Sensory systems are specialized cells of plants and animals sensitive to swift variations in the environment. To Aristotle’s five human senses (vision, hearing, taste, smell and touch) comparatively recent research added many more structures with the capacity to react upon internal or external events or stimuli. Beyond his senses man has several extrasensory ways to gather knowledge such as reason, intuition, introspection, the mind’s eye and mysticism. The combined activity of sensory systems and the brain leads to assembly of information from the environmental bombardment of 4-D stimuli. This results in experience most of which remains unconscious. As a relatively late spandrel like phenomenon of evolution consciousness arose. This brain’s action does not cause consciousness, it is consciousness.

Louw Feenstra (v) is professor emeritus of oto-rhino-laryngology and philosopher.
From sensory biology to a philosophy of perception
From sensory biology to a philosophy of perception

PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Radboud Universiteit Nijmegen
op gezag van de rector magnificus prof. dr. Th.L.M. Engelen,
volgens besluit van het college van decanen
in het openbaar te verdedigen op donderdag 27 november 2014
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Manuscriptcommissie:
Prof. dr. J.A.M. Bransen
Prof. dr. M.V.P. Slors
Prof. dr. J. van Brakel (Katholieke Universiteit Leuven, België)
Wretched mind, after receiving your knowledge from us, do you try to overthrow us? Your overthrow will be your downfall

Democritus (fr 125)

But do not confuse the sound idea that philosophy is not science with the mistaken idea that philosophy is independent of science.... [D]iscourse no longer appears as one plane parallel to another, but as a tangle of intersecting dimensions whose relations with one another and with extra-linguistic fact conform to no single or simple pattern

WS Sellars (1963,171)
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Preface

0.1 The spark

In 2002 my medical school modernized the curriculum. In this process, among other things the teaching units of oto-rhino-laryngology, ophthalmology, dermatology, neuroscience and psychiatry were amalgamated to form a new unit called 'Brain and Senses'. I was invited to write an introductory note for the ‘Senses’ part of this unit.

During the writing of my text I began to realize how inadequate my understanding of the senses was. This motivated me to amass as much information on structure, function and type of the presently known senses, a study that initiated this essay.

0.2 The process

Trained as an oto-rhino-laryngologist I became especially interested in otology (hearing, equilibrium) and pediatric oto-rhino-laryngology. Hence, the (clinical) examples which sparsely appear in the text.

After my retirement I obtained a Masters degree in philosophy. During this study I became aware of the different ways in which philosophers and scientists think about similar subjects although Bennett and Hacker (2003) show that this is not always the case. Constantly being aware of the different ways of thinking I take great pains to take Wissenschaftliche opinions, judgements and knowledge to philosophical puzzles and visa versa on the subject-matter of the senses.

As the exploratory field gradually widened I came across seers with closed eyes, non-sensory sensing, introspection, thinking without the use of language and the rôle of senses in ‘knowledge’, ‘know how’ and ‘consciousness’. Because these topics partly overlapped with the factual senses, the boundaries often were hazy, preconceived opinions crumbled, I decided to partly draw them into this essay.

1 Erasmus Medical Centre, Rotterdam.
0.3 The form

Each chapter of this essay deals with one or more subset questions; together they describe my present understanding of the senses. The overall picture presents a delta of branching and reconnecting streams. Readers considering some branches or backwaters less interesting are advised to steer their own course. (see the paragraph 0.5 on ‘reading’)

0.4 The design

This essay consists of three parts and six addenda. Part I mainly deals with the life scientific view of the senses, Part II treats subjective and philosophical views of the sensory systems and Part III tries to establish the relationship(s) between the two parts.

In Part I (chapters 1-5) I survey the way sensory systems (the term I will use for the senses) are explained by the life-sciences. Chapter 1 presents a general introduction and tentative definitions of sensory systems and perception. Chapters 2 and 3 describe in more detail the scientific views of the sensory systems that started with Aristotle and are now based on Naturwissenschaft and evolutionary theory (neo-Darwinism). An overview of evolutionary theory (chapter 4), a number of ‘sixth senses’ to be added to Aristotle’s five (chapter 5), as well as the principle of the – usually unconscious – collaboration of all sensory systems are presented. In these chapters I also touch on a few more obvious philosophical concepts such as that of mereological fallacy and the false nature/nurture-dichotomy. In the life sciences, a definition that allows a clear distinction between sensory systems and other other body systems is only arbitrary.

Part I concludes with an answer to the question of how life sciences look upon the cooperation of the sensory processes in conscious perception: (1) the brain continuously integrates all sensory processes of which only a relatively small part becomes conscious, (2) differentiation between sensing and perception is vague, and (3) the relation of consciousness with the continuous processing of the sensory systems and the brain is not yet completely clear; most of the incoming stimuli are processed without reaching consciousness.

Part II (chapters 6 -9) mainly deals with the subjective aspect of sensory systems’ operation.

It starts (chapter 6) with an overview of the concept of sense-data which was a major philosophical subject of the first half of the twentieth century and
is still supported by some philosophers. I argue that this concept is redundant as viewed from the perspective of the life sciences. Chapter 7 discusses the so-called ‘problem of perception’ which in my view is not a problem at all since most if not all of it can be explained by the life-sciences. The chapter continues with the relation between perception and environment, the world out there. The brain constructs a subjective impression of the outside world from the data the sensory systems supply. The artificial and/or loosely expressed dichotomy between the operation of (central) nervous tissue and the non-nervous tissue of the body induces a brain-body dichotomy which may even re-introduce the obsolete and redundant mind-body problem.

Chapter 8 introduces the oxymoron of non-sensory sensing and its corollary, the ancient philosophical concepts of introspection and intuition, accepted in classical rationalism as true but as unreliable by science. The chapter proceeds with the concept of ‘the mind’s eye’ as extensively used in technology and art which demonstrates beyond doubt that valuable nonverbal communication exists, can be learned and is based on cooperation of the sensory systems. Finally, the chapter introduces the concept of non-linguistic thought which includes meditation and contemplation. Chapter 9 describes mysticism, a way of non-sensory ‘seeing’, that is often said to lead to deeper understanding.

My conclusion is that neither intuition nor mysticism are helpful to clarify the sensory systems although these modalities of cognitive activity may lead to knowledge and might turn someone into a seer. The mind’s eye on the other hand is crucial for artists and the technical professions. It has relatively little status in Western philosophy – although exceptions exist – but it is held in high esteem in many Asian religious and philosophical traditions.

Part III (chapters 10-13) deals with the relation of the sensory systems and the brain, information, experience and knowledge. Chapter 10 opens with the argument that the dividing line between sensing without and sensing with awareness is gradual; discrimination between the two is a matter of degree rather than of kind. Experience is discussed and finally defined as the outcome of the continuous process of adding unconscious, subconscious and conscious new signals, stimuli, and information from outside and inside the body. My preference here is Sellars’ (1963,173) dictum; “natural science is the measure of all things, of what is that is, and of what is not that it is not”. Chapter 11 presents an analysis of the term ‘information’ which is generally taken as the principal function of sensory systems. This analysis culminates in the description of biosemiotics, a naturalistic2 scion of biology with roots in linguistic concepts.

2 I follow John R Searle’s (1997,xiv) term, i.e., biological naturalism.
Chapter 12 follows Chisholm’s solution to ‘the problem of the criterion’, i.e., knowledge needs information through perception, understanding perception needs knowledge. I am aware that with this statement I tend to enter the trap of circular reasoning. I accept van Fraassen’s (1980) constructive empiricism, more specific his scientific agnosticism. Three criteria for classifying sensory systems are proposed. The discussion then turns to the mind (a set of operations carried out in the brain), to consciousness and to self-awareness.

Consciousness, I argue is the traditional, folk psychological term for an emerging, continuously changing process of the material brain. Consciousness is probably a spandrel-like [Addendum 14.1] phenomenon of evolution, a neuronal circuits spin-off which combines incoming sensory stimuli facilitating survival of the organism and the species. Sensory systems thus control behaviour and may induce perception.

Chapter 13 tries to integrate the major points of the earlier chapters, adhering to ‘eliminative physicalism’. Moreover I admit the provisional character of scientific conclusions, including mine.
0.5 The reading

Parts of this essay may be less accessible to some readers. Recapitulations and cross-references may help to overcome this problem. Number codes between square brackets refer to sections. For example, [§ 3.1 (p.43)] should be read as ‘see/compare section 3.1 that begins on page 43’. References such as [Box 2-1 (p.28)] are used to direct the reader to textboxes, which function as illustrations but take the shape of notes. I omitted ellipsis dots and adjusted punctuation for easy reading.3

At the end, indexes are provided: the first for names of persons, the second for subjects, the third for abbreviations used throughout the book, the fourth for ‘powers of ten’.

The structure and the goal of this essay can be summed up, too, with the ancient metaphor of ‘The mountains and water’. [Box 0-1]

---

3 This subsection including the system of references is derived from van Brakel 1998, 2000.
Acknowledgements

Prof.dr. Evert van Leeuwen has been my sparring partner during the whole process of reflection and writing. Sensei Nico Sojun Tydeman was my zen-teacher and interlocutor for chapter nine. Many others helped as adviser, interlocuter, translator/corrector, moral support and/or critic, too numerous to mention here.

I am happy to record my gratitude to the department of Neuroscience, Erasmus Medical Centre, Rotterdam (chair prof.dr. Chris I. de Zeeuw) who gave generous hospitality from 2007 to this day.

Carla my beloved partner ever since our first meeting witnessed nidation, gestation, occasional abortion, birth of each idea, and the (re)writing and (re)polishing of each part.

Rotterdam, Spring 2014
Part I

What common sense and the life-sciences tell us about sensory systems
1 General introduction

1.1 Senses and their operation

The Oxford Illustrated Dictionary (1975, 1977) gives seven meanings of the word 'sense' of which I will use the first. It says: *Any of those faculties, each dependent upon specialized groups of receptors connected to the brain, by which animal and man are aware of their environment or recognize changes in their own bodily condition.*

We are familiar with our eyes, ears, nose, tongue and touch. Most of us have some experience of a (temporary) failure of one or more of them for instance loss of smelling or hearing due to a cold. We probably know someone with a more permanent loss of function such as in an old person and we are also aware of the much better ears and noses of dogs and cats. Some more reflection brings to mind colour blindness, distinctions between seeing and understanding and even remnants of half forgotten biology from school learning. We may rummage through the latter, may hunt after some other written text, and, nowadays we may consult the internet. Taken together, such daily practices bring home to us some general knowledge which philosophy calls with a slightly conceited term 'naive' (no offense) or, more friendly 'common sense-like'.

Another way to study sensory systems is to follow Henry David Thoreau's trail and experience each sense deliberately and intensively through training. (Friesen 2005) Less time consuming would be to train only one sense such as vision through painting, hearing through music, smell and taste through cookery, or propriocepsis through ice skating. Learning about perception should ideally be based on, or at least incorporate, the study of one's own bodily experiences.

As second best option, such experiences may be studied, second hand as it were, by reading famous authors like Marcel Proust's fascinating story on 'petites madeleines' [p.38] since they often are able to describe their own experiences so much better than scientists and philosophers.

An entirely other way for learning about perception consists of studying life sciences like psychology, biology or medicine. (viz. Sacks 1986; Kandel et al. 2000)

Some people seemingly restrict their musings about perception on gazing through the window or intently looking at their desk. Such practices easily lead to overemphasis of vision, however, as anyone will readily notice when browsing a few books on the philosophy of perception.
To obtain a better understanding of the sensory systems, combined use of science, life sciences and philosophy, is favoured by neurophilosophers (and myself), although some doubt the wisdom of this approach. Finally of course, one can use any combination of the mentioned approaches and one’s own common sense.

I will neither present a review of all past philosophical views about the sensory systems nor will I extensively discuss consciousness, memory, emotions and feelings. [Box 8-1 (p.98)] Various excellent historical reviews of the philosophical literature of perception (Hamlyn 1966; Dicker 1980) and the turbulent neuro-philosophical field of consciousness exist. (Blackmore 2006; Pockett et al. 2009) Wherever appropriate I will mention some (historical) philosophical views on consciousness and on emotions.

1.2 Some definitions

As a tentative definition I suggest that sensory systems are those specialized systems of an organism that enable the connection between the environment and the organism’s body, the so called interface between *milieu extérieur* and *milieu intérieur*. To perform such an activity a sensory system should meet several conditions:

1) the majority of the receiving parts of sensory systems are situated on the surface and relative surface of a living structure,

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**Box 1-1 Definitions of visible ‘light’**

Visible light – for humans – consists of electromagnetic waves with a wave length of 390 nm to about 750 nm and with an intensity of $10^{-6}$ cd/m² to $10^7$ cd/m² (nm is $10^{-9}$ m, cd is short for candela, the unity of light intensity).

Light is often ‘defined’ as that which makes the environment visible for human eyes.

Light is sometimes ‘defined’ as absence of darkness.

Comparable descriptions apply to other human sensory systems.

* List of abbreviations and powers of ten. […]

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To obtain a better understanding of the sensory systems, combined use of science, life sciences and philosophy, is favoured by neurophilosophers (and myself), although some doubt the wisdom of this approach. Finally of course, one can use any combination of the mentioned approaches and one’s own common sense.

I will neither present a review of all past philosophical views about the sensory systems nor will I extensively discuss consciousness, memory, emotions and feelings. [Box 8-1 (p.98)] Various excellent historical reviews of the philosophical literature of perception (Hamlyn 1966; Dicker 1980) and the turbulent neuro-philosophical field of consciousness exist. (Blackmore 2006; Pockett et al. 2009) Wherever appropriate I will mention some (historical) philosophical views on consciousness and on emotions.

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1 The lining of the digestive tract and the respiratory tract are considered to be body surface because both systems are basically invaginations.
sensory systems are more sensitive to changes in their environment than other surface structures. Such environmental changes can be defined in chemical and/or physical terms. There is a hidden tautology in this statement. Most of the information exchange in the own body is not consciously perceived, but sometimes it is (hunger, thirst, movements and the like),

if a sensory system is triggered by any environmental change (called stimulus), a sequence of interrelated reactions in the living structure is started. When active, a sensory system is involved in a process,
sensory systems usually are indispensable for initiating those (biological) (re)actions that are needed to preserve the specimen and/or the species,
sensory systems that are not indispensable to preserve the life of the specimen and/or the sort tend to wither and eventually disappear, be it gradually in the course of neo-Darwinian evolution or during the life-time of some species,
in other species, certainly in humans, sensory information may in part become conscious but this does not need to do so.

I will define perception tentatively as that part of information that results in awareness of (objects and events in) the environment. Thus, there is a relation between sensory systems’ activities and perception; they are not synonymous.

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2 The term ‘change’ is used deliberately. For instance, the eyes make micro-movements (micro-saccades) all the time although we are never aware of it. If the environment moves simultaneously in exactly the same manner in laboratory conditions, the eye rapidly looses its sensitivity and turns ‘blind’. Only specific changes in the environment or within the body can become stimuli.

3 ‘Consciousness’ and ‘to be aware’ are here taken to be synonymous.
So far nothing has been said about the relation of some physical object or event and the awareness one has, although as a start I tend to agree with Robinson’s (1994,1) observation that the majority of modern philosophers – that is, the majority of philosophers writing since the seventeenth century – has believed that in perception one is aware of some item other than the physical object one takes oneself to be perceiving. In the next chapters I will return to most points.

1.3 Defining the problem

My basic question is ‘What are sensory systems?’

Two (sub)questions will be dealt with more specifically:

– How do life sciences – based on Naturwissenschaft and Theory of Evolution – define sensory systems and what are the philosophical foundations.

– What is the basis of the unity of (conscious) perception.
2 What the life sciences tell about the sensory systems

2.1 Introduction

We can think of various approaches to study the perception process: an observer can examine the responses of some organism to its environment, an observer can study the process by analysing his or her personal experience or an observer can look at it as part of his cognitive processes. Prior to digging deeper into philosophy, in this chapter, I will use the first approach heavily relying on selected findings of the life sciences, more specifically of ecology and largely ignoring, for the time being, the other two approaches.

Sensory systems are a prerequisite of life. In small living organisms like bacteria that can only be viewed with a microscope, organelles and specific surface proteins may be activated by changes in their environment resulting in changes of their behaviour. It is largely a matter of convention whether the term perception may be applied to such interactions that are linked to appropriate behavioural responses without intervening conscious episodes. (Shimony 1971:577)

Ecology, a word coined by Ernst Haeckel in 1869 describes the interactions of organism and environment (inanimate objects and animate organisms), (environment understood in its daily use), with emphasis on transmission of information between organisms and environment.

Man has many reasons for paying attention to the way organisms obtain and use information about their environment. Hunting and fishing, for instance, became more effective when our ancestors understood the sensory abilities of their prey. Organisms have ‘experimented throughout evolution with’ many strategies to obtain and use information retaining the information that was most effective. (Dusenbery 1992:2)

Dretske (1971), used the bottom-up approach to isolate knowledge of the senses in a pure form, not yet obscured by irrelevant details. Using

1 I will only use ‘he’ and ‘his’ also meaning ‘she’ and ‘her’.
2 Some accept only the last two approaches as philosophy (Locke 1967:14-5) but I side with CUM. Smith’s statement cited by Hahlweg (1989,532f) that “just as Descartes, consciously and unconsciously, built his epistemology on the basis of seventeenth-century visual physiology, we should do this also”, i.e., on the basis of our times.
3 Animate agents are living substances, ranging through the spectrum of biological taxa from micro-organisms to plants and animals. (Hacker 2007,130)
FROM SENSORY BIOLOGY TO A PHILOSOPHY OF PERCEPTION

Dretske's approach, I will present two examples of reactions to specific sensory stimulation. I will subsequently discuss (the importance of) sensory systems without pleading for sensationalism. Finally, I will argue that the larger part of human ‘knowledge’ is acquired through perception that remains unconscious.

2.2 Two examples

The examples are presented to demonstrate ethological bottom-up results of research on specific sensory stimulation. Ethology is taken here as synonym of the biology of behaviour. [Box 2-1]

1. Tinbergen’s classic study of the stimuli [Box 2-5] that release the begging response of the herring gull chick is one of an extensive series of investigations to determine which features of the visual stimulus of the parent’s beak are used to elicit the response of a chick. (Tinbergen and Perdeck 1951)

This study belongs to the field of ecology, more precisely to ethology that addresses questions such as what strategies are used by living organisms to locate resources, what information they use and how it is obtained. (Dusenbery 1992,8)

Largely borrowed from Ramachandran’s (2004,46f) lively account of Tinbergen’s study, the story of the begging response runs as follows: As soon as the herring gull chick hatches, it sees its mother’s yellow beak with a red spot on it. It starts pecking at the red spot, begging for food. The

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Sensationalism is understood as the doctrine which maintains that only sensations of individual qualities can be given; that the perceptual awareness of entities is derived from sensations; and that it is derived by means of processes which are cognitive in the sense that they involve the logical synthesis of information given. (Kelley 1986,50)
mother then regurgitates half-digested food into the chick’s gaping mouth and the chick swallows the food. Tinbergen started by asking himself how the chick recognizes its mother and found that it doesn’t need a mother; a hatchling reacts in exactly the same way to a disembodied beak with no mother attached.

In this case the goal of vision is to do as little processing or computation as is necessary for the job on hand, recognizing the source of food. Obviously, through evolution the chick has acquired the ‘knowledge’ that this long thing with a red spot always has a mother attached to it. It can thus take advantage of the statistical redundancy in nature and reacts somewhat like ‘Long yellow thing with a red spot equals food’ thereby simplifying the processing and saving much computational labour.

Indeed, Tinbergen found that the chick didn’t even need a real beak. A long yellow stick with three red stripes, which looked nothing like a beak to humans was pecked at even more than a real beak. Chicks preferred it to a real beak, even though to us it didn’t resemble one. Tinbergen thus discovered a kind of super-beak for the chick’s perception. Why this occurs is not exactly known, but obviously there are neural circuits in the visual pathways of the chick’s brain that are specialized to detect a beak as soon as the chick hatches. It turns out that they fire upon the visual stimulus of red spots or red stripes on a yellow stick-like back-ground. Because of the way they are wired, they may actually more powerfully respond to the stick with three stripes than to a real beak. The neurons’ receptive field possibly embodies a rule such as ‘the more red contour the better’. Even though the stick doesn’t look like a beak to humans, this strange object (a supernormal stimulus) actually is more effective in driving ‘beak detectors’ than a real beak; and a message from the ‘beak-detecting neurons’ travels to the emotional (limbic) centres in the chick’s brain, giving it a big jolt and the behavioural reaction of pecking at that very spot.

2. Although olfaction in humans has drawn relatively little interest compared to vision and hearing, Doty’s (2003) ‘Handbook of Olfaction and Gustation’ still numbers 1150 pages or approximately 22,100 words to cover the field. The following is predominantly drawn from this textbook. (ibid. 312-6)

5 Supennormal stimulus: artificial stimulus (dummy) that elicits a particular behavioural pattern more easily than the appropriate natural sign-stimulus. In such a stimulus (also called a supra-normal stimulus) certain characteristic features of the natural sign-stimulus are exaggerated. (Bolhuis and Giraldeau 2005)
In the human nose at least four chemoreceptor systems are located, all of which develop early during prenatal ontogeny: the main olfactory system with the first cephalic nerve (CN I), the trigeminal nerve system (CN V), the vomeronasal organ and the terminal nerve (CN 0). The relative contributions of these four different chemoreceptive systems to smell is unclear. It is generally accepted that the olfactory system is tuned to detect low concentrations of volatile odourant molecules, whereas the trigeminal system is mainly sensitive to the irritant effects of higher intensity chemical stimulation. The vomeronasal organ is sensitive to pheromones in many animals but has probably few or hardly any functions in humans and the human terminal nerve is entirely rudimentary.

Odorous compounds enter the amniotic fluid via transfer of tracheal and gut wastes and the ever-increasing urination of the foetus. The volume and composition of these substances fluctuate throughout gestation and even display daily cycles. Additional sources of such olfactory stimuli include the mother’s metabolic activity, immunogenetic constitution, and diet. Thus, before birth, each neonate is likely to be exposed to a unique profile of dietary aromas and other compounds related to foeto-maternal metabolism. Research data suggest that they are involved in early sensory processing by the foetal and neonatal brain and that at 31-37 weeks gestation, premature infants detect and discriminate among lower intensity odourants that primarily activate either the olfactory or the trigeminal system.

Presumed significance of breast and milk odours produced by nursing mothers can be found in documents dating to antiquity and reviewed by Fildes (1986). Interestingly, Charles Darwin already remarked in 1877 that his one-month-old son behaved as if he perceived his mother’s bosom when three or four inches from it. He expressed doubt that the baby’s response was based on visual cues, but speculated that it may have been guided through smell. Experimental evidence in support of his hypothesis started to appear in the early seventies of the 20th century.

After birth, infants show that they are active participants in the nursing process and that maternal odours contribute to successful early nipple attachment and suckling. Experiments with human newborns demonstrate that breast-fed infants remain attracted during a limited postnatal period towards odour stimuli from the uterine environment.

6 Opinions differ. Scientific experiments have demonstrated beyond any doubt, however, that pheromones may influence behaviour of Homo sapiens without reaching awareness.
This suggests inborn responsiveness. When one of a mother’s breasts was moistened with amniotic fluid and not the other, significantly more babies selected, minutes after birth, the moistened breast over the non-moistened breast. Such early orientation to the odour of amniotic fluid may have been adaptive throughout the evolutionary history of our species, since women presumably handle(d) their babies during and immediately after expulsion from the birth canal. The mother’s hands would then have been in contact with the birth fluids, which in turn would have been transferred to her breasts when she first attempted to nurse her newborn infant. Attraction to the odour of amniotic fluid would therefore have facilitated nipple localization. After repeated exposure to milk during the first three to five days its odour is preferred over that of amniotic fluid. This change in preference is suggestive of olfactory learning. More research demonstrated that (1) babies turn their head towards the mother’s breast before any physical contact has been made, (2) bottle fed babies prefer any lactating breast over their familiar formula, (3) the own mother’s breast is preferred above some other lactating breast and (4) an unwashed areola of the nipple and the nipple itself is preferred above a thoroughly cleaned one. These findings may indicate that the newborn’s sense of smell is highly selective right from birth and that its preferences change within the first few weeks of life.

From this and similar research some conclusions may be drawn:
(i) neonates seemingly have inborn systems for discriminating certain aspects of their environment. Such an inborn ability of newborn humans that obviously makes use of sensory systems might be viewed as some kind of inborn knowledge making the hypothesis of John Locke’s tabula rasa untenable or in need of redefinition,
(ii) human infants (and those of other species as well) seem to acquire preferences after repetitive stimulation of the same kind of stimuli.

We may conclude that these two organisms (chick of the herring gull and the newborn human) seem born with preformed learning mechanisms consisting of detection systems for specific phenomena (information and discrimination) and mechanisms to rearrange incoming information into new meaningful schemes. The observation that some organisms are ap-

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7 Because neonates of a wide range of mammalian species respond preferentially to particular odours shortly after birth (before they have the opportunity to gain significant postnatal chemosensory experience), such discriminative responsiveness may be termed ‘inborn’. (Doty 2003:314)
parently able to recognize behaviourally meaningful stimuli never before experienced in their environment, and to adequately respond to them is called ‘innate releasing mechanism’. This concept focuses on the close correspondence between stimulus and appropriate behavioural response. (Ewert 2005,25 citing Tinbergen 1951) Alternatively stated: genes, internal factors and external factors continuously interact. (Crews and Groothuis 2009,55)

The first part of the learning apparatus I call sensory system, the second part learning (in a narrower sense) or cognition which is thought to be located in the brain. Later I will return to these interactions.

Interestingly, these conclusions do not contain any reference to consciousness or to the mind that so predominantly occur in most philosophical writings on perception. Perceptive abilities and the learning apparatus differ between species. Both evolved during evolution and are instrumental to survival.

2.3 Sensory systems: information and stimulus

To the preceding example of the visual stimuli for the herring gull and the olfactory stimuli for the human neonate many others can be added. Other sensory systems are stimulated by specific stimuli that also can be defined in terms of physics or chemistry [Box 2-2; Box 2-5]. Such stimuli characterize other features of the environment like presence of objects or events that are of importance to the owner of the sensory systems. Such specific features are usually called information. Sensory systems are thus thought to be the instruments of all species of animals and plants with which they passively receive and/or actively seek information. [Chapter 11] ‘Information’ is a relatively new concept the science of which (Informatics) emerged after experience with telephone systems and computers. Right after World War II mathematicians laid out a set of rules that attempted to define information and describe its ‘behaviour’. (Gleick 2011)

The transmission of information is thought to be an interaction between a source or transmitter (part of the environment and the organisms in it) and a receiver (the sense system of the organism). Between them energy or material is transferred from source to receiver. (Dusenbury 1992,33f) The significance of the transferred information is determined by comparing the change in behaviour of the receiving organism with knowledge of its requirements and estimates of what type of behaviour would be of
Box 2-2  Stimulus and the effect of some exteroceptors of animal and plant*

<table>
<thead>
<tr>
<th>stimulus</th>
<th>sense/reaction/response</th>
</tr>
</thead>
<tbody>
<tr>
<td>heat flow, thermal stimulus</td>
<td>thermoreceptor, infrared organ, klinotaxis, tropotaxis</td>
</tr>
<tr>
<td>light</td>
<td>organ of vision, eye, photoreceptor, infrared organ</td>
</tr>
<tr>
<td>sound</td>
<td>organ of hearing, ear</td>
</tr>
<tr>
<td>change in magnetic field</td>
<td>sense of direction</td>
</tr>
<tr>
<td>change in electrical field</td>
<td>electroreceptor</td>
</tr>
<tr>
<td>change in field of direct current</td>
<td>galvanotaxis</td>
</tr>
<tr>
<td>gravitation</td>
<td>statolith</td>
</tr>
<tr>
<td>change in posture</td>
<td>organ of equilibrium, muscle spindle</td>
</tr>
<tr>
<td>angular acceleration</td>
<td>semicircular canals, sense of rotation</td>
</tr>
<tr>
<td>change in external pressure, touch</td>
<td>lateral line organ, organ of touch</td>
</tr>
<tr>
<td>tissue injury</td>
<td>nociceptor, pain</td>
</tr>
<tr>
<td>chemicals; olfactory-, taste-, gustatory stimuli</td>
<td>chemoreceptors, chemotaxis, olfaction, taste, smell, vomeronasal organ</td>
</tr>
</tbody>
</table>


adaptive advantage in the particular situations. The transferred energy is usually defined in terms of chemical or physical energy such as light, sound, vibrations, electrical or magnetic fields, temperature, pressure, etc. [Box 2-2] Some of the transferred energy contains non-informational energy too. Light, for instance, provides metabolic energy to photosynthetic plants, as well as information allowing them to determine length of day and consequently season. In practice, more channels may operate simultaneously. (Dusenbury 1992,35f)

Environmental events outside the range of sensitivity of the sensory systems can not be perceived. Instruments that amplify stimulus energy, turning weak signals into strong ones have been invented, for example a microscope amplifying visual discrimination. Other instruments convert energy outside the normal range of human sensory systems to a perceptible form, like a Geiger counter that transforms information about radioactivity into sound.

Patterns in the energy transport that acquire significance as a result of an association with some state of the environment that is relevant to the receiving organism are called the code. A pattern carrying information to the organism is usually called a signal (by technicians and physicists) or a stimulus (by life scientists).
2.4 Classification of sensory-systems and some aspects of stimuli

Tradition, going back to Aristotle, holds that man was endowed with five sense organs: vision, hearing, smell, taste and touch. To these a number of other senses were added at various times. For instance the sense of equilibrium, proprioception (the sense of our own position and movement), Jacobson’s organ (vomeronasal organ), the immune system according to some and the skin as biggest of all. The skin contains receptors of a variety of different sensory systems: pain, cold and warm defined in relation to body temperature and mechano-receptors or touch.[§ 5-3 (p.69)]

Classification of sensory systems may be conveniently based on the nature of their specific stimulus. It is impossible to present an exhaustive list of all the senses since this list yearly grows but a brief overview may be helpful. [Box 2-2; § 12-4 (p.147)] Most sensory systems can be stimulated in more ways than one but each has only one specific stimulus. For instance, pressure on the eyeball, cutting of the optic nerve and electrical stimulation of some parts of the cerebral cortex may all lead to a light-like experience. The stimulus, specific for a sensory system is the one that needs the least stimulus energy to be effective. For the human eye the specific stimulus is visible light if we may be permitted a mild circular argument but the stimulus is usually described in the scientific literature in physical or chemical terms. [Box 1-1 (p.24)]

A second classification of the sensory systems is based on the distance between the percipient and the object of perception. Touch and taste are then called the near sensory systems, while seeing and hearing are (also) far or distance sensory systems. This distinction has behavioural consequences. Food that tastes bad or is painful in the mouth is quickly spit out. No time is wasted in reflection on other peculiarities of the stuff. In case of touching a hot plate one acts first by withdrawing the hand and body and then begins to analyze the situation. With the far sensory systems there is usually some time to evaluate the coming event.

A third classification discriminates between stimuli that reach sensory systems from outside the body and those that originate in the body. The stimuli coming from outside the body are called exteroceptive, the other ones have been named interoceptive.

8 Vision can pick up information originating from as far away as distant galaxies making it possible to observe events located in the past due to the time needed to cover the distance from event to the observer. This phenomenon is sometimes referred to as time-lag.
Proprioception, the ability to sense the position, location, orientation or movement of the body and its parts is a subsection of interoception. [Box 5-3 (p.69)] A great deal of the earlier misunderstanding of ‘sensing’ was based on confusion between different meanings of the term.

The sensitivity of sensory systems in the animal kingdom differs considerably. [Box 2-3] Different species therefore may have access to different kinds of information. They experience different environments and interact with them in ways that reflect their unique requirements and capabilities. Although all animals inhabit the part of the world that is usually referred to as biosphere, their perceptual worlds may differ radically as was already pointed out by von Uexküll (1909) and beautifully described in Nagel’s (1974) classical paper. [§ 3-2 (p.43); § 10-4 (p.127)] Not only the kinds of experience (understood in its daily use) of different species can not be identical, also the experiences of different people may differ as for instance between the colour blind and a normal seeing person, and between people from different environments, languages and cultures as anthropologists have shown us.

The sensitivity of a similar sensory system among different species may be almost identical as is beautifully illustrated in the example of prey and

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**Box 2-3** The range of sound frequencies in kHz (1000 cps) audible to various species at a fixed intensity of 50 dB\textsubscript{SPL} *

<table>
<thead>
<tr>
<th>animal</th>
<th>lower limit</th>
<th>optimum</th>
<th>higher limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>fish</td>
<td>0.05</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>amphibians</td>
<td>0.1</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>reptiles</td>
<td>0.01</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>birds</td>
<td>0.75</td>
<td>2-4</td>
<td>12</td>
</tr>
<tr>
<td>mammals</td>
<td>0.1</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>human</td>
<td>0.02</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>elephant</td>
<td>0.02</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>horse</td>
<td>0.20</td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>dog</td>
<td>0.2</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>cat</td>
<td>0.125</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>rat</td>
<td>1</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>bat</td>
<td>7</td>
<td>10-30</td>
<td>100</td>
</tr>
<tr>
<td>seal</td>
<td>0.5</td>
<td>1-40</td>
<td>58</td>
</tr>
<tr>
<td>dolphin</td>
<td>0.4</td>
<td>20-100</td>
<td>145</td>
</tr>
<tr>
<td>moth</td>
<td>18</td>
<td>30</td>
<td>120</td>
</tr>
</tbody>
</table>

* Feenstra and Borgstein 2003
 predator like moth and bat [Box 2-3] and also in the example of Dretske and his dog Fido. (Dretske 2000, 2006)

2.5 Some aspects of stimuli and learning-machinery

That sensory systems are not merely windows is demonstrated by the herring gull chick opening its bill widely when triggered by its mother's yellow-beak-with-red-spot. The chick is not only using its eyes and neurological wiring, it also opens its mouth; it acts. The human infant starts nosing when smelling the breast; its mouth moves immediately in the direction of the nipple when the lips touch the breast. It starts to suckle as soon as the lips close around the nipple. Smell and touch direct the motions of head and mouth. The nose, the lips, the mouth with tongue and cheek-with-corpus buccinator (the infant's fat pad in the cheek), and the relatively high position of the larynx and epiglottis compared with the adult, allow the infant to feed and breathe at the same time. All parts must act as one system to find the nipple and start feeding. Somehow this system is also able – within a few days – to recognize its mother's breast (mamma, also pars pro toto for mother). The young human organism is perfectly able to adapt to its new environment that considerably differs from the amnionfluid containing womb a few days earlier. The baby seems to have a kind of built-in knowledge and expectancy of its new environment where the sensory systems act as tools with which its expectancies, its 'hypotheses', are tested. The answers to these hypotheses are within a few days incorporated in its body as new experience. This incorporation of new bodily experience presupposes re-organization of the relation between organism and its environment. While the olfactory system can provide specific information about the chemical nature of the environment, the preference and reaction of the baby is largely dependent on experience of a variety of sub-systems of the baby.

A human infant also learns to turn its head towards the source of the sensory information of sound in the course of the first nine months of extra-uterine life. Based on this phenomenon a psycho-physical screening test for hearing acuity has been developed. (Ewing & Ewing 1994)9 The turning-the-head-to-the-source-of-noise is learned knowledge obviously

9 This screening test has been introduced in the Netherlands in the early fifties of the last century. Its use was terminated after the introduction in the eighties of objective audiometry
pre-linguistically acquired, is usually performed automatically for the rest of one’s life and is rarely if ever connected with conscious motivation. Indeed, it is harder not to turn one’s head towards some sudden (un)known noise. Such action remains unconscious most of the time although one may later call it into consciousness with some effort.

Similarly the eyes have learned to follow some slow moving object after only three to four months of life though vision only reaches maturity by age three. (Bishop 1998) The (other) functions of vision such as depth-, form- and colour-perception do not seem to mature simultaneously.

These kinds of learned behaviour can be viewed as organization of the bodily system that allows actions. The organism in this way learns parts of its new environment(s) and gradually seems to fit into it with growing confidence. I unhesitatingly consider this to be even vital knowledge, albeit not consciously acquired (see also Thelen & Smith 1994). Consciousness or ‘mind’ doesn’t seem to be required for this process.

This knowledge may later be used to consciously acquire more knowledge. At the initial stage of World War II the British, for example, used the above mentioned – very basic – orientation to sound by constructing an instrument consisting of two extended auditory canals that made it possible to spot enemy aircraft with greater accuracy, thus demonstrating how unconsciously acquired information can be made conscious.

It should be stressed that in turning the head, not only the receptors (sensors) act but the whole organism does, i.e., perception and motor organs cooperate as one (coordinated) system triggered by some stimulus or stimuli. This cooperation of sensory systems with large parts of the locomotor parts based on the registration of electrophysiological phenomena originating in the cochlea (snail or inner ear, i.e., part of the laybrinth) and hearing nerve after acoustic stimulation.

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**Box 2-4  Polanyi’s tacit knowledge**

Someone learning a skill from a teacher must try to mentally combine the movements which the performer combines practically and he must combine them in a pattern similar to the performer’s pattern of movements. Two kinds of indwelling meet here. The performer co-ordinates his moves by dwelling in them as parts of his body, while the watcher tries to correlate these moves by seeking to dwell in them from outside by interiorizing them. By such exploratory indwelling the pupil gets the feel of a master’s skill and may learn to copy that skill.

of the body functioning as a unit, is the main conclusion of the findings of Thelen’s group. (Thelen & Smith 1994) It may also be considered as (part of) the way Polanyi’s (1966) ‘tacit knowledge’ is brought about. [Box 2-4]

The infant, thus gradually acquires bits of knowledge by acting as one single unit in which sensory systems, predominantly touch and smell in the example of nipple finding, cooperate with the motor systems. The infant-‘system’ (or rather conglomerates of sub-systems) in this way collects much basic experiential ‘knowledge’ without having consciousness or language at its disposal. Consciousness gradually develops with age. Intellectual knowledge – not further outlined here – and emotional knowledge differ. Taking smell as an example again, we know that some scents evoke vivid long-buried and obscure memories, which always appear to be emotionally charged. It relates to information apparently forgotten and probably at least partially subliminal or unconsciously retained. The frequently cited story in the (olfactory) literature is Marcel Proust’s (1928,58). He muses that it is impossible to recapture one’s past merely by trying. True recapture requires that one re-experiences the sensations one originally felt. He then describes that once, when visiting his mother, he is given a cup of tea into which some crumbs of a little cake called ‘petite madeleine’, had fallen. He then finds himself overcome with an ‘all-powerful joy’, which he does not understand at first. The memory comes back gradually:

In that moment all the flowers in our garden and in M.Swann’s park, and the water-lilies on the Vivonne and the good folk of the village and their little dwellings and the parish church and the whole of Combray and of its surroundings, taking their proper shapes and growing solid, sprang into being, town and garden alike, from my cup of tea.

It seems difficult to decide with confidence which part of Proust’s memory was unconsciously or sub-consciously acquired and which was not. Clearly, the emotional part is recalled coupled to the olfactory system, a well known phenomenon. The accompanying scenery was probably sub-consciously acquired with the olfactory stimulus. The original scenery gradually returns, forcibly and consciously. Humans can recall events that had earlier gone by unnoticed.

Many philosophers have paid attention to one such example of unconscious perception called blind sight.” Some years ago a similar finding has

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10 Due to a brain lesion awareness/consciousness of vision is lost although the eyes are perfectly normal and unconscious vision remains intact. (Weiskrantz et al. 1991)
been demonstrated for smell which was consequently described as *blind smell*. (Sobel et al. 1999) Both ‘blind sensations’ allude to a behavioural effect of sensory stimuli that are not consciously perceived. In a fascinating review Weiskrantz described six such different ‘performances without awareness’.

Unconscious ‘perception’ clearly *does* exist. It is important for many aspects of life, to some of which I will return later.

The sensory systems do not only assist in the transmission of information but they facilitate direct connections between organism and environment. Sensory system-processes are activities of the whole organism that obtain new information leading to experience [§ 10-3 (p.126)] resulting in new behaviour, usually viewed as – experientially collected – knowledge. This occurs at an unconscious level in infants, and may become conscious later, but clearly not in all circumstances. Indeed conscious perception rather is the exception or more cautiously formulated the top of the iceberg of perception. By focusing on the top of this iceberg its larger unconscious part has mainly been neglected until quite recently.

### 2.6 Perception as the origin of knowledge

By unconsciously acquiring *experience* the infant demonstrates its ability to gradually obtain new knowledge. After some repetition the same stimulus or experience leads to a comparable response, a phenomenon based on behavioural expectancy well known from the experiments of Pavlov. Expectancy (cf. the olfactory milk stimulus) leads to the response (suckling). Pavlov’s finding, conditioning, is based on induction – since Hume highly suspect – is partly innate as demonstrated by the olfactory example. [§ 5-2 (p.66)] George Santayana (1923,49-62) called this process ‘groundless faith’, an animal’s faith that is unquestionably embraced in very early youth. Alston (1993,7) introduced for this ‘attitude’ the formula ‘sense perceptual practice’, which he defined as the activity of forming beliefs (perceptual beliefs) about the physical environment on the basis of sensory perception. He also called such behaviour *doxastic* practices, which are “ineluctably rooted in our lives and are loosely defined as a family of individual dispositions in order to be able to pursue our daily activities, reli-

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11 Weiskrantz L. To have but not to hold. (In: Bolhuis 2000,311-25)
12 Nursing mothers generally do not cheat their babies. Indeed, if babies are regularly cheated early in life in their inborn expectancies, predictable character-defects develop as has been demonstrated by the notorious experiments of Harlow. (Haraway 2005)
Stimulus (plural: stimuli) something, e.g., an environmental change – more specifically the pattern of physical or chemical energy caused by an object or event – that directly influences the activity of living organisms (response) by exciting a sense organ or evoking other bodily structures such as glandular secretion. In this essay stimulus, the term used by life scientists, is considered synonymous with signal, the term used by technicians.

Signal-to-noise ratio is the ratio of the signal’s energy to the energy of (unwanted) random interference.

Information consists of facts or data, especially pertaining to a particular subject or regarded as significant from a transmitter and to a recipient. Information about the environment of a living thing to which it has been exposed is obtained through sensory systems and is called sensory information. With the acquired information organisms solve a wide variety of problems (timing activities, locating resources or threats et cetera). [Chapter 11]

Homeostasis refers to the processes by which a stable state of certain conditions in the body (milieu intérieur) is maintained in spite of environmental (milieu extérieur) changes. [Box 5-4 (p.72)]

Behaviour is an organism’s response to stimulation. The part that is observable to an observer is the realm of behavioural biology, the part that is internal that of physiology. The boundaries between the two are not sharp.
explanations for many features of the perceptual powers of human beings and other animals.

The environment of an animal is almost completely independent of the animal.¹³ The other way around, the animal's life-strategy determines which aspects of its environment are important. The senses need to recognize these important aspects with sufficient accuracy and speed so that the animal can behave effectively. In practice, the evolutionary explanation of a feature of an animal's perceptual faculties consists of reasonably exhibiting its efficiency in performing the required function of recognition. (Shimony 1971.577)

Dretske (1971) in discussing Shimony's paper states that the evolutionary point of view has little to offer epistemology and that “Darwin does not help us with Descartes”. Basically, Dretske dissociates correct “answers” (his shorthand for correct perceptual judgments about the surroundings of an individual) from cognitive achievement on the part of the respondent (emphasis in the original). I do not agree with Dretske as he seems to limit cognition to its conscious part. Judgments are usually cognitive and the nipple-finding mouth of the infant is not, but it is definitely an achievement. This discussion is largely semantic and seems to centre on the meaning of the word cognitive. Dretske's theory confirms my objection in his statement that whether or not this achievement is an epistemologically significant fact will depend [...] on how liberal [...] we want to be in classifying something as 'cognitive' or 'epistemic'. Dretske then argues that Shimony's 'cognitive states' do only statistically correlate with the character of man's surroundings. He considers this insufficient to satisfy a skeptic. Dretske then attempts to support Shimony by a progressive assimilation of a causal account into an epistemological view of perception through staging. The first stage in his view is scientific and (therefore) only useful “in explaining certain phenomenological and psychological features of perception.” The second stage centres on “the view that part of what it means to say is that someone sees (hears, feels, smells, et cetera) something is that there is a certain causal relationship between the percipient and (some phase of the history of) the object allegedly seen (heard, smelled et cetera). Dretske hesitates to accept this stage as of great philosophical importance and even seems inclined to reject it. He considers the third stage, i.e., pondering the causal relationships between the object and ourselves in perceptual situations and the fourth,

¹³ This statement should be differentiated. Many animals influence their environment, i.e. birds build nests, beavers construct dams, rabbits dig holes, not to speak about the actions of Homo sapiens.
speculating on the possibility of building the outcomes of the third stage “into the very meaning of those verbal constructions which entail that we possess knowledge” really as epistemological theories of perception. He ends with the lamentation that “if one finds this classification overly rigid, leaving out much that one would like to put into epistemology, he can only invite clarification on what epistemology is supposed to be about”.

Twenty years later Dretske (1991) stated that knowledge (emphasis added) is an early arrival on the evolutionary scene, “needed by animals to coordinate their behaviour with the environmental conditions on which their survival and well-being depend.”

Ten years later again, Dretske (2000) follows this up with an article meaningfully entitled *Perception without Awareness*. In this paper he cites many (supportive) life science publications, addressing medical questions like split brains, change blindness and other neuro-/psycho-logical deficits and knowledge, and psychological problems such as attention deficit disorders. He introduces a new objective test, by looking “in the most varied possible conditions, at what an agent finds it reasonable to do, at what, therefore, given suitable desires and circumstances, the agent is motivated to do.” Dretske thus seems to gradually change his ground by finely accepting perception without awareness.

In summary, neither a herring gull chick nor an infant is a *tabula rasa* at birth. Science has confirmed that both acquire knowledge even prior to birth. Both have innate ways of behaviour provoked by stimuli, i.e., specific signals that can be defined in chemical or physical terms. An infant of even a few days demonstrates changes in its behaviour that can be interpreted as unconsciously acquiring experiential knowledge. Knowledge therefore should not automatically be taken as consciously acquired. Much basic experiential knowledge needed for survival of every organism is acquired straight after birth and some of it even earlier than that. Alston, Dretske, Santayana and Slurink, among others, examined this early experiential cognition, although using different terms. I will return to this in chapter 5.
3 What the life sciences tell about the sensory systems (continued)

3.1 Introduction

In this chapter I proceed with the life-scientific view on sensory systems. Sensory systems are our body parts most sensitive to changes in forms of physical or chemical energy in the environment. If such energy reaches the sensory system it may lead to a cascade of processes in the organism. The form of energy that evokes the cascade is called signal (by technicians and physicists) or stimulus (by life scientists). A stimulus carrying some significance for the organism is usually called information (about the environment) although it may also be interpreted as mere noise or a mixture of both. The significance of the information for the organism may be actively sought or passively received, consciously, sub-consciously or even not-consciously.

In the preceding chapter I argued that all living entities are endowed with (sets of) inborn maxims. Chick and infant, for instance, start to feed after some – retrospectively judged adequate – stimulus. They thus have specific inborn systems called ‘innate releasing mechanism’ of feeding. Another inborn maxim is the change of the human baby’s behaviour after a few days exposure to identical stimuli. I defined that change somewhat loosely as ‘learning’ (acquiring knowledge).

3.2 Scope of human sense-systems

Environmental events can only affect sensory systems if the chemical or physical stimuli are in the range for which the systems of the organism are sensitive. A form of energy that is out of bounds of the sensory systems of Homo sapiens must first be converted to a form that is in his perceptual potential with for instance a Geiger counter that processes information about the presence of radioactivity, or an infrared camera that converts infra red into visible light. The energy of other events’ may be amplified to a level that can stimulate the sensory systems, such as a microscope that amplifies phenomena otherwise not perceptible.

1 Apart from a few exceptions of non-specific stimuli as mentioned earlier. [§ 2-4]
Such events, processes that happen in the universe defined in physical or chemical terms may even pass through human bodies unnoticed and gradually become manifest later as for instance the sequellae of (too much) radioactive or ultra violet radiation. *Homo sapiens* only notices a fraction of all (possible) forms of electromagnetic energy in the universe. Stated differently *Homo sapiens* is not able to notice each and every aspect of his environment. Some physical processes not perceptible by humans may be noticed by other animals, though. Gradually other forms of chemical and physical energy became uncovered by science and, undoubtedly, many more will follow. Even if manifestly causing reactions some decennia later, such events can not be noticed immediately or, taken here as synonymous, experienced consciously by the human organism.

Only part of the electromagnetic energy in the universe may be experienced by humans without technical aid. It is largely semantics if one chooses to call the former or the totality ‘reality’. We can safely conclude that no sentient being is able to experience all aspects of the totality which we might call *universe-reality* ($R_u$). Any organism can notice with the limited number and scope of his sensory systems only part of the former reality which we might call *animalX-reality* ($R_A$). Finally the $R_H$ reality for *Homo sapiens* we may call *human-reality* ($R_H$). Not all aspects of some object, event or phenomenon in $R_u$ can thus be experienced as there may be more to it than sensory systems of our species can grasp. This of course reminds us of Kant’s *Ding-an-Sich*. We may know and understand that a bat has different sensory systems and we may try to form an idea of its echolocation but we are not able to share the subjective character of the experience of *What it is like to be a bat*. (Nagel 1974, 83)\[§ 10-3 (p.126)\]

Incidentally, the scientific knowledge about some structures of the environment that cannot be directly experienced by humans may lead to errors in reasoning. These consist of taking results of science about structures that cannot be experienced to those that can. For instance the statement that some table-top ‘in reality’ is empty based on the empty structure of molecules and atoms is wrong as the table-top is clearly solid when eyed with normal functioning human eyes and using normal daily language. Little doubt remains if you were to hit your elbow against its edge. Indeed, the word solid has received its meaning

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2 Left out in this discussion are the sensory systems that are sensitive to – say volatile – chemicals, such as smell for *Homo sapiens* and the intricate communicative ways through pheromones of many insects. They do not influence the essence of this discussion.

3 Viz. von Uexküll’s *Umwelt* [§ 11-5 (p.138)]
in the society of – as Austin (1962,9-12) would say – normal man and in normal circumstances. This kind of error in reasoning was coined a ‘mistake of category’ by Gilbert Ryle (1947,17ff, and passim) and is due to imprecise contextual use of words, essentially a semantic error. As van Brakel (2000,v) says the manifest, macroscopic image [...] is prior to the scientific, micro-reductionist image, not only in a methodological, but also in an epistemological and ontological sense. In my terminology, human experience, i.e., the manifest (noticeable) image precedes the scientific (knowable, understandable) image.

3.3 Some observations on the (human) animal’s awareness of his environment

The word perception has been tentatively defined [p.25] as that part of the information presented through the sensory systems to the brain that leads to one’s awareness or consciousness of the objects and events in the environment and of one’s own body. One of the curious phenomena of the philosophical literature on perception is that – apart from some rare exceptions – the discussion has been overwhelmingly confined to one single sense system only, i.e., vision. Occasionally hearing, smell, touch or pain are described albeit even then generally in contrast with or as an addition to vision. Except the sensus communis posit introduced by Aristotle and also used by Thomas Aquinas, Leonardo da Vinci, Descartes and more lateley by Hannah Arendt (1958)4 little thought was given to cooperation of the senses. Recently (Clark 2008) paid attention to cooperation of senses calling it multimodal perception.

Normally every organism including Homo sapiens uses all his sensory systems simultaneously and continuously although not all of them continuously at the same intensity. The variable intensity of each sensory system depends among other things on the kind of activity of its owner and the level of attention given to that specific activity (concentration). Thereby all normal functioning organisms have a three or rather four dimensional (4-D) awareness of their environment based on the (total) – mostly unconsciously acquired – information received through their sensory systems. In fact, it is the totality of this concert or rather cacophony of information that keeps animals constantly functioning (body-reacting) and occasionally even aware of (some part of) their (constantly changing) environment. This

4 See also Borren,2013
capacity, the usually unconsciously or subliminal but continuous awareness of the relation of one’s body to its environment, is gradually formed within the first few years of childhood. [§ 2-5 (p.36)] This self-evident observation should be one of the most basic statements to start discussions of human perception.

Many life scientists take for granted that such awareness concerns the brain. Indeed it is one of the fundamental objections (mereological fallacy) [Box 3-1] of Bennett and Hacker against neuroscientists. In general, they state, neuroscientists have a strong tendency to speak about a brain that knows things, reasons inductively, and constructs hypotheses on the basis of arguments, and its constituent neurons that are intelligent, can estimate probabilities, and present arguments. (italics in the original). This logical fallacy leads to a form of re-importing Cartesian dualism or even re-importing the concept of a homunculus into neuroscience, such as ‘my brain and I’.

Thelen and Smith (1994,xxii-xxiii) even widened the concept of ‘co-operation’ of the human senses. Based on the principles of nonlinear dynamic systems, they tackled the development of the child as a whole system that fundamentally is an inextricable causal web of perception, action and cognition. They conclude that one cannot separate (parts of) perception, action and cognition without considerable loss of understanding each of them.

Other criticism of the viewpoint that cognition is confined to one’s brain is coming from those researchers that advocate externalism in the philosophy of mind. (Clark 2008; Noë 2009) Some scientists advocate drawing the line still wider and further. Hutchins (1995), for instance, studied navigation teams of the USA navy by thoroughly analysing the way in which (changing) members of such teams interact, using almost all faculties and every possible navigational instrument they had at their disposal. He compared the people interacting with each other and their navigational instruments to the various parts of the human body, broadening the concept of human cognition and its usually accepted borders. He compares those instruments to the cane of a blind man, which gradually develops into an extension of his proprioception and functions as the blind man’s tool for spatial orientation. Another example of the similarity between humans and their instruments as information

5 Mereology (μέρος = part) is the theory of parthood relations, i.e., the relations of a part to the whole and those of part to part within a whole.
processing systems has led to the symbiotic hybrid called cyborg. (van Brakel 1998,9) [Addendum 14-2 (p.167)]

In summary, along with the reductive approach to study or analyse one sensory system separately, particularly vision, there are also other approaches feasible. They pay attention to the cooperation of all sensory systems and even to the interconnection with other bodily systems. Some extend this line of thought by connecting extra-corporeal systems with the human body thus ‘incorporating’ hardware and/or software.

Nothing of this is new. We are aware of the cooperation of our sensory systems even if we are very much focused on one specific activity which heavily relies on the use of one sense only. Compare for instance the concentrated intellectual activity of reading Heidegger’s Sein und Zeit. Even then, the reader remains aware of the environment in a (almost)-subconscious way by the continuous cooperation of all his sensory systems although some of them seem to be in a semi-dormant state. As soon as some strange event occurs in his environment, even when he is highly concentrated, the sensory system sensitive to that specific stimulus reacts to the sudden change in arriving

### Box 3-1  Mereological fallacy*

**ARISTOTLE**
For it is surely better not to say that the soul pities, learns or thinks, but that the man does these with his soul.

**RYLE**
[I]t is improper to speak of my eyes seeing this, or my nose smelling that; we should say, rather, that I see this, or I smell that, and that these assertions carry with them certain facts about my eyes and nose.

**WITTGENSTEIN**
Only of a human being and what resembles (behaves like) a living human being can one say: it has sensations; it sees, is blind; hears, is deaf; is conscious or unconscious.

**BENNETT and HACKER**
Mereological fallacy is the mistake of ascribing to the constituent parts of an animal attributes that logically apply only to the whole animal.

* Quotations from Aristotle (DA 408b 12-5), Ryle (1949,161), Wittgenstein (1953, § 281), Bennett and Hacker (2003,68ff)
signals, occasionally overruling all other sensory systems. Take a sudden noise. The hearing of the reader of *Sein und Zeit* remained sub-conscious (not aware of it) during the time the environmental signals were steady and expected. As soon as a significant change occurs in the environmental sounds the reader is immediately alerted. If the signal is strong enough in relation to the concentration on the task at hand, in our case reading philosophy, the body rushes into alertness with attention to the origin of the stimulus; when the qualities of the sounds and its interpretation proof to be severe, a so called *fight* or *flight* reaction may even follow. A similar example is the normal functioning nose of a sleeping human that almost immediately awakes its owner if it notices smoke.6,7

It thus is clear that paying attention to one single sensory system without taking into consideration the cooperation of them all is a form of (biased) reductionism. We should thus be cautious in drawing conclusions about the functioning of any human or animal from analysis of one single sensory system only.

In the example of reading Heidegger’s book I alluded to the mechanism by which information is selected, commonly referred to as attention. According to William James’ classic description (quoted by Bisley et al. 2010,2) attention is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, or consciousness is of its essence. It implies withdrawal from some things in order to deal effectively with others.

James discerns two attention varieties, i.e., passive (reflex, non-voluntary, effortless) and active (and voluntary). In modern terms these are classified ‘bottom-up’ ‘top-down’, respectively. (ibid.) The change from a current course of action to respond to potentially advantageous or threatening stimuli (on which survival may depend) is called the reorienting response. This involves switching from a (virtual) network in the brain that concentrates on some focused activity to another one that interrupts the former and resets on-going activity as a reaction to a vital environmental stimulus. (Corbetta et al. 2008,306)

6 One of the causes of very significant differences between young and old deaths through fire – well known within circles of insurance companies – is the loss of smell of the elderly. The normal nose of the young is generally much better than the normal nose of an older person. Decline of function of any sensory system related to age is normal.

7 Normal function: any individual subject with all sensory systems functioning according to the norm of that species at that space and time.
Box 3-2  Mental representation*

The classical answers to the question of mental representation can conveniently be divided into three types: (1) picture theories, (2) causal and/or informational theories, (3) – in the terms of W. Sellars – PMese theories (symbolic logic). All three run into the problem of accounting for cognitive errors, like misperceptions, false beliefs, confused concepts, bad inferences, unrealized intentions and so forth, summarized as the normativity problem of making the distinction between the fact of cognition and its norms.

* Millikan 1993,3

3.4  ‘Reality’ is not?

Only part of the chemical or physical changes in the environment of any species will stimulate his sensory systems; only part of the total reality may thus be directly experienced unconsciously (for each sentient being) or consciously, i.e., perceived.

Some of the chemical or physical changes that stimulate the sensory systems is used as significant information; some of it is consciously noticed, but most of it is not. Together with and through inborn (learning) maxims or algorithms this information gradually leads to the development of (new) behavioural rules. I call this a learning process the results of which are somehow stored into memory.

Difficulties arise if we try to analyse in what form the incoming information is organized and in what way it is put into storage (memory). These questions have been hotly debated and are intensely researched by life scientists (Roediger III et al. 2007) and philosophers.

We know that during the cascade of processes in an organism after stimulation of some sensory system, many transformations occur. A one to one representation of that part of reality in the body therefore is highly questionable. Some sort of – distorted – end-result is obtained in the body (memory and knowledge) which provisionally can be taken as some kind of (probably distorted) representation.[Box 3-2] The distorted representations build the way the world presents itself to us. Is Berkeley right with his Esse est percipi after all? 8 Is everything that is perceived only illusion(s)? My objection to such conclusions is that it is generally reached after analysis.

8  Esse est percipi (to be is to be perceived). Berkeley asserts of ‘unthinking things’ that ‘their esse is percipi’ (Treatise Concerning the Principles of Human Knowledge, 1710, par 3)
of one single sense system only which is, as I have argued, an unrealistic approach. No sentient being is ever using one single sensory system only. Moreover, *Homo sapiens* has survived so far with his sensory systems and his central nervous system that somehow developed during evolution. Thus the information we gather with our sensory systems must be sufficient for our survival and can not be entirely wrong. In the next chapter I will turn to evolution.

Sceptical philosophers have told us that our sensory systems often deceive us. Others aimed at absolute certainty (or truth) as one of the alleged goals of Western philosophy. Scientists have followed Hume, in that scientific knowledge is acquired inductively and therefore always provisional. Science’s consequential view is that absolute certainty of knowledge is highly questionable if not impossible. I will return to this later.
4 Darwin, anti-Darwin and Evolutionary Epistemology

Darwinism is the cornerstone for a fully naturalistic theory of persons. The theory of evolution by natural selection provides prospects for philosophical unification of all the sciences that pertain to human being. O Flanagan 2009,3

4.1 Introduction

As already mentioned in the previous chapters behavioural biology, comparative anatomy, physiology, neuroscience et cetera, in short all life sciences and many other disciplines (vide infra) are solidly united in their acceptance of evolutionary theory which I take as synonymous with neo-Darwinism. It is of paramount importance to understand the varieties and different states of development of sensory systems and the central nervous system in evolutionary context, both in se as in relation to the habitats in which they function. Wholly endorsing the quote from Flanagan above, I deem it necessary to add a chapter on this topic as I have noticed too many varieties of opposition and misunderstanding on the one hand and an almost religious idolization of neo-Darwin(ism) on the other.

Alfred Russel Wallace (1823-1913) discovered the theory of evolution through natural selection about the same time as Darwin.1 Wallace sent his manuscript on the subject, accompanied by a letter to Darwin from the Moluccas where he was collecting specimen of natural life. In this letter which reached Darwin in June 1858 Wallace asked him to read the manuscript and submit it to some journal if he found it acceptable. Charles Robert Darwin (1809-’82) asked advice of his friends, the geologist Charles Lyell (1797-1875) and the botanist Joseph Dalton Hooker (1817-1911), who together presented Wallace’s manuscript, accompanied by excerpts from Darwin’s own manuscript and letters on July 1, 1858 at a meeting of the Linnaean Society of London, amounting to a simultaneous publication of the findings of Wallace and Darwin. (Mayr 1991,7) On 24 November

1 Wallace AR independently invented the principle of natural selection during a malarial fit on the island of Ternate eighteen years after Darwin had devised the idea but before its publication. (Gould 1990,52)
1859 Darwin's *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle of Life* was first published, followed in 1871 by *The descent of Man, and Selection in Relation to Sex*.

Darwin's theory or hypothesis (*vide infra*) has led to many controversies because it seems to occupy a special place at the crossroads of science, philosophy and religion. Even before *On the Origin of Species* was printed, Asa Gray, a Harvard botanist, after receiving an advance copy sent to him by Darwin, wrote a review for the American Journal of Sciences and Arts. He prepared a series of articles to defend evolution from the anticipated charges of atheism. (Gross 1996) Orthodox (mono-theistic) religious thinkers have attacked Darwin's theory of evolution to this day. Apart from the religiously rooted objections several other ones have been formulated. I will start with the former and will subsequently say a few words on the latter.

### 4.2 Creationism and Intelligent Design

All things were made by Him, and without Him was not anything made that was made.

*John 1:23, 4*

Creationism comes in many varieties that are characterized according to the degree of biblical literalism and ranges from strict biblical literalist young-earth creationism which hardly accepts modern science, through a variety of old-earth creationists (gap-creation, day-age creationism) to progressive creationism, continuous creationism, and theistic creationism, the least literal and hardly distinguishable from nonreligious evolutionists. Specific terms may have slightly different connotations depending on who uses them.

In general, young-earth creationism posits that the universe was created at one time, within the last 10,000 years. Noah's flood is an essential element to both young-earth theology and creation science. Both have it that this flood was a historical occurrence, in which water covered the whole globe.

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2 Most of the information on Creationism in the following paragraph has been drawn from a review of Scott (1966,505-22)

3 It seems mandatory to start a survey of Creationism with some text from the Holy Book, the Holy Script, the Bible, the special revelation from God himself, demanding our absolute trust and allegiance as Plantinga (1998,674) has it.

4 Now we Reformed Christians are wholly in earnest about the Bible. We are people of the Word; *sola Scriptura* is our cry; we take Scripture to be a special revelation from God himself, demanding our absolute trust and allegiance. (ibid.)
During the year that the flood waters receded, all the geological features of the world were established.

Old-earth-creationists accept modern geology and radiometric dating and their implication of earth being an old planet. One version of old-earth-theory, gap-creationism, allows for a long period of time before the six days of creation described in Genesis, or alternatively for the six days in Genesis to be separated by thousands or hundreds of thousands of years. Day-age-creationism accommodates some modern geology by claiming that each of the six days in Genesis is actually an immensely long period of time.

In progressive creationism, God is supposed to have created the original species, which subsequently have progressed by evolving into new forms. Noah's flood is considered a local, not a universal event. Continuous-creationism and theistic evolutionism are further along the continuum, referring to a Christian perspective that accepts a considerable amount of evolution. In continuous creationism, God plays a very active role in directing evolution from the created kinds.

Theistic evolution in the most general sense is the idea that God created, but that His creation had the inherent property of evolution. By and large, theistic evolutionism accepts the evidence of science, and fine-tunes the theology if necessary. It takes Noah's flood not as a historical event, but as a metaphor of the importance of obedience to God, ultimately of God's love for humankind. Theology varies as to how involved God is in guiding the

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**Box 4-1  Fundamentals and fundamentalism**

**Fundamentals** is a testimony, published during the years 1909-1912. Three million copies were distributed to 'every pastor, evangelist, missionary, theological student, Y.M.C.A. and Y.W.C.A. secretary in the English speaking world.' (Kennedy 1957)

**Fundamentalism** is the term derived from the writings of the group of Presbyterians at Princeton University (1910) who wrote the series of pamphlets called *The Fundamentals* [...] In them they spoke out against the modernist drift of some churches, especially efforts to understand the Bible as a historical document rather than as the literal and infallible truth they believed in: the direct creation of the world and humanity by God from nothing, miracles, and the life of Jesus, his virgin birth, his death to atone for human sin, his resurrection and imminent return. In 1920, a USA Baptist editor coined the term 'fundamentalist' to describe those beliefs. Christians who hold such beliefs prefer the label 'evangelical' (MacKenzie 2005, 40-3)

* Y.M.C.A. & Y.W.C.A. = Young Men's Christian Association & Young Women's Christian Association.
evolutionary process, although this is not the main issue in the creation/evolution debate.

Special creation believes that God created according to the literal interpretation of Genesis, i.e., all at one time in its present form. The theory or – according to creationists – the hypothesis of evolution in their opinion entails that God did not specially create mankind, therefore mankind is not special to God and the fall of Adam and Eve is irrelevant. Without Adam and Eve's sin the death of Christ is irrelevant and therefore the foundation of Christianity is irrelevant. If the Bible is not (literally) true, then Revelations cannot be true and salvation is in jeopardy. Moreover, as evolutionary theory denies God, it removes the source of morality. It is clear therefore why their children’s souls should be protected from this evil.

The points of view of creationists have been formulated (summarized) in the five fundamentals [Box 4-1] against evolution: the infallibility of the Bible, the virgin birth, the atonement, the resurrection and the second coming of Christ. The root of all evil according to the five fundamentals is materialism and its parent science.

It is clear from the foregoing that Creationism, if it seeks to gather scientific evidence, it does so in order to find evidence in support of the Bible. By starting from a pre-conceived conclusion and selectively using evidence to back it up, creationists 'science' is clearly not very scientific. (Holmes 2005)

The heaviest Flak\(^5\) and opposition against evolution occurred in the USA, usually in Court, motivated by the way evolution or Creationism should or should not be taught at school. Creationism won a few battles in USA courts, but finally lost the war. As a phoenix it nevertheless reappeared under the name of “many splendoured” Intelligent Design (ID). All its varieties can again be defined with the degrees of biblical literalism as Creationism.

There is an irreconcilable contradiction between science and religious belief as the standard by which scientific facts are accepted or rejected. Scientists wish to understand how the universe works. Their theories are based on inference. On the other hand, it is also incorrect to use evolution for a deductive line of reasoning leading to a particular world-view as, for instance, Richard Dawkins is never tired of repeating. (McGrath 2004)

Neo-Darwinism [§ 4-3] still is the theory of evolutionary mechanisms that has great explanatory power, is based on observation, is open to

\(^5\) FLAK = Flug(zeug)abwehrkanone = (the fire from) anti-aircraft gun(s).
modification and is the best account we have of the origins of species. But bear in mind that in principle any theory can and must be refuted in the light of further observations. To call neo-Darwinism a theory or hypothesis is mainly semantics. Nowadays, life scientists accept neo-Darwinism as one of the cornerstones of science, in the words of Ernst Mayr (1991,162) “The basic theory of evolution has been confirmed so completely that modern biologists consider evolution simply a fact”. Neo-Darwinists, of course, are as wrong as creationists if they impose their theory as absolute truth. We can state that the evidence fits the theory very well indeed but that it should not be embraced as a religion nor accepted as absolute truth.

4.3 Darwinism and neo-Darwinism

Darwinism is the scientific theory originally called ‘natural selection’ by Darwin. After incorporation of the Mendelian laws and modern molecular biology that did much to support and buttress the theory it was renamed neo-Darwinism. Synonyms are evolutionary theory (Hull et al.1998; Ridley 2004a, 2004b) and evolutionary synthesis (introduced by Julian Huxley in 1942). Neo-Darwinism has firm roots in many if not all (life) sciences (geology, paleontology, embryology, taxonomy, comparative anatomy, physiology, molecular biology, immunology, ecology, population biology, psychology, anthropology et cetera) abundantly providing examples of Whewell’s consilience of inductions.[Box 4-2]

Evolutionary theory or neo-Darwinism, as I will call it, consists of a whole bundle of (sub)theories. Point zero of the following list does

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**Box 4-2  Consilience, triangulation, robustness**

**Consilience**, a term coined by Whewell, happens when inductive explanations of two or more different kinds of phenomena are discovered which separately corroborate one another.

**Triangulation**, defined as the use of multiple procedures, methods, or assumptions to get at the same putative object, trait, or regularity is commonplace in ordinary cognition and in science. Occasionally triangulation is also referred to as robustness.

* Whewell 1840, ii.65-80; Goldman 1986,49; Wimsatt 1981,124-63
not belong to the evolutionary theory properly speaking. It is usually mentioned in its introductory paragraphs though, occasionally with the observation that ‘everything and everybody is star dust’.

(0) the universe is about $13.7 \times 10^9$ years old taking its start with the Big Bang; the earth is about $4.56 \times 10^9$ years old,

(1) evolution, the theory that the biological development is steadily changing from its very beginning, is a scientific fact,

(2) life on earth started spontaneously about $3.8 \times 10^9$ years after the planet formed;

(3) life developed from that simple start to many and more complex forms, increasing the total biomass of animals, plants and microorganisms,

(4) thereby gradually building a ‘tree of life’ (a concept originally constructed from fossils),

(5) natural selection operates on the abundant production of genetic variation in every generation and on random genetic mutation; therefore it is not goal-directed; it is a process of trial and error (or stochastic process), leading to maturing and procreating of relatively few individuals. Survival ensures a well-adapted combination of inheritable characters producing the next generation,

(6) *Homo sapiens*, the human species, has his place in the ‘tree of life’ just like every other living thing.

From an evolutionary perspective we may take for granted that *Homo sapiens* gradually developed his phenotype. This is thought to have adapted as the

6 The Big Bang is the dominant cosmological theory about the genesis of the universe, an event that occurred about $13.7 \times 10^9$ years ago.

7 There are different hypotheses of the origin of life and how life became so diverse and widespread. Darwin believed that life appeared by some wholly unknown process, and therefore is unsoluble. I think this statement is still valid.

8 The oldest traces of life are about $3.85 \times 10^9$ years old (some material called clinopyroxene found in Akilia Island in Greenland). This – nucleated – oldest marine sediments are thought to contain some residue of organisms. The oldest still surviving creatures are *Stromatolites* first arriving around $3.5 \times 10^9$ years ago. They look like grey coli-flowers, are conglomerates of cyanobacteria and rock-dust and survive at Shark Bay on the northwest coast of Australia. They are prokaryotes (= pre-nucleated).

9 Species divided, evolved and died out. The sequence of the species is not known so that the unknown number of species that have lived over the last 4 billion years could be arranged in many ways. For instance, with a mere twenty species there are some $2 \times 10^9$ possible trees (of life), but some are more likely than others.

10 Circa 5 million years ago the family of two-legged primate animals (hominids) appeared on the scene. Some 3-2 million years ago there existed about half a dozen types of them. Finely only our species, i.e., *Homo sapiens* remained.
result of continuous interaction of the genotypes of his ancestors in relation to their continuing changing environment. The human animal proved quite successfull. Those ancestors or side branches of the hominids trajectory of the tree of life that were less successful – and/or possibly had less luck – became extinct. This competitive process of selection – so far advantageous for each species that still exists – is generally known as survival of the fittest (Darwin’s serendipitous trouvaille when reading Malthus on population). Homo sapiens thus belongs to one of the surviving species because his specific qualities have contributed to his survival, like in other – still – surviving species.

Which characteristic(s) have caused this survival of Homo sapiens? Many features have been proposed, such as the reproductive system, the erect position, the hand with the opposing thumb, the sensory systems, the hairless skin with abundance of sweatglands, the spoor reading capacity, socialisation, the central nervous system and language development. Not without reason, the combination of all of them contributed to the survival of Homo sapiens. The human phenotype is, in the words of Dawkins (1976), merely a survival machine. A holistic approach should, I suppose, pay attention to each (sub)system of the human animal but that would take too far. Leaving out of consideration the reproductive system, the erect position, the skin’s peculiarities and the hand with the opposing thumb, I will focus predominantly on the sensory systems and (the embodiment of) cognition. (see also Thelen et al 1994)

4.4 Neo-Darwinism yes, but...

I leave the religious scruples to what they are and will not touch on the objections to Darwinism from Stalin’s Russia (the Lysenko affair). The distinction between these antagonists on the one hand and scientific objections on the other occasionally is a little blurred as some representatives of both anti-Darwinist varieties were trained scientists.

11 “Fifteen months after I had begun my systematic enquiry, I happened to read for amusement Malthus on Population, and being well prepared to appreciate the struggle for existence which everywhere goes on, from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of new species. Here, then, I had at last got a theory by which to work.” (Darwin C and Wallace AR 1858:evolution by natural selection Linn. Soc.London [also G.de Beer, ed. Cambridge: Cambridge University Press, 1958] 120)
12 Liebenberg 1990, Liebenberg 2012
Another introductory comment to this paragraph is that some opponents of Darwinism have a tendency to overplay their hands, or, as Stephen Jay Gould (1976, 24ff) succinctly observed that Darwin’s theory of natural selection has been a perennial candidate for burial. Gould himself introduced additions to evolutionary theory, as in his renowned paper *The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme* (1979). He also raised critique, as for instance in his theory of punctuated equilibrium. (Eldredge et al 1972) Nevertheless the last book summarizing the evolutionary beliefs of that amazing polymath (Gould, 2002) is an extensive, scholarly and supportive survey of Darwin’s life, the development of his thinking, his worries and his evolutionary theory.

I will here briefly comment on Susan Oyama’s *developmental systems theory*. Her philosophical outlook can probably be pictured best by the story of Jorge Luis Borges. [Box 4-3] She herself refers to him as master of multiple embeddings, infinite branchings, and ambiguous boundaries. Oyama vehemently opposes Francis Crick’s dogma of molecular biology that advocates the one-way flow of information from genes to proteins acting as the ruling metaphor for development. Crick’s dogma, she says, is used as a metaphor taking many forms such as programs, blueprints and instruction algorithms, all of them involving the emanation of basic developmental causation from the DNA. (Oyama 2000b, 50) A subtle transition is thus made from ‘messages’ about molecules to messages about bodies and minds. This shift from *gene* transmission to *trait* transmission she calls genetic imperialism. (ibid. 52) Oyama believes in a multiplicity of entities, influences and environments, interconnected and measurable on more than one scale of time and magnitude. Instead of Crick’s dogma she advocates a heterogeneous array of processes, entities, and environments – chemical and mechanical, micro- and macroscopic, social and geological. What is transmitted between generations is not traits she says, or blueprints or symbolic representations of trait, but developmental *means or resources, or interactants*. These means include genes, the cellular machinery necessary for their functioning, and the larger developmental context, which may include a maternal reproductive system, parental care, or other interactions with conspecifics, as well as relations with other aspects of the animate and inanimate worlds. This *context*, which is actually a system of partially nested contexts, changes with

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13 This general rule emphasized the order of events from transcription through translation and provided the basis for much of the genetic code research in the post double-helix 1950s. The central dogma is often expressed as the following: “DNA makes RNA, RNA makes proteins, proteins make us.” (Nirenberg 2010)
time, partly as a result of the developmental processes themselves. (ibid. 29) The benefits of seeing evolution as a succession of developmental systems restores the organism as such, allows us to appreciate the role of the genes without turning them into wise little homunculi and affords us a way out of the multiple versions of the nature-nurture dialogue. (ibid.31)

Philosopher naturalist John Dupré (2012) agrees with Oyama. The life cycle is what is basic, the egg, child and adult each form a particular time slice. Indeed, each step should be taken as a process, he says, cyclical more often than not, which makes possible the recurrence of the various stages. The genome is not a mere repository of biological form, but a full participant in biological process.

Dupré, moreover, draws our attention to the large proportion of the history of life during which all species were asexual. The image of the Tree of Life, he says, has been rendered at least partially obsolete by recent developments, especially in microbiology, where so-called lateral gene transfer, the passage of genetic material not from ancestors, but from sometimes distantly related organisms on widely separated branches of the Tree of Life, is endemic among Bacteria, Archaea and Eukarya. (ibid.145ff) In that case, the metaphor of a web or a net would partially cover the development better than that of the Tree of which branches always diverge and never merge. Within the Eukaryotes (animals, plants and fungi) with a more complex cell structure including a nucleus that houses the genetic material, the Tree of Life still holds since in this class the lateral gene transfer seems to be uncommon. The transfer of genetic elements by a virus does continue though. (ibid. 149)

Epigenetics is the collective noun used to refer to both the experiential effects and their underlying molecular mechanisms – supplanting the ‘simplistic view’ of Crick’s dogma – in which gene activity can be modified by environment, history and experience. Epigenetics is an evolution of the theory of neo-Darwinism based on continuing research revealing exceptions and qualifications. It turns out that a gene may also be subjected to modifications in its chemistry, or in its chromosomal environment, which do not change the coding DNA sequence but do affect its efficiency. These epigenetic modifications come in two main varieties. First, the DNA itself may be modified by a process called methylation and second, the DNA in chromosomes is wrapped around special proteins called histones, that in

14 A variety of mechanisms are described such as conjugation (a tube from one cell is inserted into another one passing on genetic material), transformation (uptake of free DNA from the environment by a cell) and transduction (transfer mediated by a virus). (Dupré 2012,147ff)
Box 4-3  [T]he wholeness and interconnectedness of the universe, a unity that undoes individuality*.* **

The god, foreseeing that at the end of time there would be devastation and ruin, wrote on the first day of Creation a magical sentence with the power to ward off those evils. He wrote it in such a way that it would reach the most distant generations and not be subject to chance. No one knew where it was written nor with what characters, but it is certain that it exists, secretly, and that a chosen one shall read it. I considered that we were now, as always, at the end of time and that my destiny as the last priest of the god would give me access to the privilege of intuiting the script. The fact that a prison confined me did not forbid my hope; perhaps I had seen the script of Qaholom a thousand times and need only to fathom it.

Throughout the earth there are ancient forms, forms incorruptible and eternal; any one of them could be the symbol I sought. A mountain could be the speech of the god, or a river or the empire or the configuration of the stars. But in the process of the centuries the mountain is levelled and the river will change its course, empires experience mutation and havoc and the configuration of the stars varies. There is change in the firmament. The mountain and the star are individuals and individuals perish.

What type of a sentence (I asked myself) will an absolute mind construct? I considered that even in the human languages there is no proposition that does not imply the entire universe; to say the tiger is to say the tigers that begot it, the deer and turtles devoured by it, the grass on which the deer fed, the earth that was mother to the grass, the heaven that gave birth to the earth. I considered that in the language of a god every word would enunciate that infinite concatenation of facts, and not in an implicit but in an explicit manner, and not progressively but instantaneously. In time, the notion of a divine sentence seemed puerile or blasphemous. A god, I reflected, ought to utter only a single word and in that word absolute fullness.

Then there occurred what I cannot forget nor communicate. There occurred the union with the divinity, with the universe (I do not know whether these words differ in meaning). Ecstasy does not repeat its symbols.

I saw infinite processes that formed one single felicity and, understanding all, I was able also to understand the script of the tiger.

It is a formula of fourteen random words (they appear random) and to utter it in a loud voice would suffice to make me all powerful.
May the mystery lettered on the tigers die with me. Whoever has seen the universe, whoever has beheld the fiery designs of the universe, cannot think in terms of one man, of that man’s trivial fortunes or misfortunes, though he be that very man.

* Oyama 2000a, 238  
** Borges 2000, 203–7 (In South America the word ‘tiger’ is often used for ‘jaguar’ as in this story).

A turning may be altered by methylation or other simple chemical additions. Both kinds of epigenetic change add only a few atoms to the giant DNA or protein molecules and are generally not inherited, but exceptions occur that can have significant consequences: sometimes resulting in the complete silencing of a gene or even a whole chromosome. One example of epigenetic changes in eukaryotic biology is cellular differentiation in which the zygote through various divisions and cell lines delicately turns into a variety of fully differentiated cells. It does so by activating some genes while inhibiting others. Another example of epigenetic changes in eukaryotic biology are the effects of the ‘natural experiment’ of the Dutch Hunger Winter of 1944 that even brings back to mind a Lamarckian touch into human genetics.

Summarizing: all points of the list of neo-Darwinism [§ 4-2] remain valid except the later addition of Crick’s dogma [note 13 (p.58)] which should be mitigated into Crick’s general rule. The metaphor of the Tree of Life could be accommodated to incorporate asexual reproduction as John Dupré’s suggested. There are indications that some Lamarckism may still occur.

Siding with Stephen Jay Gould that neo-Darwinism is alive and kicking we can endorse Mayr’s statement [§ 4-2] that the basic theory of evolution has been confirmed so completely that modern biologists consider evolution as simply a fact. Being a scientific theory it stands to reason that neo-Darwinism still evolves; the writings of Gould, Oyama, Dupré and epigenetics should be considered as adjustments to neo-Darwinism that underline and strengthen rather than bury (t)his evolutionary theory.

4.5 Evolutionary epistemology

Evolutionary epistemology, a term coined by Donald Campbell (1974), is defined as a naturalistic approach to epistemology, which emphasizes the importance of natural selection in two kinds. In the first, selection is the generator and maintainer of the reliability of our senses and cognitive
mechanisms, as well as the fit between those mechanisms and the world. In the second kind, trial and error learning and the evolution of scientific theories are construed as selection processes. (Bradie 2008) Both varieties of evolutionary epistemology accept neo-Darwinism as a given and both argue that it is indispensable for understanding the nature and origin of knowledge. Both accept human beings and their cognitive faculties as natural phenomena. Both take the view that there is no sharp divide between epistemology and science. (Buskes 1998,8) There is thus little reason why epistemological questions should be left to philosophy and should not also be studied by psychology, cognitive science and evolutionary biology.(ibid.)

Many philosophers are reluctant or even decisively sceptical to accept science within their domain. Fumerton (1985,7) even states that “I am one of those who thinks science has no light to shed on either the epistemological or the metaphysical problems of perception.” In line with John Dewey
and Otto Neurath, Willard Van Orman Quine (1969, 126-7) claims that philosophy (epistemology) is on a par with science:

My position is a naturalistic one; I see philosophy not as an a priori propaedeutic or groundwork for science, but as continuous with science. I see philosophy and science as in the same boat – a boat which, to revert to Neurath’s figure as I so often do, we can rebuild only at sea while staying afloat in it. There is no external vantage point, no first philosophy. (Italics in original)

Finally, Quine’s book Pursuit of truth (1990) is a clear, concise formulation of his philosophical position, in which he defends that epistemology is part of natural science and by consequence philosophers and scientists should join forces in their quest for understanding how knowledge is achieved and how reliable its products are.

Of course the view that everything Homo sapiens encounters belongs to his/the world and consequently is accessible to investigation by (the appropriate methods of) the natural sciences has met with opposition. I will not explore the discussions pro and contra but refer the interested reader to others who did. (Buskes Chapter 1 & 2, 1998; Haack 1993 & 2003; Shimony 1981; Slurink 2002; Vollmer 2002).

As for evolutionary epistemology, already in 1987 Callebaut and Pinxten constructed a ‘complete evolutionary epistemology bibliography’ of almost six hundred entries. Like my introductory notes on neo-Darwinism and natural science, this summary also will therefore be brief.

The second kind of evolutionary epistemology, the one that uses neo-Darwinism mainly as a metaphor of evolutionary-like processes in other domains, is taken by some philosophers as a real exponent of evolution, with Popper (1978) and Wuketits (1986) notably as Godfathers of this concept. In the words of Wynne (2001, 351ff):

Evolutionary epistemology is the idea that evolution is a knowledge-gaining process. Universal Darwinism holds that processes of variation and selection can be observed at different levels from the primary level of biological evolution (where genes code for phenotypes) through to

16 Otto Neurath’s anti foundationalist boat metaphor: “There is no way to establish fully secured, neat protocol statements as starting points of the sciences. There is no tabula rasa. We are like sailors who have to rebuild their ship on the open sea, without ever being able to dismantle it in dry-dock and reconstruct it from the best components”. (Neurath 1983)
individual learning and culture (where the units of variation and selection are not so clear cut).

This type of evolutionary epistemology (and its varieties like sociobiology), does not seem to be correct to me. Its flaw lies in exporting to the analysis of human culture, the apparatus of the strictest form of Darwinian orthodoxy. Stephen Jay Gould criticised this school of thought, especially sociobiology, most eloquently.\(^\text{17}\) He argued that orthodoxy locates all evolutionary mechanics in the struggle for reproductive success among organisms. But effective behaviour needs not have a specific genetic ground, yet Darwinism is a theory of genetic change. The fallacy of inferring historical origin from current utility is best expressed, Gould says, by noting that many, if not most, biological structures are co-opted from previous uses, not designed for current operations. Legs were fins; ear bones were jaw bones and jaw bones were gill-arch bones; incipient wings could not power flight but may have served for thermoregulation. The same error undermines the central claim of ‘this cardboard Darwinism’. (ibid.) The human brain became large by natural selection (and who knows why). Many shapes and behaviours are fit for other functions. The continued success of flying fishes, as George Williams once noted (ibid.), depends upon their propensity for falling back into the water after they emerge. But no one in his right mind would argue that mass was constructed by natural selection to ensure a timely tumble.

Evolutionary epistemology, defined by Bradie (1986,403) as the attempt to account for cognition as a biological phenomenon in animals and humans is correct. Cognition is a straightforward extension of the biological theory of evolution. This viewpoint also accepts science as the currently most promising, indeed best way to understand the universe. Evolutionary epistemology accepts neo-Darwinian evolution. To this I wish to add that (any) scientific theory is always provisional and induction is its method of choice.

\(^{17}\) Gould 1990,26-50
5 The unacceptable legacy of Aristotle’s holy five

5.1 Introduction

In order to learn normal speech every human child needs a social and teaching environment. Pre-linguistic children who grow up in an environment without normal speaking humans will never acquire normal language. The French (le) sauvage de l’Aveyron and some other well documented so-called ‘wolf-children’ support this thesis. Another example are the experiences with deaf\(^1\) children who are unlikely ever to develop normal spoken language (see below).

Deafness also has a huge impact on social, cognitive and emotional development of a child, that has to be taught every new word by its parents or a specialized teacher: these children do not learn by hearing them. (Archbold 2010,5ff) Those are strong motives for the attempt to equip deaf infants with a so called cochlear implant during their linguistic ‘window’, the few years in which infants and young children are able to learn to speak. The acquisition of normal spoken language post-linguistic – even after receiving a cochlear implant – is not possible anymore.

Such experiences are convincing arguments for the innate ability to development of language, the necessity of sufficient hearing to acquire normal language, the acquisition of language over a certain period and the withering of the first language acquisition potential after that period. This incidentally is not only the case with Homo sapiens: vocal imitation in birdsong also relies on auditory-guided motor learning during a sensitive period of development in some singing birds. (Bolhuis et al. 2010,747)\(^2\) The ability to development of language is comparable with the

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1 Deaf is taken absolutely, i.e., no (serviceable) hearing at all. It is not synonymous to hard of hearing or hearing loss which is only partial loss of hearing. With children deafness is mostly congenital or prelinguistically acquired, the latter usually (but not exclusively) due to meningitis.

2 The fact that similar details of vocal learning arose in distinct evolutionary branches that parted ways some 300 million years ago underscores that evolutionary selection pressure can result not only in similar morphological but also in similar behavioural adaptations. Whether or not these similarities are the consequences of convergent neural architecture and information processing is one of the major challenges facing neurobiologists who study birdsong and human speech from an evolutionary perspective. (Bolhuis et al, 2010, 750)
suckling reflex, both being examples of *innate releasing mechanisms* of the human animal, which is apparently able to recognize behaviourally meaningful stimuli never before experienced and to respond to them adequately. This concept focuses on the close correspondence between sign/stimulus and the appropriate behavioural response. (Ewert 2005, 25 citing Tinbergen 1951)

### 5.2 Innateness

The issue of acquiring the ability to communicate in spoken words (language) should be part of the controversy of rationalism and empiricism. (Markie 2008) Classical rationalism assumes that humans are equipped with reason, with intuition (and a capacity of deduction), with innate ideas and – by some rationalists – innate concepts. Empiricism, on the contrary, presumes that humans are equipped with sensory systems that provide knowledge through sensory experience. Both views accept that the human species has innate faculties.

Innateness itself, however, used to be a controversial concept. The question of the dichotomy innateness versus acquired has been a philosophical issue since at least two and a half millennia. It is still with us carrying labels like innate versus learned, genes (or genetically determined) versus environment, instinct versus learning and nature versus nurture.

*Scientific* interest in this area began when Konrad Lorenz, Nico Tinbergen and Karl von Frisch established ethology, the Darwinian approach to behaviour now known as behavioural biology. [Box 2-1 (p.28)] It tries to answer the four scientific questions or four why’s, i.e., (1) causation, (2) survival value, (3) evolution as stated by Huxley (1914) and that of (4) ontogeny, added by Tinbergen. (Hogan and Bolhuis 2009, 25) One can already sense a certain blurring of boundaries between innateness and acquired in Manning’s foreword to a book on behavioural biology:

> Each species exhibits a repertoire of behaviour patterns which are “innate”, i.e., whose development is largely under genetic control, and whose performance is under the control of particular motivational states and sets of external stimuli. These latter are matched by “innate releasing mechanisms” in animals, which respond preferentially only to certain

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3 Bolhuis and Verhulst (2009, x)
aspects (sign stimuli) in the external world – often sign stimuli are specially evolved structures or displays from conspecifics (‘releasers’).

Bateson (1999.ix-xi) citing Lehrman (1970), pointed out that there are at least seven meanings of the word ‘innate’. He listed them as: (1) present at birth, (2) being a behavioural difference caused by a genetic difference, (3) adapted over the course of evolution, (4) unchanging throughout development, (5) shared by all members of a species, (6) present before behaviour serves any function, (7) not learned.

Behavioural biology is less interested in the dichotomy innateness versus acquired than in the development of behaviour. An animal, after an interaction with its environment, may have been changed by such experience and thus becomes capable of behaving differently thereafter; a change in the animal’s behaviour accepted as learning. The difference between learning and other forms of behavioural development is gradual and has to do with the specificity of external experience. Laboratory examples of such learning processes are Pavlovian conditioning, Thorndike's puzzle box and the Skinner box. The notion that learning may depend on the formation of associations has a long history in philosophy, a matter I let rest.

Apart from these acquired changes in behaviour, other examples of perceptual preferences may develop without any experience with the par-
ticular stimuli. For this the term predisposition has been coined to denote the behavioural tendency or the underlying mechanism. Predisposition plays a role in birdsong learning, in auditory preferences in ducklings, in the perception of faces in neonatal human infants and in the development of filial preferences in chicks. This phenomenon, called *imprinting* by Konrad Lorenz (1935, 1937), was already known as filial imprinting described by Thomas More in *Utopia* and was experimentally investigated by Douglas Spalding in 1873. (Bolhuis 2000, 119-45) Contemporary investigators define imprinting as the learning process through which the social preferences of young animals become restricted to a particular stimulus or class of stimuli. (ibid.)

The conclusions from study of behavioural biology so far, is that both innate and rational mechanisms are present at birth and that they may be triggered into action by a particular stimulus leading to a change of behaviour (learning). Any animal including man is born with genetically based predispositions or abilities. Experience(s) in many combinations and predispositions only manifest later in life (think of the sexual hormonal influences) may change behaviour. Predispositions and experiences, often in various combinations, may lead to learning and knowledge. Sentient beings of many species are able to acquire new knowledge in very variable and complicated ways. Indeed, both empiricism and rationalism are outworn concepts if conceived of as the sole road to knowledge.

In addition to the notion of predisposition the concept of *behaviour system* has been developed. [Box 5-1] It seems to underline the kind of reasoning so dominantly present in the writings of Oyama’s *developmental systems theory*

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**Box 5-2  Aristotle on the senses**

Aristotle summarizes the definition of sensory system as follows: (A) By a ‘sense’ is meant what has the power of receiving into itself the sensible forms of things without the matter. This must be conceived of as taking place in the way in which a piece of wax takes on the impress of a signet-ring without the iron or gold; we say that what produces the impression is a signet of bronze or gold, but its particular metallic constitution makes no difference: in a similar way the sense is affected by what is coloured or flavoured or sounding, but it is indifferent what in each case the substance is; what alone matters is what quality it has, i.e., in what ratio its constituents are combined. (B) By ‘an organ of sense’ is meant that in which ultimately such a power is seated.

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* Aristotle. On the soul DAII.5-12, DAIII.1 (Περί ψυχής, De anima)
[§ 4-4 (p.57)] and her refusal of the nature versus nurture dichotomy, the same conviction as also manifest in Thelen’s dynamic system’s approach. Both authors seem to move away from reductionism and towards a more holistic kind of reasoning.

In my opinion much of the so called ‘play’ of (young) animals and children, *Animal Ludens*, can be viewed as nature’s way of gradually acquiring essential behaviour systems under relatively safe conditions; and secondly, the concept of behaviour system also seems to be an eclectic scientific answer to the old philosophic dispute about the priority of reason or sensory systems in the acquisition of knowledge; behaviour system encompasses both and moreover reconciles the other dichotomy of the knowing *what* and the knowing *how*. The description of the human neonate’s sucking reflex is a nice example of such a system and tacit knowledge as described by Polanyi may very well be another. [Box 2-4 (p.37)]

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Democritus, after stating that “in reality there is no white, or black, or bitter, or sweet”, added: “Poor mind, from the senses you take your arguments, and then want to defeat them? Your victory is your defeat” (Diels, Fragmente der Vorsokratiker [4th ed., 1922], frag. B125, cited by Arendt,1958, note 31a,275.

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**Box 5-3  Somatosensory systems**

*Proprioception* is the sense of self. The receptors are located in skeletal muscle, joint capsules and the skin. It enables us to have conscious awareness of the posture and movements of the body. Without them movements would be poorly coordinated, clumsy and inadequate.

*Exteroception* is the sense of direct interaction of the body with the external world. The principal mode is touch (contact, pressure, stroking, motion and vibration) used for identifying objects but it also includes thermal senses and nociception (pain).

*Interoception* is the sense of the body’s internal state and of the function of the major organ systems of the body. The receptors are primarily chemo- and stretch receptors used for homeostasis. [Box 2-5 (p.40); Box 5-4; § 5-4]
5.3 Five (!) senses (?)

Aristotle’s biological papers are fascinating and precise accounts of methodologically meticulous scientific (avant la lettre) research.\(^5\) Though I seemingly attack his statements on the subject of the senses I intend to fight his parroting followers, thus agreeing with Heidegger’s thoughtful statement about the differences between modern and antique science.\(^6\)

Aristotle distinguished five human senses and even explicitly stated that there can be no sixth sense in addition to his five ones – sight, hearing, smell, taste, touch. Although clearly wrong this seemingly ‘divine’ number is still repeated daily in speech and written texts, even in (recent) scholarly ones.\(^7\) Apart from the senses, it is often said that there are sensations like itches, tickling, and feelings such as hunger, thirst and pain. I will clear up the terminology a little, summarize a few facts taken from the life-sciences, point to some concepts in passing and try to untangle a few ‘Gordian-knots’.

In chapter 1 sensory systems have been defined as all (usually paired) specialized systems of every living structure that provide information from the environment and from within the body. Noting the existence of sensory systems within plants and also the huge variety of sensory systems in different species \[\text{Box 2-2 (p.33); Box 2-3 (p.35)}\] we will from now on primarily concentrate on those of man.

*Homo sapiens* is endowed with more sensory systems than Aristotle’s five. Exploring some of them takes us into interesting definitional and conceptual problems. Let me try to make this clear with a few small detours to sensory systems other than those of Aristotle, beginning with the paired organs of equilibrium.\(^8\) These organs are mirror-symmetric structures, called vestibules, firmly connected to the cochlea (snail shell, organ of hearing). Together, cochlea and vestibular system build the (deservedly called) labyrinth (inner ear). Each vestibular labyrinth contains two different senses of equilibrium. They pass information of movements and position of the skull. One gathers information on angular acceleration (semicircular canals), the other one on linear accelerations (utricle and saccule). This

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\(^{5}\) Aristotle. The history of animals (translation D’Arcy Wentworth Thompson)

\(^{6}\) Auf jeder Seite, der der alten und der neuen Wissenschaft, handelt es sich jeweils um beides, um Tatsachen und Begriffe; das Entscheidende ist aber die Art und Weise, wie die Tatsachen begriffen und wie die Begriffe angesetzt wurden. (Heidegger 1962,51) [Both old and modern science are concerned with facts and concepts; the decisive difference lies in the way facts are understood and concepts are established]

\(^{7}\) Steup 2012; Siegel 2011

\(^{8}\) For an extensive description, see Kandel et al. 2000
description is not completely accurate. Each vestibular labyrinth comprises five clusters of hair cells that, complemented by those of the contra-lateral ear, can measure linear acceleration along and angular acceleration about any axis. All hair cells are, like the hair cells that mediate hearing in the cochlea, of roughly similar construction and act roughly in a similar manner by converting mechanical stimuli of fluid movement into receptor potentials (neural signals). The neural signals travel along the vestibular nerve to different parts of the brain. This information remains largely unconscious but ‘automatically’ leads to a variety of, often unconscious, reactions. One example is the so called vestibular-ocular reflex (VOR). Because the incoming stimuli are fed from the vestibular system into the motor nuclei of the eye muscles, movements of the head are compensated so that the eyes are kept focused on the scene of interest. If one for instance shakes one’s head while reading this sentence, one will still be able to keep it in focus thanks to this VOR. Most people will never become aware of their VOR as the actions of this system remain unconscious. The reflexes were not even noticed by Aristotle’s inquisitive eye and mind.

In summary, movements of the head are indirect stimuli to the hair cells in the organ of equilibrium. The hair cells transform the movements into neuronal signals travelling to different parts of the brain. Mainly unconscious (compensatory) motor actions of (among others) the eyes muscles are then initiated to compensate for the linear and angular acceleration of the skull: the retina of both eyes remain fixed on the scene of interest.

This is only part of the story. Largely quoting Cullen (2011), in everyday life as we move through the world, vestibular information is combined with cues from other sources in order to allow us to detect and perceive our self-motion and position. When self-motion is the result of an externally applied movement, such as riding as a passenger on the bus, the semicircular canals and otolith organs of the vestibular system encode rotation and linear acceleration information, while the visual system provides retinal-image motion (optic flow) cues. Furthermore, when self-motion is the result of voluntary movement, such as locomotion, sensory cues are not only provided by vestibular and visual systems, but also by the proprioceptive sensors of the muscles, tendons, and joints, which sense the relative position of neighbouring parts of the body. In addition, during voluntary movement, a motor command is generated to produce the movement, and thus motor-derived information is also available for integration with the existing multisensory cues to contribute to the brain’s internal estimate of self-motion.

Multisensory integration plays several important roles in the nervous system. One of the most widely recognized benefits of multisensory in-
tegration is the improvement in accuracy, precision or reaction times by simultaneous presentation of two or more sensory cues during sensory discrimination and/or detection tasks.

Before further analyzing the concept of sensory systems, I briefly turn to the skin, to interoception and to locomotion. ‘Somatosensory systems’ is the term used for (a conglomerate of) systems which are stimulated via a variety of receptors distributed throughout the body. [Box 5-3] Those of the skin (exteroception), those of movement (proprioception) and those of the physiological condition of the body also called interoception. (Craig 2002 & 2009) They come in four major modalities: (1) discriminative touch required to recognize size, shape, and texture of objects and their movement across the skin mediated by so called mechano-receptors, (2) proprioception, the sense of static position and movement (kinaesthesia) of the limbs and body mediated by mechano-receptors in skeletal muscle and joint capsules, and also present in the skin, (3) nociception, the sense that signals tissue damage or chemical irritation, typically perceived as itch or pain; it consists of mechanical, thermal
and polymodal nociceptors,\(^9\) (4) temperature sense as mediated by thermoreceptors of which humans have four types: cold, cool, warm, and hot.

Thermoregulation is a primal evolutionary requirement for all animals, particularly homeothermic (or endothermic) mammals and birds. Affective aspects – feelings of pleasantness or unpleasantness – correspond to the motivations that are essential for behavioural thermoregulation and homeostasis [Box 2-5 (p.40); § 5-4], and therefore survival.

In addition to these four modalities of receptors, the viscera have mechano-sensory and chemo-sensory receptors. They are important in the control of visceral function. Under normal conditions humans do not experience conscious sensations from the intestines but abnormal distension and stretching of visceral muscle tissue may evoke sensations of pain. Most of the interoceptive information is directly related to homeostatic needs and is associated with behavioural motivations that are crucial for the maintenance of bodily integrity. Each of these modalities is mediated by a distinct system of receptors and pathways to the brain. Each of these modalities conveys a specific form of energy, which is related to differences in structure of the nerve endings and fibres.

The foregoing detour shows that (1) defining sensory systems is not an easy matter, (2) that the simple folklore division into eyes, ears, smell, taste and touch is no longer adequate as the term sensory systems includes more than Aristotle’s original five\(^10\) as argued above, maintenance of the body position comprises joint effort of vision, sense of equilibrium, proprioception, and a multitude of mechano-receptors in muscles and joints, together with the coordinating brain, (3) in practice single nerve fibre action is exceptional and intensive cooperation the rule; all sensory systems continuously work together. If we close our eyes, we do not fall down, we still hear the birds and if chewing gum, we still taste it. The other way around, when we intensely concentrate on the taste of the gum, we still do not fall down, we still hear the car coming around the corner, the viscera continue to work, the urine seeps into the bladder, in short, not only are we able to walk and chew gum at the same time, but we are also able to carry out many other activities.

Every sensory system sends its signals to the brain, which ‘automatically’ coordinates the information with that of other sensory systems. The

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9 Pain is defined as an unpleasant sensory and emotional experience associated with actual or potential damage; like elsewhere in the sensory systems a consequence of the brain’s elaboration of sensory input.

10 Nota bene the eyes consist of a conglomerate of sensory systems conveying information on form, depth, brightness, colour and motion.
maintenance of the body position would not be possible without somatic sensation, the sense of equilibrium, the coordinating brain, the muscles of the trunk, in short with the smooth and non-conscious activities of this entire human behavioural system. It does not need our attention since the process operates unconsciously. I will return to the subject of the sense of posture in 4-D and its relation with consciousness in chapter twelve.11

5.4 Homeostasis

Homeostasis is defined as the maintenance of relatively stable internal physiological condition of the body \((\text{milieu intérieur})\) under environmental conditions that may vary in minutes, hourly, daily or seasonally. 12, 13

Without regulation homeostasis would be impossible. In the living organism regulation requires constant information of the variable \((\text{receptor})\) to be regulated, a ‘control centre’ which ‘knows’ what the optimal value of the variable should be and has the means to activate or inhibit mechanisms that increase or decrease its value. A comparable and easy to imagine example of such homeostatic regulatory systems is the thermostat that keeps room temperature at the regulated values, usually \(20^\circ\) Celcius. The control centre is informed about the room temperature by a sensor (comparable to a receptor) in its immediate vicinity. When this temperature is less than \(20^\circ\) Celcius the centre orders the furnace to produce more heat so that the desired temperature is re-established at which time the furnace is switched off by the centre. Obviously, this control lacks finesse. It can keep the temperature at \(20^\circ\) Celcius but it cannot cool the room.

The living control centre operates in a similar way. Variables like body temperature (\(37.4^\circ\) Celcius), pH (7.365), ion concentrations, glucose concentration, fluid volume, et cetera are kept at the homeostatic level. Some such living centres do have finesse. They often can actively change

11 “My sense of ‘posture’ is not stored in my brain, but, rather, the ability to create one posture from another is, the ability to establish relations. And the senses of self and speech, like posture, are constantly evolving structures.” (Rosenfield 1992,121f)
12 The attention in this paragraph is confined to endothermic animals (mammals and birds) which keep their body temperature within narrow limits leaving out ectothermic animals who exhibit wider body temperature variations (circa 35° – 40° C) and use behavioural mechanisms to change their body temperature.
13 Claude Bernard (1879) wrote “All the vital mechanisms, varied as they are, have only one object, that of preserving constant the conditions of life in the milieu intérieur.” The term homeostasis was coined by Walter Cannon (1932)
the level of the controlled variable as well as retun it to normal when it is too low.

In our homes we determine the setpoint of the room thermostat. In living things, evolution 'decided' that for us. In some of these systems the setpoint is itself dominated by higher level systems that under special circumstances may decide that for instance a higher body temperature might be more opportune. The whole system constantly oscillates about the set points of the various control mechanisms, within specific (safe) boundaries. A correction usually consists of an increased or decreased inhibition (negative feedback) leading to a stronger or weaker feedback.

An example of negative feedback is the body temperature of humans; it fluctuates between $37.2^\circ - 37.6^\circ$ C (set point $37.4^\circ$ C). Hypothermia ($< 33^\circ$ C) and hyperthermia ($> 42^\circ$ C) eventually lead to death. The body has a range of responses available, depending on the internal and external temperatures. Increased blood temperature is sensed by specialized neurons in the thermoregulatory centre of the hypothalamus in the brain. Receptors in the skin monitor the external temperature. Both sets of information lead to impulses sent to several different effectors.

An example of positive feedback is the response to injury which damages tissue and results in bleeding. This event causes release of 'tissue factor', activation of thrombin, formation of the matrix of the blood clot and speeds up the production of more thrombin. This self amplifying process is the positive feedback. The entire process is tissue damage, bleeding, clotting. Stopping the haemorrhage is the negative feedback loop activated by bleeding itself and ultimately acting to stop it.

A second example of positive feedback is childbirth, where stretching of the cervix uteri triggers the secretion of the hormone oxytocin which stimulates uterine contractions and accelerates labour. Positive feedback usually produces the opposite of homeostasis, i.e., the rapid loss of internal stability with – potentially – fatal consequences.

### 5.5 The tomato-illusion

As a thought experiment Price (1932,3) used a tomato that he compared to a "red patch of a round and somewhat bulgy shape", a quite impossible comparison I feel. [Chapter 6] If we have any experience with tomatoes, what we see is a tomato (colour, form, depth, intensity of light, shades and the rest). If we see something that looks faintly like our former tomato-experience and
we are not sure, we approach it, we touch it with our Moore-like hand\textsuperscript{14}, we smell it, we bite into it and we know that it is, indeed, a tomato. We know that we can squeeze it, that we can make soup or chutney with it or that we can fry it to prepare our full English breakfast.....In real life our sensory systems work together continuously, simultaneously, unconsciously and consciously.

If we see for the first time something that impresses us faintly as our tomato-experience but that in some aspect is quite different we tend to curiously approach the thing\textsuperscript{15}. We may then notice that it looks red and feels ripe on touch, smells and tastes like a tomato even though it may be rather small. Our green-grocer tells us that it is a “cherry tomato”, a new product. We thus have a new experience which does not only consist of a new single red bulging thing, but which is essentially and significantly a combination of vision, touch with the fingers, smell, taste and touch with the tongue combined with cognitive part(s) of our brain. We learn and know for ever \textit{ceteris paribus} what a cherry tomato is like. Leaving out all subtleties and theories of induction, inferential learning and scepis we tend to trust our green-grocer who taught us a new word for this mix of old and new experiences. We may thereby arrive at the conclusion that this miniature variation of the ‘normal’ tomato is comparable to similar experiences like a bonsai tree among trees and the dinky toy or doll’s house of our past.

Being human and belonging to the inquisitive variety we may then approach our personal computer, type ‘\textit{tomaat}’ (June 2012; the Dutch word for tomato) and receive some 2,780,000 hits within 0.12 seconds with ‘Google’. We subsequently type the term ‘tomato’ and receive some 159,800,000 hits within 0.15 seconds. We may have learnt a lot more about the subject... and happily forget the amazing formula of some red bulgy object.

The sensory systems select and continuously ‘register’ staggering numbers of simultaneously incoming bits of information from outside and inside the body. The sensory systems are (inter)-connected to other parts of the body and wired into various feed-forward and feed-backward

\textsuperscript{14} Referring to the highly influential philosopher GE.Moore (1873-1958) who was moved, not by any perplexities about ‘the world or the sciences’, but by the baffling things said about the world and the sciences by other philosophers. Famously, he started one day with the proposition that he was sure of the existence of his own (right) hand and (left) hand. (Moore 1959,146)

\textsuperscript{15} \textit{Innate releaser}. Another example [than the red dot] [§ 2-2 (p.28f)] is the stimulus for eliciting the rather stereotyped feeding behaviour shown by many animals: a small moving object first alerts a frog, then causes it to orient itself toward the stimulus, next to approach it, and finally to snap at it. Long ago it was suggested that the retinal ganglion cells in the frog that respond to small moving objects might act as such, i.e., bug detectors. (Barlow 1999,311)
loops, regulatory systems that ‘automatically’ coordinate (put differently, unconsciously, i.e., not reaching awareness) other bodily subsystems. A minor part of the incoming information from the sensory systems can be brought to awareness and may thereby be perceived, recognized and named.

Any sensory system in a narrower sense consists of a number of cells specialised to register some specific small change in its chemical or physical environment, be it stretch or pressure (mechano-receptors, touch), movement of fluid (within the labyrinth), electro-magnetic waves (vision) et cetera. [Box 2-2 (p.33)] It seems reasonable to incorporate in any definition of one specific sensory system at least the basic constituting element; the single cell with (all) its connection(s) that depolarizes after receiving its specific environmental stimulus or signal.

Apart from the sensory systems, the body contains many other systems gathering information and delivering signals. Examples like the endocrine glands come to mind that send hormones through the blood. These act as instructional messages to other parts of the body which then start to readjust their activity. A second example is the immune system that ‘recognizes’ intruding agents like parasites and micro-organisms and starts to defend the body against them; this system thus acts very much like a behavioural system after some – retrospectively – adequate stimulus. Characteristically the endocrine glands and the immune system predominantly react to biochemical instead of physical changes. Moreover, the actions of these systems are never directly perceived, although the consequences of their activity may. A third example is a sensory system-like ‘mechanism’ that has been recognized in mice and humans, situated on the relative surface of the body, i.e., the gut’s lining, with functions similar to other chemical sensory systems such as the vomeronasal organ and the taste buds of the tongue.16

Common to the more classic sensory systems and the three above mentioned ones is their influence on activity levels (behaviour) of cells, tissues, organs and organisms (whole body including brain/mind). The fundamental part in the actions of all these systems is the maintenance of homeostasis without which each system and by consequence the whole body would quickly perish. [Box 2-5 (p.40)]

16 Molecular sensing by gastrointestinal cells plays a critical role in the control of multiple fundamental functions in digestion and also initiates hormonal and/or neural pathways leading to the regulation of caloric intake, pancreatic insulin secretion, and metabolism. Molecular sensing in the gastrointestinal tract is also responsible for the detection of ingested harmful drugs and toxins, thereby initiating responses critical for survival (vomiting). The initial recognition events and mechanism(s) involved are not yet completely understood. (Rozengurt 2006)
In summary, to limit sensory systems to the conscious part of the Aristotelian (five) senses only is not acceptable. This approach:

– ignores the vast area of non-conscious information gathering and processing that is needed to keep the body going,
– ignores the continuous cooperation of all sensory systems that are coordinated in the brain,
– places the somatosensory systems in a non-sensory-systems category although they have similar construction and action as the five of Aristotle,
– pays little attention to the environment without which sensory systems do not make much sense anyway: if man is devoid of incoming stimuli (sensory-deprivation) he has a strong tendency to develop hallucinations and experiences like those induced by hallucinogenic drugs, similar to those of schizophrenia. In such situations delusions, loss of sense of reality and loss of personal identity usually occur. We obviously need a lifelong more or less continuous stream of (environmental) stimuli to function properly.

As for the information processing by any sentient being the sensory systems have much in common with the immune system, the endocrine glands and finally, the chromosome.

The chromosome, not further discussed here, contains the molecular code script in DNA (deoxyribonucleic acid), the specification of development or genetic information. The idea that a chromosome is a molecular code script containing a specification of development was beautifully formulated by Erwin Schrödinger (1944,19f,61f,68). This book inspired Francis Crick and, independently, James D. Watson to research the gene but the first one to formulate the principle of the ‘heredity molecule’ was Hermann Joseph Muller in 1922 and more elegantly in 1929. (Schwartz 2008)
Part II

From objectivity to subjectivity
6 Sense-data, the bird’s eye view

6.1 Introduction

Many philosophers speaking about perception use terms like ‘sense-datum’, ‘impression’, ‘idea’, ‘quale’, ‘image’, ‘sensum’, ‘appearance’ and ‘phenomenon’. Admittedly, there are variations within and between the exact definitions of each term depending on the philosopher using them. I will not present a thorough analysis of sense data since other supporters and opponents did this before. In the following no full justice will be done to their arguments; mine will be little more than the bird’s eye view. People interested in this field may start by reading the admirable anthology compiled by Robert J. Swartz (1965).

Interestingly, not a single one of the aforementioned terms is found in neuroscience. In its ‘bible’, containing some 1400 pages, Kandel et al. (2000,398) refer only once to one of the more or less synonymous terms mentioned before:

Since considerable progress has been made in understanding the neural basis of perception of colour without having to account for its subjective qualities, or qualia, perhaps the question about qualia is itself not so meaningful within a neurobiological approach to behaviour.” He follows with “[T]he brain does indeed construct our perception of an object, but the resulting perception is not arbitrary and appears to correspond to independently determined physical properties of the objects. What we do not understand is how action potentials give rise to meaning. Why is it that you see a face when the neurons of the inferotemporal cortex fire action potentials? (italics in original)

Sense-data (singular sense-datum) is a technical term that seems to have come into use in the beginning of the 20th century although the idea goes back to Berkely (sensations and ideas), Hume (impressions of the sense), Kant (Vorstellungen, representations) and even Plato (pathémata, the ways of being effected). Bertrand Russell writes in Mysticism and logic (1918,143):

If we have been right in our contentions, sense-data are merely those among the ultimate constituents of the physical world of which we happen to be immediately aware; they themselves are purely physical, and all that is mental in connection with them is our awareness of them, which is irrelevant to their nature and to their place in physics.
In a slightly more colloquial way, he said in Problems of philosophy (1912,17)

Let us give the name of “sense-data” to the things that are immediately known in sensation; such things as colours, sounds, smells, hardness, roughness, and so on.

Sense-data, therefore, are supposed to enter into, and depend for their existence on our consciousness whenever we see, hear, feel, taste or smell things. It is the way in which things appear to the conscious subject, the irreducible phenomenological character of an experience. A sense-datum is what something seems like in consciousness. The term has not always been used in the same way; not every philosopher using the term has precisely defined his particular view on the matter or on the relation sense data/object.

6.2 The case of the penny

Often the concept of sense-datum is explained with the example of a penny. When one sees a penny on the table viewing it from nearby and above ‘head’ up it looks round, leading to the sense-datum round; or, ‘tail’ up, it also looks round, again leading to the sense datum round. When one sees the same penny from some distance and obliquely, one obtains in the appearance language an oval and in the sense-datum terminology an elliptical sense-datum. Based on the consideration that an object cannot have two different forms some philosophers have characterized this phenomenon as a problem, which they have tried to solve in several ways. Some felt obliged to doubt the existence of the penny suggesting it could be an illusion. Others called only one of the views the illusion, the other view being the true or real shape of the coin. Scientific explanations with optics, perspectives and the like have also been proposed. Many philosophers feel that a scientific explanation should not be sought as the problem is one of experience, is subjective, is not quantifiable and therefore is impossible to solve with scientific methods.

George Edward Moore in writing on sense-data has drawn our attention to another problem of our penny although his example was not a penny but the inkstand on his desk. This observation translated to the penny is that one cannot see each side of the penny in one view. Therefore, at any time only that part of the penny’s surface turned to the eye of the observer will be contained in the sense-datum. The sceptic, on the other hand might think that the other side of the penny does not show the normal tail as it may be
a false specimen or part of a practical joke. It is a case of convention, habit or daily practice to speak of a penny when only seeing one of its surfaces, or, put differently, an act of trust. Others imagined themselves in the position of an unworldly person not acquainted with a coin and therefore unable to recognize the penny as a piece of money or even as a sort of dice to assist in making a decision by flipping it. Although such a person actually does see it, he does not understand what it is he is looking at. Finally, someone with a loss of memory might not recognize the penny as a penny at all.

6.3 Beyond the penny

The intense discussion about sense-data in the first half of the twentieth century has made clear that:

(i) every day language about perceiving, seeing, hearing, feeling, touching and the actions of all other sensory systems is not always precise,

(ii) some situations of perception, seeing, hearing, feeling, touching and the actions of all other sensory systems cannot very well be grasped with daily language,

(iii) each of the processes of perceiving, seeing, hearing, feeling, touching and the actions of all other sensory systems has subjective and objective aspects which can be distinguished,

(iv) illusions of physical things and the perceiving of physical objects – assuming that such things do exist – may lead to the same (subjective) impressions.

The term sense-data has mainly been used to detect the subjective side of – let us concentrate on the visual system – the appearance of the penny, be it illusion or reality, be it seen from above or obliquely. To state “I have an (elliptical) sense-datum of a penny” is always true given a truthworthy person. Such a statement is no more than a (subjective) description of an immediate awareness and it doesn’t tell us anything more about the penny. It does not even tell us if there really is a penny at the moment one has such a sense-datum. It does not even confirm that there exists such a thing as a penny. It is no more than a description of a subjective impression. Indeed, the relation of a sense-datum with the material world has met with many different explanations.

The explanation of this subjective impression depends on one’s philosophy. Reductionist philosophers tend to explain sense-data in terms of putative neurophysiological events in the brain and its interactions with the environment. Epiphenomenalists suppose that sense-data are causally
dependent or are ‘supervenient’ to the brain events, but cannot directly be identical with them. Dualists like Russell (see above) take sense-data to be independent of physics, an essentially autonomous, non-physical realm of the mind.

6.4 So...

I agree that there are problems in the theory of appearing. Sense-datum discussions and especially those conducted by logical positivists have made us more sensitive to the peculiarities of everyday language that often may be imprecise but on the other hand can sometimes be very much to the point in its – literally – common sense. Sense-data have circumvented the problem of illusion, the sense-datum of an illusion and the one of the real thing being identical.

I agree with the conclusions of Kandel et al. (vide supra) and R. M. Chisholm (1965) that we need not use ‘this sense-datum terminology’.

Moreover, as sense-data are wholly fictitious or theoretical entities, I consider its theory too far removed from common sense and scientific thought. Sense data look very much like a thought experiment that does not impress scientists, given the citation of Kandel et al.1 Indeed, it looks suspiciously like a metaphysical entity that reminds me of the race between the tortoise and Achilles, the fertilization theories of Aristotle and the earth centred cosmology prior to Galileo Galilei.

Thus, to paraphrase Laplace, “I don’t need that hypothesis” (Je n’ai pas besoin de cette hypothèse).

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1 About a year and a half after finishing this chapter I discovered that Kandel et al. 2013 (5th edition) although 300 pages larger than Kandel et al. 2000 (4th edition) expunged even this single passage, entirely ignoring the term quale and its synonyms.
7 Sensory perception and the environment

7.1 Introduction

Philosophy has traditionally been interested in the relationship between the (objective) reality of the world out there (the environment) and the (subjective) knowledge of the world as we perceive it. In this context a question that received at least as much attention as ‘the-case-of-the-penny’ [Chapter 6] is the problem of the straight stick looking crooked when half-way immersed in clear water and similar perceptual phenomena. Usually, such phenomena are taken together in philosophy under the heading of ‘the problem of perception’. A related question is the form adopted by the alleged representations of the environment [Box 3-2 (p.49)] in the central nervous system.

Firstly, I will try to prove that ‘the problem of perception’ is much overrated. Secondly, I will argue that the idealistic aims of reaching true knowledge or absolute truth are misconceived.

7.2 The ‘problem of perception’

‘The problem of perception’ or ‘the problem of illusion’ originates from the assumed similarity of (1) perceptual illusion or hallucination and (2) real perception understood as direct and immediate access to ‘reality’. Illusion as well as hallucination are thought to be experiences which may seem similar or even identical to the perception of a real, mind-independent object but in the case of illusion and hallucination without an actual object being present. If both experiences are identical, the argument goes, the concept of normal perception that takes experience to be solely dependent on the environment alone must be wrong. Notice that without argumentation the subject’s experience (or phenomenal character) of the ‘real observation’ as well as ‘the illusion or hallucination’ are taken to be identical. I will return to this argument that I consider to be false.

The common man, a realist, presupposes that objects of perception are mind-independent and may be perceived by any normal functioning sentient being. Theories of perception agree that our perceptual experience seems to be awareness of a mind-independent world. Moreover, most philosophers
believe the environment to be independent of our experience for its existence. We assume that there are real objects in a real world. We do not see ‘some red colour’ but we perceive a tomato, we hear ‘die Forelle’ (trout) quintet of Franz Schubert rather than some noises and we smell our coffee, in short we perceive objects as objects and we take them to be objective. Some philosophers feel though that this common sense story needs to be attacked or to be defended against the putative certainty of illusion and hallucination. This ‘argument from illusion (or hallucination)’ leads to the view that even items we regard as basic to everyday life – material objects – are merely constructs of the brain. As Gilbert Ryle once said though, illusions cannot undermine the

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Box 7-1 Illusion, hallucination, pseudohallucination and delusion*

**Illusion** is a perceptual error strikingly inconsistent with what is accepted as true. It is an embarrassment for those who would like to hold that knowledge is securely based on perception. Although illusions may occur with every sensory system, visual ones are known best.

**Hallucination** is a sensory perception in the absence of external stimuli. Its characteristics are thoughts or memory images experienced as if they are a perception and externalized but not corrected in the light of other information available.

**Pseudo-hallucination** is an imagery as vivid and immediate as perception but not mistaken as such. Pseudo-hallucinations are more likely to be perceived in response to isolation or an intense emotional need: for example, shipwrecked sailors may visualize boats coming to their rescue well before this actually occurs.

**Delusion** is a fixed, idiosyncratic belief, unusual in the culture to which the person belongs. Unlike normal beliefs, which are subject to amendment or correction, a delusion is held to, despite evidence or arguments brought against it. Delusions are usually taken to indicate mental illness, but something akin to them is occasionally observed in normal people. This – stubbornness – of someone insisting on the correctness of an idea he overvalues, denying any significance to evidence appearing to refute it, is usually accompanied by anger, whereas in mental illness the patient’s emotional response when a delusion is challenged tends to be bland or otherwise inappropriate.

* Definitions of delusion and pseudo-hallucination borrowed from Gregory 1988.
truth of other experiences because “there can be false coins only when there are coins made of the proper materials by the proper authorities”. We can, of course, also imagine objects nearly as clearly as reality. There is one important difference though: in my mind’s eye I am quite able to change the ‘image’ in limitless ways while in reality I cannot. Moreover, and very importantly, reality can simultaneously be checked with all our (other) sensory systems, and not only with the one under scrutiny, and, as argued before, we always use all our sensory systems together. The big difference between reality and illusions/hallucinations – the one psychiatrists use in their diagnostics – is that reality is perceived by all sensory systems simultaneously and for the most part unconsciously, while the ‘illusion’ involves one single sense system only. We may have an auditory illusion or hallucination and we may have an olfactory illusion or hallucination but we do not have them at the same time. Therefore, I challenge statements like the one of Crane (2011) that suggest “to accept [is] the uncontroversial idea of two experiences being such that a subject could not know, simply in virtue of having the experiences, whether they were having one or the other”. (italics added) All someone having such an experience needs to do is to check that experience using another sensory system, and if he is unable to do so a psychiatrist or neurologist can do that for him. Sometimes the argumentations are too far removed from common sense. As an example let me take the reader to the common sense approach of Shakespeare’s much quoted case of ‘Macbeth’s dagger’ and show a few common and repeatedly occurring misconceptions.

7.3 The case of Macbeth’s ‘dagger’

The case of Macbeth’s dagger has also been quoted as an illusion of a dagger and even Macbeth’s delusion of a dagger. It is neither, though! It is not even a hallucination! The text:

1 ‘Normal’ hallucinations, i.e., the Charles Bonnet Syndrome (CBS) type, are rather frequently occurring phantom phenomena based on partial loss of audition or vision; they are confined to one sensory system only. Degenerative neurological diseases, epileptic fits and a few other specific neurological disorders may be accompanied by complex and often multisensory illusions that more often lead to delusions.

2 The neurologist O. Sacks (2012) discerns ‘organic psychoses’ (transient phenomena associated with delirium, epilepsy, drugs use and a few other medical conditions, remembered in vivid detail of real waking time) from dreams (possessing their own, self-contained narrative setting, without critical consciousness outside it) and hallucinations arising from mental diseases (schizophrenia, bipolar psychosis).
Is this a dagger, which I see before me,
The handle toward my hand? Come, let me clutch thee.
I have thee not, and yet I see thee still.
Art thou not, fatal vision, sensible
To feeling, as to sight? Or art thou but
A dagger of the mind, a false creation,
Proceeding from the heat-oppressed brain?
I see thee yet, in form as palpable,
As this which now I draw. Thou marshal'st me
The way that I was going; and such an instrument
I was to use. Mine eyes are made the fools
Of the other senses, or else worth all the rest.
I see thee still;
And on thy blade and dudgeon gouts of blood,
Which was not so before. There's no such thing.
It is the bloody business, which informs
Thus to mine eyes. Now o'er the one half world
Nature seems dead, and wicked dreams abuse
The curtain's sleeper; Witchcraft celebrates
Pale Hecat's offerings; and wither'd Murder,
Alarum'd by his sentinel, the wolf (...)3

Macbeth, planning to murder Duncan, sees a dagger. After the first line this could be an illusion as well as a hallucination, or even a delusion. [Box 7-1] He is not dreaming for he just said farewell to a servant. Macbeth, quite sensibly (no delusion by definition) uses his other senses too: he tries to 'clutch' it. The thing proofs not to be 'sensible to feeling' after which Macbeth himself concludes quite correctly 'A dagger of the mind, a false creation, proceeding from the heat-oppressed brain'. Quite, the dagger is a pseudo-hallucination, i.e., perceiving a thing that is not there, although he can see it clearly 'in a form as palpable, as this which now I draw'. As a kind of overkill Macbeth states 'Mine eyes are made the fools of the other senses, but (...) I see thee still.' 4 The pseudo-hallucination or in Sacks' terminology 'organic psychosis' [note 2] is quite strong! Note that the definition of pseudo-hallucination

3  Macbeth, Act II, Scene I
4  G. Harman (2004,645) beautifully describes Macbeth's act in the same vein as I do. He writes: "Let us use 'see†' ('see-dagger') 'for the sense of 'see' in which the object seen might not exist, as when Macbeth saw a dagger before him and let us use 'see*' ('see-star') for the sense of 'see' in which only things that exist can be seen. Macbeth saw† a dagger but he did not see* a dagger." Harman paid no attention to Macbeth's own conclusion that he did see† the dagger and not see*
states ‘more likely to be perceived in response to isolation or an intense emotional need’. I take it that most of us are satisfied that this was, indeed, the case with Macbeth at the time of this act II, scene II.

I am not the only philosopher who feels that one should use common sense to deny the unrealistic way of talking about illusion and hallucination (see for instance Austin 1962,48-9 and McCulloch 2002 chapter 7). Although in itself discussions about delusion, illusion and hallucination are interesting, they do not seem to take us far with our philosophy of sensory systems. One of the basic mistakes speaking about illusion and hallucination is disregarding the process side of these phenomena, ignoring the temporary state of mind (and/or one single sense system) that will subdue and may be corrected by the use of other sensory systems or, in case of toxic states of the mind, by waiting to come down or become sober again by consulting another person, preferably a psychiatrist who is trained in these matters.

7.4 Fruits of perception

Traditionally philosophy has approached the continuous activity of the sensory systems yielding information about the environment in the context of ‘the basic theory of knowledge'. Two of the questions most discussed have been (1) which of the human inborn instruments is the most important one for acquiring knowledge, i.e., the sensory systems or reason, and (2) whether absolutely certain Truth/Knowledge may ever be obtained in man’s quest for knowledge. The second question may be the centre of some theory of truth but is understood here as the problem of justification.

As to the first question, I have tried to make clear that in my view the age-old bickering between empiricism’s or rationalism’s primacy in acquiring knowledge is obsolete [§ 5-2 (p.66)] as Homo sapiens has behaviour systems [Box 5-1 (p.67)] at his disposal, a concept that runs counter to the old dispute between empiricists and rationalists. Moreover, the fixed a priori that intuition is reliable as implicit in rationalism is antithetic to science. [§ 4-2 (p.52); § 8-3 (p.99)]

As to the second question of judgment and the acknowledged truth of (a piece of) knowledge, the answer has traditionally been ‘a justified belief’ until 1963, the year in which this answer was challenged by Gettier. It led to

based on his own sense of touch. Harman missed the ‘diagnosis' pseudo-hallucination within an ace.
a stack of papers on ‘the Gettier problem’, basically a thought experiment in which one’s true ‘justified’ belief might have been founded too much on luck.

I admire the pragmatic solution of Bas van Fraassen (1998, 213) [§ 12-3 (p.144)] better. His approach is the ‘scientific agnostic’ one of trying to find the empirically adequate best answer/solution to some specific spacetime problem, not believing it to be true or false. This presumed best answer to any problem or question in the context of some four dimensional (4-D) problem is also known as inference to the best explanation. Thus, truth will be understood as the pragmatic, temporary and tentative answer to some specific 4-D problem.

7.5 Sensory systems and the environment

The origins of the structure and functions of our sensory systems are [§ 4-4 (p.57)] largely determined by our evolutionary history. The effects of the mechanisms of our sensory systems will (gradually) become manifest in the form of experiences [Chapter 10] and learning programmes. The effects of the ‘genetic knowledge’ is translated into behavioural systems. “If they do not function in the programmed way of the species, if in short they do not work correctly, its owner tends to die or with luck will continue to live but probably has less chance of offspring.” In the latter case his evolutionary line will ‘conveniently’ end with him, others who have been born with better judgmental reactions taking care of the species offspring.

As for the behavioural part of the outcome of sensory systems a large difference exists between humans and species with less developed central nervous systems that will always react stereotypically. The more primitive reactions are inflexible, such that one specific stimulus always leads to the same reaction. Two examples borrowed from Slurink (2002) will illustrate this.

A wasp will always fly in the direction of light even if it would bring death: It has no choice. A small moving object within the visual field of a frog’s eye always leads to the frog jumping forward and shooting out its tongue in order to catch the object. In its natural environment this object is (always)

5 The contrasting view is the ‘scientific gnostic’ one, someone who believes the science he accepts to be true.
6 I am aware of discussions about 2-D, 3-D, 4-D and even more D(imensions). The sensory systems of all (human) animals, together with the processing brain seem to be adapted to 4-D environments. (see also Markosian 2008)
7 Creatures inveterately wrong in their inductions have a pathetic but praiseworthy tendency to die out before reproducing their kind. (Quine 1969, 126)
a flying insect\textsuperscript{8} rather than the doings of a biologist in a laboratory setting. Both reactions are inflexible (neither wasp nor frog can act otherwise). Once the adequate stimulus is there, the animal’s reaction will follow. These fixed reactions have major advantages as I already indicated in the herring gull chick’s begging response. [§2-2 (p.28)] It apparently only needs simple neurological wiring and thus saves much tissue and energy. Such rigidly pre-programmed advantages have disadvantages too. A processional caterpillar for instance has the habit to always follow the one before him. If one puts the foremost behind the last one, the procession will continue to walk in circles until the laboratory researcher ends his game. (ibid.2002,xv) The caterpillar is never able to unlearn this habit. Species with a more developed central nervous system are more flexible in acquiring new behaviour through experiences post factum called learning, sometimes even after one ‘try’ (one trial learning for the psychologist, ‘once bitten twice shy’ for folk wisdom).

The ability to learn from experience is greater when young and decreases when growing older. The first lessons learned from experience are usually taught by the mother in many mammals and are intended to increase chance of survival. We can even define experiencing as nature’s way of teaching. [§10-3 (p.126)] Experience may be considered as a kind of half-product of the sensory systems’ informational processing system in which learning acts as the closure of a feedback loop, i.e. sensing and learning form a continuous process.

Consider the way a child learns to raise its head, to sit, to walk, to notice that there is a world beyond his body, that a sound may arrive from different sides, that it may be able to notice what its hand does, that biting on its own finger is not a good idea et cetera. Most people forget that all basic knowledge has been learned (unconsciously) in infancy and has been incorporated through the information provided by the sensory systems and continuously managed by the coordinating central nervous system. Gradually, each child probably also learns that in general repeating the same action will yield the same effect, in short he learns to rely on induction, like any learning species. Animal research of the Pavlov’s variety is based on conditioning. If one studies an infant’s behaviour one immediately notices the child’s induced, spontaneous and seemingly stereotypical actions usually repeated a few successive days after which the specific actions will lose the child’s interest, gradually decline and stop. The infant has mastered a new action or trick, it has acquired (again, unconsciously) knowledge. [§ 2-2 (p.28); §

\textsuperscript{8} Indeed, the frog would ignore a dead insect; the animal will only recognize an object as food if it is small and moving.
2-5 (p.36); § 3-3 (p.45)] In the mere functioning self lies the achievement of the child which obviously is happy with each (new level of) achievement. New activities are thus learned through a process in which cognition, sensory and musculo-skeletal systems function as a totality. Gradually also, the child learns to rely on its achievements and will connect them with other experiences to construct more complex ones. This induces the child's conviction of causality and induction, certainly the result of habituation. Anyone used to kittens and pups will notice the similarities between them and the human infant in their learning and in their acceptance of inference as a basic fact of life: Animal ludens => animal apprehendens. Russell's quip of the daily fed chicken that should have been better versed in philosophy to have evaded its neck being wrung overlooked Pavlov's experimental findings, the economy and the efficiency of animal behavioural systems.

Thus the ‘fruit of all (unconscious) perception’ is (unconscious) knowledge learnt through experience. Its acquisition is a complicated process which cannot scientifically be reduced to smaller parts without loss. To exclude unconsciously acquired knowledge or focus on abstractly obtained fruits of sensory systems clearly is a biased restriction and reduction. This conclusion is similar to Millikan’s (1993,13-29) in that all of the basic norms applying to cognition are biological norms. Correct cognition is, much like all other biological activities, not what always or even on average happens. Millikan also concludes that the pragmatic question that connects a perception or a thought to the state of affairs it represents is more important than haggling about the normativity problem which she ascribes to evolution. The yield of a creature’s first encounter or experience with some situation is – pragmatically – the acquired knowledge or belief with which the next occasion, judged as similar, will be handled.

Dretske (1995,22) argued that the content of an experience is fixed by the biological and phylogenetically determined function of the systems of which it is a state. His views are not far removed from mine except that I believe it to be less of a state than a continuing process and sub-processes that together may be taken as continuously developing maps or networks in the central nervous system. [§ 10-3 (p.126); § 12-4 (p.147)] The continuity of the development and partially change of the brain’s network representations in the brain contain – at least in part – some characteristics of the environment which implies the philosophical view of externalism.9 Experience viewed

9 Externalism with regard to mental content says that in order to have certain types of intentional mental states (e.g., beliefs), it is necessary to be related to the environment in the right way.
as the bodily representations or maps in the central nervous system will continuously be updated through new information and mechanisms that are composed of evolutionary ‘fixed’ parts and parts that are acquired later in life. As said before, a sensory system should not be reduced to some information gathering instrument only. Rather, all sensory systems and the brain act as one continuously experience gathering and processing system. Together with the motor mechanisms of the body the sensory systems and the brain build behavioural systems. Consider the cerebellar processes that simultaneously run with the informational side to form continuous feed-forward and feed-backward loops that make the otherwise jerky movements of conglomerates of active muscles smooth and supple. [§ 5-3 (p.70)]

### 7.6 The ‘fit’ of the sensory systems with the environment

The previous paragraph may be taken as the metaphysical realist point of view defined by Rescher (2000,71) as:

> Metaphysical realism maintains investigation-antecedently that there is a physical state of natural reality, and scientific realism maintains investigation-consequently that science shows us what this state is like. [This] suggest that thus ‘what reality is like’ is nothing definitive and categorical but something contextual and limited to a particular state-of-the-art level of sophistication in point of scientific technology. (italics in original)

All present-day existing species including *Homo sapiens* have managed to survive in their allotted and/or chosen environment(s). This argument seems to support scientific realism and points to a seemingly adequate attunement between the species bodies (including sensory systems and central nervous systems, if any) and their environments. If such a fit would have failed or if it would have been worse than the analogue fit of competing predators, the species would have become extinct. Or as Rescher puts it (2000,105):

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10 Even the sensory maps of the body surface in the cerebral cortex are not hard-wired and the pathways from the receptors in the skin to the cortex are not completely fixed early in development. The maps do change during life and details of the maps vary considerably from one individual to another. Training enlarges, disuse reduces. (Kandel 2013,378)
If [human animals] did not assume from the very outset that [their] sensations somehow relate to an extra-mental reality, [they] could clearly make no use of them to draw any inference whatever about ‘the real world’. Experience would then lack any and all evidential bearing.

In extension of Rescher’s inference about the outside world is that of a body of experience which is continuously expanding because of the addition of new experiences. At any moment, the internal concept of the real world is the yield of all the animal’s know-how in the broadest meaning at that very moment.

Species with a central nervous system that is more developed than a ganglion, i.e., brains of sorts are continuous learning living processors. This ever changing and developing knowledge, this continuous process materially resides in the body, and is based on the experience of the usability of observational data as a source of (objective) information. As – again – Rescher (ibid.) says about ourselves, it “leads us to accept that what we take to be evidence is evidence”.

The only reasonable course is to heed Charles S. Peirce’s pivotal injunction never to bar the path of inquiry. Our commitment to realism pivots on a certain practical modus operandi, encapsulated in the precept: ‘Proceed in matters of inquiry and communication on the basis that you’re dealing with an objective realm, existing quite independently of the doings and dealings of minds.’ And on this basis we also standardly operate on the presumption of objectivity reflected in the guiding precept: ‘Unless you have good reason to think otherwise (that is, as long as nihil obstat) treat the materials of inquiry and communication as veridical – as representing the nature of the real.’ (ibid.107)

In the same vein, a belief may be considered to be an assumption based on the state of the then available personal knowledge that preludes one’s next action or thought. Justification then may be considered as the result of – or answer to – the best possible test of this belief.

Of course, knowledge and belief and justification are temporary phases within the knowledge-forming processes, phases as parts of a continuing set of processes and not holy facts, ready to be rejected if the justificative process chosen does fail its substantiation.

In principle this process is very much like the diagnostic one of the physician or the motor mechanic who proceeds accordingly to – hypothetically – the best fit for that specific 4-D problem. It is even similar to, indeed
identical with the ways our ancestors since the dawn of times read tracks. (Liebenberg 1990, especially chapters 6 and 11) Liebenberg argues – convincingly to my mind – that the reading of spoor might very well be the origin of science which he even states in the titles of his books (Liebenberg 1990 and 2013). Observing and through that learning and knowing, mutually discussing and teaching their offspring the ways of (other) animals has been the fundamental basis for survival of our ancestors. Basically, he argues, this still is the way of the scientist.

This 4-D web of developing knowledge rests on Homo sapiens’ inborn tentatively acceptance of his mere existence and that of his environment. Such acceptance implies Self. David Hume: “When I turn my reflection on myself, I can never perceive this self without one or more perceptions; nor can I ever perceive anything but the perceptions. It is the composition of these, therefore, which forms SELF.” One caveat though, ‘composition’ should be understood as a process, i.e., within a (continuous changing) 4-D context. [Addendum 14-5 (p.174)]
8 Non-sensory sensing and non-linguistic thinking

8.1 Introduction

In the title of this chapter I have taken together phenomena that may emerge in twilight-like transitions between sensory systems, subconsciousness, unconsciousness, feelings and emotions. [Box 8-1] Von Helmholtz's concept of *unconscious inference* and the ideas of other forerunners about the unconscious and subconscious mind should be acknowledged. Their extensive study, however, began with Freud and Jung.

Distinct from these phenomena, philosophy embraced other non-linguistic and non-sensory oriented cognitive faculties using expressions derived from sensory systems. These putative faculties may be subdivided into *introspection, intuition, the mind's eye*, and the pair *contemplation* and *meditation*. I will discuss these notions in this and the next chapter.

A characteristic feature of philosophy – even almost *a prioristic* – is its linguistic basis. Many philosophers were and many still are convinced that thinking is entirely based on language (*private talk*, often referred to as *inner speak*) although Wittgenstein and his followers took language as an interhuman, collective phenomenon denying the existence of private-language. In the next paragraphs I will occasionally refer to this topic also.

8.2 Introspection

“*A subject’s* awareness of his own mental state is analogous to perception of things distinct from himself, being another species of the same genus. The terms ‘reflection’, ‘inner sense’, and ‘introspection’ have been used for the former, and labels such as ‘sensation’, ‘outer sense’, or ‘perception’ for the latter” (Stevenson 1982,73f). The targets of introspection (Latin intro = into, speculari = to view) may conveniently be distinguished by their shots:

– Folk psychologists aim at their own conscious thoughts and feelings,

– Faith in all its varieties has the common goal of reflection and mysticism, [Chapter 9]

– Philosophy, according to Schwitzgebel (2010), the comparative and the Western variety, reflected on ‘the inner gaze’ from its very beginning,
Box 8-1  Emotion and feeling*

Emotions are the set of physiological responses that occur more or less unconsciously when certain challenging situations are detected. In the brain these automatic physiological responses involve changes in arousal levels and in cognitive functions such as attention, memory processing and decision making. In the body proper they involve autonomic, musculoskeletal and endocrine responses.

Feelings are the conscious experiences representative of the physiological phenomena generated by the emotional state.

* Ledoux JE, Damasio AR. Emotions and feelings. (Kandel et al. 2013,1079)

Psychology and psychiatry separated from philosophy in the course of the 19th century and subsequently developed into many schools of thought all with their own view on introspection, viz. behaviourism, Gestaltpsychology, psychoanalysis and its varieties, phenomenology and cognition, (Boring 1953)

“Until the end of the 19th century the chief method for understanding the mind,” writes Kandel (2013,371) “was introspection. In fact, this scholarly study of the mind was a branch of philosophy. By the middle of the 19th century, however, the philosophical approach gave way to empirical analysis and eventually to the formation of the independent discipline of experimental psychology.”

We need not pay attention to every point of view on introspection of all these disciplines. The reader may consult the above cited sources as a more extensive introduction. The essence of the old belief is that introspection provides ‘privileged access to our mental states (including sensory, bodily, cognitive, emotional et cetera) and thus is unique’. This old position is untenable, however, since experimental psychology showed that introspection is often mistaken, is unreliable, is auto-suggestive and may be biased. Boring (1953) posed the question in the introduction of his scholarly review of introspection “what became of introspection?” and concluded “...thus dynamic psychology carries on with the basic assumption that one cannot trust the subject’s personal belief (introspection) for the true assessment of his motives”.

1 Danziger (1980) in his discussion of Boring’s paper draws the attention to historical discrepancies between Anglosaxon and German psychological views on introspection which do not need to concern us here.
Many modern philosophers began with introspection of their own mental states. From Descartes onwards, knowledge so acquired was widely viewed as providing a unique – putatively incorrigible – foundation for philosophical investigation. (Papineau 2009) The discussion centred on the status of the beliefs obtained through introspection with questions whether ‘they were justified’ and ‘how likely is it that they are false’. (Noordhof 1995).

More recent philosophers have been less sympathetic to incorrectable introspective knowledge than Descartes and other founding fathers of modern philosophy. The scientific requirement of corrigibility is at odds with the ability of introspection to yield substantial information about reality, even about internal mental reality. Papineau (2009) observed that in the twentieth century people like Wittgenstein and Sellars argued that this tension discredited the entire idea of incorrigible introspection. Even philosophers who still support incorrigible self-knowledge for a limited range do not see it as playing a central methodological role in philosophy. I endorse the naturalistic and scientific conclusion that introspection is not a reliable source of knowledge. Sense data’s concept was so conceived and as stated earlier its existence has never been scientifically proved. [§ 6-4 (p.84)]

8.3 Intuition

“Intuition has been described by serious and sober writers as the only way to absolute truth, and by others writers, equally serious and sober as an illusionary path to absolute nonsense. The term, the concept, the fact of fiction of intuition all carry emotional overtones, regardless of the persuasion of the writer or the context of the writing. These emotional overtones range from contemplative delight to livid disgust.” (Westcott 1968)

Intuition (Latin intuere = to see) denotes the hypothetical power of the mind to perceive or ‘see’ certain self-evident truths. Intuition or insight is a private affair, an experience of sensing or obtaining knowledge without the use of rational processes, which is difficult to observe or communicate. Intuition supposedly has a direct relation to visual seeing, between the

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3 van Leeuwen (1986,4-8 & ch.ii) – starting from the premise that Descartes’ Regulae explain the process of his methodical thinking that constitutes his philosophy – argues convincingly that introspection in se as used by Descartes is to be taken as a metaphor only to substantiate (t)his process of thinking.
4 Gregory R, 1988,388-9
mind and something abstract, not accessible to the sensory systems and sometimes with mystical overtones. Intuition is thought to be an original and independent process of acquiring knowledge. Intuitions have been important in logic, metaphysics, ethics, and epistemology. Omitting for the moment statements on logic or mathematics as laws, axioms and truisms as well as intuition in the domains of metaphysics and ethics, I will focus on intuition as it occurs in epistemology and science. I will not discuss intuitionism or the philosophers who held it in high regard like Spinoza to whom it provided a superior way of knowing truth, mystical, without prior knowledge and the use of reason, i.e., knowledge of the supernatural, and of God. [Chapter 9]

In my discussion of innateness [§ 5-2 (p.66)] I said that intuitions were accepted as independent and trustworthy sources of knowledge by rationalists but were rejected by empiricists as being unreliable and often wrong. [§ 4-2 (p.52)] Nevertheless, many people rely on intuition in their daily life and often do so successfully. Can such apparently contradicting opinions be reconciled?

The intuitive mind thinks synthetically where a deductive mind will prefer to reason by analysis and abstraction. In the second place intuition uses association and is fast, while the rationalist analysis, takes time and, apperantly, more effort. Intuition is fallible but may lead to (lucky) hunches and quick insights; it certainly has glamour, and seems related to creativity and the momentary flash of insight or expression of eureka which of old had connections with the divine (in-spirare).

Cognitive scientists consider intuition as a first and fast assessment of some situation leading to a provisional hypothesis. It usually takes place in stress-like situations and is based on extensive experience and knowledge in the given field or discipline in which the intuition occurs. Therefore, intuition is a domain-specific phenomenon, which is based on much training, skill, talent and perseverance. It seems to be a gift of an effortlessly operating master in some art. Being an expert the master is usually right. Intuition is praised by people like Hadamard, Poincaré and von Helmholtz. Einstein once said, alluding to his E = mc² "there is no logical way to the discovery of these elemental laws. There is only the way of intuition, which

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5 Here no specific attention is given to ‘female intuition’. According to Gregory et al. (1988,389) female intuition is probably based on the subtle use of almost subliminal cue’s in social situations like gestures, casual remarks, and knowledge of behavioural patterns and motives. It heavily relies on capabilities to interpret body language, non-verbal communication and understanding feelings.
is helped by a feeling for the order lying behind the appearance”, and again, “The really valuable factor is intuition”. We cannot (entirely) rely on intuitions and creative insights: we must treat them as hypotheses in need of empirical testing. (Feenstra 2005,13-27)

Gladwell (2005) describes intuition as the power of thinking without thinking and claims that this is one of the brain’s strategies to make sense of a situation, which he describes as the fast operating, almost immediately and entirely below the surface of consciousness working system in which our ‘brain’ reaches conclusions without immediately telling us that it is reaching them. (Beware of the mereological fallacy) [Box 3-1 (p.47)] He cites Gigenrenzer calling this the ‘fast and frugal’, and ‘just feeling something’. Gladwell describes this phenomenon as the mind operating most efficiently by delegating much of high-level, sophisticated thinking to the unconscious. The adaptive unconscious does an excellent job of sizing up the world, warning people of danger, setting goals, and initiating action in a sophisticated and efficient manner. Intuition also is the ability of mind-reading that is based on the unconscious to find patterns in situations and behaviour. Moreover, one immediately knows that something is a tomato (§ 5-5 (p.75)], an ornithologist recognizes a bird, and anyone recognizes danger, without using logic or consciousness in this way; one ‘knows’ it at a glance. One knows but doesn’t know how one knows it. This kind of intuitive grasp (and/or subliminal perception) is extensively studied by, among others, the group of Dijksterhuis (2006,2007). Dijksterhuis himself argues that one’s ‘smart unconsciousness’ rather than conscious reason makes the better decision in – for instance – purchasing a new house. He describes this smart unconsciousness as a mixture of feelings, emotions and rational information acquired earlier.

In summary, intuition exists as a time honoured, independent – partly unconsciously or subconsciously operating – source of knowledge that is based on earlier acquired experience in the field to which the specific intuition is related. From ‘direct seeing and experiencing ultimate reality’ in the past it became ‘the immediate apprehension of justifiable belief’ that may show a (new, best) way. Its results should be looked upon as a

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6 „Es ist der Instinkt des Tieres, der in uns erwacht, der uns leitet und beschützt. Er ist nicht bewußt, er ist viel schneller, viel sicherer, viel unfehlbarer als das Bewußtsein. Mann kann es nicht erklären”. Remarque EM 1929/1993,48) [It is the animal instinct which alerts us, guides and protects us. It is not conscious, much faster, safer and more secure than consciousness. It can’t be elucidated]

7 Viz. Descartes ‘lumen naturale’ as a universal human attribute (van Leeuwen 1986, ch.ii & 56-97)
hypothesis that must be tested. Intuition then is based on the operation of un- or sub-consiousness that digested and processed much accumulated knowledge acquired by the information of the sensory systems.

8.4 The mind's eye

When I was a kid growing up in Far Rockaway, I had a friend named Bernie Walker. We both had “labs” at home, and we would do various “experiments.” One time, we were discussing something – we must have been 11 or 12 at the time – and I said, “But thinking is nothing but talking to yourself inside.” “Oh yeah?” Bernie said. “Do you know the crazy shape of the crankshaft in a car?”
“Yeah, what of it?”
“Good. Now tell me: how did you describe it when you were talking to yourself?”
So I learned from Bernie that thoughts can be visual as well as verbal.

Feynman 1988

8.4.1 Introduction

It is hardly possible to outdo Bernie Walker’s quote in proving the existence of non-linguistic thoughts. It thus would most likely be smarter to stop at this point rather than dwell upon the topic of the 'mind's eye' which is at the root of Feynman's anecdote. The essence of the mind's eye as described by Ferguson (1977) in the introduction of his paper 'nonverbal thought' is 'thinking with pictures', an essential strand in the intellectual history of technological development. He clarifies this as:

Many features and qualities of the objects [knives, chairs, lighting fixtures, motorcycles etc.] that a technologist thinks about cannot be reduced to unambiguous verbal descriptions; they are dealt with in his mind by a visual, nonverbal process. His mind's eye is a well-developed organ that not only reviews the contents of his visual memory but also forms such new or modified images as his thoughts require. As he thinks about a machine, reasoning his way through successive steps in a dynamic process, he can turn it over in his mind. The designer and the inventor, who brings elements together in new combinations are each able to assemble and manipulate in their minds devices that as yet do not exist. .....Pyramids,
cathedrals, and rockets exist not because of geometry, theory of structures, or thermodynamics, but because they were first a picture – literally a vision – in the minds of those who built them. Beginning with the Renaissance of the 15th century, a vast body of technical knowledge has been recorded and conveyed in the form of drawings and pictures. As soon as printed books superseded manuscript codices, large numbers of identical illustrations began to be reproduced. (Ferguson, 1977)

Ferguson cites Luis Vives, a philosopher and tutor at the English court, who as early as 1531 urged scholars to pay attention to the world around them, including the work of artisans, in order that their speculations might be grounded in reality rather than in “foolish dreams”. François Rabelais also advised teacher and pupil to visit shops of artisans and thus complete a liberal education, while Newton advised a young friend to seek out and observe “Trades & Arts” on the Continent and also to see what the Dutch had achieved in the grinding and polishing of “glasses plane”. (ibid.) Graphic inventions in the 15th century and drawings in perspective provided a consistent and uniform convention for pictorial representation of three-dimensional objects that can relatively easily be interpreted. He draws the attention to Leonardo da Vinci’s invention of the “exploded” view.

Ferguson (1992) elaborated his ‘Science’- paper in a highly recommendable book with many more examples and thoughtful analyses. His firm conviction is that “an engineering education that ignores its rich heritage of nonverbal learning will produce graduates who are dangerously ignorant of the myriad subtle ways in which the real world differs from the mathematical world their professors teach them.” (ibid. xii) “The mind’s eye”, he says, “is the locus of our images of remembered reality and imagined contrivance, an organ of incredible capacity and subtlety. Collecting and interpreting much more than the information that enters through the optical eye, the mind’s eye is the organ in which a lifetime of sensory information – visual, tactile, muscular, visceral, aural, olfactory, and gustatory – is stored, interconnected, and interrelated.”(ibid.41f)

8.4.2 Other fields

The mind’s eye is also used in other disciplines. Consider the anatomical atlases without which no person can hope to become a physician not to mention a surgeon. Consider the hands-on training which is extensively used in many laboratories in a variety of trades. No otologist can hope to learn his profession without many dissections in the temporal bone
laboratory and extensively studying surgical atlases that contain many drawings but few words. New surgical technology is taught and learned through hands-on courses, enriched with many movies and demonstrations of life operations. Again, words are used sparingly; instead obtaining such skill and technology needs long hours of intense and concentrated observations and hands-on practice, which reminds one of Polanyi’s tacit knowledge [Box 2-4 (p.37)] and the above mentioned ‘lifetime of sensory acquired information’. A good clinical examination and a thorough medical history are learned in the same way. A detailed talk with the patient is half the diagnosis. This art, as again Ferguson tells us, can not be taught through written text. Observation and learning by doing, i.e., practice only can teach trainees these activities. There is little difference between the training in medicine and surgery on the one hand and that of artisans, engineers, sportsmen and artists on the other.

Another example of training the mind’s eye to which Ferguson points is the use of ‘models’ which brings the trainee a dimension nearer to reality than a drawing and provides ‘nonverbal, sensual visual, tactile, muscular, and nowadays even aural information.’

Hamilton (2001) also citing Ferguson argues in ‘Wittgenstein and the mind’s eye’ 8 that the visual thinking involved in technical drawings of engineering design has crucially influenced the structure of the Tractatus Logico-Philosophicus (hereafter Tractatus) and influenced Wittgenstein’s conception of the Bild theory of language. “A proposition shows its sense” (Tractatus 4.022), “Propositions show the logical form of reality. They display it” (Tractatus 4.121). “What can be shown, cannot be said” (Tractatus 4.1212).

Wittgenstein once described his own distinction between ‘saying’ and ‘showing’ as “the cardinal problem of philosophy”. (Monk 1990,164) And, again, a “picture ... cannot represent its form or representation; it shows it forth”. (Tractatus 2.172)

8.4.3 Sensory systems and the mind’s eye

Like introspection and intuition, the mind’s eye is not an example of some special anatomical or physiological sensory system or a special unit. Its importance for my theme lies in the similar ways people think and speak about the sensory systems and the mind’s eye. Metaphor and reality may be confused. Moreover, the process of intense cooperation of many simultaneously active sensory systems in acquiring and mastering knowledge and

skill(s) is similar to the process of acquiring a mind’s eye. If this combination of knowledge and skill has been attained we tend to refer to that status as being experienced in that specific skill.

In this context I like to point out a typical Dutch term for the mixture of knowledge and (professional) skill which differentiates it from pure, i.e., predominantly theoretical knowledge. [Box 8-2] The combination of theoretical knowledge and proficiency may be compared with both knowledge what and knowledge how. (Ryle 1949,28) Granted that transitions occur and that the difference is not always sharp the meaning of both notions (i.e. ‘kennis’ and ‘kunde’) although the German term, like the Dutch ‘kennis’ tends to stress the theoretical side.

8.5 Meditation and contemplation

Intuitive knowledge may also be obtained through meditation and contemplation. These terms are often used as more or less synonymous but they are not.

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Box 8-2  Two Dutch terms discriminating theoretical from applied Wissenschaften

The Dutch word ‘kennis’ is used for knowledge, of the more theoretical variety in the first place.

The Dutch word ‘kunde’ is used for the mixture of knowledge and (professional) skill, a word also used in compounds such as ‘verloskunde’ (literally deliver-‘kunde’ = obstetrics).

Viz. the German word ‘Kunde’ is now obsolete but is still used in compounds like ‘Heilkunde’ (literally heal-‘kunde’ = surgery); ‘Kenntnisse’ (plural) covers both the Dutch ‘kennis’ and ‘kunde’ although the German term, like the Dutch ‘kennis’ tends to stress the theoretical side.
Meditation is focusing one’s thoughts and seriously concentrating on one subject. The aim of meditation may be religious or profane. In the Roman Catholic tradition it is considered to be a silent prayer concentrated on a religious truth.

Contemplation is the activity of viewing and continuously concentrating on spiritual phenomena as a form of devotion. In Roman Catholic tradition the devotion to transcendental truths by way of contemplation is thought to be the third and last preparatory step (after cogitation and meditation) before the soul’s vision of God.

Devotees consider meditation and contemplation useful to intuitively acquire knowledge. They are sources of alleged intuitive ways of acquiring knowledge of an entirely different variety than that which is the product of conscious ways of using sensory systems and of scientific enquiry.

Zazen9 training by a zen-teacher brought me into contact with Zazen’s putative target, i.e., practical mysticism as way of gaining knowledge which I will address in the next chapter.

8.6 Summary

Philosophical tradition attached great value to cognitive faculties like introspection and intuition, a little less value to the twins of contemplation and meditation, and hardly any value to the relatively unknown mind’s eye. Introspection is no longer accepted as a reliable cognitive system. Intuition has also met with conflicting opinions, is still valued but its cognitive meaning changed from ‘direct seeing and experiencing ultimate reality’ to ‘the immediate apprehension of justifiable belief’. The mind’s eye entirely relies, like introspection and intuition, on prior input of the sensory systems and on time for un- and subconscious processing and assimilation. Indeed, thinking, speaking and writing about these cognitive phenomena is distinguished by the use of a terminology derived from the sensory systems. Occasionally, the dividing line of metaphor and reality is – unwittingly – crossed.

9 Zazen is a meditative discipline or technique of just sitting in meditation, suspending all judgmental thinking and letting words, ideas, images and thoughts pass by without getting involved in them.
9 Mystical experience as an empirical fact

In most circles where it is fashionable to be rational, it is not fashionable to be mystical; and in most circles where it is fashionable to be mystical, it is not fashionable to be rational.

JF Staal 1975,12

You can have an (epistemically) objective science of an (ontologically) subjective consciousness.

JR Searle 2011

9.1 Introduction

In the humanities perception may be understood as an intuitive ability to understand (Verstehen). Perception thus understood seems to border on inner or spiritual vision and contemplation. This chapter deals with the ‘humanities version’ of perception, which according to Wittgenstein is ‘the inexpressible’.1

Meditation, contemplation and mystic insight or enlightenment may be understood as variations of perception as Aurelius Augustinus (St. Augustine) knew. It concerns a kind of perception that leads to some special experience, one that is significant for the perceiver but impossible – or very hard – to be vindicated by others.

The literature on mysticism is extensive. A recently released encyclopaedia of mysticism written in Dutch took ten years, thirty four collaborators and 1149 pages. (Baers et al. 2003) My present review of the matter will of course be ‘brief’. Although I will try to present the information systematically, it should be kept in mind that mysticism usually ignores all rules of taxonomy.

9.2 Sources

The obvious way to study mysticism is not merely indirect and from without, but also directly and from within, comparable to work on perception. While

1 Es gibt allerdings Unaussprechliches. Dies zeigt sich; es ist das Mystische’ (There is indeed the inexpressible. This shows itself; it is the mystical)(Wittgenstein 1976,6.522)[§ 8.5.2]
the knowledge of perception is generally taken for granted, for mysticism we have no storehouse of knowledge to draw upon personally. Staal (1975,125f) continues (t)his statement by comparing it with the way in which a blind man would study vision. He says:

that mysticism is not (often) studied directly and from within (1) because it is not so simple, (2) because of the general prejudice that mysticism by its very nature is mysterious and cannot be studied, (3) because of the general mistrust on the part of many contemporary philosophers, psychologists, and behavioural scientists generally, of anything that is not either an aspect of behaviour or a fact of physiology, (4) because of particular beliefs concerning mysticism.

The indirect way relies on accounts of the mystic experience itself which may take a variety of forms: a first-person report, the mystic’s interpretation at a later stage, the interpretation of third persons in the same religious tradition, the similar experience in other traditions. (Katz 1978,23) The literary genres that mystical writings tend to turn up in, are aphorism, biography and hagiography, report on visions, commentary, dialogue, various forms of instruction (sermon, private counselling, theoretical and practical teaching), prayer, religious poetry and fiction. (Keller 1978,78-9) Even more important for handing down the tradition – as all mystical traditions acknowledge – is the teacher, in clerical circles called mystagogue but now generally known with the originally Sanskrit term guru. Gurus derive their position from the state of their own mystical experiences. Eastern religions tend to call these individuals enlightened.

9.3 Language

Someone who has had a mystical experience usually automatically voices this event in his or her frame of reference, usually the terminology of the person’s religious/cultural upbringing. Every mystical text should thus always be interpreted in the context of the relevant religious/cultural tradition – including any specific subgroup and the historical time – in which it was written, be it atheistic, monotheistic, polytheistic, pantheistic or animistic. One should also be aware of the constant change in meaning of the terms used over time.

As there is a close relationship between the language and way of thinking of the mystic, and the contents of the visions he may have, Christians tend
to see Christian symbols and Buddhists Buddhist ones (Keller 1978,86). Katz upholds the even more extreme position that the mystic’s experience is shaped by the religious tradition he was brought up in. (Katz 1978,26) 

Mystical texts have a peculiar quality so that mystical experiences cannot be couched in plain language. Typically therefore, mystical texts make use of a number of figures such as metaphors, images, emblems, symbols, over-excited expressions, hyperboles, contrasts and contradictions, denials and paradoxes, seemingly illogical comparisons, ‘enrichment’ with neologisms et cetera. Grasping (the ‘reality’ of) mystical experiences with words remains a chimera. One of the Zen metaphors for this is like pointing to the moon; it is never identical with the moon itself. Often mystical language seems to have a florid, poetical, in Christianity frequently (homo) erotic – occasionally rather baroque – quality. (Kripal 2001) The reader must find his way back to the source of the thoughts of the mystic, his mystical intuition. Listening to a speaking mystic with all the nuances of his voice (sermo mysticus) may easily lead to real apprehension. 

There is still another reason why the mystic’s language often is hardly comprehensible: mystics of the three monotheistic religions (Judaism, Christianity and Islam) entangled themselves in self-contradictions as they twisted their statements in order to make them acceptable to the orthodox variety of their religious brand.

9.4 Experience

After reading many historical and contemporary accounts of mystical experiences William James (1958,292f) decided that an experience could only be called mystical if it complied with (one of) the following four characteristics: (1) ineffability, i.e., no adequate report of its content can be given in words. Its quality must be directly experienced and cannot be imparted or transferred to others. Mystical states are more like states of feeling than of intelligence, (2) noetical quality, being to those who experience them to be also states of knowledge, or insight. The following are less sharply demarcated, but are usually found, (3) transiency, i.e., cannot be sustained

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2 The view that some realms of reality where ordinary language is not applicable is not, of course, paradoxical, inconsistent or contradictory. Such a situation is common not only in philosophy, but also in mathematics or engineering, where for that reason artificial languages are constructed. (Staal 1975,53)

3 The metaphor of ‘the mountain and water’ [Box 0-1 (p.16)] may be taken as an example; the logic being in the eye of the beholder.
for long; half an hour or at most two hours seem to be the limit, (4) passivity, the experiences can be facilitated but once the characteristic sort of consciousness has set in, the mystic feels as if his own will was in abeyance, and indeed sometimes as if he were grasped and held by a superior power.

Bharati (1980,59) describes his mystical experience in a way that agrees with James' criteria:

For a moment, or for an hour – I no longer know which – I was that which is proclaimed in the four great axioms of Upanishad wisdom: Aham brahmasmi – I am the Absolute; tattvamasi – Thou are that; prajnatma brahma – everything that is truly the Brahman. Only now had I become a real apostate, because I had fulfilled the original heresy in me – that mystical pantheism against which early Christianity fought so hard, and with final success. I am God – that is supreme wisdom; I – not the unimportant, physical bodied I, not the wishing I, not the intellectual I – but all one impersonal I which alone exists. I experienced all this in that blessed moment for which I had not directly striven.

Some claim that they found differences between these experiences and those of the monotheistic traditions that hold that the mystic moves through stages leading toward its divine presence outside himself, i.e., transcendent. When such a person has been granted the intuitive apprehension of reality it is considered a divine gift of grace.

Buddhist mysticism teaches that the universal principle (Buddha nature) already exists in every person (and everywhere else), i.e., immanent.

Other religions contend that there is a third category, that of the prophetic ones. They practice intense, devotional worship that lends a distinctive, numinous (implying the sense of having encountered the sacred divinity) interpretation to the religious experience. (Austin 1999,15).

9.5 Substance

Mystics believe that they have access to a special form of knowledge described as revelation, insight or intuition. They are convinced that this knowledge is of a different reality, superior to the daily one that strikes them as illusionary. Its ‘reality’ is a happier one and it is continuously at hand. They are as sure – sceptics might say cocksure – about their convictions as any direct sensory experiences can be; and – as Russell (1918,16) has it – they
accept them, as a rule, as more convincing than results established by mere logic. They just know!

A second characteristic of the mystical experience is an overwhelming feeling of unity, together with a refusal to accept duality in general. Reality is one and indivisible (Parmenides). Bharati (1980,38) says in this connection:

The one impersonal God presents Himself in many manifestations and many functions. Just as one man plays the role of father to his sons, husband to his wife, friend to his friends, and master to his servants, so God is father to the one, lord and master to the other, a friend to the third, and on (….) Upanishad declares: there is only one truth, but Wise Man call it by many names.

Because all is one, the distinction of past and future is an illusion and time is not important.

Mystical states tend to be brief and bring happiness in a way that James calls ‘cosmic emotion’. In many mystics cosmic emotion inevitably takes the form of enthusiasm and freedom (they are animally happy, positively refusing to feel unhappiness). (James 1958,77)

The Buddhist variety of prajna or insight-wisdom is described as a leap of intuition that takes place in the presence of full awareness, but in the absence of self and of other dualities or formal analysis; transmitting its special knowledge wordlessly. This knowledge is more than the German kennen und wissen or the French connaître et savoir. It is more like understanding, comprehending, knowing in its broadest sense. It is cognition, thought, affection, cutting through the usual emotions attached to the psychic self. It is a quick grasp of unlimited, universal reality which clarifies the vast unity of all things. The actions directly coming out of prajna are swift, sure, and free of error, especially free of self-centred mistakes. (Austin 1999,545-6)

Mystics also tend to consider evil as an illusion and some even regard evil and good as illusions. The ethical characteristic of mysticism is absence of indignation or protest, acceptance with joy, disbelief in the ultimate truth of the division into two hostile camps, the good and the bad. This attitude is a direct outcome of the nature of the mystical experience; with its sense of unity is associated a feeling of infinite peace. Indeed it may be suspected that the feeling of peace produces, as feelings do in dreams, the whole system of associated beliefs which makes up the body of mystic doctrine. (Russell 1918,17) On the other hand, Bharati (1976,53) emphatically states that it is wrong to assume that the mystic should be ethical (…) Indeed he states that each is irrelevant for the other.
9.6 Training

Many techniques have been used and are still in use for preparing the seeker: fasting, prayer, drugs, self-mortification, fornication, yoga procedures, grace et cetera. Eliade described them extensively in two of his books. (Eliade 1964; Eliade 1969) It seems irrelevant how one achieves a mystic experience. (Bharati 1976, 219) There are methods for which exist independent and purely secular justification: (1) fasting (which has very definite effects on the body), (2) ‘withdrawal of the senses’ (in the Yogasūtra called pratyāhāra) or sensory deprivation, (3) meditation, (4) breathing exercises (= training of the body-mind complex) which are similar to incantation and recitation (Huxley 1944, 143ff), (5) detachment which can be induced by recitation or meditation on a mantra (Staal 1975, 136f), (6) sexual practices (tantrism) which are rejected when they are held to be conducive to an increase in mental tension, but are on the contrary utilized in order to bring about greater detachment from the rules of morality. (ibid. 139)

Many events can and do initiate or trigger a mystical experience, which cannot be reduced to sexuality or a chemical compound or the notes on the page. It is also irrelevant to mysticism – though of course not to ideological afterthoughts of a theological or anti-theological kind – whether the experiment allocates the zero-splash to ‘nature’, to himself as now integrated, or to deity however conceived and theologized. (Bharati 1976, 51f)

Methodical cultivation as an element of religious life may lead, stepwise, to a higher state of contemplation in which – generally – the intellectual, dualistic way of thinking and desire drop off, unity remains, and indifference begins. Higher stages reach a region where nothing exists, a next higher one where the meditator says: “There exists absolutely nothing; neither ideas nor absence of ideas.” Then another region where, “having reached the end of both idea and perception, the meditator stops finally.” This stage seems to be as close an approach to Nirvāṇa as this lie affords. (James 1958, 308)

In Christianity the basis of the (mystical training) system is ‘orison’ or prayer-meditation, the methodical elevation of the soul to God. (ibid. 309f) This may bring the person to a condition called raptus or ravishment by theologians; breathing and circulation are so depressed that some wonder if the soul is temporarily uncoupled from the body. It leads – according to Teresa d’ Avila and John of the Cross – to enrichment of, and to bringing energy to the soul and to even the attainment of absolute truth, usually formulated in negations as it goes above every definable experience and knowledge. Like Hegel in his logic, mystics journey towards the positive pole of truth only by the ‘Methode der Absoluten Negativität’. (ibid. 316-9)
To overcome all usual barriers between the individual and the Absolute is the great mystic achievement. In mystic states (Hinduism, Neoplatonism, Sufism, Christianity, Buddhism) mystics both become one with the Absolute and come aware of a feeling of oneness. (ibid.321)

9.7 After-effects

William James writes that the fundamental inner conditions of mystical experiences have characteristic practical consequences which he lists as (1) ascetism (up to pleasure in sacrifice), (2) strength of soul (fears and anxieties go, and blissful equanimity takes their place), (3) purity (cleansing of existence from brutal and sensual elements, contact with such elements is avoided), (4) charity (to all kind of men and even to animals; Francis d'Assisi and Ignatius De Loyola). (ibid.215-25)

Tenseness, self-responsibility, and worry go, equanimity, receptivity, and peace arrive when simple relaxing and throwing off the burden occur. Great emphasis is laid on the concentration of consciousness when the moment is at hand. (ibid.229) There are three minor branches of self-mortification: chastity, obedience (in different ways) and poverty. (ibid.244-55)

If it does anything directly to the average man with an average mind, it makes him more observant, more detached – it makes him see persons and events around him in a healthier, more humorous hierarchy, falling in line, below the zero-experience, as less important, less pernicious, and thus less serious. (Bharati 1976,225)

Far-reaching were the consequences the mystic experience had on persons, like Francis d'Assisi and Ignatius De Loyola. Some mystics paid with death. Indeed, each of the three monotheistic religions has victimized mystics.

Incidentally, changes in worldview after having had a mystical experience are comparable although not identical with other upsetting experiences of the self. Overactivity in the right hemisphere at the junction of the temporal and parietal cerebral cortex can create ‘out-of-body-experiences’, the experience of looking at one’s body from the outside; damage to the right hemisphere can cause one to look on a limb as ‘not me’. These abnormal experiences can be explained as the result of faulty neural representations of the body and its parts in space.4

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4 Frith CD. Disorders of consciousness and unconscious mental processes In: Kandel 2013:1373-88
9.8 Social status of the mystic

Many mystics are drop-outs; mysticism has an asocial or anti-social point of view. Mystics often express their dislike or contempt of society. In Yoga, the first step on the mystic path is *vairāgya*, ‘detachment, renunciation’, and this is primarily directed towards our social attachments. Jesus said: “If any man comes to me and hates not his father, and mother, and wife, and children, and brethren, and sisters, yea, and his own life also, he cannot be my disciple” (Luke 14:26) Tao is noted for its anti-establishment, anarchist, and *laissez faire* attitude, (Staal 1975,102) as is Zen (Feenstra 2005,95-101). In Hinduism, where the prevailing ideal results from a synthesis or compromise between the requirements of ascetism and of society, the mystical path of *sannyāsa* is generally advocated only for those who have gone through the entire gamut of social responsibilities.

A person, who in his search for mystical experience turns away from society, cannot be expected to bring the solution of social problems. But it does not follow that mysticism does not have social implications, even constructive ones. Later Taoism, for instance, became an expression of protest, not only for ‘escapist intelligentsia’, but also for ‘rebellious peasantry’. (Staal 1975,103)

9.9 Points of debate

The fourth edition of the Diagnostical Statistical Manual of Mental Disorders (DSM-IV) for the first time contains an item on ‘religious or spiritual problems’ under the category V62.89. Earlier, Freud had already judged the ‘Oceanic experience’ of mystics as nothing but a regression to infantile helplessness and primary narcissism. Others called it borderline psychosis, dysfunction of the temporal brain and some even denied the existence of mind and soul all together.

In a thoughtful analysis, De Waard (2007,9) criticizes the formal view of official psychiatry (*Group for the Advancement of Psychiatry, Thomas Szasz, Ronald D Laing, Jan Foudraine et cetera*) on mysticism as “old fashioned mysophobia and shivering on the brink”. It shies away from accepting mystical experiences as an empirical fact.

William James (1958,29) vehemently opposes this kind of thinking. He called it ‘medical materialism’ which classifies the apostle Paul’s vision on the road to Damascus as a discharging lesion of the occipital cortex, he being an epileptic, snuffs out Teresa d’ Avila as a hysterical and Francis
d’Assisi as a hereditary degenerate. He says that in the natural sciences and industrial arts one’s opinion is never refuted by pointing out the author’s or inventor’s neurotic constitution. “In the end it has to come to our empiricist criterion: By their fruits ye shall know them, not by their roots”. (ibid.34)

A second point of discussion is the one of the recognized similarities or dissimilarities between mystical experiences and different religious traditions. Many are of the opinion that all mystical experiences are – basically – the same, and transcend cultural or religious diversity. Others hold that all mystical experiences are the same but the mystics’ reports about their experiences are culturally coloured. Some consider that all mystical experience can be grouped into various types which cut across cultural boundaries. Although the language is culturally bound, the experiences of mystics are not. Katz (1978,23ff) argues that such a thing as Huxley’s *philosophia perennis* does not exist.

He holds the view “that there are NO pure (i.e. immediated) experiences”: “All experience is processed through, organized by, and makes itself available to us in extremely complex epistemological ways. The notion of unmediated experience seems, if not self-contradictory, at best empty.” He strongly holds the view that to understand the reports of the mystic after the experiential event, not only the experience itself but also the form in which it is reported, is formed by concepts which the mystic brings to, and which shape, his experience. (ibid.26; italics in original)

Monotheistic religions seem to strive for the *unio mystica* with God and, in Christianity, also with Jesus Christ and the Holy Ghost. Bharati (1976,28) observes that:

Orthodox Jews, Christians, and Muslims really cannot seek this union and be pious at the same time, because losing one’s identity and becoming the cosmic ground is a deadly heresy in these teachings.

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5 *philosophia perennis* coined by Augustinus Steuchius (16th century theologian and librarian of the Vatican) via Godfried Leibniz (1646-1716) chosen by Huxley (1894-1963) as the title of one of his books. (Huxley 1944) It is the philosophy that man cannot learn the one divine (spiritual) reality through the intellect but only by direct experience.
Those mystics are an embarrassment to the established religious order. If they cannot be suppressed, they will be ‘neutralized’. They may be permitted to withdraw to cloistered retreats, there to remain hidden from the eyes of the world, put into jail or even tortured. The more reputed of their number may be sainted – saints to be revered but not imitated.” (ibid.20)

Mysticism of monotheistic religions differs from those that strive for negation and vanishing in nirvana. The religious experience of certain forms of Buddhism, Taoism and others are more mystical, while the prophetic ones (Christianity, Judaism, Islam) are more numinous. (Gimello 1978,171) Gimello suggests that a numinous experience is one of an encounter with a being wholly other than oneself and altogether different from anything else. This sort of encounter is usually said to be gratuitous, in the sense that those subject to it are not themselves responsible for its occurrence, and it is typically described as both overwhelming and self-authenticating. The mystical experience, in contrast, is not so much an encounter with a ‘sacred other’ but the interior attainment of a certain supernatural state of mind, the result of the subject’s efforts in following a contemplative discipline or method. (ibid. 172) Indeed, reading the sermons and treatises of Meister Eckhart or the writings of John of the Cross one cannot suppress the feeling that they also tend to find the Holy in themselves rather than in a divine structure. Both of them ran into trouble with the Inquisition. Like Staal and Bharati state and many other people have experienced, no (believe in a) godhead is needed to have an illuminative experience.

A third point of debate concerns the numerous parallels and similarities between drug-induced states and mystical states. The great variety of mystical states, of preparatory exercises between different systems or within the same system, of drugs with different effects make comparison difficult. The same drug may induce different states among different people or in the same person at different times. (Staal 1975,148) The religious use of drugs is old and widespread.6 Institutionalized religions do not like drugs. Religions are not so much concerned with religious or mystical experience as with ethics, morality and the continuation of the status quo. One of the ways to make ethical actions palatable and even desirable is to show that they are meritorious. The mere ingestion of a drug can hardly be considered meritorious, so how could it lead to such an exalted state? That would seem unfair, to say the least. Hence the moralist’s (Eliade) distinction between

6 Extensive references on psychedelics in Kripal 2007
easy and difficult path’s. (Staal 1975,156) Even if the differences turn out to be fundamental after thorough and close study, the known similarities between drug-induced states and mystical states are far too profound to be brushed aside. (ibid.158)

A fourth debatable issue that preoccupies philosophers in their investigations of mysticism, i.e., how to distinguish between mystical experience and the interpretation by the mystic himself, and between others in the same tradition and from another tradition. Whether or not, or to what extent, mystical experience can be invoked to justify the truth-claims of certain propositions of religious or metaphysical belief; the manifold problem of defining relationships between mystical experience and other areas of human concern such as morality, aesthetics, mental health et cetera. (Gimello 1978,170-2)

In conclusion, mystical experiences happen from time immemorial and occur in every culture. Supposedly, they are specific and special states of mind commonly achieved through some form of self-cultivation and are characterized by the following of these features separately or in combination: (Gimello 1978,178)

– a feeling of oneness or unity,
– a strong confidence in the ‘reality’ or ‘objectivity’ of the experience, i.e. a conviction that it is somehow revelation of ‘the truth’,
– a sense of the (final) inapplicability of conventional language to the experience,
– a cessation of normal intellectual operations (e.g. deduction, discrimination, ratiocination, speculation, et cetera) or the substitution of them by some ‘higher’ or qualitatively different mode of intellect (e.g. intuition),
– a sense of the coincidence of various kinds of opposites, (paradox),
– an extraordinarily strong affective tone, of various kinds (e.g. joy, serenity, fear, pleasure, often in an unusual combination).

Mysticism and the arts of the spiritually contemplative life have always been comparatively marginal activities in the western traditions, being usually subordinate to prayer, ritual, the sacramental life, worship, moral endeavour, study of the Law. In Eastern religions, Buddhism in the first place, in contrast, meditation has always been one, if not the central form of praxis. One should not be surprised, then, if it were found that Buddhism offers a more sophisticated set of analytical instruments with which to examine such phenomena as obtained in disciplines of mental cultivation. (Gimello 1978,180)
9.10 Mind and brain in relation to mysticism

In the last paragraph I used the formula *specific and special states of mind* which seem to border on consciousness. It is very difficult to precisely define consciousness, especially with respect to the mystical states. The best I can do is quoting the metaphor of Austin (2000,308) which he names ‘global analogy’:

> They [geologists] now have remarkable evidence about Earth’s active early history. Our planet’s crust sinks, thrusts up, breaks apart, drifts, and reassembles in new configurations. Subterranean forces are still causing our continents to move. Even viewed in slow motion, these dynamic geological changes are a useful metaphor for the active processes that create the astonishing mental landscapes and deep, V-shaped ocean trenches of our extraordinary alternate states. And it is also true that the experiant, like a wide-eyed Marco Polo, will be witness to novel continents of experience, worlds that could never have been imagined. (italics in original)

In describing consciousness in relation to mystic (zen)-states Austin discerns many layers that – as he puts it – may be ‘lumped’ or ‘divided’. He suggests a middle way by lumping and dividing the layers into ten varieties. (ibid.298-305) In the perspective of my essay his varieties of mystical states do not include consciousness, moreover; daily consciousness in mystical states is either ‘non-existent’ or ‘heightened’ which amounts to the difficulty described earlier in defining such states in every day language. That being said, it seems that the conscious experience of an I-me-mine as Austin has it, alternatively stated, the *Ich* or *Ego*, fades into some – almost Léon Battista Alberti-like – vanishing point.

An interesting and rather recent development is the introduction of modern medico-biological research tools into meditation/illumination like EEG, PET-scan, fMRI. These methods demonstrate different images of the meditating brain of a seasoned practitioner (whether Roman Catholic nuns and Tibetan monks) or of laymen. (Newberg et al. 2001) Notice that these kind of images only demonstrate process(es) occurring in the brain of people during meditation. They are no more than bodily correlates of the mystic process, or, possibly, independent bodily correlates during the mystic process.

Some eliminative materialists – notoriously the Churchlands and Dennett – think that is all there is. Some others are inclined to express dualistic
explanations in the age old mind-body discussion, nowadays more often reformulated in terms of neurophilosophical brain-body discussion. Still others tend to believe in an idealistic monism. Underneath there lurks a semantic distinction emphasized by Rescher (1996,114): “From the conceptual point of view, mind is understood autonomously, from the causal view it can be explained.” (italics in original)

9.11 Conclusion

Mysticism is thus understood as a special experience that cannot directly be imparted or transferred to others. It is more a state of feeling and being. Mysticism presents knowledge, insight, illumination or intuition that is felt to be of a different reality, superior to the daily real one, that strikes the mystic as illusionary. Its ‘reality’ is a happier one, continuously at hand and as certain as any direct sensible experiences can be. A mystic just knows! This knowledge, being more than the German kennen and wissen or the French connaître and savoir, is more like understanding, or comprehending. It is cognition, thought and affection, cutting through the usual emotions [Box 8-1 (p.98)] attached to the psyche. It is a brief grasp of unlimited, universal reality which illuminates the vast unity of all things. The actions, directly coming out of prajna are swift, sure, and free from error, especially free from self-centred mistakes.

The bodily experience takes place predominantly in the mind/brain. The boundaries with perception, consciousness, memory and cognition seem faint and partly semantic.

Conscious states of mystics are outside the normal use of the word consciousness. Direct sensory perception in mystical states is near-absent.

Thus mysticism has little to offer to the analysis of sensory systems in se although it certainly changes the way the environment and the self is perceived by their votaries. Still, introspection, intuition,[chapter 8] contemplation and meditation, none of them resting on sensory systems directly are, even so, putative ways to specific kinds of (by many highly esteemed) knowledge.
Part III

From sensing and perception to consciousness.
Braiding the wattle, constructing the raft
10 From sensory systems to experience

10.1 Introduction

From the smallest subatomic particles to the largest stellar structures everything in the universe is part of processes with greatly different time scales. [Box 10-1] Our spatiotemporal, 4-D world, the roughly twenty kilometre thick layer of the earth and its atmosphere is called biosphere. From its conception onwards every organism is confronted with 4-D conditions increasing in size and in number of capabilities and functions. Its development may be described as a sequence of parallel, successive and multiple processes according to its genetic plan ultimately leading to death and decay.

Life may thus be characterized by its constituent processes that can be described in terms, formulae and laws from physiology, (bio)physics, (bio)chemistry, psychology et cetera. The sensory systems, as suggested before, form part of many complicated (sub)-processes. Although expressions like ‘eye’ or ‘ear’ almost automatically presume these structures to be static or stable configurations they are almost continuously active, i.e., occupied with selecting, and translating into neuronal codes most of the massive bombardment of incoming signals from the environment and the body.

The – coded – information [Box 2-5 (p.40)] provided by sensory systems may be integrated in a variety of (behavioural) systems. [Box 5-1 (p.67)] The definition and the genesis of behavioural systems are intimately connected with experience. The relation between sensory systems and experience is the theme of this chapter.

10.2 Levels of sensing and levels of perception: prelude to experience

Perception has been provisionally defined in the first chapter of this essay [p.25] as that part of the sensory systems’ activity that culminates in awareness of objects and events in the environment. Problems with this definition arise if we accept awareness to be the dividing line between sensing and

1 The eye, for example, contains more than one visual system, accounting for perception of form, depth, brightness, motion and colour which lead through processes in the brain to the way we perceive our 4-D environment. In order to do so the retina sends millions of measurements per second to the brain where they are processed by some billion cortical neurons.
perceiving which run from *not-sensing* or *not-yet-sensing* to and including the highest levels of cognition. [Box 10-2]

The unconscious part of the sensory system’s activity is *not* perception in the narrower meaning according to my earlier definition. Even if we rigorously draw the line here problems will still arise as a few examples may show:

1. The regulation of equilibrium, the activity of the skin receptors and interoception [Chapter 5] are generally excluded by philosophers as not being perception but ‘mere bodily sensations’. As explained before, these always alert sensory systems are the receptor-part of (homeostatic) mechanisms [§ 5-4 (p.74)] that provide continuous information of the environment and the body itself to the control centres of which the reactions keep the *milieu intérieur* constant. Very little homeostatic control reaches awareness although we may consciously notice some consequences like gooseflesh and shivering as responses to decreased temperature.

2. From the moment we button our shirt or buckle our belt we forget them and generally do not pay attention to them until the moment of undressing some sixteen hours later. If asked to focus on the shirt’s third button from above, consciousness is able to immediately locate them.

3. A new scent is quickly noticed, is no longer noticed a few minutes later but may recur by inhaling deeply and paying attention.

4. The phenomenon of blind sight, originally described by Weiskrantz (1991) as a brain lesion causing loss of awareness/consciousness when

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**Box 10-1 The environment of the Earth***

When life appeared on Earth the ‘faint young Sun’ only radiated about seventy percent of the energy it now generates. The core of the sun is gradually being enriched in helium. It is contracting and the temperature of the core where most of the thermonuclear reactions occur is increasing. The rate of thermonuclear reactions is sensitive to temperature and this will cause the insolation to increase about one percent per hundred million years. The sun, inevitably progressing along its evolutionary path, before five billion more years will expand beyond the present orbit of the Earth and become a red giant. The oceans will boil away and the Earth will be cooked into lifelessness like Venus is today. Life has already existed on earth for three quarters of its allotted time.

* Yokey 2005,133f
looking with both perfectly normal eyes caught wide philosophical attention.

(5) The sensing by the vomeronasal organ of man never reaches awareness. Noë therefore excluded the organ as a sensory system although Keeley (2009, 226-50) contradicted Noë most convincingly.

(6) The satisfaction of suckling during and shortly after feeding does probably not involve consciousness.

(7) Withholding early maternal care causes unhappy maternal-infant relations with permanent damage to the infant in later life as has been shown by Harlow’s [note 12 (p.39)] experiments with infant-monkeys even though consciousness at the time of the missed care did not seem to be involved.

(8) Tinbergen’s herring gull chick eyeing the red dot on its parental bill (the innate releaser) [Chapter 2] is part of an intricate feeding pattern that belongs to the intrinsic need of the body to grow. This experience is not consciously noted.

(9) The molecular sensing by gastrointestinal epithelial cells [note 16 (p.77)] may be viewed as a sensory system although no one would accept this as ‘perceiving’.

These examples are manifestations of bodily effects following specific stimuli that usually do not but occasionally may reach awareness.

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**Box 10-2 From sensing via perceiving to cognition**

| un-conscious | viz. molecular sensing, blind sight, vomeronasal organ’s action etc. |
| sub-conscious hear | viz. ‘automatic pilot’, Proust’s story about petites madeleines passive; one may hear a sound or an utterance but not correctly catch the sounds, viz. E.A.Poe’s story of The murders in the Rue Morgue |
| listen 1 | active listening but unable to catch an utterance correctly for example due to an inadequate stimulus to noise ratio |
| listen 2 | active listening correctly catching an utterance but not understanding it as for instance hearing a word in an unfamiliar language |
| understand | understanding an utterance but not its meaning |
| comprehend, grasp | correctly understanding the utterance |

* Molecular sensing in the gastrointestinal tract [note 16 (p.77)], blind ‘perception’ [p. 38f], Proust [p.38],
** E.A.Poe’s The Murders in the Rue Morgue (Graham Magazine, 1841) is an early detective story. Two ladies were killed. Many listeners had noticed someone shouting but no one could tell what language had been used. The suspected ‘person’ turned out to be an escaped orangutan.
Some people consider the ‘sensing’ of the endocrine system and the immune system also as sensory systems. [§ 5-5 (p.75)]

When infected with the mumps virus, we may fall ill; on the other hand, the infection may pass unnoticed. Nevertheless, after our first encounter with the mumps virus our body has developed resistance to this virus; the body ‘experienced’ the virus and ‘recognizes’ it whenever new contacts occur. For the other examples similar arguments can be presented.

Between the unconscious and the conscious level of the sensory systems' effects a grey zone exists that is usually described with some metaphor like ‘automatic pilot’. We may be in deep thought about problems during work while driving home. The automatic pilot safely takes us there while we not consciously notice anything of the drive. If need arises later, however, we can usually recall the drive and bring back into consciousness much which we only noticed subconsciously. Sometimes the delay between the unconsciously noticed phenomenon and the recollections may take years as Proust’s reflections on the smell of his ‘petite madelaine’ demonstrates. [p.38] Subconscious sensations or ‘perceptions’ have effects and thus they must be accepted as experiences. The difference between sensing and (my original definition of) perception seems marginal since other examples of subconscious ‘perception’ never reach consciousness. Like the unconscious level of perceiving, also the subconscious level should be represented in a general definition of perception. If not, the logical consequence is that young children, animals and plants do not perceive, which clearly is not the case. All other levels of perception [Box 10-2] belong to the generally (philosophical) accepted definition of perception since consciousness is clearly involved albeit with variable intensities. Definitions of perceptual experience that do not pay attention to the borderline phenomena are incomplete.

10.3 Defining experience

Many discussions about perception simply accept experience (veridical or illusory as a given and tend to formulate it in the context of belief or knowledge acquisition. The Oxford English Dictionary (OED) gives three meanings of experience: (1a) direct participation or observation, (1b) the knowledge, skill, or practice derived from such experience, especially over a period of time, (2) something personally encountered or undergone, (3) the sum total of conscious events that make up an individual life or the
collective past of a community, nation, et cetera. In the philosophical literature, experience is generally tightly coupled to Aristotle's five senses, predominantly vision, to empiricism, to consciousness and to knowledge.

The OED's definition of experience (2): "something personally encountered or undergone" corresponds best with the way in which I use the term. That definition omits consciousness and subjectivity. The definition encloses perception, sensations, homeostasis, the immune system and the endocrine system. It includes infants, animals and plants. It includes time and thus experience is a process and not a thing. [§14-5 (p.174) A variety of adjectives and elucidations may be attached to the term experience in order to specify the nature of the 'something' in the definition, such as: mental-, spiritual-, mystical-, bodily-, life-, technical-, professional-, animal-experience et cetera.

### 10.4 The something personally encountered and undergone

#### 10.4.1 Introduction

Essentially the OED definition of experience uses the verb encounter or undergo signifying what makes an experience an experience. Without encounter, no experience; experiencing is undergoing something.

The 'something' that is personally encountered or undergone may not be consciously noticed as in the light variety of mumps. If noticed, the experience is usually described by philosophers as "having some phenomenal character (some phenomenology) or what it is like for the subject to have them" (Siegel 2011). In the case of a bat this would mean "that there is something that is like to be a bat" (Nagel 1974). The subjective character of experience is underscored by Nagel. Experience, he writes, includes enormous variation and complexity, and while we do not possess the vocabulary to adequately describe either of them, its subjective character is highly specific. The gap between the sensory systems’ of oneself and those of another sentient being, Nagel says, can fall anywhere on a continuum. Even for other persons the understanding of what it is like to be them is only partial. When one turns to different species understanding of them will even be less. The psychiatrist R.D.Laing (1967,16) put it even more explicitly: “I cannot experience your experience. You cannot experience my experience. We are both invisible men” and “I see you, and you see me. I experience you, and you experience me. I see your behaviour. You see my
behaviour. But I do not and never have and never will see your *experience* of me." (ibid.15. Italics in original).

The doctrine that physical objects are reducible to (the) sensory experiences of an organism or that physical object-statements can be analysed in terms of phenomenal statements describing sensory experiences has been called phenomenalism. Instead of stressing the phenomenal side of experiencing I opt for the pragmatic *acceptance of the phenomenal aspects of experience as a biological fact*. Studying experience from an individual’s subjective side easily leads to unproductive solipsism or to unscientific reasoning.

### 10.4.2 Phenomena

The process of encountering or undergoing that makes something into an experience has, as it were, two ends: (1) the factual of physical objects and events in (a) the organism and (b) in its environment, (2) the experiencing body, subjective or phenomenal.

Phenomena\(^2\) are *observable* facts or events, i.e., objects of sensory perception. In chapter 6 we met philosophers who take (private) perception rather than facts or events as their starting point of philosophizing. These philosophers try to show how the contents of facts and events involve little more than sense data or activity of sensory systems. As said in the introduction of this paragraph [§ 10.4.1] I consider this approach as less profitable than following Sellars’ (1963,173) dictum that “natural science is the measure of all things, of what is that is, and of what is not that it is not”. This point of view denies the anthropocentric subjectivity of sense data and (other) philosophical idealism. It accepts that there *is* a real world in which – among other organisms – *Homo sapiens* lives.

### 10.4.3 The consciousness side of perceiving

With respect to experience, philosophers usually have in view the conscious part of the phenomenon. For example Stevenson (1982) in his *The metaphysics of experience,* defines experience as:

> the common use in English [as] to mean knowledge, skill, or wisdom acquired from life and practice over a substantial period of time. (Stevenson 1982,1)

\(^2\) Left out in this essay are noumena (Plato’s Ideas and Forms) and Kant’s discussions thereof.
He continues with:

that which has featured so centrally in modern epistemology, namely to refer to the momentary states of consciousness of an individual perceiver and thinker. In this philosophical usage, which is also in common speech, the term has a plural, as in I’ve had several peculiar experiences today. All that we assume about experience is that it involves both perception and thought. That is any subject of experience has, in our definition, both sensibility (the capacity for sensory awareness) and understanding (the ability to make judgments about what he is aware of). (ibid. italics added)

In this definition Stevenson refers to (an English translation of) Kant’s Kritik der reinen Vernunft – [critique of pure reason] (A15/B29, A19/B33, A50/B74) which is in agreement with the statement in his own preface where he says that his own book is to be understood as “inspired by this [Kant’s] work”. Stevenson confirms his views on experience with:

The conditions we are concerned with are those logically or conceptually necessary for experience. If it is physically necessary for such experience that there be so many million neurones (or equivalent functional units) with certain complicated patterns of interconnection, supplied with blood (or other energy input), that is no business of ours. The subject-matter here is not the physics but the metaphysics of experience. (ibid. 5)

In fairness to Stevenson, he also says:

It may well be claimed that a fish can perceive a fly, and see that it is moving downstream, without thinking of the fly or judging that anything is the case. We do not deny that in one sense of ‘experience’ many creatures incapable of assertion, judgment, or thought can have, enjoy, or suffer various kinds of experience including sensations and perceptions. We just point out that our subject-matter here is the experience of rational beings, who can apply concepts to their intuitions and thus make judgements about what they are aware of. Exactly what is implied in these notions of “rationality”, “concept”, and “judgment” will be examined in more detail later. (ibid. 3-4, underlining in original)

Ignoring the inconsistency within his definition of perception and the difference between experience (with -) and experience (without -) judgment or thought in the last quote, Stevenson excludes the ‘animal side’ of human
experience as the target of his inquiry. He underscores this line of reasoning again when defining ‘sensibility’ [...] the capacity for awareness of particular items’. (ibid.11, italics added)

I will return to consciousness later but wish to stress here that Stevenson’s type of experience, goes hand in glove with, as he formulated it in the first quote, knowledge, skill, or wisdom to which I like to add “perception and information”.

We may thus postulate characteristics of experience as follows:

1. sensing and perception are the beginning of experience,
2. it is/they are/ (a) process(es) situated in time and taking (any length of) time,
3. relations exist between the goings on at the milieu extérieur and the milieu intérieur,
4. all sensory systems contribute to experiences of an organism and all sensory systems are continuously active when awake,
5. some (isolated, or cut off) period or part of time and combination of sensing/perception may be referred to as a (specific) experience,
6. awareness may be involved but it is not a necessity,
7. someone’s experience at any moment $t$, the thing that Siegel coined overall experience (although she seemingly excludes some of it) is the person’s total experience (the accumulated exposures to objects and events) at $t$. This of course includes cognition and emotion although so far I have not mentioned anything explicit about either.

To define experience at time $t$ as the sum of everything that entered an organism’s body (including its brain) through all sensory systems, unconsciously or consciously up to $t$, is certainly not the general view in philosophy.

In the next chapter I will pay attention to the informational aspect of sensory systems and perceiving.
11 Information

11.1 Introduction

In the preceding chapter ‘experience’ of an organism at some time \( t \) was defined as the sum of the effects of all stimuli that entered the organism via the sensory systems (in the widest meaning) up to \( t \). ‘Experience’ that has been accumulated in the course of evolution by cells, tissues, organs and organisms and that has been ‘stored’ in their genes has been deliberately omitted so far but I will return to it in the course of this chapter.

Previously I have defined a stimulus (or signal) as an environmental change or more specific, the characteristic physical or chemical energy generated – directly or indirectly – by an ‘observed’ object or event. This definition is valid for any living cell, tissue, organ and organism; stimuli thus convey environmental features which is usually called information. Sensory systems are thought to be the machinery with which an organism seeks and receives ‘information’, [Box 2-5 (p.40)] a subject that deserves now my attention.

Information can be defined in many different ways.\(^1\)\(^,\)\(^2\)\(^,\)\(^3\)\(^,\)\(^4\) For this essay I definitely add may own definition: ‘all specific features of their environments’ conveyed to a cell, to a tissue, to an organ and to an organism. I will first pay attention to ‘information’ itself and then extend the discussion to biosemiotics, an interdisciplinary scientific study of signs and codes in living systems.

11.2 Information as features of the environment

In order to introduce the subject I return to the herring gull chick and the new born human, [Chapter 2-2 (p.28)] which showed specific behaviour in

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1 Previous examples of such ‘specific stimuli’ were the temperature gradient in the watery environment of some micro-organisms, the red spot on the beak of mother herring gull for her chick and the smell of the mother’s breast for the new human baby.

2 Information is notoriously a polymorphic phenomenon and a polysemantic concept so, as an explicandum, it can be associated with several explanations, depending on the level of abstraction adopted and the cluster of requirements and desiderata orientating a theory. (Floridi 2009,13)

3 According to Francis Crick’s ‘central dogma’ of genetic inheritance, information is synonymous with the sequence of amino acid residues per se without any regard to cognitive or semantic considerations.

4 According to Claude Shannon at al (1949,8), information is the diminution of uncertainty in a system.
response to an environmental change immediately after they were born. For the herring gull chick this change (= stimulus) was the appearance into its proximity of a yellow object with a red spot, representing the beak of its mother. In response the chick started pecking at the red spot. The mother responding to the opened bill placed regurgitated food into the chick’s beak. These environmental changes (stimuli, signals) function as information, i.e., they are specific features of the environment, very important to the chick and the mother. If we wave a yellow red-striped stick near the chick’s head it opens its bill too and the response may be even greedier than the natural one, i.e., its mother’s beak. This phenomenon, called superstimulation (superreaction might be a more accurate term) obviously is mis- or false information since the chick is offered no food at all.

The human baby opens its mouth when its lips are gently touched with the mother’s nipple or finger, and puts its lips around them (the finger is thus falsely taken to be a nipple: misinformation) and starts the coordinated muscle activity called sucking. Shortly before the lips touch the nipple the baby turns its head towards it, the smell being the stimulus. For the human baby the smell and the lip-touch are the environmental changes that – normally – lead to food/drink if it starts to suck. (I omit here the interoceptive sensation of hunger).

These actions are basic examples of the informational process which starts with a looked for or contingent environmental change relative to an organism. This change (= stimulus) may lead to one or more reactions of the receiver. In the given two examples of the processes we have:

(a) a looked or not looked for situation or environmental (physical, chemical) change (or distinction) – relative to one or more sensory systems of the organism – that,

(b) may be sensed by an organism’s sensory systems because of the strength of the change and the properties of its sensory systems, (if sensed, the environmental change is called stimulus or sign retrospectively),

(c) may not be noticed (= unconsciously) or noticed (sub)consciously by the organism (as some of its bodily reactions and reflexes may indicate),

(d) may be deliberatedly ignored or not. This phase implies a choice as the human baby may stop sucking because it is tired or satiated. Probably the baby continues to receive stimuli and may take note of them. Ignored here is the question if a baby may be credited or not with consciousness.

Interestingly, none of these steps seems to have a generally accepted name in the information literature. Luciano Floridi (2010,23) speaks about (a) up
to and including (d) as ‘data in the wild’ or *dedomena* (‘data’ in Greek) with the comment that the term ‘data’ originates with the Latin translation of a work by Euclid entitled *Dedomena*. He describes *dedomena* as ‘fractures in the continuum’ or ‘lacks of uniformity in the fabric of reality’, ‘pure data prior to interpretation or cognitive processing’. This description amounts to ‘sensing’, the reaction of a sensory system to a change in the environment. Floridi defines *environmental information* as the possibility that data may be meaningful independently of an intelligent producer/informer. The often cited example, also put forward by Floridi, is the cut tree trunk with the tree’s yearly formed concentric rings to estimate its age. Environmental information, he says, does not need to be ‘natural’; a flashing red light *indicating* that the battery is flat may also be taken as an example of (non-natural) environmental information. (ibid.32f)

An observer may *decide* to attach meaning to some feature like the red spot on the bill of mother herring gull or the smell of the mother’s breast and the touch on the lips of the baby. The organism’s or observer’s (reflex or conscious) *decision* to attach meaning to observed phenomena in the environment is an interpretation in itself, an *inferential biological decision* or reaction upon some observed ‘fracture in the continuum’. *Meaning* is thus based on *observed correlations*, indicating the (repeatedly) observed *relation* of some specific environmental change or ‘fracture in the continuum’ on the one hand and another (co-existing) phenomenon, i.e., in my examples the perceived effects (the specific behaviour of our chick and baby). Environmental change may also consist of a *network of patterns or correlations*. Observed correlations may be due to physical, chemical or biological laws that are after all regular relationships observed by human observers. These relationships became generally accepted as physical, chemical or biological *laws*.

In the literature on information the phase of (‘first’) noticing and assessing a correlation is often overlooked or taken for granted (‘data in the wild’) as for example the concentric rings in the wood of a cut tree (Floridi, vide supra). Someone must have noticed this pattern in all felled trees of all ages which led him to the conclusion that the patterns were related to the age of the tree. Only *after* such *observation, interpretation and establishment* we accept a relation as a fact (datum) and may start to find (causal) explanations for the phenomenon. A datum, thus, is a conclusion based on observed correlations. Only *after* a first establishment of a relation, already a conclusion, we can speak (tentatively) of a datum.

From this point onwards we enter the domain of cognition and mind of the owner of the sensory systems, i.e. the chick and the baby. The change
between (c) and (d) in the list above is gradual although the extremes are clearly different.

The retrospective establishment of an observed correlation between an environmental change and a consequent effect (or behaviour in case of an organism) such as mentioned under (c) and (d) I called meaning. Others call only this part of information a ‘datum’ and start discussions about meaning of from there. Millikan (1984,85) following Peirce states:

Natural signs, animal’s signs, people’s signs, indexes, signals, indicators, symbols, representations, sentences, maps, charts, pictures – there is no generic term in English that naturally covers all of these. Yet it has been felt by many philosophers that these are all related, and it is the term “sign” that has most often been used to cover them all, or all that were felt to be related. [Moreover she says] Most signs mean. But “mean” has various senses. Storm clouds mean rain; John means well; Hund means dog.

Interpreting a physical or chemical change in the environment as ‘meaning’ Millikan called intentionality or teleosemantics. The notion of intentionality, she proceeds, was reintroduced into modern philosophical vocabulary by Brentano to be able to make a clear cut between the mental and the physical. The term intentionality is related with what Millikan calls ‘mapping’ relations, it is not unified by a definition but by a paradigm.(ibid.86) She says that basic intentionality is something that only mental things have.(ibid.89, emphasis added) I do not agree with Millikan on this point. All organisms are born with abilities to react upon physical and/or chemical changes in their environment. All organisms therefore demonstrate intentionality if the term ‘mentality’ is re-interpreted to mean the ability to (re)action to an environmental stimulus. They act or react, genetically programmed, to a stimulus, thus demonstrating a potential of discrimination between at least two alternatives and thus of a capacity of interpretation. Millikan admits that “there are no signs without potential interpreters” and “the interpreter of a natural sign may have learned to interpret the sign”.(ibid.118f) I agree with her “with respect to the continuity of selection processes and semantic representation”. That, of course, suggests the possibility of non-mental (mental taken here in the more classical sense) intentionality which to me is identical to the classic physiological term ‘excitability’ the word for (potential) reactivity upon a stimulus.

Millikan (2004) further argues that the correlations organisms rely on often only exist for limited 4-D situations and often are imperfect. Nevertheless, under many circumstances it pays to quickly act disregarding
perfection. Accidental relations are of little use in (scientific) explanations. Only relations existing for a reason are interesting and require (causal) explanations and/or interpretations. Millikan defines the domain of a natural sign as that in which the reason for correlation subsists. She calls these correlations ‘local natural information’.

Not yet discussed is the domain of cellular communication, i.e., processes concerning molecular biology, DNA, cell interactions, hormones, enzymes et cetera. That subject is part of the domain of biosemiotics to which I will return shortly.

11.3 Interlude

Primitive organisms have few receptors, sense few changes in their environment and have few potential reaction mechanisms. Less primitive ones have conglomerates of specialised tissue, mainly products of the ectoderm. Ectoderm develops into skin, sense organs, and neuronal tissue (ganglion) in each segment of the organism’s body-to-come. Higher organisms retain remnants of the original fetal segmental construction like vertebrae, neuronal segmental distribution of skin sensitivity, basic reflexes et cetera; ontogeny tells us that evolution rarely if ever completely discards anything that was. Primates, among them Homo sapiens, in the course of evolution obtained more neuronal tissue in the cranial (front) part of the body. This process was accompanied with the parallel introduction and development of new sensory systems and reaction mechanisms. Understanding the biomedical side of man is simplified by comparative studies of many other organisms. It is important to realize that brain tissue needs more energy than other tissues, that a large animal needs more neuronal tissue than a small one because of the greater number of muscle cells, and that large brains would be a handicap for a bird’s flying capabilities.

From time to time we need to revert to comparative anatomy, comparative functions et cetera to understand. Most human functions are approximately equivalent to those of other species. I thus wholeheartedly endorse Millikan’s (1984,7) statement in this context that

5 Shortly after fertilization the embryo develops three so called germ layers: ectoderm, mesoderm and entoderm which – by and large – generate covering tissues and organs, the locomotory system and the intestines respectively.

6 The human brain consumes about 20% of the energy intake of the whole body while only constituting about 2% of the body weight and is thus an energetic-expensive structure.
'Man is a natural creature and a product of evolution. Man's capacities (as a knower) are also a product of evolution. The capacities to believe and know are therefore natural evolutionary products. Knowing instead of not-knowing must be advantageous and must have adaptive worth. Knowing must be some kind of natural relation that he often bears to his world.

As soon as sensory receptors present their stream of ‘information’ through nerve cells to the brain, the information gets organized. This ultimately leads to patterns of behaviour, to memory (future reference) and for a small part in a few species including *Homo sapiens*, to conscious knowledge. I will return to this in the next chapter. In the context of information, however, I will first discuss biosemiotics.

11.4 Biosemiotics

We can see then that whenever biology uses semiotic terms such as information, adaptation, signal, messenger, fidelity, cross-talk, cue etc. it tacitly presupposes some homunculus-like principle to substitute for Darwin's “striving”. (Hoffmeyer 2009)

One philosopher muttered “He probably heard bacteria talking to one another.” In the meantime, the course of development has proven this thesis correct on all counts. “Using advanced linguistic capabilities, bacteria can lead rich social lives for the group benefit. They can develop collective memory, use and generate common knowledge, develop group identity, recognize the identity of other colonies, learn from experience to improve themselves, and engage in group decision-making, an additional surprising social conduct that amounts to what should most appropriately be dubbed as social intelligence.” (Witzany 2010 citing Jacob et al 2004)

11.4.1 Prelude

Biosemiotics – a relative new speciality in biology – is an interdisciplinary scientific study of signs and codes in living systems. The linguistic part was

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8 For a comprehensive historical overview see the introduction of Favareau’s (2010,1-77) anthology.
modelled after Charles S. Peirce (1839-1914) and Charles W. Morris (1903-79) but Jakob von Uexküll (1864-1944) was the early pioneer. The founding fathers of biosemiotics were Thomas Sebeok (1920-2001) and Thure von Uexküll (1908-2004, Jakob’s son). The term ‘biosemiotics’ was used for the first time by Frederich Solomon Rothschild9 but probably already emerged in Russia in the 1970s, where it was used to refer to the study of natural signs – including the study of communication systems in organisms – particularly with reference to Jakob von Uexküll’s work.

11.4.2 Basics

The history of semiotics has been influenced by structuralism in linguistics, and semiology is related to a similar structuralist movement in theoretical biology. Semiotic biology sees living creatures not just as passively subjected to universal laws of nature, but also as active systems of sign production, sign mediation and sign interpretation, that makes use of physical laws in order to live and sometimes to make a more complex living.

Biosemioticians claim that life is fundamentally grounded in semiotic processes. They approach (1) the cell as a real semiotic system, (2) the genetic code as a real code, (3) the evolution as a process of natural selection and natural conventions, and (4) natural conventions, i.e., organic codes, as origin to the great novelties of macroevolution.

According to the analysis of information [§ 11-2] a sign is ‘accepted’ as a sign only after it has been associated with a meaning. Organisms (‘agents’) have a built-in drive to ‘make sense’ of their environment. When an organism reacts to a stimulus from the environment in a certain pattern or lawlike behaviour, the reaction implies meaning. Correlation of sign and meaning implies a relationship between receptor and stimulus. Thus, sign and meaning are the two sides of the coin. A sign stands for something that is other than itself, implying at least some degree of independence; there is no deterministic relationship, no necessary connection between sign and meaning, between names and objects. A semiotic system, therefore, is a combination of two or more worlds between which there is no necessary link. This implies that a bridge between the worlds can be established only

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9 We speak of biophysics and biochemistry whenever methods used in the physics and chemistry of lifeless matter are applied to material structures and processes created by life. In analogy we use the term biosemiotic. It means a theory and its methods which follows the model of the semiotic of language. It investigates the communication processes of life that convey meaning in analogy to language. (Rothschild 1962)
by *conventional rules*, i.e., by the *coding*. This is what qualifies the *semiotic system*: a system consisting of independent worlds that are connected by the conventional rules of a code.

A semiotic system, in conclusion, is necessarily made of at least three distinct entities: signs, meanings, and code. This definition explicitly states that a code is an essential component of a semiotic system. The coding creates a correspondence between signs and meanings.

Biosemiotics and biocommunication investigate communication processes in and among cells, tissues, organs and organisms as sign-mediated interactions, i.e. language-like text, which follows three kinds of rules: combinatorial (syntactic), context-sensitive (pragmatic), and content-specific (semantic).

We need to keep in mind that signs and meanings are mental entities when the codemaker is the mind, but they are organic entities when the codemaker is an organic system without mind.

### 11.5 Biosemiotics and perception

In biology, *quorum sensing* has become the designation for a kind of communicative activity in bacteria where the density of bacteria present is a causal factor. In short, quorum sensing is due to a process where each single bacterium excretes a certain chemical compound such that the concentration of this compound in the medium will reflect the number of bacteria per unit of volume. Quorum sensing occurs if the compound, after having reached a threshold concentration, binds to a regulatory protein in the cell and thereby intitiates the transcription of specific genes. (Hoffmeyer, 2008, 91)

As early as 1928 Jackob von Uexküll introduced the term *Umwelt* which he defined as the perceptual world of organisms, the subjective or phenomenal world of the animal. He argued that animals spend their lives ‘locked up’ inside their subjective worlds, in their subjective *Umwelt*. While modern biology employs the term *ecological niche*, the set of conditions of their environment, the *Umwelt* is the ecological niche, so to speak, the organism itself perceives. [§ 3-2 (p. 43)]

One of von Uexküll’s prime examples was the tick, known to crawl up branches to quietly wait for a warm-blooded animal to pass by below. Only then the tick let go and lands itself upon the animal or human, where it
burrows itself into a fixed position. The signal that awakens the tick is butyric acid, a compound secreted by the skin of all mammals, and thus the Umwelt of the tick is characterised by the presence or absence of butyric acid. (ibid.171)

Another example of von Uexküll (1982,(1940),45), cited by Hoffmeyer are the different imprints of a girl, an ant, a larva of the spittlebug and a cow on the meadow flower: the girl picks the flower as a decorative object in her Umwelt, the ant uses the flower's petals as a natural ladder in its Umwelt, the larva of the spittlebug bores its way into the stalk to obtain the material for constructing its ‘frothy home’ using the flower as construction material in the larva’s Umwelt and the cow eats the flower as fodder in the cow’s Umwelt.

Dretske (1985,181) gives an almost identical example when he notices a daisy while taking his two year old daughter and his dog for a walk. The daughter “has experience of the world as rich and as variegated as that of any knowledgable adult but differs from an adult in the capacity to exploit these experiences in the generation of reliable beliefs (knowledge)” about what she sees. All three are able to observe the daisy. Dretske sees the flower as a daisy, his daughter sees it simply as a flower, and “who knows about the dog?”

In the examples of von Uexküll and Dretske all involved inhabit his/her/its own Umwelt that guides each one’s activity in his/her/its semiotic niche, i.e., the world around the agent which he must wisely interpret in order to keep life. This implies [§ 3-2 (p.43)] that every one of them is constructing its own area of experience, his own virtual reality (R). A corollary is that perception is to be understood as giving meaning about something. As Jakob von Uexküll (1982 (1940),31) said: “Every action [...] that consists of perception and operation imprints its meaning on the meaningless object and thereby makes it into a subject-related meaning-carrier in the respective Umwelt.” We thus construct an immediate experience of an external world that is continuously presented to us in a 4-D fashion by our sensory systems.

I do not see reason to dismiss such experiences as ‘Folk psychological constructions’. They are teleonomic evolutionary facts that function as appropriate experience-based selection models or information for actions.

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10 Teleonomy is the quality of apparent purposefulness and of goal-directedness of structures and functions in living organisms derived from their evolutionary history. Teleology is a doctrine explaining phenomena by reference to planned goals or purposes.
11.6 Summary in a larger context

This chapter is devoted to the concept of information and sign, both conceived as circumstances in the environment in relation to sensory systems, and leading to experience(s) in the cell, the tissue, the organ and the organism.

Information, as the term is used in the neuroscientific sense, is defined by the four elementary features of a stimulus leading to activation of a receptor: modality, location, intensity and timing. In the next chapter I will follow the path that this stimulus, this type of information, takes from the receptor to the cerebral cortex.
12 The construction of some foothold in the swamp

You cannot theorize about the world without making decisions and choices about how to theorize.

BC van Fraassen 2002,224

12.1 Introduction

In bygone ages the Netherlands contained large areas of swamps and marshes. Three ways were and are still used to construct buildings which, nevertheless, keep our feet dry:

1. driving piles into the swamp until they hit a solid layer (usually clay, loam, rock or sand); on the tops of these piles one constructs the true foundation for a building,
2. sinking into the moor a mattress that provides the solid layer; various materials have been used for such mattresses. Amsterdam is partly built on cow-hides and Dutch dykes on sunken fascine mattresses,
3. constructing a caisson that ‘floats’ in the soggy bog.

In the last decennia a new method came into use: temporarily freezing the part of a swamp needed for some activity such as a timber-yard. Finally, baron von Münchhausen [Box 12-1] brings back to memory the fascinating – admittedly fictive – method of ‘bootstrapping’!

Some of these methods may be used as metaphors for a number of philosophical concepts: the pile driving method may be compared to foundationalism, the willow-twig mattresses to coherentism and the floating construct to Neurath’s ship, the other two methods – may be – as

1 Feenstra is a Frisian family name. ‘Feen’ stands for ‘peat-bog’, and ‘–stra’ stands for ‘native of’.
2 A fascine mattress consists of a flexible layer of brushwood often several hundred feet long, weighted down with stones and sunk into a river or sea bed to prevent scour. The brushwood is harvested from coppices, in Dutch ‘grienden’. This particular kind of copse generally grows in wet or boggy areas, in earlier days in tidal areas where access is generally only possible on foot or by water. The vegetation mainly consists of very short willow or ash stumps from which osiers grow. One most famous ‘griend’ in The Netherlands is the National Park ‘De Biesbosch’.
3 Sellars (1997,147) famously compared foundationalism to the tortoise – the mythical beast of burden carrying the universe – and coherentism to the ouroboros (the earliest alchemical symbol) or ‘great Hegelian tail-biting serpent’.
Box 12-1  How I once rescued myself from a moor*

If you run the risk to sink into a moor you should remember this history as once truly happened to me. During an excursion my horse and I entered a moor. We had to cross it as there was no alternative route to our destination. Since we couldn’t pass through it we had to jump.

The first try was too short. During the jump therefore, we had to turn and we landed in exactly the same place as where we took off.

At the second jump we were not able to turn and we crashed onto the subsoil of the moor.

My horse and I would have sunk without any hope if I wouldn’t have been able to draw myself out of the moor by my own hairlock. Of course I also rescued my trusty horse.

Indeed there is great advantage in having a well trained body.

Hieronymus Carolus Friedricus Freiherr von Münchhausen known as the Baron von Münchhausen (1720-1797) or Lügenbaron [the lying baron] wrote immortal and fantastic stories about his experiences and impressions during his military career. Anonymously he published his Wunderbare Reisen zu Wasser, zu Lande, Feldzüge und lustige Abentheuer des Freyherrn von Münchhausen. [Marvellous expeditions by sea and land, campaigns and amusing adventures of Baron von Münchhausen, 1786]

*Bürger,1786, Kapitel 4: Abenteuer im Kriege gegen die Türken.

thought experiments. Finally, the marsh can be compared to all uncertain ground we may so stumble on. Foundationalism, the golden standard lost its solidity in the second half of the twentieth century partly due to quantum mechanics, but it still has its supporters.

Keeping in mind van Fraassen’s statement at the top of the last page, I will present my starting point under the heading of ‘Chisholm’s philosophic compass’. I will then briefly present my selection of (the extensive) philosophy of science and braid my ‘fascine matress’ about sensory systems and perception devoting a few paragraphs to ‘consciousness’. 
12.2 Chisholm's philosophical compass

Quoting Montaigne and Mercier, Chisholm (1982, 61-75) wrote a beautiful paper with the significant title ‘The problem of the criterion’. No one, says Chisholm, has begun to philosophize until he has faced the following two questions and recognized how unappealing in the end, each of the possible answers is:

(A) “What do we know? What is the extent of our knowledge?”

(B) “How are we to decide whether we know? What are the criteria of knowledge?”

Chisholm compares three positions: (c) the one of the sceptic who says that you cannot answer either question without presupposing an answer to the other, so neither can be answered, (b) the one of the dogmatist or ‘methodist’ who thinks he has an answer to (B) and then works out his answer to (A) and finely (a) the one of the ‘particularist’ who starts to answer (A) and then tries to give an answer to (B).

Approvingly citing Spinoza’s “in order to know there is no need to know that we know, much less to know that we know that we know”, and St. Augustine’s “It is more reasonable to trust the senses than to distrust them”, Chisholm finely settles for (his) three firm starting-points. The first, a moral one, is having the courage to recognize that we can deal with the problem only by circular reasoning. The second, also a moral one, is to be true to this recognition and not try to pretend that it is not so. The third one is to follow Mercier’s concept of objectively making a reasonable preferential choice based on the context and circumstances. In order to make such a choice, his advice is to recognize and make use of Leibniz’s ‘truths of reason’ and ‘truths of fact’ to make propositions that are certain for man. Adding to Chisholm’s set of rules the – probably superfluous – remark ‘at a given time’

4 Pour juger des apparences que nous recevons des sujets, il nous faudroit un instrument judicatoire; pour verifier cet instrument, il nous y faut de la demonstration; pour verifier la demonstration, un instrument; nous voylà au rouet. Puisque les sens ne peuvent arrester notre dispute, éstans pleins eux-mesmes d’incertitude, il faut que se soit la raison; aucune raison s’establiira sans une autre raison: nous voylà à reculons jusques à l’infiny. (Montaigne) The passage appears in Book 2, Ch 12 (An Apologie of Raymond Sebond). It may be found on p.544 of the Modern Library edition of The Essays of Montaigne. (Chisholm 1982, 61-75, note 3) [To judge the appearances that we receive of things we need a decision instrument; to verify this instrument we need proof; to verify this proof an instrument; there we have the circle. Because the senses cannot determine our dispute being full of uncertainty themselves, it must be done by reason; but no reason stands firm without another reason; and so we turn round without end].
takes it into the concept of process, which I venture to name ‘Chisholm’s philosophic compass’, that I wish to sail by.

12.3 The circle of knowledge and perception

To be able to speak about knowledge we need information from the sensory systems. In order to understand the sensory systems we need knowledge. Much like Montaigne and Chisholm we cannot possibly escape this circle so that the only way left is Baron von Münchhausen’s variety of ‘bootstrapping’. I will thus discuss perception based on knowledge and knowledge based on perception together.

Philosophers speaking about knowledge readily tend to focus on propositions, something offered for consideration or acceptance, or, more colloquially, taken to be true or false. The notation is ‘S knows that p’, where ‘S’ stands for the subject who (thinks he) has knowledge and ‘p’ for the proposition that is known. The definition of knowledge then is generally taken to be a justified true belief and a Gettier condition. [§ 7-4 (p.89)]

The discussion then moves away to the relation between proposition and (factual) evidence, meaning – in the end the basics of – empiricism [Box 12-2] or the reliability of our (instrumentally assisted) sensory systems. With ‘instrumental’ in this context I have in mind each and every means and expedients including formulae and language(s).

Kvanvig (2005,290f) argues that the goal of knowledge should not be the meta-epistemological question ‘if truth is the primary (teleological) goal of epistemology’.

Van Fraassen’s (1998,213) choice for a ‘scientific agnostic’ approach aims to find the empirically most adequate answer to some specific spacetime problem not worrying about ‘Truth’ or falseness. Ten years later van Fraassen (2008,1-3) repeats (t)his view:

To understand science we need to approach it from many directions. (2008,1)
I try to be an empiricist, and as I understand that tradition (what it is, and what it could be in days to come). It involves a common sense realism in

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5 Steup (2012) starts his paper on epistemology by saying that he leaves all other forms of knowledge out of consideration in his paper on epistemology.
6 King (2011), Steup (2012)
7 The contrasting view is the ‘scientific gnostic’ one, someone who believes the science he accepts to be true.
which reference to observable phenomena is unproblematic: rocks, seas, stars, persons, bicycles... Empiricism also involves certain philosophical attitudes: to take the empirical sciences as a paradigm of rational inquiry, and to resist the demands for further explanation that lead to metaphysical extensions of the sciences. There is within these constraints a good deal of leeway for different sorts of empiricist positions. For my part, specifically, I add a certain view of science, that is the basic aim – equivalently, the base-line criterion of success – is empirical adequacy rather than overall truth, and that acceptance of a scientific theory has a pragmatic dimension (to guide action and research) but need involve no more belief than that the theory is empirically adequate. (2008,3)

This describes unqualified acceptance; in practice, acceptance will come with restrictions and qualifications, and belief will come in degrees (2008,345,note 3)

This presumed best answer to some four dimensional (4-D) problem is also known as inference to the best explanation. An empirically adequate or a pragmatic, tentative answer to some specific 4-D problem is to be found in the notion of evidence which is based on experience(s), prediction (might be called 'reasoned belief'), and reliable external conditions and processes. Since I do not believe in a priori concepts and I cannot accept such armchair

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* van Fraassen (2002,201-5)
philosophy my method of choice would be empiricism and naturalism9 with Francis Bacon’s bee-like inclinations. [Box 12-2]

Quine (1969,69) states that the foundations of science are conceptual and doctrinal. Conceptual foundations are concerned with meaning, clarify concepts by defining them, if need be occasionally in terms of other ones. Doctrinal foundations concern truth, establish laws by proving them, sometimes on the basis of other laws. Ideally, the obscurer concepts would be defined in terms of the clearer ones in an attempt to maximize clarity, and the less obvious laws would be proved from the more obvious ones to maximize certainty. Ideally, the definitions would generate all the concepts from clear and distinct ideas, and the proofs would generate all the theorems from self-evident truths. (Quine 1969,70)

Ultimately, justification may be thought to be internal, i.e., based on mental states and/or on reflection which is not empirical. On the other hand justification may be thought to be external if it is based on reliable external conditions and processes. Empiricism and naturalism rest on sensory experience10 and has to be justified in sensory terms. Theories are constructed through contextual definitions in sentences as the primary vehicles of meaning. Quine is, like Chisholm, not in the least impressed by the inherent circularity of his reasoning.

On the basis of the foregoing I opt for an eliminative physicalist approach [Addendum 14-4 (p.172)] to develop my point of view that consciousness and perception are biological activities of the sensory systems and the brain of Homo sapiens. They arose in the course of Darwinian evolution gradually coming into being in the course of infancy and with precursors in animals. The term consciousness is either a misnomer or too vague. (vide infra) Searle (1997) concluded that consciousness is a ‘state’, but it is not, it is a continuing process. We should pay more attention to Herakleitus’ Panta Rhei, to the fourth dimension.

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9 Philosophical naturalism firmly believes that reality contains nothing supernatural: no souls, no spirits divine or human, no entelechies, no vital forces, no mental substances, no spooks, no demons and no universals. Methodologically philosophical naturalism also firmly believes that scientific method(s) should be used to investigate all areas of reality including epistemological issues. [Box 14-1 (p. 173)]

10 Foundation of knowledge begins with experience but does not provide the foundation, and foundations are conceived as a metaphysical thesis of the sort against which empiricism stages its recurrent rebellion (van Fraassen 2002,38)
12.4 Classification of sensory systems

12.4.1 Introduction

When scientists discuss the sensory systems they usually do this in terms of the signal and the sensitive receptor defined in (bio)chemical and (bio)-physical terms. [Chapters 2,3,5] In this essay I sofar paid little attention to the philosophers’ criteria for classifying the senses. Many but not all of them preferably concentrated on the aspects of the perceiver’s intuition, introspection, analyzing terms, and one sensory system in particular, usually vision. (see the anthology of Macpherson 2004).

I do not accept intuition and introspection as reliable ways for studying the sensory systems. [§ 8-2 (p.97); § 8-3 (p.99)] Aristotle, son of a physician, used both in his De Anima. His first criterion, which he considered ontologically prior, concerns the special properties that each sense directly reveals. His second criterion is the medium through which information is transmitted, for each of his five senses another one. For example vision through a transparent medium, and hearing through trapped air. For an extensive discussion of Aristotle’s theory of number and nature of the senses see Keeley (2009).

12.4.2 Criteria for classifying

Many criteria have been suggested to classify the sensory systems. Some authors chose even combinations of such criteria, be it a priori or a posteriori. Most if not all proposed criteria have been readily attacked by always available antagonists. Agreement is the exception rather than the rule although scientists do agree on a few basics. To begin with, I present a small potpourri of criteria (pro or contra) and discussions (pro or contra) about senses that are (explicitly) included or (explicitly) excluded in classifications of sensory systems:

(i) the observer’s criteria: the properties of sensory experience, qualia, the special introspection, 12
(ii) feelings, proprioception, pain, temperature, hunger, thirst, sexual arousal, vomeronasal’s effects, number sense, time sense, language,

12 Grice HP. Some remarks about the senses. In: Macpherson (2011,83-100)
homeostatic control mechanisms, the immune system [§ 5-4 (p.74)]
and somatosensory systems in general [Box 5-3 (p.69)],
(3) folk psychological arguments such as custom and convention,\textsuperscript{13}
(4) extensionally versus intensionally premises,
(5) uni-sensorial or multi-sensorial; this applies with respect to one of
two possible directions: (a) one sensory system that incorporates
more capabilities, e.g., vision (colour, shape, movement, brightness,
circadian rhythms) and vestibular system (angular acceleration, linear
acceleration) [§ 5-3 (p.70)] and (b) two sensory systems cooperating for
one ‘sensory quality’ as vision and touch to determine ‘shape’, or vision
and audition in understanding speech as demonstrated by McGurk\textsuperscript{14},
or ‘taste’ as the combined sensory activities of tasting, olfactory taste
(smelling) and the tongue’s touch;
(6) consciousness considered mandatory versus consciousness not (always)
necessary;
(7) active (exploration) versus passive (‘mere’ experience), for example
looking versus seeing, touching versus feeling, sniffing versus smelling
(Grice 1962).

Sensory systems could even be considered a ‘cluster concept’ such that sev-
eral criteria are relevant to it, but none necessary. In different contexts, dif-
ferent criteria may also be weighted differently.\textsuperscript{15} Macpherson (2011,36)\textsuperscript{16} in
the extensive introduction of the book she edited, summarizes the diversity
of criteria as “the proximal stimulus, the representation, the phenomenal
character and the sense organ criterion”, adding, “So, we should stop trying
to artificially determine or stipulate which Aristotelian sense any sense
is – or to shoehorn each sense into one of a small number of discrete kinds.”
In the same vein Heil (2011,154)\textsuperscript{17} writes “An exhaustive taxonomy of the
senses is, after all, an empirical task”, a view I certainly endorse.

Rather than discussing each and any point of view or each and any
argument pro and con I prefer a more pragmatic approach starting from
three premises:

\begin{itemize}
\item Nudds M. The senses as psychological kinds. In: Macpherson (2011,311-40)
\item The McGurk effect: normal people will better understand speech if the simultaneously
viewed lip movements on a screen are the same as the words spoken than if they are different.
(McGurk, 1976)
\item O’Dea J. A proprioceptive account of the sense modalities. In: Macpherson (2001,297-310)
\item Macpherson F. Individuating the senses. In: Macpherson (2011,3-43)
\item Heil J. The senses, excerpt from perception and cognition. In: Macpherson (2011,136-55)
\end{itemize}
(1) I accept the daily use of terms and criteria of the common man, or, in the wording of Heil (1983,3)18 “Perceiving is a general term, a technical – or, at any rate, quasi-technical – expression covering what one does with one’s senses”.

(2) Evolutionary theory applies to all properties and principles of life on earth. Any organism in the biosphere is subjected to the laws of (bio)physics, (bio)chemistry and biology.

(3) Anyone who wants to academically discuss sensory systems should be aware of the accumulated empirical knowledge in the field, an opinion I share with Keeley (2009,226)19, Heil (2011,284)20 and many other philosophers and scientists thinking about ‘perception’.

Consequently, speculation about organisms and their sensory systems without these restrictions in mind is pointless. These considerations, then, considerably reduce the number of criteria to classify sensory systems.

12.4.3 An attempt at a classification

The previous chapters suggest that a structure can only be called a sensory system if it complies with three conditions, P₁ – P₃:

P₁ Sensory systems of an organism have receptors, cells responsive to a particular type of physical or chemical form of energy, the stimulus.

The term ‘stimulus’ may only be used after it is proven to be effective and then is synonymous (in the context of neurophysiology) with information and with energy. There may be a hidden tautology (for instance, eye ↔ light) in the first part of the statement ‘P₁’, avoidable by inclusion of the second part.[§ 1-2 (p.24)]

P₂ The receptor cell transduces the stimulus energy into a – usually electric – output signal which can be considered the receptor cell’s stimulus to its (cellular) environment, or to more centrally located structures.

18 Heil (1983,5) obviously is not interested in discussing each and every point of view either (quote: “I shall not here attempt to elucidate the view that emerges in Grice’s [1962] discussion”).
19 “It is my thesis that neurobiological facts are necessary for the attribution of an important understanding of modality”(Keeley BL. The role of neurobiology in differentiating the senses. In: Bickle 2009,226- 50)
20 Heil J. The senses In: Macpherson (2011,284-96)
Sensory systems do not function in isolation but are connected to other systems that may (re)act; they are part of biological loop-like processes.

A good example to explain the relation of a stimulus and the body's reaction is the knee jerk reflex: sudden light stretch of the hamstring muscle tendon slightly below the kneecap is followed by movement of the lower leg forwards. The reflex action, part of the function of the leg while a person is standing or walking, remains unnoticed. Only when a physician taps the tendon of the hamstring muscle, the reflex is consciously noticed: movement is seen and felt. Reflexes help to maintain body function, i.e., regulatory circuits used to maintain a constant state of the basic conditions such as temperature, water content, or position.[§ 5-4 (p.74)]

We may thus define a sensory system as the assembly of a sensor (receptor, some specialized cell(s) that transduce(s) incoming energy into an action potential) which is conducted to a control centre from where usually other signals are transmitted to parts of the body in need of control.

In this context the discussions among authors (scientists as well as philosophers) writing about the definition of ‘vision’ demonstrate views which I find very difficult to accept. I will describe a few of them here.

Some authors are convinced that only one-lens-eyes should be included which omits the facet eye of insects and the tiny pinhole eyes of simple invertebrates. If the stimulus of sensory systems is taken into consideration as life sciences do this criterion makes no sense anyway.

Others accept the human eye as the sensory system of vision but exclude all non-conscious perception. The pupil reflex, however, the unconscious narrowing of the pupil if environmental light is intensified, does belong to the human eye. Does the pupil reflex then not belong to ‘vision’? To me that does not make sense.

Still others argue that the evolutionary path of ‘the eye’ is the most important criterion. Some ‘eye-like structures’, however, have appeared and disappeared in the course of evolution more than once. Some of these structures might have complied with the definition while others did not. The evolutionary beginnings of the vertebrate’s eye are the only ones that seem always to have been accepted as real ‘vision’ by the advocates of this concept of ‘vision’.

In conclusion, Macpherson rightly stated that we should stop trying to artificially determine or stipulate senses into a classification since that will always be arbitrary. To illustrate her point I present the very cumbersome and unwieldy definition of Gardner and Johnson (2013):
[s]ensory information is neural activity originating from stimulation of receptor cells in specific parts of the body. These senses include the classic five senses [audition, smell, taste, touch, vision] plus a variety of modalities not recognized by the ancients [itals added] but essential to bodily function: the somatic sensations of proprioception (posture and movement of our body), pain, itch, and temperature; visceral sensations of proprioception (both conscious and unconscious) necessary for homeostasis; and the vestibular senses of balance (the position of the body in the gravitational field) and head movement." 21

This anthropocentric definition omits the sensory systems of many lower animals and plants.[§ 1-2 (p.24); Box 2-2 (p.33)] Such organisms have sensory systems albeit not (always) accompanied by neural tissue; they use other ways of transmission or 'communication', usually volatile or humoral. We call such 'reflexes' or reactions after stimulation of the receptor a very basic biological decisionary process or, perhaps, an inferential reaction.

In order to grasp the whole field of perception, I need now to discuss the central nervous system, consciousness, cognition and the mind.

12.5 Receptor signals in the CNS

12.5.1 Introduction

Until the middle of the nineteenth century all efforts to understand the significance of sensory systems, perception and the mind belonged to the realm of philosophy. From the middle of the nineteenth century the philosophical approach gave way to the more empirical analysis approach of physiology and the young experimental psychology. Later, in the second half of the twentieth century cognitive neural science emerged, a sort of cooperation of cognitive psychology proper and neural science, itself a sort of amalgamation of molecular biology, cell biology, electrophysiology, neuroanatomy and other (sub)- specialities.

In the early 1980s Patricia Churchland coined the term neurophilosophy. Neurophilosophy and philosophy of mind share interests but are not identical. Neurophilosophers such as the Churchlands and Dennett, like neuroscienists in general, support eliminative materialism [Addendum

Bernard Bolzano

12.5.2 The brain

Neuroscientists consider the brain as an information processing organ. Cognition is understood as the summation of processes by which sensory input is transformed, reduced, elaborated, stored, recovered and used. A great deal of cognitive processing proceeds unconsciously. Five subjects are studied by neuroscience: perception, action, emotion, language and memory. Since perception is the dominant subject of my essay I will here concentrate on that theme with occasional trips into related fields.

Different modalities of perception – an object seen, a velvet cushion touched, coffee smelled, a concert heard – begin with stimulation of the receptors of the different sensory systems. The receptors convey the information to specific (unimodal) regions of the cerebral cortex along individual axons (projecting part of a neuron conducting centripetally). In this way the peripheral nervous system supplies the central nervous system with a continuous stream of information about the external and the internal environment of the body.

The human nervous system contains approximately 10^9 neurons, each of which has and makes thousands of connections. The neurons in the brain and spinal cord are clustered in discrete functional groups (nuclei) which are connected with others to create functional systems.

In the brain the information is processed in a hierarchical fashion, i.e., the action potential is passed through a succession of subcortical and cortical regions. At each level of processing the information becomes more and more complex. Moreover, different types of information are processed in several anatomically discrete nuclei; a light touch and a painful

22 In the middle of the 19th century von Helmholtz already concluded – based on conduction velocity measurement of nerve impulses – that information needs time for unconscious inference in order to reach conscious perception. In the beginning of the 20th century Freud concluded that much of mental activity is unconscious. In the preceding chapters I made clear that unconscious activity of the CNS is far more extensive than the conscious one, including ‘perception’.
pinprick in the same area of skin are mediated by different pathways in the brain.

The different unimodal regions represent different sensory modalities that communicate with multimodal association areas through specific subcortical pathways. In this network signals are selected and combined into an apparently unified perception.

The brain produces integrated perception by nerve cells that are wired together according to a general plan that does not vary greatly among normal individuals. Nevertheless, the connections are not exactly the same in all individuals because the connections between cells can be altered by activity and by learning. Indeed, details of these maps vary considerably from one individual to another. Disuse, for instance due to injury, can cause dramatic loss in afferent connections, a phenomenon well-known as phantom limb syndrome and tinnitus (ear ringing). We remember specific events because the structure and function of the connections between nerve cells are modified by those events.

Although the networks depend on the qualities of its individual neurons, they are not identical or even similar to these qualities but an emergent quality of the way those different cells are interconnected. This raises empirical questions about the relation between observed neurophysiological and mental processes.

12.5.3 Mind and consciousness

What we call mind is not a separate structure but a set of operations carried out by the brain. Because consciousness is a property of the mind, it too must be a function of the (physical properties of the) brain. We should be able to identify the neural circuits that contribute to it. Before theories of consciousness can be developed it must first be defined in operational terms. (Kandel 2013,370-91) The concepts neuroscientists used to describe mental processes – such as learning, memory or consciousness – were developed by philosophers before it became known how mental processes are mediated by the brain, or in other words before the birth of (cognitive) neuroscience. (ibid.)

Consciousness, a (usually wrongly called state-like) process of self-awareness, is characterised by subjectivity, unity and intentionality. The subjectivity of self-awareness is central in (personal) experience [§ 10-4

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23 Roberts et al. 2010
24 Use of the term ‘emergent’ does not necessarily support the concept of emergentism.
(p.127]) due to nature and nurture. [§ 5-2 (p.66)] The story of the aroma of Proust’s ‘petites madeleines’ [p.38] is not only an olfactory process from receptor to olfactory cerebral cortex including the genes that gave rise to them, but it is also determined by his personal history – the experience recalled from memory – and since experiential history is highly individualized, aroma’s may not produce the same subjective sensations in everyone.

Conscious experience is fundamentally *subjective*. The *unity* of self-awareness refers to the fact that experience of the world at any given moment is based on the continuous combined activity of all sensory systems, [§ 3-3 (p.45)], i.e., the various sensory modalities of which are blended into one (seemingly) single experience.

Self-awareness has *intentionality*, the state of mind that is ‘about’ things or represents them (beliefs, wishes, desires, hopes are often called ‘intentional states’ or ‘aboutness’).

Important in the discussion of subjectivity, be it perception or consciousness, is the so called *explanatory gap* (Levine 1983), also called the *hard problem* (Chalmers 1996). The explanatory gap concerns the doubt if a complete explanation of consciousness is feasible. In other words, is it possible to abridge the gap between the (objective) neuroscientific knowledge on the one hand and the qualitative (subjective) properties on the other hand. There are three different philosophical convictions:

(a) some philosophers are convinced that the gap remains unbridgeable,
(b) some philosophers are convinced that the bridge might be ‘bridgeable’ by explaining it away with a specific concept such as enactivism and sensorimotor theories,
(c) some philosophers deny existence of a gap believing that consciousness is nothing but the ‘computational’ activity of certain areas of the brain.

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25 William James defined consciousness as “the continuous stream that is only accessible to the subject experiencing it” an entirely subjective affair.
26 Chalmers (1996,i.x,cii) defines as *easy problems* the ones like “how does the brain process environmental stimulation, how does it integrate information and how do we produce reports on internal states. The hard problem is why is this processing accompanied by an experienced inner life?”
27 Wallis and Wright. In: Bickle (2009,255)
28 Degenaar 2012
12.5.4 Conscious(ness) or not, gap or not: the question

Look at the bright yellow flower and the bright green stem of a daffodil in early spring (feel the pleasant temperature, perceive the beautiful colours and the shape, be aware of your inner speak and snif to smell ...). I always immediately respond to that sight and its smells. I love that flower (feeling) decorating my mother’s breakfast table on an Eastermorning (memory). At such moments my ‘experiencing’ the daffodil starts the combined subjective and objective process, making an extensive list of the peculiarities of a daffodil (*Narcissus pseudo-narcissus*)[Addendum 14-3 (p.170)], its yellow colour, form, 4-D analysis, the garden where my grandfather taught me its name, the first Easter breakfast with my grandparents, parents and brother in the Netherlands and much, much more, associating in ever wider circles... (knowledge). I am very much aware that I live, think, feel, love the world, love the universe: I feel great!

Other philosophers might be inclined to extend such musings. They may reflect about the metaphysical discussion concerning the relation of objects and properties, i.e., are objects conglomerates of properties or are properties universals residing in substances. I do not accept universals. That places me in the camp of nominalism or, more precisely tropes. (Garrett 2006,65ff,75; Rodriguez-Pereyra 2008) Trope theory predicts that properties and realties are themselves particulars; abstract but not in the sense of being outside space and time, but because they are subtle, diffuse and partial. One’s length, colour of the eyes, but also bikes and trees are examples of concrete particulars, composed of abstract tropes. Likewise events and facts are held to be constructed of tropes.

Heidegger (1962) devotes an essay on the topic of thing (das Ding) and Rescher (2000,25) – more succinctly – presents an example that beautifully displays the point:

Consider its [a stone] physical features: its shape, its surface texture, its chemistry, etc. And then consider its causal background: its subsequent genesis and history. Then consider its functional aspects as relevant to its uses by the stonemason, or the architect, or the landscape decorator, etc. There is in principle, no theoretical limit to the different lines of consideration available to yield descriptive truths about a thing, so that the totality of potentially available facts about a thing – about anything real whatever – is in principle inexhaustible.
I do not want to enter the discussion of the relation of objects and properties to explain sensory systems. Its answer can be found in the quote of Rescher. Paraphrasing this into ‘There is in principle no theoretical limit to the different ways sensory systems may perceive something, so that the total sum of potentially available (perceivable) facts about something, anything real what-ever, is in principle inexhaustible’. I might even return to and fix my attention upon sensory systems again terminating my musings that started with the yellow *Narcissus pseudo-narcissus* (daffodil).

Our sensory systems thus are continuously processing in varying relations to each other and in varying environmental circumstances and the results are continuously compared with earlier experiences. [§ 10-4.3 (p.128); § 11-3 (p.135)] The focus of a philosopher’s attention should be less on the putative static character of an object and more on the processes of the *human sensory systems in relation to their environments*. The combined actions of our sensory systems and the coordinating brain defines reality, earlier called $R_h$ [§ 3-2 (p.43)], our human construct of the world.

In perceiving (the daffodil or the tomato, Heidegger’s *das Ding* or Rescher’s *stone*) our brain combines the incoming stimuli of all sensory systems, compares them with memories ‘intellectual’ and ‘emotional’ (the animal side) and ‘feelings’ (the coginitive side of the same). We can then say ‘daffodil’, a word, a *flatus vocis*, a term, a name, a symbol of sorts and we may say ‘look at this daffodil, *das Ding*, that stone’. We will feel connected with the whole world or the Universe, widening our perception and experience: a mystical moment. (viz. Bharati [§ 9-4 (p.109)]) On the other hand, we may regress to a habituation of our earlier school days and kick the stone away, deep in thought. Anyway we are – in principle – there, our mind being focused on the daffodil, *das Ding*, Rescher’s stone). Whatever we think or do, we always use all our sensory systems and our locomotor apparatus, while our urine still seeps into the bladder, the heart and lungs work, we still have an upright position et cetera, et cetera. We started life in this way, sucking with our whole body.

Tradition and folk psychology call sensations and their awareness ‘consciousness’. This is also a short hand for one momentary state of being within Herakleitos’ or James’ continuous stream that may be – reductionistically – explained as activities of neurons in their circuits, comparable to my impression of the yellow daffodil. Consciousness is the subjective aspect of a series of moments rooted in our experiences. James’ continuous stream is only accessible to the subject experiencing it, or, as Patricia Churchland

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29 See Feyerabend 1999 (Terpstra ed) about Parmenides vs. Herakleitos
says it is comparable to ‘an electrical current in a wire [that] is not caused by moving electrons, it is moving electrons’.

We should not ask the why- but the how-question. Why the sun shines is not interesting and leads to speculation and metaphysics. It is the question how it does, which leads to understanding.

Stimulation of receptors may lead to actions, to phenomena; no mystery. Some effects are muscular, secretions of glands, some give rise to experiences like recognition of a familiar face, the exclamation “hello Gerald”; again: no mystery in these phenomena. Each effect has a usually arbitrarily chosen name. Consciousness is a ‘term’, not a thing, not an object, little more than moving electrons (trains of action potentials in nerves) in wires. The subjective nature of perception does not prevent one person from objectively studying what another person perceives, the approach of psycho-physics, well known in laboratories.

Perceptions typically consist of multiple sensations by our processing central nervous system, not of just one. A multimodal percept arises from activity in numerous brain regions but we sense the conscious experience as one seamless unity. The link between discrete functional systems in the brain that gives rise to the experience of consciousness is called the binding problem. According to one scientific view conscious experience occurs when neural activity in disparate regions of the brain is time locked: the activity in these areas is temporarily synchronized. (Small and Heeger, 2013.437) We should not forget, however, that – even this account – cannot be the whole story. All sensory systems leading to perception are intimately cooperating with other body systems as already pointed out in the examples of the herring gull and suckling.

12.5.5 Consciousness

In the course of evolution, precursors of consciousness have been found in other species as the work of animal behaviourists like Frans de Waal showed. We can also notice the gradual genesis of consciousness in our growing children. We notice the variations of consciousness in ourselves and between different people in variable circumstances. We have a reasonable knowledge about consciousness, most of it due to a mixture of case histories

31 (a) The state of sentience and awareness between two episodes of sleep, if not ‘unconscious’, in coma or dead. (b) An inner, first-person, qualitative phenomenal process with variable levels of alertness (from drowsiness to full awareness).
of patients and neurologists’ observations. They concern patients with brain lesions due to neurosurgical and other trauma’s, tumours, haemorrhages, infarcts, a variety of debilitative diseases et cetera, coupled to post mortem studies of the brain. The last century registration and imaging technology of the central nervous system became more sophisticated.

Fascinating are the bizarre behaviours of patients usually described with much empathy and understanding by their attending physicians. Well-known examples even to the layman are the accounts of the neurologists-writers Israel Rosenfield (1992) and Oliver Sacks. Sacks (1984), moreover, communicated his experiences as a patient with a paralysis of a leg due to a traumatic meeting with a charging bull in Norway. This story was extensively commented upon by Rosenfield.

Consciousness gradually emerged during Darwinian evolution. The fully developed human central nervous system is the most developed brain at this point of evolution.

Consciousness on the personal level grows out of the coordination of all incoming sensory information, begun in the pre-conscious period of our lives. The incoming signals from the sensory systems gradually form neuronal networks (‘maps’) that become connected with other networks into behavioural systems.\[§ 5-2(p.66); Box 5-1(p.67)\] Human consciousness is then best understood as a brain-process generated through the constant flow of new stimuli integrating with memories of older ones, similar to Bergson’s (1908) *le souvenir du présent* and Edelman’s (1989) *the remembered present*.\[33\]

Some take consciousness as an illusion, others as a pseudoproblem or as a state of the brain (Papineau 2002). Again, some suspend their opinion as advised by the Flemish-Dutch Simon Stevin (1548-1620): "Wonder en is gheen wonder" (miracle is no-miracle) meaning that what we don’t understand today will (probably) be explained in the future.\[34,35\] In the meantime, biology firmly points in the direction of an ‘emerging’ phenomenon of the central nervous system, emerging *not* to be understood as an *explanation*

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32 Defined by Searle (2001) as the qualitative, subjective states of feeling or sentience or awareness, and by Searle (1997,161) brain processes cause consciousness but consciousness is a feature of the brain.

33 The comparison is borrowed from Rosenfield and Ziff (2008).

34 Devreese and Vanden Berghe 2003

35 In the wording of Dennett (2005,ch.1) "indeed a wonderful thing, but not *that* wonderful – not too wonderful to be explained using the same concepts and perspectives that have worked elsewhere in biology". (italics in the original)
but as a description of physiological processes.\textsuperscript{36} We may still be used to ‘folk psychology’: subjective experiences in daily language originated in times long ago. The (neuro)physiological\textsuperscript{37,38} data point to a continuous process, experience, based on continuous sensory information that is being added to former experiences and ‘framed’ in our neuronal networks within the limits of our genetic ‘plan’ as a spandrel-like phenomenon. (Gould and Lewontin 1979)\textsuperscript{[Addendum 14-1 (p.167)]}

The experiential side of consciousness, what it is to have and what it means to lose one or more function(s) has exceptionally well been described by Rosenfield (1992). He emphasizes the relation of consciousness to memory. Memory without consciousness is impossible and vice versa.\textsuperscript{39} Indeed consciousness arises from the “dynamic interrelations from the past, the present, and the whole body image.” (ibid.84)

[A] sense of consciousness originates in the flow of perceptions, the relations among them (both spatial and temporal), the dynamic but constant relation to them as governed by one unique personal perspective sustained throughout a conscious life. This dynamic sense of consciousness eludes the neuroscientists’ analyses. (ibid.6)

The essential ingredient of consciousness is self-awareness:

My memory emerges from the relation between my body (more specifically my bodily sensations at any given moment), and my brain’s “image” of my body (an unconscious activity in which the brain creates a constantly changing generalized idea of the body by relating the changes in bodily sensations from moment to moment). This relation creates the sense of self. (ibid.8)

\textsuperscript{36} The brain needs to create unique internal (mental) representations that otherwise do not exist at the level of individual sensors. Given the complexity of such internal representations, computational hypotheses are essential to help understand what information a neural population encodes and how the new representation is created.

\textsuperscript{37} The term neuroscience was coined by Francis Schmitt in the early sixties at MIT (Boden 2006,1112)

\textsuperscript{38} Churchland 1986

\textsuperscript{39} Without knowledge of one’s own being, one can have no recollections. How can I remember my parents, my house, if I am not sure I exist? We must not overlook the essential nature of all human (and perhaps some animal) memories: Every recollection refers not only to the remembered event or person or object, but to the person who is remembering. (Rosenfield 1992:41-2. Italics in original)
Rosenfield stresses the importance of “self-reference” which “means that a brain must be able to relate to a dynamic bodily structure in terms of which stimuli get meaning, just as words and sentences become meaningful in terms of the dynamic articulatory structures of the vocal apparatus.” (ibid.139) Memory is a continuing activity of the brain. The sense of self is essential to memory because all private memories are of the owner, of a *myself*. They are part of the structure we accept as the sense of self. Memory and the self are intertwined with the sense of self. Our conscious perceptual experiences are of our environment’s impact on our body. Moreover, intentional actions are typical of our moving body and its impact on the world. This conscious experience of one’s own body as an object in 4-D is constructed in the brain and is the key element of all conscious experiences.40 Rosenfield also draws attention to the development of our consciousness in youth:

At the moment of birth, a newborn infant is probably not conscious. Its bodily movements, which are genetically determined reflexes, are the frame of reference within which the baby organizes the stimuli it encounters in its first contacts with the world; as the brain organizes these stimuli, newer stimuli begin to be “understood” in terms of those already organized. The relation between the new and the old brings the first glimmerings of consciousness. Little by little, the infant becomes aware, in however primitive a way, of its surroundings. For sure, this occurs so rapidly that we may have the illusion that the newborn infant is already conscious at birth. But consciousness continually builds on itself; and linguistically, for example, it will be many years before the child will acquire a “full” consciousness that permits to understand complex ideas. (ibid.60f)

The highest forms of abstraction require language, but even linguistic forms build on themselves.(ibid.104) a child masters size (“big” and “little”) before it can master color (“red”, “green”). The *linguistic* category of “red” is considerably more abstract than that of “big” or “little”. Learning complex relations requires first learning simple ones. This might explain why it is most unlikely that we can retain infantile or very early childhood memories. It is only when linguistic structure attains a certain complexity that “memory” becomes truly possible.(ibid.105)

40 Consciousness is a “happening”: “This is the case with all the higher projectional aspects of sensation; they form a continuous series of dispositions, determined by previous events of a like order. The unit of consciousness, as far as these factors in sensation are concerned, is not a moment of time, but a happening.” (Head H. Studies in neurology, vol.II. London,1920,754, cited by Rosenfield 1992,49)
Summarizing: body/mind dualism is not acceptable anymore and consciousness is little more than a (biological) process, a quality of the brain of *Homo sapiens*, which arose in the course of Darwinian evolution with precursors in animals and gradually coming into being in the course of infancy.

12.6 Commuting between consciousness and perception

Most philosophers tend to take perception as a cognitive activity only, in the wording of Dretske (1985,181) citing and extending R.N.Haber “a form of recognizing, identifying, categorizing, distinguishing, and classifying the things around one using one’s mind”. Dretske criticizes this approach and continues [his ‘duck’ altered into ‘my’ ‘tomato’]:

Too many people (both philosophers and psychologists) tend to think about perception *only* in the latter form, and in so doing they systematically ignore one of the most salient aspects of our mental life: the *experiences* we have when we see, hear, and taste things. The experience in question, the sort of thing that occurs in you when you see a [tomato] (without necessarily recognizing it as a [tomato]), the internal state without which (though you may be looking at the [tomato]) you don’t *see* the [tomato], is a stage in the processing of sensory information in which information about the [tomato] is coded in what I call analog form, in preparation of its selective utilization by the cognitive centres (where the *belief* that it is a [tomato] may be generated). (italics in original)

Dretske further writes that one cannot possibly give a cognitive form of all information embodied in the sensory representation (experience) of – his example – “walking into a library filled with books or a garden ablaze with flowers”. He further explains that from all sensory information available in a sensory representation everything is systematically stripped away from components of information (relating to size, colour, orientation, surroundings [et cetera]) which makes the experience of – say our tomato – the phenomenally rich thing we know it to be – the one that it is a [tomato]. Essential to this stripping process of – his term – ‘digitalization’ (the essence of conceptualization) is the *loss* of this surplus, or redundant information.

41 Recall the similar experience of Proust. In his memory there were still phenomena coming back after smelling the *petite-madeleine* crumbs again. Then, for the first time, he experienced *consciously* phenomena he had *unconsciously* perceived/sensed in his past.
(ibid.182ff) Interestingly, Dretske thereby gradually strips away a lot of *conscious experiential phenomena* in order to arrive at the unconscious part of his experience(s). His (second) example ‘seen as a daisy’ is the condensing catchphrase or labeling of the experiential information stored in one or more of the many networks of the brain that are continuously fed with new experiences in its ‘storehouse’ of memory. Effort is necessary to do the stripping and each step in that process (Dretske’s digitalizing) may lead to some (new) philosophical concept, sometimes the start of a whole avalanche of ‘concepts’ so that perception turns into “a form of recognizing, identifying, categorizing, distinguishing, and classifying, the things around using one’s mind”.

If we compare Dretske’s philosopher’s approach and the scientific explanations of the homeostatic control of for instance the body temperature [§ 5-4 (p.74)] or the human system of maintaining equilibirum [§ 5-3 (p. 70)] described earlier, we may see similarities. Remember that the vestibular system intimately cooperates with the visual system, propriocepsis (Craig 2002, 2009) and different areas of the central nervous system (Green and Angelaki 2010, Cullen 2011). Dretske’s analytic stripping and the neuroscientific explanations are opposite ways of telling the same story. Drestke’s analysis on the one hand and the neuroscientific approach on the other, present a picture similar to that of the schoolboy who tries to find the solution of a mathematical problem by reasoning from either end.

_Homo sapiens’_ grasp of his environments is constructed in his body, using all his sensory faculties.42 The sensory systems' output is coordinated by the ascending, cooperating and interconnected centres and maps in his ever adapting central nervous system. The parts of the variable maps in the central nervous system are wired such that after a few contacts with a tomato a person will immediately recognise a tomato when he sees it, as both our experience and scientific explanations show. The scene will even be named by the label or catchword ‘tomato’ through neural connections within the brain’s linguistic centres. One needs much rationalistic, phenomenological but _unrealistic_ reasoning to ‘see’ a red bulging thing, or to break it down into ‘sense data’ after we learned on our mother’s knee that this, my dear, is called (a) tomato. It is more pragmatic and safer for _Homo*

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42 Sensory receptors connected to the brain select from among a stream of sensory signals those events in the environment that are important to the individual. The brain actively organizes perception, some of which is stored in memory for future reference (learning and experience), and some of which is transformed into immediate behavioural responses. All this is accomplished by interconnected nerve cells.
sapiens who has ‘learned through evolution’ and from birth, by gradually developing and improving his behaviour systems [Box 5-1 (p.67)] to immediately grasp the essentials in one’s overcrowded environment\(^{43}\) and to act (fight or flight reaction), rather than complacently analyze what is essential and what not through speculative thought experiments and be killed by a local predator (in early days), a highwayman (in later days) or a misfit (in our days). Perception and consciousness are tools to support life among congeners, beset by danger, the priority being to learn from others.

Neuroscience tells us that, contrary to an intuitive analysis of our personal experience, perceptions are not precise copies of the world around us. Sensation is an abstraction, not a replication, of reality in the ‘language’ (= processes) of neurons and neural networks. The brain constructs ‘representations’ of external physical events after first analyzing their properties that are not intuitively or reasoned concepts but neurophysiological processes. This has been forcefully formulated by Purves D et al. (2010) as:

The evidence described in the[ir] article points to the same basic strategy for contending with this biological challenge: visual perceptions arise by linking retinal stimuli with useful behaviors according to feedback from trial and error interactions with a physical world that cannot be revealed by sensory information. In consequence, what we see is a world determined by the behavioral significance of retinal images for the species and the percipient in the past rather than by an analysis of stimulus features in the present.

[and again]

[Although no one would argue with the idea that vision evolved to promote useful behavior, the theory presented here relies entirely on the history of behavioral success rather than on image analysis.]

### 12.7 Conclusion

Dretske (American philosopher), Tao (Chinese philosophy), Zazen (Asian meditative discipline) and science (Western branch of systematized knowledge) all try to avoid the part of the brain’s activity that ‘retrospectively

\(^{43}\) Such processes are called feature detection, a concept proposed by Barlow 1953, and which became world-known under the title ‘what the frog’s eye tells the frog’s brain’ (Lettvin et al 1968,233-58), by Hubel and Wiesel as ‘the cat’s retina’ and Tinbergen’s ‘herring gull chick’ [§ 2-2 (p.28)]
The activity of the body-including mind'. It is synonymous with the 'chatter-box-activity' (Lamme 2011) of the left-brain\textsuperscript{44} that always tries to explain and to cast brain-body decisions in language, retrospectively.

Avoiding the chatter-box takes us closer to more automatic cortical-functions of the brain. They may also be reached through massive training programme's leading to experience which creates so-called 'completely automatic' reactions like an aikido-expert, the samurai of old, Polanyi's 'tacit' knowledge and Lamme's example of the soccer-keeper Jens Lehman (ibid. 59ff). It also brings back to mind Hume's bundle of sensations that constitutes 'self'. [§ 7-6 (p. 93)]

Using an old Zen-metaphor 'pointing to the moon', different people and traditions point to the same feature. Dretske, Tao, Zen, Hume, Neuroscience, Neurophilosophy's materialism and Dennett arrive at an identical conclusion: consciousness is a construct that doesn't exist as a thing, it's the life-long process based on continuously processing by a combination of sensory systems and integrating neuronal maps. That might also have been an old nominalistic conclusion.

Recently I read the common sense formula of Tim Birkhead who characterises himself as 'a behavioural ecologist first and an ornithologist second: a behavioural ecologist who studies birds'. This may be the most practical description of (the relationship of) sensory systems and behaviour.

The sensory system controls behaviour: it encourages us to eat, to fight, to have sex, to care for our offspring, and so on. Without it we couldn't function. Our behaviour is controlled by our senses, and as a result, it is behaviour that provides one of the easiest ways of deducing the senses that animals use in their daily lives.(Birkhead 2012, xiii-xiv)

The same holds true for perception and its firm connection with consciousness\textsuperscript{45} as argued above.

For the time being I will leave it at that. The future will tell if humanity finds a definite solution or continues this search until Armageddon and the final stages of our galaxy. [Box 10-1 (p.124)] Zen and the great mystic mechanic\textsuperscript{46} taught us that meanwhile at a certain point\textsuperscript{47} .......

\textsuperscript{44} Mind the mereological fallacy that is omnipresent in the writings of Lamme [Box 3-1 (p.47)]
\textsuperscript{45} I am aware of putative distinctions between self-consciousness and (overall) consciousness.
\textsuperscript{46} Eagleton 2005
\textsuperscript{47} ‘Wovon man nicht sprechen kann, darüber muss man schweigen’. [Whereof one cannot speak, thereof one must be silent] Wittgenstein 1976,7
13 Twining the pieces together /
‘Summing-up’

Many descriptions and even prescriptions try to tell us what science is or should be. These run from dogmatism to Paul Feyerabend’s ‘anything goes’ which, I think, became recently supported in Shapin’s (2010, chapter 3) review. I tend to ignore the extensive philosophy-of-science discussions and to follow Bas van Fraassen’s (1980) constructive empiricism accepting his scientific agnostic approach that chooses the empirically most likely (= adequate) hypothesis for any given 4-dimensional problem.

With this approach I treated the subject of sensory systems, fully aware of the inherent circle so well described by Montaigne and Chisholm [§ 12-2 (p.143)] implying a certain von Münchhausen’s manoeuvre (bootstrapping) to find solutions. Thus I recognize the tentativeness of scientific conclusions when they depend on the span of (aided) human organism’s sensory systems with which human organisms tend to build their Umwelt(s).

Hypotheses – even those that construct theories about their genesis – are formulated in terms of structures, functions, mechanisms and processes. Homo sapiens generates hypotheses. He is a living organism with a body that includes sensory systems and a brain.

Sensory systems are the structures and processes that enable an organism to establish contact with its environment and with all parts of its own body. These systems continuously gather up-to-date information. To obtain it the body uses intero- and exteroceptors, modified, mainly epithelial and mesothelial cells that can react to physical and chemical stimuli. Interoceptors constantly monitor the human milieu intérieur; without them the body would soon perish. Similarly, exteroceptors constantly appraise the outer world.

This information is continuously received in a 4-Dimensionally or spatiotemporal distribution of signals to the brain, an information processing complex of cooperating neurons. The brain (cave the mereological fallacy) ‘combines’ all information, ‘compares’ (= interpretes) it with earlier acquired information (= experience, memory, knowledge, skill), ‘decides’ (usually automatically, unconsciously, instinctively) and ‘sends’ instructions/signals to other structures in the body (organs, tissues, cells, fluids, et cetera). Thus, in the brain most ‘decisions’ are automatic, inferential choices.

Consciousness emerged as a late-evolutionary spandrel-like brain spin off. [§ 14-1 (p.167)] The term has been created to comprise all subjective
brain activities and experiences the human body ever had and has at a certain time $t$. Consciousness may occur almost simultaneously with obtaining information but after unconsciously inferential choices in the brain. It is intimately connected with experience and memory, and with the – relatively small – part of incoming information that the organism is aware of, i.e., perception.

For all processes mentioned so far the organism needs genetic, inborn, behavioural systems and (body-brain complex) experience. The new born enters the world with a (evolutionary acquired) set of sensory systems linked up with the brain. Gradually he structures his environment. He does so through continuously gathering information and steadily obtaining more experience, skills, knowledge and consequently consciousness. These functions are normal – but awe-inspiring biological phenomena of living (neuronal) tissue.

The main characteristic of perception then is the process of information assembly in an organized and coherent fashion from the environmental bombardment of 4-D stimuli by means of the sensory systems and the brain. Other phenomena that may arise in human bodies, probably as direct or indirect side-effects of perception, are consciousness, language, introspection, intuition, the inner eye, mysticism, et cetera.

In philosophy this view belongs to physicalism [Box 14-4 (p.172)], a naturalistic world-view that denies the existence of anything besides the natural world and its regularities (laws).
14 Addenda

14.1 Spandrel

A spandrel is:
1. the roughly triangular area of masonry that fills the space between one side of an arch, a wall, and the ceiling (rectangular framework) surrounding it.
2. the space between the two shoulders of adjoining arches and a horizontal moulding, ceiling or cornice above them. A spandrel (or pendentive) is found particularly between the arches supporting a dome in Gothic churches.

In 1978 Stephen Jay Gould visited Venice and noted that the beautiful spandrels of the San Marco cathedral were not planned by the architect but rather originated as “necessary architectural byproducts of mounting a dome on rounded arches.” Gould (1979). Together with Richard Lewontin he introduced the architectural term spandrel into evolutionary biology.

They thus defined spandrels in evolutionary biology as any biological feature of an organism that arises as a necessary consequence of other features, not directly opted for by natural selection.

In Voltaire’s Candide, Dr. Pangloss is portrayed as a scholar without common sense who, despite the evidence, insists that “all is for the best in this best of all possible worlds”.

Gould and Lewontin asserted that it is Panglossian for evolutionary biologists to view all traits as atomized things that had naturally been selected for, and criticised biologists for not granting theoretical space to other causes, such as phyletic and developmental constraints. The relative frequency of spandrels, so defined, versus adaptive features in nature, remains a controversial topic in evolution theory.

14.2 On Sensory Substitution Devices (SSDs)

14.2.1 Introduction

Canes and crutches, spectacles, artificial limbs, dentures, and other prosthetic devices are age-old expedients. Today, robots and cyborgs (a human/
machine merger) are commonplace as movies like ‘The Terminator’ and ‘The Matrix’ show.

Technological developments caught up on these phantasies and even produced some of their own. Information is readily available at computer sites like Youtube, Google and Wikipedia under headings like robotics, cyborgs, implants, artificial intelligence, digital identity, growing brain tissue, deep brain stimulation, human enhancement/upgrade and a few others (Warwick 2010), often indicated – characteristically – by acronyms.

I will not dwell upon the impressive scientific and technological successes but briefly mention aids and appliances that over time became gradually more complicated: from the cupped hand, via the ear-trumpet, the hearing aid, the bone anchored hearing aid (Baha) to the Cochlear Implant (CI). Neither will I discuss the ethical problems that may accompany these developments. This discussion will thus be limited to aspects pertinent to this essay.

14.2.2 Some examples and some discoveries

The difference between amplification of a signal by a cupped hand and transforming an audible sound into an electric pulse which directly stimulates the hearing nerve like a cochlear implant does, is impressive. Such a device circumvents the influences of the auricle, the ear canal and the middle ear system.

Greater transformations were achieved since the early 1960s when a visual image was converted into a tactile one (visual-tactile sensory substitution)\(^1\)\(^2\) used as an aid for blind people to ‘see’. Interestingly already after only five to fifteen hours of training the patients ‘forgot’ the camera on the head and the vibro-tactile stimulation of their (abdominal) skin, the two exterior devices of the assembly; they distinguish 3-D images instead, static as well as moving.

In the eighties a comparable visual-tactile sensory substitute was constructed that used the surface of the tongue. This device is about five times more precise, the tongue being the most densely innervated organ of the body. Moreover, it uses only three percent of the voltage needed for

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1 A sensory substitution system allows information coming from an artificial receptor to be processed by a different sensory organ from the one normally used to transduce this information (Bach-y-Rita et al 1969)
2 A sensory substitution device (SSD) replaces one or several functions of a deficient sensory modality by means of another sensory modality. (adapted after Auvray et al 2009)
the abdominal skin device and the electrical resistance remains almost constant due to the saliva.

Other examples of converters used for blind people are visual/auditive and echolocation in which the reflection of emitted ultrasound are transformed into audible frequencies presented to two ear phones.

An important moment during the revalidation process is the first time that the exteriorisation is perceived, i.e., the moment the subject distinguishes between the signals from the device and other (normal) environmental sounds, although much difficult training will still be necessary. In the end, however, the perception of objects becomes ‘automatic’ and needs no more conscious analysis. The ‘signals’ of the new device are no longer perceived as sounds and the provided information is felt as a direct part of the self. One user of the device compared this feeling with climbing the stairs; “I needn’t slow down when reaching them and I don’t bother about how to adjust my legs.” (Auvray 2003) All users report that the device does not feel as an eye substitute or amplifier but gives the sensation of a new sensory tool to get in touch with the world.

Auvray et al. (2009) performed an in-depth analysis of the literature on sensory substitution devices (SSDs) trying to learn which sensory modality the device particularly favours, the substituting or the substituted perception. Their search addressed eight aspects of sensing, i.e., the sensory organ, the stimuli, the properties, the qualitative experience, the behavioural equivalence after specific stimuli, the dedication and the sensorimotor equivalence. Auvray et al. firmly reject the assumption that perception after sensory substitution can be conceived of as equivalent to perception in any already existing modality. They argue that the effects of an SSD are comparable to cognitive enhancement through external devices, an addition, augmentation, or extension of the perceptual abilities. They conclude that SSDs are not ‘substitutions’ but tools, sensory extensions, supplements or transformers. They propose to place SSDs into the category of mind enhancing tools (METs coined by Clark 2003) such as sketchpads or computers which are means of expanding cognition in ways that would have been impossible without them.

Another important topic discussed in the paper of Auvray c.s. (2009) is the lack of emotional responses while perceiving objects which one would expect in the case of unaided perception. When a person blind from birth was shown an image of his wife, and two blind students were shown pictures of naked women they could describe them in detail but their descriptions were without emotional content. Absence of affective and emotional content associated with seeing colours and faces is also shown by patients...
born blind from congenital cataract whose vision is surgically restored (Gregory, 1966, 2003).

Two hypotheses, not mutually exclusive, can explain these lack of emotions experienced by people using a perceptual prosthesis: (1) the feeling of emotions needs a perceptual learning process or, (2) emotions can only arise by inter-subjective building of values in a community of persons with similar means of perception. The first hypothesis implies that emotions might be better developed if the SSD were applied earlier, e.g., in children or for longer periods of time. (Auvray et al 2009) Attempts to equip babies with a ‘tactile visual substitution system’ (TVSS) suggested that this might be the case (e.g., the babies smile when perceiving their mother; Bach-y-Rita et al., 2003).

14.3 Narcissus

« (Daffodil, Jonquil, and Narcissus)
Family: Amaryllidaceae
Hardy and tender perennial bulbs
Position: sun or partial shade
Propagation: seed or division of dormant bulbs
Cultivation: very easy
Fragrant
Useful for cutting
Poisonous

O Proserpina!
For the flowers now that frightened thou let’s fall
From Dis’s waggon! daffodils
That come before the swallow dares, and take
The winds of March with beauty...

(Shakespeare, The Winter’s tale, Act IV, Scene 3)

The reader who expects to read here something of the fables concerning the mythical Narcissus will be desillusioned. The flower of this name has nothing to do with that neurotic, self-loving youth. According to Pliny the Elder, Plutarch, and many other Classical writers, the name of the genus

3 Pizetti I and Cocker H 1975,880-1
Narcissus derives from the Greek *narkan*, which means to stupefy (the word narcotic is derived from the same root), because it was thought that both the scent of narcissus flowers and the substances contained in them possessed narcotic properties. In Antiquity the flower was often associated with Avernus, a sort of limbo or forecourt to the Underworld, where the dead first arrived – and from where a return to earth was still possible – before the final crossing of Lethe on the journey down to Hades or Elysium. Thus, to the pre-Classical Greeks, Avernus signified a stage that was not as final as death, a strange borderland that lay on the fringes of consciousness and unconsciousness (a state being for which narcotics often provide the key). This association with the limbo-Avernus was not due solely to the narcotic properties of the narcissus but also to the rather deadly, almost lunar pallor of the flowers. There are further Classical connexions with the Underworld. When Persophone was abducted by Hades she was gathering poppies, violets, and narcissi; and it was at the moment that she plucked the narcissus that Hades burst forth and carried her to his domain. The Greeks also dedicated the flower to Hecate, Queen of the Underworld, and to Demeter, Persephone’s mother and goddess of fertility.

The mythological aspects of the narcissus were not always associated with the valley of the shadow, however. Garlands of the flower were often used to adorn status of Dionysus, and, according to some mythographers, narcissi were favoured by Aphrodite, who, to make herself even more beautiful in the eyes of Paris, appeared before him surrounded by a veritable sea of narcissi. Poetic allusions to narcissi – associating the flower with Persephone or, in the case of Theocritus, with Europa, as well as with that pallid youth, Narcissus – are so numerous that it would be a great effort to cite them all, and a still greater effort to read them. It is sufficient to recall such names as Virgil, Ovid, Sophocles, and Shakespeare.

“Wilson and Bell take up more than ten pages of their book, *The Fragrant Year*, to give extremely useful information concerning narcissus perfume. They note that all narcissus blooms are to a greater or lesser degree fragrant. Those not scented constitute rare exceptions. Concerning the perfume of Narcissus Pseudo-narcissus, Fletcher writes that the trumpet types of narcissus have a fragrance difficult to describe. It is not sweet like that of lillies, nor aromatic like many herbs, and it is doubtful if anybody would appreciate it bottled, since it is not that kind of fragrance, but it is strong, agreeable, almost earthy, and garden-like. The same author notes that the older varieties are the most strongly scented, and the types with the smallest cup or trumpet have the most pronounced perfume (such as the *Jonquilla* and *Tazetta types,*’(ibid, 883)
14.4 Eliminative materialism

[T]he greatest single philosophical obstacle to getting a satisfactory account of consciousness is our continuous acceptance of a set of obsolete categories, and an accompanying set of presuppositions that we have inherited from our religious and philosophical tradition. We still start off with the mistaken assumption that the notions of “mental” and “physical”, of “dualism” and “monism”, of “materialism” and “idealism” are clear and respectable notions as they stand, and that the issues have to be posed and resolved in these traditional terms.”(Searle 1997,xif)

Dualism as traditionally conceived seems a hopeless theory because, having made a strict distinction between the mental and the physical, it cannot then make the relation of the two intelligible. It seems that to accept dualism is to give up the entire scientific worldview that we have spent nearly four centuries to attain.(ibid.xiiif)

The term ‘elimination’ in eliminative materialism or eliminativism suggests that mental states do not truly exist. The concept first appeared in the works of CD.Broad, J.Cornman (who introduced the term), P.Feyerabend, WVO. Quine, R.Rorty and W.Sellars.4 It claims two things: (1) that common sense mental views are not real and mental terms empty (true eliminative materialist), and: (2) that mental views can somehow be reduced to neurological (or perhaps computational) states of brain activity (materialist/reductionist).

The first claim can be called ontologically radical, the second one ontologically conservative. An illustration of the ontologically radical claim could be that while lightning is no longer caused by the stroke of Thor’s hammer (Mjölnir), the old notion became empty. An illustration of the ontologically conservative is that lightning is now identified as electro-magnetic radiation, the notion of lightning still holds.

In such discussions, the term ‘theory-theory’ often emerges, which refers to the putative theoretical framework used to explain and predict (intelligent) behaviour. An example of this is ‘folk psychology’: the generalizations or laws and specific (daily) theoretical postulates such as beliefs. Eliminative materialists argue that postulates of folk psychology are little more to the mind than brain activity. Moreover, mental states are irreducible not because they are non-physical but because they do not exist. Staunch

4 Ramsey 2007
defenders of this view are Patricia S. Churchland\textsuperscript{5}, her husband Paul M. Churchland and Dennett (2005 ch 1). The last author writes:

[T]he same mismatch between means and ends haunts us today: Noam Chomsky, Thomas Nagel and Colin McGinn (among others) have all surmised, or speculated, or claimed, that consciousness is beyond all human understanding, a mystery not a puzzle, to use Chomsky’s proposed distinction. [reasoning] After all, we have now achieved excellent mechanistic explanations of metabolism, growth, self-repair, and reproduction, which not so long ago looked too marvellous for words. Consciousness, in this optimistic view, is indeed a wonderful thing, but not \textit{that} wonderful – not too wonderful to be explained using the same concepts and perspectives that worked elsewhere in biology.

\textsuperscript{5} Patricia Churchland once said “electrical current in a wire is not caused by moving electrons; \textit{it is} moving electrons. Genes are not caused by chunks of base pairs in DNA, they \textit{are} chunks of base pairs.”
Folk psychological concepts, the subject-matter of people’s everyday understanding of one another in psychological or mental terms could be explained scientifically or ‘translated’ into scientific concepts.

Many philosophers believe that the mystery of ‘how action potentials give rise to meaning’ has still not been solved.

Neuroscience tries to formulate operational definitions of different aspects of mind, put them to the test by teams of collaborators of disciplines such as philosophy, anthropology, neuroscience, computer modelling, artificial intelligence (AI) et cetera.

I strongly believe that eliminative physicalism, the naturalistic philosophy based in the sciences (Naturwissenschaft) including eliminative materialism is the optimal course to (come to) understand the mind and the sensory systems.

14.5 Process

Le monde meurt tous les jours, le monde naît tous les jours. Il n’y a pas là de début ni de fin extrêmes entre lesquels comprendre le déroulement, celui-ci est une variation de tout moment. Toute fin, en elle-même, est un début, elle débute en même temps qu’elle achève – la transition est continue.

F Jullien (2001,75) 6

In paragraph 4-3 dealing with evolutionary theory I stated that:
(i) the universe began with the Big Bang about $13.7 \times 10^9$ years ago and the earth is about $4.56 \times 10^9$ old,
(ii) life on earth started about $3.8 \times 10^9$ years after the planet was formed and developed from a simple form to many and more complex ones, increasing the total biomass of animals, plants and microorganisms, and, thereby gradually building a ‘tree of life’ in which Homo sapiens has his place,
(iii) natural selection is not goal-directed but a stochastic process.

The introductory statement of paragraph10.1 proclaimed that we may be aware that everything in the universe from the smallest particles to the largest

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6 Jullien François. Du « temps ». Éléments d’une philosophie du vivre. Grasset, 2001,75 [The world is continuously dying, the world is continuously being born. There is no ultimate beginning and ending between which to grasp its course, there is ongoing changing. Each end in itself is a new beginning, it commences as it completes – in a continuous transition]
stellar structures is subject to processes – granted – with different time scales. [Box 14-2] Our spatiotemporal (4-D) world, the roughly twenty kilometre thick layer of the earth in which all organisms dwell is tautologically called biosphere. Every organism is influenced by 4-D conditions from its conception. It will then develop, i.e., grow in size and in number of capabilities and functions. We understand this development as entering into a sequence of parallel, successive, multiple and often complicated processes according to its genetic plan, ultimately leading to death and decay. Life is characterized by on-going processes that may be described in terminology, formulae and regularities (laws) from physiology, (bio)physics, (bio)chemistry, psychology et cetera.

The conclusion of paragraph 12.4 is that consciousness is not a thing; it is a continuing (biological) process, a quality of the brain of Homo sapiens. Consciousness appeared in the course of Darwinian evolution with precursors in animals. In the course of infancy it gradually emerges from experiences which are themselves formed by what our sensory systems perceive.

From the aforementioned paragraphs I conclude that everything in the universe is best understood in terms of processes rather than things, of modes of change rather than fixed entities. Change is the pervasive and predominant feature of the real, of all that exists, that what characterizes it. Reality does not consist of a constellation of things but of processes as Heraclitus Ephesus⁷ already saw. To understand reality the concept of

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⁷ Heraclitus (ca.500 BC): Everything flows and nothing abides. Everything gives way and nothing stays fixed. You cannot step twice into the same river, for other waters and yet others, go flowing on.
processes is fundamental. They create, are productive, can destabilize and can be destructive. Nothing exists for ever.

14.6 Apology

Un sage [...] est sans idée. [...] « Sans idée » signifie que le sage n’est en possession d’aucune, prisonnier d’aucune. Soyons plus rigoureux, littéral: il n’en met en avant aucune.

F Jullien (1998,13)8

We have a habit in writing articles published in scientific journals to make the work as finished as possible, to cover up all the tracks, to not worry about the blind alleys or describe how you had the wrong idea first, and so on. So there isn’t any place to publish, in a dignified manner, what you actually did in order to get to do the work.

R Feynman (Nobel lecture,1966)

1. My quest as stated in the first paragraph of the preface, began with an effort to obtain as much knowledge on the subject of sensory systems as I reasonably could.9 Two of my early academic readers subsequently advised me to formulate one or more specific – ‘scientific’ – questions.

2. The word ‘scientist’ was introduced in 1833 by William Whewell, a nineteenth-century Cambridge philosopher and mineralogist. At that time Whewell was waging a deliberate campaign to establish science as a professional discipline distinct from philosophy. As we now know, Whewell was successful and in the eyes of some even too successful.

3. Do philosophers and scientists differ in their way of posing questions? Do they differ in the sort of problems they want to deal with?

4. “Like every biologist,” writes the animal behaviourist Frans de Waal (2001,55), “I learned that one needs to build an extensive background knowledge before one can even begin to address detailed questions.”

8 Jullien François. Un sage est sans idée ou l’autre de la philosophie. Éditions du Seuil, 1998
[A wise man [...] has no opinion [...] "No opinion" stands for the wise man having no opinion whatsoever, he is enslaved by none. Let’s be more precise, literally: he sets none before]

9 “For it is owing to their wonder that men both now begin and at first began to philosophize”. This wonder is meant “to escape ignorance”. Aristotle’s Metaphysics 982b12ff (cited by Arendt,1958,302)
He continues to say quoting Lorenz (1981) that one needs to grasp the whole before one tries to grasp its parts:

One cannot master set research tasks if one makes a single part the focus of interest. One must, rather, continuously dart from one part to another – in a way that appears extremely flighty and unscientific to some thinkers who place value on strictly logical sequences – and one’s knowledge of each of the parts must advance at the same pace. (italics added)

I endorse de Waal’s and Lorenz’s points.

5. Personal experience taught me that explaining problems to others, presenting a paper or writing a text-book (on oto-rhino-laryngology) led to growth of my own knowledge and understanding. Knowledge is comparable to a texture. As Lorenz stated, to progress with knowledge one should continue darting from one part to another. Haack compares such behaviour with the metaphor of doing a crossword puzzle.

6. Medawar (1963) in a paper with the significant title ‘Is the scientific paper a fraud?’ stated his belief that the scientific paper misrepresents the proces of thought that accompanied or gave rise to the work described in the paper. He also formulates his response to the title of his own paper: ”my answer to it is ‘yes’. ” The scientific paper in its orthodox form embodies a mistaken conception, even a travesty, of the nature of scientific thought. Scientific discovery or the formulation of the scientific idea on the one hand, and the demonstration of proof on the other, are two entirely different notions. (ibid.)

7. In the same vein, Wolpert (1992,186) laments that “if perceptivity and curiosity are indeed critical for scientific progress, why do not behavioral scientists teach their students to keep an open eye? Instead, we urge them to develop hypotheses, faithfully list them in the introductions to their papers, then devote the rest of their work to a demonstration of the correctness or incorrectness of their predictions. Not surprisingly, students develop a knack of writing introductions that make them look prescient: it is often hard to tell whether their predictions fit the facts or the other way around. There is little against such neat presentations as long as we realize that they are only that – a way of organizing and presenting our work. The structure of papers is not to be confused with the actual process of science, with its detours, surprises and frustrations.”

10 van den Broek and Feenstra 2007
8. Scientific work of an experimental or exploratory nature begins with expectation(s) about the outcome of the inquiry, expectation that form the initiative and incentive for the inquiry. The observations and considerations 2-6 (vide supra) are the reason to decide against too specific (and reductionistic) questions.

The process of writing this essay, much like my earlier experience (see number 5 above) taught me much. [Box 0-1 (p.16)] The two ‘academic’ questions [§ 1-3 (p.26)] were formulated in retrospect at a time that most of my understanding and most of the writing were already done, in order to please my two early readers. I still feel that it is better to expose than to hide the genesis of this essay. So after all, these two ‘academic’ questions are only that: academic. As for the last question of the two formulated in chapter one, i.e., ‘what is the basis of the unity of (conscious) perception’ a tentative answer might be ‘an evolutionary spandrel, a function of the brain of Homo sapiens, still hazy in part’.
Chapter 1 defines sensory systems as those specialized parts of (plants and animals) that are most sensitive to variations in its environment, which are generally defined in chemical or physical terms. When such a variation hits a sensory system leading to events in the body, the variation is called ‘stimulus’. Perception is defined as stimuli leading to awareness.

Chapter 2 presents a life scientific survey of sensory systems. Two ethological examples are given: Tinbergen’s herring gull chick begging for food and the human baby’s first suckling. These newborns thus start life with detection mechanisms for specific environmental variations (‘innate releasing mechanisms’) and the potential to rearrange this information into new meaningful schemes: new behaviour or ‘learning’. Both mechanisms developed during evolution, differ between species and are only sensitive for parts of the chemico-electro-magnetic environment of the newborns.

Environmental events outside the sensory systems’ sensitivity range cannot be experienced although instruments may amplify or convert signals into perceivable ones. Classification of sensory systems may be based on the kind of stimulus, the distance between stimulus origin and receiving sensory systems, and on the location of the source, i.e., inside (interoception) or outside the body (exteroception).

Sensory systems are not mere ‘windows’ but function within the context of bodily actions. When the suckling infant’s nose smells the breast its whole body acts to feed. Thus sensory systems and motor organs cooperate as one coordinated system. The infant as a system unconsciously collects much basic experiential ‘knowledge’ although it does not yet have consciousness and language. It so acquires ‘pieces of knowledge’ among which the Pavlovian expectancy of ‘same stimulus/same consequence’ (causality, induction).

Chapter 3 continues with the survey of chapter two. Some environmental electro-magnetic changes are not sensed but still influence the body as demonstrated by sequellae of radioactive and ultra-violet-radiation. No organism is able to experience all aspects of potential electromagnetic and chemically conveyed signals. Therefore, total ‘reality’ can not be known. Organisms notice only those aspects of reality perceivable by their sensory systems.
Philosophy of perception has so far mainly been confined to vision; little attention has been paid to cooperation of sensory systems. Sentient organisms, however, always use all sensory systems simultaneously and continuously, resulting in a continuous 4-D(imensional) awareness of the environment and of their own body. The intensity of each sensory system’s reaction depends on its owner’s kind of activity and attention. Such bodily awareness regards the whole person and not merely his brain; to claim the opposite is called a mereological fallacy.

A whole-system approach to the study of the developing child stresses the inextricable causal web of perception, action and cognition. Some even study man connected with machines (cyborgs) and/or other people as one large system.

Processes occurring in the body after receiving a stimulus necessarily modify stimuli. The relation ‘representation’ and the ‘world out there’ has been of particular interest to philosophers. Sceptics stress deception caused by sensory systems’, other philosophers seek certainty and ‘Truth’. Scientists accept that their inductive way results in knowledge that is inherently provisional.

Chapter 4 places the birth of evolutionary theory at 1 July 1858 when both Wallace’s and Darwin’s manuscripts were presented in London. Creationism and intelligent design criticised On the Origin of Species but science accepts the theory of neo-Darwinism (or evolutionary theory) almost unconditionally. This theory consists of yet unexplained ‘spontaneous’ simple beginning(s) gradually developing into many and increasingly complex forms building a ‘tree of life’. Natural selection operates on the abundant production of genetic variation in every generation, and on random genetic mutation. Evolution is not goal-directed but a stochastic process leading to the survival of relatively few individuals. Survival rests on well adapted specimens of a species producing the next generation. Homo sapiens is part of the tree of life like any other creature. Neo-Darwinism consists of a bundle of scientific theories that evolved in the course of time. Evolutionary theory is generally accepted as a fact.

Evolutionary epistemology is based on neo-Darwinism and defined as a ‘naturalistic approach to epistemology’. It emphasizes selection as the generator and maintainer of the human sensory systems and cognition.

Not all philosophers accept science into their traditional domains but some do. Views run from “I am one of those who thinks science has no light to shed on either the epistemological or the metaphysical problems of perception” to “I see philosophy not as an a priori propaedeutic or groundwork
for science, but as continuous with science. I see philosophy and science in the same boat.”

Chapter 5 introduces ‘ethology’ (‘behavioural biology’). Biologists concluded that ‘innate’ and ‘rational mechanisms’ are present at birth and may be set into action by a particular stimulus which leads to a change of behaviour (‘learning’). Any animal is born with genetically based predispositions. Experience(s) in many combinations and predispositions becoming manifest only later in life, may change behaviour. Predispositions and contingent – experiences, often in various combinations, may lead to ‘learning’ and ‘knowledge’. Therefore, the old philosophical struggle between rationalists and empiricists arguing for their private road to knowledge is passé.

Biology introduced the concept of behaviour system which consists of a central mechanism, perceptual mechanisms, and motor mechanisms corresponding to structures in the brain. Many of these mechanisms and their connections only develop after a particular stimulus. The followers of Aristotle parroting the ‘holy number’ of the five senses (sight, hearing, smell, taste and touch) probably do not realize that equilibrium, skin sensory systems, nociceceptors and propriocepsis are also sensory systems.

The sensory systems send coded neuronal signals to the brain that coordinates the incoming information, most of the time unconsciously.

In addition to the sensory systems the human body has other systems that gather information and deliver signals. Endocrine glands and the immune system come to mind, systems the effects of which are usually not directly perceived although their consequences may be felt. All information influences ‘behaviour’ of cells, tissues, organs and the whole body (including ‘Mind’). Most important effect of this behaviour is homeostasis, the maintenance of the ‘milieu intérieur’.

Chapter 6 presents a bird’s-eye view on ‘sense-datum’ and its synonyms. Sense data were introduced in the beginning of the 20th century, motivated by discussions about illusion. Sense data are defined as ‘those things that are immediately known in sensations like colours, sounds etc.’ We must be conscious to notice them, but a biological substrate of them is not known. I argue that sense-data are fictitious entities that are too far removed from common sense concluding, paraphrasing Laplace, “I do not need that hypothesis” (“Je n’ai pas besoin de cette hypothèse”).
Chapter 7 introduces three problems, (1) that of perception or illusion, (2) that of content of perception or experiencing the world, and (3) that of the relation of environment and knowledge thereof.

I argue that ‘illusion’ and ‘real perception’ may occasionally appear to be similar but that they are not identical. Macbeth’s dagger, often quoted in this context as an illusion, a hallucination, or even a delusion is – in fact – an excellently portrayed pseudo-hallucination.

Representations of the environment in the central nervous system (CNS) on the one hand and the ‘fit’ of the CNS and the world on the other attracted much philosophic attention.

Justification strikes me as less important than the pragmatic chosen answer to the best solution for a given problem in a specific spatiotemporal (4-Dimensional) situation.

Chapter 8 offers an introduction to other ways of acquiring knowledge than directly through the use of sensory systems, i.e., by ‘introspection’, ‘intuition’, ‘meditation’, ‘contemplation’ and the ‘mind’s eye’. Until the end of the 19th century the chief method for understanding the mind was introspection but after the birth of psychology it is no longer accepted as reliable. Intuition mainly acts unconsciously, is a creative, immediate apprehension of justifiable belief but must further be studied. The mind’s eye works through a non-linguistical grasp of Gestalts, indispensable for artists, technicians, crafts and trades. Wittgenstein, by training an engineer, used the term ‘das zeigt sich’ (shows, displays, cannot be said et cetera) in the same vein. Through contemplation and meditation people may acquire knowledge seemingly of another variety than that acquired via sensory systems.

Chapter 9 begins with a review about what, according to Wittgenstein, is ‘the inexpressible’, the realms of transcendental sensory experience.

The literary genres of mystical writings are variable and sometimes weird for the newcomer. The best way to acquire mystical knowledge is under guidance of a mystagogue or ‘guru’, a teacher with personal mystical experiences.

Examples are presented of such experiences; from those of atheists to those of a variety of religious creeds. I also describe the effects of mystical experience on the beliefs and behaviour of mystics. Mysticism, however, does not help in understanding sensory systems.

Chapter 10 takes off with the statement that everything in the universe is subject to processes with different time scales. In the biosphere every
creature is subject to the 4-D world from its conception to its decay. Life thus is an on-going process that may be described in formulae and regularities of physico-chemical laws. Any sensory system consists of a conglomerate of complicated, integrating sub-processes, that continuously select parts of the massive bombardment of incoming signals from the environment and the own body.

Sensory systems thus produce experiences (practice, skill, knowledge) many of which remain unconscious. New information and experience is ‘automatically’, unconsciously compared with earlier ones and re-arranged if necessary resulting in (life-long) ‘learning’.

Experience at time $t$ is finally defined as the sum of everything that entered the body through the sensory systems, unconsciously or consciously up to $t$.

**Chapter 11** discusses information as the attachment of meaning by the receiving organism to incoming stimuli from his environment. Information is a key element of the relative new biological speciality of biosemiotics. An introduction of biosemiotics is presented and its relation with perception is discussed. Resemblance and distinction between von Uexküll’s *Umwelt* and *ecological niche* is explained in that they correspond to $R_A$ and $R_U$ in chapter three. *Umwelt* stands for the environment as perceived by any organism ‘locked up’ inside its own subjective world. *Ecological niche* is the set of conditions of the environment as conceived by an observer.

**Chapter 12** uses the Dutch constructs in swamps and marshes to define foundationalism, coherentism and Neurath’s ship, omitting scepticism since that is but indirectly constructive, if at all. A second metaphor used is the quintessence of Chisholm’s paper ‘the problem of the criterion’ called his philosophical compass. Both metaphors are used as *Leitmotiv*.

Introduced is the unavoidable circle of knowledge needed to understand sensory systems, and sensory information to acquire knowledge. Bootstrapping like Baron von Münchhausen did before, I discuss knowledge and sensory systems simultaneously. Van Fraassen’s ‘*scientific agnosticism*’ is taken as the pragmatic and tentative answer to any scientific 4-D problem.

The many criteria for classification of sensory systems used in the literature are given: the empirical one of scientists is judged as the best.

A stimulus received by a receptor is conducted to the cerebral cortex, the final information processing organ. Cognition is defined as all processes in the brain by which sensory input is transformed, reduced, elaborated,
stored, recovered and used. Mind and consciousness are processes of the brain comparable to Patricia Churchland's quote 'an electrical current in a wire is not caused by moving electrons, it is moving electrons.' Perceptions in this vein would thus be more an abstraction than a replication of 'reality' and typically made up of multiple sensations; its consequences are called 'behaviour' and 'learning'.

Difficulties arise as soon as behaviour (= body-including-brain decisions) is 'retrospectively' explained in 'logical' language. Many problems in the field of perception and consciousness were and are due to speculations caused by inadequate scientific knowledge.

*Homo sapiens* has no more than the support of his body and its processes. He is thus able to construct his own reality only, which is but part of the universal reality.

*Chapter 13* presents a short conclusion of this essay already covered by this summary.

*Chapter 14* presents the addenda:
- *spandrel* describes how this architectural term was introduced into evolutionary biology, and its significance;
- *sensory substitution devices*, describes technical inventions to lighten the burden of loss of sensory systems;
- *narcissus*, a guide's description of the flower carrying that name;
- *eliminative materialism*, presents a short description of this specific epistemological view;
- *process*, a description of what I mean by this much used term in this essay, arguing that anything in the universe is inevitably subjected to 'birth', 'death' and 'decay', be it on different time scales;
- *apology*, a defense against an insolence of a befriended early adviser to formulate one or two 'academic problems' instead of quenching my thirst for understanding and knowledge in the selected domain(s)....
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## Abbreviations

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<td>AI</td>
<td>artificial intelligence</td>
</tr>
<tr>
<td>CBS</td>
<td>Charles Bonnet syndrome</td>
</tr>
<tr>
<td>cd</td>
<td>candela, measure of light intensity</td>
</tr>
<tr>
<td>cps</td>
<td>(synonym = Hz), cycles per second, number of vibrations per second</td>
</tr>
<tr>
<td>C</td>
<td>Celcius</td>
</tr>
<tr>
<td>Cl</td>
<td>cochlear implant</td>
</tr>
<tr>
<td>CN</td>
<td>cephalic nerve</td>
</tr>
<tr>
<td>CN 0</td>
<td>cephalic nerve number 0 (synonym n.terminalis)</td>
</tr>
<tr>
<td>CNS</td>
<td>central nervous system, i.e., brain and spinal cord</td>
</tr>
<tr>
<td>D</td>
<td>dimension(s) as in 4-D</td>
</tr>
<tr>
<td>dB</td>
<td>decibel; intensity of loudness</td>
</tr>
<tr>
<td>dB&lt;sub&gt;HL&lt;/sub&gt;</td>
<td>decibel; intensity of loudness in relation to reference Hearing Level</td>
</tr>
<tr>
<td>dB&lt;sub&gt;SPL&lt;/sub&gt;</td>
<td>decibel; intensity of loudness in relation to Sound Pressure Level</td>
</tr>
<tr>
<td>DNA</td>
<td>deoxyribonucleic acid</td>
</tr>
<tr>
<td>Flak</td>
<td>Flug(zeug)abwehrkanone = the fire from anti-aircraft guns (heavy opposition)</td>
</tr>
<tr>
<td>Hz</td>
<td>(synonym = cps) Hertz, number of vibrations per second</td>
</tr>
<tr>
<td>iff</td>
<td>if and only if</td>
</tr>
<tr>
<td>kHz</td>
<td>kilo-Hertz, thousand Hz (see table 3)</td>
</tr>
<tr>
<td>MET</td>
<td>mind enhancing tool</td>
</tr>
<tr>
<td>n</td>
<td>nervus, nerve</td>
</tr>
<tr>
<td>orl</td>
<td>otorhinolaryngology</td>
</tr>
<tr>
<td>pH</td>
<td>measure of the hydrogen ion concentration</td>
</tr>
<tr>
<td>R, R&lt;sub&gt;A&lt;/sub&gt;, R&lt;sub&gt;H&lt;/sub&gt;, R&lt;sub&gt;U&lt;/sub&gt;</td>
<td>reality, animal reality, human reality, universe reality</td>
</tr>
<tr>
<td>RNA</td>
<td>ribonucleic acid</td>
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<tr>
<td>SSD</td>
<td>sensory substitution device</td>
</tr>
<tr>
<td>TVSS</td>
<td>tactile visual substitution system</td>
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<tr>
<td>VOR</td>
<td>vestibular-ocular reflex</td>
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# Powers of Ten

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<thead>
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<th>prefix</th>
<th>symbol</th>
<th>powers of ten</th>
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<tbody>
<tr>
<td>yotta</td>
<td>Y</td>
<td>$10^{24}$</td>
</tr>
<tr>
<td>zeta</td>
<td>Z</td>
<td>$10^{21}$</td>
</tr>
<tr>
<td>exa</td>
<td>E</td>
<td>$10^{18}$</td>
</tr>
<tr>
<td>peta</td>
<td>P</td>
<td>$10^{15}$</td>
</tr>
<tr>
<td>tera</td>
<td>T</td>
<td>$10^{12}$</td>
</tr>
<tr>
<td>giga</td>
<td>G</td>
<td>$10^9$</td>
</tr>
<tr>
<td>mega</td>
<td>M</td>
<td>$10^6$</td>
</tr>
<tr>
<td>kilo</td>
<td>k</td>
<td>$10^3$</td>
</tr>
<tr>
<td>hecto</td>
<td>h</td>
<td>$10^2$</td>
</tr>
<tr>
<td>deca</td>
<td>da</td>
<td>$10^1$</td>
</tr>
<tr>
<td>deci</td>
<td>d</td>
<td>$10^{-1}$</td>
</tr>
<tr>
<td>centi</td>
<td>c</td>
<td>$10^{-2}$</td>
</tr>
<tr>
<td>milli</td>
<td>m</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>micro</td>
<td>m</td>
<td>$10^{-6}$</td>
</tr>
<tr>
<td>nano</td>
<td>n</td>
<td>$10^{-9}$</td>
</tr>
<tr>
<td>pico</td>
<td>p</td>
<td>$10^{-12}$</td>
</tr>
<tr>
<td>femto</td>
<td>f</td>
<td>$10^{-15}$</td>
</tr>
<tr>
<td>atto</td>
<td>a</td>
<td>$10^{-18}$</td>
</tr>
<tr>
<td>zepto</td>
<td>z</td>
<td>$10^{-21}$</td>
</tr>
<tr>
<td>yocto</td>
<td>y</td>
<td>$10^{-24}$</td>
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About the author

Louw Feenstra (v) is professor emeritus of otorhinolaryngology and philosopher.
He lives in Rotterdam, the Netherlands.
Samenvatting

Het woord vooraf vermeldt de aanleiding voor dit boek: een curriculum-wijziging binnen de medische faculteit van de Erasmus Universiteit. Deze vernieuwing bracht onder meer een blok ‘Hersen en Zintuigen’. Een inleiding tot het zintuigdeel werd noodzakelijk geacht. Bij het schrijven daarvan bleek me dat mijn biologische en filosofische kennis van zintuigen ontoereikend was. Dit boek is de neerslag van een wat uit de hand gelopen poging in die leemte te voorzien. De vorm van het boek gelijkt op die van de Nederlandse delta: meanderende rivieren, beken en sloten, steeds weer splitsend en samenvloeiend.

Hoofdstuk 1 omschrijft zintuigen als de gespecialiseerde orgaansystemen van levende organismen (wezens, plant en dier) die gevoeliger zijn dan andere delen van het organisme voor specifieke veranderingen in de omgeving. Deze veranderingen die kunnen worden beschreven in chemische en fysische termen kunnen leiden tot een cascade van processen in het lichaam. Gebeurt dat, dan wordt de verandering ‘stimulus’ of ‘prikkel’ genoemd. Wanneer een dergelijke stimulus tot bewustzijn komt spreken we van ‘perceptie’.

Hoofdstuk 2 biedt een biomedisch en ethologisch overzicht van zintuig-systemen. Twee voorbeelden van specifiek gedrag na een zintuiglijke stimulus worden uitvoerig besproken: Tinbergen’s voedsel-bedelend meeuwenkuiken en het zuiggedrag van een pasgeboren mensenbaby. Daaruit wordt afgeleid dat deze pasgeboren (1) verschijnselen in de omgeving kunnen waarnemen, (2) daarop reageren en (3) daarvan leren, wat zich uit in verander(en)d gedrag. Deze drie ‘mechanismen’ zijn in de loop van de evolutie gevormd.

De gevoeligheid voor stimuli leidt ertoe dat individuen aan de hun omringende omgeving ‘informatie’ onttrekken. Informatie wordt omschreven als een voor het organisme relevant verschijnsel. Als de stimuli niet kunnen worden waargenomen doordat ze buiten het bereik van de zintuigsystemen vallen ‘bestaan’ ze niet voor de eigenaar daarvan.

Mensen kunnen door middel van instrumenten sommige niet waarneembare verschijnselen zichtbaar maken zoals (1) door te vergroten met een microscoop of (2) door om te vormen zoals röntgenstraling met een Geigerteller.

Zintuigen kunnen worden onderscheiden naar (1) de aard van de stimulus waarvoor zij gevoelig zijn, (2) het soort zintuigssysteem, (3) de afstand tussen stimulusbron en zintuigssysteem en, tenslotte, (4) de locatie van de stimulus-
bron (exteroceptief versus interoceptief, respectievelijk van buiten- of van binnen het lichaam komend). Zintuigsystemen nemen deel aan processen. Zo maakt de reuk van de zuigende baby deel uit van het zuigproces waarin ook (o.a.) verschillende spiergroepen, de smaak en het maagdarmstelsel als één geheel worden ingezet om te drinken. Daarbij wordt onbewust ervaring opgedaan. Filosofie heeft aan onbewust verkregen ervaring nauwelijks aandacht geschonken.

**Hoofdstuk 3** vervolgt het overzicht van zintuigen. Infrarood, ultraviolet licht en röntgenstralen kunnen door de menselijke zintuigen niet worden waargenomen. Het leidt tot de conclusie dat geen enkel levend wezen op aarde alle verschijnselen van zijn omgeving direct kan waarnemen. Ieder organisme wordt begrensd door zijn zintuigelijke mogelijkheden, al zijn die voor de mens ‘verrijkt’ door vele en veelsoortige instrumenten.


**Hoofdstuk 4** neemt als begindatum van Darwinisme 1 juli 1858 toen de manuscripten van Wallace en Darwin’s in Londen ten doop werden gehouden. ‘Creationisme’ en ‘Intelligent Design’ gaven en geven beide veel tegengas maar de wetenschap erkent evolutie als een feit. Neo-Darwinisme, evolutietheorie gekoppeld aan genetica, gaat ervan uit dat het leven eens ‘spontaan’ ontstond zonder bekende oorzaak en dat daaruit alle levensvormen ontstonden via vele tussenstappen. Natuurlijke selectie verloopt via

Evolutionaire epistemologie, een vorm van naturalistische filosofie ziet de mens en zijn cognitieve functies als product van de evolutie. Daarnaast bestaat een door mij niet aangehangen vorm van evolutionaire epistemologie die ook sociaal-maatschappelijke ontwikkelingen onder een evolutionaire paraplu poogt te brengen.

Naast filosofen die menen dat filosofie en wetenschap elkaar niet veel hebben te bieden zijn er, vooral de laatste decennia, filosofen die met wetenschap(pers) samenwerken en vinden dat zij ‘in hetzelfde schuitje’ zitten.


Via een excursie naar het evenwichtszintuig en de zintuiglijke informatie vanuit huid, spieren en banden wordt aangetoond dat de mens meer zintuigen heeft dan de vijf van Aristoteles. Het onderscheid tussen enerzijds het zintuigssysteem en anderzijds het immuunapparaat en de hormonale systemen is niet scherp.

Het in stand houden van het milieu intérieur is de belangrijkste taak van de gezamenlijke informatie-systemen.

Hoofdstuk 7 behandelt drie problemen, (1) het ‘probleem van perceptie’ alias ‘illusie-probleem’, (2) het probleem van de inhoud van perceptie, het ervaren van de wereld, (3) het probleem hoe perceptie tot kennis van de omgeving kan leiden.

Het eerste probleem is gebaseerd op de vermeende overeenkomst tussen (1) illusie en hallucinatie enerzijds en (2) de ‘werkelijke perceptie’ anderszijds. Ik stel dat die twee inderdaad in de verte op elkaar kunnen lijken, maar nooit aan elkaar gelijk zijn. Een illusie betreft nagenoeg altijd één zintuigsysteem; waarnemingen zijn altijd multi-zintuigsysteem-activiteiten. Shakespeare’s ‘dolk van Macbeth’ is in tegenstelling tot wat daarover vaak wordt geschreven geen illusie, geen hallucinatie, geen waan maar een leerboekvoorbeeld van een pseudo-hallucinatie.

De relatie tussen ‘afbeeldingen’ van de omgeving in de hersenen van de waarnemer en die omgeving zélf hebben in de filosofie veel aandacht ontvangen. Het komt mij voor dat de rechtvaardiging (justification) van uitspraken (proposities) van minder belang is dan de – pragmatische – beslissing over de beste keuze in een bepaald 4-D(imensionaal) probleem.


Wittgenstein die tot ingenieur was opgeleid maakte later in zijn filosofie vaak gebruik van terminologie zoals ‘das zeigt sich’, (dat toont zich, dat is zichtbaar, dat kan niet in woorden worden weergegeven). De werking van het ‘geestesoog’ logenstraft de dominante (filosofische) visie dat kennisvergaring uitsluitend talig kan zijn.
Contemplatie en meditatie berusten (onder andere) op uitschakelen van zintuiglijk waarnemen. Beide zouden leiden tot – intuïtieve – kennis die anders is dan die welke wordt verkregen via zintuiglijke perceptie. Voor verkrijgen van mystieke ervaring kan enige theoretische achtergrond handig zijn maar is vooral belangrijk praktijkervaring te verwerven onder leiding van een mystagoog (guru).

Hoofdstuk 9 geeft een literatuur-overzicht van mystiek, volgens Wittgenstein ‘het onuitsprekelijke’, het gebied van transcendentere ervaring. De literatuur over mystiek is op zijn zachtst gezegd apart en (mede) daardoor vaak moeilijk begrijpbaar.

Mystiek is een oeroud verschijnsel dat in elke cultuur en in elke religie voorkomt. Een mystieke ervaring kan op zeer verschillende wijzen tot stand komen en wordt op zeer veel verschillende wijzen beschreven, vaak in de taal van de religie waarin de persoon was opgevoed, ofschoon – nadrukkelijk – ook atheïsten en agnosties een dergelijke ervaring kunnen hebben. Vaak laat zo’n ervaring diepe sporen na en een blijvende verandering in gedrag. In de monotheïstische religies is mystiek altijd met enig wantrouwen benaderd; elke religie heeft onder zijn mystici slachtoffers gemaakt.

Hoofdstuk 10 stelt dat alles in het universum deel uitmaakt van een of meer processen, zij het met verschillende tijdschalen. In de biosfeer is elk levenswezen vanaf de conceptie tot en met uiteenvallen na de dood bepaald in de tijdruimte (4-D). Levensvormen zijn doorlopende processen die kunnen worden beschreven in formuleringen van regelmatigheden zoals die in de natuur kunnen worden aangetroffen. Elk zintuigssysteem bestaat uit een samenstel van ingewikkelde processen, die elk ook weer zijn opgebouwd uit (deel)processen. Uit het ‘bombardement’ van binnenkomende signalen afkomstig van de inwendige en uitwendige wereld worden door de zintuigssystemen continu signalen geselecteerd en aan de hersenen doorgeleid. Werkzaamheid is de stimulans voor elk orgaansysteem.

Activiteit van zintuigssystemen, gecoördineerd door hersenactiviteit waarin nieuwe ervaringen worden vergeleken met eerdere, kan leiden tot theoretische kennis en praktische vaardigheden. Het merendeel daarvan wordt onbewust verworven. Leren, dat wil zeggen verwerven van nieuwe kennis- en praktische ervaring zijn continue, grotendeels onbewust verlopende processen; nooit statische. Ervaring op tijdstip t wordt tenslotte omschreven als de som van alle stimuli die het organisme tot op dat tijdstip ooit hebben bereikt via de zintuigen, onbewust of bewust.
**Hoofdstuk 11** bespreekt ‘informatie’ als het/de proces(sen) van betekenisverlening door het ontvangende organisme aan stimuli vanuit de omgeving (en vanuit het eigen lichaam). Informatie is de hoeksteen van het relatief nieuwe biologische specialisme genaamd biosemiotica. Een inleiding daarop wordt gegeven en de verhouding tot perceptie belicht.

Overeenkomsten en verschillen tussen von Uexküll’s begrip *Umwelt* en *ecologische ruimte* worden besproken. *Umwelt* is de omgeving zoals waargenomen door een organisme dat ‘opgesloten is in de wereld zoals die door zijn zintuigen wordt aangeboden’ en *ecologische ruimte* komt overeen met de omgevingsvoorwaarden voor het organisme zoals die door een observerende wetenschapper kunnen worden vastgesteld.

**Hoofdstuk 12** gebruikt voor de opbouw van kennis de metafoor van Nederlandse oplossingen voor bouwen in drassige ondergrond. Een artikel van Chisholm, *‘Het probleem van de toets’* (*the problem of the criterion*) wordt als ‘filosofisch kompas’ gekozen.

Opgemerkt wordt dat er een onvermijdelijke circulaire redenering ontstaat als men kennis eist voor begrijpen van zintuigsystemen en zintuigen behoeft om kennis te vergaren. Als men beide tegelijk wenst te bespreken moet men zich als baron von Münchhausen uit het moeras trekken. Uitgaande van wetenschappelijk agnostische empirie (van Fraassen) stel ik dat elk antwoord op een wetenschappelijke (4-D) vraag voorlopig is.

Opnieuw wordt een overzicht geboden over de diverse criteria die zijn toegepast om verschillende zintuigsystemen van elkaar te onderscheiden. Ik kies onomwonden voor de wetenschappelijke indelingscriteria zoals verwoord in Deel I van dit essay.

De stimulus, aangeboden aan een zintuig wordt gevolgd op zijn weg tot in de hersenschors. De hersenen worden opgevat als een informatie verwerkend systeem, cognitie als het geheel van alle processen dat stimuli verwerkt, verandert, bewerkt, opslaat in het geheugen en weer terugvindt in dat geheugen.

Het verstand en het bewustzijn worden opgevat als hersenprocessen, ongeveer zoals Patricia Churchland schrijft dat ‘een electische stroom in een koperdraad niet wordt veroorzaakt door bewegende electronen, maar dat het bewegende electronen is.’ Analoog wordt perceptie – eerder abstraheren dan afbeelden van de werkelijkheid – opgevat als te zijn opgebouwd uit vele gewaarwordingen; ‘gedrag’ is daarvan het gevolg.

Problemen in het begrijpen van processen op het terrein van perceptie en bewustzijn rijzen vaak als gevolg van logisch *lijkende* verklarende speculaties achteraf zonder dat voldoende wetenschappelijke kennis daarover
beschikbaar was/is. Principieel kunnen wij slechts als mens de menselijke werkelijkheid construeren met behulp van het ons ter beschikking staande lichaam waarin het orgaan dat hersenen wordt genoemd.

**Hoofdstuk 13** bevat de conclusies van dit essay zoals vervat in deze Nederlandstalige samenvatting.

**Hoofdstuk 14** bestaat uit enkele addenda:
- *zwik* (hoekvulling, boogvulling, vulstuk, tympan, angelsaksisch ‘*spandrel*’) beschrijft hoe een bouwkundige term werd ingevoerd in de evolutietheorie ter verklaring van sommige (toevallig) ontstane biologische vormen en functies;
- *zintuigelijke vervangingsinstrumenten* beschrijft apparaten die werden ontwikkeld ter (gedeeltelijke) vervanging van aangeboren of verkregen uitval van bepaalde zintuigen;
- *narcissus* is een lang citaat over de narcis uit een bloemengids;
- *eliminatief materialisme* beschrijft kort een specifiek kennistheoretische opvatting;
- *proces* beschrijft een veel gebruikte term in dit boek en bepleit de overtuiging dat alles in het heelal onherroepelijk onderhevig is aan ‘geboorte’, ‘dood’ en ‘verval’, zij het dat er grote verschillen bestaan in de tijds;
- *apologie* is, zoals het woord aangeeft, een verweer(schrift) tegen het advies van een bevriende lezer de gebruikelijke vorm van een ‘gelikt’ wetenschappelijk artikel te volgen, uitgaande van (onder andere) enkele gericht ‘wetenschappelijke vraagstellingen’. Ik heb dat geweigerd. Het ging mij er om, zoals verwoord in de inleiding, meer kennis en meer inzicht te verwerven over zintuigen. De deelvragen, te weten: (a) hoe kijken de levenswetenschappen – gebaseerd op natuurkunde en evolutie-theorie – aan tegen zintuigen en wat zijn daarvan de filosofische achtergronden, (b) wat is de basis van de eenheid van bewuste perceptie, zijn apocrief geformuleerd, waarvan acte.