses a prima facie challenge to the Assumption of Experience-Based Control. More importantly, it provides (I shall argue) fuel for an alternative and philosophically suggestive account of the functional role of conscious visual experience.

1. The Assumption of Experience-Based Control

Here is Brian O'Shaugnessy's description of the act of intentionally bringing one's index finger down onto the center of a printed cross. During such an action, O'Shaugnessy suggests:

> one keeps looking as one guides the finger, and does so right up until the moment the finger contacts the cross, and the reason, surely, is that sight is continually informing one as to where in one's visual field to move one's visible physical finger
>
> (O'Shaughnessy, 1992, 233).

It is clear, from the larger text, that by "sight" O'Shaughnessy here means "conscious visual experience". But this assumption – that conscious visual *experience* provides the very information continuously used for visually based motor control – is precisely the one shortly to be challenged. Perhaps we keep looking not because our visual *experience* (or its inner substrate) is itself guiding the action, but because other (non-conscious) inner systems are also, and simultaneously, using visually transduced information to guide behavior.

The assumption to be called into question may be put like this:

Assumption of Experience-Based Control (EBC)

> Conscious visual experience presents the world to the subject in a richly textured way; a way that presents fine detail (detail that may, perhaps, exceed our conceptual or propositional grasp) and that is, in virtue of this richness, especially apt for, and typically utilized in, the control and guidance of fine-tuned, real-world activity.

EBC is itself neutral, as far as I can see, with respect to the ongoing debate concerning the need (or lack of one) to acknowledge a so-called 'nonconceptual' component in the contents of many perceptual experiences[2]. But, as the parenthetical clause in EBC is meant to indicate, some version of EBC is often invoked as part of the characterization of the functional role of any (putatively) nonconceptual contents of conscious visual experience. Certain components of our conscious visual experiences, according to these accounts, may be said to be nonconceptual in the sense that they may occur in the absence of the concepts

[2] A good entry point into this debate is Tim Crane 1992, especially sections 2 and 3. Also, Evans 1982 Ch. 4, 6 and 7, Peacocke 1986, 1992a, Cussins 1990 and various papers in Crane (ed) 1992.

that an agent, or a theorist, might typically use in attempting to describe them. Such contents may thus figure in the conscious perceptual experiences of beings lacking such concepts (young infants, non-linguistic animals), as well as in the experiences of adult, linguistically skilled humans. The contents of our perceptual experiences, accordingly, may be much finer-grained than the concepts we use to describe them. Thus Jose Luis Bermudez comments that:

> The central impetus for legitimating a notion of nonconceptual content has come from the study of perceptual experience… Theorists have been attracted to nonconceptual content by the thought *that the richness and grain of perceptual experience is not constrained by the concepts that a believer might or might not possess*.
>
> (Bermudez 1998, 50. My emphasis).

Peacocke (1986)(1991) is likewise motivated by the need to accommodate "the remarkable range of detail in the perceptual content [and] the range of different , and philosophically interesting, types of content that can be possessed by a particular experience" (Peacocke 1992b, 105). To this end he develops, the notion of "scenario content": a type of representational content fixed by specifying how the physical space around the subject can be filled if the content is to be correct (1992b, 105-110).

Driven as they are by this imagined gap between our concepts and certain conscious perceptual contents, appeals to the notion of nonconceptual content face an obvious challenge. The challenge is to say what then makes it the case that some specific nonconceptual content is present and figures in an agent's conscious perceptual experience. This is where something like EBC seems to enter the scene. For the appeal to verbal report, drawing as it does upon a subject's conceptualized grasp of the visual scene, looks relatively impotent here[3] . To meet this challenge, many theorists of nonconceptual content appeal to various kinds of link with action. The nonconceptual contents of perceptual experience are thus often depicted as being at least partially constituted by their roles in guiding various forms of world-involving action. Thus Peacocke speaks of a profound "connection … between the nonconceptual content of perception and bodily action" (Peacocke 1992b, 131). In describing the specific role of scenario content in human action, Peacocke claims that "perception supplies that nonconceptual information in a form immediately usable if the subject wants to move his body … towards … what he perceives" (ibid). Gareth Evans, in a (1985) paper entitled "Molyneux's Question", suggests that the nonconceptual content of a sensation is in part a function of the organism's sensorimotor skills – a function of the way the perceptual experience could be used to guide various kinds of skilled activity. Speaking of the way we can hear a sound as coming from a certain location, Evans famously claims that:

[3] But note the recent literature concerning the possible role of demonstratives in characterizing even very fine-grained perceptual contents. See Peacocke 1998, McDowell 1998b

> the complex property of auditory input which codes the direction of the sound acquires a spatial *content* for an organism by being linked with behavioral ouput.

(Evans 1985, 385)

Grush (1998) notes that this is *not* to claim that the experience must actually lead to skilled sensorimotor response, nor even that the organism be currently capable of such response (it may have the skills but be injured or paralyzed and unable to use them). The idea is just that the experience (by which I shall always mean 'conscious experience') must, in normal conditions, normally serve to guide skilled sensorimotor engagements. It is this capacity to guide action that, according to Evans, imbues the experience with spatial content[4].

As a final example, consider Adrian Cussins description[5] of the skilled motorcyclist's nonconceptual knowledge of her speed. The motorcyclist, Cussins points out, may not know that her speed is, say, around 70 mph. But she may

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[4] Evans' overall account, however, is complicated by an important wrinkle. He depicts conscious experience as resulting when "the inner states which have a content by virtue of their phylogenetically more ancient connections with the motor system also serve as input to the concept-exercising and reasoning system" (1982, 227). The content of conscious perceptual experience, on such a view, depends not just on appropriate connections with motor actions but also on the accessibility of that content to conceptualized thought. Nonetheless, such access is depicted (Evans 1982, 159, Davies 1997, 312) as taking place without transforming the nonconceptual content of the perceptual experience into a conceptual one.

[5] The example was given in Cussins' presentation to the Eastern APA, Washington, 1998, and is reproduced with the author's permission.

nonetheless have a precise sense of how fast she is going: a sense fully manifest, Cussins argues, in the skilled responses and micro-adjustments made while she is in control of the bike. The conscious-but-nonconceptual content of her experience of speed is thus cashed out as a matter of

> "knowingly making micro-adjustments of … speed … in response to changing road conditions"
> (Cussins 1998, 10)

and as:

> "hands on engaged knowledge … manifested in *experience-guided activity and potential activity*"
> (Cussins 1998, 22, my emphasis).

I conclude that, in several influential treatments (Evans, Peacocke, Cussins), a notion of the nonconceptual content of conscious perceptual experience is, prima facie, being required to play a dual role: to reflect, on the one hand, the nature and grain of our conscious experience; and to make intimate contact, on the other hand, with the ongoing control of motor activity. What holds these two strands together is the perfectly commonsensical (but potentially false) Assumption of Experience-Based Control. This assumption thus plays a special role in attempts to legitimate a notion of nonconceptual content. But it is equally implicated both in a certain intuitive picture of the functional role of conscious visual experience (roughly, that we use conscious seeing to guide fine motor activity) and in any philosophical account which seeks to fix the contents of perceptual experience (whether conceptualized or not) by invoking direct links with action. . Certain teleosemantic accounts (eg Millikan (1984) may thus be equally at risk, as are accounts (such as Dennett (1991)) which unpack experiential content in terms of undifferentiated patterns of behavior and response.

For what if – contrary to strong readings of EBC– our experiences *don't* control our behavior, or do so only in a rather more indirect manner than we intuitively believe? What if, to be blunt, experiential content and action-guiding content prove to be empirically quite distinct? In the next two sections, I examine some evidence that seems to support just such a radical dissociation, and that sets the scene for the conceptual re-evaluation attempted in the subsequent (and final) section.

2. Visual Awareness and Visuomotor Control

Despite the intuitive appeal of EBC, is is surely equally clear that a great deal of our daily, fine-tuned motor activity proceeds quite independently of the current contents of conscious visual experience. Thus consider the way we use visual information (as well as proprioceptive) information to make tiny, continuous postural adjustments while 'standing still' on a moving bus. In a controlled experiment, Lee and Lishman (1975) placed subjects in a room which was (unbeknownst to them) suspended from the ceiling of a larger room and was gently swaying back and forth. The subjects were shown to be using both visual and prorioceptive information to make fine postural adjustments while remaining quite unaware of either these adjustments or of the gentle swaying of the room[6].

In another series of experiments subjects were required to both visually track and manually point out a visually presented target. This target, however, was sometimes suddenly (unexpectedly) slightly displaced after the original presentation. Bridgeman et al (1979) showed that subjects would accommodate this displacement (as evidenced by accurate saccades and pointing) whilst remaining quite unaware that the target had moved. Moreover, in those cases where the displacement was large enough to attract attention and hence to enter conscious awareness, the on-line adjustments were much less fluid and less successful (see Milner and Goodale, 1995, 161). To round this story off, Wong and Mack (1981) showed that subjects who automatically and unconsciously accommodate the smaller displacements will, if subsequently asked to point to the remembered location of the (now-removed) target, actually point to the original (non-displaced) location. Similar results have been obtained for grasping motions directed at present versus remembered visually-displayed objects (see Milner and Goodale 1995, 170-173). Memory-driven responses thus seem to be

[6] This example is reported in Milner and Goodale 1995, 175

tied to the contents of conscious visual experience, while on-line object-engaging performance is driven by a distinct and more sensitive resource. This alignment of memory with conscious visual experience is a matter to which we will later (section 4) return.

None of this, I submit, will come as any surprise to an expert sportsplayer. In returning a fast tennis serve, to take an obvious example, one's bodily adjustments and responses seem quite clearly to be governed by the unconscious use of visually processed information. More recent work on cognitive disabilities (and in cognitive neuroscience more generally) suggests, however, the perhaps unsuspected extent to which visually-based daily action is under the fine control of non-conscious visually-based processes.

The most dramatic evidence of dissociation between conscious visual experience and vision-for-action is found in certain neurologically compromised patients. The patient DF, a victim of carbon monoxide poisoning suffering from widespread lesions of the so-called ventral visual stream (see fig.1 and description later in the text), cannot identify objects by sight (though she can do so by touch). Nonetheless, she is able to pick up these very same objects – that she cannot visually identify – using fluent, well-oriented precision grips. Others, by contrast, suffer dorsal stream lesions. These 'optic ataxics' :

> have little trouble seeing [that is. identifying objects in a visual scene] but a lot of trouble reaching for objects they can see. It is as though they cannot use the spatial information inherent in any visual scene
>
> (Gazzaniga 1998, 109).

DF, while claiming that she cannot see the orientation of a displayed slit, can nonetheless (on demand) successfully 'post' a letter through the slit, with the letter pre-oriented so as to pass easily through. The optic ataxics, by contrast, are able to consciously perceive and report the orientation of the slit but are unable (and not due to any brute physical impairment) to pre-orient and post the letter. Such patients are aided somewhat if the slit is presented then removed, and the request is to orient the letter in the way that would have been appropriate were the slot still available. This allows the use of a distinct, memory-based strategy. DF, by contrast, is unable to perform at all under this 'delay' condition. Once again, then, we see tight links between memory and conscious visual awareness, and a dissociation between both of these and on-line object-engaged performance . DF cannot consciously perceive the orientation, nor can she succeed in the delay condition, while the optic ataxics can consciously perceive the orientation and actually do better in the delay condition- see Milner and Goodale 1995, 96-101, 136-138.

All of this, as Milner and Goodale stress, makes excellent computational sense. For fine-grained action-control requires the extraction and use of radically different kinds of information (from the incoming visual signal) than does recognition, recall and reasoning. The former requires a constantly updated, egocentrically-specified, exquisitely distance and orientation sensitive encoding of the visual array. While the latter requires a degree of object-constancy, and the recognition of items by category and significance irrespective of the fine detail of location, viewpoint and retinal image size. A computationally efficient coding for either task precludes the use of the very same encoding for the other: a diagnosis also supported by work revealing the very different response characteristics of neurons in the dorsal and ventral streams (see Milner and Goodale, 1995, 25-66).

The best interpretation of all these bodies of data, according to Milner and Goodale, is that memory and conscious visual experience depend on a type of mechanism and coding that is different from, and largely independent of, the mechanisms and coding used to guide visuomotor action in real-time. The former, they suggest, depend on processing in the so-called 'ventral stream' leading from primary visual cortex to temporal areas. While the latter (the action-guiding resources) depend on the 'dorsal stream' leading to parietal cortex (see Fig. 1).

Fig. 1 Schematic diagram showing major routes whereby retinal input reaches the dorsal and ventral streams. The inset shows the cortical projections on the right hemisphere of a macaque brain.

LGNd, lateral geniculate nucleus, pars dorsalis; Pulv, pulvinar nucleus; SC, superior colliculus.

The general idea then, is that the ventral and dorsal visual streams (originally glossed as "what" and "where" pathways – see Ungerleider and Mishkin, 1982) may be better glossed[7] as "what" and "*how*" pathways, with the ventral ("what") stream specialized for object identification, categorization, off-line reason and recall, and conscious perception, and the dorsal ("how") stream specialized for fluent motor interaction, in the here-and-now, with the target physically present. Nor, by way of an aside, is this functional compartmentalization unique to vision. Rauschecker (1998) presents powerful evidence for a similar dissociation in audition, positing "the existence of a dorsal stream for the processing of auditory spatial information and a ventral stream for the processing of auditory patterns, including communication sounds and speech" (Rauschecker, 1998, 516).

As a final (though, as we shall see, problematic) example of these dual visual systems in action in normal, unimpaired subjects, consider Milner and Goodale's account of certain results involving illusory size distortions. Figure (2) shows the famous "Tichener circles" illusion in which we misjudge the sizes of the central discs. In the topmost drawing, the two central discs are (in fact) equal in size, whereas in the lower drawing they are different in size. The effect of the surrounding rings of large and small circles, in each case, leads us to perceptually misrepresent the actual size of the central discs, seeing them as different when they are the same (top case) and the same when they are different (bottom case).

Fig. 2 Diagram showing the 'Tichener circles' illusion. In the top figure the two central discs are of the same actual size, but appear different; in the bottom figure, the disc surrounded by an annulus of large circles has been made somewhat larger in size in order to appear approximately equal in size to the other central disc. (From Milner & Goodale 1995. By permission).

Conscious visual experience, in this case, delivers a content which seems to misrepresent the actual size of the center discs This misrepresentation surely occurs *within* the conscious visual experience itself. For we are capable of altering our conceptual judgment without thereby altering the way the visual scene appears to us in perceptual experience. Once we know about the illusion

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[7] Milner and Goodale (1995) is, in effect, an extended defense of just this claim. A related way of describing the functional separation is offered by Zeki (1993), who also posits two 'form' systems, one (the ventral stream) treating form in association with color and static properties, the other (the dorsal stream) concerned with 'dynamic' form and motion – see also Jeannerod 1997, 20. Jeannerod endorses the idea of these dual visual pathways but lays a greater emphasis (than Milner and Goodale) on the interactions between the two systems. Jeannerod agrees, however, on the description of the dorsal system as specialized for vision-for-action (Jeannerod 1997, 11, 20) and on the special role of the ventral stream in

we may judge that the center circles in the topmost picture are identical in size despite the persistence, in our conscious visual experience, of the illusion But now let's add a surprising twist.

Aglioti et al (1995) set up a version of the illusion using thin poker chips as the discs, and asked subjects to "pick up the target disc on the left if the two discs appeared equal in size and to pick up the one on the right if they appeared different in size" (Milner and Goodale 1995, 167). The surprising upshot was that even when subjects were unaware of – but clearly subject to – the illusion, their motor control systems produced a precision grip with a finger-thumb aperture perfectly suited to the *actual* size of the disc. This aperture was not arrived at by tactile means, but was instead the direct result of fine-grained, visually-guided adjustments. Yet it reflected not the illusory disc size given in the subject's visual experience, but the actual size. In short:

> Grip size was determined entirely by the true size of the target disc [and] the very act by means of which subjects indicated their susceptibility to the visual illusion (that is, picking up one of two target circles) was itself uninfluenced by the illusion.
>
> (Milner and Goodale 1995, 168)

This is, it seems to me, a somewhat startling result. If the Milner and Goodale story is accepted, there is at least a *prima facie* problem certain readings of EBC

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processing object-identity (Jeannerod 1997, 148). We shall return to the complex topic of the interactions (the assumption of experience-based control). For it is no longer clear that conscious visual experience is deeply linked to the fine-grained control of motor action.. The kind of coding and processing implicated in the real-time guidance of delicate, fluent, object-engaged action is, it now seems, frequently and significantly distinct from that which supports our ongoing perceptual experience of the scene. Indeed, the two can often conflict with little or no effect on the fluent, world-engaging action. As a result the inner resources that determined (for example) the shape and character of Cussins' motorcyclist's multiple micro-adjustments of speed and tension (section 1 above) may turn out to be surprisingly independent of those that determined the character of her ongoing perceptual experience. In such cases, the nonconceptual content of our perceptual experience, although genuinely and importantly *distinct* from the contents of our propositional judgments, is by no means identical with fine action-guiding contents either. More generally, the contents of conscious visual experience may play no ongoing role in the fine tuning of our object-engaged motor behaviors. When, to recall the opening image from O'Shaugnessy, we continue to look as we bring our finger down onto the center of the printed cross, we may be looking so as continuously to feed visual information to a thoroughly non-conscious action-guiding system - a kind of vision-using zombie, to borrow Gaazzaniga's (1998) characterization. The functional role of conscious seeing, if this is correct, is simply not as we might have imagined.

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between the dorsal and ventral streams in Section 4.

3. Weighing The Evidence

Perhaps we need to clarify, or even radically re-configure, our understanding of the links between conscious visual experience and here-and-now visually guided action. Before undertaking such a task, however, it is wise to ask ourselves: just how compelling is the empirical evidence just presented, and what exactly does it demonstrate or suggest? In particular, the difficulty (see below) of interpreting the dramatic experiment involving the Tichener circles will illustrate the need for due qualification and for wideranging attention to all the evidence now in play.

Before proceeding, it is worth sounding a small note of caution. The Tichener Circles case study, it needs to be stressed, is just one small brick in a densely constructed wall of evidence (it occupies, to give you a sense, just 4 pages of the 250 page treatment by Milner and Goodale (1995)). I have tried to present a wider and more balanced body of evidence. Nonetheless, certain worries concerning the illusory size distortions example may have a rather wider significance, and can help lead us towards a more nuanced view of the functional role of visual experience.

One worry about the use of the Tichener circle experiment (first suggested to me by Christopher Peacocke and Martin Davies (personal communications)) concerns the precise nature of the putative misrepresentation. If we allow, for example, that a single perceptual experience may present multiple inconsistent contents, then we need not accept that there is (in the experience) any misrepresentation of the actual size of the center disc. It is possible (to take the bottom-most case in the diagram) that the size of each disc is given correctly in experience, but that we are prone to an illusion concerning (only) the relative sizes of the two discs. That is to say, each disc is represented as being the size it is, but we misrepresent the relation as one of (in this case) sameness rather than difference.

A neat way to illustrate the kind of possibility in question has been presented by Smeets and Brenner (2001) using a modified version of the Muller-Lyer illusion (fig 3 below).

Fig. 3. The Brentano version of the Muller-Lyer illusion is an example of the inconsistent perception of physically related spatial attributes such as extent and positions. The alignment of the points of the arrows in (a) with the vertical lines in (b) is based on the perceived positions of the line intersections, whereas the bisection of the horizontal lines is based on the perceived extent of the line segments.(From Smeets and Brenner 2001.By permission of the authors and of Elsevier Science Ltd)

In this version of the famous illusion, the addition of two vertical lines, aligned with the arrowheads and bisecting an additional horizontal line yields a display in which:

> The vertical lines and the points of the arrows appear to be exactly aligned (which they are). The central vertical line...appears to divide the horizontal line in two equal parts (which it does). Nevertheless the central arrow...seems to bisect the upper horizontal line in two unequal parts (which it doesn't).
>
> (Smeets and Brenner 2001,287)

The various spatial contents made available to our conscious visual awareness are thus inconsistent. A similar result could, as a reader for this journal has pointed out, be obtained for the Tichener circles simply by adding two parallel lines tangent to both center circles on opposite sides. Our conscious visual experience may thus comprehend multiple, not necessarily consistent, components. As to which of these components is then implicated in some specific response, that may well vary with the task, the context, and the expertise of the agent. Caution is therefore indicated, since the fact that performance on a given task seems to suggest that we are not consciously aware of something (such as the correct size of the circles) may be misleading. Choose a different task and we may get a different answer.

All this leads, rather naturally, towards a second, and even more general, kind of reservation. Milner and Goodale depict a single, stable, strong dissociation between the neural resources used for conscious seeing and those used for on-line, object-engaged visuomotor control. But several experiments suggest that what we actually confront may be more closely akin to a task-variable recruitment of different resources. Thus, contrary to a maximal reading of the

Milner and Goodale results, recent evidence suggest that conscious visual illusions *do* influence grasp, although only to a small degree. Thus consider Ellis et al (1999) – a study involving illusions in which visual experience misrepresents the centerpoint of a bar due to the presence of a misleading background (the 'Ponzo' illusion (Brenner and Smeets (1996)) or other misleading cues (such as those presented by a variant of the famous Müller-Lyer illusion developed by Judd (1899)). Ellis et al found that visually-based judgments of the centerpoint of the bars were indeed skewed, just like the judgment of relative size in the Titchener circles case. But they *also* found that subjects' attempts to grasp the bars at the centerpoint were not (pacé Milner and Goodale) completely uninfluenced by the illusion. Grasp-points were significantly more veridical (closer to the real centerpoint of the bar) than estimates grounded in visual perception, but they were *even more veridical* in the control (no illusory backdrops) condition. Ellis et al thus conclude that the visual illusion *does* influence the action systems, but that the action (grasp) system must also have access to more veridical information and that the results obtained reflect the interaction between the two. The image is one of "partial rather than absolute dissociation" between vision-for-action and vision-for-perception, such that "the motor system has access to both the illusory perceptual information (presumably obtained from the ventral stream) and the veridical information (presumably obtained from the dorsal stream)"(Ellis et al 1999,113). More generally, Jeannerod (1997) offers a variety of evidence likewise favoring a greater degree of interaction between vision-for-perception (specifically, object recognition) and vision-for-action (specifically, the use of spatial information for object-relative ("allocentric") navigation) – see Jeannerod 1997, 88-92. Finally, Decety and Grèzes (1999) use PET neuroimaging studies to support the conclusion that the degree of dissociation and segregation of labor between the dorsal and ventral pathways depends crucially on the nature of the activity. When perception has a clear, explicit problem-solving goal, intense segregation of labor is observed. But "when perception has no explicit goal…both visual pathways are found to be implicated" (Decety and Grèzes 1999, 177). The nature and extent of dorsal-ventral interaction may thus depend in part on the task at hand, rather than being a fixed feature of human vision[8].

The most significant reservations concerning the very strongest forms of the dual visual systems hypothesis are thus twofold:

1. The possibility that conscious visual experience involves multiple, potentially inconsistent, contents.

and:

[8] Carey 2001 offers a balanced review of the data concerning visual illusions and concludes that most, though not all, of the new evidence is fully compatible with a strong, dual visual systems hypothesis.

2. The idea of task-specific recruitment of resources, and hence of a task-variable relationship between the contributions of the dorsal and ventral streams.

Taking both these worries on board, we would end up with a potentially shifting boundary between the conscious and nonconscious uses of visual information, and with a methodological challenge in plotting the precise contents of visual awareness (since different experimental designs might probe different (and potentially inconsistent) conscious contents).

Such complications and caveats do not, however, undermine the central challenge to EBC. For that challenge depends only upon the general (and more-or-less uncontroversial) idea of visually-guided yet non-conscious, fine-action-controlling systems. And this idea is fully compatible both with a physiological story involving on-the-spot, task-specific recruitment of resources, and with the presence, within conscious visual awareness, of multiple inconsistent contents. Conscious visual experience may indeed present multiple inconsistent contents. But in so doing, it need not present any of those contents in a computational format apt for use in the fine control of on-line, skilled motor action.

Moreover, this general story is one that enjoys widespread cognitive scientific support (see for example Zeki (1993) Jeannerod (1997), Gazzaniga (1998) , Decety and Grezes (1999), Carey (2001) and many more). The story also has some intuitive appeal, once we reflect of expert sports performance, driving skills etc. What is increasingly apparent (see especially Gazzaniga 1998) is that the involvement, in our daily activities, of these non-conscious, fine-action guiding systems is immense and pervasive. It is sufficiently immense and pervasive, in fact, as to render initially puzzling the functional role of conscious vision itself.

For Milner and Goodale, this latter amounts to a question concerning the functional role of the coding in the ventral stream, and (hence) of the nature of the interactions between this stream and its dorsal cousin. But the question of how conscious seeing interacts with the on-line control of skilled action is, clearly, a much more general one which may be addressed independently of these specific physiological conjectures.

Let us begin, though, with Milner and Goodale's own suggestion. Despite their overall stress on the relative independence of the dorsal and ventral visual streams, Milner and Goodale accept that there has to be some kind of important interaction between the two. As they themselves comment (Milner and Goodale 1995, 201-204), the two streams must act harmoniously, non-competitively and – in some sense – co-operatively. Even the neuroanatomy exhibits multiple instances of cross-connectivity between the streams, and displays certain neuroanatomical areas as common ground between the two (areas such as V3A and MT – see Felleman and Van Essen 1991). This makes obvious functional sense. We are clearly able to factor stored high-level information into basic action routines, for example when our reach and grip is adjusted to the known weight and slipperiness of a visually encountered object. In this vein, Milner and Goodale (1995, 202) explicitly allow that part of the process of visuomotor grasping probably involves "the transfer of high-level visual information between the two streams," and add that:

> Understanding these interactions would take us some way towards answering what is one of the central questions in modern neuroscience: how is sensory information transformed into purposeful acts?
>
> (Milner and Goodale 1995,202)

The immediate question, then, is how to capture the shape of the crucial interactions. Milner and Goodale's suggestion is that such interaction occurs largely at the level of target and action-type selection. Roughly speaking, the conscious visual contents (supported, they claim, by activity within the ventral stream) are said to figure prominently in our *selection* of goal-objects and in our choice of *types* of action, while a largely independent (and, they suggest, dorsal stream based) coding provides the spatial and physical form information needed for the fine-grained control and maintenance of the ensuing activity. The process of selection of objects to be acted upon may, it is speculated, involve mechanisms of attention that "flag" the goal-object and initiate the retrieval of whatever high-level information needs to be factored into the visuomotor routine. The act of grasping a fork, for example (see Milner and Goodale 1995, 203) requires not *simply* the provision of an accurate precision grip, but a grip appropriate to the intended *use* of the fork.[9] And this requires the dorsal stream to be influenced by the high-level products of ventral stream processing. Interaction thus occurs, and is vital to normal functioning. But the influence is high-level and does not (contrary to one way of unpacking the notion of the nonconceptual content of perceptual experience) involve the use of a rich, common (nonconceptual) content-base both to guide fine-grained action and to support the phenomenal experience.

This broad notion of a relatively high-level 'executive' interaction between conscious seeing and fine-grained motor control is, I suggest, highly attractive. It can be maintained, moreover, even while accepting the twin caveats mentioned earlier. And it helps make sense of those interesting linkages (remarked several times in the text) between conscious visual awareness and memory, and of the equally interesting dissociations between both of these (on the one hand) and fine-tuned, object-engaging action (on the other).

[9] Sirigu, et al, 1995 describes a patient who looks to have intact processing in both the dorsal and ventral streams, but to suffer from impaired interaction between the two. This patient can grasp objects fluently, and can name objects, but will often display an efficient (well-calibrated) grip that is inappropriate to the objects use – see the brief discussion in Milner and Goodale 1995, 203 and the longer one in Jeannerod 1997, 91-93.

Thus consider Prinz's suggestion that "the key to connecting consciousness with action might involve memory systems rather than motor systems" (Prinz 2000, 252). Prinz's idea is that conscious awareness is intimately bound up with the use of attentional systems to put sensory systems into contact with working and episodic memory. Such contact developed, he conjectures, so as to allow stored memories of specific incidents to guide planning and action-selection. It was the relatively recent co-evolution of consciousness and new memory systems (especially episodic memory) that, on this account, then freed certain creatures from the here-and-now, and opened the doors to planning and reason as we know them. The upshot was to drive a new wedge between sensing and acting, rendering the relation at times indirect. The functional role of conscious visual perception, on this model, is to support reason, recall and reflection. It is only indirectly to guide (better, to select) actions in the here-and-now.

Such indirect modes of influence would include, as Milner and Goodale suggest, the selection of action types and of targets. The apparently fine detail (but see recent work on 'change blindness' for some highly relevant doubts about this appearance of rich visual detail[10]) of our conscious visual awareness is not, if this is correct, the ongoing driving force behind our successful object-oriented manipulations. Instead, conscious seeing makes its contribution at a rather more

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[10] See for example Simons and Levin (1997).

executive level: a level which guides my behavior only in the same sense as my love of pasta may be said to guide my selection of a menu item.

Despite the caveats, then, I think there exists a strong empirical case for the operation of two fairly distinct visual systems underlying human performance. If this is so, then we do indeed need to clarify, or perhaps revise, the assumption of Experience-Based Control (EBC). In the next, and final, section, I attempt such a reformulation, and canvass the implications for some philosophical projects.

4. Re-thinking Experience and Action[11]

The functional role of conscious visual perception, I have argued, is not quite as it sometimes seems. For although it may seem as if conscious seeing is what continuously and delicately guides our fine-tuned motor activity, such on-line control may be largely and typically devolved to distinct, non-conscious, visual input using systems. Conscious visual experience, by contrast, is delicately geared to knowing the visual scene in ways appropriate for planning, recall, and reason-based action selection. And it is only in this rather indirect sense that conscious seeing may be said to guide our actions. The potentially misleading

[11] Special thanks to Martin Davies , Chris Peacocke, and an anonymous referee for helping to clarify these matters. They are not, alas, to he held responsible for any mistakes, errors or misinterpretations.

formulation in EBC (section 1 above) should thus be replaced with something more transparent, such as:

Hypothesis of Experience-based Selection (EBS)

> Conscious visual experience presents the world to a subject in a form appropriate for the reason-and-memory based selection of actions.

The explicit replacement of EBC with EBS is, I believe, a positive step in the large-scale philosophical project of understanding the nature of (and the links between) conscious perception, action and reason. It is a step, moreover, which has clear implications for existing work.

Thus, regarding the (putative) nonconceptual contents of conscious visual experience, EBS clearly favors at most a rather indirect account of the relation between such contents and profiles of world-engaging action. Thus whereas Cussins (1990) (1998)) seeks to cash out the nonconceptual aspects of visual experience by appeal to very fine-grained capacities to move and react (recall the motorcyclist's multiple 'microadjustments'), EBS must incline us towards a more indirect account, perhaps along the lines of Peacocke (1992a,b). In Peacocke's account the link between content and action is routed via the distinct intermediary stage of (for the visual case) *spatial reasoning*. It is not the actual or potential actions of the subject which thus determine the correctness of specific assignments of nonconceptual content, so much as the way those experiences inform episodes of spatial reasoning. Such reasoning, in all the central cases Peacocke discusses, crucially involves the presence of specific demonstrative beliefs and desires: the belief that *that* tree is located in *that* part of (egocentrically identified) physical space, etc. (see Peacocke 1992b,131). Visual perception thus supplies nonconceptual information which supports spatial reasoning, as when the subject intends to point to a certain tree and – courtesy of the experientially presented nonconceptual information – forms the intention to move her arm in an appropriate (again nonconceptually identified) direction.

Martin Davies (personal communication) concludes that accounts that in this way mediate the perception-action linkage (via the use in thought of perceptual demonstrative concepts) are less threatened by the apparent empirical dissociation[12] between conscious visual experience and the on-line control of fine-grained visuomotor action. The threat is by-passed, it seems, because the content-constituting link is now *not* directly between conscious visual experience and physical action, but between such experience and the processes of thought

[12] A refereee notes, correctly, that the kinds of empirical story scouted in the text do not strictly speaking imply dissociation. The mere fact that our experiences and actions often have common causes might, for example, keep them associated. In speaking of dissociation, I intend only the standard cognitive psychological sense, in which two cognitive capacities are said to be dissociated to the extent that each can function independently of the other (even if, normally, they non-accidentally march in step).

and reasoning which may inform subsequent actions. In Peacocke's treatment the bonds between nonconceptual contents and patterns of possible real-world action are thus much looser than those invoked by Cussins.

This proposal, positing as it does a much more indirect link between the contents of visual experience and environmentally-engaged action, fits quite well with Milner and Goodale's own conception (Section 3 above) of the role of visual experience in guiding action. Guided by this account, EBS re-casts the notion of experience-based control so as to require only that visual experience inform our high-level goals and intentions[13], which then flag targets for the vision-for-action system to engage.

It may seem, however, that EBS comports best of all with accounts that simply reject the notion of a nonconceptual component in visual experience altogether. For according to EBS the *deep* joint in our cognitive nature is between the non-conscious, action-supporting system and the conscious system that perceives, experiences, categorizes, and – given a public language – issues verbal,

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[13] In this vein, Frank Jackson suggests that for the assignment of content to mental states what *matters* about the relation between experience and action is the "distinction between behavior that does, and behavior that does not, count as satisfying the subject's desires if their beliefs are true" (Jackson, personal communication).

propositional judgments.[14]. On this view, categorization, awareness, experience, recognition and abstraction all characterize an integrated perceptual-cognitive system, while on-line, fine activity-guiding know-how operates from a quite different base. Conscious visual is, according to EBS, intrinsically poised to figure in processes of off-line reflection, recall and cascading abstraction (recall the ventral stream's involvement in object identification, awareness, and delay-condition responses). As such, it is a closer cognitive neighbor to full-bloom conceptual content than to on-line, daily activity-guiding know-how.

Where the friends of nonconceptual content aligned visual experience and visuomotor action, and kept these distinct from conceptual reason, EBS thus invites us to align conscious visual experience and conceptual reason, and to keep these distinct from visuomotor action. This empirical story recalls philosophical accounts that depict perceptual *experience* as in some sense *already conceptualized*. For the coding that supports conscious visual experience is geared to the extraction of "viewer-independent" features – those relatively permanent features of objects (color, shape irrespective of viewing angle, etc.) that, plausibly, enter deeply into our perception of a world of enduring, independent objects. EBS thus comports rather nicely with, for example, John McDowell's

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[14] Fodor (1998) defends a related view . According to Fodor, having a concept is not a matter of being able to do anything in particular, but is rather a matter of "being able to *think* something." (Fodor 1998,29, italics in original.)

depiction of perceptual experience as 'bringing objects into view', and as a process:

> in which objects are manifestly there for thinkers, immediately present to their conceptually shaped sensory consciousness.
>
> (McDowell 1998a, 465)

Conscious visual experience, according to EBS, is already formatted, packaged and poised for use in conceptual thought and reason: it is part of what Milner and Goodale (1998, 4) suggestively describe as a system for "insight, hindsight and foresight about the visual world". The contents of conscious visual experience are, on this story, entirely and profoundly *concept-ready*. And what this costs them is their ability to play a direct role in the on-line support of fluent, object-engaged behavior.

It does not follow, however, from such contents being 'concept-ready' that they are in some sense already conceptualized: they may, that is to say, be non-conceptual contents in good standing. Let me end, then, by mentioning one last (rather more radical) way in which to accommodate both EBS and something like a notion of the nonconceptual content of visual experience. Up to this point I have taken it more or less for granted that the contents of visual perceptual experience are exhausted by (roughly speaking) the perceived filling out of local visual space. But an ambitious theorist might try for a "thicker" notion of the content of the visual perceptual field. Instead of seeing it as the simple filling out of visual space, an ambitious theorist might construct a kind of duplex notion of the character of visual experience: a notion that involves both a relatively passive perceptual content (the perceived filling out of visual space) *and* the way our visual experience presents that space as an arena for fluent, engaged action[15]. Thus on visually encountering, say, a letterbox and an envelope of a certain size, it may be deemed *part* of my ordinary visual experience that the world, as thus presented, affords the opportunity of fluent grasping and posting. In this sense, my implicit knowledge of my own potential for finely-tuned action may be deemed part of[16] my conscious visual experience– and this despite the fact that the inner representational resource supporting the sense of spatial filling-out is not *itself* the content-base for the fluent world-engaged action itself. Such accounts preserve something like the idea of a nonconceptual component within visual experience, but identify that component with implicit knowledge of potentials for fine-tuned action.

[15] For examples of such accounts, see Gibson (1979), Reed (1996)

[16] For just such an account, see O'Regan and Noe (In Press, 2001). Also, see Susan Hurley's important (1998) account in which perceptual experience and action are woven into an especially intimate whole. Notice, incidentally, that nothing in the present treatment is incompatible with Hurley's important suggestion that perception and action each involve whole cycles of sensory input and motor output. For some discussion of this, see Clark (1999).

Such a position is compatible with a certain reading of Evans. Thus Grush (1998) argues, following Evans, that many aspects of experiential content depend on complex links with the potential deployment of sensorimotor skills. Commenting on the experience of hearing a sound as pulsating, Grush comments that:

> …. part of the normal content of pulsatingness, for us, is that it is something with which we can coordinate a number of sensorimotor skills
>
> (Grush 1998 para. 21)

When we hear the beat, we are implicitly aware of our capacity, should we wish, to tap our fingers in time with the pulses, to anticipate the pulses, to swing a conductor's baton in time with the pulses, and so on. A person lacking *all* such skills, yet not bio-mechanically incapacitated in any way, could not (on this account) be said to directly perceive the sound *as* pulsating. These experiences have the contents they do, it is concluded:

> in virtue of the fact that they poise the organism to non-inferentially engage some range of skills, and guide the organism's execution of these skills, if they are executed
>
> (Grush 1998, para. 23).

The point to notice, then, is that all this is perfectly compatible with the kind of significant dissociation between conscious visual experience and sensorimotor action described earlier. But it is compatible only if, once again, we are very careful about the claim that the experience *guides* the executing of the skill. In line with EBS, we must unpack that notion of guidance as the high level, intentional selection of action types and targets – we must depict it as the capacity to consciously use the perceptual array to identify goals, plan actions and select skilled routines (for example, a finger tapping routine), but not to control the fine detail of those sensorimotor routines themselves. The ultimate picture, as Goodale (1998, 491) nicely notes, is reminiscent of the interaction between a human operator and a smart teleassistance device. The operator decides on the target and action-type (for example "pick up the blue rock on the far left") and the robot uses its own sensing and acting routines to do the rest. Knowledge of our capacity to *engage* such routines may, on the present account, be essential to the content of the experience, even if the routines themselves employ sensory inputs in a very different, and largely independent, way.

5. Conclusions.

Substantial empirical evidence, I have argued, favors the replacement of the Assumption of Experience-Based Control (EBC) with the less ambiguous Hypothesis of Experience-Based Selection (EBS). EBS clarifies the functional role of conscious visual experience and offers a clear account of the relation between conscious seeing and the fine detail of on-line, object-engaging action. It depicts conscious seeing as tightly geared to presenting the world in ways appropriate for planning, reason and high-level action selection, and it helps make sense of the apparently deep links between certain memory systems and conscious visual experience. According to EBS it is only the high-level aspects of planned, intentional action that are directly informed by the information provided in conscious visual experience. The link between visual experience and fine-grained visuomotor action emerges as much less direct and intimate than we might otherwise suspect. A certain commonsense conception of the role of visual experience is thus revealed as potentially misleading, while philosophical theories that attempt to explain the contents of conscious perceptual experience by direct appeal to the control of object-engaging action are undermined.

In displaying conscious visual experience as geared to thought and reason, rather than to the fine control of action, EBS might seem to lend strong support to accounts (such as McDowell (1994) (1998)) that depict perceptual content as already conceptualized. Such a reading, however, is not forced upon us by the adoption of EBS. For EBS is equally compatible, we saw, with some (but by no means all) ways of cashing out a notion of nonconceptual content. The simplest way to do so is to locate the content-constituting link not between conscious visual experience and the fine detail of motor action (as does Cussins (1990) (1998)) but between such experience and the processes of thought and reasoning which may subsequently inform the executive selection of such actions.

The main moral of the discussion is, however, independent of such local disputes. It is that conscious visual perception is part and parcel of a cognitive system dedicated to recall, reason and imagination, and only indirectly associated with the systems controlling the detailed execution of selected actions. Consciousness, memory, and reason thus emerge as a functionally unified grouping, while the on-line execution of fine motor activity calls on a distinct (and phylogenetically more ancient) resource.

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