Athens Institute for Education and Research
ATINER

ATINER's Conference Paper Series
PHI2012-0175

Is Perception Representational? Tyler Burge on Perceptual Functions

Bernardo Aguilera
PhD Student
The University of Sheffield
UK

Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10671 Athens, Greece
Tel: + 30 210 3634210 Fax: + 30 210 3634209
Email: info@atiner.gr URL: www.atiner.gr
URL Conference Papers Series: www.atiner.gr/papers.htm

ISSN **2241-2891**
13/09/2012

An Introduction to ATINER's Conference Paper Series

ATINER started to publish this conference papers series in 2012. It includes only the papers submitted for publication after they were presented at one of the conferences organized by our Institute every year. The papers published in the series have not been refereed and are published as they were submitted by the author. The series serves two purposes. First, we want to disseminate the information as fast as possible. Second, by doing so, the authors can receive comments useful to revise their papers before they are considered for publication in one of ATINER's books, following our standard procedures of a blind review.

Dr. Gregory T. Papanikos
President
Athens Institute for Education and Research

This paper should be cited as follows:

Aguilera, B. (2012) "**Is Perception Representational? Tyler Burge on Perceptual Functions**" Athens: ATINER'S Conference Paper Series, No: PHI2012-0175.

Is Perception Representational? Tyler Burge on Perceptual Functions

Bernardo Aguilera
PhD Student
The University of Sheffield
UK

Abstract

A philosophical issue raised by perception is whether some perceptual states have representational content. Dominant approaches to cognition explain perceptual systems in information-processing terms and often include representational states in their explanations, yet controversy remains as to where precisely representations begin and even whether they originate at the level of perception at all.

Burge (2010) has recently defended the claim that perception is representational. Based on a teleological notion of perceptual systems, he argues that perceptual systems have the function of accurately representing certain basic environmental attributes. However, he departs from mainstream teleological theories that rely on a biological notion of function (e.g. Millikan, 1989; Papineau, 1987) and offers an alternative account of perceptual functions that he calls 'representational functions'.

In this paper I explore Burge's account of representational functions and discuss two problems that it might present. First, that his critique of biological functions is not compelling and thus weakens one important motivation for his alternative account of perceptual functions; and, second, that his overall picture of how representational functions intertwine with other biological functions of the organism is problematic, in particular for the case of the determination of representational content.

Contact Information of Corresponding author:

Introduction

> 'Perceptual representation is where genuine representation begins. In studying perception, representational psychology begins. With perception, one might even say, mind begins.' (Burge, 2010, p. 367).

Dominant theories of cognition explain perceptual systems in information-processing terms. Often these theories apply to representations, however it is controversial whether peripheral information-processing systems such as those underlying perception really involve representations. It has been suggested that their processes may be individuated in purely computational terms that are not essentially representational (e.g. Egan, 1995).

In his recent book Origins of Objectivity Tyler Burge[1] argues that the most elementary forms of representation are already present in perception (especially vision). He develops a teleological account of perceptual systems that ascribes them the function to represent basic environmental kinds, properties or relations. A particular aspect of Burge's account is that contrary to mainstream teleological theories he does not rely on a biological notion of function. This issue gives rise to some controversies that I shall explore in this paper.

In the next three sections I begin with some background about informational and teleological theories of perception and representation. In section 5 I discuss Burge's critique to mainstream teleological theories to then in section 6 address his own notion of representational function. In the final section I discuss two worries that arise from Burge's critique of biological approaches to perceptual functions and with his overall teleological picture of cognition.

Information-processing Theories of Perceptual Psychology

Information-processing theories explain how cognitive processes work by appealing to computational processing of information. They lie in the conceptual and empirical foundations of cognitive science, with theories of visual perception as the paradigmatic case (Marr, 1982, Pylyshyn, 1984, Fodor and Pylyshyn, 1981). Burge agrees with some of the fundamental tenets of this theory and uses them as a basis for developing his approach. I shall present some of the main tenets of these theories as a background to prepare the discussion that follows.

According to information-processing theories sensory systems pick up information from the world, which is then processed by perceptual systems. Perceptual processes are supposed to be contained in perceptual modules understood in a (roughly) Fodorian sense (cf. Fodor, 1983), viz. they are computational devices that process domain-specific information in an automatic way and in isolation from central cognition. This last aspect of modularity is important since it highlights the idea that at least the earlier mechanisms of perception take part without the intervention of central

[1]Henceforth, all references to pages correspond to this book.

cognition (e.g. beliefs and expectations). This view also holds that perceptual processing is inferential, in the sense that sensory information is processed by perceptual systems that compute non-demonstrative, inductive-like, inferences. This allows perceptual systems to transform information encoded from the surface of sense organs into perceptual states that correlate with distal features of the environment, such as types of objects, properties or relations.

This approach focuses on low-level computational processes which are 'not imputable to the individual perceiver' since they are 'unconscious, automatic, relatively modular aspects of perceptual systems' (pp. 23-24). A typical example is what is called early vision. At this stage visual systems deliver a 3-D perception of the shape, size, colour and motion of what is in the field of view. The most remarkable aspect of this stage of perceptual processing is that it operates from sensory stimulation that is variable, fragmentary and mathematically insufficient to recover data about distal properties. So perceptual systems must carry out inferences that constrain the possible interpretations that could be drawn from this information, in order to generate the right 3-D perception of the environment.

This capacity to detect a given object or property as the same despite significant variation in proximal stimulation allows the generation of what is called 'perceptual constancies'. For example, we recognise an approaching object as having the same size even though the size of the pattern projected in our retina is increasing and also perceive its colour as remaining constant despite varying illumination conditions. Burge takes these perceptual constancies as primary forms of perceptual type-individuation of specific environmental properties, and calls them objective empirical representations or percepts. They mark a fundamental distinction between sensory states and perception and are where Burge believes representation begins.

Representation and Misrepresentation

So far, I have presented dominant theories of perception that explain how perceptual systems process information in a way that allows them to instantiate percepts. I have also introduced Burge's claim that these percepts are not mere computational states but objective representations of distal environmental properties. But before addressing Burge's account in more detail, let me sketch his general of representation and discuss how the computational approach standardly deals with them.

According to Burge, an essential aspect of representations is that they bear reference relations to a subject matter, such as objects or properties of the environment. These reference relations are 'established by a person or animal [...] by the way of some thought, cognition, perception or other psychological state of event' (p. 31). Paradigmatic forms of representation are propositional thought and concepts, however Burge believes that the 'the most primitive form of representation is perception' (p. 9), in particular the type-individuation of distal environmental properties instantiated by percepts.

As it is widely acknowledged, Burge recognises that any account of representation must explain how they could fail to refer to what they are

supposed to be about. To use a common terminology, they must explain how misrepresentation is possible (cf. Warfield and Stich, 1994). Thus a central issue for Burge's representational account of perception is to explain how percepts could have what he calls 'veridicality conditions', viz. the perceptual analogs to truth-conditions of belief. This issue has been particularly troublesome for information-processing theories, in particular those grounded on strict nomological dependencies between a percept and an environmental property, where the former cannot exist if the latter does not occur. Characterised in this way, perceptual states cannot misrepresent a property that actually is not present.

One way information-processing theories have attempted to deal with this problem has been to appeal to the distinction between sensory information and percepts. Recall that whilst sensory states are directly correlated with proximal environmental properties, percepts are inferentially mediated. Some authors have proposed that this inferential route that runs from sensory information to percepts can be regarded as setting a normative standard for what is an accurate percept, and interestingly open the possibility of error (Fodor and Pylyshyn, 1981). The idea is that when a percept is the result of the right inferential process then it is accurate, and when this process fails but the same type of percept is instantiated then we have case of misrepresentation. But a problem that emerges is to determine which is the right inferential process without begging the question. A common way theorists deal with this issue is to link perceptual accuracy with some sort of regularity or statistically constant inferential pattern, thus explaining misrepresentation in terms of statistical atypicality. But as Burge notes 'abnormality and interference with regular processes are not themselves errors or even failures' (p. 299). It is perfectly possible, for instance, for a perceptual system to perceive accurately certain environmental object even though it is highly infrequent or even if it has never appeared before.

The problem of misrepresentation is then transformed in the problem of explaining how the inferential processes of perception could be normatively constrained and in this way account for perceptual error[1]. Burge proposes to supplement computational approaches with the notion of function to explain this normative dimension, however his own account of representational function differs from mainstream teleological approaches, as I shall explain in the next section.

Teleology Enters the Scene

Before addressing Burge's particular version of perceptual functions and to prepare the following discussion, I shall introduce teleological approaches to perception in general. Teleological theories attempt to apply the notion of function to explain how perceptual systems work. To ascribe a system with a

[1]Of course, information-based theorists have formulated more elaborate ways to deal with the problem of misrepresentation, most notably Fodor's Asymmetric Dependence Theory (Fodor, 1990). Burge also rejects this view (see p. 307) however for reasons of space, and since the purpose of this paper is to focus on Burge's teleological approach, I pass over this debate.

function means to understand its mechanisms as aimed to attain certain end or goal (telos). A characteristic of functional explanations is that they are normative, in the sense that a functional system ought to perform its functions, and failure to perform them is a kind of error.

One advantage of ascribing functions to perceptual systems is that they could be used to explain the normative character of perceptual states. By ascribing certain perceptual mechanism with the function of detecting properties of the environment, teleological theories attempt to characterise it as having the purpose of instantiating an accurate representation of these properties. And conversely, if the mechanism ends up detecting a different property than the one corresponding to its function, then it would be a case of malfunctioning and misrepresentation.

Teleological theories typically make use of a biological approach to functions, which analyses them in terms of their aetiology, viz. by identifying what is the function of a system with the reasons why the system has that function (Wright, 1973). Since the mainstream view among philosophers of biology is that the best explanation of why systems have functions is natural selection, teleological theories normally define functions by appealing to how they evolved by natural selection (Allen 2009). For example, they consider that the function of the heart is to pump blood because this function played some role in enhancing the survival and reproduction of the organism, and hence the species. I shall call this biologically inspired version of teleology 'teleo-biological theories'.

Burge Against Teleo-biological Theories

In Origins of Objectivity Burge develops a teleological approach to perceptual functions, which he calls 'representational functions'. However, he explicitly puts forward his approach in opposition to teleo-biological theories. His main motivation for this is that he believes the representational and biological functions of perception do not necessarily match one another:

> 'The key deflationist [teleo-biological] idea in explaining error is to associate veridicality and error with success and failure, respectively, in fulfilling biological function. [...] Explanations that appeal to biological function are explanations of the practical (fitness) value of a trait or system. But accuracy is not in itself a practical value. Explanations that appeal to accuracy and inaccuracy -such as those in perceptual psychology- are not explanations of practical value, or of contributions to some practical end.' (p.301)

Burge identifies perceptual accuracy with veridical representation and argues that pairing veridicality with biological success is problematic. A common case used to illustrate this problem concerns predator-detection systems. For instance, several species of birds have evolved systems that respond to aerial predators and elicit a fleeing response (Marler and Hamilton, 1966). Since the main predator during their evolution were hawks, a teleo-biological

explanation would say that this system has the representational function of detecting hawks. But note that under certain ecological conditions it would have been perfectly possible for these birds to evolve predator-detectors that were highly inaccurate. Just imagine that the energy consumed by the fleeing response is very low, whilst the real occurrence of a predator almost always results in being caught. Then even if the predator-detector is highly inaccurate and triggers many false alarms (e.g. by responding to any winged-silhouette), it could still had been recruited by evolution to perform a hawk-detection function. Burge offers a variant of this example by pointing out that fleeing responses to false alarms could also have improved fitness by means of increasing strength and agility, and in this way favoured the selection of hawk-detectors even if they misrepresent most of the time (p. 302).

Defenders of teleo-biological views have responded to cases like this by accepting that inaccurate perceptual systems could have evolved by natural selection (Godfrey-Smith, 1992, Millikan 1989). According to teleo-biological theories all that matters is that hawks were the relevant environmental condition that explains the selection of the predator-detector during the evolutionary history of the birds. Even if the system was highly inaccurate and gave rise to many false alarms, the reason it was selected is that the few times it was successful in detecting hawks had a significant effect in enhancing the survival of the species. Therefore the system has the biological function of detecting hawks, and in cases when it responds any other winged-silhouette it is just misrepresenting hawks.

But Burge replies that views like this are counterintuitive and at odds with perceptual psychology, for nothing in the bird's perceptual computational machinery appears to have the capacity to discriminate between hawks and other aerial objects with winged-silhouettes. When an aerial predator approaches all the perceptual system can probably do is to infer from sensory information the perceptual constancy of a winged-silhouette. Then it would be successful when detecting winged-silhouettes, even if what explains its evolutionary origin was the detection of hawks. Burge takes cases like this to support this claim that 'the function fulfilled by representational success, by perceptual veridicality, is not a biological function' (p. 308).

However, I believe his move is too fast, since he misses one possible reply from teleo-biological theories. For it could be the case that the bird's predator-detection system has the biological function to detect hawks in virtue of detecting winged-silhouettes. As Neander (1995) suggests, both functions need not be mutually exclusive if we take them to be complementary functions at different levels of description. The function to detect winged-silhouettes can be regarded as the underlying mechanism that enables the bird to carry out its biological function of detecting predators. Even though at the level of early vision this mechanism cannot detect hawks, the fact that it is a crucial part of a larger system that evolved with that function of detecting predators suffices to ascribe it a biological function.

This view seems compatible with both Burge's account of representational functions and teleo-biological theories of perception, and so it is perhaps surprising that he gives no attention to it in his book. I shall return to Burge's

critique to teleo-biological theories in the final section of this paper. For now, let us focus on Burge's positive account of perceptual functions.

Burge's Account of Perceptual Functions

As I explained in the previous section, Burge claims that standards of veridicality do not need to mesh with any practical value and therefore that perceptual functions are essentially independent from biological success. Instead, he characterises them as representational functions to emphasise the alleged representational nature of perception. In Burge's words:

> 'Biological functions and biological norms are not the only sorts of function and norm that are relevant to explaining the capacities and behaviour of some animals. Given that veridicality and non-veridicality cannot be reduced to success and failure (respectively) in fulfilling biological function, we must recognise a type of function that is not biological function, a representational function.' (p. 339)

As Burge acknowledges, biological functions[1] 'are functions that have ultimately to do with contributing to fitness for evolutionary success' (p. 301) and 'their existence is explained by their contribution to the individuals' survival for mating, or perhaps in some cases the species' survival' (p. 326). This corresponds to a standard teleo-biological approach that analyses functions in terms of their aetiology, often by reference to the process of natural selection[2]. In contrast, Burge's notion of representational function is consistent with a non-etiological, and sometimes called dispositional[3], construal of functions, viz. one that does not define their nature it terms of aetiology but in terms of their current roles in carrying out some capacities of the organism. More precisely, Burge's representational functions have their metaphysical grounds on scientific realism, viz. the idea that we can adopt a positive epistemic attitude towards the theoretical components of our best scientific explanations. This allows Burge to take a realistic stance towards representational functions given the assumption that the most successful explanations in perceptual psychology constitutively make use of them:

> 'The conclusion that perception has a representational function [...] derives from reflecting on the nature of explanatory kinds in perceptual psychology. [...] There is extensive empirical support for explanations in which the representational aspects of perceptual states are explanatorily central. [...] Such explanations evince the existence of perceptual states.

[1]Biological functions are not always characterised in teleo-biological terms, but for expository purposes I shall follow Burge in doing so.
[2]Natural selection need not be the only source aetiology. Some teleo-biological approaches also claim that functions can result from learning or conditioning. See e.g. Papineau (1987).
[3]For a good exposition of both opposing theories of functions in the context of psychological explanation see Price (2001).

> So they support the claim that there are representational states that have representational functions.' (p. 310)

It is important not to read Burge as arguing that representational functions did not evolve by natural selection. On his account he can just remain neutral about aetiology and instead focus on what are the functions settled by our best current explanations of how perception works. It is also interesting to note that a similar analysis of functions is commonly adopted by computational approaches to psychology. They characterise psychological capacities such as perception, memory or decision-making by looking at how they are actually structured in terms of their input-output relations, regardless of their historical origins (e.g. Cummins, 1983; Crane, 1995; Fodor, 2000; for a general discussion on dispositional theories of function see Koons, 1998).

Accordingly, Burge believes that several cognitive capacities have non-biological functions. Besides perception, he also alludes to functions for belief-formation, deductive reasoning and primitive agency. One peculiar aspect of Burge's proposal is that biological and representational functions actually coexist in the same organism, what gives rise of to a complex array of different functions and normative constraints. I find this functional picture puzzling, but I shall reserve my arguments for the next section and conclude this exposition by trying to explain how Burge suggests these functions could be organised in an organism.

A basic idea behind most teleological approaches is that functions have a place in a functional analyses of the organism, where it is decomposed into systems (e.g. circulatory system) which are then decomposed into their parts (e.g. heart, arteries, veins, etc.). All these subsystems are at least partly explained in terms of their causal contribution to the functioning of the whole-organism. In Burge's words:

> 'Whole animal function is exemplified by the basic biological activities - eating, navigating, mating, parenting, and so on. These activities are functional in the most commonly cited sense of biological function [...] They are distinctive in being functions of the whole individual -not the individual subsystems, organs, or other parts.' (p.326)

In his book the author describes biological functions as coordinated sub-systems organised towards their contribution to fitness. But on the other hand, representational and other non-biological functions are also compositionally described. For example, Burge points out that perceptual systems deliver accurate representations to belief-formation systems which have the function of generating true propositional representations, which then interplay with systems of deductive inference, and so forth.

But how could both biological and non-biological functions be integrated? Here Burge introduces the notion of agency as the capacity to generate 'functioning, coordinated behaviour by the whole organism, issuing from the individual's central behavioural capacities, not purely from subsystems' (p. 331). He claims that agency is what makes possible the integration of

biological and representational functions insofar as they operate in coordination towards the fulfilment of functions of the whole-individual. To put it roughly, once agency is present, it is the individual who perceives and not just its subsystems.

The notion of agency also helps Burge to explain why perceptual systems are not just peripheral, automatic computational subsystems such as reflexes, that do not qualify as part of representational explanations. For cognitive psychology considers their products within explanations of behaviour imputable to the whole-organism and not merely to its computational subsystems. Hence Burge believes that what makes percepts genuinely representational is the conjunction of having the computational machinery to type-individuate percepts and the possession of whole-individual agency, viz. having perceptual systems integrated with central cognitive capacities that issue in behaviour.

Problems with Burge's account

In this final section I discuss two problems concerning Burge's account of perceptual functions: (i) whether his rejection of teleo-biological theories of perception is compelling; and (ii) whether his mixed picture of representational and biological functions is plausible.

Is Burge's rejection of teleo-biological theories of perception compelling?

As already noted, Burge develops his account of representational function in opposition to teleo-biological theories of perceptual functions and so much of the plausibility of his proposal rests on his rejection of them. In section 5 I discussed Burge's worry about the association between perceptual accuracy and biological success and argued this this does not represent all possible teleo-biological views, and that there appear to be ways in which these theories could be revised to fit with information-processing theories of perception. In this section I shall examine two further arguments Burge raises teleo-biological theories and conclude that his overall rejection of them is not convincing.

The first is that he finds teleo-biological theories too deflationary, in the sense that they end up attributing representations to simple organisms that do not even have perceptual systems. For example, Millikan (1989) and Dretske (1987) claim that some bacteria can have representations by virtue of having the biological function to detect and respond accordingly to certain environmental conditions. But as Burge argues, an explanation based on purely biological and informational notions would suffice to explain the behaviour of the bacteria. Nothing in the way bacteria process information suggests that they go beyond mere sensory registration of information, or that they are capable of type-individuating distal environmental properties.

I believe Burge's critique is essentially right in pointing out that teleo-biological theorists have often overlooked the distinction between sensory and perceptual systems, and that to apply representational notions to explain sensory phenomena appears to trivialise the term. However, this does not undermine the plausibility of ascribing biological functions to perceptual

systems. For a teleo-biological theory can agree with an information-processing approach to perception and recognise that the biological function to represent corresponds to inferentially mediated percepts, and leave sensory functions as just having the function to encode environmental information. So Burge's critique does necessarily lead to the rejection of teleo-biological theories, however can be granted as a valuable terminological advice concerning the use of representational explanations.

Finally, another argument put forward by Burge against teleo-biological theories is that he regards them as an attempt to naturalise the notion of representation 'by reducing it to notions in sciences other than psychology, particularly natural sciences' (p. 296). He claims that in their eagerness to assimilate perceptual explanations to biology, teleo-biological theories distort representational notions that actually have a respectable place in the context of perceptual psychology. He points out to the teleo-biological idea of attaching perceptual success to the satisfaction of biological needs as an example of this attempt, however as I argued in section 5 this argument does not seem convincing.

On the other hand, it is unfair to claim that teleo-biological theories always work towards a strong reduction of psychological notions to biological terms. Instead, what they pursue is to enrich psychological explanations and make them more integrated with biology and not to replace them with pure biological vocabulary. Teleo-biological approaches may improve information-processing theories of perception by making them compatible and more integrated with more fundamental explanatory levels.

In sum, I believe Burge's reasons for abandoning teleo-biological approaches to perceptual functions are not convincing and do not contribute to make more plausible his positive account.

Is Burge's mixed picture of representational and biological functions plausible?

In general terms, the idea that perception and cognition have a functional organisation is widely accepted. Controversies often hinge on whether cognitive functions should be characterised in etiological or non-etiological terms, and in some particular issues within each of these programmes. This seems natural insofar as both teleological theories constitute different epistemological and metaphysical approaches towards the ascription of functions, as explained in section 6.

However, I believe problems begin when Burge combines representational and biological functions, since each comes from different teleological approaches that need not always agree about how to characterise the same function. For example, suppose that our best physiological theories explain how the heart works by ascribing it the function of pumping blood. Then from a non-etiological approach it would be a fact that the heart has precisely that function. But imagine that we find out that the heart was not selected because it pumped blood, or that it simply did not evolved by natural selection. Then from a teleo-biological viewpoint the heart would have a different biological function, or worst, no function at all. So if we adopt, as Burge does, a realist

approach to functions, both teleological theories can lead to clashing functional ascriptions and therefore can barely be implemented at the same time.

Let me explain the same idea in a context more akin to Burge's account. A well known problem associated with teleological theories of representation is how to avoid the indeterminacy of content (cf. Fodor, 1990). Recall the example of the predator-detection system of birds and imagine that it responds to flying boomerangs in exactly the same way as with hawks. An information-processing explanation of how its perceptual system type-individuates environmental properties might fit equally well with percepts representing winged-silhouettes, boomerangs, and perhaps other coextensive things. This is problematic since it is implausible that birds have such set of representational contents. At this point teleo-biological approaches are often called to disambiguate; they can argue that the function of the system is to represent winged-silhouettes, because winged-silhouettes and not boomerangs (or other coextensive objects) were selectively responsible for the evolution of that system (cf. Sterelny, 1990).

But, of course, Burge rejects teleo-biological theories of perception and so his non-etiological version of representational functions cannot appeal to evolutionary history for the individuation of content. However, he appears to be doing precisely this when he says:

> 'the framework for perceptual reference and perceptual representational content is set by organism's responses to the environment in fulfilling individual biological functions, in the evolutionary prehistory of the perceptual system.' (p. 321).

Burge's account of the individuation of content is complex and I do not have the space here for a full discussion of it. However, he is clear in stating that representational content is partly determined by the biological functions of other subsystems of the organism (cf. p. 327). To see why this could be problematic recall that on his account of representational functions they were supposed to be determined by their current roles in scientific explanations of perception. Therefore we would have a twofold way for the individuation of content, one based on current scientific explanation and other on how it is constrained by other biological functions. I believe this idea is puzzling since both ways of ascribing content may actually clash. Just imagine that as a consequence of new archeological evidence we have to modify some of the biological functions of an organism, which also happen to be relevant for the fixation of representational contents. Then even if the role of these contents in our best explanations of perception remains unaltered, we would have to modify them in the light of changes in our account of the organism's evolution, something that clearly generates a tension in Burge's account.

Bibliography

Allen, C. (2009). Teleological Notions in Biology. In E. N. Zalta (Ed.), The Stanford Encyclopedia of Philosophy. Available at <http://plato.stanford.edu/archives/win2009/entries/teleology-biology/>

Burge, T. (2010). Origins of Objectivity. New York: Oxford University Press.

Crane, T. (1995). The Mechanical Mind: A Philosophical Introduction to Minds, Machines and Mental Representation. Harmondsworth: Penguin Books.

Cummins, R. (1983). The nature of psychological explanation. Cambridge, MA: MIT Press.

Dretske, F. (1987). Misrepresentation. In R. Bogdan (Ed.), Belief: Form, Content, and Function (pp. 17-36). Oxford: Oxford University Press.

Egan, F. (1995). Computation and content. The Philosophical Review, 104(2): 181-203.

Fodor, J. (1983). The Modularity of Mind:An Essay in Faculty Psychology. Cambridge, Massachusetts: MIT Press.

Fodor, J. (1990). A Theory of Content and Other Essays. Cambridge Mass: MIT Press.

Fodor, J. (2000). The Mind Doesn't Work That Way. Cambridge, Massachusetts: MIT Press.

Fodor, J. A., & Pylyshyn, Z. W. (1981). How direct is visual perception: some reflections on Gibson's "Ecological Approach. Cognition, 9: 139-96.

Godfrey-Smith, P. (1992). Indication and adaptation. Synthese, 92(2): 283–312. Springer.

Koons, R. C. (1998). Teleology as Higher-Order Causation : A Situation-Theoretic Account. Minds and Machines, (8): 559-585.

Marler, P., & Hamilton, W. J. (1966). Mechanisms of Animal Behavior. New York: Wiley.

Marr, D. (1982). Vision. New York: W. H. Freeman.

Millikan, R. G. (1989). Biosemantics. The Journal of Philosophy, 86: 281-297.

Neander, K. (1995). Misrepresenting & Malfunctioning. Philosophical Studies, (79): 109-141.

Papineau, D. (1987). Reality and Representation. Oxford: Blackwell.

Price, C. (2001). Functions in Mind: A Theory of Intentional Content. Oxford: Oxford University Press.

Pylyshyn, Z. W. (1984). Computation and Cognition. Cambridge Mass: Bradford Books/MIT Press.

Sterelny, K. (1990). The Representational Theory of Mind: An Introduction. Oxford: Basil Blackwell.

Warfield, T. A., & Stich, S. (1994). Introduction. Mental Representation: A reader (pp. 3-8). Cambridge: Blackwell.

Wright, L. (1973). Functions. The Philosophical Review, 82: 139-168.