The Eye's Mind:  
a philosophical discourse  
on the non-inferential and conceptual nature of visual perception  
and its implications for educational theory  

by  

Dennis Ray Lomas  

A thesis submitted in conformity with the requirements  
for the Degree of Doctor of Philosophy  
Department of Theory and Policy Studies in Education  
Ontario Institute of Studies in Education of the  
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ABSTRACT

Visual perception, I argue, is both conceptual and non-inferential. This opposes philosopher Tim Crane (following Gareth Evans and Christopher Peacocke) and vision scientist Zenon Pylyshyn who contend perception is nonconceptual. It also opposes philosopher Gilbert Harman and vision scientist Irvin Rock who subscribe to perceptual inference theory. Regarding my first claim, because object recognition — perceptual categorization of particulars as instances of types — is all-pervasive within visual perception it must be regarded as conceptual. Regarding the second claim, neither retinal stimulations nor beliefs can be “premises” for inferences, as claimed in perceptual inference theory. The former are not conceptually structured and, although beliefs sometimes influence perception, the fact that many visual illusions are not revised by contrary beliefs shows that they are also not premises for inferences to perceptions.
Because beliefs are conceptual, in order to justify them visual perception must be conceptual. If visual perceptions were due to inference from beliefs, visual perception would not supply belief-independent justification of belief. Visual perception must also be generally veridical if it is to justify belief. Our everyday experience indicates that it is; and scientific knowledge of the vision system confirms this assessment. Since visual perception is conceptual, non-inferential and generally veridical, it can objectively justify belief. This offers an answer to one important facet of the traditional problem of “scepticism about the senses”.

Visual perception cannot fully justify beliefs because it is not always veridical and it does not “tell us” which perceptions are veridical and which are not, although it does supply information on which such judgements are made. Full justification must further advert to rational-scientific-mathematical forms of life, i.e., broad, historically-determined activities and practices that arise within the fields of rational, scientific, and mathematical inquiry. These forms of life alone cannot, however, warrant knowledge and principles in these fields. Veridical perception as a justification of belief is also required, e.g., to make reliable observations. Relying solely on so-called forms of life — as one trend in contemporary philosophy of mathematics education would have it — leads to an unacceptable extreme relativism in which social agreement alone is thought to determine knowledge.
"...[L]ife steals across the visual field and secretly binds its parts together."

(Merleau-Ponty 1962, p. 35)
Throughout the course of my degree, Chris Olsen (my supervisor) and my thesis committee (Bill Seager and Jim Brown, in addition to Chris) helped me clarify my ideas. Chris's philosophy-of-mind research group provided an arena for many valuable philosophical discussions. At one time or another most of my thesis was presented to the group. A lot of indirect assistance was due to the remarkable intellectual climate at the University of Toronto. A talk at McMaster University given by Patrick Cavanagh was quite useful. His scientific defence of template-matching theory prompted me to incorporate that theory into my basic argument. Before I embarked on philosophy, the work of John Tsotsos (the supervisor of my masters degree in computer vision) turned my attention to scientific and theoretical questions concerning perception. Many acquaintances with students, staff, and professors — especially with fellow student Karim Dharamsi — made the work pleasant. OISE Graduate Assistantships for four years in the Philosophy of Education program and SSHRC research in mathematics education with Gila Hanna helped make the whole enterprise financially possible. Insightful comments of Lorne Maclachlan, my external examiner, made for an interesting discussion at the oral defence.
DEDICATION

I dedicate this study to Linda who suggested academia to me many years ago, to my father, now deceased, who took pleasure in my “late-blooming” academic accomplishments, and to my mother who has provided constant encouragement.
## CONTENTS

<table>
<thead>
<tr>
<th>ABSTRACT</th>
<th>ii</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>v</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>vi</td>
</tr>
<tr>
<td>CONTENTS</td>
<td>vii</td>
</tr>
</tbody>
</table>

### Chapter 1

**Visual perception: conceptual but not inferential**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Introduction: perception, an enduring philosophical problem</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Object recognition and the conceptual nature of visual perception</td>
<td>2</td>
</tr>
<tr>
<td>1.3 “Non-conceptual content” of visual perception</td>
<td>6</td>
</tr>
<tr>
<td>1.4 Perceptual inference theory</td>
<td>15</td>
</tr>
<tr>
<td>1.5 Can visual perception justify perceptual belief?</td>
<td>29</td>
</tr>
</tbody>
</table>

### Chapter 2

**Visual perception of diagrams**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Diagrams in geometric problem solving</td>
<td>34</td>
</tr>
<tr>
<td>2.2 Visual perception and abstract objects</td>
<td>41</td>
</tr>
<tr>
<td>2.3 The foundational role of perception</td>
<td>52</td>
</tr>
<tr>
<td>2.4 Conclusion</td>
<td>58</td>
</tr>
</tbody>
</table>

### Chapter 3

**Shape perception and object recognition**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Introduction</td>
<td>60</td>
</tr>
<tr>
<td>3.2 The nature of visual perception of shape</td>
<td>62</td>
</tr>
<tr>
<td>3.3 The sensation-perception distinction</td>
<td>70</td>
</tr>
<tr>
<td>3.4 Visual perception: a non-conceptual awareness of shape?</td>
<td>87</td>
</tr>
</tbody>
</table>

### Chapter 4

**Template matching and visual object recognition**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Introduction</td>
<td>95</td>
</tr>
<tr>
<td>4.2 The template matching model of visual object recognition</td>
<td>99</td>
</tr>
<tr>
<td>4.3 The homunculus problem and related problems</td>
<td>115</td>
</tr>
<tr>
<td>4.4 Does the template-matching model conform to representational theory?</td>
<td>125</td>
</tr>
<tr>
<td>4.5 Scientific motivation for the template-matching model</td>
<td>133</td>
</tr>
</tbody>
</table>

### Chapter 5

**Visual perception and justification of belief**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 McDowell’s resolution of philosophical “anxiety”</td>
<td>149</td>
</tr>
<tr>
<td>5.2 Transducers and the retina</td>
<td>164</td>
</tr>
</tbody>
</table>
Chapter 6
What can go wrong in foundational accounts when perception is ignored

6.1 Introduction ............................................. 167
6.2 Ernest’s social constructivism .......................... 172
6.3 Perception and mathematical objects ................. 176
6.4 Ernest’s philosophical blind spot ....................... 181

The Forest ......................................................... 190

Bibliography ....................................................... 194
Chapter 1

Visual perception: conceptual but not inferential

There have been natural tendencies to assimilate [perception] on the one hand to sensation, to the having of experiences in the most elementary sense, and on the other hand to judgement, to an activity of the mind. (Hamlyn 1961, p. ix)

Once vision is defined in the empirical way as the possession of a quality impressed upon the body by the stimulus, the least illusion, endowing the object as it does with properties which it does not possess on my retina, is sufficient to establish that perception is a judgement. (Merleau-Ponty 1962, p. 32-33)

Section 1.1 Introduction: perception, an enduring philosophical problem

Perception is our “window on the world”. Its nature substantially determines whether we obtain or can hope to obtain objective knowledge. Perception is so central to our cognitive makeup, as well as to that of our animal cousins, that no philosophical or general scientific account of cognition can afford to ignore perception. Although an analysis of perception is often integrated into the overall argument of a philosophical study, the nature of perception is a legitimate philosophical study in its own right (attested to by the many philosophical studies which concentrate on the nature of perception), especially because the nature of perception is, in a sense, prior to many other philosophical questions such as the question of perceptual justification of belief.

Philosophical and scientific positions on the nature of perception are many and varied. Two broad currents of opinion on the nature of perception are evident. Either perception is thought of as part of the mental or it is not. Perception, when thought of as part of the mental, is variously described as conceptual, inferential, rational, linguistic (language-
like) or attitudinal, or some combination thereof. Perception, when thought of as non-mental, is described as mere causal processing and/or as involving "raw sensations" only.

This study concentrates on visual perception. What, then, is the nature of visual perception? Visual perception is both conceptual and non-inferential, a position which, for convenience, I call non-inferential conceptualism. Non-inferential conceptualism, I argue, demonstrates the possibility of perceptual justification of belief, a possibility which would be blocked if visual perception were either non-conceptual or inferential.

Section 1.2 Object recognition and the conceptual nature of visual perception

Object recognition is all-pervasive in visual perception.1 (By the term 'object recognition' I refer to a mental event or state which involves perception of a concrete particular as an instance of a type.) This observation is not an entailment of a deep theory about visual

---

1 Anne Treisman writes: "The world that we effortlessly — and usually accurately — perceive consists of complex objects that are characterized by their shapes, colors, movements, and other properties" (Treisman 1996, p. 31). Along the same lines, Phillip J. Kellman and Martha E. Arterberry write:

It is an interesting exercise to glance around a room, close one's eyes, and then attempt to remember a lamp, television, sofa, some small pillows, a notepad, and a pair of shoes. It is striking that our inventory of the environment consists primarily of objects. Object perception reveals the physical units in the environment — where the world comes apart.

(Kellman and Arterberry 1998, p. 135)

Angus Gellatly remarks:

[W]e can never escape seeing as. Prior to seeing the stimulus as a dog we were seeing it as a puzzle picture, or as black marks on white paper, or as part of the paraphernalia in a psychologist's laboratory. (Gellatly 1999, p. 378)

H.H. Price gives a definition of recognition:

It would seem ... that recognition of individual objects, persons or places is a more complicated process than recognition of characteristics. Recognition of characteristics is indeed a part of it. But something more is needed: what may be called the postulation of continuance through time, or the disregarding of intervals of non-perception. (Price 1953, p. 39)

Price further remarks: "The fundamental intellectual process seems to be the experience of recognition" (p. 35).
perception. Instead it arises from ordinary experience. When our eyes are open, we are always recognizing objects: our fellow human beings, dogs, cats, and other animals, plants that we encounter in our day-to-day lives, and artifacts, such as televisions, microwaves, refrigerators, and computer monitors. We visually recognize simple objects such as geometric diagrams and complex objects such as people, tractors, and trees. Parts of objects are also recognized as objects in their own right. We cannot “turn off” our visual object-recognition capacities, except by closing our eyes. Even when we continuously look at a single object we do not stop recognizing it after the initial recognition. During the whole ten seconds in which I stare at an apartment building across the street, I visually experience it as an apartment building. When I visually perceive a novel object, I visually recognize it as a determinate object even though I might not classify it more finely or even classify it correctly. In addition to fully conscious visual recognition, there is recognition that is less conscious. I visually experience a dog staring up a tree at a squirrel. At the same time, I am only slightly visually conscious of another dog some thirty yards away. Some visual recognition may not be full. I may visually recognize an animal thirty yards away but not recognize it as a dog. All these observations serve to show that visual object recognition is all-pervasive in visual perception.

The all-pervasiveness of object recognition in visual perception entails that visual perception is conceptual\(^2\) — that is, involves concept use — because object recognition is

\(^2\) Many philosophers and vision theorists would demur. In philosophy there is Tim Crane (1992), Gareth Evans (1982), Martin Davies (1991), and possibly Christopher Peacocke (1992). In psychology much the same position as theirs is argued at the level of brain functioning by Zenon Pylyshyn (1999). Among those who can be taken to hold that perception is conceptual are, in philosophy, D.W. Hamlyn (1994 & 1996), Christopher Olsen (in preparation), John McDowell
eminently conceptual. It is a subjective or perspectival perception of an object as an object of a certain type and sometimes also as a specific individual. Jumpy is visually recognized by the general public as a dog and is visually recognized by its owners as their dog, Jumpy. A good deal of the rest of this work develops or complements this argument that visual perception is conceptual.

A component of visual object recognition which is worth stressing to highlight its conceptual nature is perception of an object as an object. Here, the term ‘object’ refers to something that is a single, cohesive, spatial particular existing continuously through time and differentiated from a background. Most higher animals, for example, are perceived as objects. A dog is not visually perceived as a miscellaneous collection of parts and properties but as a single object. It is visually perceived as being cohesive, as existing continuously through time, as shaped, and as being distinguished from a background. My intent here is to highlight an important conceptual dimension of visual object recognition, not to give a developed account of what it is to be a visual object, a task which would take us somewhat far afield. Nonetheless, the attributes of visual objects just mentioned (cohesiveness, etc.) are among those that are commonly accepted in perception literature and, for the purposes of this study, specify what it is to be an visual object.

Characterizing visual perception in terms of visual object recognition has the advantage of strongly suggesting that visual perception is conceptual because it is object-involving from a subject’s point of view. However, some terminological clarification is in order. Not all types of recognition of visible objects are part of visual experience. For

(1994a), and Sonia Sedivy (1996).
example, consider my recognizing that a mathematical formula represents an ellipse. Recognition of what the formula represents is not part of my visual experience, even though recognizing the symbols in the formula is part of this experience. In order to avoid confusion, in this study ‘visual object recognition’ refers narrowly to visual object recognition that occurs within visual experience only, unless otherwise indicated. That is, ‘visual object recognition’ refers to perception of an object as an instance of an X rather than non-perceptual realization or judgement that an object is an instance of an X.

The term ‘perception’ can create confusion in much the same manner as ‘recognition’. While viewing a mathematical formula, I could report: “I perceive (or see) that this is a mathematical formula for an ellipse”. Here I am not reporting on something that I am visually experiencing, although I am, during the report, visually experiencing the mathematical symbols. In fact, the following report could mean the same thing: “I understand that this is a mathematical formula for an ellipse”. Accordingly, to avoid confusion, I stipulate from the outset that in this study ‘visual perception’ is used in much the same way as ‘visual experience’ and ‘visual sense experience’.

A final point related to terminology has to do with the narrow focus on visual perception in this work. Except for the occasional comment, no attempt is made to generalize from visual perception to all of perception, as is often done in the literature on perception. The claims of philosophers and vision scientists addressed hereafter are mostly general claims which pertain to all the sense modalities. Because my concerns rest almost exclusively with visual perception, my comments on positions of others pertain only to that aspect of their positions concerning visual perception. There is no difficulty here because, in all cases,
their positions, which encompass all modalities, are worked out predominately with respect to visual perception. This justifies adopting the following convention. Throughout this work, references are made to positions on visual perception often without adding that these positions are considered by their authors to apply to all sense modalities.

Section 1.3 “Non-conceptual content” of visual perception

One way to deny non-inferential conceptualism is to adopt *non-conceptualism* (a term of my invention), the position that visual perception is not conceptual or, as it is sometimes put, has “non-conceptual content”. This is the position of Tim Crane³ (pp. 149 ff.), which is derived in part from Gareth Evans (1982, pp. 122 ff.). Crane’s position is important to address for three reasons. First, his argument is indicative of a range of arguments that rely on illusory perception to make the case that visual perception is non-inferential. (I partially agree with Crane’s argument.) Second, Crane argues that visual perception is not conceptual because it is not inferential. This position needs to be countered if non-inferential conceptualism is to stand. Third, Crane’s argument that perception is non-inferential is seriously flawed even though visual perception is non-inferential.

I just asserted that Crane tries to show that perception is non-conceptual by showing that it is non-inferential. This is not quite right, although it seems to be at the heart of his argument. Crane writes that his argument has two stages. “The first stage is to show why,

³ In this chapter, references to Crane pertain to Crane 1992.
contrary to what some philosophers think, perceptions are not beliefs.\(^4\) The second will be to show how this entails that perceptions have nonconceptual contents” (p. 149-150). However, the weight of Crane’s argument (pp. 149 ff.) is directed at showing that perception is not inferential, from which he concludes that it is not conceptual (has “non-conceptual content”). In this way, he attempts to show that perceptions are not beliefs. That is, a perception is not a belief, he alleges, because it is not inferential.

According to Crane, perceptions do not have inferential relations to beliefs.\(^5\) In contrast, beliefs are inferentially related to each other.

“Beliefs are holistically related to one another by at least three kinds of inferential relations. The first are the logical or deductive relations. The second are what I call the ‘semantic’ relations. And the third are the evidential relations. ... It is because beliefs stand in these relations that they have conceptual structure.” (Crane, p. 151)

Logical or deductive relations exclude holding contradictory beliefs (Crane, p. 145). Semantic relations impose rationality constraints on beliefs: “The idea is that if you have the belief that \(p\), then there are certain other beliefs that you ought to have if that belief is to have the content \(p\)” (Crane, p. 154). Evidential relations impose revisability conditions on beliefs based on evidence possessed by a believer (Crane, p. 151).

\(^4\) Crane is referring here to D. M. Armstrong (1968) and George Pitcher (1973). Crane further remarks:

... I would also count as belief theories those theories which employ notions like ‘judgement’ (Craig 1976) or ‘hypothesis’ (Gregory 1970) — notions which must be defined in terms of belief. Many of the arguments for the belief theory are disposed of by Jackson 1977. (Crane, pp. 149-150, n. 17)

\(^5\) Crane, following Peacocke 1992, develops a possession condition for concepts that forms part of his argument. However, it can be understood without getting into a discussion of this condition.
To argue his case, Crane utilizes the Müller-Lyer illusion, illustrated below. The horizontal lines are perceived as nonequal in length when in actuality they are equal.⁶

Crane’s sometimes complicated argument appears to be this. First, because our belief that the horizontal lines are equal does not alter the illusion, perception is not inferentially related to belief. That is, perceptions are not logically or deductively,⁷ semantically (Crane, p. 154), or evidentially (Crane, p. 151) related to beliefs.⁸ (Even though Crane’s argument is partially correct, it has a serious failing which is discussed shortly.) Crane then concludes that perception is non-conceptual (that is, perceptions do not have “conceptual content”). However, even experiencing the Müller-Lyer illusion requires engagement of conceptual perceptual capacities. To compare the two horizontal lines, the concept length is required.

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⁶ Some theorists, for example Pylyshyn (1999), maintain that visual processing takes place within a module that is not influenced by “cognitive” processes. (In Pylyshyn’s words, visual perception is “cognitively impenetrable”.) Pylyshyn appeals to the experience of visual illusions to back his claim. If visual perception were cognitively penetrable then attitudes such as our beliefs and expectations would influence our perceptions. This is not so, Pylyshyn claims. (The term ‘attitudes’ in my usage refers to attitudes such as beliefs and expectations without the implication that these attitudes are necessarily propositional, as is sometimes assumed.)

⁷ Crane writes: “... [T]he Müller-Lyer Illusion shows ... there are values of p for which asserting ‘I perceive that p but not p’ is perfectly coherent” (Crane, p. 151).

⁸ In his paper, Crane argues that perceptions are not inferentially related to beliefs. Although he also holds that perceptions are not inferentially related to other perceptions, he does not specifically argue for this position.
Furthermore, in order to compare the lengths of the lines, we have to visually recognize\(^9\) the lines as lines, for which application of the concept line is required.\(^{10}\)

Notice that there is a tacit assumption in Crane’s argument, namely, being inferential is a necessary condition for being conceptual. This assumption is widely accepted in vision theory and philosophy of mind. Nonetheless, it is wrong. The perception of unequal relative lengths of the horizontal lines in the Müller-Lyer diagram demonstrates that visual perception is non-inferential. Yet, perception of the relative lengths requires application of concepts such as line, etc.

What about the cogency of Crane’s argument that the Müller-Lyer illusion demonstrates that perception is not inferentially related to belief? Although I am sympathetic to Crane’s conclusion, his argument is seriously flawed. Contrary to Crane, perception of unequal lengths of the horizontal lines is revisable by belief, at least in part. Many contemporary philosophers who comment on this illusion hold the opposite, agreeing with Crane that the illusion is not revisable at all. An exception is Hamlyn (1996, pp. 42-43). According to psychological evidence Hamlyn is right.\(^{11}\) For me, the illusion is somewhat revisable. If I look at the diagram more closely, imagining vertical lines joining the end

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\(^9\) Despite grammatical admonitions about split infinites, I deliberately split the infinitive in ‘to visually recognize’, ‘to visually perceive’, and ‘to visually experience’ for reasons of flow and clarity.

\(^{10}\) Similar points are made by Hamlyn (1994, pp. 140 ff.) and Olsen. As Olsen puts it: In “seeing” the lines as being unequal in length, the concepts of ‘line’ and ‘equal length’ (and perhaps a number of other concepts) must come into play merely to “see” them as being of unequal length whether they are or not. (Olsen, in preparation)

\(^{11}\) D.J. Schiano and K. Jordan (1990) write: “It is generally accepted that the magnitude of the Müller-Lyer illusion declines substantially under conditions of prolonged visual inspection and repeated judgements” (p. 307).
points of the two horizontal lines, I can briefly perceive the horizontal lines as having equal length.¹²

It may be that some people always experience a full illusion and cannot, even for a moment, perceive the horizontal lines as being equal. Even if this is so, this would not entail that the visual experience of the lines is totally in conflict with the belief that their lengths are equal, contrary to Crane who seems to hold that the perception is completely in conflict with the belief. The illusion is not totally in conflict with the belief because the horizontal lines are perceived to be close enough in length not to dispel a belief that they are equal in length. To illustrate this observation, before having viewed the following diagram, suppose we believe someone's report that the two horizontal lines in the diagram are equal in length.

\[ \text{Diagram:} \]

Would visually perceiving the diagram shake our belief? Of course it would. In contrast, in the Müller-Lyer diagram illusory perception of the lengths of the horizontal lines as unequal is not totally in conflict with a belief that the lines are equal.

As well as failing to justify the claim that the Müller-Lyer illusion is not revisable at all, Crane fails to recognize in his account that there are numerous illusory visual perceptions

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¹² Consciously directing visual attention to correct for illusion is sometimes called “analytic perception”, a term used by Merleau-Ponty (1962, pp. 8 & 11) regarding perceptual correction of the Müller-Lyer illusion. A more recent term for the same thing is 'cognitive recalibration', used by Schiano and Jordan (1990).
that are obviously revisable by beliefs. Mirrors are a font of examples in this regard. Even though mirrors induce illusory perceptions, a belief that a mirror is producing an illusory perception often changes the perception. So a perception of a fellow slyly looking my way from across a restaurant can be revised by a belief (that I am looking into a mirror) to a perception of myself in a mirror. Instead of perceiving the fellow as someone else, I perceive the fellow as my reflection in the mirror. The perception changes due to the influence of the belief. This is not to say that beliefs can revise all illusions, even in part. Many are not revisable, such as the Ames room illusion. In the case of the Ames room illusion, we believe and judge it to be an illusion even in the midst of the illusory experience. It is reasonable to conclude that beliefs can revise some illusory perceptions, partially revise others, and not revise still others. Crane's analysis is too simplistic because he speaks only of perceptions which are not revised by beliefs.

There is considerable experimental evidence to support the view that belief and other attitudes influence visual perception. Coren et al. (1986) have shown, for example, that expectations of subjects significantly influence the illusory contour they experience at the centre of the following figure.

13 Below, I cite evidence from psychological testing to back the claim that beliefs and other attitudes alter perceptions to a degree.

14 See Rock's discussion of the effect of belief on perception (Rock 1983, pp. 300 ff.). The Ames room illusion is a well-known example of an illusion that is not revisable by beliefs.
If subjects expect an illusory circle, 67% experience an illusory circle in contrast to 0% who experience an illusory square. However, if subjects expect an illusory square, 38% experience an illusory square as opposed to 10% who experience an illusory circle. In a useful philosophical paper, Ralph Baergen draws on this and other empirical evidence to argue that "the dependence of perception upon cognition admits of degree" (1993, p. 14). He remarks further:

The experimental results I have presented show that cognition influences not only our judgements or interpretations of what we perceive, but the character of the sensations themselves. Putting this in terms of modules, the data show that the systems which generate our conscious perceptual experiences are not completely modular. (1993, p. 22)

Here Baergen argues that our perceptions are changed (to a degree) by expectations, for "cognition" influences "sensation" as well as influencing judgements and interpretations.

In general, Crane's argument seems to erect too much of a cognitive barrier between visual perception and belief. If beliefs could not influence perception, some perceptual

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15 Baergen claims (1993, p. 13) that the question of the influence of belief on perception is related to but distinct from the question of theory-ladenness of observation. According to Baergen, one can coherently maintain that observation is not theory-laden while still holding that beliefs can affect perceptions to a degree.
learning would be an enigma. The influence of belief on perception seems indispensable for at least some types of perceptual learning. A biologist, for example, fails to visually recognize a member of an unfamiliar species on the first encounter. Investigation convinces her that it is a member of species X, a belief which influences perception so that she becomes able to visually recognize members of species X. It seems that the influence of belief on perception is indispensable for this type of perceptual learning.

All in all, Crane’s way of arguing for the non-inferentiality of visual perception conflicts with scientific findings and does not account for the fact that beliefs affect perceptions to a degree.

There is another way to argue that visual perception is non-inferential without committing Crane’s mistakes. It is to argue that beliefs and other attitudes non-inferentially influence visual perception to a degree. This influence is non-inferential because, for one thing, some illusions such as the Ames room illusion, are not revisable by beliefs at all. The Müller-Lyer illusion, as well, indicates the non-inferential character of perception. The illusory perception is often not revised by a belief to the contrary, indicating that there is no inferential relation between the perception and the belief. Even when beliefs contribute to the revision of the illusory perception (so that it is no longer illusory), the revision is often not permanent. This is another indication that visual perception is not inferential. However, just because belief and other attitudes do not stand in an inferential relation to visual perception, there is no need to deny that attitudes influence visual perception. Clearly they do. Instead, attitudes can be thought to exert a non-inferential influence that alters
perceptions to a degree (actually to varying degrees depending on the belief and the perception).

Crane is wrong on two counts. First, he does not account for the influence of belief on perception. This problem does not arise if it is acknowledged that beliefs non-inferentially affect perception to a limited degree. This does not require backing down from the fundamental stance that visual perception is non-inferential. Second, he concludes from the existence of visual illusions that visual perception is not conceptual because it is not inferential. His conclusion is wrong because having perceptual illusions presupposes conceptual perception. In the case of the Müller-Lyer illusion, we need to apply concepts in order to visually recognize the horizontal lines and to experience them as unequal in length. (See n. 10, p. 9.)

While Crane is mistaken in holding that visual perception is non-conceptual, the view that visual perception is non-inferential is correct (even though Crane's argument is flawed) and brings into precise focus a mental attribute that distinguishes visual perception from belief. That is, beliefs are inferentially related to each other while perceptions are neither inferentially related to each other nor to beliefs.¹⁶ (Merely contending that perceptions are not beliefs, without specifying whether or not perceptions are inferentially related to each other and/or to beliefs, leaves open whether perceptions are inferential.)

¹⁶ This way of differentiating visual perceptions from beliefs stands in contrast to the position of Fred Dretske whose way of differentiating between the two types of states “depends ... on a difference between a concept-free mental state (e.g., an experience), and a concept-charged mental state (e.g., a belief)...” (Dretske 1993, p.263). My position is also distinct from Armstrong’s (1968, pp. 208 ff.) theory of perception wherein perception is construed as acquiring belief.
Section 1.4 Perceptual inference theory

While visual perception is conceptual it is not inferential. In visual perception, we are not engaged in avoiding contradiction, drawing conclusions based on evidence, preserving truth values, or concluding what ought to be the case. Inferentialists think otherwise. For them, visual perception is due to inference from retinal stimulations (or outputs) and from background information such as beliefs. Inferentialism is compelling to many vision scientists because it seems to explain perception of objects, or parts of objects, that are not in the visual field. These nonexistent perceived things are purportedly inferred.\textsuperscript{17} In philosophy of mind and in vision theory inferences are widely held to depend on language. So understandably inferentialism is closely linked with linguistic accounts of perception.\textsuperscript{18} Rock (1983), for example, proposes an inferential-propositional-linguistic account of visual perception. Inferentialism seems to face an uphill battle because perception does not, \textit{prima facie}, seem to involve inference. We visually perceive thousands of objects as we go about our daily business without any sense that we are inferring anything. In fact, during perception our "minds" are often on other things.

In reply to the contention that we do not seem to be engaging in inference in ordinary perceptual experience, most inferentialists would hold that perceptual inferences are unconscious. It is apposite to question the coherence of this contention since it relies on an esoteric construal of inference, for inference seems to require conscious deliberation. Even

\textsuperscript{17} See the Merleau-Ponty remark at the head of this chapter.

\textsuperscript{18} W. Martin Davies (1996, esp. pp. 13 ff.) comments extensively on this trend.
if the notion of unconscious perceptual inference is coherent, the claim that visual perception is due to unconscious inference is still wrong, as has already been shown in discussing Crane's position. Neither conscious nor unconscious inference revises illusory perception despite beliefs to the contrary.

The involvement of inference in learning to visually recognize many objects may seem to be evidence of the involvement of inference in visual perception. However, the involvement of inference in learning to visually perceive many objects does not necessarily entail that inference is involved in the perception itself, either before or after the learning stage is complete. (Similarly, the fact that use of language is required in learning to visually experience many objects does not necessarily imply that language is constitutive of visual perception. Name recall often accompanies visual perception. But this does not imply that language is constitutive of visual perception.) Suppose someone, who lives in a suburb where all television broadcasting is supplied by cable, has read about television antennas but has never seen one. When she first encounters them on her travels abroad, she uses inference from her background knowledge to recognize television antennas (non-perceptually) by their location, colour, shape, rigidity, etc. After a time, she is able to visually perceive the television antennas. Even though inference is involved in learning to perceive television antennas, it does not follow that inference is involved in the perception itself. Even in the learning stage, it does not follow that visual perception is due to inference. Rather, beliefs
and other attitudes engendered by inference could non-inferentially beget perceptual learning.\(^{19}\)

A response to the standard poverty-of-stimulus argument employed by inferentialists can be given along a similar vein. Inferentialists argue that because the visual stimulus does not contain sufficient information to determine visual perception (that is, the stimulus is under-determined), at least some of our visual experience must be due to inferences from background information. However, stimulus under-determination, if that claim holds, does not necessarily entail the need for inference of perceptions. Background information could already be incorporated (non-inferentially) through a learning stage into a non-inferential perceptual neuronal architecture.\(^{20}\) Visual experience that relies on this information would not be due to inference.

Some visual illusions might seem to play into the hands of inferentialists. One of these is used by Gilbert Harman in *Thought* (1973). Harman's argument is akin to a way of

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\(^{19}\) This approach coheres with the skill-acquisition theory of perceptual learning, associated with the psychologists J. J. Gibson and E. J. Gibson (1957), which construes perceptual learning as akin to skill acquisition. In much the same vein Hamlyn remarks: "...[I]nstead of attempting to construe our perception of the world in terms of the ideas of data and inference or judgment, one might better invoke the notion of skill" (Hamlyn 1983, p. 24). See Kellman and Arterberry 1998 (pp. 15 ff.) for a recent discussion of the inference and the skill-acquisition models of perceptual learning. These are discussed under the headings of, respectively, *constructivist* and *ecological* models. In Helmholtz, perceptual learning involves inductive inference. According to Richard L. Gregory: Helmholtz stresses that the association of word with meaning, and of sensation with meaning in perception, comes from regular experiences of the connection with no (or few) exceptions. In this way, meanings are built *inductively* (from many instances to a conclusion that is not logically necessary), both for language and for perceptions. (Gregory, 1987, pp. 608-609)

For the inferentialist doctrine of theory-ladenness of observation (P. Feyerabend 1962 and N. R. Hanson 1958), it would seem that perceptual learning takes place in conjunction with a cognizer’s acceptance of a new theory (i.e., a new system of beliefs) from which new perceptions are inferred.

\(^{20}\) In Chapter 4, a plausible theory of non-inferential perceptual neuronal architecture responsible for visual object recognition is examined.
arguing that is, in one form or another, a mainstay of inferentialism. So the following response to Harman applies to a host of variations of the same type of argument. He uses a diagram like the following (1973, p. 175):

![Diagram](image)

and argues:

Ordinarily one would assume that A overlaps and is therefore in front of B. That assumption would ordinarily represent a warranted inference. If A and B are both circles and A is in front of B and slightly to its left they would present that appearance. The hypothesis accounts for the way they look. On the other hand, if B is closer than A, B must have an irregular shape. Ordinarily it is more plausible to assume that B has a regular shape and is therefore behind A. Under special laboratory conditions, this reasoning might not be warranted; but ordinarily it is. (Harman 1973, p. 176)

Accordingly, “perception involves inference” (1973, p. 175) by Harman’s lights. Of course, the perceptual inference, if it obtains, must be unconscious (as Harman agrees) because within perception there is no conscious assumption “that A overlaps and is therefore in front of B”. Instead, one just sees A overlapping B. The claim that unconscious inference induces this perception is dubious, even though the perception is influenced by past experience. A more likely explanation is that the propensity to perceive the diagram in a certain way is due to potentials within a (non-inferential) neuronal architecture, potentials that are a result of past perceptual experience. Certainly, some of these mechanisms might seem to mimic

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21 See, for example, Palmer 1997, pp. xiii-xiv.
inference in some cases. Nonetheless, the mechanisms that bring past experience to bear on occurrent perception produce contrary-to-belief illusions such as the Müller-Lyer illusion, and so these mechanisms are not inferential. Finally, Harman's example can be used to conclude that inferentialism is mistaken. If perception were inferential, we would not perceive \( B \) as lying behind \( A \), because we perceive the diagram as being completely flat. There cannot be anything lying behind \( A \) on the page. (Unaccountably, Harman does not notice this problem in his argument or even acknowledge that it may be a problem.) Hence, Harman's argument cannot be right because our perception of \( B \) as lying behind \( A \) cannot be due to inference from information readily available to perception.

The perception of \( B \) as lying behind \( A \) despite the concurrent perception of the diagram as completely flat is a doubly useful observation against inferentialism. It can also be used to respond to a typical resource employed by inferentialism to explain why we have illusions despite beliefs to the contrary. Perceptual inference, it is said, has only limited access to our knowledge base, whereas inference in the belief system has full access to our knowledge base. This explains discrepancies between perception and belief, it is claimed. However, we perceive \( B \) as lying behind \( A \) at the same time as we perceive the diagram as being flat. So perceptual inference, if it obtained, would have access to information to infer \( B \) as not lying behind \( A \). But this inference is not made within perception.

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22 Although Harman argues that warranted inference accounts for the perception of \( B \) lying behind \( A \), Pylyshyn (1999, sec. 2, pp. 344-345) points out that psychological studies of amodal completion indicate otherwise. ('Amodal completion' refers to experiencing a complete object when only parts of the object are visible. In Harman's example, we experience the complete object \( B \), even though only part of it is visible.)
In vision science, the theory that perception is due to unconscious inference from retinal stimulations (or outputs) and background expectations and beliefs, etc., has many adherents. Irvin Rock systematically develops such a theory in *The Logic of Perception* (1983, see especially pp. 240 ff.). Stephen Palmer (1997), for whom Rock was a mentor, in a forward to a recent book edited by Rock, remarks on the position of Rock and his coworkers as follows:

The perceiver is given the spatiotemporal pattern of stimulations on the retina and must "infer" what environmental situation or event is more likely to have produced that retinal stimulation .... In essence, the inferential approach hypothesizes that observers make very rapid and unconscious inferences based jointly on optical information in their retinal images and internally stored knowledge of the likelihood of various real-world situations given particular kinds of image structure. (Palmer 1997, p. xiii)

Many other vision scientists going back to H. Von Helmholtz 1867 are in the same camp.

In *The Logic of Perception* Rock holds that reasoning — including using inference, propositions, and language — is engaged in visual perception (1983, pp. 300 ff.). He theorizes about constancy phenomena such as colour and shape constancy, "perceptual problem solving", and perceptual categorization of shape (form). For him unconscious inference is engaged in the first two (Rock 1983, pp.19-20) but inference is not involved in shape perception (Rock 1983, p. 95). Shape perception, for Rock, is a type of lower-level perception. However, he seems to tacitly characterize shape perception as inferential. Consider the first three stages in his eight-stage theory of shape "description" (leaving a ninth

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23 Written after Rock's death, Palmer's forward is entitled "The Legacy of Irvin Rock".  
24 Gregory (1997, p. 2) claims that Helmholtzian inferentialist accounts of visual perception now dominate vision theory. Another version of inferentialism has recently emerged: Bayesian perceptual inference theory. (See W. A. Richards et al., 1996.)
stage for object recognition): “[t]he information for location may derive from local sign on the retina”; “[t]he location of these constituent points relative to one another is derived”; “[d]ecisions are made by the cognitive apparatus as to which such points belong to one another as parts of larger units (organization)” (Rock 1983, p. 95; my italics). The emphasized words are from the inferentialist’s lexicon and, moreover, the “decisions” seem to bear a strong resemblance to conclusions of inferences. This interpretation of Rock’s account of shape perception accords with his contention that shape perception produces descriptions of a linguistic-propositional nature (Rock 1983, pp. 91-92). It is hard to exclude inference if this is the end product. Thus, Rock’s account of shape perception may well not be an exception to his inferentialism. In any case, with the possible exception of shape perception, Rock generally wholeheartedly embraces and champions inferentialism and identifies his theory with that of Helmholtz.

Rock’s theory faces the problem that retinal stimulations, according to Rock (and inferentialists in general), are merely spatiotemporal patterns on the retina. As such these

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25 There are ways to be an inferentialist without talking about physical states such as retinal stimulations. Another of Harman’s arguments in Thought has this flavour. This is his argument pertaining to so-called “Gettier examples”:

A person may see that there is a candle a few feet in front of him. Another person may be equally justified in believing that there is a candle in front of him and he may be right too, although a mirror intervenes between the second person and his candle so that what he sees is the reflection of a different candle off to one side. A speaker of English is inclined to say that the first perceiver knows that there is a candle in front of him but the second does not, even though both have justified true belief.

One cannot easily account for perceptual Gettier examples unless one assumes that even simple perceptual knowledge is based on inference. In that case, the perceiver can be assumed to infer that the explanation of there seeming to be a candle ahead is that he is seeing a candle there. He comes to know that there is a candle there only if he is right about why it seems to him that there is a candle there. (Harman 1973, p. 55; my italics)

So, for a perceiver “seeing a candle there” is due to an inference from “there seeming to be a candle ahead”. An infinite regress seems to be lurking in this argument because “there seeming to be a
patterns cannot be constituents of inferences because they are not conceptually structured. This is a crucial problem for Rock's theory, as it is for inferentialism in general. Some inferentialists acknowledge this problem without, however, shifting away from their fundamental position. For example, in the (p. 20) quotation, Palmer puts scare quotes around the term 'infer' before blithely going on to remark:

In essence, the inferential approach hypothesizes that observers make very rapid and unconscious inferences based jointly on optical information in their retinal images and internally stored knowledge of the likelihood of various real-world situations given particular kinds of image structure. (my italics)

In this respect, Palmer is faithful to the basic position of inferentialism. Thought and perception share the same fundamental property. They are both inferential. It would seem that inferentialism as a theory of perception would lose a crucial tenet if inference from retinal stimulation were dropped from the theory. Perhaps for this reason, it is typical for

candle ahead must be a perception or due to a perception. In the latter case, this perception must be due to inference, according to Harman. In the former case, "there seeming to be a candle ahead" is due to inference, according to Harman. In either case, infinite regress seems to ensue.

Robert Schwartz argues that perceptual-inference theory is plagued by the following problem. There can be no firm criterion that justifies a distinction between "givens" and the rest of visual processing (Schwartz 1994, pp. 84-124, esp., pp. 120-121). He contends that the debate over "perceptual inference" is counterproductive:

Pulling away from the debate over inference ... will not solve or dissolve the serious, empirically significant issues in the theory of vision; but it will keep us from wasting time on a lot of bogus controversies. (1994, p. 121)

Exasperation with unresolved conflicts has led Schwartz to disparage the debate over perceptual inference in favor of "empirically significant issues in the theory of vision". However, the empirical question of how to characterize visual perception in both its conscious and its neurological aspects is intimately bound up with debate over perceptual inference.

Pylyshyn argues: "...[P]erceptual principles, unlike the principles of inference, are responsive only to visually presented information" (Pylyshyn 1999, sec. 2, fourth paragraph, p. 344). He contends that visual perceptual processing is "cognitively impenetrable".

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inferentialists to argue that perceptual inference is full-fledged, not a sort of watered down or technical variety of inference.\textsuperscript{28}

An aspect of Rock's (1983, p. 100) theory, and other versions of inferentialism, concerns what Rock calls "perceptual problem solving", a capacity which includes our ability to visually recognize hidden images in puzzle pictures. This capacity, it is held, shows that visual perception is inferential. Insofar as problem solving is part of visual perception, it would seem that visual perception is conceptual. This much in Rock's position can be granted without granting that the problem solving that is involved in visual perception is inferential. There are good grounds for this stance. Take the case of looking at a drawing that is, at first, perceived as a jumble of ink blobs and later, after a belief is formed that the puzzle picture depicts a horse and rider, is perceived as a depiction of a horse and rider.\textsuperscript{29} The perception of the depiction of a horse and rider does not seem to be due to conscious inference from the belief, even though the belief can influence the perception to a degree. Furthermore, our belief that there is a horse and rider in the picture does not necessarily lead to the perception of the horse and rider in the picture. We may fail to perceive the horse and rider. Accordingly, the perception is not inferred from the belief. This reinforces the tenet of non-inferential conceptualism that inference is not involved in visual perception. This is not to say that inference does not indirectly influence the perception. A belief that a jumble of

\textsuperscript{28}There is nothing special or out of the ordinary about perceptual inference according to Harman (1983, pp. 176-179). He accepts the argument of Gregory (1970) whom Harman (p. 177) cites favourably.

\textsuperscript{29}I refer here to a puzzle picture depicted in Rock (1983, p. 12). Rock describes the process leading to the perception of this picture as a case of "perceptual problem solving" (1983, p. 12).
ink blobs depicts a horse and rider may be due to an inference. This belief could then non-inferentially influence perception so that we come to perceive a horse and rider.

Is unconscious inference involved in visual perception of hidden images in puzzle pictures? If so, we would still expect the perception of a depiction of a horse and rider to ensue once the belief is established that there is a horse and rider depicted in the puzzle picture. However, this generally does not happen. The perception of a depiction of a horse and rider is far from guaranteed. That is, we can rightly believe that the puzzle picture portrays a horse and rider, without a perceptual inference that a horse and rider is in the picture. Such an inference, however, conscious or otherwise, would be drawn if visual perception were inferential.

Terminological ambiguity leads to wrongly thinking that inference is involved in the perception of hidden images in puzzle pictures. The term ‘perceptual problem solving’, as employed by Rock (and as generally employed in vision theory), lends credence to inferentialism by referring to an amalgamation of cognitive capacities that, in the type of problem-solving situation under consideration, are either part of, or not part of, perception. This amalgamation makes it wrongly seem that inference is involved in visual perception. Consequently, there is a need for more terminological precision. For example, the term (of my invention) ‘perception-related problem solving’ could be used to refer to all the cognitive capacities involved in solving puzzle pictures and similar cognitive tasks and the term ‘perceptual problem solving’ could be used to refer a subclass of these cognitive capacities situated within perception only. Rock’s terminological ambiguity has the effect of falsely leading to the view that problem solving within visual perception is due to inference.
We have seen that inferentialism faces several problems. Even though inference is often involved in learning to visually experience many objects, it does not follow that inference is constitutive of the experience. (Inference is indirectly involved in such learning when it engenders beliefs that non-inferentially influence visual perceptions.) Because inference is not consciously engaged in perception, inferentialists propose that perceptual inference is unconscious. However, the persistence of visual illusions, despite conflicting beliefs, shows that perception is not due to inference from beliefs. Additionally, thinking of retinal stimulations as constituents of inferences is untenable because, if non-conceptual, these stimulations cannot be constituents of inferences. Finally, inference is not involved in perceptual problem solving, even though inference can influence this problem solving to a degree.

I am drawing a theoretical picture of visual perception as a primitive conceptual capacity. Inferentialism makes visual perception seems much more "sophisticated" or "intelligent" than it really is. My theoretical picture of visual perception is well-illustrated by recent scientific investigation of a neurological process known as filling in, a process which "fills in" missing gaps in our visual field due to scotoma (areas of diminished vision within the visual field). Scotoma can be simulated by viewing a diagram such as the following which is similar to a diagram in Gregory's Eye and Brain (1997, p. 59).
The unlined circle is “treated” as a scotoma by perceptual processing. For most people, after ten seconds of focusing on the small, black square, the circle is ignored or filled in with the surrounding pattern. Gregory writes: “This process occurs quite early [in visual processing], for it takes no account of object-knowledge. Thus a missing nose is not added: The process works merely for patterns, not objects” (Gregory 1997, p. 60). The filling in must be non-inferential because it occurs despite our belief that there is an unlined circle in the figure. Yet, our experience before, during, and after filling in is object-involving. Before filling in, we experience the unlined circle, during filling in we experience the filling in of the circle, and after filling in we experience no circle, just the larger patterned object. So even though the experience is non-inferential, the visual experience is conceptual (because it continues to be object-involving). Another visual experience pertaining to the same display again illustrates the non-inferential (yet conceptual) nature of visual perception. To have this visual experience, a subject views the above display on a computer screen until filling in occurs. At this point, all the lines are removed from the screen so that there are no longer any physical lines on the screen. The only physical item displayed on the screen is the fixation point. Then something amazing happens. The subject, who is instructed to remain visually
fixated on the small square, continues to experience the filled-in circle but not the larger pattern: “The result is remarkable. A small bit of pattern of the switched-off pattern is seen on the blank screen, in the region of the missing bit of pattern of the first display, though somewhat degenerated” (Gregory 1997, p. 59). Because the filled-in region is experienced as an object, the experience is conceptual. However, it would be farfetched to think of the experience of the filled-region as due to inference from retinal stimulations and attitudes.

In The Modularity of Mind, Jerry A. Fodor considerably modifies unconscious perceptual inference theory. Judging from the multiple caveats in the following short passage, he recognizes its pitfalls:

Input analyzers are ... inference-performing systems within the usual limitations of that metaphor. Specifically, the inferences at issue have as their ‘premises’ transduced representations of proximal stimulus configurations, and as their ‘conclusions’ representations of the character and distribution of distal objects. (Fodor 1983, p. 42)

Accordingly, these “inference-performing systems” are not full fledged. By Fodor's lights, the output of the visual module is constrained because the module is “in certain respects unaffected by ... feedback” from “information that is specified only at relatively high levels of representation”; that is, the visual module is “informationally encapsulated” (1983, pp. 64-65). Its output is in the form of “basic categorizations” (1983, p. 97) which are categorizations “on the basis of the visual properties of objects” (1983, p. 97).

[B]asic categorizations are typically the most abstract members of their inferential hierarchies that could be assigned by an informationally encapsulated visual-input analyzer; more abstract categorizations are not reliably predicted by visual properties of the distal stimulus. (Fodor 1983, p. 97)
So the categorization *dog* but not *animal* is output by the visual module (Fodor 1983, p. 96).³⁰

Fodor offers no alternative to the theory of unconscious inference from retinal stimulations. His theory is within the inferentialist current as far as the notion of unconscious inference from retinal stimulations is concerned. (This comes out clearly in Fodor 1985.) That being the case, he fails to escape a fundamental problem that Rock encounters. Retinal stimulations — that for Fodor and Rock are non-conceptual — cannot be premises for inference. Finally, it is not clear that visual perception is inferential even to a limited extent of correctly placing objects into a limited inferential hierarchy that does not go beyond so-called basic categorizations. A statue of a dog can be mistaken for a dog!³¹

Construing visual perception as inferential may seem to stand in contrast to construing it as non-conceptual. Certainly, the latter deprives visual experience of any conceptual character, unlike the former. Despite this, the two construals share a tacit assumption: being inferential is a necessary condition for being conceptual. We have already seen that this assumption underlies Crane’s position. The same applies to inferentialism. Many philosophers and vision theorists, including Harman and Rock and going back to Helmholtz, who realise that visual perception is conceptual, cannot resist concluding that it

³⁰ It is questionable whether Fodor can have both “basic categorizations” as output and “informational encapsulation”. This problem is pointed out by Hilary Putnam (1984/1994b, esp. pp. 411 ff.).

³¹ Although Fodor seems to accept (with caveats) the notion of unconscious inference from retinal stimulations, he is not an inferentialist. For him, inference from attitudes to perception is a false notion. (See especially Fodor 1985.)
is inferential. Accordingly, the difference between the two currents of opinion is not as deep-seated as it may at first seem.

Section 1.5 Can visual perception justify perceptual belief?

One of the traditional problems of justification of beliefs concerns foundational beliefs, namely, those beliefs which are not inferred from other beliefs and which provide a basis or foundation for inference to other beliefs. Empiricism, including sense-datum theory in this century, holds that foundational beliefs are justified by sensings or experiences of so-called sense data, such as colour patches — the givens in experience. According to sense-datum theory, the sensing of sense data is self-authenticating and indubitable, thereby providing justification of our foundational beliefs about the world.\footnote{Although the claim of justification of beliefs based on givens in experience is associated with the empiricist tradition, it also reflects the influence of Descartes, a rationalist, who held that a belief is justified if it is clear and distinct and if there can be no doubt or error about it.} A tenet of empiricist and sense-datum theory — the claim that visually sensing of sense data is non-conceptual — is particularly relevant to this study. The non-conceptual nature of these sensings bars them from justifying beliefs because non-conceptual sensings are not the type of thing that can justify belief. That is, in order to warrant a belief, a sensing must be conceptually structured, for it needs to supply a reason, as it were, to hold the belief.

This failing of empiricism and sense-datum theory is often discussed in terms of the "myth of the given". (This way of expressing the failing of empiricism and sense-datum theory, from what I can ascertain, is due to Wilfrid Sellars 1956.) McDowell says this about the myth of the given:
When we are tempted by the Myth of the Given, we carefully ensure that relations across the envisaged outer boundary of the space of concepts, relations between bits of the Given and the most basic judgements of experience, can be reason-constituting; that is the point of taking the space of reasons to extend more widely than the space of concepts. (1994a, p. 8, n. 7)

When "tempted by the Myth of the Given", McDowell says, we propose that non-conceptual sensings or experiences — "bits of the Given" — can justify belief.

The position of Crane and other non-conceptualists does not lend itself to a justificatory account that avoids the myth-of-the-given error of empiricism. If perceivings are non-conceptual, they are not the type of thing that can justify belief. In contrast, thinking of visual perception as conceptual avoids the error of empiricism. My belief that the object to my right is a computer mouse is justified by my perception of the object as a computer mouse. I am not just guessing.33

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33 This type of position was seen by Sellars who nonetheless rejected it as an option for other reasons (according to Robert Brandom 1997, p. 129). In suggesting how a sense-datum theorist could get out of his/her difficulties, Sellars wrote:

[The classical sense-datum theorist] must say something like the following:

The non-inferential knowing on which our world picture rests is the knowing that certain items, e.g. red sense contents, are of a certain character, e.g. red. When such a fact is non-inferentially known about a sense content, I will say that the sense content is sensed as being, e.g., red. I will say that a sense content is sensed (full stop) if it is sensed as being of a certain character, e.g. red. Finally, I will say of a sense content that it is known if it is sensed (full stop), to emphasize that sensing is a cognitive or epistemic fact. (Sellars 1956, sec. 4, p. 17)

This position is consistent with McDowell’s claim that “we must not suppose that receptivity makes an even notionally separable contribution to its co-operation with spontaneity” (p. 51), a claim which makes way for an account in which intakes can provide justification for thought. By McDowell’s lights, this view can usher in a different notion of the given:

“... When we trace the ground for an empirical judgement, the last step takes us to experiences. Experiences already have conceptual content, so this last step does not take us outside the space of concepts. But it takes us to something in which sensibility — receptivity — is operative, so we need no longer be unnerved by the freedom implicit in the idea that our conceptual capacities belong to a faculty of spontaneity. We need not worry that our picture leaves out the external constraint that is required if exercises of our conceptual capacities are to be recognizable as bearing on the world at all. (McDowell 1994a, p. 10)
Unlike non-conceptualism, inferentialism holds that visual perception is conceptual, in fact, inferential. So inferentialism, it may seem, is not prone to the type of givenness problem which befalls non-conceptualism. However, inferentialism faces a similar problem. This problem pertains to the non-conceptual character of retinal stimulations, which act, on inferentialism's showing, as premises for inference. Because these "premises" are non-conceptual, they fail to bring a subject into a conceptual relation with the world. Perception that relies on these "premises" cannot provide objective reasons for belief. This implies it cannot warrant belief. These non-conceptual premises do not imply that for inferentialism perception is non-conceptual. Inference from beliefs and other attitudes would make perception at least partially conceptual. However, inferring perception from attitudes does not put a subject in a conceptual relation with the world. Like non-conceptualism, then, inferentialism fails to account for perceptual justification of beliefs.\(^\text{34}\)

To justify beliefs, perception needs to meet the condition of establishing a conceptual relation between a subject and the world. Perception fails to satisfy this condition under the accounts of both non-conceptualism and inferentialism. That is, neither non-conceptual perception, nor perception "inferentially" derived from non-conceptual retinal stimulations,

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\(^{34}\) Because vision science is so influential and because inferentialism is so influential within vision science — a potent influence going back to Helmholtz — inferentialism's failure to provide an account of the justification of beliefs has had considerable repercussions. In particular, according to Pylyshyn (1999, pp. 341-342), the New Look movement in psychology, a brand of inferentialism founded by Jerome Bruner, provided suspect support for, and encouragement of, the doctrine of theory-ladenness of observation of Feyerabend (1962) and Hanson (1958). Pylyshyn's 1999 paper directly opposes Bruner and the New Look movement. (For Bruner's position, see Bruner 1953/1973.) Fodor's notion of "information encapsulation" is a direct response to Bruner, as well. (See, especially, Fodor 1985.)
can establish a conceptual relation between a perceiving subject and the world. By contrast conceptual, non-inferential perception is capable of establishing such a relation.

Inferentialism faces another problem as far as justification is concerned. Inferring perceptions from beliefs makes perceptions dependent on beliefs. That is, inferentialism puts the "justified cart" before the "justifying horse". This problem is compounded by the problem of inferentialism just discussed: non-conceptual retinal stimulations cannot establish a conceptual relation between a perceiving subject and the world. This picture of visual perception puts inferentialism in more jeopardy because beliefs and other attitudes become the only source of justification in the inferentialist model. Retinal "premises" are excluded because they are non-conceptual. But beliefs cannot provide independent justification of beliefs. The inferentialist model, thus, leaves systems of belief "spinning in the void", that is, without an adequate grounding in the objective world.

Another condition needs to be satisfied by visual perception before it can be said that visual perception provides objective justification for belief. Visual perception needs to be generally veridical. (Non-veridical perception obviously cannot provide objective justification for beliefs.) Finally, a further question pertaining to visual perceptual justification needs to be discussed. Can visual perception, in itself, provide full objective justification of beliefs or does full objective justification require more than perception alone? This issue, as well as the issue of whether or not visual perception is sufficiently veridical to justify belief, are left to forthcoming chapters.
Chapter 2

Visual perception of diagrams

"Diagrammatic reasoning is the only really fertile reasoning." (C. S. Pierce)

My defence of non-inferential conceptualism against Crane’s position concentrated on perceptual illusions, in fact, on the Müller-Lyer illusion. These illusions demonstrate the non-inferentiality of visual perception but not, as Crane would have it, its non-conceptuality. I argued that visual perception must be conceptual in order for the illusion to obtain. Crane’s position also fails to account for non-illusory perception. In this chapter, I argue that visual perception must be conceptual because the utility of diagrams in diagrammatic reasoning can be explained only by supposing that visual perceptions supply conscious, conceptual shape information (about which we reason).

I focus on a single type of diagrammatic reasoning: demonstrating or proving geometric propositions such as the Pythagorean theorem. There is an affinity between all types of problem solving utilizing diagrams. In all cases of diagrammatic reasoning — working out geometric problems, figuring out routes in maps, designing a building using architectural drawings, and so on — to perceive diagrams (I shall argue) provides conscious, conceptual shape information. This affinity entails that focussing on geometry does not unduly diminish the generality of my argument.

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1 This quotation is attributed to Peirce by the Diagrammatic Reasoning Site (http://morpheus.hartford.edu/~anderson/).
Geometric reasoning is importantly different from other type of diagrammatic reasoning, however. Objects such as perfect squares are abstract. They are not instantiated in roads, cement, or any other material. So these objects cannot be visually perceived, even though diagrams which depict them can be perceived. This state of affairs is sometimes denied. Some theorists contend that visual perception gives us direct cognitive access to abstract mathematical objects. This issue is addressed as well.

The successful use made of diagrams in diagrammatic reasoning helps to show, I argue in this chapter, that visual perceptual is sufficiently veridical to provide a foundation for objective knowledge.

The role of diagrams in geometric problem solving is discussed within both philosophy of mind and philosophy of mathematics. Some philosophers of mathematics think intuition of mathematical objects is strongly analogous to perception. Contemporary discussions of diagrammatic reasoning span philosophy of mathematics, philosophy of mind, psychology, education and other disciplines. There is considerable cross fertilization. For example, philosophers Jon Barwise and John Etchemendy, whose contribution is addressed below, draw on insights from psychology regarding the cognitive use of diagrams and apply these insights to mathematics education and philosophy of mathematics.

Section 2.1 Diagrams in geometric problem solving

Diagrammatic reasoning is not new to philosophy. It goes back a long way. Fortunately in the annals of philosophy there is an excellent description of geometric reasoning with
diagrams. This is Plato’s dramatization in *Meno*\(^2\) 81e - 86b where a boy, under Socrates’s questioning, figures out how to double a square, that is, how to construct a square exactly twice the area of a given square. Plato’s dramatization provides a reference point for discussing this issue. The boy learns that a square with a side equal to the diagonal of the given square is twice its area. This proposition is illustrated in the following diagram. The larger square, whose side is a diagonal of a smaller square, is twice the area of the smaller square.

![Diagram](image1)

By Socrates’s lights, the boy’s learning is “remembering” from past lives.\(^3\) Even though Plato uses this scene to develop a theory of “reminiscence” from past lives, the scene is an even-handed portrayal of a diagrammatic proof. Given that Socrates’s leading questions supply the boy with new information, the scene reads like an implicit challenge from Plato.

It is as if he is saying:

Here is a typical way in which a student learns to double a square. I claim that the student is really remembering from past lives. This may seem improbable and granted Socrates gives the student important hints which the dullard Meno misses. Even so, try to come up with a better theory.

No full theory is proposed here. Instead, an account is developed of the role of visual perception in the boy’s ability to solve the problem.

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\(^2\) Grube’s (1981) translation is used throughout.

\(^3\) “[T]here is no teaching but recollection….” (*Meno*, 82a).
The linguistic prerequisites for solving the problem are implicitly given at the beginning of the scene:

S: Is he a Greek? Does he speak Greek?  
M: Very much so. He was born in my household. (82b)

So the boy is proficient in Greek and of course considerable language understanding is required to follow Socrates's questions. In fact, Socrates and the boy share many concepts; otherwise they could not converse with each other. The boy knows some mathematics. He knows, for example, what a square is: "S: Tell me now, boy, you know that a square figure is like this? — I do (82b)." and he knows four is double two (85b).

Relying on the particular figures in the sand, after a few false starts which he corrects under Socrates's careful questioning, the boy learns how to double any square. The diagrams in the sand are crucial for solving the problem. For example, once the boy examines this diagram

![Diagram](image)

(a diagram indicated by Socrates at 85a) he realizes, after Socrates asks him a few more questions, how to double a square. The solution in essence is this. The square formed by the diagonals, illustrated by shading in the diagram below, is twice the area of any of the four smaller inside squares, one of which is illustrated by stripes in the diagram below. The shaded square is composed of four small triangles, whereas the striped square is composed of two small triangles. (All the small triangles have equal area.)
Consequently, the shaded square has twice the area of the striped square. Furthermore, a side of the shaded square is a diagonal of the striped square. This solves the doubling a square problem because it demonstrates that a square (as indicated by the shaded square above) with a side that is the diagonal of another square (as indicated by the striped square above) is double its area. This scene shows that diagrams can play a central role in some geometric proofs.⁴

This assessment might be challenged by disputing the role of diagrams. In fact, diagrammatic proofs are held in disrepute by most mathematicians and logicians. At best they are considered mere "aids to intuition" and not legitimate constituents of mathematical proofs mainly because of the danger of generalizing from accidental features of diagrams.

Logician Neil Tennant adheres to this standard view:

[The diagram] is only an heuristic to prompt certain trains of inference: ... it is dispensable as a proof-theoretic device; indeed, ... it has no proper place in the proof as such. For the proof is a syntactic object consisting only of sentences arranged in a finite and inspectable array. (Tennant 1986, taken from Barwise and Etchemendy 1991, p. 8)

Barwise and Etchemendy correctly contend that this stance is mistaken, provided care is taken not to use accidental features of diagrams in proofs. In challenging the dogma that all sound reasoning must be exclusively sentential, they draw on the work of psychologists such

⁴ Doubling a square shows $a^2 + a^2 = c^2$. This equality is a special case of the Pythagorean equality $a^2 + b^2 = c^2$ that occurs when $a=b$. 
as Keith Stenning (1977) and Stephen M. Kosslyn (1980) who similarly have challenged this dogma.\textsuperscript{5}

Barwise and Etchemendy hold that reasoning is "heterogeneous", that is, not characterized by any one representationalist system. To illustrate their point they present a typical proof of the Pythagorean theory (Barwise and Etchemendy 1991, p. 12). This proof now presented in a slightly modified form. The task is to show, starting with an arbitrary right-angle triangle with sides $a$, $b$, and $c$, as in the top diagram, that $a^2 + b^2 = c^2$. First construct a square on the hypotenuse $c$, as in the middle diagram, and then replicate the triangle three times, as in the lowest diagram. Since the sum of the angles of a triangle is a straight line, it can be easily shown that ABCD is a square. Now the area of ABCD can be computed in two ways. Since each side of ABCD is $(a + b)$ in length, its area is $(a + b)^2 = a^2 + 2ab + b^2$. Alternatively, the area is the sum of the four triangles plus the area of the central square which is $4 \times \frac{1}{2}ab + c^2$. Because these are two ways of calculating the same area, the two results are equal. Hence $a^2 + 2ab + b^2 = 4 \times \frac{1}{2}ab + c^2$ which, by cancellation of $2ab$, yields the desired result of $a^2 + b^2 = c^2$.

Barwise and Etchemendy argue:

It seems clear that this is a legitimate proof of the Pythagorean theorem. Note, however, that the diagrams play a crucial role in the proof. We are not saying that one

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\textsuperscript{5} Here is what Jon Barwise says about his paper on his internet webpage:
It is always fun to work with John Etchemendy. This paper argues for the rehabilitation of diagrams as legitimate tools in proofs. I think it will turn out to be one of the most important things I have contributed to, though most of my logician friends think I'm wrong. We'll see.
could not give an analogous (and longer) proof without them, but rather that the proof as given makes crucial use of them. To see this, we only need note that without them, the proof given above makes no sense.

This proof of the Pythagorean theorem is an interesting combination of both geometric manipulation of a diagram and algebraic manipulation of nondiagrammatic symbols. Once you remember the diagram, however, the algebraic half of the proof is almost transparent. This is a general feature of many geometric proofs: Once you have been given the relevant diagram, the rest of the proof is not difficult to figure out. It seems odd to forswear nonlinguistic representation and so be forced to mutilate this elegant proof by constructing an analogous linguistic proof, one no one would ever discover or remember without the use of diagrams. (Barwise and Etchemendy 1991, p. 12)

So Barwise and Etchemendy rightly dispute Tennant’s contention that a diagram is “only an heuristic to prompt certain trains of inference”. Instead, diagrams take centre stage in many geometric proofs, so much so that algebraic manipulation is “almost transparent” once the relevant diagram is recalled. (“Once you have been given the relevant diagram, the rest of the proof is not difficult to figure out.”) An objection may be that alternative proofs may not

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5 Friedman gives an account of the position of Kant which indicates that Barwise and Etchemendy are somewhat in accord with Kant. Friedman reconstructs a proof, given by Kant, that the sum of the angles of a triangle is $180^\circ$:

Kant [gives] the standard Euclidean proof of the proposition that the sum of the angles of a triangle $= 180^\circ = $ two right angles .... Given a triangle $ABC$, one prolongs the side $BC$ to $D$ and then draws $CE$ parallel to $AB$ .... One then notes that $\alpha = \alpha'$ and $\beta = \beta'$, so $\alpha + \beta + \gamma = \alpha' + \beta' + \gamma = 180^\circ$. Q.E.D. (Friedman 1992, p. 57)

He then notes:

In contending that construction in pure intuition is essential to this proof, Kant is making two claims that strike us as quite outlandish today. First, he is claiming that (an idealized version of) the figure we have drawn is necessary to the proof. The line $AB$, $BD$, $CE$, and so on are indispensable constituents; without them the proof simply could not proceed. So geometric proofs are themselves spatial objects. Second, it is equally important to Kant that the lines in question are actually drawn or continuously generated, as it were. Proofs are not only spatial objects, they are spatio-temporal objects as well. (Friedman 1992, p. 57-58)

7 They also observe:

We want to suggest that the search for any universal scheme of representation — linguistic,
utilize diagrams. However, that does not undermine the full-fledged role of diagrams in proofs that utilize them, as Barwise and Etchemendy point out.

The utility of diagrams in geometric problem solving can be explained only by supposing that visual perception supplies conscious, conceptual shape information with which to reason; therefore, diagrammatic reasoning requires conceptual perception (implying in particular that Crane's position does not hold). This argument applies not only to geometrical problems, but to a host of other problems such as figuring out routes using maps. Even Tennant's position does not undermine the assessment that visual perception is conceptual. His contention that diagrams are merely heuristic is compatible with conceptual perception of diagrams. Indeed, perception would have to be conceptual for a diagram "to prompt certain trains of inference". Showing that perception plays a conceptual role in geometric problem solving indicates that in situations where inference, propositions, and language play an indispensable role in cognitive activity, such as in doubling a square or designing a building, visual perception can still make a conceptual contribution.

Visual perception supplies shape information that is used in solving problems. In the case of perceiving a diagram of a square, we become consciously, conceptually aware of shape properties of the diagram: its number of sides, the equality of angles and sides, and various symmetries, information that is needed in order to solve the doubling-a-square problem.\footnote{Barwise and Etchemendy remark that "inference ... is the task of extracting information implicit in some explicitly presented information" (Barwise and Etchemendy 1991, p. 180).} Presumably, it is perceived shapes that assist us in figuring out the solution

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Barwise and Etchemendy remark that "inference ... is the task of extracting information implicit in some explicitly presented information" (Barwise and Etchemendy 1991, p. 180).
because, in a geometric diagram, information about shape is the only type of information that is relevant to solving geometric problems. This observation applies to other types of diagrams. The predominant type of information that is typically available in a diagram is shape information. Consider, for example, the type of information that is available in maps or architectural drawings. It is, by and large, shape information.

My previous arguments against inferentialism suggest it would be wrong to hold that inferential perception is responsible for supplying this conscious, conceptual shape information. Of course, inference is involved in diagrammatic reasoning. It is not, however, involved in perception.

Section 2.2 Visual perception and abstract objects

Geometry is concerned with abstract geometric objects (for example, perfect or ideal squares), which cannot be perceived because they are immaterial. It might, then, seem that visual perception cannot play a conceptual role in geometric reasoning because visual perception cannot give us cognitive access to abstract geometric objects. However, as already shown, the utility of diagrams in geometric reasoning can be explained only by supposing that visual perception supplies conscious, conceptual shape information. How, then, does visual perception supply this information? One suggestion is this. Visual perception gives us conceptual access to diagrams, which we then non-perceptually construe to be representations of abstract geometric objects. This seems to be part of the answer because in order to reason about abstract geometric objects, we need a way to represent them. This is not the full answer, however, because in order to facilitate geometric reasoning, a
diagram typically needs to mimic, in a significant way, the shape of the abstract geometric object (or objects) that the diagram represents. Why should this be so; that is, why should the shape of a diagram matter in this way?

The answer to this last question seems to be a variation on what has already been argued: visual perception of a concrete diagram in a way supplies conscious, conceptual information about the shape properties of the abstract object, shape properties which the diagram mimics in some significant way. But how is visual perception able to do this? To understand what is going on we need to observe, first, that geometric reasoning takes place within the context of our having acquired the concept abstract geometric object. (This is not to say that we know everything about an abstract geometric object that we are studying. In fact, the aim of geometric reasoning is often to discover more properties of abstract geometric objects. We do know, however, that the object is abstract and in what sense it is abstract.) In this context, visual perception greatly contributes to our conscious, conceptual awareness of the shape properties of abstract geometric objects even though we visually perceive only shape properties of concrete diagrams that depict abstract objects and have similar shapes to these objects. That is to say, the perception of shape properties of concrete diagrams is a surrogate for conscious, conceptual awareness of shape properties of abstract geometric objects depicted in the diagrams.\(^9\) This surrogate consciousness can arise for a

\(^9\) A similar conclusion is drawn by Marcus Giaquinto in his discussion of the role of perception in the proof of doubling a square set down by Plato in the *Meno*:

>Vision was a means of getting information about things that were not before one's eyes. Seeing the diagram as a geometrical figure of a certain sort, seeing parts of it as related in certain geometrical ways and visualizing motions of the parts, enabled us to tap our geometrical concepts in a way which feels clear and immediate. (Giaquinto 1993, p. 95)
subject only if the subject knows what an abstract geometric object is, in particular, knows that its shape can be only approximated by a diagram. As an example of the surrogate role of visual perception, consider perception of the following depiction of an abstract geometric object

![Diagram](image)

(a depiction used in trying to solve the problem of doubling an *abstract* square). The configuration of lines, edges, angles, etc., in this diagram is similar to the configuration of lines, etc., in the abstract object that the diagram depicts. Visual perception of this configuration can then be used as a surrogate for conscious, conceptual awareness of a similar configuration obtaining in the abstract geometric object that the diagram depicts.

In what sense is the configuration of lines, edges, and angles, etc., in a diagram similar to the depicted abstract geometric object? To address this question we consider a simpler diagram, namely this,

![Diagram](image)

and suppose that it represents a perfect square. Evidently, this diagram is relatively precise. Likely, the lines are within one tenth of an inch of being equal and the angles are within a couple of degrees of being equal. So if our eyesight is working properly, we probably perceive a diagram that is similar in shape to a perfect square in the sense of being within the

the role of visual perception in some aspects of geometric reasoning. Crane's theory of non-conceptual content, taken up in the previous chapter, closely follows that of Peacocke.
mentioned tolerances. This means that our visual experience of shape properties of the concrete diagram can become a surrogate for conscious, conceptual awareness of the shape properties of an abstract square. In perceiving, for example, the above diagram we experience the same number and the same connectivity of lines as occurs in an abstract square. Visual perception plays a conceptual role by supplying a surrogate for conscious awareness of the properties of abstract geometric objects.\(^\text{10}\)

A diagram need not be accurately drawn in order for perception of its shape properties to act as a surrogate for conscious awareness of shape properties of the abstract object depicted in the diagram. For example, this diagram,

![Diagram](image)

if taken as a depiction of the abstract geometric object used in the doubling-a-square problem, is inaccurate. Nonetheless, perception of its shape properties can still act as a surrogate (for conscious, conceptual awareness of the shape properties of the depicted abstract geometric object) in much the same way as does perception of the shape properties of the more accurate depiction. For example, although the angles and line lengths in this diagram are quite inaccurate, aside from this the configuration of lines is still the same.

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\(^\text{10}\) How do we come to comprehend or intuit abstract geometric objects such as perfect square? One approach involves imagining a process of successive, unending refinements to a concrete square. A perfect square is considered to be the ultimate product of these refinements. This is the approach of Bernard Lonergan (1957, pp. 31-32). I return to how we come to comprehend or intuit abstract geometric objects in Chapter 6.
Perception of this configuration, then, can be a surrogate for conscious, conceptual awareness of the same configuration in the abstract geometric object.

The conceptual role of perception in reasoning about abstract geometric objects (a role just described) is another indication of the conceptual nature of visual perception. No separate argument is required to demonstrate that this role is non-inferential. The perception at issue is just ordinary perception, which as already argued is non-inferential. It is beyond the scope of this study to investigate whether (or not) the surrogate conscious awareness at issue is always necessary for reasoning about abstract geometric objects. It might be that ultimately we cannot conceptualize spatial properties without recourse to visual (or tactual) perception or without recourse to imaging. For this study, it is enough to argue that visual perception is useful in geometric problem solving because experiencing shape properties of concrete diagrams is a surrogate for conscious, conceptual awareness of shape properties of abstract geometric objects.

In discussions on the role of perception in mathematics, it is sometimes claimed that we visually perceive abstract mathematical objects. In his account of mathematical intuition, Charles Parsons (1980) seems to hold this view. His theory of perception is intended to contribute to a theory of mathematical intuition, the concept of which, according to him, is "strongly analogous to [the concept] of perception" (Parsons 1980, p. 162). By his showing, we conceptually perceive tokens (that is, particulars). This much I agree with. However, he seems to insist on an odd additional idea that we perceive abstract types as objects.

Parsons (drawing from Hilbert), in particular, investigates perception of strings of strokes (stroke-strings). Examples of token strings of strokes are ||, ||||, |, ||||, and ||. Strings
of strokes are of special interest because they are, as *types* — but not as *tokens* — isomorphic to the natural numbers: 0, 1, 2, 3, and so on. He remarks: "This yields an interpretation of arithmetic as a kind of geometry of strings of strokes" (Parsons 1980, p. 153). By Parsons's lights, perception of a token string of strokes is conceptual (which agrees with non-inferential conceptualism). "One has to approach [a string of strokes] with the concept of a type, first of all to have the capacity to recognize other tokens as the same type or not" (Parsons 1980, p. 154). We perceive a string of strokes as a string of strokes. More is required of perception if perceiving a string of strokes is to count as perceiving a number. If we only perceive tokens, and not types, as objects, he argues, the "geometry of strings of strokes" would "[leave] out the concept of number, that is the role of natural numbers as cardinals and ordinals" (Parsons 1980, p. 153). According to Parsons, we not only perceive tokens as *instances* of types, but we perceive types as objects: "Something more than the mere capacity [to recognize other tokens as the same type or not] is involved, which might be described as seeing something as the type" (Parsons 1980, p. 154). By "seeing something as the type" Parsons does not mean seeing something as an instance of a type, as the last sentence in the following remarks makes clear. Parsons draws on ordinary perceptual experiences to make his case:

> [I]n some cases, taking what is given as a type is quite spontaneous and natural. The most obvious is the understanding of natural language: the hearer is without reflection ready to reidentify the type (in the linguistic, not the acoustic sense). Typically, the hearer of an utterance has a more explicit conception of what was uttered (e.g., what words) than he has of an objective identification of the event of

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11 In order for Parsons's proposal to work, he needs to show that we can immediately perceive the distinction between || as a single token and || as two tokens of the same type. For the sake of discussion, I grant him this.
the utterance. I believe that the same is true of some other kinds of universals, such as sense-qualities and shapes. Indeed, in all of these cases it seems not to violate ordinary language to talk of perception of the universal as an object, where an instance of it is present. This is not just an overblown way of talking of perceiving an instance as an instance (e.g. seeing something red as being red) .... (p. 154)

Parsons seems to be confusing perception with talk of perception. He argues "it seems not to violate ordinary language to talk of perception of the universal as an object, where an instance of it is present". He needs, or at least seems to want, to show that we actually perceive types or universals as objects. We might talk as if we perceive types as objects when we perceive word tokens, sense-qualities, and shape tokens and it might be natural to talk in this way. But that does not warrant the odd claim that we perceive types or universals as objects. I do not dispute that we acoustically perceive word tokens as instances of types; but we do not perceive word types as objects. Similarly, we do not visually perceive the type red as an object but we perceive only instances of red. The same applies to perception of shapes. We perceive only instances of shapes. For example, we perceive only instances of concrete triangles (as instances of triangles) but we do not perceive the universal triangularity. This distinction is fundamental. There is nothing in principle wrong with examining talk of perception to illuminate the nature of perception. However, because language is so well-suited to expressing abstractions, this approach poses the danger of supposing that we can perceive abstract entities when in fact we might only talk at times as if we do. This is a danger that Parsons fails to avoid. There is no denying that without perception we would likely not be able to ascertain that there is an isomorphism between the types of stroke-strings and the natural numbers. Furthermore, perception of a token stroke-string can be a surrogate for the conscious awareness of a type of stroke-string. In much the same way,
perceiving the shape of a concrete diagram is a surrogate for conscious awareness of the shape of the abstract geometric object depicted in the diagram. But perception of a stroke-string token can only be a surrogate for conscious awareness of stroke-string types; we do not perceive these types as objects.

The contention that we perceive "the universal as an object, where an instance of it is present" is wrong for other reasons. Parsons's use of 'where' (in "where an instance of it is present") is ambiguous. Neither side of the ambiguity, however, yields what Parsons wants. In one sense, Parsons can be interpreted as claiming that we perceive a type (as an object) at the location of the particular. In perceiving this token $\Theta$, on Parsons's showing, we would perceive the type happy face at the location of the token of a happy face. This might not seem to be problematic until simultaneous perception of more than one token of the same type is considered. For example, in perceiving two tokens of happy faces in one viewing, as in perceiving this $\Theta\Theta$, we would simultaneously perceive (as an object) the type happy face twice. This has the unfortunate consequence of increasing (for us) the number of the type happy face to two. This consequence is a reductio ad absurdum of Parsons's theory of perception.

Even if it is not, simultaneously perceiving two types (as objects), when two identical tokens (of the type) are perceived, undermines Parsons's attempt to account for intuition of natural numbers, because if we simultaneously perceive the tokens $\mid \mid$, we perceive the type $\mid$ (single stroke) twice. Simultaneously perceiving multiple versions of a stroke-string type, like perceiving multiple tokens of a stroke-string, "[leaves] out the concept of number". That is to say, there cannot be multiple perception of a single stroke-string type (as an object), if
perceiving this type is supposed to count as perceiving a number. Parsons might take the recourse of arguing that, in the case of there being multiple tokens of the same type in view, we only perceive one token at a time and so the problem of multiple simultaneous perceptions of the same type does not arise. However, there is good evidence from studies of “subitizing” that we can simultaneously perceive about seven copies of simple tokens of the same type.¹²

There is another sense of ‘where’ which Parsons might be using in “it seems not to violate ordinary language to talk of perception of the universal as an object, where an instance of it is present”. Here, ‘where an instance of it is present’ might be interpreted as having the same sense as ‘in the case that at least one instance of it is present’. Under this interpretation, Parsons might be contending that we do not perceive the type happy face (as an object) twice when we perceive the two tokens of a happy face, ☻☻. Instead, we perceive the type happy face only once, even when we simultaneously perceive two or more tokens of it. Similarly, he might argue that we perceive the type | (as an object) only once, when two instances of it are present (as here | |). In this case, we would perceive only one type, yet we perceive two tokens. As a consequence perceiving a type (as an object) is not directly tied to perceiving any particular token of the type, even though perceiving one token of the type is necessary. What then is being described as perception would be a sort of occurrent cognitive access to a type as an object of thought. This access is prompted by perception of one or more tokens of the type. Describing this cognitive access to abstract types as

¹²E. L. Kaufman et al. (1949) studied this sort of experience with respect to numerosity. They found that adults can accurately, confidently, and rapidly report the number of items in a set provided the set has six or fewer items. This ability is termed ‘subitizing’.
perceptual seems to be an undue relabelling of faculties that are non-perceptual to make it seem that this cognitive access to abstract types as objects is perceptual. Consequently, interpreting ‘where an instance of it is present’ as having the same sense as ‘in the case that at least one instance of it is present’ does not benefit Parsons’s case.

How symbols are handled in mathematical practice might seem to favour Parsons. In working out mathematics problems a sort of mental shorthand arises in which a symbol for a mathematical object is handled or thought of as if it were the mathematical object itself. In this way, the token stroke-string \( \| \) might be thought of as a number, rather than a symbol for a number. This diagram \( \square \) might be thought of as a perfect square rather than a symbol for a perfect square. This mental shorthand may create a sort of mental illusion that we are perceiving abstract objects. It is only an illusion. We do not perceive abstract objects, as already argued. (This is not to say that mathematical intuition is an illusion. I remain neutral on the issue of mathematical intuition in this study.)

It would seem that Parsons wants to accomplish three interrelated things with his argument. Its failure undermines all three. First, he wants to account for intuition of abstract mathematical objects in terms of the concepts used to describe perception.\(^{13}\) Certainly, concepts used to describe perception such as *immediacy* and *obviousness* can help us understand intuition. Nevertheless, since we do not perceive abstract objects, it is difficult

\(^{13}\) Parsons writes:

If a positive account of mathematical intuition is to get anywhere, it has to make clear, as its advocates intended, that mathematical intuition is not an isolated epistemological concept, to be applied only to pure mathematics, but must be so closely related to the concepts by which we describe perception and our knowledge of the physical world that the “faculty” involved will be seen to be at work when one is not consciously doing mathematics. (Parsons 1980, p. 155)
to see how the concepts used to describe perception of concrete objects can account for intuition of *abstract* objects. Second, as mentioned above, Parsons wants to give an account of the concept of mathematical intuition which is "strongly analogous to [the concept] of perception" (p. 162). Since we do not perceive abstract objects, explaining mathematical intuition of *abstract* objects by analogy with perception is not sufficiently revealing. Concepts used in descriptions of perception such as *immediacy* and *obviousness* help us, by analogy, to describe intuition. But what is crucially required is an account of how it can be that we intuit *abstract* mathematical objects. Third, Parsons wants to show that "[t]he quasi-perceptual manner in which mathematical objects can be given to us is in a certain way exemplified by situations of *ordinary* perception or imagination of realizations (sometimes partial) of structures involved" (p. 153). (I leave aside the issue of imagination.) Presumably Parsons is referring to the purported perception of abstract types as objects. His contention that mathematical objects are "given to us" in "a quasi-perceptual manner" (a vague claim) rings empty because he has not demonstrated that abstract mathematical objects are "given to us" in a way "exemplified by situations of *ordinary* perception ... of realizations ... of structures involved". I presented a way in which ordinary perception can play a role in reasoning about abstract geometric objects, but that way does not involve perception of abstract objects (as objects). It involves visual perception of the shape of geometric diagrams acting as a surrogate for conscious, conceptual awareness of shape properties of abstract geometric objects. In contrast, by confusing perception with talk of perception, Parsons wrongly thinks that abstract types are visually perceived as objects. Visual perception decidedly cannot do this.
There is an argument which Parsons might resort to, namely this: because we intuit abstract mathematical objects and because perception is the only means we have of doing so, it follows that we must, in a way, perceive abstract mathematical objects. I do not take a stand on whether we intuit abstract mathematical objects or not. However, even granting that we do intuit abstract mathematical objects, it is far from clear that this intuition must involve perception in the way described by Parsons. There is a range of cognitive resources in addition to perception that could be constitutive of mathematical intuition, including imaging, imagination, and the use of language. By denying that we perceive abstract mathematical objects, I therefore am not committed to denying that we intuit these types of objects.

Parsons's position is a way of exaggerating the conceptual capacities of visual perception without advocating a version of inferentialism. (Probably no type of inferentialism would suit Parsons’s purpose of accounting for intuition of abstract mathematic objects.)

**Section 2.3 The foundational role of perception**

An aim of this work is to establish that visual perception provides a foundation for objective knowledge. I established in the previous chapter (pp. 29 ff.) that visual perception needs to be both conceptual and non-inferential to be a foundation for objective knowledge. In this chapter, the conceptual nature of visual perception has been confirmed by arguing that the utility of diagrams in reasoning can be explained only by supposing that visual perception supplies conscious, conceptual shape information. Additionally, it was argued that visual perception of the shape properties of a geometric diagram acts as a surrogate for conscious,
conceptual awareness of shape properties of the abstract objects depicted in the diagram (with the proviso that, in order for a perception to play this surrogate role, a subject needs to realize what an abstract geometric object is).

So far, it has not been argued that visual perception is sufficiently veridical to justify beliefs objectively. This question will occupy us now and in subsequent chapters. For now, a partial answer is given in the form of an observation. In general, visually perceiving objects of a simple type (such as the type involved in proving the Pythagorean theorem) is veridical. In fact, provided lighting conditions are good, we are quite good at veridically perceiving most objects, especially those which we encounter in our day-to-day lives. The “ordinary person” would readily attest to this claim. Though this empirical observation to the effect that visual perception is for the most part veridical has a somewhat “pre-philosophical” aura about it, the philosophical ground has been prepared by developing the thesis of non-inferential conceptualism. This view reveals that visual perception can play a justificatory role.

Our visual perception is not completely veridical, so visual perception cannot be an absolute foundation. It is a non-absolute foundation. Occasionally we misperceive ordinary objects even in good lighting conditions and there are many well-known situations in which visual illusions occur, as we have seen. Visual misperceptions show that visual perception

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14 Sense-datum philosophers granted that the “ordinary man” feels secure about the deliverances of vision. However, invoking the “argument from illusion”, they made a case that certainty about the external world could not be guaranteed. Briefly, they argued that illusions demonstrate that the cause of visual perception is not objects such as trees, dogs, squirrels, etc., but primary givens or sense data about which and only about which we can be certain. The next chapter returns to the issue of so-called givens in experience and other types of non-conceptual givens.
is veridical only for the most part. (Despite the possibility and actuality of non-veridical perceptions, visual perception is, in fact, predominately veridical. Thus suggests a foundational role for visual perception, even though this foundational role is non-absolute.) Visual perception is a non-absolute foundation for another reason as well. Visual perception alone cannot "tell" us which perceptions are veridical and which are not, although visual perception can supply information on which to base judgements to that effect.

Because in good lighting conditions we visually perceive most ordinary objects veridically (and because visual perception is conceptual and non-inferential) visual perception can act as a foundation for objective knowledge, including knowledge of geometric propositions such as the Pythagorean theorem. Accordingly, it is no surprise that diagrams are ubiquitous in many areas of science. Perceiving diagrams is a reliable (and often convenient) way to supply information with which to reason.

Because visual perception cannot objectively justify belief fully (for visual perception is not completely veridical and visual perception alone cannot "tell" us which perceptions are veridical and which are not), full objective justification of beliefs must rely on objective judgements based on rational, scientific, and mathematical knowledge and principles. Without basing judgement on this knowledge and these principles, we could, for example, believe that Jove appears in clouds when we view part of a cloud in the shape of a bearded face. These judgements do not accompany most perceptions. However, they can (non-inferentially) alter some of our perceptions and, furthermore, we are potentially able to judge objectively — based on rational, scientific, and mathematical knowledge and principles — the veridicality of any perception. We do not need to be philosophers, scientists, or
mathematicians to make these judgements. It is sufficient to be raised in a society founded on rational, scientific, and mathematical knowledge and principles and to base our judgements on this knowledge and these principles. Those who do not rely on such knowledge and principles might still have some objective (perceptual) beliefs. However, because their judgements are not based on rational, scientific, and mathematic knowledge and principles, their beliefs are not and cannot be objectively justified in any full way.

Rational, scientific, and mathematical knowledge and principles depend upon certain historically accepted activities and practices — such as developing and applying criteria for evidence — which ultimately act as a ground or foundation for this knowledge and these principles. I call these activities and practices *rational-scientific-mathematical forms of life*. (For this study, I accept and rely on the Wittgensteinian claim that forms of life provide foundations for knowledge. 15) Generally speaking, we are initiated into these forms of life to various degrees in the course of our upbringing. Justification of rational, scientific, and mathematical knowledge and principles cannot rely solely on judgement based on this knowledge and these principles. It must also rely on veridical perception. (For example, in science we need to be able to read dials, printouts, etc., reliably) Consequently, rational-scientific-mathematical forms of life do not fully justify rational-scientific-mathematical knowledge and principles. They must be linked to other foundations including perceptual foundations. The forms-of-life foundations and the perceptual foundations complement each other (in ways I hereafter describe regarding visual perception). 16

15 See, for example, Olsen 1978, pp. 109 ff. for an account of “forms of life”.

16 This idea is derived from Christopher Olsen’s “Epistemology and the Developing Child” (1978).
In using the plural ‘forms of life’ rather than the singular ‘form of life’, I have in mind a range of broad types of human practice and activity which are rational, scientific, and mathematical. There are various disciplines within science and mathematics which have their own distinct practices and activities. Also, many people are integrated into rational-scientific-mathematical activities and practices only to a limited degree, compared with experts; nonetheless this integration is important. These people, too, have been integrated into rational-mathematical-scientific forms of life to a degree.

Discoveries which arise from rational-scientific-mathematical forms of life provide reasons for believing that most visual perceptions are veridical and explain why some perceptions are illusory. Consequently, the security of visual perception felt by the “ordinary person”, and even by some philosophers, can be sustained by reasons taken from science. Many of these reasons are available to the “ordinary person”. Additionally, because visual perception plays an important role in coming to understand the truth of many geometric propositions, if these propositions are indeed true, it would be a good indication that visual perception is sufficiently veridical to count as a foundation of the type I have been advocating. Specifically, the shape of a diagram and our perception of that shape should be sufficiently correlated to allow, for the most part, for sound reasoning using perception of the diagram to take place. This perception need not be precise. If the boy in the *Meno* has severe astigmatism, his perception could still be sharp enough to muddle through anyway. It is a safe bet that hosts of geometric propositions, including the Pythagorean theorem, are indeed true. There are over two hundred different proofs of the Pythagorean theorem; engineering and architectural designs which rely on its truth have guided the manufacture of countless
sound structures; the Pythagorean theorem has survived millennia. There is not a hint — not even the slightest hint — among contemporary mathematicians that it may be wrong. The belief in these geometric propositions (which in large part are justified by mathematical forms of life) indicates that visual perception plays a foundational role. That is, it is sufficiently veridical for sound geometric reasoning to proceed based, in part, on this perception. (Similarly, the success of engineering projects is testimony to the veridicality of visual perception of engineering drawings used to guide construction.)

So far, my discussion of the foundational role of visual perception in mathematics has been limited to its foundational role arising from perception of geometric diagrams. Visual perception also plays a role in confirming or justifying mathematical propositions. This view is sustained (in a way explained below) by a remark of James Robert Brown:

…[p]ictures are crucial. They provide the independently-known-to-be-true consequences that we use for testing the hypothesis of arithmetization. Trying to get along without them would be like trying to do theoretical physics without the benefit of experiments to test conjectures. (Brown 1999, p. 29)

Brown presents a picture proof which illustrates the way in which pictures “provide the independently-known-to-be-true consequences that we use for testing the hypothesis of arithmetization”. This proof confirms Bolzano’s arithmetic proof of the intermediate value theorem. This theorem states: If $f$ is a continuous function on the interval $[a,b]$ and $f$ changes sign from negative to positive (or vice versa), then there is a $c$ between $a$ and $b$ such that $f(c) = 0$. Referring to this figure
Brown remarks: "Just look at the picture. We have a continuous line running from below to above the x-axis. Clearly, it must cross that axis in doing so. Thus understood, it is indeed a 'trivial' and 'obvious' truth" (1999, p. 27). In this way, the picture proof independently confirms the arithmetic proof, implying that the picture proof provides a warrant for the arithmetic proof.

Although Brown does not directly discuss the justificatory role of visual perception, it is evident that visual perception plays this role. Visual perception may not be doing all the problem-solving work in the picture proof. Nonetheless, visual perception plays a role in warranting the arithmetic proof of the intermediate value theorem, for we cannot visually trace the path of the continuous curve without crossing the x-axis.

Section 2.4 Conclusion

We have seen that visual perception needs to be conceptual in order for diagrams to play a useful role in diagrammatic reasoning. In geometric reasoning, perceiving a diagram's shape acts as a surrogate for conscious, conceptual awareness of the shape properties of the geometric object depicted in the diagram. The conceptual role of visual perception in these
circumstances is not bought at the expense of granting that it is inferential or, as Parsons seems to argue, at the expense of granting that we perceive abstract objects.

A couple more components of my justificatory account have been put in place. First, visual perception is generally veridical, allowing it to be a foundation for objective knowledge. Second, visual perception alone does not provide a foundation for full objective knowledge. For this, visual perception needs to act in conjunction with rational-scientific-mathematical forms of life.
Chapter 3

Shape perception and object recognition

"Just now I looked at the shape rather than at the colour." Do not let such phrases confuse you. (Wittgenstein 1958, Philosophical Investigations, Il Xi)

Section 3.1 Introduction

In Chapter 1 my central argument for the claim that visual perception is conceptual relied on the observation that object recognition is all-pervasive in visual perception. Object recognition, however, is not the full extent of visual perception. It includes as well visually experiencing relations such as distance between objects, and properties such as shape, motion, colour, and texture. We also experience scenes composed of groups of objects. I do not address in any detail the visual experience of these things except for experiencing the shape of objects. This topic constitutes a good deal of the subject matter of this chapter.

The question of the character of visual perception of shape has a significant bearing on non-inferential conceptualism, specifically its tenet (sometimes hereafter referred to as conceptualism) that visual perception is conceptual. Suppose some or all of visual perception of the shape of objects is non-conceptual. On that showing, a type of non-conceptual perception pervades some or all of our visual perception. This would entail that visual experience is at best an amalgam of conceptual and non-conceptual components. Many philosophers and vision scientists accept this view. If it were true, it would seriously

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1 In this discussion, 'visual perception' is largely used in the same sense as 'perceptual experience' or 'visual sense experience', a usage that adheres to the sense of 'perception' employed in this work, as already indicated in Chapter 1. In line with this usage, 'visual perception of shape' has the same sense as 'visual experience of shape' and 'visual sense experience of shape'.
undermine conceptualism. For this reason, my attention will now be directed at arguing that such an amalgam does not obtain, that our visual experience of shape is totally conceptual.

There are other aspects of our visual experience that, if they were non-conceptual, would threaten conceptualism in similar way. For example, if perception of any visual property, such as motion, colour, texture, or location were non-conceptual, conceptualism would be undermined. In this chapter, I first argue that visual perception of shape is conceptual, after which I briefly sketch how this conclusion can be generalized to perception of other visual properties of objects and to perception of visual relations between objects.

Arguing, as I do in this chapter, that visual perception of shape is conceptual is also directed against an influential type of outright non-conceptualism within vision theory and philosophy of perception. For reasons explained later, I name this position centralism. According to centralism, all visual perception is essentially non-conceptual perception of shape. Another threat to conceptualism, discussed in this chapter, comes from the sensation-perception distinction which entails that there are two fundamentally different kinds of visual experience; one kind (sensation) is non-conceptual and the other kind (perception) is conceptual.

The issue of visual perception of shape is considerably intertwined in vision theory and philosophy of perception with theories of the character of the neurological processing of shape stimuli. This interconnection is especially pronounced in centralism. In addressing the sensation-perception distinction and in addressing centralism, I join this discussion and address neurological issues pertaining to the processing of shape stimuli.
In a sense, this chapter continues the argument in the previous chapter. The utility of diagrams in geometry (and other types of reasoning) can be explained, it was argued, only by supposing that visual perception supplies conscious, conceptual shape information with which to reason. This argument shows that visual perception of shape is conceptual.

In one of the following arguments, I show that object recognition must be involved in visual perception of shape. That is, we perceive shape as object-shape. Perception of shape as object-shape implies perception of shape is conceptual, I show.

Section 3.2 The nature of visual perception of shape

The non-inferential, conceptual nature of visual perception of shape is argued in three ways in this section. First, I consider visual perception of whether simple two-dimensional shapes are the same or different. We visually experience the sameness of these two shapes □□ and the difference of these two shapes □△. Because these shapes are perceived in one case as the same and in the other case as different, the concepts same shape and different shape must be applied within perception. Therefore, visual perception must be conceptual in order to perceive simple two-dimensional shapes as being the same or different. The same argument, mutatis mutandis, shows that visual perception must be conceptual in order to perceive simple, concrete three-dimensional geometric shapes as being the same or different and, for that matter, in order to perceive a considerable range of other simple shapes as being the same or different. For example, we visually experience two cars as having the same shape or different shapes. It might seem that we cannot visually experience whether complex shapes are the same or different. For example, we cannot (echoing Descartes) visually perceive the
difference between a hundred-sided polygon and a hundred-and-one-sided polygon. This does not amount to an argument against the view that we visually perceive whether shapes are the same or different. More complex shapes are perceived as being the same or different even though this perception may not be veridical. We visually perceive two many-sided polygons as having the same shape or different shapes, even though this perception may not be veridical, again showing that visual perception must be conceptual because either the concept same shape or different shape is applied within visual perception. (Even where there is only one shape in our visual field, if this situation could arise, we would still have the potential of comparing this shape to another shape within visual perception, if another shape should come into view. Visual perception must be conceptual for this potential to obtain; that is, visual perception must have the potential to apply the concepts same shape and different shapes.)

Visually experiencing whether shapes are the same or different is non-inferential. We just "see" the shapes of the objects as being the same or different. No inference is required. An inferentialist objection to this argument runs as follows. Our perception of whether shapes are the same or different is due to unconscious inference (within perception) from retinal stimulations acting as premises. For example, these two patterns of activation on the retina, $\mathcal{A}$, could be premises from which perception of different shapes is inferred. A key problem with this inferentialist objection has already been basically covered. Patterns of activation on the retina cannot be premises for inference if, as inferentialism holds, they are not conceptual.
We do not experience shape on its own; instead we experience shaped objects. This observation leads to another argument for the conceptual nature of visual perception of shape. That is to say, shape is not experienced in a "raw" manner; instead we visually experience shape as *determinate*-object-shape. (Hereafter, my talk of visually perceiving shapes as object-shapes assumes the objects in question are determinate objects.) Thus, within visual perception, shape is subsumed under a concept of an object, which implies that perception of shape is conceptual. For example, we experience a shape of a cat as a *cat*-shape. Consider aspect shifts pertaining to the well-known duck-rabbit line drawings. If we experience one of these drawings as a depiction of a rabbit, then we experience the shape of the drawing as a rabbit-shape (and/or as the shape of a line drawing of a rabbit). However, if we experience the drawing as a depiction of a duck, we experience the shape of the drawing as a duck-shape (and/or as the shape of a line drawing of a duck). In both cases, because we experience a shape as an object-shape, the visual experience of shape must be

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2 Associative visual agnosia might seem to undermine the claim that shape is not experienced separately from objects. This affliction seems to affect object recognition but not shape perception, suggesting a two-stage, modular process. Drawing this conclusion from such a dissociation of function was common in cognitive science a decade ago. Yet, dysfunction of this type is not necessarily evidence for modularity of a *normally* functioning system. The modularity could simply be a feature of the dysfunctional system and not a feature of the normal system. (A useful paper on the mistake of necessarily taking functional dissociation as evidence of modularity is Elkhonon Goldberg's "Rise and Fall of Modular Orthodoxy", 1995.) In associative agnosia it is not clear that the cognitive deficit is limited to object recognition. Farah (1990, pp. 99-100) argues that shape perception is also impaired.

3 This position seems to be akin to the position of Merleau-Ponty: "In actual perception taken at its origin, before any word is uttered, the sign offered to sense and the signification are not even theoretically separable" (Merleau-Ponty 1962, p. 38). If shape perception is taken as a "sign offered to sense" and object recognition is taken as "signification", then my position accords with Merleau-Ponty's insofar as I do not separate shape perception from object recognition. However, using the sign-signification terminology in reference to shape perception and object recognition seems to create unnecessary confusion. A perceiving of shape is not an awareness of a sign for an object but is constitutive of recognizing the object.
conceptual. We visually experience not "raw" shape, but conceptually specified shape. (That is, we visually experience shape as the shape of an object.)

A seeming exception to the claim that we visually experience any shape as the shape of a particular object concerns simple geometric diagrams. Perceiving geometric diagrams may seem to be an exception because, it might be claimed, the only thing that we perceive is shape. However, geometric diagrams are visually perceived as objects — namely as diagrams.

Another seeming exception occurs when we experience the shape of objects that (purportedly) we do not recognize, such as may be thought to occur when we perceive a duck-rabbit line drawing without recognizing anything pertaining to either a duck or a rabbit. In this type of situation, do we visually perceive shapes but not objects? If so, this would weaken the claim that any shape is visually experienced as the shape of an object. However, in these circumstances we do experience a shape as object-shape. We perceive the shape of a duck-rabbit drawing as the shape of lines on a page, which implies that we visually experience the shape as the shape of objects, namely particular lines. (Describing what is perceived using the phrase 'shape of lines on a page' does not imply that this or any synonymous phrase is evoked in perception. Indeed, an animal such as a chimpanzee which does not use language would likely have much the same visual experience.) A similar case concerns novel objects. It is commonly but mistakenly thought, especially in some psychological theories of perception, that we can visually experience a shape of a novel object without experiencing an object. Of course, we sometimes perceive a shape without recognizing a particular object of the type that is rightly, conventionally, or commonly
associated with the shape. However, the key question is whether or not we perceive a shape as the shape of a particular (determinate) object. The object need not be the “right” object. At a time when computer monitors were novel objects for me, I perceived a computer monitor as a television. Accordingly, I perceived the shape of a computer monitor as the shape of an object, namely a television. If we did not visually perceive a novel object as an object, the parts of the novel object would probably be perceived, if perceived at all, as components of other objects in our visual field. I may not perceive a camouflaged animal of a novel species as a single object. This could occur if the animal were so well camouflaged that I perceived its various parts not as parts of an animal but as parts of other objects. I may perceive a leg of the animal as the trunk of a small tree. Even in this circumstance, perception

4 It is part of Rock’s theory that there can be shape awareness in visual perception without visual object recognition (although he does not conclude that shape perception is thereby non-conceptual). Rock says:

... I will argue that cognitive events are at work [in form perception] ..., that one cannot simply understand form perception in terms of a picturelike internal representation of the retinal-image or in terms of a sum of the separate features that the object might be said to possess. (Rock, 1983, p. 43)

He contends that a perceptual language is employed in “propositional descriptions” of shapes: “...[W]e can view form perception and recognition as very similar processes. Both have the status of propositional descriptions and both entail categorization” (pp. 91-92). Pertinent here is his distinction between perception and recognition. For Rock “perceptual categorization is presumably not dependent on past experience, whereas recognition categorizing is by definition a function of past experience” (Rock 1983, p. 91). Utilizing the same distinction he writes: “[N]ot all objects are familiar, particularly to the child, so that form perception without the final step of recognition occurs very often” (Rock 1983, p. 44). According to Rock, one perceives the shape of a novel object but does not recognize the object; on subsequent viewings, one perceives its shape and probably recognizes the object. Even though I can agree with Rock that shape perception is conceptual, the claim that there sometimes occurs “form perception without the final step of recognition” challenges my contention that we experience shape as object-shape and thereby undermines my argument that visual perception of shape is conceptual. I should add that Rock contends that in certain cases the steps of form perception followed by object recognition do not obtain. He remarks: “In certain cases ... the form description itself depends upon recognition...” (Rock 1983, p. 92). (This question of shape perception depending on object recognition is pursued later in this chapter in relation to the phenomenon figure-ground separation.)
of the shape does not take place without object recognition. In perceiving a leg of an animal as a trunk of a tree, the perceived shape is that of a trunk of a tree. This visual experience of shape is conceptual because we experience a shape as the shape of a particular object. Though we may not visually perceive the shape of a hundred-sided polygon as distinct from a hundred-and-one-sided polygon, we still perceive this shape as the shape of an object, namely the particular diagram of a many-sided polygon.

An argument for the non-inferentiality of the visual experience of shape as object-shape follows similar lines to those previously pursued with respect to inferentialism in general. Within visual experience, we do not infer that a shape is the shape of an object and the argument that we unconsciously infer shape from non-conceptual retinal stimulations or outputs is answered by observing that, for one thing, these stimulations or outputs cannot be premises for inference. Accordingly, our experience of any shape is non-inferentially conceptual.

A third way to understand that visual perception of shape is conceptual is to consider that visually perceiving any thing — including shape — is an experience of the thing as existing through time.5 (Even a tachistoscopic image flashed at a subject is perceived as

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5 This is a form of individuation that is not due to inference. When we continuously perceive something we (non-inferentially) individuate it as a particular. We (non-inferentially) experience something as being in a temporal continuum and so the condition for individuation is trivially satisfied. This perceptual individuation seems to be akin to what P. F. Strawson calls “demonstrative identification” (1959, pp. 18-19). For Strawson, demonstrative identification satisfies a sufficient, but not a necessary, condition of identification. This condition is “that the hearer can pick out by sight or hearing or touch, or can otherwise sensibly discriminate, the particular being referred to, knowing that it is that particular” (p. 18).

Recognition of a thing as being in a temporal continuum during the time we are viewing it — a type of individuation, as I have put it — is called temporal binding in vision science. (See Treisman 1996.) It seems to be consistent with a primitive type of object awareness that Spelke (1988 & 1990) claims neonates possess. This view is paraphrased by Karmilov-Smith:
existing over a very brief span of time.) If this were not so, our visual experience would probably be bizarrely disjoint. The visual experience of the same thing over time is non-inferential. That is, within visual perception we do not infer that a thing in view exists through time. (This is not to say, of course, that all realizations of the existence of things through time are non-inferential.) Consequently, we non-inferentially visually perceive a shape as existing in a temporal continuum. In perceiving a shape as existing through time, we perceive the shape as object-shape because a crucial condition of objecthood — continuous existence through time — is met. Once again the conclusion is that we non-inferentially perceive shape as the shape of an object. It might be objected that other considerations need to be brought into play before we can conclude that perception of shape as object-shape takes place. Whatever the case may be, to make the case that we visually perceive shape conceptually, it is sufficient to observe that we visually perceive any shape as existing through time. In (non-inferentially) perceiving shape as existing through time the concept existing through time is applied in the perception. (This does not entail, of course,

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Four principles — boundedness, cohesion, rigidity, and no action at a distance (i.e., no action without some form of contact) — underlie the perceptual analysis of the [visual] array. Such principles make it possible for the infant (and the adult) to distinguish between the presence of a single object and more than one object when they are adjacent or partially occlude each other. (Kamilov-Smith 1992, pp. 67-68)

6 H.H. Price gives a definition of object recognition:
It would seem ... that recognition of individual objects, persons or places is a more complicated process than recognition of characteristics. Recognition of characteristics is indeed a part of it. But something more is needed: what may be called the postulation of continuance through time, or the disregarding of intervals of non-perception. (1953, p. 39)

7 This consideration applies to the experience of "negative space", the shape formed by the boundaries of neighbouring objects. Negative space is perceived as existing in a temporal continuum.
that the phrase 'shape existing through time', or something similar, is evoked in visual perception. Most visual perceptions of shape occur without the involvement of language.)

So far, three characterizations of visual experience of shape have been argued, each of which supports the proposition that perception of shape is non-inferentially conceptual. First, we non-inferentially visually experience whether shapes are the same or different. Second, we non-inferentially visually experience shapes as shapes of objects. Third, we non-inferentially experience all shapes as existing in a temporal continuum.

These arguments lay another plank in the justificatory account begun in the first two chapters. Because perception of shape is non-inferential and conceptual, it satisfies two critical conditions (discussed in Chapter 1) that perception must meet if it is to play a justificatory role. (Visual perception must be conceptual if it is to justify beliefs; but visual perception cannot justify beliefs if it is inferentially derived from them.) In the case of perception of shape, this justificatory role pertains to beliefs about shape.

The second characterization above can be extended to other dimensions of visual experience including the experience of colour, texture, location, and so on, by following a similar line of argument as was used to arrive at the second characterization.\(^8\) We do not experience "raw" colour, motion, location, etc. Instead, we visually experience these things as properties of objects or relations between objects. We do not have "raw" visual perceptions of red, but visually experience red as the colour of objects; we experience spatial distance as distance between objects. The same argument, \textit{mutatis mutandis}, shows that

\(^8\) It seems evident that the third characterization, as well, can also be extended to all visual properties and relations.
perception of the other visual properties and relations is subsumed under concepts of objects. This implies that our visual experience of visual properties and relations is conceptual.

Section 3.3 The sensation-perception distinction

The reader may have noticed that in my analysis of visual experience of shape no mention has been made of visual sensation of shape. This may raise the concern that my arguments amount to a sleight-of-hand because they simply ignore the domain in which visual experience of shape is non-conceptual, namely the domain of visual sensation. It could be alleged that I have shown that a portion, but not the whole, of our visual experience of shape is conceptual and that, really, (conscious) visual experience of shape is an amalgam or combination of conceptual perception of shape and non-conceptual sensation of shape. There is no sleight-of-hand because, I argue, there is no visual sensation of shape.

In the vision science and the philosophy of perception literature the term 'sensation' is often used ambiguously. It is often not clear whether 'sensation' is used to refer to conscious states that are induced by neuronal activation, to the neuronal activation itself, or to a combination of both.\(^9\) Without this ambiguity, the claim that we have visual sensations would seem odd. We have sensations of heat, pain, roughness, and so on, but we do not have visual sensations. With the ambiguity, it might begin to seem that we really do have visual

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9 Gilbert Ryle (1949, pp. 228 ff.) remarks on the ambiguity of the term 'sensation'.
sensations that are a sort of correlate of the goings-on in the retina. The fact of goings-on in the retina, however, cannot sanction the odd notion of visual sensation.\textsuperscript{10}

The notion of sensation of shape (and of other visual properties) receives support from one or another version of the \textit{sensation-perception distinction}, a term used by Robert Schwartz 1994. (Many philosophers and vision theorists subscribe to this distinction perhaps because it seems to be a reasonable compromise between thinking of visual experience as completely conceptual and thinking of it as completely non-conceptual.) As well as relying on ambiguity of the term ‘sensation’, this distinction is backed by theoretical arguments that require response. Aptly described by Robert Schwartz (1994, p. 91), the distinction alleges that “core” or immediate, conscious visual sensations of shape (and other visual properties) are directly determined by retinal representations. Sensations are also considered to be physical goings-on in the retina and the bottom-up visual pathway. Visual perceptions are said to be “based on or derived from sensations” as Schwartz puts it in his description of the sensation-perception distinction.\textsuperscript{11}

\textsuperscript{10} In keeping with the literature, I employ ‘visual sensation’ even though this troubling term need not be used in discussing vision. It can be replaced with ‘non-conceptual visual perception’. (I hold, of course, that there is no non-conceptual visual perception.) We do not need the term ‘sensation’ to refer to neurological processes or entities in the visual system. Phrases such as ‘neurological processing or entities’ will do. Under this terminological modification, the sensation-perception distinction can be described in this way: visual experience is an \textit{amalgam} of conceptual and non-conceptual perception.

\textsuperscript{11} The sensation-perception distinction is described by Schwartz as follows:

This claim has two parts: first, that perceivers have both sensations and perceptions; and second, that perceptions are based on or derived from sensations. On this account, what we are immediately or initially aware of is a sensory core or phenomenal manifold that serves as a stimulus or sign for perception. Perception of objective distance, size, shape, and in some cases even properties of colour and brightness result from processes that have sensations as their input. The sensory core has usually been understood to map rather directly the spatial and light properties of the retinal image: the greater the retinal area
A version of the sensation-perception distinction forms part of an inferentialist theory of visual perception. (Schwartz 1994 discusses the sensation-perception distinction in this vein.) This version, as it pertains to shape sensation and to visual perception, can be encapsulated in this way.

A. Visual experience is an amalgam of conscious, non-conceptual sensation of shape and conceptual perception, including visual object recognition;

B. Conscious, conceptual visual perceptions are inferred
   1. from conscious, non-conceptual sensations (signs) of shape, and/or
   2. from non-conceptual, neuronal sensations (stimulations) of shape.

B2, the claim that conscious, conceptual perceptions are inferred from neuronal sensations of shape has already been addressed. It is basically the same as the claim that (conscious, conceptual) visual perception is inferentially derived from retinal stimulations or outputs. B2,

stimulated, the larger the phenomenal extent; sensory shapes are determined by the shape of the retinal image; sensed color and brightness reflect the quality of the light striking the specific retinal location. This claim, that we experience a sensory core that corresponds more or less directly to the spatial and light properties of the retinal image, came to be called the “constancy hypothesis”. (Schwartz 1994, p. 91)

In keeping with the general usage in the literature, Schwartz’s description uses ‘sensation’ ambiguously: “On this account, what we are immediately or initially aware of is a sensory core or phenomenal manifold that serves as a stimulus or sign for perception.” In talking of “a sensory core or phenomenal manifold” (that is, a sensation) as “a stimulus or a sign for perception”, without being explicit he seems to be referring to something that is either a neurological entity (which “serves as a stimulus … for perception”) or a conscious state (which “serves as … a sign for perception”). Schwartz reviews challenges to the sensation-perception distinction (1994, pp. 91-92).

One or another version of the sensation-perception distinction is advocated by many philosophers, including, it would seem, Hamlyn, who writes favourably about Thomas Reid as follows:

Sensation, [Thomas Reid] said, was an act of the mind which has no object other than itself. Perception, by contrast, was directed to objects in the world, and involved concepts of such objects, together with beliefs in their existence which were not the result of any reasoning or inference. (Hamlyn 1996, p. 5)

then, has the failing of thinking of non-conceptual stimulations as premises for inference. B1, the claim that conscious, conceptual perceptions are inferred from conscious, non-conceptual sensations of shape, is a traditional view of empiricism and sense-datum theory. This claim meets with the objection that conscious, non-conceptual sensations also cannot be premises for inference because they are non-conceptual (that is, they do not have the requisite conceptual structure). Another objection to B1 has already been argued, namely that the notion of conscious visual sensation of shape relies on the ambiguity of the term 'sensation'. The same objection applies to A, the claim that visual experience is an amalgam of non-conceptual sensation of shape and conceptual perception.

A version of the sensation-perception distinction is incorporated into causal, non-inferential accounts of how visual perception is induced. This version can be encapsulated in this way.

A. Visual experience of shape is an amalgam of non-conceptual sensation of shape and conceptual perception;
B. conscious, non-conceptual sensation of shape is correlated with retinal activations or goings-on, i.e., the neuronal aspect of sensation of shape;
C. conscious, conceptual perception, in particular object recognition, is non-inferentially induced (caused) by non-conceptual, neuronal sensation of shape (and other neuronal sensations).

(Conscious, conceptual perception would include conscious, conceptual perception of shape.)

The claim that there is conscious, non-conceptual sensation of shape has already been answered. This version (A-C above) of the sensation-perception distinction is a widely held,
especially with regard to the claim that neuronal sensations induce conceptual perception. Although this version of the sensation-perception distinction, unlike the inferentialist version, does not propose that non-conceptual neuronal sensations of shape play a role as premises for inference, it commits a similar error. It wrongly proposes that non-conceptual processes induce conceptual states. Under this version of the sensation-perception distinction, the inducing of object recognition becomes a mystery.

This error I shall name the *neuronal givenness problem*. It involves the assumption that merely non-conceptual neuronal perceptual processes (or entities or states) can induce conceptual perception. Both versions of the sensation-perception distinction share this problem. In one version the inducing is inferential and in the other it is not. So far in this study, insofar as givenness worries are concerned, I have concentrated on the failure of non-conceptual perception to justify belief. Conceptual perception is required to justify beliefs. The neuronal givenness problem compares with the myth-of-the-given problem. In both, something that is merely non-conceptual is expected to do the work of something that is conceptual.

In order to avoid the neuronal givenness problem it is necessary to take a careful look at what conditions a neuronal process needs to satisfy in order to induce object recognition. I shall now turn to this task. The problems with the sensation-perception distinction will be thereby further elucidated. (My term 'visual neuronal system' is used extensively hereafter. It refers, to a first approximation, to the neuronal system associated with vision, including the retina, the neuronal pathway from the retina to the visual cortex, and the visual cortex. It is that part of neuronal machinery which underlies visual perception. In terms of Fodor's
1983 taxonomy, the visual neuronal system consists of the visual transducers — the retina, etc. — and the visual input system.) I concentrate on processing of shape stimuli which induces visual object recognition. First, I should clarify what I mean by ‘induce’.

Many terms, including ‘induce’, are used to refer the role of neuronal processing of shape in bringing about conceptual perception, including visual object recognition. Theorists and philosophers speak of this processing as “actualizing”, “triggering”, or “causing”, to mention a few terms. For the following discussion, it is relatively arbitrary which term or terms are employed. I use the term ‘induce’.

I use ‘induce’ (and its cognates) in a narrow sense when writing of processes which give rise to conceptual perception, including object recognition. These processes directly bring about conceptual perception, including object recognition; thus, they do not include processes that merely make conceptual visual perception possible, such as reflection of light off an object, refraction of light in the cornea and lens, and absorption of light in the rods and cones. Inferentialism would claim that processes which induce object recognition are inference-generating mechanisms in the visual neuronal system. I shall argue that processes in the visual neuronal system which induce object recognition are neither inferential nor merely causal, but are conceptual in a sense specified presently.

With this terminological clarification in hand, I contend that in order to induce visual object recognition, processes in the visual neuronal system need to meet two conditions.

A. The neuronal processes that induce visual recognition of an object X (in view) need to receive and to bear sufficient information about object X to
induce (for the most part) recognition of object X. (I say that these processes must be *informationally conceptual*.)

B. The information needs to be structured into these processes in such a way that the processes are able to induce perceptual categorization (recognition of object X). (I say that these processes need to be *structurally conceptual*.)

A neuronal process is *conceptual*, I claim, if it is both informationally and structurally conceptual. The informational condition (A) is uncontroversial and requires no motivation. The structural condition (B) has been basically motivated previously in my formulation and discussion of the neuronal givenness problem. I have, in effect, argued that the neuronal givenness problem obtains because processes which induce object recognition are not considered to be structurally conceptual. There are non-conceptual processes, neuronal and otherwise, that are necessary conditions for visual object recognition. One such process is the refraction of light occurring in the cornea and lens of the eye. Though these processes make visual object recognition possible, they do not induce visual object recognition (by the narrow meaning of 'induce' I am employing), but feed into processes that do.

Both the causal and the inferential versions of the sensation-perception distinction propose processes that satisfy the information condition. Neuronal sensations are thought to carry sufficient information to induce (or at least significantly contribute to the inducing of) object recognition. The processes postulated by both versions of the sensation-perception distinction fail to satisfy the second condition. In neither is the information structured into the processes which induce object recognition in such a way that they are capable of inducing perceptual categorization. In the case of the inferential version of the sensation-
perception distinction, stimulations on the retina, because they are non-conceptual, cannot be premises for perceptual inference. In the case of the causal version of the sensation-perception distinction, retinal stimulations, in which information is not conceptually structured, are wrongly thought to induce categorization. The explanation for object recognition given by the sensation-perception distinction, then, is plagued by the neuronal givenness problem: processes (or states or entities) which lack conceptual structure are said to induce object recognition. For convenience, I call such processes, etc., neuronal non-conceptual givens. Neuronal non-conceptual givens are commonly posited in accounts of the processing that induces conceptual perception, particularly visual object recognition.

As an aside (which anticipates subsequent arguments in this study), one philosophical posture insists that neurology does not and should not have a bearing on ascertaining the essential nature of visual perception. Along similar lines, it is sometimes said that neuronal processing is just physical and because of this neurological facts should not have a bearing on an account of how we gain conceptual access to the world. These attitudes, I argue, are mistaken. In the next chapter, I use the template-matching model to argue that, plausibly, processes which induce visual object recognition are conceptually structured. Studying these processes, I also argue, reveals how we gain conceptual access to the world.

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12 This is McDowell's position, discussed in a later chapter.

13 Some neurological studies directly pertain to philosophical treatments of the nature of perception and mind. For example, neurological investigations of "visual binding" seem unwittingly to retrace a Kantian treatment of the mind. In this regard, Andrew Brook writes:

Not only is Kant's doctrine of synthesis not very strange, but both parts of it are again appearing in contemporary work. The first has reappeared as the notion of binding (in the psychological, not the linguistic sense). Colours, lines, shapes, textures, and the like are represented in widely dispersed areas of the brain. Somehow these dispersed representations get tied together into a representation of an object. This process is called binding. Treisman
In the foregoing I have attempted to answer the neuronal claims of the sensation-perception distinction. It is important to answer these claims, it was noted, because non-conceptual neuronal sensation is given as a reason for holding that there is non-conceptual visual experience. My answer puts me in good stead to assess, below, the contentions of the sensation-perception distinction in the light of considerable scientific evidence that might seem to play into the hands of this distinction. (My answer to the sensation-perception distinction will also put me in good stead to answer the position of Pylyshyn and others who construe visual perception as an essentially non-conceptual awareness of shape.)

There is impressive scientific evidence that neuronal processing of shape stimuli is of decisive importance for visual object recognition. Although processing of colour and processing of other visual properties play a role in visual object recognition, shape processing seems to be decisive. This is the assessment of Shimon Ullman, a prominent vision scientist, who writes:

Most common objects can be recognized in isolation, without the use of context or expectations. For the recognition of many objects, color, texture, and motion, play only a secondary role. Furthermore, as far as recognition is concerned, shape usually dominates over other cues: we can easily recognize, say, a pink elephant, despite the unusual color. Recognition by shape properties is probably the most common and important aspect of visual recognition and therefore “object recognition” is often taken to mean the visual recognition of objects based on their shape properties. (Ullman 1996, p. 3)

and her co-workers have even erected a very Kantian theory of holding that three stages of visual processing are involved. The three stages involve feature modules, a map of locations, and recognition network/object files; they parallel Kant’s apprehension, reproduction, and recognition in concepts. It is a testimony to how little is known about Kant’s work on synthesis that workers on these processes invented a new term instead of just continuing to use the one Kant used. (Brook 1994, p. 35)
(In vision science, perception of shape is often referred to as perception of form.) Some cases of visual agnosia confirm this assessment. If someone cannot visually perceive any shapes, the ability to visually recognize objects becomes extremely impaired. Robert Efron, a neurologist, reports on a case of a man who suffers from the effects of carbon-monoxide poisoning. The man has visual perceptual capacities that seem normal with the significant exception of his inability to name an object in view, even when he can name the object if he holds it in one of his hands. Efron entertained the hypothesis that the patient could not name most of the objects he saw because he could not determine their shape: “...[I]t seemed possible to me that the patient could not name the object even when he saw it moving because he could not determine [a] key attribute of an object, its shape” (1990, p. 14). In testing the patient for this deficit, Efron found “…that [the patient] had virtually no capacity to discriminate objects on the basis of their shape in the visual modality.” (1990, p. 15). Efron’s patient could not pick out the shape X from the series L O X N, nor could he

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14 Efron writes:

...[I]t was evident that he was not blind in the usual sense of the word, because he responded normally to small light flashes in various parts of his visual field. Further, when asked, he could track, by pointing his index finger, a small object that was moved in front of him, but he could never name the object that he obviously was seeing and tracking. Now, was this inability to name objects due to a disturbance of linguistic function? Was he simply aphasic? Although he had an obvious aphasia as well as a number of other cognitive and physical disabilities, none of these deficits seemed to be sufficient to explain why he could not name any object placed before him, since he could name any object placed in his right or left hand, and say how it was used, about as well as any blindfolded normal subject. Thus, his naming problem was restricted to the visual modality. Was his visual acuity so poor that he couldn’t see the object clearly enough to name it? This was easily ruled out by tests of visual acuity. At this point some of you will know that his behavior deficit is characteristic of a syndrome called visual agnosia .... (Efron 1990, p. 12)

15 Efron did not exclude the possibility that the symptom was also due to a failure of figure-ground separation and/or a failure to recognize faces in those cases where faces were presented (Efron 1990, p. 15).
 distinguish among rectangles of the same area but with differing shapes.\textsuperscript{16} Under Martha Farah’s 1990 taxonomy of visual agnosias, Efron’s patient suffers from “apperceptive agnosia” (Farah 1990, p. 29-30), an inability to recognize objects correctly except on the basis of often unreliable, non-shape visual properties such as motion, colour, and texture.

It might seem that the sensation-perception distinction benefits from the scientific evidence that shape processing plays a critical role in inducing visual object recognition. However, although neuronal processing of shape stimuli is crucially important for inducing visual object recognition, it does not necessarily follow that this processing is non-conceptual. By my interpretation of the template-matching model, which we get to in the next chapter, this neuronal processing can be construed as conceptual. For now, I point out that the position that non-conceptual processing of shape stimuli induces visual object recognition runs into the neuronal givenness problem, as already basically argued. Even if neuronal non-conceptual givens contain sufficient shape information to induce object recognition, this shape information is not structured so that it can be used to induce categorization. The sensation-perception distinction falls short of explaining why an object in view is recognized as an object of a specific type — dog, teapot, golf ball, or whatever.

The condition suffered by Efron’s patient is revealing. In this patient, the shape stimuli are not processed in such a way that shape information can be used to induce object recognition.

The consequence of my argument against the sensation-perception distinction is this. If object recognition is induced within the visual neuronal system, the neuronal processing of shape stimuli which induces object recognition must be structurally conceptual. A couple

\textsuperscript{16} This information is from Farah 1990, p. 12, figure 3.
of comments clarify this argument. First, I do not claim that all processing of shape stimuli is conceptual. This view is probably false. Instead, the claim is directed toward the contention that non-conceptual processing can induce (directly bring about) visual object recognition. Second, my argument is not directed against positing a non-conceptual stage of visual neuronal processing. My argument, however, opposes the notion of a stage of visual neuronal processing whose non-conceptual output induces object recognition.

As we saw, the sensation-perception distinction entails that the outputs of some non-conceptual processing of shape stimuli both induce visual object recognition and underlie an immediate, non-conceptual sensation of shape. Another way to respond to the sensation-perception distinction is to find instances of visual object recognition that induce visual perceptions of shape — not what we would expect if the sensation-perception distinction were true. (This visual object recognition could be unconscious.) If these perceptions of shape could be found, they would be consistent with the conclusion of my argument and with conceptualism in general. It turns out that there are well-known examples of perception of shape which are induced by, or depend upon, visual object recognition. For example, familiar objects such as cats and telephones can be depicted without employing depth cues (such as perspective). Yet the depicted objects are perceived three-dimensionally. Rock thinks that "[t]he same kind of effect may occur even with the objects themselves and not merely with pictures of them" (1983 p. 92).

A revealing finding concerns figure-ground separation. It has long been thought that the neuronal processing responsible for figure-ground separation is a non-conceptual

17 See Rock (1983, p. 93) for some examples of these depictions.
precursor to neuronal processing responsible for object recognition. That is, the shape of a foreground object is separated from its background by non-conceptual neuronal processes. Processing associated with figure-ground separation is one of the key ways in which it is thought (especially by Gestaltists and those influenced by them) that shape stimuli are non-conceptually processed.

However, recent findings indicate that figure-ground separation provides an example of conceptual processing of shape stimuli. Mary Peterson and Bradley S. Gibson (1994) demonstrate that visual recognition is not just operative after figure-ground separation, but also significantly influences figure-ground separation (Peterson and Gibson 1994, p. 553). This discovery puts in question the contention that figure-ground separation is a non-conceptual process that prepares the way for object recognition. Instead, by Peterson and Gibson’s lights, figure-ground separation is highly influenced by an object-recognition function in early vision. Specifically, they propose the following:

Our account is unique in proposing a substrate for shape recognition processes (i.e., edges detected early in processing) that permits them to be initiated as early in processing as those processes that analyze other variables relevant to figure-ground organization (e.g., depth cues and configural cues).

Thus, the essential difference between our theory and other theories is our proposal that prefigural recognition processes operate on both sides of edges that are detected early in visual processing. (Peterson and Gibson 1994, p. 553)

Peterson and Gibson used the following figures in their experiments.

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18 Peterson and Gibson employ ‘prefigural recognitional processes’ to “… refer to the shape recognition processes that operate prior to the completion of figure-ground computations” (p. 553).
As just cited, they claim that, in examples of figure-ground separation such as these, what becomes figure and what becomes ground depends on whether an edge, detected by neuronal processes in early vision, is recognized as tracing an object to the left or to the right of the edge.\(^{19}\) It is therefore plausible that neuronal processing of figure-ground separation is significantly conceptual because it relies on object recognition. This is a rather startling assessment, especially in the light of the tradition of twentieth century vision science in which figure-ground separation has been (following the Gestaltists) almost axiomatically thought to be non-conceptual.\(^{20}\) Peterson and Gibson’s finding does not accord with the

\(^{19}\)This finding of Peterson and Gibson at least partially confirms Hamlyn’s 1957 observation made in the course of criticizing the Gestalt movement in perceptual psychology. He argued that the “figure-ground hypothesis” does not deserve the dignity of being named a hypothesis for it trades on “the logical truth that the concepts of ‘object’ and ‘background’ presuppose each other” (Hamlyn 1957, p. 57). He also says:

[W]hen we identify an object we must distinguish it from everything else which forms its background. What we mean by an object is something which can be so distinguished and it would not make sense to talk of our seeing an object which was not so distinguished. (Hamlyn 1957, p. 56)

\(^{20}\)Many psychological studies confirm that visual perception of shape is conceptual. Rock, in particular, systematically challenges the Gestaltist contention that shape perception is only due to grouping and other non-conceptual mechanisms. For example, Rock and his colleagues have in effect demonstrated that perception of symmetry is conceptual. They remark: “One of the main purposes of [our] study was to demonstrate that there is nothing special about the perception of symmetry beyond the perception of the equality of the halves of a figure on each side of its vertical bisector” (Janet P. Szlyk et al. 1997, pp. 187 ff.). By this account, perception of symmetry depends
sensation-perception distinction in which shape processing (sensation) is thought to be non-conceptual.

An important feature of the neuronal processes responsible for figure-ground separation, under the account of Peterson and Gibson, bears pointing out. These processes are to a large degree global. That is to say, they cannot be described simply in terms of local activation of neuronal synapses or local propagation of electrical impulses along nerve fibres. Instead, global neuronal processing which encompasses and integrates vast arrays of neurons and neuronal connections seems to be going on. Since this processing determines what object is traced out by an edge in a display, it at least involves in an integrated way all the neurons associated with detecting the edge. (This processing seems to be accounted for in large part by the template-matching model of visual object recognition, as we shall see in the next chapter.) It is important to emphasize the global nature of this neuronal processing because the case for the non-conceptuality of the neuronal processing of shape stimuli is often made by wrongly adverting to local neuronal processes only, and then concluding that these could not induce conceptual perception.

It was important to establish that perception of shape — as well as the other dimensions of visual perception — is non-inferentially conceptual. If shape perception were not conceptual a tenet of non-inferential conceptualism would fail. In that case visual

on recognition of the sameness of two shapes, one of them being a mirror image of the another. Accordingly, the concept same is applied in perception. Rock extensively examines the nature of shape perception in The Logic of Perception (1983, pp. 43-99). Although he errs in characterizing shape perception as propositional and "descriptive", his experimental results (like those just mentioned concerning symmetry detection) bolster the case that visual shape perception is conceptual.
perception would be, at best, an amalgam of non-conceptual and conceptual components. However, this implication does not obtain because perception of shape is (non-inferentially) conceptual, as previous arguments have shown. These arguments led to three characterizations of perception of shape that support non-inferential conceptualism:

1) we non-inferentially visually experience whether shapes are the same or different;
2) we non-inferentially visually experience any shape as the shape of some determinate object; and
3) we non-inferentially visually experience shape as existing in a temporal continuum.

It was also shown that the second characterization can be extended to the other dimensions of visual perception. This implies that the whole of visual perception is non-inferentially conceptual.

The conceptual nature of visual perception of shape was also argued on the neurological front in response to the sensation-perception distinction. It was argued that the sensation-perception distinction cannot have non-conceptual processing of shape that induces conceptual visual perception. Instead, neuronal processing of shape which induces conceptual visual perception, including visual object recognition, must be conceptual. My argument is confirmed by recent experimental work on the nature of figure-ground separation.

Having discussed necessary conditions for neurological processing to induce conceptual perception, it is appropriate to comment on what it would mean for neuronal processes to induce perceptual inference, specifically regarding object recognition. In order
to do this, processes in the visual neuronal system, I argue, need to meet two conditions (which are parallel to the condition for conceptual processing).

A. The neuronal processes that induce visual recognition of an object X need to receive and to bear sufficient information about object X to induce (for the most part) inferential categorization of object X, that is, the placing of object X in its proper position in an inferential hierarchy. (I will say that these processes must be *informationally inferential*.)

B. The neuronal processes are structured to implement an inference in such a way that the information about object X becomes a premise in the inference. (I will say that these processes must be *structurally inferential*.)

A neuronal process is *inferential*, I claim, if it is both informationally and structurally inferential. Inferentialist accounts have no difficulty with the first condition. Perceptual inference is able to draw on background knowledge to make up for whatever information is missing in retinal stimulations. Sparse information in the stimulus, thus, presents no fundamental difficulty. Input-system processes (under Fodor’s construal) do not seem to be informationally inferential. “Informational encapsulation” blocks access to background information, so that it cannot used to compensate for missing information in retinal stimulations. To distinguish a realistic-looking robotic dog from a real dog, more than visual information is required. The processes which induce conceptual perception, including object recognition, do not meet the structural condition, for information about an object contained in retinal stimulations cannot be a premise for inference because these stimulations are not conceptually structured (as already argued).
Section 3.4 Visual perception: a non-conceptual awareness of shape?

The next position I examine can be called centralism after the so-called central cognitive systems — which, in Fodor's theory, operate over symbols in "mentalese"\textsuperscript{21} — that are considered by some to be the seat of all concept application. Like the sensation-perception distinction, centralism is a broad current of opinion. Although versions of centralism are found in the positions of Pylyshyn (1999) and of David Marr (1982), neither Pylyshyn’s terminology nor Marr’s will be relied on to describe it. Centralism holds that visual perception is non-conceptual; it contends that all visual perception is essentially non-conceptual perception of shape. Only central systems have conceptual capacities. Object recognition, in particular, is induced within the central systems.

Centralism presents a further challenge to the contention that visual perception is conceptual. It contends, in effect, that the coordination between central systems and the visual neuronal system is so close and finely tuned that we can be deceived into thinking of visual perception as conceptual. By these lights, the approach of assessing perception by examining conscious visual experience, an approach that I heavily rely on, is mistaken. The true nature of visual perception, according to centralism, can only be revealed in careful scientific experiments. There is a similarity between centralism and the positions of Rock, Harman and others who talk about unconscious perceptual inference. Centralism considers visual perception to be \textit{unconsciously} non-conceptual.

\textsuperscript{21} The terms ‘mentalese’ and ‘central systems’ are Fodor’s (1975 & 1983).
If Pylyshyn is correct, visual perception cannot be conceptual because there is no conceptual processing within the visual neuronal system. If our conscious visual perceptions were cited to argue otherwise, he would reply that conscious perceptions are entirely different from what we pre-scientifically think they are. (Pylyshyn's position is taken up in detail below.)

My response to centralism comes in two parts. First, centralism, like the sensation-perception distinction, has a neuronal givenness problem. The output of the visual neuronal system consists of non-conceptual neurological givens. The information in the output is not conceptually structured; therefore the output cannot induce visual object recognition. The information about an object X cannot be used to induce recognition of an object X. (Suppose, in response, it is argued that this output does not induce visual object recognition but instead the central system merely "reads" the output. This engenders a homunculus problem about which I will have more to say in the next chapter.) The second part of my response to centralism (pursued in the next chapter) opposes centralism's assessment of the nature of the visual neuronal system. This system is not completely non-conceptual, I argue. Some significant conceptual processing occurs in this system, in particular processing that induces visual object recognition. (Of course, centralism presents no challenge to non-inferentialism because all processing in the visual system is thought to be non-conceptual.)
Pylyshyn's 1999 position is basically centralist.\textsuperscript{22} He speaks of the "vision system" or the "early vision system" (terms he uses interchangeably\textsuperscript{23}) as being "cognitively impenetrable", that is, "prohibited from accessing relevant expectations, knowledge and utilities in determining the function it computes" (p. 341). Instead, the early vision system "provide[s] a structured representation of the 3-D surfaces of objects sufficient to serve as an index into memory..." (p. 341). He is definitely not an inferentialist, as we saw in Chapter 1: "...[P]erceptual principles, unlike the principles of inference, are responsive only to visually presented information" (p. 344). And he seems to subscribe to non-conceptualism. The notion of cognitive impenetrability is reasonably understood as meaning just that. Granted, he speaks of the visual system as delivering "shape-classes": "[t]o a first approximation, the classes provided by the visual system are shape-classes, expressible in something like the vocabulary of geometry" (p. 361). However, he is quick to make it clear that shape classes do not arise from the perceiver's knowledge base: "the visual system does not identify the stimulus in the sense of cross-referencing it to the perceiver's knowledge base, the way a unique label might" (p. 361). His description of how visual scenes are represented reinforces the impression that he is a non-conceptualist: "...our representation of the visual scene is unlike our picture-like phenomenological impression, insofar as it can be shown to be nonuniform in detail and abstractness, more like a description cast in the

\textsuperscript{22} Subsequent quotations from Pylyshyn are from his "Is Vision Continuous with Cognition? The Case for Cognitive Impenetrability of Visual Perception" (1999).

\textsuperscript{23} He remarks regarding his term 'early vision': "... I only introduce the qualifier "early" to avoid unnecessary quarrels over terminology. I still believe that "vision" is the correct usage" (p. 405). Pylyshyn often substitutes 'visual' for 'vision' in 'vision system'.
conceptual vocabulary of mentalese, than like a picture …” (p. 362). Pylyshyn is highly suspicious of “phenomenology”:

"[P]henomenology of visual perception might suggest that the visual system provides us with a rich panorama of meaningful objects, along with many of their properties such as their colour, shape, relative location and perhaps even their “affordances” …. Yet phenomenology turns out to be an egregiously unreliable witness in this case. Our subjective experience of the world fails to distinguish among the various sources of this experience, whether they arise from the visual system or from our beliefs. … The output of the visual system is a theoretical construct that can only be deduced indirectly through carefully controlled experiments. (1999, p. 362)

Pylyshyn acknowledges that visual perception is exceedingly complex. In fact, some of the functions of the visual system as he describes them — like delivering shape categorizations and providing indexes to memory — could well be considered to be conceptual, although Pylyshyn does not concede as much. Additionally, Pylyshyn seems to ignore some examples of visual perception that directly challenge his notion of cognitive impenetrability, such as the findings about figure-ground separation previously reviewed. Nonetheless he seems to be sensitive to some examples of perception which might indicate (in my terms) that visual perception is conceptual. In this regard, we can look at his notion of “compiled transducers”:

[A] post-perceptual decision process can, with time and repetition, become automatized and cognitively impenetrable, and therefore indistinguishable from the encapsulated visual system. Such automatization creates … “compiled transducers”. Compiling complex new transducers is a process by which post-perceptual processing can become part of perception. If the resulting process is cognitively impenetrable — and therefore systematically loses the ability to access long-term memory — then … it becomes part of the visual system. (p. 360)

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34 Below I discuss further Pylyshyn’s position on the functions of delivering shape categorizations and of providing indexes to memory.
Here Pylyshyn is trying to accommodate his theory to the many instances of perceptual learning in which a cognitive task reaches a point at which many higher-level mental capacities are no longer needed to perform it. Perception alone suffices. Although Pylyshyn acknowledges that the processing involved in this type of visual perception is exceedingly complex, his choice of the term ‘compiled transducers’ to describe the processing reveals what seems to be his considered opinion. Despite its complicated character, this processing is not conceptual. Thus, although Pylyshyn is not blind to the complicated nature of visual perception, including perception of shape, he comes down on the side of centralism and non-conceptualism.

Due to the influence of Marr, Pylyshyn and many others, centralism is a major contender in philosophical and scientific studies of visual perception. By opposing the contention that visual perception is conceptual, centralism stands in direct opposition to non-inferential conceptualism. Additionally, by opposing reliance on “phenomenology” to ascertain the nature of visual perception, centralism opposes a way in which I uphold non-inferential conceptualism. For these reasons, and because centralism is so influential, the next chapter takes up the task of answering the neurological account of centralism. There I discuss the template-matching model of visual perception and argue that this model complements non-inferential conceptualism.

Before taking this course, I examine more closely some aspects of Pylyshyn’s position, including his contention that shape categorization is “cognitively impenetrable”. An object is partially categorized by its shape. Having a dog shape is a good deal of what it is to be a dog. Granted, a realistic depiction of a dog can have a dog shape without being a
dog. Still though, having the same shape as a dog is a good deal of what it is to be a realistic depiction of a dog. Because Pylyshyn grants that the visual neuronal system delivers shape categorizations, it is difficult for him to hold that all processing in the visual neuronal system is non-conceptual. This is all the more the case when we consider that for Pylyshyn “a structured representation of the 3-D surface objects ... serve[s] as an index to memory” (p. 341). He seems to be saying that processing in the visual neuronal system induces object recognition by producing representations that serve as an index to memory. If this is the case, it would seem that these processes should be described as informationally and structurally conceptual.

A similar point can be made with regard to Pylyshyn’s position on the output of “compiled transducers”. Pylyshyn is attempting to account neurologically for well-known phenomena. A trained doctor can visually perceive a faint shadow on an X-ray as an indication of a certain medical condition. (Though inference is often involved in the learning to perceive things in a certain way, as in learning to read medical X-rays, it does not follow that inference is involved within perception itself, as pointed out in Chapter 1.) It is wrong to describe this capacity to read X-rays properly as being due to transduction because the induced visual experience categorizes for the perceiver, which is to say, that the visual experience is conceptual. A problem with Pylyshyn’s theory with regard to “compiled transducers” can be expressed in terms used by Pylyshyn. He insists that the visual system does not have access to a perceiver’s knowledge base. Yet “compiled transducers” must have access to a perceiver’s knowledge base, at least in part, for “compiled transducers” induce perception that categorizes for a perceiving subject (such as in the case of reading X-rays).
A cardinal motivation for Pylyshyn's work is his opposition to inferentialism, especially as it is expressed in the works of Bruner (1957/1973). Bruner's proposal is summed up by Pylyshyn:

[T]he perceptual process is like science itself: it consists in finding partial clues (either from the world or from one's knowledge and expectations), formulating a hypothesis about what the stimulus is, checking the data for verification, and then accepting the hypothesis or reformulating it and trying again in a continual cycle of hypothesize-and-test. (pp. 341-342)

As Bruner put it, "all perceptual experience is necessarily the end product of a categorization process" and therefore "perception is a process of categorization in which organisms move inferentially from cues to category identity and ... in many cases, as Helmholtz long ago suggested, the process is a silent one."²⁵ (p. 342)

Pylyshyn observes,

...the belief that perception is thoroughly contaminated by cognition became received wisdom in much of psychology, with virtually all contemporary elementary texts in human information processing and vision taking that assumption for granted. ... The continuity view also became widespread in philosophy of science. Philosophers of science such as Hanson (1958), Feyerabend (1962), and Kuhn (1972) argued that there was no such thing as objective data because every observation was contaminated by theory. These scholars frequently cited the New Look experiments showing cognitive influences on perception to support their views. Mid-twentieth-century philosophy of science was ripe for the new holistic all-encompassing view of perception that integrated it into the general framework of induction and reasoning. (p. 343)

Although this study does not specifically consider the issue of the theory-ladenness of observation as argued in philosophy of science, I join with Pylyshyn in opposing the notion of theory-ladenness of observation because it is an inferentialist proposal.²⁶ W. Martin Davies aptly describes the notion of theory-ladenness of observation as "the move to conflate


²⁶ As part of his general critique of inferentialism, Davies (1996, pp. 191 ff.) criticizes the doctrine of theory-ladenness of observation.
observational and theoretical terms, and to make the origin of their meaning come from the one and the same theoretical (and hence, inferential) source” (1996, p. 194). The domain in which I differ with Pylyshyn does not pertain to inferentialism, which he heartily opposes, but concerns the conceptual character of visual perception. Pylyshyn seems to think concept application requires inference. If visual perception is non-inferential, it is not conceptual. For this reason and because he wishes to oppose inferentialism outright he seems to have no alternative but, for example, to talk of “compiled transducers” to describe neuronal processes that induce visual experiences that are clearly conceptual.

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27 This assessment of Pylyshyn's view arises from a number of remarks in his 1999 paper, including this remark:

The particular way I have tried to distinguish vision and cognition and the criteria I have suggested stem from a general goal I set for distinguishing inference-based (semantically-dependent) processes from functions that we may treat as essentially "wired in" in the organism. (p. 404)
Chapter 4

Template matching and visual object recognition

When an object strikes a perceiver in some way — visually, tactually, or whatever — the perceiver receives an appearance. The result is an “imprint” ... in the soul. “Imprint” is a metaphor from stamping a seal, and the early Stoics understood this in different ways:

Cleanthes understood the imprint in terms of recess and projection, just like the imprint of seals on wax, but Chrysippus thought such a thing absurd.¹

Socrates: Now I want you to suppose, for the sake of the argument, that we have in our souls a block of wax, larger in one person, smaller in another, and of purer wax in one case, dirtier in another; in some men rather hard, in others rather soft, while in some it is of the proper consistency.

Theaetetus: All right, I’m supposing that.

Socrates: We may look upon it, then, as a gift of Memory, the mother of the Muses. We make impressions upon this of everything we wish to remember among the things we have seen or heard or thought of ourselves; we hold the wax under our perceptions and thoughts and take a stamp from them, in the way in which we take the imprints of signet rings. Whatever is impressed upon the wax we remember and know so long as the image remains in the wax; whatever is obliterated or cannot be impressed, we forget and do not know. (Theaetetus, 191d-e, quoted from Burnyeat 1990, p. 325)

Above all, don’t wonder “What can be going on in the eyes or brain?” (Wittgenstein 1958/1997, IIxi, p. 211)

Section 4.1 Introduction

The previous chapter opened up a discussion of the nature of the underlying neuronal processes involved in visual perception. Additionally, we saw in the previous chapter that, in vision science, object recognition is thought to be primarily due to neuronal processing of shape stimuli. The current chapter is devoted to investigating the template-matching model of visual object recognition. This neurological model shows how neuronal processing of shape stimuli induces visual object recognition. This model has the merit, I will show, of

¹ This whole quotation, which addresses the position of the Stoics, is from Julia E. Annas (1992, p. 73). In the indented portion, she quotes Sextus Empiricus (Sext. Emp. Math. 228-31 [= SVF 2. 56]).
explaining (without resorting to neurological non-conceptual givens) how a good deal of visual object recognition is induced; that is to say, the template-matching model is amenable to demonstrating that information about an object X is structured into certain neuronal processes in such a way that these processes can induce recognition of object X. Furthermore, the template-matching model is amenable to demonstrating that this processing does not bring about perceptual inference. The template-matching model, I argue, complements and supports both non-inferential conceptualism and my account of the justificatory role of visual perception.

The template-matching model is one of a number of neurological theories in which it is thought that visual object recognition is due to a match that takes place between a shape that is causally derived from an object's shape and a similar shape stored in memory. Not all such theories are suited to my claims about visual perception. In Marr's centralist theory (1982), for example, visual perception of shape is non-conceptual. In that account, the 2-D sketch, 2½-D sketch and 3-D model are all processed non-conceptually and are all non-conceptual states. Furthermore, the matching does not produce object recognition, but rather a non-conceptual "categorization" of shape. (We saw in the previous chapter that Pylyshyn 1999 continues to defend this position.) So Marr's theory is not amenable to non-inferential conceptualism because it supports non-conceptualism. In Rock's theory, neuronal processing of shape stimuli induces object recognition but in a much different way than proposed by Pylyshyn. As we saw in Chapter 1, Rock propose that object recognition is due to inference from propositional-linguistic representations of shape, as well as from similar representations of other visual properties. This position is not amenable to non-inferential conceptualism
because it complements inferentialism. We see in this chapter that the template-matching model can be reasonably construed to oppose both non-conceptualism and inferentialism and to complement non-inferential conceptualism.

Fodor extrapolates from Marr's theory as follows:

From our point of view, the main interest of 3-D sketch representations lies in the conjecture that they can be computed, more or less algorithmically, from a specification of such primitive information as sequences of retinal mosaics. ... If it is, in fact, true, then we can imagine that the final stage of visual input analysis involves accessing a 'form-concept' dictionary which, in effect, pairs 3-D sketches with basic categories.² (Fodor 1983, p. 137, n. 34)

(Marr discusses 3-D models not 3-D sketches. For Marr, a model is an object-centred representation whereas a sketch, of either the 2-D or the 2½-D variety, is a viewer-centred representation.) Fodor "imagines" that the last stage in visual processing involves pairing 3-D "sketches" with basic categories. For Fodor this processing is a type of concept application. Fodor's position is probably not what Marr intended. His theory does not include a "form-concept" dictionary, at least stated in those terms. Instead, Marr theorizes that 3-D models (which are produced by the perceptual apparatus) are matched with 3-D models in a catalogue residing in memory (Marr 1982, pp. 318 ff.). These 3-D models in a catalogue in memory can be labelled as cow-shape, human-shape, etc. This seems to be the closest that Marr's theory gets to advocating any type of concept application in visual perception. It might be argued that a match categorizes 3-D models that are processed by the perceptual apparatus. However, even here, Marr likely had a non-conceptual labelling or non-conceptual "categorization" (as it were) in mind, rather than any sort of concept application. Marr’s

² It is not entirely clear whether Fodor actually subscribes to Marrian theory. See Fodor 1983 pp. 93-94.
theory does not seem to embrace the claim that concepts are applied in visual perception, as judged by his remark:

[My] theory has nothing to say about semantic recognition, object naming or function, though that is most certainly a path almost as useful as shape determination for recognition in the external world…. I think that the problems of understanding what we mean by the semantics of an object are fascinating, but I also think that they are very difficult indeed and at present much less accessible than the problems of visual perception. (Marr 1982, p. 355)

Here Marr seems to be suggesting that visual perception is merely a matter of "shape determination". It is possible to remain true to Marr by holding that the visual system delivers non-conceptual shape "descriptions" that are subject to conceptual processing in "central systems". Under this construal, concept application occurs only in the "central systems". This seems to be the position of Pylyshyn (1999, esp. sec. 1.1 & sec. 7.2 n. 15). In this regard, Pylyshyn's position appears to be more in the spirit of Marr than is Fodor's interpretation.

At this point in my study, it may seem that I have painted myself into a corner. I reject any proposal to the effect that visual object recognition is induced by non-conceptually-structured processing. Many vision scientists and philosophers in effect contend otherwise. For them object recognition is somehow triggered or caused by processes which have no conceptual structure.³ Proposals such as these, I contend, stem in large part from a too-elevated criterion for what it is to be conceptual. For example, if you think that conceptual

³ According to McDowell,

[c]onceptual episodes of the relevant kind are triggered by impacts from the environment on a perceiver's sensory equipment. If the impacts are suitably similar, there is nothing puzzling about a similarity between the conceptual episodes they trigger. ... [C]onsciousness comes into play only with conceptual episodes, triggered by nonmentalistically described impacts on sensory equipment. (McDowell 1998, pp. 443-444)
and rational capacities are one and the same (and if you are not an inferentialist), then you have little else to appeal to other than some sort of non-conceptual "triggering" to explain visual object recognition, if you want to explain it in terms of physical processing.

However, once it is realized that perception is non-inferential (and not dependent on language and not rational), then the way is cleared for examining processes in the visual neuronal system with a view to finding out if some are conceptual (that is, if some are both informationally and structurally conceptual, as defined in the previous chapter). I contend specifically that significant facets of shape processing are part of a shape-based system of conceptual processing which induces visual object recognition. The template-matching model of visual object recognition is used to argue this contention. For those who, like perhaps the Stoic Chrysippus (referred to in a quotation at the head of this chapter), have difficulty imagining, or conceiving of, template matching taking place "in the head", I suggest construing the template-matching model as a metaphor designed to show the possibility of conceptual, non-inferential processing which induces visual object recognition. For myself, perhaps like the Stoic Cleanthes, I have no difficulty imagining, or conceiving of, template matching taking place "in the head".

Section 4.2 The template matching model of visual object recognition

My aim is to draw on the template-matching model to establish that, plausibly, conceptual and non-inferential processing within the visual neuronal system induces visual object recognition. The template-matching model is hardly ever discussed in philosophy. (I have not encountered a single philosophical treatment of this model.) In vision science, the
template-matching model was proposed a few decades ago and is currently receiving increased attention. Generally, vision scientists do not hold that the template-matching model solves the scientific problem of visual object recognition. That problem remains unsolved. Nonetheless, the template-matching model is taken seriously as a working hypothesis of how neuronal processes induce object recognition based on the shape of an object.

After first presenting a brief description of the template-matching model, I make the case based on this model that, plausibly, processes that induce visual object recognition are conceptual and non-inferential. I then argue that the template-matching model does not entail a neuronal givenness problem or a homunculus problem. If the template-matching model entailed either of these problems, my use of it would be misguided. A more detailed description of this model is left to the final section of this chapter where authorities from vision science are cited. Here, I answer the charge that the model is too simplistic.

The template-matching model of visual object recognition explains how visual processing of shape information induces visual recognition of objects.⁴ According to the template-matching model, object recognition is induced by a match that takes place in the Visual Buffer in the visual cortex.⁵ The match takes place between two neuronal structures. One is a pattern of activation across many neurons in the Visual Buffer. This pattern is

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⁴ In vision science literature, the template matching model of object recognition goes by other names including "viewpoint-specific", "viewpoint-dependent", and "viewer-centered" models of object recognition. Pylyshyn (1999, sec. 7.2, n. 15, p. 365) considers that template matching is a non-conceptual, pre-recognitional stage in object recognition. The account which follows offers a contrasting account of template matching.

⁵ Whether the Visual Buffer is in V1 or some other part of the visual cortex is unimportant for my purposes. The usage of the term 'Visual Buffer' corresponds to the usage of both Tye (1994, p. 357) and Kosslyn (1994, p. 70).
produced primarily by bottom-up processing involving edge detection. (‘Bottom-up processing’ refers to processing that takes places along the neuronal pathway from the eye to the visual cortex.) I will call this pattern of activation a 2-D Bottom-up Pattern or a Pattern for short.⁶ (In the vision science literature, this pattern of activation is often called a representation. I avoid the term ‘representation’ for reasons explained below.) The shape of a Pattern can be likened to a line-drawing of the object from the point of view of the perceiver. Suppose, for example, a simple object such as a square (like this □) is in view. Bottom-up edge-detection processing causes neuronal activation in the shape of a square across many neurons (in the Visual Buffer). (There are distortions in the mapping from the retina to the visual cortex. Nonetheless, the mapping is retinotopic.)⁷ Although it is useful to employ the metaphor of a line drawing to describe activation across the Visual Buffer, it could be somewhat misleading because “edges” extraneous to object recognition are also “picked up” by edge detection mechanisms. Shadows cast on an object, for example, can produce extraneous edges.

The other neuronal structure (which is involved in a match) is often called a Template. It resides in memory. The Pattern is matched with a Template. In order for a match to take place, a Template must have a similar shape to a Pattern with which the Template matches. (A Template need not and probably does not match with all of the Pattern. For example, it need not match with those parts which derive from cast shadows.) A Template

⁶ The Pattern is a two-dimensional projection of the object in view.

⁷ In a retinotopic mapping, shapes of neuronal activation on the retina are preserved on the visual cortex, except for a “stretching” of distances on the cortex favouring regions projected to the cortex from in or near the fovea of the retina.
is “bundled” together with other Templates pertaining to the same type of object into a
structure which is referred to as a *Prototype*. The match of a Template with a Pattern
induces recognition of an object. The categorization that takes places is determined by what
Prototype the matched template belongs to. This account assumes that Prototypes with their
Templates are already in place in memory before visual object recognition takes place and
that these templates are correctly “bundled” together in Prototypes. Template matching is
uninterrupted. It takes place continuously. Even after a match is achieved and recognition
takes place, this match is continuously refreshed (as long as the same object stays in view),
producing continuous visual recognition of an object, if it remains in view.

In the above description of template matching, the term ‘representation’ has been
avoided, even though both Templates and Patterns are often called representations in the
vision science literature. In particular, I have used my own term ‘Pattern’ instead of the term
‘representation’. Avoiding the term ‘representation’ avoids confusing Patterns and Templates
with mental representations as understood in the philosophy of mind literature. Mental
representations *stand for* something; that is to say, mental representations are intrinsically

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8 The referent of ‘Prototype’ varies somewhat from theorist to theorist. The way I use the term is in
line with general usage. (My usage varies somewhat from that of Shimon Edelman 1998.)

9 It could be that a Prototype is not limited to encoding spatial templates, even though visual objects
are recognized mainly by their shape. That is, it could be that Prototypes encode visual attributes
such as colour and texture and that some object recognition depends on this encoding in Prototypes.
I do not know whether Prototypes are thought of in this way in vision science or not. If Prototypes
use a range of such encoding to recognize objects, it could be supposed, following a current trend
in vision science, that connectionist architecture is responsible for brain-level coordination of a set
of Templates associated with each Prototype and for brain-level coordination of various ways in
which an object can be visually recognized (by way of shape, colour, texture, etc.). (See n. 10, p.
108.) Having made the point that Prototypes might encode visual attributes other than shape and that
these attributes sometimes play a role in object recognition, I henceforth concentrate on those aspects
of object recognition pertaining to the shape of an object.
about something else (or, more technically, mental representations are intrinsically intentional).

Although the term ‘representation’ is employed extensively in vision science, including in accounts of template matching, usually it is not meant to designate a mental representation. What is often meant by calling a pattern of neuronal activation a representation is only that the pattern is in some way isomorphic to certain aspects of the visual properties of distal objects. I grant that some vision scientists in describing template matching may use the term ‘representation’ to designate mental representations. Also, some philosophers might be inclined to regard Patterns, Templates, or Prototypes as mental representations. I later argue that template matching can be described without resorting to the notion of mental representation.

When template matching is described in the above way, which is in line with the way it is described in the vision science literature, it might seem that the model invites a homunculus problem and perhaps other problems associated with representationalist theory. A critic might, for example, suggest that a Prototype plays the role of a homunculus by interpreting a Pattern. This impression, however, is mistaken. In the next section, I show that the template-matching model does not have a homunculus problem. Another problem, sometimes levelled against the template-matching model, is that it is scientifically simplistic. This charge needs to be dealt with insofar as it may undermine my arguments stemming from the template-matching model. Instead of responding to this charge now or elsewhere in the midst of my key arguments, the problem is better dealt with in the final section of this chapter where scientific motivation of the template-matching model is presented. For the
present purposes, the brief statement of the template-matching model, just given above, will suffice.

This model yields (I soon show) the results I want: it is plausible to suppose that there are (informationally and structurally) conceptual processes within the visual neuronal system which induce visual object recognition and these processes are non-inferential; specifically they are not structurally inferential. (I refrain from commenting on whether or not template-matching processes are informationally inferential.) Both these conclusions, we shall see, are non-question begging in the sense that they do not arise from an argument which in effect derives the character of the processes from the character of the perceivings that the processes induce. Instead, the template-matching model allows us to determine the character of the processes independently of perceivings. Thus, through a study of the processes which induce perceivings, we can learn that these perceivings are conceptual and non-inferential.

I begin by showing that the processes which induce (directly bring about) visual object recognition are both informationally and structurally conceptual. The notion of processes that are both informationally and structurally conceptual was developed in the last chapter. (See p. 75.) For a process to induce visual object recognition, I argued, it is necessary that it be both informationally and structurally conceptual. Basically, what the template-matching model tells us is that visual object recognition is usually induced by a Template-Pattern match which captures a central, defining property of an object, namely its shape (from a particular point of view). Template matching is informationally conceptual because it receives and bears information about a defining property of an object, its shape. Template matching is structurally conceptual because this shape information is structured
into these processes in such a way that the processes are able to induce perceptual categorization that is based on an object's shape. The assessment that template matching is both conceptually and structurally conceptual crucially depends on the proposition that the shape of most visual objects captures a central, defining property of the objects. Said in a different way, the shape of an object largely determines what the object is. It may be claimed that the shape of an object does not determine what the object is. An object with a dog-shape is not necessarily a dog. It could be a statue of a dog. However, having a dog-shape \textit{largely} determines what this object is, namely a statue of a dog. Shape largely determines the nature of an object, even though it does not fully determine its nature. The shape of some visual objects may constantly change as does the shape of an amoeba. In this case, no single shape is the defining property of the object, but the object is defined by many shapes. (The template-matching model can handle this situation by positing multiple Templates for each Prototype. This provision of the model is discussed again later in this chapter.) At the extreme, the shape of a visual object could be so variable that shape does not determine what the object is. (I cannot think of an example of such an object.) In this case, the object could not be visually recognized based on its shape and template matching would not apply. The template-matching model works for a broad range of visual objects because the shapes of most visually perceived objects are relatively stable.

In vision science, the discussion of the issue of the fundamental character of visual perception and of visual perceptual processing often takes the form of discussing so-called \textit{top-down} influences on visual processing. The term ‘top-down’, like the term ‘bottom-up’, is a term of art in vision science. The term ‘top-down’ is ambiguous because its meaning is
neutral on the nature of the influences at issue. Often, however, in vision-science literature ‘top-down’ refers to conceptual influences. An exception is the use of ‘top-down’ in descriptions of primitive attention mechanisms that direct some eye movements. I am concerned with top-down conceptual influences only. It is not difficult to establish that top-down conceptual influences sometimes guide visual perception and to argue that to this extent visual perception is conceptual. An example pertains to the experience of visually perceiving hidden figures in a puzzle display, such as a drawing that appears to be merely a jumble of blobs and lines but actually depicts a Dalmatian. Without foreknowledge, it is hard to spot the likeness of a dog. The task becomes much easier with a hint to look for a depiction of a dog. It is reasonable to suppose that in this circumstance the concept dog guides visual perception. The belief (which of course is conceptual) that there is a Dalmatian in a puzzle picture (non-inferentially) influences our perception. (In Chapter 1 I argued that such top-down influences should not be considered to be inferential.)

Cavanagh argues that, in some cases, an initial Template-Pattern match guides subsequent processing that induces three-dimensional visual experience:

In most natural images where many redundant cues are available, the prototype may be chosen based on 3-D information. In high-contrast images that I have used, no 3-D information is available from the image either directly or through pictorial cues such as perspective, contour intersections, or deep concavities. I claimed that for these images an initial 2-D match selected the best prototype to guide image interpretation. (Cavanagh 1991, 303)

Presumably, the “guiding” that Cavanagh has in mind (in his suggestion that “an initial 2-D match selected the best prototype to guide image interpretation”) is due to weighted neuronal connections in the Prototype that are activated by the 2-D match. Cavanagh in effect is saying that template matching can sometimes play a conceptual, top-down role as a sort of guide in
visual processing. Actually, a stronger claim can be made. It would seem that template matching is always due in part to top-down influences because Prototypes largely determine what things are potentially recognizable and what they are potentially recognizable as.

Cavanagh's suggestion provides a processing-level explanation of recognitional capacities that Peterson and Gibson (1994, p. 553) found were operative prior to figure-ground separation. As mentioned in the previous chapter, Peterson and Gibson found that edges of objects were recognized prior to figure-ground separation. Following Cavanagh's suggestion, the template-matching model could be used to explain the results of Peterson and Gibson in the following way. A Template matches an edge and then the Prototype to which this Template belongs guides subsequent processing of information, which in this case pertains to figure-ground separation.

Processes which induce object recognition in the template-matching model are not structurally inferential. In template matching, there is no manipulation of symbols according to a logical calculus, the typical way it is thought that inferences are implemented at the neuronal level. In template matching, instead, a Pattern and a Template are matched if they are sufficiently similar in shape. This matching does not even remotely resemble symbol manipulation according to a logical calculus. In particular, the template matching is not structured so that shape information constitutes a premise for inference. Template matching, then, is structurally non-inferential. The structurally non-inferential character of template matching entails that template matching is akin to a type of processing advocated by connectionism, that is, non-inferential processing that depends on weighted connections.
derived from past learning and innate endowment. The template-matching model supports the contention that visual perception is conceptual (because template matching is both informationally and structurally conceptual) and non-inferential (because template-matching is not structurally inferential). The template-matching model, then, yields an independent argument for non-inferential conceptualism. It yields an argument, which is independent of references to the phenomenology of visual experience, that processing in the visual neuronal system induces conceptual but non-inferential perception.

My argument, using the template-matching model, that processes which induce object recognition are conceptual and non-inferential, has the same generality or scope with

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10 Connectionist architectures figure strongly in theories of how the various elements of visual perception are coordinated. (See, for example, Kosslyn 1994, pp. 25-28.) Recognition of objects depends on visual properties other than shape, including colour, shading, location, texture, size, and motion. Connectionist architecture helps account for how all these play a coordinated role in object recognition. This question is addressed in vision science under the rubric of the “binding problem”. (See Treisman 1996 and von der Malsburg 1995.) Also, visual recognition can sometimes involve recalling the name of the object and other forms of recall not directly involving visual attributes of the object. This recall is generally based on prior learning in which appropriate associations are drawn. Connectionism has successfully modelled many aspects of this type of association. Of course, non-inferentiality of the visual neuronal system is not universally accepted. There is the Helmholtzian/Rockian current of thought that holds that the structure of the visual neuronal system is inferential.

Despite some limitations of connectionist theory, it seems in general to model underlying brain processes that support cognition much better than theories advocating serial computation. Brain processes do not seem to be anything like those of a digital computer. This, in particular, was an assessment of James A. Anderson et al. in 1977. This assessment holds good today, even though there remain persistent defenders of the Fodorian model, including Fodor himself. According to Anderson et al.:

The brain is best adapted to interacting, highly complex, spatially distributed parallel operations. ... We may conclude that the elementary operations used by the brain are of a much more powerful and different kind than the simpler instructions familiar to us from our experience with computers. (Anderson et al., 1977, p. 414)

One of the studies of Anderson et al. is directly relevant to the nature of perception. The study concluded, from simulations of perceptual catagorization, that a natural perceptual system “does not ‘analyze’ its inputs in the sense that a computer or logician might analyze them, by dissecting them into component parts, but it simply responds to them” (Anderson et al. 1977, p. 433).
regard to the processes involved in visual object recognition as the template-matching model itself. Although the template-matching model addresses object recognition based on shape only, the pivotal importance of shape in visual object recognition entails that the template-matching model applies to all but a small fraction of visual object recognition.\(^\text{11}\) (It should be kept in mind that, as observed in the previous chapter, it is not necessary to show that all visual-neuronal-system processing is conceptual in order to sustain the proposition that visual experience is conceptual. Presumably there is a whole lot of processing in the visual neuronal system that is not conceptual.)

The template-matching model also applies to the recognition of the parts of an object. (Parts of objects are also objects in their own right.) We often perceive parts of an object in great detail, recognizing many parts of the object as well as the object itself. We can recognize some parts either collectively or individually as in recognizing each limb as part of a body or a whole set of limbs as part of a body. The boundaries of some of parts of objects are indeterminate. In humans the nose and the cheek overlap somewhat, for example. Recognition need not be limited to large parts of an object. We recognize moles, scars, individual hairs, eyelashes, etc. All parts of an object need not be recognized in order to recognize an object, and, of those that are recognized, many are not recognized in a fully conscious way. I may be visually aware of a dog, yet might not be fully conscious of its tail. Yet often the state of recognizing the object includes recognizing many of its parts. When

\(^{11}\) A more complete assessment of processing involved in inducing visual object recognition would address other processes, such as those which induce colour processing, either demonstrating that these processes are non-inferential and conceptual or, if some are not, arguing that conceptual and non-inferential neurological processing is prominent enough to sustain non-inferential conceptualism.
we recognize a dog, we often visually recognize its head, eyes, feet, tail. The shape of parts, like the shape of the whole object, plays a decisive role in recognizing the parts. This means that the template-matching model applies to recognition of parts of objects, as well as to recognition of objects themselves. Because template matching applies to recognition of parts, the non-inferential and conceptual character of template matching, demonstrated previously, shows that the neuronal processes that induce recognition of visual parts of objects are non-inferential and conceptual.\(^\text{12}\)

In addition to giving us independent reasons for the truth of non-inferential conceptualism, the template-matching model, I show below, helps explain why our visual experience of shape is conceptual and why visual perception is generally veridical, especially with regard to simple two-dimensional geometric objects and similar two-dimensional objects. The template-matching model, I also show, gives reasons for supposing that science can play a role in justifying perceptual beliefs.

The template-matching model yields a plausible explanation for our visual perception of shape as object-shape. Because \textit{shaped} things in our environment cause (by way of template matching) object recognition, wherever in our visual field we perceive shape there also we perceive objects with those shapes. In this way, template matching induces conceptualization of every shape in the perceiver's visual field as the shape of some object.

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\(^\text{12}\)Experiencing parts of objects as parts of objects requires massive computation at the brain level. This computation need not be characterized by syntactic manipulation of symbols. Many scientific studies of these computational mechanisms do not characterize these mechanisms as such. (See for example Anne Treisman 1996 and Christophe von der Malsburg 1995 who both review the current research on this and related computational problems. The "parts binding problem" is the name given to the issues that this research addresses.) Additionally computation of the syntactic-symbol-manipulation variety runs up against the problem of "combinatorial explosion".
The template-matching model helps to explain why visual perception is generally veridical, and in particular why visual recognition of simple two-dimensional geometric objects and of two-dimensional objects in general is highly veridical. In the template-matching model there is a causal relation between a viewer-relative, two-dimensional shape of an object $X$ and the shape of a Pattern in the Visual Buffer. The shape of the Pattern is caused to be the same *inherent* shape as that of (a two-dimensional projection of) object $X$. (I say two shapes are the same *inherent* shape if they are the same shape except for rotation, scale, some limited skewing, and retinotopic distortion. For example, this figure $\triangle$ has the same inherent shape as this figure $\triangle$. I explain in a subsequent section of this chapter that inherent shape of a Pattern is what matters in the template-matching model of visual object recognition.) The shape of the Pattern is *caused* to be the same inherent shape as that of object $X$ in a familiar way. Light rays reflect off the object, the cornea and lens of each eye focus light, and bottom-up visual neuronal processes produce a retinotopic mapping to the Visual Buffer. The inherent shape is generally preserved in the strictly causal processes such as reflection of light off the object and in the conceptual processes of template matching. Since the shape of the Pattern is inherently the same shape as (a two-dimensional projection of) object $X$, this Pattern is likely to match with one of the Templates of a

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13 Brian Cantwell Smith speaks of the preservation of shape from an object (a fly) to the frog retina in this way:

A property we ultimately associate with both subject and object — that of a boundary or edge — is in the first instance a property of their interaction. What we register as the edge of the fly (strictly speaking, the two-dimensional projection of its three-dimensional boundary tangential to the direction of illumination) corresponds directly to an “edge” of a very important column: a column of differential energy levels in the incident flood of frog-directed electromagnetic radiation, which corresponds in turn, through all the mediating mechanisms of physical coupling, to an edge of an impulse or differentiable region of energy in the retinal circuits in the frog. (1996, p. 216-217)
Prototype associated with object $X$, in this way inducing recognition of object $X$. The following picture thus emerges:

I.  the inherent shape of (a two-dimensional projection of) an object is preserved in the causal processing preceding template matching,

II.  this inherent shape is preserved in template matching, and

III. template matching induces recognition of an object based on this inherent shape.$^{14}$

Object recognition is thus usually veridical because what an object is is determined by its inherent shape (or, more precisely, the inherent shapes of its two-dimensional projections). To recap briefly with an example, the inherent shape of this object $\odot$ is preserved by strictly causal processing such as reflection of light off the object and by the conceptual processes of template matching which induce visual recognition of a depiction of a “sad face”. This preservation of inherent shape accounts for the mostly veridical recognition of the depiction of a “sad face”. Generally, preservation of inherent shape is a way in which visual perception is closely tied to stimulus configurations. This promotes veridical perception.

A dollhouse has the same inherent shape as a real house, so inherent shape does not completely determine what an object is. In particular, the shape of an object does not place the object in an inferential hierarchy. Nonetheless, it largely determines what an object is, as

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$^{14}$ Consequently when we experience the profile of an object we experience a shape that is the same inherent shape as the shape of the Pattern. (This formulation avoids the suggestion that we experience something that is in our heads when we visually perceive an object.)
has basically been argued previously in my discussion of how the shape of an object determines what an object is.\textsuperscript{15}

The template-matching model does not account for the veridicality of many aspects of visual perception. It has little to say, for example, about the veridicality or lack thereof of colour perception. Nonetheless, because template matching is based on preserving information pertaining to the inherent shape of an object in view — and this inherent shape in large part determines the nature of an object — the template-matching model goes a good way toward establishing that visual perception is veridical for the most part. Additionally, the template-matching model can be used to confirm that visual perception of simple two-dimensional geometric objects is highly veridical. A plausible reason for this is that a minimum amount of additional processing is required after the template matching. So there is less to go wrong.

This account is not bought at the cost of incurring the problem of accounting for misrepresentation that causal representational theories of perception face. The problem for these theories, simply stated, is this: if representations are caused by the things they represent, there seems to be no way in which these representations can be wrong.

\textsuperscript{15} In this way, the object of perception can be said to play a role in its own recognition by way of the causal processes that produce the Pattern. The object is heavily responsible for the Pattern that is produced. McDowell says:

Sellars's idea is that for thought to be intelligibly of objective reality, the conceptual representations involved in perceptual experience must be guided from without. Indeed they are, I can say. But there is no need for manifolds of "sheer receptivity" to play this guiding role. ... [t]he guidance is supplied by objects themselves, the subject matter of those conceptual representations, becoming immediately present to the sensory consciousness of the subjects of these conceptual goings-on. (McDowell 1998, p. 467).

(Likely, this "guidance" for McDowell is not physical-causal. This issue addressed in the next chapter.)
Accordingly, regarding visual perception, these theories cannot account for misperception. The template-matching model (which is essentially non-representationalist, I later argue) does not share this problem. In template matching, it is possible for Templates from distinct Prototypes to match with the same Pattern, not all at once, but on different occasions. This is so because there are objects of different types that share similar shapes from one or more points of view. (‘Points of view’ here should be taken literally.) Accordingly, the template-matching model can account for misperception. For example, a partially burned log, from a point of view, could have a shape similar to a crouching cat, from a point of view. In this case, due to stimulus similarities, template matching could induce mistaken recognition of a cat. The misrepresentation problem that haunts causal theories of representation, thus, does obtain in the template-matching model.

A tacit assumption in my arguments for the veridicality of visual object recognition is that our environment is generally conducive to veridical visual perception. Given science’s discoveries of the mechanisms of visual perception, it is not difficult to conceive of a world of “smoke and mirrors” in which visual perception is systematically non-veridical because visual perceptual mechanisms are systematically “tricked”. Current “virtual reality” devices may not be far from doing this. The possibility and even plausibility of “virtual reality” might seem to undermine any foundational role of visual perception. However, visual perception is generally veridical in the context of our normal environment. We cannot be absolutely certain of this but it is a pretty good bet. Our confidence in the deliverances of visual perception is reinforced by various branches of science. The reflection of light off objects, its refraction in the cornea and lens, the photon-absorption patterns of rods and cones in the
retina, the neuronal mapping of the retina to the visual cortex — the natures of these and many other processes reinforce the thought that visual perception is generally veridical. For example, as already observed, these processes preserve inherent shape.

The discoveries of science which enhance our confidence in visual perception are themselves justified by the practices and activities that serve to warrant scientific knowledge. In this way the warranting practices and activities in science (that I have been calling scientific forms of life) underwrite scientific reasons for believing that visual perception is generally veridical.

So far my account of template matching has accomplished its main purpose of sustaining and developing non-inferential conceptualism and my justificatory position. It remains to show that the template-matching model is not beset with the homunculus and neuronal givenness problems which might render my advocacy of it misguided.

Section 4.3 The homunculus problem and related problems

It is not uncommon in perception theory to encounter criticisms of neurological accounts to the effect that these accounts commit the blunders of positing internal homunculi\(^\text{16}\) and of positing neuronal non-conceptual givens (to use my expression) that induce object-recognition and other conceptual processes.\(^\text{17}\) (The latter problem entails the neuronal

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\(^{16}\) For example, John R. Searle remarks: "[I]t looks throughout Marr’s book, and in other standard works on the subject, as if we have to invoke a homunculus inside the system to treat its operations as genuinely computational" (Searle 1992, p. 212). Also see Luiz Pessoa et al. (1998, sec. 9.1, para. 4).

\(^{17}\) Schwartz observes in commenting on philosophical debates over the character of visual processing:

‘Nowadays, the idea that there is a set of perceptual items that is epistemologically privileged...’
givenness problem from which, I argued in the previous chapter, centralism and the sensation-perception distinction suffer.) Regarding the template-matching model, it might seem that Patterns are neuronal non-conceptual givens that induce object recognition, and that Prototypes are really internal homunculi that interpret Patterns. It might also seem that there are or must be homunculi to interpret Prototypes. I shortly show that the template-matching model does not need to posit or assume neuronal non-conceptual givens or homunculi. The benefit of choosing the template-matching model emerges here, for the processing proposed in the template-matching model has no need of neuronal non-conceptual givens or homunculi. My strategy for showing this is to show that the structures in the template-matching model (Patterns, Templates, and Prototypes) are neither neuronal non-conceptual givens nor homunculi, and that homunculi need not be posited or assumed to interpret Prototypes.

In the previous chapter, I canvassed the problem of supposing that neuronal non-conceptual givens can induce object recognition. There it was argued that these givens are not the type of thing that can be used in this capacity because they are not conceptually structured. A potential problem, then, is whether a Pattern (in template matching) is such an

... has lost most of its appeal. What has not lost its appeal, however, is the conviction that perception must start somewhere, that it must ultimately be based on some data or evidence that is given to us, even if our knowledge of this data is not assumed to be mistake-proof or error-free. (Schwartz 1994, p. 118).

By McDowell’s lights, reliance on “non-conceptual impacts” for justification constitutes the “idea of the Given”. In his words,

[t]he idea of the Given is the idea that the space of reasons, the space of justifications or warrants, extends more widely than the conceptual sphere. The extra extent of the space of reasons is supposed to allow it to incorporate non-conceptual impacts from outside the realm of thought. (McDowell 1994a, p. 7)

According to McDowell, analysing perception in terms of “non-conceptual impacts” is the project of “bald naturalism”, a reductionist philosophical trend which heavily relies on scientific findings.
entity. In the template-matching model, a Pattern is the most likely candidate for being a neuronal non-conceptual given because it is largely the outcome of bottom-up neuronal processes, which in other theories of visual perception, such as Pylyshyn’s, give rise to (in my terms) neuronal non-conceptual givens (which, these theories propose, induce object recognition and other conceptual functions).

A homunculus problem arises in perception theories in which an internal structure — a homunculus — is unwittingly or tacitly assumed to perform the task of interpreting the output of bottom-up processing. Such assumed homunculi prompt the charge of question begging. It is question begging to offer, as an explanation of visual object recognition, an account which in a tacit or hidden way assumes the existence of an internal structure or function that itself brings about object recognition by interpreting output of bottom-up processing. It is sometimes said that such structures or functions, which contribute nothing to explanation, are undischarged homunculi. It is often further observed that in order to perform its function, a homunculus requires its own internal homunculus, and that this homunculus, in turn, requires another homunculus of its own, and so on. This leads to an infinite regress. Some theorists, including Daniel Dennett (1978 & 1994), attempt to get around the infinite regress problem. Homunculi, in Dennett’s theory, become stupider and stupider until they merge into the merely causal. In this way, his homunculus theory captures cognitive processes without implying infinite regress, he claims. I leave aside whether

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18 Dennett completely embraces the notion of homunculi: “...the way to explain the miraculous-seeming powers of an intelligent intentional system is to decompose it into hierarchically structured teams of ever more stupid intentional systems, ultimately discharging all intelligence-debts in a fabric of stupid mechanisms” (Dennett 1994, p. 240).
Dennett is correct or not and concentrate instead on showing that template matching has no need for homunculi in the sense of internal structures with the task of interpreting the output of bottom-up processing. The problem of neuronal non-conceptual givens and the homunculus problem are related. If information for object recognition is supplied by neuronal non-conceptual givens then, it would seem, an internal homunculus is required to interpret these givens.

I first turn to showing how template matching can avoid homunculus problems. (Another model of object recognition is not being developed here. In the following I am merely showing that template matching has no need for homunculi.) I begin with Prototypes (that have Templates as components). A Prototype that helps bring about recognition of, for example, a teacup is associated with many Templates each of which is able to match with one of many Patterns (in the Visual Buffer) that could arise when a teacup is in view.

A Prototype can be in one of two fundamental states which I call coupled and non-coupled. (In discussing these states, I am not making any empirical claims that are not in line with the template-matching model as already described.) A coupled Prototype has one of its Templates matched with a Pattern in the Visual Buffer. None of the templates in a non-coupled Prototype is matched with a Pattern. The schematic below illustrates this coupled/non-coupled distinction pertaining to Prototypes, as well as the notion of multiple Templates associated with each Prototype.
The diagram on the left represents a coupled Prototype and its associated Templates. The solid line in the upper portion of this diagram (on the left) is meant to represent a coupled Prototype. It is coupled because one of its Templates is matched (with a Pattern). The matched Template is represented in the lower portion by a solid line. Unmatched Templates are symbolized by the lower dotted lines. A non-coupled Prototype is represented on the right by the dotted line in the upper portion. It is non-coupled because none of its Templates (depicted by the lower dotted lines) is matched.

The template-matching model needs no other fundamental mental structure. That is to say, coupled and non-coupled Prototypes, in addition to Patterns, are the only fundamental structures that need to be postulated by the template-matching model. In particular, there is no need to posit homunculi with the task of interpreting Prototypes. If this claim is true, and I argue shortly that it is, homunculi need not be posited or tacitly assumed, unless Prototypes themselves are homunculi. I also argue shortly they are not.19

19 By way of clarification, in thinking of coupled and non-coupled Prototypes (in addition to Patterns) as the only fundamental neuronal structures, I am not blind to the many and diverse neuronal structures that contribute to visual object recognition based on shape. I claim only that coupled and non-coupled Prototypes (in additional to Patterns) are the only fundamental structures in template matching. Additionally, I am not forgetting about the neuronal underpinnings of other mental faculties, such as those pertaining to beliefs. These neuronal underpinning could affect visual perception. Although there are undoubtedly numerous cross influences at the neuronal level, I
Why are coupled and non-coupled Prototypes the only fundamental structures that are needed (in addition to Patterns) in template matching? First, the template-matching model shows (I have explained above) that the neuronal inducing of visual recognition of an object X occurs when a Prototype associated with the object X becomes coupled. (Specifically, one of the templates in this Prototype is matched with a Pattern derived from the shape of object X.) This relation is illustrated below.

The solid line at the left represents neuronal inducing of visual recognition of object X. At the right Prototypes are represented. The one pertaining to recognition of object X, represented by the solid line on the right, is coupled. More than one object can be visually recognized at a time. Visual recognition of more than one object at a time would be induced by coupled Prototypes, one pertaining to each recognized object.

Second, a perceiver has the potential of being able to visually recognize a vast range of objects. This potential needs to be supported by neuronal processes. Non-coupled

assume that the processing involved in visual object recognition is sufficiently modular to treat it as a distinct unit. A final clarification concerns other processing in the visual neuronal system, such as processing colour information. My main task is to show that template matching, which involves the processing of shape information, does not require undischarged homunculi. So non-shape elements of processing in the visual neuronal system are not considered.
Prototypes do this work. That is, non-coupled Prototypes support the potential to recognize objects. This idea is illustrated below.\textsuperscript{20}

Here the \textit{dotted} line at the left represents the neuronal processes supporting the potential to recognize a range of objects and the \textit{dotted} lines on the right represent a range of non-coupled Prototypes pertaining to that range of objects. (Here, again, I am not making any empirical claims which are not in line with those made in the template-matching model as previously described.)

The way of formulating template matching just given — a way which is true to the scientific description — shows that in the template-matching model the only fundamental neuronal structures required to induce the recognition of objects are coupled and non-coupled Prototypes (as well as Patterns). Prototypes are not homunculi nor do they require homunculi to interpret them. A coupled Prototype is not a homunculus because it does not interpret a Pattern, as one would expect from a homunculus, but instead one of its Templates matches

\textsuperscript{20} The set of all the Prototypes is akin to Kant's global representation, as it pertains to the visual-experiential domain. Regarding Kant's position, Andrew Brook remarks:

To a first approximation, what makes Kant's theory different is that he did not just think of the mind as \textit{having} a system of representations; he also thought of it as \textit{being} a representation, namely, the global representation, the single representation within which many of the usual denizens of a system of representations are all contained. (1994, p. 44)
with a Pattern to induce object recognition. A non-coupled Prototype is not a homunculus for a similar reason. In neuronally underlying the potential to visually recognize an object of a certain type (a dog, for example), a non-coupled Prototype is not underlying a potential to interpret a Pattern in the Visual Buffer. Instead one of its Templates has the potential to match with a Pattern and induce object recognition, should this Pattern emerge in the Visual Buffer.

A question pertaining to homunculi remains: are homunculi needed to interpret Prototypes? By now my answer to this question can be anticipated. Inducing visual object recognition is not a matter of interpretation of bottom-up output, the type of thing a homunculus would do. Instead it is a matter of activating a potential capacity of a Prototype to induce visual recognition of a specific object. Homunculi are not needed because Prototypes do their job of inducing visual object recognition when they are coupled, when, that is, one of their Templates is matched with a Pattern in the Visual Buffer. I have shown that Prototypes are not homunculi and they do not require homunculi to interpret them. Therefore, template matching does not require homunculi.

It may seem as if my argument that Prototypes are not homunculi and do not require homunculi to interpret them is belaboured. The attention given to this issue is justified by prevalent philosophical assessments of neuronal accounts of visual perception which charge that these accounts tacitly assume homunculi. Showing that template matching is non-homuncular bolsters the case that visual perception is conceptual and non-inferential because the template-matching model was used in support of this evaluation of visual perception.
I now consider whether the template-matching model avoids neuronal non-conceptual givens, that is, non-conceptual processes, states, etc., that are thought to induce (directly bring about) visual object recognition. The structures that need to be considered are Patterns and Templates (within Prototypes). Both of these are integral components of template matching which, as already shown, is a structurally conceptual process. In particular, shape information is structured into a Template-Pattern match in such a way that visual recognition of an object specified by this shape information is induced. In short, template matching is structurely conceptual. Consequently, Templates and Patterns are not neuronal non-conceptual givens. (Properties other than shape of an object also contribute to object recognition and, as well, past experience and learning are factors affecting object recognition. These considerations do not detract from the assessment that Patterns and Templates are not non-conceptual givens, but are structurally conceptual.)

A possible objection to this line of argument runs as follows.

There are many bottom-up processes (and stages), delivering informational intake to the Visual Buffer where template matching occurs, processes that produce neuronal non-conceptual givens, such as the output of rods and cones, patterns of colour patches, motion indicators, edge indicators, and so on. These surely cannot all be conceptual. It is farfetched to claim that the output of, for example, rods and cones plays a conceptual role. Since perceptual recognition relies on these, we cannot avoid positing brain-level non-conceptual givens.

In reply, I should say that I do not maintain that the visual neuronal system consists solely of conceptual processes. The heart of my concern is that non-conceptually structured processes, because they are non-conceptual, cannot induce visual object recognition (although they can feed into processes that do). The template-matching model, as I have shown, manages to avoid this problem. In the visual neuronal system there are many non-
conceptual processes. Problems arise only if it is claimed that they somehow induce visual object recognition. (That is, problems arise if neuronal non-conceptual \textit{givens} are postulated.) Something more than mere causal processing is required to explain the inducing of visual object recognition. Conceptual processing is required. Of course, non-conceptual processes, such as light absorption, are necessary for visual object recognition. Adverting solely to them, however, leaves fundamentally unexplained the inducing of visual object recognition for which structurally conceptual processing is required.\footnote{Schwartz (1994, p. 116 ff.) documents the argument for non-conceptual givens in discussions in visual theory. The argument, he observes, usually takes the form of supposing that concept application must "start" somewhere in visual processing and that neuronal non-conceptual givens are processed beforehand. Schwartz attempts to deflate the "given-going beyond dichotomy", as he calls it: On the one hand, it is possible to maintain that all is given and hence that there is no need for inferential supplementation. On the other, it is possible to maintain that all perception requires inferential supplementation because visual experience and judgments are never themselves "simply" given. But I believe that there is no pressing need to defend either of these extremes or to fix on any specific place in between. For there are no firm grounds for settling on a unique construal of the given-supplementation divide, and consequently there is no one way to distinguish between \textit{the} data and \textit{the} inferred. (Schwartz 1994, p. 120). As I have made clear above, I have no quarrel with positing neurological non-conceptual processes provided it not assumed that these processes induce conceptual perception.}

I have no principled objection to the notion of a transducer, a function whose output is totally non-conceptual, provided a transducer’s output is not construed as inducing visual object recognition and other aspects of conceptual visual perception.\footnote{Fodor says "transducer outputs are most naturally interpreted as specifying the distribution of stimulations at the ‘surfaces’ (as it were) of the organism" (Fodor 1983, p. 42). He also refers to these outputs as "transduced representations of proximal stimulus configurations" (Fodor 1983, p. 42). On Fodor’s showing, transducers are distinct from input systems which "deliver representations that are most naturally interpreted as characterizing the arrangement of \textit{things in the world}"(Fodor 1983, p. 42).} My contention is that processing which induces visual object recognition must be structurally (and informationally)
conceptual. This condition is met by the template-matching model and not met by the processing proposed by the sensation-perception distinction or by centralism. It so happens that in the visual neuronal system conceptual processing seems to start at the retina because edge detection which constructs the Pattern starts at the retina. This entails that the retina is not a pure transducer but begins conceptual processing. (I have charged that retinal stimulations or outputs cannot be premises for inference if they are non-conceptual, as inferentialists claim. If inferentialists granted that retinal stimulations or outputs are conceptual in some way, they might have an easier time of it.)

Section 4.4 Does the template-matching model conform to representational theory?

Although the template matching model is not a newcomer to vision science, as noted earlier, in contemporary philosophy of perception it is hardly ever addressed. In particular, as far as I know, the following question has not been addressed. What philosophical theories of perception is the template-matching model amenable to and what theories is it not amenable

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33 Evidence that edge detection begins at the retina comes from studies of the cat retina. See Malcolm Slaughter 1990, pp. 71-72, and also Gregory, 1997, p.55. The nature of the retina is discussed again in the next chapter.

34 Claiming that conceptual processing begins at the retina does not in itself entail a reductionist position, for there are sources of concept use which derive from social interaction. Hamlyn (1996, p. 24 ff.) provides insight with regard to the place of causal accounts in the philosophy of perception: "[I]n the history of the philosophy of perception after Aristotle theories of perception tend either to assimilate perception to sensation, thus emphasising the causal aspects which are most obvious in connection with sensation, or to assimilate it to judgment, thus making less obvious how the causal processes which seem to underlie perception are in fact connected with it. (Hamlyn 1996, p. 25)

Later in the same work, he remarks: "The place of causality in perception is unmistakable, but it is not all that there is" (Hamlyn 1996, p. 30).
to? I concentrate on showing that the template-matching model is not a representationalist theory of perception. 

I alluded to this issue earlier in explaining my reason for avoiding the term 'representation'. In the vision literature, this term has two distinct meanings which are often conflated. This ambiguity has the consequence of making it seem that vision science conforms to the philosophical theory called the representational theory of mind (RTM) which I will refer to as standard representationalism. In standard representationalism, the term 'representation' designates an intermediary between a perceiving subject and an object in the world. A representation intrinsically stands for the object; that is to say, it is intrinsically intentional. Standard representationalism thus holds that there is a three place relation among objects in view, internal representations, and the perceiving subject. This is the central tenet of standard representationalism. Typically, in standard representational theory, patterns of activation, such as those on the visual cortex and perhaps in the retina, are characterized as

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25 Marr associated his theory with philosophical representationalism. From a philosophical point of view, the approach that I describe is an extension of what have sometimes been called representational theories of mind. ... Modern representational theories conceive of the mind as having access to systems of internal representations; mental states are characterized by asserting what the internal representations currently specify; and mental processes by how such internal representations are obtained and how they interact. (Marr 1982, p. 6)

Rock, who proposes a much different theory from that of Marr, also seems to subscribe to representational theory:

External objects and events are represented mentally in the form of propositional knowledge. The very essence of intelligence in living creatures, in my opinion, is the capacity to "know," to represent objects, events, and relations in a form that is subject to confirmation or disconfirmation. The claim, then, is that perception also is based on this form of representation. (Rock 1983, p. 15).

26 Putnam, in a paper containing his 1994 Dewey Lectures, contends that "the idea that there has to be an interface between our cognitive powers and the external world" needs to be rejected (Putnam 1994a, p. 453). It is commonly thought that positing these intermediaries poses homunculus and myth-of-the-given problems. See Pessoa et al. 1998 (section 9, esp. paragraphs 2-7).
representations. These patterns of activation are usually claimed to be in some way informationally isomorphic to visual properties of distal objects in view. (This isomorphism is used to argue that the patterns of activations are representations.)

In vision science, generally the term 'representation' has a different meaning. It too is used to refer to patterns of activation that in some way are informationally isomorphic to visual properties of distal objects. Typically, however, there is no suggestion that these patterns are intrinsically intentional. In Marr 1982, for example, despite his advocacy of a representational theory of mind near the beginning of his book (see my n. 25, p. 126), the term 'representation' generally does not refer to intrinsically intentional patterns of activation. In vision science the term 'representation' is not usually used in the context of assuming or proposing a three place relation among an object in view, a representation, and a perceiving subject.

Unfortunately, these two senses of 'representation' are often not clearly kept apart. The resulting ambiguity of the term 'representation' wrongly makes it seem that vision science largely conforms to standard representationalism. Instead, the use of the term in vision science conforms to the so-called "information-processing" paradigm in which causal relations among patterns of activations are investigated. Certainly, there are standard representationalist versions of information processing. However, these versions tend to be those of philosophers and philosophically-minded vision scientists. In most of the scientific literature there is no commitment to standard representationalism (although, of course, there is a commitment to information processing).

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27 Images on the surface of the retina are not representations in this sense.
Evidently, the template-matching model conforms to the information-processing paradigm. (It definitely does not conform to the Gibsonian approach to visual perception in which investigating internal information processing is considered unimportant.) Why does this model not conform to standard representational theory? The key components of the template-matching model as described earlier are:

A. A Pattern, with the same inherent shape as object $X$, is produced in the Visual Buffer (by processes including light reflecting off the object $X$ and bottom-up neuronal processing);

B. the shape of one the Templates of a Prototype pertaining to object $X$ sufficiently resembles the shape of the Pattern to match with it; and

C. this Pattern-Template match induces the recognition of object $X$.

The template-matching model, as I have described it, does not conform to standard representational theory because there is no need for internal mental representations in the processing proposed by this model. That is to say, in order to use the template-matching model to explain visual object recognition, there is no need to suppose that any component of the model is a representation.

It is useful here to draw an analogy between Prototypes and enzymes. A Prototype coupled with a Pattern can be likened to an enzyme of the type which is activated by chemically combining with a substrate. The similarity holds in the following respects.

An enzyme is inactive before combining with a substrate. A Prototype does not induce visual object recognition before one of its Templates matches with a Pattern.
An enzyme becomes active after combining with a substrate.

A Prototype induces visual object recognition after one of its Templates matches with a Pattern.

The combination of an enzyme and a substrate is based, in large part, on the similarity in shape of one part of an enzyme with the shape of one part of the substrate.

The match of a Template and a Pattern is based on similarity in their shape.

This analogy has its limits. For one thing, unlike an enzyme, a Prototype cannot be described in biochemical terms (at least that is what I believe). However, there is an important similarity which justifies the analogy. What is crucial for the activation of an enzyme is combining with a substrate. Similarly, what is crucial for object recognition is the Template-Pattern match. The substrate becomes part of the enzyme, just as the Pattern can be thought of as becoming part of a coupled Prototype. In both cases, there is no intermediary.

The enzyme-substrate analogy helps show that a criticism levelled against Marr’s theory does not apply to the template-matching model. The charge is that a 3-D model seems to become a copy of a three-dimensional object in view. A Prototype no more becomes such a copy than an enzyme becomes a substrate after the two of them are chemically combined.28

28 C.C.W. Taylor defends Aristotle’s perception theory in a similar way:

...[Aristotle’s] view is that certain physiological changes are actualisations of sense-faculties; i.e. acts of recognition or discrimination. One might then suppose that he has fallen into the error of supposing that he can explain perception by transferring the objects of perception from the external to the internal realm; we see things by having pictures in the head, which are visible to the eye of the soul, hear external sounds by having sounds in our ears which the soul hears, and so on. But for Aristotle this would be a pointless reduplication. A sense-organ is an embodied faculty for the reception, i.e. the registering, of sensible objects such as colours or tastes; since these objects are registered in the activity of the organ, there is no need for a further organ to perceive them. And if it is suggested that the sense-organ is in the body, whereas what is needed is a sense-organ in the soul, Aristotle’s answer is that qua embodied faculty the sense-organ is in, i.e., is a part of, the soul. (Taylor 1990, p. 139)
Neither a Pattern nor a Template is a copy of the object in view because both capture viewer-centered, two-dimensional information.

Does the template-matching model necessarily exclude representations? It probably does not. However, since by my showing representations are not required, Ockam’s razor is satisfied. Furthermore, suppose representations were introduced into a template-matching model. A typical way to do this in vision science would be to hold that object recognition is due to a match between two representations. One is due to bottom-up processing in the visual neuronal system. The other representation is retrieved from memory. This type of "representational" model seems to be an amalgam of two theories of perception. One of them is standard representationalism. The other seems to have an ancestry in an ancient theory of visual perception, attributable to Aristotle and perhaps also to Plato, in which the mind or soul is thought to conform to the form of an object. A match of a representation retrieved from memory with a representation due to bottom-up processing can be thought of as a type of conforming of the mind. This amalgam of two distinct theories is not aptly described as representational. Therefore, even if representations are included in a description of template matching in a way which would be typical for vision science, a "pure" standard representationalism would likely not be attained.

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29 Edelman, a prominent vision scientist, writes:
Recognition implies a match between two entities, one of which is normally an internalized version of the present stimulus, and the other a memory trace laid down by some stimulus or stimuli at an earlier time. I shall refer to both entities participating in the process of recognition as "representations." (Edelman 1998, p. 11)

30 See n. 31 in this chapter.
It may have been noticed that template-matching theory is broadly similar to Aristotle's perception theory as laid out in *De Anima*.\(^{31}\) It would take me too far afield to argue this in full. Of course, like Aristotle's theory, the template-matching model does not conform to standard representational theory. The template-matching model has another similarity to Aristotle's theory, specifically to his contention that the sense organs *qua* cognitive entities are part of the soul.\(^{32}\) Under the template-matching account Patterns, Templates, and Prototypes perform conceptual functions.

The relationship between brain processes and experience can be characterized in many ways. A substance dualist would say that they pertain to two irreducible substances.

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31 Taylor's encapsulation of Aristotle's theory in *De Anima* follows. Aristotle's account (in *De Anima*) of the nature of the actualisation of a particular sense (for instance sight) is as follows:
1. That which is capable of perception ... is potentially what the object of the sense is actually (418a3-4).
2. Perception is a sort of alternation in that which is capable of perceiving (416b33-5); it is acted on by the object of perception, so as to become what that object is actually (417a6-20).
3. The sense (... 424a17-19) or the sense-organ (... 425b23-4, 435a22-4) receives sensible forms without their matter.
4. The actualisation of the sense and the actualisation of its object are one and the same, but their being is different (425b26-7, 426a15-17).
5. The sense judges or discriminates its proper objects (418a14-15, 424a5-6, 432a16).
6. It is impossible to be mistaken regarding the proper objects of any sense (418a12-16).
7. When we perceive by any sense, we perceive that we perceive (425b12). (Taylor 1990, p. 137-138)

This theory, Taylor observes, is also found in Plato's *Theaetetus* 156c-157c. Aristotle's position is not internally consistent according to Taylor:

Aristotle ... faces a dilemma. He holds both (propositions 1-3) that the sense-object acts on the faculty by imposing on it the form which it (the sense-object) actually has, and (proposition 4) that before the perceptual act the sense-object has its form only potentially, acquiring it actually in the act of perception; yet these claims are incompatible. (Taylor 1990, p. 140)

This criticism does not apply to the template-matching model because the shape of an object is not "actualised" in perception. An object's shape is actual before, during, and after perception.

32 See footnote 28 in this chapter for Taylor's (1990) account of this aspect of Aristotle's theory.
A property dualist would contend that they pertain to two irreducible properties of the same substance. A double-aspect theorist would contend that descriptions of brain processes and descriptions of visual experience address different aspects of the same thing. In contemporary philosophy there are those who contend that physiology has little or nothing to do with accounts of experience. At the opposite pole there are those who contend that accounts of physiology and of experience are complementary. Nearly half a century ago, U.T. Place wrote the following. It is insightful even today.

Once we rid ourselves of the phenomenological fallacy [the assumption that ...our descriptions of things are primarily descriptions of our conscious experience and only secondarily, indirectly, and inferentially descriptions of the objects and events in our environments] we realize that the problem of explaining introspective observations in terms of brain processes is far from insuperable. We realize that there is nothing that the introspecting subject says about his conscious experiences which is inconsistent with anything the physiologist might want to say about the brain processes which cause him to describe the environment and his consciousness of that environment in the way he does. When the subject describes his experience by saying that a light which is in fact stationary, appears to move, all the physiologist or physiological psychologist has to do in order to explain the subject's introspective observations, is to show that the brain process which is causing the subject to describe his experience in this way, is the sort of process which normally occurs when he is observing an actual moving object and which therefore normally causes him to report the movement of an object in his environment. (Place 1956/1962, pp. 108-109)

On this showing, the explanation of visual experience in terms of brain processes offered by the template-matching model has the status of a legitimate explanation of experience, provided it is a reasonable empirical account.

This basically brings my overall arguments about the nature of visual perception to a close. Neurological arguments have complemented and developed non-inferential conceptualism and my construal of visual perception as a foundation for objective
knowledge. The rest of this study supplements what has already been argued, as well as applying my position to an important issue in philosophy of education.

If I were asked what the key contribution of this study is to our understanding of perception, my answer would be this. Although non-inferential conceptualism and my justificatory account are important, the key contribution consists in showing that our visual experience of shape is conceptual (and non-inferential) and showing that, plausibly, visual object recognition is induced by non-inferential and conceptual neuronal processing of shape information. (I do not claim originality here although I know of no other such account which incorporates the template-matching model from vision science.) This aspect of my study avoids homunculus and myth-of-the-given perils that have plagued perception theory and philosophy of perception for a long time.

Section 4.5 Scientific motivation for the template-matching model

This chapter was laid out to facilitate presentation of my key arguments with a minimum of intrusion from the scientific literature that defends the template-matching model. Because the template-matching model has an important bearing on my key arguments, this section is devoted to responding to criticism that this model is too simplistic, and to showing that a sector of the vision science community considers that the model plausibly explains neurological inducing of a good deal of shape-based object recognition.

Scientific support for the template-matching model comes from many sources, including studies showing that activation in many areas of the visual cortex is retinotopic. These studies reveal that the two-dimensional contours of an object from a perceiver's point
of view are correlated with activation in the visual cortex except for size, orientation, and distortions in the mapping from the retina to the visual cortex. These findings (which stem from the results of David H. Hubel and Torsten Wiesel and are probably at par in importance with Kepler's discovery that light is focussed on the retina by the cornea and lens) are consistent with template-matching theory.

A source of scientific support for the template-matching model is the study of Palaeolithic drawings. These drawings are markedly similar to simple outline drawings that are still produced today, as John Halverson remarks:

[P]aleolithic art is an art of outline. The fully painted polychrome figures of Altamira and Lascaux are the glories of cave art and naturally the most frequently reproduced and most familiar paintings of the era, but they are exceptional; most of the art — perhaps ninety percent — is simple outline. Engravings especially, which outnumber paintings, are almost all outline figures. ... Palaeolithic art is in a certain general sense 'realistic'. It is not in the least photographic, nor is there anything remotely approaching 'trompe l'oeil' in Paleolithic art — in fact, it is closer to cartoon art than to any other modern art form; it is realistic in the elementary sense that it permits fairly easy recognition of the subject depicted. (Halverson 1992, p. 390)

Halverson cites evidence that this type of depiction is universal:

The universality of outline drawing in both time and space has been shown by [J.M.] Kennedy and [J.] Silver (1974), who examined some 657 examples from all over the world from Palaeolithic to modern times, and found that 99% had the common feature of 'occluding bound'. The evidence seems very good, then — and there seems to be none to the contrary — that, in the proper circumstances, object recognition from outline drawings is universal and innate ....(Halverson 1992, p. 390)

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33 See, for example, Kosslyn 1994 (p. 14). Kosslyn reproduces the results of R.B.H. Tootell et al. (1982).

34 For Kennedy and Silver, the "occluding bound" or "occluding edge" is the outside edge of an object from a point of view.
The universality of this type of depiction, Halverson claims, is due to the way in which outline drawings tap cognitive resources involved in perception of ordinary objects:

"... [T]he silhouette of a rhinoceros, mammoth, or deer, if, as in profile, it displays the animals' distinguishing characteristics of form, is as recognizable as the fully illuminated creature — in some circumstances even more so, as for instance when there is a 'noisy', visually confusing background (of which both natural and man-made camouflage takes advantage). The pictorial outline abstracts from the silhouette its only signifying feature, its occluding edge, or, better, its 'occluding bound' .... Thus, although an unnatural artifact, the pictorial outline successfully exploits a fundamental component of natural object recognition. (Halverson 1992, p. 391)."

Thus, our ability to perceive two-dimensional figures seems to indicate a fundamental element of our cognitive makeup. That is, the cognitive resources needed to recognize two-dimensional figures seem to be the same as a significant component of the cognitive resources needed to recognize three-dimensional objects. The template-matching model is consistent with this assessment.

An (opaque) object occludes or blocks light from objects lying behind it from the point of view of a perceiver. Furthermore, the shape that an object occludes is invariant (except for size) under all lighting conditions, sunny light of a summer day, dim candle light, subdued reddish tones of twilight, cold light from a full moon, dimness of a night lit only by the stars, and even the almost total blackness of a dark, cloudy night. Suppose, to take an example, I view a teapot. The teapot blocks light from passing through it, thereby occluding light from objects behind it relative to my point of view. It is as if the teapot "cuts" a "patch" in the shape of a teapot out of the background. The boundary of the "patch" is what Halverson and Kennedy call, by the somewhat technical term, an "occluding edge" or "occluding bound". It is this occluding edge that is invariant, from a particular point of view,
under all lighting conditions. Whether I view the teapot at night, in twilight, or in daylight, the occluding edge remains the same shape. Furthermore, this shape is also preserved over distances. Of course size varies. Provided my line of sight remains the same, the perceived silhouette of the teapot remains essentially the same no matter what distance it is from me, so long as I can see it, and so long as its visual presence doesn’t shrink too much. So it seems that object recognition based on the two-dimensional shape of objects has something quite important going for it. It is based on invariant features of objects over distance and over lighting conditions. This invariance under conditions of night light is particularly important because, often, under those conditions, only the information in a silhouette is visually available. All in all, there are compelling reasons to suppose that object recognition based on two-dimensional shape is part of our evolutionary, biological heritage. This view is consistent with the template-matching model. Having presented some scientific findings that are consistent with the template-matching model, I now turn to discussions of the model within vision science.

Not all vision scientists regard the template-matching model as an adequate model of visual object recognition. According to Kosslyn:

When most people begin to think about the problem of object identification, the first mechanism they think of (and one of the first that was thought of historically, see [U.]Neisser 1967) is template matching. A template, in this sense, is a stored model of a shape. The idea is that one has in memory a template of each familiar shape, and when an object is seen its input image is compared to the templates; the template that overlaps the most with the image is selected as the best match.

This approach was quickly ruled out when researchers considered our ability to identify objects when their shapes vary. For example, say you stored an image of

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35 The template-matching model seems to be akin to Plato's wax-signet-ring metaphor (Theaetetus, 191a-195b).
an open hand and matched input to it when later trying to identify hands. This procedure might work well if the hands you saw were always open. But what happens when you see a hand that is closed, gesturing two fingers, and so forth? Imagine that you had a photograph of the different hands taken on transparent pieces of plastic, and placed them over the photo of an open hand. If you measured the degree of overlap, you would find that a hand balled into a fist barely overlaps the open hand — in fact, it overlaps a hand grenade better than a hand!

One approach to solving this problem is to store a separate template for each possible shape. The large number of necessary templates that are required by this scheme is not such a terrible flaw; ... human memory has a truly awesome capacity to store information. A fundamental problem with this approach is that we see novel shapes all the time, and can identify them anyway. For example, you may never have seen a man squatting on one foot with both hands pointing to the sides of his neck, but you can identify the shape as a person nevertheless...[W]e can identify objects in an astounding range of circumstances. (Kosslyn 1994, pp. 69-70)

Here Kosslyn holds that the template-matching model fails to account for recognizing objects that present novel shapes to a perceiver (such as “a man squatting on one foot with both hands pointing to the sides of his neck”) and that the theory fails to account for recognition of objects given the many and varied shapes objects can assume.36 Regarding the latter potential deficiency in the template-matching model, Kosslyn accepts the remedy that there is “a separate template for each possible shape”.

Despite opposition, such as that expressed by Kosslyn,37 the template matching model retains favour among some prominent vision scientists. In fact, as Patrick Cavanagh notes,

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36 Although Kosslyn is critical of the template-matching model, his model may be considered to be substantially within that framework. See Kosslyn 1994 (pp. 120-121) where he seems to adopt a template-matching model augmented by the inclusion of neural-net “vector” completion to fill in missing elements from the input.

37 William R. Uttal is less favourably disposed to template matching than Kosslyn. He writes:

The implausibility of the existence of a huge set of templates, some of which may never have been experienced previously and the equally implausible nature of a exhaustive search through the library of templates have always provided strong conceptual arguments against the template hypothesis. (Uttal 1988, p. 228)
this theory has gained favour. One reason for this is that it seems to explain some aspects of visual perception left unexplained by other models. For example, recognition of two-tone pictures, Cavanagh claims, can only be accounted for by the template-matching model.

Pictures can ... be very sparse and an extreme example is the two-tone image style which emerged in the world of graphic arts at the end of the last century. In these images, there is a minimum of information and yet the object has a compelling 3-D structure.... Here are some of the interesting properties of these images. First, there is no counterpart to these images in the real world — there are no circumstances which give rise to two-valued images for real 3-D objects. A dark object silhouetted against a bright background comes close, but silhouettes lack internal detail whereas two-tone images like that [in the figure below]

have complex internal detail. Since monkeys can also recognize two-tone images such as these (or at least their face-sensitive cells do, after one exposure to the grey-scale version of the same image ...), we cannot appeal to learned conventions of our culture. These images cannot be interpreted on the basis of the local structure of their outlines — the contours alone often appear as meaningless scribbles. The parts and features of the objects in the images cannot be determined from intersections, junctions, or deep concavities (try it). These images are impossible to interpret with

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38 Cavanagh observes:

It is once more possible to read the word 'template' in articles about object recognition (albeit, more sophisticated templates). Several papers propose that recognition may depend on 2-D views rather than general 3-D models of objects (Rock et al. 1981; Tarr and Pinker 1990; Cavanagh 1991; Bulthoff and Edelman 1992; Logothetis et al. 1992). (Cavanagh 1995, p. 1227)
the aid of any part-based model (e.g., geons, generalized cylinders, or superquadrics), structural encoding (e.g., medial axes, cores, or codons), distinctive features (colours or textures), or depth recovery process (texture gradients, disparity, or pictorial cues). What can possibly be left if no parts can be found, if no depth relations can be determined, and if it is unknowable whether any contour belongs to an object or to a cast shadow? Quite likely, the only remaining process is the simplest of all pattern operations: viewpoint-specific recognition. This is, undeniably, a modern code word for 2-D templates. Parts of the pattern match a particular 2-D view of, in this case, a face — perhaps a generic face. Once a match is found, other parts of the pattern can be interpreted in that context. As would be expected for such a top-down process, it only works for familiar objects seen from familiar viewpoints. (Cavanagh 1995, pp. 1230-1231)

By building a number of sophisticated aspects into the template-matching model, advocates of this model have responded to the charge that it is too simple to explain the many and varied shapes an object can assume and still be recognized. A Prototype "bundles" multiple Templates so that, for example, each Template within a Prototype for recognizing Jumpy (Uncle's rambunctious fox terrier) corresponds to a viewpoint of Jumpy. In fact, within this Prototype, each viewpoint could have multiple Templates in order to be able to recognize Jumpy in the many different positions that he can get himself into from each point of view. (This is basically the proposal accepted by Kosslyn in the above passage.) Additionally, in the template-matching model, each Template within the Prototype for Jumpy can be rotated, expanded or contracted, and/or skewed to match a Pattern, so a Template in the shape of a side view of Jumpy can be expanded or contracted to adjust for the distance away from Jumpy. (When Jumpy is close, the 2-D Bottom-up Pattern is relatively large. When he is far away it is relatively small.) Similarly, a Template can be rotated so that Jumpy can be recognized standing on an upgrade. (Rotation, expansion or contraction, and skewing of Templates entail that a Template is sensitive primarily to the inherent shape of
the Pattern. Therefore, the inherent shape of two-dimensional projections of objects is
primarily what matters to template matching.)

In addition to rotation, expansion or contraction, and skewing, approximate matches
can take place that compensate for signal noise and slight variation in the shapes of objects
of the same type. So a match can obtain even if Jumpy has hairs out of place. Allowing
approximate matches entails that template matching does not require an infinite number of
Templates for each Prototype. Nonetheless, a high finite number of Templates within each
Prototype is compatible with memory capacities of the brain.39 An innovation on the notion
of an approximate Template-Pattern match is the “deformable-template” proposal of Alan
Yuille and Peter Hallinan (1992). Instead of an approximate fit to achieve a match (after
rotation, expansion or contraction, and/or skewing), a Template (after rotation, etc.) is able
to “deform” slightly to achieve this match. In effect, the edges of the Template adjust slightly
so that it becomes the same shape as the Pattern. All in all, in achieving a match, a Template
can rotate, expand or contract, become skewed, and deform slightly to achieve a match. A
short way of expressing this is to say that a Template conforms to achieve a match. The
provision in the template-matching model of various ways that a Template can conform to
achieve a match as well as the idea of multiple templates, responds to the charge, raised by

39 Another type of approximate fix pertains to recognition of partially occluded objects. In this case,
the Pattern, which is produced by bottom-up processes, corresponds to only part of the two-
dimensional projection of the object, the part that is not occluded. Recognition takes place on the
basis of a partial match between this Pattern and a Template.
Kosslyn in the above passage, that the model is too simple to account for the many and varied ways in which the shapes of known objects are visually encountered.⁴⁰

In the above quotation Kosslyn also charges that the template-matching model cannot account for the recognition of visual objects in completely novel positions. This is likely often true but this does not diminish the plausibility of the model. To be plausible, the model does not have to account for all types of recognition of visual objects. The model, for example, does not need to account for non-perceptual recognition. Recognition of a visual object in a completely novel position, if recognition occurs, could rely on non-perceptual cognitive resources, including inference from perceptions of parts of the object and background beliefs. (I am referring to inference that takes place outside of perception.) When for the first time I see “a man squatting on one foot with both hands pointing to the sides of his neck”, I can inferentially recognize a man, based on perceiving a head, arms, torso, etc.

⁴⁰ There is convincing evidence that, in tactual perception, shape-based object recognition occurs, based on the detection of edges and contours as in the visual case. In fact, object recognition likely involves similar brain mechanisms in vision and touch. This issue has received considerable attention, especially regarding the blind. See, for example, Kennedy 1993 and Morton A. Heller and William Schiff 1991. Understandably, there are some differences between the two modalities in the ways objects are recognized. For example, Roberta L. Klatzky et al. write:

We began by suggesting that touch is a spatial modality, raising the issue of the importance of spatial information in haptic object identification. Despite the fact that a lower level of spatial precision is possible with the haptic than with the visual modality, we have presented evidence that the information about an object's structure extracted through haptic exploration is of substantial value in determining its identity. This does not mean, however, that vision and touch rely equally on spatial properties; material properties also make an important contribution to object recognition by touch. Further, the salience of material properties seems to characterize the cognitive representation of objects that are apprehended through haptic exploration. (Klatzky et al. 1993, p. 204)

('Material properties' refers to, for example, smoothness and roughness.)

Template-matching theory can be adapted to tactual perception in cases in which object recognition takes place on the basis of a two-dimensional projection of the object's shape. A Pattern could be produced in the Tactual Buffer when, for example, we trace a finger around an edge of an object. The Pattern is the causal outcome of bottom-up tactual processing. In tactual perception, a Template-Pattern match induces tactual object recognition.
(In this case, the recognition that occurs is non-experiential, although it relies on experience.) This is not a concession to inferentialism. It is just a case of employing inference to enhance categorization beyond that which is supplied by visual experience. Template matching is still playing a role by inducing recognition of the head, arms, etc., upon which the non-perceptual inferential recognition is based. Much the same could be said about the recognition of novel visual objects. This recognition need not be based exclusively on template matching. Again inference could play a role in conjunction with perceptually recognizing parts of a novel object through template matching.

The template-matching model does not explain other ways in which objects are perceptually recognized. For example, we might recognize an object based on a non-inferential generalization from recognition of some of its parts. As well, there are types of visual object recognition that do not rely on the shape of the object. An orange hanging in a tree may be recognized on the basis of its colour and location. The template-matching model has little or nothing to say about this type of object recognition. These exceptions do not diminish the plausibility of the model, unless it is mistakenly assumed that the model must account for all aspects of the recognition of visible objects. The aim in this section is not to claim that the template-matching model accounts for all visual object recognition. It does not. Instead, the aim is to show that the template-matching model is not simplistic, and that it is accepted by sectors of the vision science community as a plausible model for a great deal of visual object recognition based on the shape of objects.

41 A Template could be generated such that on subsequent viewings I could visually recognize a man in such a novel position without recourse to inference.
I have left out many aspects of the template-matching model. A vision scientist would certainly notice that much more can be said. It is not necessary to draw a complete scientific picture of template matching in order to draw some important philosophical lessons from this model. What is needed is an accurate appraisal of the scientific issues and, equally important, of how these issues contribute to an elucidation of philosophical questions, which in this case pertains to the character of visual processing that induces visual object recognition.\(^{42}\)

I close this section with comments on how the template-matching model can account for some visual experiences in low light conditions. Visually experiencing physical objects in the dark of night affords abundant examples of experiencing three-dimensional physical objects where only the silhouettes of the objects are visually "present". Glistening curves on the object, cast shadows, and back-reflected light — these and other clues of three-dimensionality are generally lacking in the dark. Many objects such as trees are visually "present" only in silhouette against a moon-lit sky. Yet the information in a silhouette of a

\(^{42}\) Hamlyn's comments are of considerable merit here:

[I]t should not be presumed that our common-sense understanding of what is involved could not be corrected at certain points by scientists with greater knowledge of what is involved. What one needs is what is sufficient for answering the question whether some being can perceive, and for that purpose one needs at least a working knowledge of the kinds of processes involved, but not necessarily knowledge of all the details. What such a working knowledge amounts to cannot be answered in a general way; it depends on the particular questions being asked. For philosophical success in this area, as elsewhere, a sense of the appropriate questions and about what they really amount to is sometimes as important as providing the answers to them.

But one thing is clear — that in trying to provide an understanding of perception it is not enough simply to list the components involved in it — causal processes, sensations, concepts and so on. One needs to know how they fit together. One of the big issues in this area, for example, is how the experiences one has are related to one's belief and knowledge about the world. Another is how the causal processes involved are to be seen as related to the ways in which things look to us, and what indeed it is for things to look such and such to us. All such matters are ones on which a philosophical theory of perception ought to cast light. (Hamlyn 1996, p. 7)

Also see Hamlyn 1996, p. 35.
tree is enough for me to visually recognize a tree. Furthermore, I don't first recognize a silhouette, perhaps as a sign of a tree, and then infer that there is a tree before me. In fact, it is sometimes difficult to realize that the only aspect of the tree that is directly "present" visually is its silhouette.

Automatically recognizing the tree in these circumstances is a puzzling phenomenon. In the first place, the available information is considerably diminished in contrast to daytime viewing, when we can perceive colours and intricate details of the tree. This relates to another puzzling phenomenon. Why do we visually recognize the tree and not merely a sort of two-dimensional cutout of a tree? The situation is all the more puzzling if we consider that there is no direct, three-dimensional information available in a silhouette of a tree (as seen at night). It is as if the "direct object" of perception is a flat, two-dimensional surface. The puzzlement continues when we consider that the silhouette of a tree has an abstract quality because it is two-dimensional whereas the tree is three-dimensional.

The template-matching model resolves these puzzles. Consider my bygone boyhood days when I spent considerable time playing among fir trees. I perceived them in many different situations. I visually perceived them from a distance and from close up; I felt their texture, realized they were solid and had prickly needles and rough bark, learned that they were called "fir trees", learned their cones contained seeds, etc. During this time, a neuronal Prototype pertaining to fir trees emerged. This Prototype is neuronally encoded in such a way that when it becomes coupled (that is, when one of its Templates matches with a Pattern in

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43 This line of thought can lead to a version of sense datum theory in which it is claimed that we are aware of surfaces and not of the objects.
the Visual Buffer), the Prototype induces a visual experience that is more than that of shape. It is an experience of an object with a certain shape, solidity, roughness, prickliness, and so on. When a Pattern with the inherent shape of a fir tree activates (through template matching) the Prototype that induces object recognition of a fir tree, I experience a fir tree. For this, no inferences are required; just a Template-Pattern match that induces visual object recognition. I recognize the fir tree at night in a way that is as immediate as recognizing the fir tree in daylight.

This account is all well and good but suppose a park keeper, unhappy with the philosophical purposes to which I am putting the park in my neighbourhood, decides to play a devilish trick on me. She erects cutouts of fir trees throughout the park. They fool me at first but after a while I catch on. I realize that many times what I first recognize as fir trees are not really fir trees but cutouts of fir trees. I have to be more careful. I have to consider whether I am viewing a tree or a cutout of a tree and make a judgement based on other factors. This does not throw a spanner into the template-matching model. There is no reason, as mentioned previously, to hold that template matching is responsible for all recognition of visible objects nor that it will guarantee veridical perception.

If the park keeper is persistent I may cease to experience fir trees in my nightly perambulations in the park. This would be a case of beliefs altering perception.
Chapter 5
Visual perception and justification of belief

In order to know and act, it is necessary both to see and to think.¹

A basic principle has guided the development of my account of the nature of visual perception. Non-conceptual givens (either neuronal or experiential) cannot bring a subject into a conceptual relation to the world, contrary to the many proposals to that effect. As we have seen, these non-conceptual givens come in a wide variety of types, depending on the theory. They include sense data of sense-datum theory, retinal stimulations of inferentialism, sensations (both neuronal and experiential) of the sensation-perception distinction, and outputs of the visual neuronal system of centralism. In particular, processing of shape stimuli and visually experiencing shape are often thought to be non-conceptual and to induce (directly bring about) conceptual perception including object recognition. The crucial role of shape processing in inducing object recognition gives credibility to positing neuronal non-

¹ This remark is Lewis White Beck’s hesitant encapsulation of the whole of Kant’s philosophy. In occurs within the following remarks: Bergson wrote that every great philosopher has said only one thing, and James remarked that any worthwhile system of philosophy can be written on a postcard. It is an amusing jeu d’esprit to take a philosopher’s ten or twenty volumes and try to compress them to postcard length. My proposal for doing this to Kant’s will be disappointing, since hardly anyone nowadays will deny the sentence but many will deny that it is the seminal thought in Kant. But it was a highly disputable proposition in his day, and I think that some of the lasting importance of Kant is shown by the fact that it is no longer disputed. The sentence would be: In order to know and to act, it is necessary both to see and to think.

I hesitate, of course, to say that this insipid statement is the sum and substance of Kant’s philosophy. But when I see how much of his philosophy depends on it, how much is an elaboration and defence of it, and how many of his polemics are against those whose philosophy was an implicit denial of it, I think there is merit in this as a summary if one insists upon postcard brevity in the history of philosophy. (Beck 1978, pp. 17-18).
conceptual givens pertaining to shape, as witnessed by the continuing influence of the sensation-perception distinction and centralism which both posit neuronal non-conceptual givens that supposedly induce visual object recognition. The two previous chapters were devoted to demonstrating two contentions: the conceptual nature of the perception of shape and the conceptual nature of neuronal processing of shape information that induces object recognition. (As I have made clear, I do not hold that all processing of shape stimuli is conceptual.) I have demonstrated the possibility of perceptual justification of our beliefs about the world by showing that visual perception brings the perceiving subject into a conceptual relation to objects in the world. Furthermore, visual perception is generally veridical, as I argued first in Chapter 2 where it was pointed out that we generally veridically recognize simple objects such as simple geometric diagrams. This justificatory role of visual perception, it was previously argued, is complemented by scientific judgements that objects in the world are normally “present” to visual perception in such a way that perception does not go wrong.

Another central component of my justificatory account draws on non-inferentialism. Specifically, beliefs and other attitudes do not inferentially determine visual perceptions, although attitudes can influence visual perceptions to a degree. Visual perceptions are, therefore, relatively autonomous from beliefs and other attitudes, neither dependent on, nor determined by, them. Taking perceiving to be dependent on beliefs would undermine any position which relies on visual perception to justify beliefs. It would put the justified cart before the justifying horse.
Because visual perception can be counted on as a source of justification of beliefs, it is appropriate to characterize it as a foundation for objective knowledge with the understanding that this foundation is not absolute, that is, not the type of foundation sought by traditional empiricists and rationalists. Additionally, this foundation is linked to, and overlaps, other non-absolute and non-privileged foundations (in particular, rational-mathematical-scientific forms of life) that complement and enhance visual perception's foundational role.

The foregoing comments serve to summarize the basic position on justification as developed so far. Below I examine John McDowell's position, expressed in *Mind and World* (1994a). Those familiar with this work will have noted an affinity on a few counts between it and my account. Reviewing McDowell's work with an eye to the similarities and differences between his account and mine serves to supplement and develop my account. Later I return to a question briefly touched on in the last chapter, the role of the retina in bringing a subject into a cognitive relation with the world. I answer McDowell's charge (1994b, p. 200) to the effect that transducers (by which term I assume he includes the retina) block off the environment from the nervous system. I also argue against McDowell's rejection of scientific accounts of perception as revealing of the constitutive nature of perception.
Section 5.1 McDowell's resolution of philosophical "anxiety"

McDowell's *Mind and World*\(^2\) has brought the issue of justification of beliefs to centre stage in contemporary philosophy. McDowell's aim is to resolve "a tension between two forces [in modern philosophy]" (p. xvi). These two forces (or "frames of mind" as he also calls them) are associated on the one hand with minimal empiricism and on the other hand with a coherentism arising out of Sellars's critique of empiricism. Sellars charged that empiricism relies on various types of what I have been calling non-conceptual givens which cannot play the justificatory role claimed for them by empiricism. Referring to the two forces or frames of mind, McDowell writes:

> [o]ne is the attractiveness of a minimal empiricism, which makes out that the very idea of thought's directedness at the empirical world is intelligible only in terms of answerability to the tribunal of experience, conceived in terms of the world impressing itself on perceiving subjects. The other is a frame of mind that makes it seem impossible that experience could be a tribunal. (p. xvi)

In short, minimal empiricism seeks justification of beliefs in non-conceptual givens; coherentism says this is impossible. These two philosophical positions are both untenable, yet modern philosophy of mind is characterized by an oscillation between them. He says:

> "[W]e are tempted to suppose we can reinstate friction between thought and the world by making out that justifications of empirical judgements stop at objects of pure ostension, uncontaminated by conceptualization. But when we think this alternative through, we realize that these supposed stopping points for justification cannot intelligibly serve as a subject's reasons for her judgements. Now we are tempted to recoil back into renouncing the need for friction. (McDowell, p. 66)

When we turn to a minimal empiricist approach to the justification of our beliefs, McDowell says, we realize that the non-conceptual givens posited by this approach do not provide the

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\(^2\) Hereinafter, references to McDowell are to his *Mind and World* (1994a), unless otherwise indicated.
needed justification for our beliefs. We turn then to coherentism and "stop trying to make out that empirical thinking is rationally constrained by experience" (p. 67). This will not do either, however, as McDowell immediately remarks: "I have been urging that this is intolerable: within this conception of the possibilities, there is no way to credit thought with friction against independent reality, but we must have that if we are to have empirical content in our picture at all" (p. 67-68). Whether or not it is true that philosophers intellectually "recoil" from one position to another, McDowell puts his finger on an important lacuna in contemporary philosophy and gives an argument (which I present immediately) to redress it. Until the publication of Mind and World, there did not seem to be any pressing motivation within contemporary philosophy to argue for perceptual justification of beliefs.\(^3\)

McDowell proposes that experience establishes a conceptual friction between thought and world which does not meet with Sellarsian objections regarding the myth of the given and which satisfies justificatory demands. (The term ‘friction’ is used in Mind and World in a range of places, including in the above quoted passage, to encapsulate the notion of a sufficient connection between “mind” and “world” to warrant beliefs about the world. We shall see later that McDowell’s notion of friction may not have anything to do with physical

\(^3\) John R. Searle, for example, contends:

Descartes together with the British empiricists and right up through the Positivists and the Behaviorists of the twentieth century have given us the impression that the question: "How do you know?" asks the fundamental question, the answer to which will explain the relation between us as conscious beings and the world. The idea is that somehow or other we are constantly in some epistemic stance toward the world whereby we are making inferences from evidence of various kinds. ... Against this tradition, I want to say that epistemology is of relatively little interest in philosophy and daily life. It has its own little corner of interest where we are concentrating on such things such as how to understand certain traditional skeptical arguments, but our basic relationships to reality are seldom matters of epistemology. (Searle 1994b, pp. 217-218)
states or events, despite what seems to be suggested by the term ‘friction’. McDowell puts his position in this way:

The position I am urging appeals to receptivity to ensure friction, like the Myth of the Given, but it is unlike the Myth of the Given in that it takes capacities of spontaneity to be in play all the way out to the ultimate grounds of empirical judgements. This is what enables us to reinstate friction without undermining the very idea of ultimate grounds, as the Myth of the Given does. (p. 67)

In other words, because perceptual experience is conceptual, it is the type of thing that can warrant beliefs. That McDowell thinks of perceptual experience as conceptual is confirmed by his remark: “we must not suppose that receptivity makes an even notionally separable contribution to its co-operation with spontaneity” (p. 51). (I take it that he uses ‘notionally’ synonymously with ‘conceptually’.) Since McDowell considers that “receptivity” produces perceptual experience⁵ and construes “spontaneity” as involving conceptual capacities,⁶ his

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⁴ McDowell puts this point in a number of different ways. He writes, for example:

When we trace justifications back, the last thing we come to is still a thinkable content; not something more ultimate than that, a bare pointing to a bit of the Given. But these final thinkable contents are put into place in operations of receptivity, and that means that when we appeal to them we register the required constraint on thinking from a reality external to it. (pp. 28-29)

⁵ McDowell writes: “Experiences are impressions made by the world on our senses, products of receptivity; but those impressions themselves already have conceptual content” (p. 46; my italics).

⁶ For McDowell, the term ‘spontaneity’ refers to conceptual capacities. McDowell says:

The original Kantian thought was that empirical knowledge results from a co-operation between receptivity and spontaneity. (Here “spontaneity” can be simply a label for the involvement of conceptual capacities.) (p. 9)
remark indicates that he is committed to the view that perceptual experience is conceptual. This is also the main message of his 1998 article.

By construing perception as conceptual, McDowell is able to offer an account of the justification of empirical thought that does not rely on “non-conceptual impacts” (as he puts it in the following quotation). For McDowell this reliance on “non-conceptual impacts” for justification constitutes the “idea of the Given”. In his words (repeating a quotation in n. 17, p. 115),

[the idea of the Given is the idea that the space of reasons, the space of justifications or warrants, extends more widely than the conceptual sphere. The extra extent of the space of reasons is supposed to allow it to incorporate non-conceptual impacts from outside the realm of thought. (McDowell, p. 7)]

Thus, he agrees with Sellars that the “idea of the Given” cannot provide justification for thought. By McDowell’s lights, my belief that there is a computer mouse to my right can be justified by my perception of the computer mouse because perception is conceptual and thereby is the type of thing that can justify a belief. By holding that perception is conceptual, McDowell avoids relying on non-conceptual givens as the source of justification, as traditional empiricism had done.8

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7 In other places, McDowell remarks:

“Conceptual capacities … can be operative not only in judgments … but already in the transactions in nature that are constituted by the world’s impacts on the receptive capacities of a suitable subject; that is, one who possesses the relevant concepts.” (p. xx)

[T]he conceptual contents that sit closest to the impact of external reality on one’s sensibility are not already, qua conceptual, some distance away from that impact. (p. 9)

This unqualified claim that the content of perceptual experience is conceptual will have been raising some eyebrows…. (p. 46)

8 Perceptual experience plays a foundational role by categorizing for a perceiving subject, according to McDowell.
In arguing that perceptual experience is conceptual McDowell opposes Evans (1982), Crane (1992) and others who hold that perception is non-conceptual. As pointed out in Chapter 1, Crane (1992, pp. 149 ff.) in line with Evans (1982, p. 123) argues that the Müller-Lyer illusion demonstrates that perception is non-conceptual (that perceptual experience has "non-conceptual content") because the illusion persists despite beliefs to the contrary. If perceptual experience were conceptual (had "conceptual content"), Crane argues, this illusion would be corrected by beliefs to the contrary. Crane concludes that perceptual experience must therefore be non-conceptual. While McDowell does not dispute that our perceptual experiences are beyond our control (McDowell, p. 11), he disagrees with the conclusion of Crane, Evans and others that perceptual experience is non-conceptual. Even though we cannot control perceptual experiences, they are still the type of thing about which judgements can be made. For this reason, McDowell argues, these experiences are conceptual.

McDowell might be claiming more than this, namely, that perceptual experience exerts a rational influence on thinking or has a rational bearing on thinking. For example, he remarks, "Because experience is passive, the involvement of conceptual capacities in experience does not by itself provide a good fit for the idea of a faculty of spontaneity"

Impressions can be cases of its perceptually appearing — being apparent — to a subject that things are thus and so. In receiving impressions, a subject can be open to the way things manifestly are. This yields a satisfying interpretation for the image of postures that are answerable to the world through being answerable to experience. (p. xx)

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9 He writes: "How one's experience represents things to be is not under one's control, but it is up to one whether one accepts the appearance or rejects it" (p. 11). Then in a footnote he argues: "The point here is well illustrated by familiar illusions. In the Müller-Lyer illusion, one's experience represents the two lines as being unequally long, but someone in the know will refrain from judging that that is how things are" (p. 11, n. 9).
(McDowell, pp. 10-11). (By McDowell’s lights, the conceptual capacities involved in spontaneity are rational capacities.) It is not a good fit, but still it fits, McDowell seems to be claiming. This impression is reinforced by his (already quoted) remark on the co-operation between receptivity and spontaneity: “we must not suppose that receptivity makes an even notionally separable contribution to its co-operation with spontaneity” (p. 51).

Granted, McDowell might not be committed to the notion of the rational nature of perception. His formulations are vague in this regard. If, indeed, he is claiming that visual perception is rational, he faces a problem similar to one faced by inferentialism. The perception of the Müller-Lyer diagram is not rational, just as it is not inferential, because it conflicts with a considered belief. In fact, as McDowell avers, we judge that our perception

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10 In this regard, McDowell follows Kant as commonly understood. McDowell writes: “When Kant describes the understanding as a faculty of spontaneity, that reflects his view of the relation between reason and freedom: rational necessitation is not just compatible with freedom but constitutive of it. In a slogan, the space of reasons is the realm of freedom” (p. 5).

11 In another passage in Mind and World, he holds that “we cannot simply insulate the passive involvement of conceptual capacities in experience from the potentially unnerving effects of the freedom implied by the idea of spontaneity” (p. 13). Here ‘simply insulate’ is ambiguous. On the one hand, in using it McDowell may wish to suggest that rational capacities are engaged in learning to perceptually experience certain objects. This is uncontroversial with respect to many perceptions that are learned. This does not entail, however, that rational capacities are constitutive of the experience itself. On the other hand, McDowell’s use of ‘simply insulate’ in the above passage might be intended to suggest that rational capacities are constitutive of perceptual experience. The phrase ‘draws into operation’ in the following expression is similarly ambiguous: “The view I am recommending is that even though experience is passive, it draws into operation capacities that genuinely belong to spontaneity” (p. 13). Using ‘draws into operation’ might suggest that the capacities of rationality are constitutive of experience; or it could mean that experience causes these capacities to be actualized, but not within experience. So use of both ‘simply insulate’ and ‘draws into operation’, in one reading in their respective contexts, suggests that rationality is constitutive of perceptual experience. Yet, under another reading the usage does not carry that sense.

12 Fodor (1998) seems to read McDowell as advocating the view that perception is rational. “McDowell has in mind a certain account of what the rationality of a perceptual judgement consists in, and that account isn’t satisfied if the world’s contribution is merely to provide the judgement with the right sort of etiology” (p. 5).
of the relative lengths of the horizontal lines in the diagram is illusory. A visual perceiving is better described as a type of forced or mandatory, non-rational (and non-inferential) categorizing.

A distinctive feature of McDowell's position is his contention that science has nothing to say about the conceptual nature of perception.

It would be dangerous to deny, from a philosophical armchair, that cognitive psychology is an intellectually respectable discipline, at least so long as it stays within its proper bounds. ... [I]t is a recipe for trouble if we blur the distinction between the respectable theoretical role that non-conceptual content has in cognitive psychology, on the one hand, and, on the other, the notion of content that belongs with the capacities exercised in active self-conscious thinking — as if the contentfulness of our thoughts and conscious experiences could be understood as a welling-up to the surface of some of the content that a good psychological theory would attribute to goings-on in our cognitive machinery. (p. 55)

What McDowell seems to be saying, here, is that science cannot tell us anything essential about the conceptual nature of perceptual experience. This stance extends to his opposition to what he calls "sideways-on" accounts,¹³ that is, scientific accounts of the perceptual apparatus that are used to justify beliefs. In the same vein he also opposes scientism¹⁴ and

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¹³ Regarding "sideways-on" accounts McDowell writes:

We find ourselves always already engaging with the world in conceptual activity within such a dynamic system. Any understanding of this condition that it makes sense to hope for must be from within the system. It cannot be a matter of picturing the system’s adjustments to the world from sideways on: that is, with the system circumscribed within a boundary, and the world outside it. This is exactly the shape our picture must not take. (p. 34)

¹⁴ Regarding scientism and "a sideways-on picture", McDowell has this to say:

[A] sideways-on picture of understanding and the world [is] a picture that places reality outside a boundary enclosing the conceptual. A scientistic naturalism encourages a version of that picture, in which what is outside the boundary is the realm of law. And if conceiving reality as the realm of law leaves it disenchanted, what is outside the boundary can contain no demands of reason or the like. (p. 82)
what he calls "bald naturalism".\textsuperscript{15} McDowell's essential thought seems to be this: Scientific accounts of the perceptual apparatus can neither help us understand the conceptual nature of perception, nor help us justify our beliefs because these accounts trade only in non-conceptual content. (Later, I examine another paper by McDowell which explains his opposition to scientific accounts in the study of the essential nature of perception.)

While McDowell's position in this regard is apposite in one respect, it is too extreme. It is apposite because, on pain of infinite regress, a subject needs to rely on his/her conceptual perception at least in part to justify beliefs. However, McDowell's position is too extreme. It seems evident that cognitive science accounts offer reasons for accepting (or rejecting) the deliverances of perception. Previously, we saw a way in which scientific insights can be brought to bear on answering why it is that the perception of certain types of objects, such as simple geometric diagrams in good lighting conditions, is generally veridical. The template-matching model highlights a basic principle: visual perception is tied to stimulus configurations in a way that engenders veridical perception for the most part. (It was argued in the previous chapter that template matching engenders veridical perception because it works with the inherent shape of distal objects.) This principle coheres with the argument back in Chapter 2, where it was observed that simply shaped objects such as simple diagrams lend themselves to veridical perception. This principle (visual perception is significantly tied

\textsuperscript{15} McDowell takes aim at "bald naturalism":

The modern scientific revolution made possible a newly clear conception of the distinctive kind of intelligibility that the natural sciences allow us to find in things.... We must sharply distinguish natural-scientific intelligibility from the kind of intelligibility something acquires when we situate it in the logical space of reasons. That is a way of affirming the dichotomy of logical spaces, as bald naturalism refuses to. (p. xix)
to stimulus configurations) can be extended to account for some types of non-veridical perception. The significant dependence of visual perception on stimulus configurations helps us understand non-veridical perception, as when I mistakenly visually perceive the far-distant CN Tower as a television antenna on the roof of a nearby apartment building. Similarity of stimulus configurations significantly contributes to this misperception.

McDowell proposes that all conceptual capacities, including those engaged in perception, are secured through the acquisition of a second nature. A second nature is acquired through a proper upbringing in which we are initiated into the "logical space of reasons", that is, into rational discourse. Acquiring a second nature primarily and necessarily involves acquiring a natural language. According to McDowell, we humans do, but animals do not, have the capacity for conceptual perception because developing a second nature is a prerequisite for concept possession. That is, it is only through initiation into a rational culture that concepts are acquired. Because chimpanzees and other non-human animals do

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16 McDowell writes:

Human beings acquire a second nature in part by being initiated into conceptual capacities, whose interrelations belong in the logical space of reasons.

Once we remember second nature, we see that operations of nature can include circumstances whose descriptions place them in the logical space of reasons, *sui generis* though that logical space is. This makes it possible to accommodate impressions in nature without posing a threat to empiricism. From the thesis that receiving an impression is a transaction in nature, there is now no good inference to the conclusion drawn by Sellars and Davidson, that the idea of receiving an impression must be foreign to the logical space in which concepts such as that of answerability function. Conceptual capacities, whose interrelations belong to the *sui generis* logical space of reasons, can be operative not only in judgements — results of a subject’s actively making up her mind about something — but already in the transactions in nature that are constituted by the world’s impacts on the receptive capacities of a suitable subject; that is, one who possesses the relevant concepts. (p. xx)
not undergo this initiation, they do not acquire concepts. In particular, they have no concepts that can be applied within visual experience.

The picture McDowell draws of the way in which concepts are acquired presents a problem for his justificatory account, a problem of the sort that he sought to avoid in *Mind and World*. If concept application is solely due to the acquisition of a second nature, it becomes problematic how coherentism can be avoided. Concepts applied in perception and in other cognitive capacities could be systematically wrong. That is to say, it could be that we are systematically mis-educated. Our concepts could have a rational bearing on each other but could fail to bring us into an objective relation with the world. Though some philosophers contend that coherentism is the best we can hope for by way of solving the problem of objective reference, McDowell does not count himself among them. He opposes coherentism. (See, e.g., pp. 14 ff.)

McDowell appeals to the notion of the *passivity* of perception to avoid coherentism. However, perception cannot be passive in a way suited to avoid coherentism unless it is relatively independent from language and from enculturation in general. Perception cannot provide independent justification for beliefs if its justificatory resources are derived solely from enculturation. The source of independence of perception, I claim, is *conceptual* processes in the visual neuronal system which are able to induce generally veridical perceptions because these processes are by and large tied to stimulus configurations. Advocating these processes as a source of the independence of visual perception is not open for McDowell because, on his showing, these processes are non-conceptual. On my showing, in contrast, conceptual neuronal processes induce visual object recognition based on the
shape of objects. The character of these processes indicates that visual perception is conceptual and passive. Perception can thus play a justificatory role relatively independently of enculturation.

Lastly, given McDowell’s view that conceptual capacities arise only with the acquisition of language, it becomes a mystery how a human language is learned, both how humans first develop a natural language and how pre-linguistic infants come to learn (auditorily, visually, or tactually) natural languages. In order to learn the meaning of a word, a capacity to perceive a word as a word must be in place. If McDowell’s view holds, this capacity must depend on the previous acquisition of language. It thus becomes a mystery how language acquisition ever gets started. Recognizing a word as a word prior to language acquisition presents no problem if conceptual perceptual capacities are not tied to the acquisition of a language.  

As mentioned and discussed above, McDowell contends that cognitive science accounts of perception fail to address the conceptual nature of perception and therefore these accounts cannot be used to justify beliefs. Because this stance is at the heart of McDowell’s thinking, it is worthwhile pursuing his argument further and responding to it more thoroughly. It is useful to look at another work of McDowell, “The Content of Perceptual

17 A number of problems with McDowell’s theory of second nature have been pointed out by some philosophers. One is that, by his theory, pre-linguistic infants and all non-human animals are excluded from using concepts. Putnam (1994a, p. 493, n. 17) raises this problem. Another pertains to how second nature is historically or evolutionarily acquired. Paul M. Pietroski remarks: “[W]e are offered the intriguing idea that humans acquire a second nature in virtue of which they cease to be mere animals. But we are offered no real account of how this takes place” (1996, p. 636).
Experience" (1994b, esp. pp. 196 ff.), to grasp fully his position on cognitive science accounts. McDowell writes:

A sub-personal\(^{18}\) \ldots informational system is a physical mechanism, connected to its surrounding by transducers that convert physical impacts from outside into events of the sort that the system can work on, and perhaps by transducers that convert the system’s end-products into physical interventions in the exterior. This system knows nothing even about the character of the immediate physical impacts on the input transducers, or the immediate physical interventions in the exterior that result from its operations by way of the output transducers, let alone about the nature and layout of the distal environment. The operations of the system are determined by structures exemplified in the initial contributions of the transducers, and in intermediate events and states in the system, which have no meaning for the system. In short, in Dennett’s own memorable and exactly right phrase, the system is a syntactic engine, not a semantic engine. The same goes for its parts. (1994b, p. 198)

In contrast, we are not “in the predicament of our nervous systems, blocked off from the environment by transducers rather than inhabiting it” (McDowell 1994b, p. 200). (I later address McDowell’s position regarding transducers with respect to the nature of the retina.) Furthermore “access to our interiors cannot be what constitutes our dealings with content, since there is no content in there, although it is enormously useful to talk as if there were” (McDowell 1994b, p. 200). McDowell further remarks:

The truth is that our brains are indeed brains in vats, and that is exactly why we must not identify ourselves with them. To a brain it is all one whether its vat is glass or bone, and what, if anything, is outside its input and output transducers. To repeat, a brain knows nothing and understands nothing: all it does is to manipulate structures that have no meaning for it. That is not the truth about us. (1994b, p. 201)

Although McDowell acknowledges “the enormous power of cognitive science to enable us to explain our mindedness” (1994b, p. 201), this does not mean that cognitive science can give a “constitutive explanation” of mindedness (1994b, p. 201). So McDowell appears to

\(^{18}\) McDowell also writes of a “‘sub-personal’ information system” of nonhuman animals (1994b, p. 195).
be claiming that cognitive science cannot account for what mindedness essentially is. Cognitive science provides only "as-if" explanations (1994b, pp. 199-201). Brain-level accounts have no place in discourse about the constitutive nature of mindedness.

McDowell's outright opposition to scientific accounts (as constitutive explanations of perception) raises a question directly related to his justificatory account. How can friction between a perceiving subject and the world be explained? It would seem that McDowell cannot appeal to physical goings-on in the nervous system of any sort. Because these goings-on would not address the constitutive nature of perception, they would miss what is essential about perception's role in justification (that is, its provision of reasons). McDowell would likely respond that he is not seeking an account of friction between thinking and physical processes and entities, but rather an account of friction between thought and the world as conceptualized, following the principle that the world we encounter is always one to which our concepts are applied (1994a, pp. 24 ff.). This seems to be what McDowell has in mind in the following:

The impressions on our senses that keep the dynamic system in motion are already equipped with conceptual content. The facts that are made manifest to us in those impressions, or at least seem to be, are not beyond an outer boundary that encloses the conceptual sphere, and the impingements of the world on our sensibility are not inward crossings of such a boundary. (1994a, p. 34)19

There seems to be a fairly straightforward response to McDowell, if indeed he is claiming that friction is derived from already conceptualized impingements. There are physical

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19 Impingements are not already conceptual, as McDowell claims. For one thing, it normally takes in the range of 1/20 second to visually recognize an object after it comes into view. Non-conceptual impingement temporally precedes the application of concepts in visual object recognition. Additionally, some impingements are not conceptualized at all. If an image is flashed at a perceiver in less that 1/1000 second, probably it is not conceptualized at all.
impingements, such as photons entering the eye, which establish a physical link between a distal object and a perceiving subject. It would seem that this link should figure in any assessment of the connection (friction) between mind and world. McDowell’s rejection of all attempts on the part of cognitive science to justify beliefs blocks any account of passive engagement of conceptual perception based on physical links and processes. The term ‘friction’, then, as employed by McDowell, seems to have a specialized meaning somewhat distant from its ordinary meaning. For McDowell, the notion of friction seems not to entail any sort of physical connection between the world and a perceiving subject. Instead, it entails a relation between a subject and the world as conceptualized.20 By rejecting neurological accounts as a source of justification of belief, McDowell is barred from helping himself to the rich storehouse of scientific knowledge about perception which gives us confidence that our perceptual beliefs stand on generally secure grounds of perception. Vision science confirms, for example, that our visual perception of shape is generally veridical by showing that perception of shape is tied to the shape of objects by neuronal processes which preserve shape information. (This was pointed out in the previous chapter.)

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20 This stance naturally raises the question of whether McDowell is offering an idealist solution to the justificatory problem. McDowell comments on this issue in Mind and World and in a later paper (McDowell, 1998). In this paper, he denies holding the view according to which the so-called objects can only be projections of our thinking. Objects come into view for us in actualizations of conceptual capacities in sensory consciousness, and Kant perfectly naturally connects sensibility with receptivity. If we hold firm to that, we can see that the presence of conceptual capacities in the picture does not imply “idealism,” in the sense in which Sellars means invoking “idealism” to frighten us. If we conceive subjects as receptive with respect to objects, then, whatever else we suppose to be true of such subjects, it cannot undermine our entitlement to the thought that the objects stand over against them, independently there for them. (1998, p. 470)

I preserve the reference to Sellars in quoting McDowell in order to retain the flow of his point. I do not comment on Sellars’s view as contained in his Science and Metaphysics (1968).
In brief summary, in *Mind and World* McDowell argues that

A. visual experience is conceptual and that, because it is conceptual, it can justify our beliefs;

B. cognitive science accounts cannot establish the justification of beliefs; and

C. conceptual perception arises only with acquiring a second nature which primarily and necessarily includes learning a language.

I have also pointed out the negative consequences of holding that perception is rational. (McDowell's view, as noted, is ambiguous on this score.) Though, by construing perception as conceptual, McDowell does not fall prey to the type of criticism levelled by Sellars against traditional empiricism, McDowell's account of perception does not lend itself to a justificatory position in which physical linkages and processes count. 21 McDowell relies on claiming that perception receives its capacity to justify beliefs by virtue of the subject's integration into a rational culture through a proper upbringing. This exclusive reliance on acquiring a second nature prevents the resolution of the philosophical "anxiety", which McDowell is wont to talk about. McDowell is in danger of providing another account in which our thinking seems to "spin in a void" because our perceptions seem to be detached from the physical entities and processes which play a decisive role in inducing conceptual perception.

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21 In a later paper, McDowell (1998, pp. 443-444) appears to have relaxed his opposition to "sideways-on" accounts somewhat. (See my n. 3, p. 98.)
Section 5.2 Transducers and the retina

To answer McDowell's somewhat peculiar contention regarding transducers, consider the case of the retina. It is commonly thought to be a transducer or at least part of a transducer. Does the retina in some way block off the nervous system from the environment, as McDowell contends? (I explain later why McDowell's contention is peculiar.) This issue is of no small consequence for the development and defence of my position, for in the previous chapter I argued that there are some components of the visual neuronal system that enable object recognition. If these components are blocked off from the environment, the claim that these components enable visual object recognition would be undermined.

We have already encountered one way in which the retina can reasonably be construed as connecting the environment to the nervous system, including those parts of nervous system engaged in conceptual processing (parts hereafter referred to as mind-brain). Edge detection on the retina, it was argued in the previous chapter, opens up the environment for mind-brain by beginning the process of visual object recognition.

This assessment is consistent with neurological findings which suggest that the retina is part of the brain. Neurology has discovered that the retina is not a mere sheet of light-sensitive transducers, each pulsating signals to higher centres. Instead, many types of cells — rod and cone, bipolar, horizontal, interplexiform, amacrine — form a complex laminated structure with millions of forward, backward, and sideways connections. This laminated structure is similar to the neo-cortex and other areas of the brain. In Retina: an approachable part of the brain John E. Dowling (1987) contends that the retina is part of the brain. Hubel writes:
The retina is part of the brain, having been sequestered from it early in development but having kept its connections with the brain proper through a bundle of fibres — the optic nerve. Like many other structures in the central nervous system, the retina has the shape of a plate, in this case one about a quarter millimetre thick. It consists of three layers of nerve-cell bodies separated by two layers containing synapses made by the axons and dendrites of these cells. (Hubel 1988, p. 36)

D. N. Spinelli highlights the difference between retinated eyes of vertebrates and most light-sensitive devices in invertebrates:

Eyes of almost any conceivable type and complexity, signposting evolutionary experiments, exist among invertebrates. But a curious phenomenon about the vertebrate eye is this: ‘Within the vertebrate phylum, the eye shows no progress of increasing differentiation and perfection as seen in the brain, the ear, the heart and most other organs. In its essentials, the eye of a fish is as complex as that of a bird or a man .... The vertebrate phylum is of enormous antiquity and stems from the primitive Agnatha which are 400 million years old, their descendants have become the lords of the earth.... In the extant representatives of this primitive stock, the lampreys, the eyes emerge as fully differentiated organs’ ([S.] Duke-Elder, 1958).

To be sure, there are minor variations between members of the series. They represent adaptation to habitats rather than expressions of phylogenetic evolution. But in each vertebrate there is a three-layered retina, pigment epithelium, the same dioptic apparatus. And, most important, the eyes of vertebrates arise from the neural ectoderm rather than from the surface ectoderm. Because of its origin, the vertebrate eye has been called ‘the cerebral eye’. (Spinelli 1987, p. 166)

The scientific findings indicated by Dowling, Hubel, Duke-Elder, and Spinelli show that the retina is part of the brain in terms of structure, ontogeny, and phylogeny. The findings are consistent with the contention that those neuronal connections on the retina responsible for edge detection are part of mind-brain.

Earlier, I wrote of McDowell’s peculiar notion that the nervous system is blocked off from the environment by transducers. His notion is peculiar because if transducers as they are typically construed are properly doing their job, they should not block the possibility of the mind-brain getting in contact with the environment. Consider Fodor’s remark that “transducer outputs are most naturally interpreted as specifying the distribution of
stimulations at the 'surfaces' (as it were) of the organism” (Fodor 1983, p. 42). (Presumably, in his caveat, Fodor is trying to accommodate the fact that the retina is not on the surface of the body.) If indeed a transducer functions in this way, there appears to be no grounds for supposing that it blocks the environment from mind-brain provided that the input to the transducer is not rigged in a way that the mind-brain is systematically tricked (which is possible). The success of artificial transducers such as hearing aids is testimony to the soundness of the idea that transducers deliver information from the world to mind/brain. Even though the idea of a transducer is sound, we should still ask if there are any pure transducers in visual perception. I contend there are not because conceptual processing begins at the retina, as already argued (p. 125).

McDowell’s denial of what transducers really are suggests that in reacting to scientism, “bald naturalism”, and the like, he has turned reality on its head. It was necessary for me (as I remarked briefly earlier) to reply to McDowell’s notion that transducers block the environment from the brain. If he is right, all attempts, including mine, to appeal to the neurology of visual perception to justify beliefs would be misguided. In particular, my claim that conceptual processing in the visual neuronal system induces object recognition would fail, for such processes would not have access to information necessary to do their work.
Chapter 6

What can go wrong in foundational accounts when perception is ignored

Section 6.1 Introduction

My justificatory account to this point can be encapsulated as follows. Visual perception is a relatively independent, non-absolute foundation for objective knowledge, a foundation which is linked to, and partially overlaps, other such foundations, each of which complements the others. Visual perception is a foundation because it is conceptual and generally veridical; it is a non-absolute foundation because visual perceptions are sometimes non-veridical; and it is an independent foundation because perceptions are not inferentially derived from attitudes or assimilated to them. It is a relatively independent foundation because to a degree it is non-inferentially influenced by attitudes including beliefs. Of particular concern for this work is the link between the foundation of visual perception and the foundations of rational, scientific, and mathematical forms of life. The learning of one or more natural languages is a feature of rational-scientific-mathematical forms of life. Acquiring a natural language allows a subject to weigh evidence and engage in other rational endeavours that serve to judge the soundness of propositions. In a scientific or mathematical field a specialized language is required to understand and to judge the propositions in that field’s domain. Natural and specialized languages are thus central to the foundations of rational-scientific-mathematical forms of life. Under my construal, rational-scientific-mathematical forms of life develop in the context of perception, including visual perception, which constrains belief formation and in doing so constrains the development of rational-
scientific-mathematical forms of life. Rational-scientific-mathematical forms of life can influence perception to a degree; for example, beliefs learned in schooling can non-inferentially influence perceptions to a degree. So rational-scientific-mathematical forms of life and visual perception are, I say, linked, overlapping foundations for objective human knowledge.

With these preliminaries we turn to the social constructivist current of thought within educational theory. As the term ‘social constructivist’ partially suggests, social constructivism maintains that all or most knowledge arises from and receives its warrant from social, often institutionalized, practices and activities. This social underpinning of knowledge, in the eyes of many social constructivists, entails that important areas of knowledge are significantly insecure, so to speak, because new social relations can arise that remove the warrant from even seemingly secure knowledge. Social constructivists in education, for example, have studied how the notions of race and gender arise in a social setting. (This analysis leads to attempts to formulate policies to eradicate stereotyping in education, “empower” students, and so on.) A common thread in social constructivist theory seems to be the rejection of the epistemologies of rationalism and empiricism. Probably little else can be reasonably asserted about common tenets of social constructivist theories in education (beyond what I have already stated) because the theorizing and research that in one way or another is considered to be within the purview of social constructivism is highly diverse.¹ Nonetheless, the common tenets of the diverse social constructivist theories are

¹ Sally Haslanger observes:
[T]here is striking diversity in how the term “social construction” (and its cognates) is used, and consequently diversity in what revisions to the old models are proposed. In addition to
widely accepted in educational theory and significantly influence a great deal of research and theorizing in education studies.

Social constructivism is a very influential current of thought in theory and practice of science and mathematics education. In my study, only one of the considerable array of social constructivist positions is considered, that of Paul Ernest who concentrates his work on mathematics and mathematics education. Another current of opinion which exerts considerable influence in mathematics and science education is (so-called) constructivism which generally looks to Piaget for guidance and stresses subjective dimensions of knowledge, unlike social constructivism which generally looks to Vygotsky for guidance and stresses the social character of knowledge. (Sometimes, confusingly, social constructivism and constructivism are subsumed under the term ‘constructivism’.) An extremely relativistic version of constructivism is set down by Ernst von Glasersfeld in his theory of “radical constructivism”. There is no attempt to extend the following critique of Ernest’s work to constructivism.

Within mathematics education Ernest’s theory exerts a considerable influence. Ernest is concerned with developing a philosophy of mathematics which addresses foundational issues in the philosophy of mathematics, pedagogical questions in mathematics education, and the claims that race, gender, and sexuality are socially constructed, it is also claimed, for example, that the “subject,” “identity,” “knowledge,” “truth,” “nature,” and “reality” are each socially constructed. On occasion it is possible to find the claim that “everything” is socially constructed, or that it is socially constructed “all the way down.” (1996, p. 84)

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3 According to Michael Matthews (1999), Ernest is “a major proponent of social constructivism in mathematics education”.
education, the social setting of mathematics practices and activities, ethical questions in mathematics and in mathematics education, and other issues. I concentrate on his extreme social relativism regarding mathematics knowledge, a relativism motivated by tenets he shares in a large part with most social constructivists. Concentrating on this aspect of his theory does not detract from addressing his essential position because this aspect forms the heart of his theory. Addressing this aspect of his work is directly philosophically relevant to the broad questions of whether mathematical knowledge taught to students is fallible, whether its truth (if we can speak of truth when considering knowledge as construed by extreme relativism) completely depends on historically shifting social practices and activities, or whether mathematical knowledge has some other status.

Concentrating on Ernest’s view does not unduly limit my discussion to mathematics education theory as opposed to educational theory as a whole, because Ernest works from commonly accepted tenets of social constructivism. In particular, Ernest’s positions are closely aligned with prominent social constructivist theories in science education.4

We have already gone through, in Chapter 2, the reason why diagrams can be used in geometric reasoning: perceiving a geometric diagram is a surrogate for conscious, conceptual awareness of the abstract geometric object depicted in the diagram. The foundational role of visual perception entails that students learning geometry have a way to assess geometric propositions separate and apart from what a teacher or textbook says. Visual perception plays a similar foundational role in those aspects of scientific knowledge and

4 See, for example, Helga Kragh (1998).
other types of knowledge which depend on diagrammatic reasoning (as was commented on in Chapter 2).

The main problem as I see it in Ernest's theory (and we get to a closer examination of it shortly) is strict social foundationalism, the contention that objective knowledge relies only on forms of life and that these forms of life are not constrained by perceptual modalities. I have no quarrel with forms of life acting as foundations for objective human knowledge with the proviso that these forms of life are importantly constrained by perception and that perception, as well, plays a relatively independent foundational role. My quarrel is with strict social foundationalism in which perception plays no foundational role, a stance which leads to the type of relativism advocated by Ernest and others. I argue hereafter that Ernest's relativism is not justified with regard to simple geometric objects and propositions about these objects. Even though I do not make a general case that perception provides a warrant for all mathematical knowledge, I show that Ernst's theory does not have general applicability.

Putting a dent in Ernest's position is far from developing a general alternative position with regard to the role of perception in justifying mathematical knowledge as a whole, a project, if it is worth undertaking and not ill-considered, which is far beyond the scope of this work and which would likely need to address the philosophy-of-mathematics literature far more extensively than is done here. In any case, Ernest's work likely pertains to education theory and philosophy more than it does to contemporary philosophy of mathematics (where his work has not made an impact even though he addresses philosophy-of-mathematics issues). In the arena of theory and philosophy of mathematics education,
Ernest’s position appears as a natural extension of currently influential social constructivist approaches insofar as he develops the common theoretical tenets of social constructivism (mentioned above), and subscribes to pedagogical tenets of social constructivism, such as “empowering” students, promoting collective engagement in learning endeavours, and so on. I have no particular quarrel with much of the theoretical and practical work taking place in the name of social constructivism, including in mathematics pedagogy. Rather my concern is that judging from the positive reception from within educational theory to Ernest’s social constructivism, many education theorists at least tacitly embrace strict social foundationalism as Ernest does. Replying to Ernest, then, serves the general purpose of addressing social constructivism in education theory as a whole insofar as its various adherents downplay, or perhaps do not consider, an independent foundational role for perception.

Section 6.2 Ernest’s social constructivism

Ernest summarizes his position toward the end of his 1998 book:

Social constructivism takes the primary reality to be persons in conversation, persons engaged in language games embedded in forms of life. These basic social situations have a history, a tradition, which must precede any mathematizing or philosophizing. We are not free-floating, ideal cognizing subjects but fleshy [sic] persons whose minds and knowing have developed through our bodily and social experiences. Only through our antecedent social gifts can we converse and philosophize. I have argued for epistemological fallibilism and relativism, but instead of rendering social constructivism groundless and rootless, I have found its grounds and roots in the practices and traditions of persons in conversation. (1998, p. 275)

In the last sentence, we find Ernest’s brand of social constructivism is consistent with strict social foundationalism (as described above). (He often, as above, uses ‘language games embedded in forms of life’ and similar phrases drawn from Wittgenstein’s work. His intent
is simply and rightly to emphasize that mathematical activities and practices, the mathematical forms of life, are largely characterized by a specialized language and mode of argumentation into which students of mathematics are initiated through a course of training and testing.5) The only hint that Ernest looks to perception as a source of objective knowledge is his reference to "bodily...experiences". There is no discussion of bodily experiences in the book relevant to foundational issues, just as there is no discussion of perception in this regard. Indeed, there is no discussion of visual perception at all.

In the above quotation, Ernest remarks: "I have argued for epistemological fallibilism and relativism". It is often unclear what he means in his writings by 'epistemological fallibilism and relativism'. Instead of getting into various niceties of these terms, especially regarding their use in philosophy of mathematics, and further instead of commenting on Ernest's confusing usage of these terms (a task which is competently taken care of by Frederick William Kroon 1994 in relation to an earlier work of Ernest 1991), I quote another passage from Ernest's recent book which expresses his relativism sufficiently clearly for present purposes.

I have argued that in the social construction of mathematics we act as gods in bringing the world of mathematics into existence. Thus mathematics can be

5 Ernest appeals to Wittgenstein to a considerable extent. I do not comment on this except to note that it is not clear that Wittgenstein advocates a mathematical conventionalism "all the way down", as Ernest seems to do (pp. 66 ff.). For example, in a passage not mentioned by Ernest, Wittgenstein remarks:

This is how our children learn sums; for one makes them put down three beans and then another three beans and then count what is there. If the result at one time were 5, at another 7 (say because, as we should now say, one sometimes got added, and one sometimes vanished of itself), then the first thing we said would be that beans were no good for teaching sums. But if the same thing happened with sticks, fingers, lines and most other things, that would be the end of all sums. (Wittgenstein 1956, remark 37, quoted from Benacerraf and Putnam 1964, p. 425)
understood to be about power, compulsion, and regulation. The mathematician is omnipotent in the virtual reality of mathematics, although subject to the laws of the discipline .... (1998, p.276)\textsuperscript{6}

Ernest holds that mathematicians "act as gods" in creating mathematics and the "mathematician is omnipotent in the virtual reality of mathematics". This is to say (it would seem) that mathematical knowledge is strictly relative to the will and power of mathematicians who are subject only to "the laws of the discipline". It is, therefore, fair to say, without getting into finer characterizations (which are not necessary for the present purposes), that Ernest is an \textit{extreme social relativist} regarding mathematical knowledge, a stance which arises, in large part, from his strict social foundationalism. (Though strict social foundationalism is amenable to extreme social relativism, strict social foundationalism is consistent with realism; that is to say, it is not contradictory to argue that "language games embedded in forms of life" are sufficient to attain truths that are independent of mathematicians and mathematical communities.) It is not a big step from extreme social relativism to the thought that mathematical knowledge is essentially insecure.\textsuperscript{7} It only needs to be argued, as Ernest does, that differences in forms of life have the potential to render mathematical knowledge insecure; even the significance and meaning of mathematical

\textsuperscript{6} Ernest remarks: "... [W]e shall adopt a necessary condition for objectivity, social acceptance, to be its sufficient condition as well" (1991, p. 45).

\textsuperscript{7} Ernest seems to be a relativist in two senses. He seems to be an epistemological relativist because, for him, what we take to be mathematical truth depends on historical shifts in forms of life. And he seems to be an ontological relativist because, in his philosophy, there is no fact of the matter about mathematical truth; mathematical truth is created by omnipotent mathematicians. (In his review of Ernest’s 1991 book, Kroon argues [1994, p. 80] that Ernest is both an ontological and an epistemological relativist.)
statements can fundamentally change. This conclusion may seem reasonable enough if forms of life are construed as the only foundations. Ernest’s picture of basically insecure knowledge does not hold up, though, if it is allowed that perception acts as an independent foundation. I am not going to try here to show that perception is a foundation for all mathematical knowledge. Rather, I challenge Ernest’s view only in the field of geometry.

Already in Chapter 2, a foundational role for visual perception was mapped out with regard to knowledge of geometry. Visual perception, it was argued, contributes to the justification of the Pythagorean theorem, and other propositions from geometry, by supplying conscious, conceptual, generally veridical shape information. Visual perception makes this contribution, it was argued, as a relatively independent, non-absolute foundation linked with the foundations of mathematical forms of life. My perceptual foundational account avoids the insecurity about mathematical knowledge found in Ernest’s social constructivism and helps explain why much of geometric knowledge is secure. After all, millennia have passed and the Pythagorean theorem is still going strong.

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8 Ernest is sympathetic to the view that “mathematical knowledge items (utterances or texts) differ in significance and meaning according to the context, that is, according to the language games and forms of life of which they are a part” (1998, p. 227). The remarkable stability of mathematical knowledge stands against Ernest’s view. He attempts to explain this stability as follows: “The novelty of social constructivism … is to realize both that mathematical knowledge is necessary, stable, and autonomous but that this coexists with its contingent, fallible, and historically shifting character” (1998, p. 259). It is difficult to comprehend how mathematical knowledge can be autonomous if mathematicians “act as gods” in creating mathematics and the “mathematician is omnipotent in the virtual reality of mathematics”. How mathematical knowledge can be both necessary and contingent is also quite puzzling. Equally puzzling is the contention that mathematical knowledge is autonomous yet has a historically shifting character.
Section 6.3 Perception and mathematical objects

So far I have not directly addressed how Ernest handles the problem of accounting for mathematical objects. Not surprisingly Ernest remarks: "[t]he social constructivist approach to this problem is that the objects of mathematics are among the social constructs of mathematical discourse" (1998, p. 193). Perhaps on first impression this position seems plausible, perhaps even a trump card for strict social foundationalism, because mathematical objects such as numbers, mathematical groups, perfect or ideal geometric objects, and so on, are abstract. (In this respect, Ernest’s argument regarding mathematics has a dimension not found in similar arguments regarding science, although in other respects the discussions largely overlap.) In particular, it might seem that mathematical forms of life, which engender mathematical language, provide the only foundation for our knowledge of these objects. I argue (hereafter) that visual perception plays a foundational role in our knowledge of many abstract geometric objects, a role which seems to block extreme relativism even though we cannot perceive abstract geometric objects. This knowledge is of a more basic kind than addressed previously in Chapter 2. There I discussed the role of visual perception as a foundation of our knowledge of the Pythagorean theorem and other geometric propositions. Here I am concerned with our understanding of squares, circles, and other simple geometric objects.

9 Further on he remarks: “Mathematical signifiers and signifieds are mutually interacting and constituting, so the discourse of mathematics which seems to name objects outside of itself is in fact the agent of their creation, maintenance, and elaboration, through its use” (1998, p. 193).
To begin, though, I first take a brief look at a likely response to Ernest's social constructivism from the mathematical Platonist point of view in which mathematical objects have the status of real things, separate and apart from our cognizing them. Most mathematicians who are philosophically minded subscribe to mathematical Platonism. The metaphysical outlook of mathematical Platonism is complemented by an epistemological stance which contends that mathematical intuition is used to gain knowledge of abstract mathematical objects.¹⁰ (In this study, I remain neutral on the epistemological and metaphysical issues posed by mathematical Platonism.) Gödel, one of the most prominent mathematicians of this century, famously contended that

... despite their remoteness from sense experience, we do have something like a perception also of the objects of set theory, as is seen from the fact that the axioms forces themselves upon us as being true. I don't see any reason why we should have any less confidence in this kind of perception, i.e., in mathematical intuition, than in sense perception.... (pp. 483-484)

Mathematical Platonism in general would take a considerable distance from Ernest's extreme social relativism regarding mathematical objects because for mathematical Platonists mathematical objects are independently real. Another evident difference between Ernest's theory and mathematical Platonism concerns the mode of cognitive access to mathematical objects. For Ernest, the only mode of access is discourse in a mathematical language.

¹⁰ Ernest charges that

[i]f access [to mathematical objects] is through intuition, then a reconciliation is needed between the facts that (1) different mathematicians' intuitions vary, in keeping with the subjectivity of intuition, and (2) Platonist intuition must be objective, or intersubjective at least, and lead to agreement. (p. 62)

Ernest seems to be assuming, without argument, that intuition of mathematical objects is necessarily merely subjective. This is far from a settled question. Gödel, Parsons (1980) and others argue that mathematical intuition is objective. Mathematical intuition is often metaphorically likened to perception of an object, such as a mountain, perception that is objective and generally veridical. See Gödel (1947, p. 484) and Parsons (1980, p. 151).
Mathematical Platonists on the other hand think of our cognitive access to abstract mathematical objects as analogous to perception (or even as a type of perception) and do not grant language the same elevated status as Ernest does. These differences between Ernest’s view and mathematical Platonism entail a difference in the level of confidence in our knowledge of mathematical objects. Ernest’s view would have our knowledge of mathematical objects vary with social setting, whereas a mathematical Platonist view, shared by most mathematicians, regards the security of our knowledge of mathematical objects as being at par with our confidence in perception of ordinary objects. This confidence is typically quite high for mathematical Platonists who, like Gödel, employ the perception metaphor. All in all, the social-linguistic relativism of Ernest stands in sharp contrast to the intuitionist realism of Platonism.

To see how visual perception plays a role in our basic understanding of abstract geometric objects and provides a foundation for knowledge of these objects, consider visual perceiving of concrete geometric objects, including concrete diagrams. In particular, consider a diagram of a circle such as this: \( \circ \). In this work, I have argued that visual perception of this and other concrete geometric objects (and a host of other concrete objects) is conceptual and generally veridical; because visual perception is both conceptual and generally veridical, it (I have also argued) provides a foundation for our beliefs, including beliefs about diagrams of simple geometric objects. This contention is not sufficient to answer Ernest, however, because the objects at issue, such as the diagram of a circle, are not abstract objects. Nonetheless, visual perception can be, and typically is, used, in conjunction with other cognitive abilities, to arrive at the concept of an abstract geometric object such as
a perfect circle. This occurs when a student, as part of learning what, for example, a perfect circle is, is asked to draw a series of circles of increasing accuracy. It is then suggested to the student that a perfect circle is or would be the outcome of a unending series of ever-more precise refinements of a concrete circle.\textsuperscript{11} Considerably more than the capacity of visual perception is involved in this way of coming to know a perfect circle. Language is certainly involved and probably mental imagery and imagination. Nonetheless, visual perception plays a key role, for this way of acquiring a concept of a perfect circle presupposes perception of a concrete circle. (There might be ways of acquiring the concept of a perfect circle without using perception. If so, and it seems unlikely, this would still not detract from the role of perception in the way of acquiring this concept.)

This description of a way of acquiring the concept of a perfect circle helps reveal a foundational role of visual perception in knowledge of a perfect circle. When we think of a

\begin{flushright}
\textsuperscript{11} Bernard Lonergan remarks on a similar procedure:  
As every schoolboy knows, a circle is a locus of coplanar points equidistant from a center. What every schoolboy does not know is the difference between repeating that definition as a parrot might and uttering it intelligently. So, with a sidelong bow to Descartes’s insistence on the importance of understanding very simple things, let us inquire into the genesis of the definition of the circle…. Imagine a cartwheel with its bulky hub, its stout spokes, its solid rim.

Ask a question. Why is it round?

Limit the question. What is wanted is the immanent reason or ground of the roundness of the wheel. Hence a correct answer will not introduce new data such as carts, carting, transportation, wheelwrights, or their tools. It will refer to the wheel.

Consider a suggestion. The wheel is round because its spokes are equal. Clearly, that will not do. The spokes could be equal yet sunk unequally into the hub and rim. Again, the rim could be flat between successive spokes.

Still, we have a clue. Let the hub decrease to a point; let the rim and spokes thin out into lines; then, if there were an infinity of spokes and all were exactly equal, the rim would have to be perfectly round; inversely, were any of the spokes unequal, the rim could not avoid bumps or dents. Hence we can say that the wheel necessarily is round inasmuch as the distance from the center of the hub to the outside of the rim is always the same. (Lonergan 1957, pp. 31-32)
\end{flushright}
perfect circle we must consider it to be approximately the same shape (but not necessarily the same size) as an accurately rendered concrete circle, such as this $\bigcirc$, and we realize that a perfect circle cannot approximate the shape of many other simply shaped objects such as this $\bigtriangleup$ or $\bigcirc$. In this way, visual perception plays a foundational role in our knowledge of what constitutes a perfect circle, even though we cannot perceive a perfect circle. The same argument, *mutatis mutandis*, applies to other simple geometric objects.

There is no foundational claim made here that pertains to all mathematical objects or even to all geometric objects. My argument pertains only to simple (abstract) geometric objects such as a circle. It is enough to show that visual perception plays a foundational role in our knowledge of these objects to defeat Ernest's strict social foundationalism. Also, I do not dismiss the possibility that knowledge of simple geometric objects can be obtained without perception (although this possibility seems unlikely). A final clarification pertains to other foundations of our knowledge of simple geometric objects, specifically mathematical forms of life that engender specialized mathematical language. A perfect circle expressed in mathematical language is typically thought of as a set of points of equal distance from a fixed point (in a formula, $(x + a)^2 + (y + b)^2 = c^2$). Certainly, mathematical forms of life, which engender specialized mathematical languages, warrant our knowledge of a circle and other geometric objects. In fact, one of my central contentions has mathematical forms of life complementing the foundational role of visual perception, a lesson of Chapter 2, and a lesson of this chapter as well. My disagreement with Ernest concerns *strict* social foundationalism, which ignores the possibility that perception, in particular, visual perception, can play a foundational role.
This disagreement with Ernest extends to all social constructivists insofar as they are committed to the view that historically established social practices and activities are the only foundations for objective knowledge.

Section 6.4 Ernest’s philosophical blind spot

With one exception, it is beyond the intention and scope of this study to delve into the implications for education of Ernest’s brand of social constructivism. The exception: Ernest’s picture of mathematical knowledge as strictly relative to the will and power of mathematicians entails that students do not, and cannot, objectively determine whether mathematical propositions are necessarily true. Of course, there are many mathematical propositions which are beyond the comprehension of students. Someone at the stage of learning multiplication is in no position to judge propositions in point-set topology. Nonetheless, students are in a good position to judge the necessary truth or falsity of mathematical propositions they are currently learning or have learned. If, however, mathematical knowledge is strictly relative to the will and power of mathematicians, the convictions of students have the epistemological status of delusions. This implication of Ernest’s position goes against the historical stability of the mathematics that students learn and believe. The mathematics taught in primary and secondary schools is incredibly stable and well established. Surely, for example, students through the ages have acquired an objective, necessary truth in learning the Pythagorean theorem.

In response, Ernest argues that even the certainty of the Pythagorean theorem is derived solely from “language games embedded in forms of life”, so a student’s conviction
about the theorem rests not in his ability to think the theorem through himself, but rests solely on social interactions (e.g., with the teacher) that sanction the theorem. Ernest favourably quotes the following passage from Richard Rorty.

If, however, we think of “rational certainty” as a matter of victory in argument rather than relation to an object known, we shall look toward our interlocutors rather than to our faculties for the explanation of the phenomenon. If we think of our certainty about the Pythagorean Theorem as our confidence, based on experience with arguments on such matters, that nobody will find an objection to the premises from which we infer it, then we shall not seek to explain it by the relation of reason to triangularity. Our certainty will be a matter of conversation between persons, rather than an interaction with nonhuman reality. (Rorty 1979, pp. 156-157; in Ernest 1998, p. 183)

Thus, even such enduring items of knowledge as the Pythagorean theorem receive justification solely from social interactions. Students who have thought through a proof of the Pythagorean theorem, and have, in effect, concluded that it expresses a necessary truth, are not likely to accept a suggestion that the truth of the theorem can be overturned by shifts in mathematical activities and practices. To learn the Pythagorean theorem is to learn that its truth holds everywhere and for all time.

Ernest’s brand of social constructivism, thus, does not seem to fit well with the thinking of students. We are faced with a couple of conflicting options. We could conclude, in line with Ernest’s theory, that students’ convictions are really delusions (for mathematical knowledge is strictly relative to the will and power of mathematicians). Alternatively, we could conclude that, in learning a proposition such as the Pythagorean theorem, students acquire knowledge of a proposition whose truth is independent of “language games embedded in forms of life”. Adopting the option that coheres with Ernest’s account would be theoretically reasonable only if it could be shown that mathematical knowledge depends
exclusively for its justification on "language games embedded in forms of life". This is not the case, however; visual perception (as has already been shown) provides justification for concepts of many mathematical objects and for many mathematical propositions. Although I have shown that perception plays this role for a limited range of mathematical objects and propositions, this range is of utmost importance for mathematics education because this range includes a great deal of primary and secondary school mathematics (as well as the mathematics learned before schooling begins). Accordingly, even though, in answering Ernest, I limited my argument to a narrow range of mathematics, my argument addresses a broad range of mathematics learned in primary and secondary education. Because perceptual justification pertains more directly to mathematics learned from birth to graduation from secondary school, Ernest's view is especially vulnerable in regard to this range of mathematics.

To this point, I have given examples of ways in which visual perception provides justification for mathematical beliefs. In Chapter 2, I argued that visual perception of diagrams used to prove the Pythagorean theorem plays a justificatory role by supplying conscious, conceptual, and accurate shape information. In the same chapter, I argued that visual perception provides justification for the intermediate value theorem by playing a crucial role in a picture proof which justifies that theorem. In the present chapter, I argued that visual perception of concrete circles provides justification for the concept of an abstract circle. The following example illustrates how visual perception provides justification for some algebraic rules. This example strikes at the heart of Ernest's position because, by his
lights, such rules are constituents of mathematical "language games", which receive their justification solely from mathematical forms of life.

Consider the following algebraic identity, which students encounter: \((a + b)^2 = a^2 + 2ab + b^2\). For example, \((4 + 1)^2 = 16 + 8 + 1\). This identity is arrived at by adhering to distributive, commutative, and associative rules (over the real numbers). Under these rules, the derivation is (in brief):

\[
(a + b)^2 = (a + b) \times (a + b) \\
= a \times a + a \times b + b \times a + b \times b \\
= a \times a + a \times b + a \times b + b \times b \\
= a^2 + 2ab + b^2.
\]

What is the experience of students? Many students probably just memorize the rules and apply them on tests, if they can. But some students systematically check out the results and find that indeed the identity, \((a + b)^2 = a^2 + 2ab + b^2\), holds over every instance that they check. This inductive testing gives students a sense of the correctness of the algebraic rules independent of the authority of the teacher and of the textbook. There are other ways for students to ascertain the correctness of the algebraic rules. One of these is to consider that \((a + b)^2\) gives the area of a square illustrated below with each side of length \(a + b\).
Now students can “see” that the area of the square with sides of length \(a + b\) is also the combined area of each of the four rectangles inside the square. This combined area is \(a^2 + 2ab + b^2\). Because the same area is also equal to \((a + b)^2\), \((a + b)^2\) and \(a^2 + 2ab + b^2\) must be equal because they are both equal to the area of the thing. This result holds no matter how big the square is and no matter what relative length \(a\) and \(b\) are to each other. This too can be “seen” by students.

These observations, which many students assimilate, put in question the contention that mathematics is an instance of “power, compulsion, and regulation” in which the mathematician is omnipotent in “the virtual reality of mathematics”. The example of the two ways to calculate the area of a square shows the truth of the identity, \((a + b)^2 = a^2 + 2ab + b^2\), is independent of algebraic manipulation. Each of \((a + b)^2\) and \(a^2 + 2ab + b^2\) is equal to the area of the same square; so they must be equal to each other.

The algebraic rules, thus, receive justification from a picture proof that yields the same results as the rules. Evidently, visual perception is not the only cognitive capacity which is engaged in the picture proof. Nonetheless (as in the case of the picture proof of the intermediate value theorem) visual perception plays a crucial role. Visual perception, e.g., supplies the information that the four interior rectangles have the same area as the large square. By significantly contributing to our understanding of the picture proof that justifies the algebraic rules, visual perception significantly justifies those rules.

Visualization techniques in mathematics and mathematics education are gaining ground. The dogma of regarding sentential thought as the sole means to mathematical truth is being challenged; its days may be numbered. Though Ernest, who is a mathematics
educator, is probably familiar with these trends, perceptual issues have no bearing on his philosophy. Ernest can be faulted insofar as he ignores current trends in mathematics and mathematics education that undermine his view. Of course, since trends are sometimes short lived, Ernest might not be too badly off for ignoring them (although he does not ignore pedagogical trends which conform with his social constructivism). Ernest can, however, be faulted for ignoring the place of perception in philosophical accounts of mathematics on which he otherwise extensively relies. I have already pointed out (n. 5, p. 173) a perception-related passage in Wittgenstein, not mentioned by Ernest, that puts in question Ernest's use of Wittgenstein in support of Ernest's extreme social relativism. It is plausible, as I remarked earlier, that Wittgenstein did not hold that mathematics is socially constructed "all the way down".

Omitting to mention perception-related aspects of a philosopher's position is not confined to Wittgenstein's position. Ernest (1998, p. 139) basically adopts Philip Kitcher's model of mathematical practice without mentioning Kitcher's semi-empiricist foundational account that goes with his model. Ernest adopts Kitcher's model "as a tentative naturalistic model of mathematical knowledge. The five components of the model are as follows: the language L, accepted statements, accepted reasonings, mathematical questions, and
metamathematical views" (Ernest 1998, p. 139). The part of Kitcher’s account that Ernest fails to mention is this:

[W]e can regard the history of mathematics as a sequence of changes in mathematical practices, that most of these change [sic] are rational, and that contemporary mathematical practice can be connected with the primitive, empirically grounded practice through a chain of interpractical transitions, all of which are rational. (Kitcher 1988, p. 299; my italics)

For Kitcher, the rational interpractical transitions and the primitive, empirically grounded practices provide a foundation of mathematical beliefs:

Our present body of mathematical beliefs is justified in virtue of its relation to a prior body of beliefs; that prior body of beliefs is justified in virtue of its relation to a yet earlier corpus; and so it goes. Somewhere, of course, the chain must be grounded. Here, perhaps, we discover a type of mathematical knowledge in which people are justified through their perceptual experiences in situations where they manipulate their environment (for example, by shuffling small groups of objects). (Kitcher 1988, p. 299)

Ernest does not respond to — or, it seems, even mention — Kitcher’s assessment of rational interpractical transitions originating from primitive, empirically grounded practice.

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12 Ernest’s tentative adoption of Kitcher’s model signifies minor disagreement with it only. Ernest levels two criticisms against this model. First, while Kitcher’s notion of a mathematical practice represents a significant naturalistic advance over the traditional conception of mathematical knowledge, it remains a simplified and depersonalized representation of a form of life. However, this criticism is irrelevant to the use made of the model here. (1998, p. 143)

Second, there are a number of potentially significant components of mathematical knowledge or practice not properly accommodated. For example, the set of methods and procedures of mathematics is omitted. ... Although Kitcher partly subsumes mathematical methods under accepted reasonings, the incorporation does not really reflect the significance of such methods as the “diagonal method” in recursive theory and logic. (1998, p. 143)

Since these disagreements are strictly minor, Ernest is in basic agreement with Kitcher’s model.

13 See also Kitcher 1983 (p. 226).
How is one to explain Ernest's philosophical blind spot that blocks out the issue of perceptual justification? The source of the blind spot is not philosophy of mathematics. Prominent philosophers in this field including Parsons (1980), whose position I addressed in Chapter 2, Penelope Maddy (1980), and Kitcher speak to this issue. The source of Ernest's blind spot, instead, is likely the general lack of concern for perceptual justification within philosophy as a whole. In philosophy of education, in particular, it is rare to find a treatment of perception, let alone of perceptual justification. The general lack of concern for the issue of perceptual justification does not exculpate Ernest's omission; he should have addressed Kitcher's foundational account. Kitcher uses his model to show that mathematical knowledge receives objective grounding in antecedent perceptual experience. By adopting Kitcher's model without responding to Kitcher's justificatory account, Ernest leaves his relativistic argument in an unfinished state. Nonetheless, the general lack of interest in the issue of perceptual justification in philosophy, including in philosophy of education, makes Ernest's omission understandable.

Ernest's work can be viewed as a case study of the consequences of ignoring the issue of perceptual justification. Once perceptual grounding is ignored (or rejected), it is easy to slip into one or another stance that, in effect, has thought "spinning in the void". Coherentism is one such stance; judging from Ernest's work, another is extreme social relativism in which it is held that social agreement alone determines objective knowledge. There may be factors specific to the character of mathematics and of mathematics education that press Earnest toward extreme relativism. Nonetheless, by ignoring the possibility of perceptual justification, Ernest is left placing too much emphasis on social context and language. Paying
no heed to ways in which perception informs and constrains thought, including mathematical thought, leads him to extreme social relativism.
The Forest

In the course of this study, not all the components of my case were given equal treatment. Some were touched on briefly; others I returned to repeatedly. Because of the novelty of the template-matching model, extensive space was devoted to showing how this model supports the claim that visual perception is both conceptual and non-inferential. It is appropriate, then, at the end to view my case in broad outline.

Helmholtz’s theory of perceptual inference set the stage for a still-unresolved discussion in philosophy of perception and vision science. Thinking of visual perception as conceptual and non-inferential provides a resolution to this discussion. Why is visual perception conceptual? Object recognition is all-pervasive within visual perception; object recognition is necessarily conceptual; therefore, visual perception must be conceptual. Furthermore, the usefulness of diagrams in geometry (and other types of reasoning) is explained only by supposing that visual perceiving supply conscious, conceptual shape information. Crane’s position founders on an incorrect, tacit assumption that inference is necessary for concept use. The non-inferentiality of visual perception cannot be used to establish non-conceptuality. Furthermore, those visual illusions that occur despite contrary beliefs — the evidence Crane relies on in his argument that perception is non-inferential — can occur only if visual perception is conceptual. Centralism — another type of non-conceptualism — regards visual perception as fundamentally a non-conceptual awareness of shape. According to centralism, visual perception only seems to involve concept use. In reality, the non-conceptual neuronal capacities of visual perception are so smoothly interlaced with the conceptual neuronal capacities of central systems that we get the false
impression that visual perception involves concept use. In fact, all concept use stems from central systems. Object recognition, according to centralism, is induced by non-conceptual shape "categorization" delivered by the visual neuronal system to central systems. Centralism errs on two fronts. (1) Its contention that non-conceptual processing induces (directly brings about) visual object recognition entails the neuronal givenness problem — the problem of supposing that non-conceptual processes, etc., can induce conceptual perception, including object recognition. (2) Plausibly, conceptual processing of shape information within the visual neuronal system induces visual object recognition. (The template-matching model was used to establish this claim.) Making the latter case relies on the assessment of visual perception as non-inferential, for if visual perception were inferential, it would be highly unlikely that shape processing could induce visual object recognition. A neuronal pattern, itself, cannot be a premise for inference.

Inferentialism commits the error of regarding retinal stimulations (or outputs) as premises for inference. However, if (as inferentialism contends) retinal stimulations are not conceptually structured, they cannot be premises for inference. Visual illusions that conflict with beliefs indicate that visual perception is not due to inference from beliefs. For this reason, it is best to describe the affects of belief and other attitudes on perception (in cases in which such affects obtain) as non-inferential. Additionally, again using the template-matching model, a plausible case can be made that the neuronal inducing of object recognition is not inferential.1

1 As well as opposing inferentialism, I argued (sometimes only parenthetically) against a range of views that have in common an exaggerated view of the mental prowess of visual perception. (I maintain that it is conceptual only.) Visual perception, I argued, is not inferential, linguistic
The sensation-perception distinction occupies an intermediate position between conceptualism and non-conceptualism. This position makes the mistake of holding that non-conceptual processing of shape information induces conceptual visual perception, including visual object recognition. The sensation-perception distinction is also wrong in proposing that non-conceptual processing of shape underlies non-conceptual sensation of shape. There is no non-conceptual awareness of shape. In visual experience, shape is subsumed under concepts of objects because we visually experience any shape as the shape of some determinate object; hence our visual experience of shape is conceptual.

The conceptual and non-inferential character of visual perception makes it possible for visual perception to justify beliefs. Because visual perceivings are conceptual, they can warrant beliefs. A non-conceptual perceiving is not the type of thing that can justify beliefs. Because visual perceivings are not inferred from beliefs, they are sufficiently independent of beliefs to warrant beliefs.

A further condition needs to be met if visual perceptions are to justify beliefs. Visual perceptions need to be generally veridical. Visual perception of simple objects, especially diagrams, is highly veridical. Scientific knowledge of the nature of the visual neuronal system provides reasons for accepting the general veridical nature of visual perception. For example, it is known that the visual neuronal system preserves shape information upon which object recognition is largely based.

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(language-like), rational, or any combination thereof, nor do we visually perceive abstract mathematical objects, as Parsons contends. I also took aim at McDowell’s second-nature-linguistic theory in which pre-linguistic humans and all non-human animals do not have the capacity for conceptual functioning.
Visual perception on its own cannot be a foundation for objective knowledge because not all visual perceptions are veridical and because visual perception does not tell us which perceptions are veridical and which are not (although visual perception can supply us with information on which to make judgements to that effect). It can only play this type of role in conjunction with other foundations, in particular rational-scientific-mathematical forms of life. Scientific knowledge of the visual neuronal system, for example, provides evidence that visual perception is generally veridical. Rational-scientific-mathematical forms of life alone do not provide a foundation for belief. Veridical perception is also required. Science, e.g., relies on generally veridical perception for reliable observation. A reliance on forms of life alone sets the stage (as in a trend in philosophy of mathematics education) for a relativism in which justification of belief is thought to arise solely from social relations.
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