

The Self in Neuroscience and Psychiatry



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CAMBRIDGE
UNIVERSITY PRESS

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS

The Edinburgh Building, Cambridge CB2 2RU, UK
40 West 20th Street, New York, NY 10011–4211, USA
477 Williamstown Road, Port Melbourne, VIC 3207, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain
Dock House, The Waterfront, Cape Town 8001, South Africa

<http://www.cambridge.org>

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First published 2003

Printed in the United Kingdom at the University Press, Cambridge

Typefaces Minion 10.5/14 pt. and Formata *System* $\text{\TeX}$ 2 ϵ [TB]

A catalogue record for this book is available from the British Library

Library of Congress Cataloguing-in-Publication Data

The self in neuroscience and psychiatry / edited by Tilo Kircher and Anthony David.
p. cm.

Includes bibliographical references and index.

ISBN 0 521 80387 X – ISBN 0 521 53350 3 (paperback)

1. Self. 2. Psychiatry. 3. Neurosciences. I. Kircher, Tilo, 1965– II. David, Anthony S.

RC489.S43 S445 2003

616.89–dc21 2002031550

ISBN 0 521 80387 X hardback

ISBN 0 521 53350 3 paperback

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Self-consciousness: an integrative approach from philosophy, psychopathology and the neurosciences

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Abstract

In this chapter, we want to try and integrate the divergent lines introduced in the other parts of this book. We propose a model of self-consciousness derived from phenomenology, philosophy, the cognitive and neurosciences. We will then give an overview of research data on self-processing from various fields and link it to our model. Some aspects of the disturbances of the self in pathological states such as brain lesions and schizophrenia will be discussed. Finally, the clinically important concept of insight into a disease and its neurocognitive origin will be introduced. We argue that self-consciousness is a valid construct and, as shown in this chapter, it is possible that it can be studied with the instruments of cognitive neuroscience.

Introduction

The *self* as an entity distinct from the *other* has entered western thought through Greek philosophy (see chapter 1, this volume, for details). Throughout history, a myriad of different notions, starting from theology, philosophy, psychoanalysis, to early psychological concepts, psychopathology, the social sciences, and, more recently, cognitive psychology, neurology and the neurosciences have been developed. With the advent of scientific interest in consciousness towards the end of the twentieth century, self-consciousness has also become a topic taken up by the neuroscientific community. As a first phenomenological approximation based on commonly shared experience, we know that we are the same person across time, that we are the author of our thoughts/actions, and that we are distinct from the environment. These ‘feelings’ are so fundamental to our human experience that we hardly ever think about them. However, there are neuropsychiatric conditions where this basic tone of selfhood loses its natural givenness, with subsequent changes in the perception of oneself and the environment.

In the following, we wish to introduce a model of self-consciousness which will serve as a framework for the understanding of most of the chapters in this book. We then present examples of neuroscientific studies of the *self*. We will further discuss selectively clinical cases with an alteration of 'selfhood' and will focus particularly on schizophrenia, applying our model to some of its symptoms such as hallucinations and delusions of alien control. Another important aspect to altered states of self-consciousness is a loss of insight into one's own state. The study of pathological states is particularly helpful, because tacit assumptions during the construction of explanatory models for the faculty in question may be exposed.

A model of consciousness and self-consciousness

Due to the elusiveness of the *self*, we need a conceptual framework before we can begin to map out its neural basis and its disorders. Then it will be possible to generate testable hypotheses. Since the scientific study of consciousness and particularly self-consciousness is still very young, and there is not as yet a vast amount of empirical data, we need to investigate findings and concepts from different sources such as philosophy, cognitive psychology, neuroscience and psychopathology. Phenomenology may serve as a starting point. With the help of detailed phenomenological analysis, the foundations of scientific psychology (W. Wundt, W. James) and later psychiatry (K. Jaspers) were outlined. In the study of self-consciousness phenomenology will now again serve as the appropriate defining base on which the sciences may develop their starting point. The model we present below is derived from phenomenological (for further details see Henry, 1963, 1965; Merleau-Ponty, 1965) and analytical philosophy (for further details see Bermudez et al., 1995; Metzinger, 1995; Block et al., 1997), cognitive psychology, psychopathology and the neurosciences. It will serve as an initial framework and is meant to be largely descriptive. Later we will focus on some of the details of its subcomponents.

What do we mean by 'consciousness'? We have a certain, privileged access to our own mental states that nobody else has and that cannot be accessed from the outside in its primary subjective givenness. When I look at the colour of the sky, the experience of the blueness is something of which I myself am immediately aware. It is the subjective, prereflexive givenness of any experience that nobody else can have in my particular form. In the philosophical literature, these conscious experiences are variously called 'phenomenal consciousness', 'raw feelings', 'qualia' or 'first-person perspective' (see chapters 2 and 17). We will use the word 'qualia' here in the sense of 'purely subjective, prereflexive, first-person experience' (Figure 22.1).

Every experience – the humming of the computer, the smell of perfume, the numbness of my foot, the memory of yesterday's dinner or a vague feeling – is the content of phenomenal consciousness. It is the characteristic feature of qualia that they exist only through their content. We may at some point be able to characterize

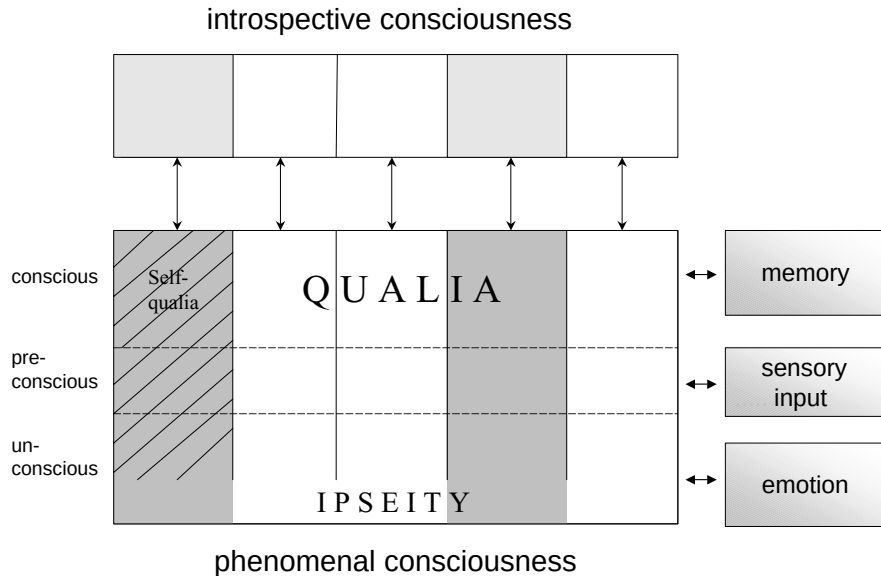


Figure 22.1 A model of consciousness and self-consciousness. The contents of phenomenal consciousness (intentionality) are prereflexive, raw feelings, qualia. They may be sensory experiences, memories and emotions. Their content is on a continuum of high (grey) or low (white) self-valence (e.g. perception of one's own face versus stranger's face). They may be conscious, when they are attended to; preconscious, when they are not attended to; or unconscious (e.g. information from the autonomous nervous system, such as heart rate or blood oxygen level). Ipseity is the unifying 'basic tone' of the first-person givenness of all experiences. There is a special type of self-qualia, responsible for the feeling of unity, coherence, self-affectability and agency. If we reflect on qualia (i.e. think about primary experiences), the content enters introspective consciousness.

fully the brain state (or third-person perspective) that corresponds to a 'raw feeling'; however, even the most thorough description will entirely lack the subjective experience that only I have. The blueness of the sky is nothing but light waves of a certain length; the experience of the colour only becomes real in my mind. An even better example might be pain: the feel of a pinprick is only in my mind; without the subjective feeling of pain, it is not pain. It is not the firing of neurons in my spinal cord or in my brain that constitutes pain, but the awareness of a sensation in only my consciousness.

These phenomenal states are something special, different from physical (chemical, neurobiological) states, because they are characterized by 'transparency', 'presence', and 'perspectiveness' (Metzinger, 1995). *Transparency* means that the brain constructs our reality, but the mechanism of this construction is not represented in it. The representational character of phenomenal consciousness is not accessible to consciousness. We cannot be aware of how our brain constructs qualia in terms of its neurocomputational mechanisms. If we did, neuroscience would

be trivial or may not even exist at all. Transparency leads to a 'naive realism', the tacit assumption that the content of phenomenal consciousness has a direct contact to the environment, and is not a mere construct whose effects may have stronger implications for the behaviour than the 'true' content. If parts of the representational system, e.g. the right parietal lobe or Wernicke's area (left superior temporal lobe), are lesioned, the patient may be unaware of the resulting deficit (hemineglect, aphasia), which leads to a lack of insight into the illness (see below). Transparency is also a prerequisite for the development of hallucinations.

Conscious states are further characterized by their *presence*, i.e. they are in the focus of our attention. Once we accept that phenomenological states are present, it follows logically that there are others that are not present at the moment. There are preconscious experiences which can enter phenomenological consciousness once we direct our attention to them. When I focus on the blueness of the sky (quale A), I am usually not aware of the ground pressing against my feet (quale B). We would argue that there are mental phenomena that may never enter phenomenal consciousness, but still may influence our behaviour. For example, there is now evidence from functional brain-imaging studies for the unconscious processing of sensory stimuli in healthy subjects (Srinivasan et al., 1999; Dehaene & Naccache, 2001; Rees, 2001). These results show that stimuli are processed in specific brain areas but do not enter phenomenal consciousness. Unconscious states encompass all mental activity that is not accessible to consciousness (e.g. sensorimotor self-monitoring; see chapters 18 and 19).

A third factor is important, if we wish to understand what phenomenal consciousness is. This is the fact that experiences are always and only experiences of an 'I'. It is me who realizes the blueness of the sky, the smell of perfume, the taste of wine. This notion is called the *perspectiveness* of phenomenal consciousness. Further, we suggest that we have to distinguish two types of perspectiveness: *ipseity* and *self-qualia*. Let us first consider what philosophers mean by ipseity. The *I* in every experience (qualia, raw feelings) is implicitly and prereflectively present in the field of awareness and is crucial to the whole structure. The *I* is not yet a 'pole' but more a field, through which all experiences pass. This basic self does not arise from any inferential reflection or introspection, because it is not a relation, but an intrinsic property of qualia. When I have a perception of pain, this perception is simultaneously a tacit self-awareness, because my act of perception is given to me in the first-person perspective, from my point of view and only in my field of awareness. This basic dimension of subjecthood, ipseity, is a medium in which all experience, including more explicit and thematic reflection, is rendered possible and takes place (see chapters 3, 11 and 12; also Henry, 1963, 1965; Parnas, 2000). What is this particular functional property of ipseity that makes it the centre of phenomenal consciousness? Ipseity might be granted in the brain by a continuous

source of internally generated input. Each and every time when there is conscious experience (i.e. when we are awake), there is the tacit existence of internal proprioceptive input. The perpetual flow of background cerebral activity is the centre of phenomenal consciousness. The content of this background activity is the continuous flow of unconscious 'thoughts' (Dennett, 1991) and maybe even more so, a representation of a (spatial) model of our body independently of somatosensory input, the 'background buzz of somatosensory input' (Kinsbourne, 1995). It is this feeling of ipseity that makes our experiences feel a united, single being (see chapter 5).

Besides this tacit ipseity, there are also very particular types of qualia that might be called 'self-qualia' or '(phenomenal) self-consciousness'. Their content is the pervasive feeling of *self* and its different aspects. Depending on the author, the content of phenomenal self-consciousness may differ somewhat, but basically it is: (1) self-agency, the sense of the authorship of one's actions; (2) self-coherence, the sense of being a physical whole with boundaries; (3) self-affectivity, experiencing affect correlated with other experiences of self; and (4) self-history (autobiographical memory), a sense of enduring over time. Self-qualia are not different from any other type of qualia in the way they are transparent, present and perspective. Usually their content is preconscious and also encompasses unconscious activity (e.g. auditory or sensorimotor self-monitoring; see chapters 6, 18 and 19). How does the pervasive feeling of selfhood (see chapter 10 for the role of emotion), the sum of the experience of all self-qualia (the self-construct) arise? Because self-qualia, like other qualia, are transparent. The representational structure is not represented in the generation of these self-experiences. In the same way that we think we are in direct contact with the world, although it is a mere construct in our brain, we feel in direct contact with ourselves. We do not at all realize that it is just a construct that can be overthrown, for example in depersonalization or delusions of alien control.

So far we have described the first level of consciousness, i.e. phenomenal self-consciousness. At a second level, we can reflect about the content of phenomenal consciousness: it is a reflective awareness of qualia. Versions of this 'introspective consciousness' can be found in the works of John Locke (1959), William James (1950), David Armstrong (1980), Paul Churchland (1995), William Lycan (1997) and others. It is also called 'higher-order thought', 'perception of the mental', 'second-person perspective' (see chapter 2), 'second-order thoughts' and may be conceptualized as a perception-like, higher-order representation of our own mental states. For example, I can reflect about the pain of a pinprick, or the blueness of the sky. It may still be a preverbal thought; once I verbalize the reflected content (Kircher et al., 2000), I can communicate it to somebody else (see chapter 4 for linguistic implications).

For a coherent self-structure across time, an unimpaired memory system is necessary (see chapter 9). We would claim that all phenomenal experiences, be they memories, feelings or sensory perceptions, can be processed on a self versus nonself continuum, depending on the self-valence of its content. For example, the autobiographical content of being in love has a high self-valence, whereas the insignificant event of a bee landing on a flower (observed by you) has a low self-valence. This means that the content of phenomenal consciousness and introspective consciousness is processed on a self versus nonself dimension. We will later report some experiments investigating this point.

Data from neuroscience

Once we have accepted that there are experiences of selfhood (phenomenal self-consciousness), we can start to look at their neural correlates. What has been done in neuroscience thus far is mostly investigating the cognitive and neural structures of phenomenal consciousness, triggered by external sensory stimuli with little or no self-valence (vision, hearing, memory, attention). More recently, not commonly shared subjective experiences such as emotion processing have drawn attention. There is reason to believe that the most subjective experiences, *self-qualia*, are also amenable to scientific research. Having introduced a model of consciousness, we can frame experimental results and concepts from neuroscience within it. We will focus on phenomenal self-consciousness, introspective self-consciousness and the question of self-valence. Most studies in this context have entailed processing of stimuli with high versus low self-valence, including autobiographical memory, as well as sensorimotor and auditory self-monitoring, theory of mind and perspective taking (ego- and allocentric space processing).

In our model we have proposed that all information can be processed on a self versus nonself continuum (self-valence). We propose that self processing is domain-specific, i.e. a deficit in a particular function does not imply a deficit in another function (McGlynn & Schacter, 1989). In terms of our model, for example, a loss of autobiographical memory does not change somatosensory or verbal self-monitoring. What brain areas might correspond to particular functions of our model? Regarding neurological instantiation, it is known that lesions in the posterior parietal and prefrontal regions produce a lack of awareness of deficits (Keefe, 1998), that is, the ability to reflect upon one's own abilities is impaired. We therefore suggest that these areas constitute an important part of a network subserving self-processing. The basic level of self-processing (pre- or unconscious self-qualia) involves sensory integrative functions of the sort carried out by the parietal lobes. Lesions in these areas lead to neglect phenomena. Visuospatial neglect is associated with right, language-related neglect with left temporoparietal lesions

(Leicester et al., 1969). Also at this level is 'internal information', such as mental images or inner speech, recognized as self-produced via efference-copy mechanisms (see chapters 18 and 19; Sperry, 1950; von Holst & Mittelstaedt, 1950). Operations on this level are highly overlearned and not necessarily conscious. A second level of self-processing (introspective self-consciousness) is associated with the executive control functions of the lateral prefrontal cortex. Here, complex behaviour is governed and this requires active decisions and involves conscious processes. The two primary symptoms in almost every patient with a lesion in the prefrontal regions (Luria, 1969), including leucotomy (Walsh & Darby, 1999), are: (1) a disturbed critical attitude toward and inadequate evaluation of one's own state or deficits and (2) a loss of spontaneity. We therefore suggest that it is a crucial region in introspective self-consciousness.

Facial self-recognition

The face is our most distinct external feature. The ability to recognize oneself in the mirror is regarded as a test for 'self-awareness' in animals (see chapter 7). Mirror self-recognition does not occur in humans before 18 months or in other primates, except adult great apes (Gallup, 1970; Parker et al., 1994). In order to recognize oneself in the mirror, a concept of the *self* is necessary. The existence of 'phenomenal self-consciousness' (conscious self-qualia) is a prerequisite for self-recognition, giving rise to the pervasive feeling of *self*. Whether introspective self-consciousness is necessary is still a matter of debate. The ability to solve theory of mind tasks is also dependent on functioning phenomenal self-consciousness, because only when a being has a stable self-concept, can s/he infer mental states of others. Theory of mind refers to the ability to infer mental states of other persons (see e.g. Hong et al., 1995; Povinelli & Preuss, 1995). This faculty is impaired in schizophrenia (Sarfati & Hardy Bayle, 1999) and autism (Pilowsky et al., 2000).

In a series of experiments, we tested whether one's own face is processed differently from other faces (see chapter 8). One major problem when studying self-face processing is to control for emotional salience and overlearnedness, since both are known to influence processing (Klatzky & Forrest, 1984; Young et al., 1985; Valentine & Bruce, 1986). We tried to overcome this by using the face of each subject's partner for comparison. The idea behind these experiments was to investigate cognitive processes involved in qualia experiences with very high self-valence that would trigger phenomenal and introspective self-consciousness. The other idea was that qualia with high self-valence (own face) is processed differently from qualia with lower self-reference (partner's face). We presented adult, healthy subjects with either their own face, their partner's face or an unknown face, one at a time, on a computer screen and measured reaction time and accuracy of recognition by button press. In different experiments, with different groups of subjects, we presented the

faces: (1) centrally on a screen; (2) to one or other hemifield; (3) subliminally (for an average of 32 ms using backward masking); and (4) morphed with another identity (Kircher et al., 2001b; Yoon 2001). As expected, we found faster reaction times for the recognition of familiar (self and partner) versus unfamiliar faces. There was however no robust difference in response time or error rate between the 'self' and 'partner' conditions.

To explore the neural correlates of phenomenal and introspective self-consciousness, we used functional magnetic resonance imaging (fMRI) to measure brain activation while subjects viewed morphed versions of either their own or their partner's face, alternating in blocks with presentation of an unknown face. When subjects viewed themselves (minus activation for viewing an unknown face), activation was detected in right limbic (hippocampal formation, insula, anterior cingulate), left prefrontal and superior temporal cortex. In the partner (versus unknown) experiment, only the right insula was activated (Kircher et al., 2001b). The activation consequent upon recognizing one's own face was more extensive and the pattern striking. The right limbic regions, which were extensively activated when self was contrasted with novel, are known to be engaged in pleasant and unpleasant emotional responses (Lane et al., 1997; Phillips et al., 1997). We interpret the activation of the right limbic system in our study as a unique, strong emotional response to seeing our own face. The left prefrontal cortex, which was only activated by self-faces, is thought to have an important role in executive processes such as the conscious integration of information to form a coherent 'whole' from multimodal inputs (Miller, 1992; Vandenberghe et al., 1996). The combination of right limbic and left cortical activation could underlie human self-recognition. Experiments with split-brain patients (Preilowski, 1979; Sperry et al., 1979; Gallois et al., 1988) have shown that, although rudimentary self-recognition occurs in the disconnected right hemisphere, only transcallosal transfer of information enables the sensory experience to reach awareness.

The onset of self-recognition in human infancy correlates with the myelination of fibres in the frontal lobe (Kinney et al., 1988). Isolated failures of self-recognition have yet to emerge in the neurological/psychiatric literature. Such failure does not seem to occur following isolated frontal lesions or in cases of amnesia with profound loss of autobiographical memory (Tulving, 1993b) where there is a preservation in phenomenal self-consciousness. The relatively widespread and bilateral activation we have demonstrated in response to self-stimuli suggests that many processes contribute to self-perception with some built-in redundancy, hence the resistance to disruption by common neurological lesions. We suggest that a neural network involving the right limbic system in conjunction with left-sided associative and executive regions enables the integration of self-valent affect and cognition to produce the unique experience of phenomenal and introspective self-consciousness.

Autobiographical semantic memory

The facts about oneself, William James' 'me', must be stored in the memory system and can be reflected upon in introspective consciousness (see chapter 9). The memory system components of relevance here are episodic and semantic memory (Tulving, 1991). Semantic memory is concerned with acquisition, retention and use of organized information in the broadest sense; its principal function is cognitive modelling of the world. For example, our knowledge that Rome is the capital of Italy is processed via semantic memory. Episodic memory depends on semantic memory for many of its operations; its purpose is to retain the memory for events (e.g. facts about my recent holiday in Italy).

Evidence suggests that memories about ourselves are stored and divided according to these categories. Episodic or autobiographical memory enables the individual to remember personally experienced events in subjective time as embedded in a matrix of other personal happenings, for example the circumstances of our last holiday, yesterday's departmental meeting and today's lunch. An aspect of semantic memory is personal semantic memory: this comprises information about ourselves, our personality and who we are. The validity of this distinction between episodic and semantic self-knowledge stems from behavioural, brain lesion and functional imaging studies. In an experiment by Klein & Loftus (1993), subjects were presented with a personality trait word and asked to perform one of three tasks: to indicate whether the word is self-descriptive (describe), to retrieve an autobiographical memory related to the word (remember) or to define the semantic meaning of the word (define). In a second step, they were asked to perform either the same or different task from the first one. The paradigm is based on the following premise: if, in the process of performing the first task, information relevant to performing the second task is made available, then the time required to perform the second task should be less than if that information were not available. The authors found that the autobiographical memory task did not influence performance (response time) on the self-descriptive task, nor did the self-descriptive task influence performance on the autobiographical memory task. These results indicate that subjects do not search autobiographical episodic memory to come up with a judgement about themselves, nor do they access abstract (semantic) self-knowledge whilst retrieving autobiographical memories.

These experiments can be questioned on the grounds that these memory systems may interact with each other to perform the task and it is therefore difficult to demonstrate compellingly that the two systems are independent. However, there are amnesic patients with intact semantic but impaired access to episodic memory. Of interest is the case described by Hodges & McCarthy (1993) of a then 67-year-old male garage owner who sustained bilateral paramedian thalamic infarctions. General intellectual functioning, language and immediate memory were

relatively normal. However, he had a profound deficit in autobiographical memory, believing himself to be currently serving in the Navy – in fact he served from 1941 to 1946. He could recall virtually no events, personal or public, after 1945; he confused his grown-up children and could not say which were married, had children and so on. On the other hand, he was able to provide answers rich in detail to questions about famous people from all eras but not equally famous events. How can this pattern be explained? The authors argue that a simple account in terms of loss of stored information is not adequate but instead suggest that retrieving information organized by personal themes (high self-valence) may be specifically disrupted by thalamic lesions.

There are case studies which are illuminating in regard to the distinction between semantic and episodic self-knowledge (Kapur et al. 1995). One patient, KC, was involved in a motorcycle accident at the age of 30 (Tulving, 1993a). As a result, he suffered from anterograde and retrograde amnesia. Besides the amnesia, the brain damage produced a profound change in his personality from outgoing, adventurous and gregarious to a now passive, cautious and reticent man. He does not remember a single event or happening from his life and does not know how he behaved in any particular instance. Does this patient know what kind of person he is? To test this, he and his mother were given the same list of trait adjectives and both were asked to rate their own and the other's personality (after the accident). The mother's ratings of the patient's personality were consistent with his own and vice versa. Since the accident that caused profound amnesia and a change in personality, KC has relearned his personality traits despite the fact that he cannot access any recollection of his own behaviour and so is unable to infer traits from behaviour.

Another case is WJ, an 18-year-old female college student who suffered temporary loss of episodic memory following a head injury – a dense retrograde amnesia of 6–7 months (Kapur et al., 1995). During this time and despite being unable to remember anything about college or anything else happening at around that time, she was able to describe herself accurately, according to friends' ratings and her own rating on recovery when her memory returned to the preinjury level. Despite all the limitations of single case approaches, it is shown here that semantic self-knowledge is represented in a memory system other than episodic memory.

The question remains whether semantic self-knowledge is different from semantic knowledge about other persons. In a typical experiment designed to answer this question, participants are given lists of personality trait words which they have to judge for self or other descriptiveness. When recall is tested subsequently (usually 0–10 min after encoding), self-descriptive traits are better remembered (for review, see Symons & Johnson, 1997). Thus, a person remembers the word 'friendly' better after answering the question 'Does the word "friendly" describe you?' than after answering the question 'Does the word "friendly" describe your

father?’ (Lord, 1980; Ferguson et al., 1983; Keenan & Baillet, 1983). This has been termed the self-reference effect (Rogers et al., 1977). Related work has shown a reaction time advantage in decision tasks for self-descriptive versus nonself-descriptive personality traits (Markus, 1977). The most commonly given explanation for the self-descriptive effect is that it promotes *elaborative* processing (Rogers et al., 1977; Keenan, 1993). Elaboration is the ‘breadth, extensiveness and amount of processing that occurs at any particular level of depth of analysis’ (Eysenck & Eysenck, 1979). During elaborative processing, multiple associations between the stimulus word and other material are evoked (Anderson & Reder, 1979; Klein & Loftus, 1988). Furthermore, it has been argued that this elaboration occurs incidentally, i.e. without the wilful act of self-reference processing (Markus, 1977; Symons & Johnson, 1997). From this research it has been concluded that semantic self-structure in memory is highly elaborated and organized, invokes multiple associations and is continually and incidentally updated, well learned and often used (Kihlstrom, 1993; Maki & Carlson, 1993; Symons & Johnson, 1997).

Surprisingly, very little is known about the cerebral structures involved in semantic autobiographical processing. In our own study, we used fMRI to delineate significant changes in blood oxygenation level-dependent contrast as an index of changes in local neuronal activity in human volunteers (Kircher et al., 2002). Our aim was to probe the model described above and test whether there was differential cerebral activation for incidental (preconscious) and intentional (introspective) semantic self-processing. In two individually tailored experiments, we measured localized MRI signal changes while subjects judged personality and physical trait words, differing in the amount of self-valence.

In the first experiment (intentional semantic self-processing), subjects were presented with personality trait adjectives and made judgements as to their self-descriptiveness (versus nonself-descriptiveness). In the second experiment (incidental semantic self-processing), subjects categorized words according to whether they described physical versus psychological attributes, while unaware that the words had been arranged in blocks according to self-descriptiveness. Regarding our consciousness model (Figure 22.1), we probed the neural correlates of preconscious qualia with high versus low self-valence retrieved from semantic autonoetic memory. In both the intentional and incidental experiment, preconscious self-qualia are evoked automatically. The subjects had previously rated the words for self-descriptiveness 6 weeks prior to the scanning session. A reaction time advantage was present in both experiments for self-descriptive trait words, suggesting a facilitation effect (Markus, 1977). Common areas of activation for the two experiments included the left superior parietal lobe, with adjacent regions of the lateral prefrontal cortex also active in both experiments. Differential signal changes were present in the left precuneus for the intentional and the right middle temporal gyrus

for the incidental experiment. The results suggest that self-processing involves distinct processes and can occur on more than one cognitive level with corresponding functional neuroanatomic correlates in areas previously implicated in awareness of one's own state.

Overall, the results of both our experiments show that self-descriptive compared to nonself-descriptive traits evoke a unique pattern of neural activation. When subjects process self-descriptive words (versus nonself-descriptive words), whether intentional or incidental, they activate the superior parietal cortex and left inferior frontal gyrus. This result confirms our predictions based on the model presented. We suggest that information is processed on a self versus nonself dimension in multimodal integration areas (superior parietal and inferior frontal gyri). We speculate that the rich associations evoked by self-relevant processing are integrated in the inferior frontal and superior parietal lobe (Markus, 1977). The reason that such a specific self-activation network might have developed is perhaps the biological need to distinguish between self and other or the outstanding subjective importance of the self.

The area solely activated in our intentional self (minus nonself) condition included the precuneus. This structure has previously been identified in memory encoding and retrieval paradigms in functional imaging studies (Shallice et al., 1994; Fletcher et al., 1995; Krause et al., 1999; Wiggs et al., 1999). The paradigm employed in the incidental experiment was essentially a semantic categorization task, yet we argue that self-relevant words evoke memories automatically, hence the overlap with content-neutral studies of memory retrieval. We suggest that the precuneus plays a crucial role in memory processes that involve processing with high self-valence, as in episodic memory, and that the self component is an important factor in its involvement.

In a related positron emission tomography (PET) study by Craik et al. (1999), trait adjectives were presented in different sets of scans and participants had to judge on a four-point scale whether the adjective described themselves, Brian Mulroney (former Canadian prime minister), the general social desirability of the trait or instead they were requested to indicate the number of syllables in the word. They found a small increase in activation only in the self versus general conditions, but not in any of the other direct comparisons in the right anterior cingulate. Comparing self versus syllable, the left inferior frontal gyrus was activated, similar to our signal changes in the intentional experiment. However, they did not tailor their stimuli to the individual participants, which could explain the lack of differential activation. Computations for high and low self-valence would both be present in their self-condition, thus diluting the effect.

Social self

Using introspective consciousness, we can reflect on our own mental states. We can retrieve memory traces from our memory stores about past events, other people and ourselves, and think about them. We have a stable mental representation of a particular person – ourselves – and as such this is part of the individual's wider knowledge concerning objects and events in his or her world. The knowledge of ourselves and its organization is usually called *self-concept* in social science and personality psychology. An early debate revolved around the question of whether the self-concept is unitary (Snygg & Combs, 1949; Allport, 1955) or multidimensional (for review see Kihlstrom & Cantor, 1984; Marsh & Hattie, 1996). Early multidimensional models were proposed by social psychologists Cooley (1902) and Mead (1934), who suggested that the individual perceives him- or herself largely through the reaction of others. Each person possesses as many selves as there are significant other persons in the environment. Nowadays, multidimensional models in various forms are favoured (Neisser, 1988). Here, different aspects of the self-concept, like physical, academic, social, family and emotional self-concept, are grouped as hierarchical, correlated or independent factors. Just as the theories and definitions of self-concept have varied widely across times and researchers, so has the assessment methodology taken many forms. For example, semantic differentials, adjective checklists, drawing tasks, projective tests, actual–ideal measures and third-party reports have been used (for review, see Keith & Bracken, 1996). Several validated self-report questionnaires, usually based on one of the multidimensional models, have been developed (for review, see Wylie, 1989; Hattie, 1992).

Recent work in the field of social cognition and abnormal psychology has thrown up at least two relevant and heuristic constructs: self-complexity (Linville, 1987) and self-discrepancy (Higgins, 1987). Self-complexity could be regarded as the number of (integrated) selves one defines oneself by or at least the number of social roles one has. High self-complexity seems to protect the individual against stress. Crudely, if a person defines herself as doctor, mother, wife, singer, runner, cook, councillor, etc., then a disruption or loss of one of these roles will be buffered by the presence of those remaining. Someone with low self-complexity would be more vulnerable.

The self-discrepancy model (Higgins, 1987) has been taken up by Bentall and colleagues (Bentall et al., 1994) as a basis for persecutory delusions (see chapter 14). Higgins subdivides the self-concept into different domains: (1) the actual self, which is my representation of attributes I believe I possess; (2) the ideal self, which is my representation of the attributes that I would like to possess; and (3) the ought self, which is my representation of the attributes that I believe I should or ought to possess. Bentall et al. (1994) explain persecutory delusions through a

discrepancy between the content of these domains. If there is a mismatch between the actual self and the ideal self, triggered by an external event, (deluded) patients try (unconsciously) to diminish this painful discrepancy at the expense of perceiving others as having a negative view of themselves (Kinderman & Bentall, 1996). They do not see themselves in an unfavourable light, but externalize this feeling on to others.

Schizophrenia

Generally, neuroscientific investigations have so far mostly dealt with the processing of sensory stimuli. They can be well controlled and the experiences are commonly shared by healthy subjects (blue is usually blue for you and me). The investigations become more difficult with higher-order, intrinsically generated phenomena. Even more difficult is the investigation of genuinely subjective experiences, such as emotions, self-valence or the feeling of selfhood. An intrinsic problem of phenomenal self-consciousness in general is that it can only be mediated through introspective consciousness, which requires a great amount of reflectivity and verbal–intellectual capacity. Thorough, easy-to-understand descriptions of the feeling of self or self-qualia in particular are further hampered by its ‘immediate givenness, wholeness and embodiment’. This means it is a fundamental, affective tone of mental, emotional and bodily unity which is so basic to our experience that it is very difficult to grasp. Descriptions of phenomenal self-consciousness are the realm of phenomenology. Edmund Husserl (1922) and Maurice Merleau-Ponty (1965), in particular, have described subtle intrapsychic phenomena on the basis of a ‘pure I’, where through self-consciousness the connection of experiences is given. The problem with their descriptions is that they are not intuitively understandable but require some effort from the reader. This, their subjective givenness and the complexity of the phenomena are the reason why they have not been the focus of much scientific research.

Consciousness and self-consciousness are probably the most complex phenomena we know of. An intrinsic problem in the investigation of phenomenal consciousness is its transparency, i.e. the structure of its representation is not represented (see above). That means, if we want to know something about the cognitive structure and brain states correlated with the perceptual experience of ‘greenness’ it does not help to reflect on ‘greenness’ via introspective consciousness, but only to do neuroscientific experiments (e.g. on the visual cortex). Another possibility is to interview and test patients with impairments in the experience in question. We can then compare their experiences and test results with those of healthy controls and thus generate tentative models of the underlying neurocognitive structure, correlating with the experience.

Phenomenology of ego-disorders in psychosis

One way of understanding self-qualia is to look at pathological states of phenomenal self-consciousness and to develop systematic descriptions and models. Here we want to focus especially on schizophrenia, arguably the best-known, most prevalent and most severe disorder of the self. Schizophrenic disorders were described at the turn of the twentieth century (see chapter 1). Eugen Bleuler (Bleuler, 1916, p. 434) considered in schizophrenia ‘the whole personality loosened, split and forfeit its natural harmony’. All the other basic and accessory symptoms would be a result of this core pathology. Kraepelin (1913) claimed that a disunity of consciousness (‘orchestra without a conductor’) was the core feature of the illness. The disunity was closely linked to ‘a peculiar destruction of the psychic personality’s inner integrity, whereby emotion and volition in particular are impaired’ (1913, p. 668, my translation). A contemporary of Bleuler and Kraepelin, Joseph Berze (1914) was the first to propose explicitly that *a basic alteration of self-consciousness*, a peculiar change, a diminished luminosity and ‘affectability’ of self-awareness, was a primary disorder of schizophrenia. He presented a number of case histories with patients complaining: ‘I have no self-consciousness’, ‘I think I have a diminished, unclear I-feeling’, ‘... a diminishing of the feeling of being a centre of connection of a present organisation...’ (p. 62).

The most influential classification of self-disturbance (*Ichstörung*) was proposed by Jaspers (1913, 1963), which was further elaborated by Scharfetter (see chapter 13; Scharfetter, 1980, 1981). These classifications are primarily based on examining the various self-disturbances in schizophrenic patients, drawing inferences from these observations onto the ‘normal’ self-experience. This seems reasonable, since unimpaired people are inclined to take the basic dimensions for granted and entertain no doubts about them. Among different translators, the original German ‘*Ich*’ (‘I’) was variably translated as ‘self’ or ‘ego’: these terms are therefore here used synonymously. The German ‘*Ich*’ (‘I’) has a more philosophical connotation than in English when it is used as a noun (‘*das Ich*’; ‘the I’), therefore ‘*Ich-Störungen*’ (‘ego-disturbances’, which in English is more connected to the psychoanalytical tradition, in contrast to German.) The ‘I’ refers to the certainty of experience. It is I myself: living, functioning on my own, unified and coherent, delineated by a boundary open for communication in an afferent direction, self-identical through the course of life and in various situations’ (Scharfetter, 1980).

There are five basic unimpaired dimensions of ego-consciousness: these would be the different self-qualia in our model presented above. The pathology of *ego-vitality* (Jaspers’ *Daseinsbewußtsein*: awareness of existence) can result in the patients’ experience (or fear) of their own death, the ruin of the world, humanity, the universe. Being in this state, ‘the individual, although existing, cannot feel his/her existence any more. Descartes’ “*cogito ergo sum*” can only be superficially thought,

but it is no longer a factual experience' (Jaspers, 1963). Ego-vitality is heightened in mania. The concept of *ego-activity* is probably best known and had its forerunners (besides Jasper's *Vollzugsbewußtsein*: awareness of one's own performance) in Kronfeld (1922), Gruhle (1932) and Schneider (1967). Its disturbance results in a lack of one's own ability for self-determined acting, thinking, feeling and perceiving. Secondary to this, delusions are formed of alien control, made or stopped feelings, thoughts, perceptions. Clinically, psychomotor slowing to the point of stupor might occur. The disturbance of *ego-consistency* (Jasper's *Einheit des Ich*: unity of the self) resulted in the invention of the term schizophrenia by Bleuler. It is conceptualized as the destruction of the coherence of one's self, the body and soul, as a unitary being; the connection of thinking and feeling is disrupted. Diverging and ununifiable feelings and thoughts are experienced simultaneously. Multiple personality or heautoscopy is sometimes given as an example of this disturbance (Sims, 1988). But disturbance of ego-consistency is not 'to be confused with the so called "double personality", which appears objectively in alternating states of consciousness' (Jaspers, 1963, p. 125). In cases of 'double personalities or alternating consciousness [the] dissociated psychic life appears so richly developed that it feels as if one is dealing with another personality' (ibid., p. 404). In the condition of multiple personality, each of the distinct personalities has a feeling of a cohesive whole (David et al., 1996). Heautoscopy is an optical phenomenon of seeing oneself outside oneself, yet at the same time retaining one's ego-experience intact. If *ego-demarcation* (Jaspers' *Ichbewußtsein im Gegensatz zum Außen*: self distinct from the outside world) is impaired, the patient can no longer distinguish between inner and outer; he/she feels defencelessly abandoned to all manner of external influences. Patients may believe that they themselves experience what they see or hear from others, e.g. 'I have to suffer everything that other patients on this ward have to undergo'. Disturbed *ego-identity* (Jaspers' *Identität des Ich*: identity of the self) manifests itself in a loss or change concerning the own identity in respect of gestalt, physiognomy, gender, genealogical origin and biography. This is often accompanied by disturbances of bodily experience, of ego-consistency and ego-vitality. As a secondary formation of delusions, a new identity, often of higher status, can take over the patient's lost one.

Kurt Schneider (1967) addressed self-disorders in his description of passivity phenomena, allegedly reflective of a loss of 'ego-boundaries'. Detailed descriptions of self-disturbances, usually associated with the explorations of the sense and the nature of self, are to be found in phenomenologically oriented work (see chapters 11 and 12). The main implication is that self-disorders represent the *core feature* of schizophrenia, conferring on it a unique gestalt and reflecting its pathogenic nucleus. Because these psychopathological phenomena are difficult to grasp in clinical work, there has been little empirical research done on them so far.

When patients experience profound alterations of themselves and their environment, coupled with strong affects, it is only natural that their self-construct (in the terminology of social psychology) changes. Due to hospitalization, symptoms and changes in personality due to the disease process, their course of life and their self-narrative can be strongly affected (see chapters 15 and 16).

Self-recognition in schizophrenia

From phenomenological observation we have learnt that at least some patients with schizophrenia have a profound alteration of phenomenal and introspective self-consciousness. Earlier in this chapter we showed that an intact phenomenal self-consciousness is related to the ability to recognize oneself in the mirror and that facial self-recognition results in a unique pattern of cerebral activation. In another study we wanted to test whether there is an impairment in facial self-recognition in patients with schizophrenia as a result of disturbed self-functions.

Twenty right-handed patients with schizophrenia and 20 matched healthy controls were required to indicate by button press whether a face presented on a computer screen depicted themselves, their same-sex first-degree relative (as a control face for familiarity and emotional salience) or a stranger's face (Kircher et al., 2002). The faces were presented individually for 100 ms to one hemifield, so that only one cerebral hemisphere would process the stimulus initially. Hemifield presentation was introduced, because, as discussed earlier, we have suggested that an interplay between the two hemispheres is crucial in facial self-processing (Kircher et al., 2001b). Reaction times did not differ within the two groups across the identities for lateralized presentation. Similarly, there was no difference in the error rate across the identities for left-hemispheric presentation within both groups. However, there was a significant interaction for group $\times$ hemifield ($P = 0.04$) and group $\times$ identity ($P = 0.02$) in the error rate. This was due largely to the patients showing an increase in error rate for the recognition of their own face presented to the right hemifield/left hemisphere compared to the other identities ($P = 0.004$). Recognition of their own face presented to the left hemisphere was selectively impaired in patients with schizophrenia. We interpret this finding as evidence for a disturbance in self-processing, resulting from an alteration of self-awareness (phenomenal self-consciousness and introspective self-consciousness).

Self-monitoring

One fundamental cognitive ability is to attribute events observed in the environment to one's own or somebody else's actions. Most results with regard to self-monitoring have been obtained in neuropsychological studies investigating patient groups that were suspected of having some deficits in self-monitoring. Frith (1982) and Feinberg (1978) proposed that certain symptoms of schizophrenia, such as

delusions of control and hallucinations, are due to deficits in self-monitoring. Delusions of control refer to movements, thoughts or emotions being inserted or controlled from outside. In this theory such passivity phenomena (or ego-disorders, which are subsumed under 'bizarre delusions' in the Anglo-American literature) are explained by a failure in the anticipatory control of one's own movements. A problem with this theory is that movements are treated like thoughts. The core assumptions of the theory are similar to the ones made by the corollary discharge (Sperry, 1950) or efferent copy model (von Holst & Mittelstaedt, 1950). These models were devised to explain how the central nervous system compensates for eye movements in order to enable a stable perception of the visual world. They assume that an efference copy is derived from each motor command to be executed which predicts the sensory consequences of the command. In the case of eye movements this prediction can be used to keep the perceived visual world stable. It has been shown that predictions of sensory consequences are also derived from other motor systems (Wolpert et al., 1995). Comparisons of the predictions with changes in the sensory input allow the self-monitoring system to determine which of these changes are due to one's own actions. Several studies have been conducted to provide evidence for this assumption (Frith & Done, 1989; Daprati et al., 1997; Franck et al., 2001). Failures in the prediction itself or the comparison of the prediction with the sensory input can lead to some of the symptoms of schizophrenia, like delusions of control, because they lead to incorrect attributions to self or other (see chapters 18 and 19).

There are at least two further patient groups that seem to have problems with monitoring the relation between their own movements and their perceived consequences. A study with the alien-hand task showed that apraxic patients with lesions in the left parietal cortex more often confuse the experimenter's hand with their own hand than healthy controls (Sirigu et al., 1999). Sirigu and coworkers interpret this result as evidence that apraxic patients have problems with generating and maintaining a kinaesthetic model of their movements.

Patients with lesions of the prefrontal cortex also have problems with self-monitoring. Slachevsky and coworkers (2001) compared this patient group with healthy subjects on their performance on a task originally devised by Fournieret & Jeannerod (1998). The task was to trace a straight line by moving a stylus on a writing pad. Their hand was hidden behind a mirror that reflected a computer monitor displaying the line to be traced and the line produced by the participants. In some trials, angular perturbations between the actual movement and the visual consequences observed on the screen were introduced. Frontal patients and healthy participants were able to compensate well for smaller perturbations. However, frontal patients had more problems compensating for larger perturbations. Slachevsky and her coworkers concluded from the first result that an automatic

compensation mechanism is still intact in frontal patients. The second result was explained by the assumption that frontal patients remain unaware of larger perturbations that require the conscious monitoring system to become involved and therefore have more problems in compensating them.

In a series of experiments we have further explored self-monitoring in healthy participants – in particular, the sensitivity for detecting changes in mapping between their movement and their visual consequences (Knoblich & Kircher, 2002). There are essentially three possible mechanisms for monitoring the relationship between these two sources of information. The first and simplest assumption is that proprioceptive and visual information can be directly compared if the task at hand makes such a comparison necessary. As soon as these two information sources diverge to a certain extent, an external influence is inferred. A second possible assumption is that the execution of a motor command automatically leads to a prediction of the sensory consequences, including changes in the visual input. This prediction is compared to the sensory input. As soon as there is a certain amount of divergence between the predicted consequences and the actual input, an external influence is inferred (Blakemore et al., 1998a). The third possibility is that there are actually two separate processes (Jeannerod, 1999; Slachevsky et al., 2001). The first process operates on representations that are not cognitively penetrable and automatically uses deviations between a prediction of the sensory consequences of an action and the actual sensory input to adjust future motor commands (this process would be very similar to the one described in the second assumption above). The second process operates on representations that are cognitively penetrable, namely expected and actually observed events, and leads to explicit attribution of events to oneself within a certain range of deviation.

We investigated the sensitivity for mapping changes between movements and their consequences. In several experiments, participants drew circles on a writing pad and observed a moving dot on a computer screen that exactly reproduced their movements. At some point, the mapping between the movement and its visual consequences (the movement of the dot) was changed to different extents. Participants were instructed to lift the pen immediately when they detected a change. The main results were that the sensitivity was surprisingly low, even for large mapping changes, and that the participants compensated for these changes without noticing that they did so. This pattern was found under a number of different conditions, e.g. different drawing velocities. The results support the assumption that self-monitoring is based on a comparison between intended and observed events and not on a comparison between visual and proprioceptive information.

Regarding our model on self-consciousness presented above, self-monitoring is part of the unconscious self-states (Figure 22.1). It is likely that self-monitoring is domain-, i.e. modality-specific (sensory, motor, verbal, etc.), and that there is no

single brain region responsible for self-monitoring in general. Functional brain-imaging studies in healthy people have shown the cerebellum to be involved in predicting the sensory consequences of movements (Blakemore et al., 1998b) and prefrontal, premotor, motor and parietal cortical regions to be responsible for the generation of self-paced movements (Spence et al., 1997). Together, these areas might be responsible for intact sensory motor self-monitoring. In patients with schizophrenia and passivity phenomena, cingulate and parietal regions were hyperactivated in the study by Spence et al. (1997), suggesting an anatomical substrate for the misattribution of internally generated acts to external sources. Verbal self-monitoring (Indefrey & Levelt, 2000), which is considered to be impaired in patients with schizophrenia suffering particularly from hallucinations and formal thought disorder, has been attributed to the superior temporal regions (Kircher et al., 2001a; McGuire et al., 1995).

Insight in psychopathology

General considerations

Insight in psychosis has been conceptualized as a multidimensional construct which encompasses at least three elements (David, 1990):

1. awareness that one is suffering from a mental illness;
2. the capacity to relabel psychotic experiences as such;
3. understanding the need for, and compliance with, treatment.

Many factors must contribute to the acquisition of insight, including the social milieu of the individual and his/her notions of illness and illness attribution – clearly a matter influenced by culture, education, factual knowledge, upbringing and wider social norms beside the individual's perspective (Amador & David, 1997). Nevertheless, at its heart lies the notion of self-awareness: the individual, ego (or part thereof) observing his or her own thoughts, perceptions and beliefs and coming to a view about them in a second-person perspective. To achieve this, that is, to 'expect a patient to arrive at a conclusion that his illness is nervous we are in many cases expecting a very remarkable exercise from him' (Lewis, 1934). Aubrey Lewis goes on:

The hysteric brings to bear on his symptoms . . . a hysterical mind, not a healthy mind with a limited separable disturbance . . . The obsessional brings his repetitive self-torturing mind to bear on his condition . . . The schizophrenic, the manic or the depressive patient . . . all contemplate their apprehensive change with that disturbed mind. His judgements and attitude can therefore never be the same as ours because his data are different, and his machine for judging is different in some respects.

Such a feat requires that certain psychological functions of judgement or appraisal or 'insight' must be separable, to an extent, or, to use modern terminology, 'modular'

(Fodor, 1983). The plausibility of such a state of affairs is given credence by the kind of dissociations between functions reported in the neuropsychological literature, including those relating to deficits in awareness (see below).

One might even ask, is insight possible for a person with schizophrenia? Jaspers did not think so. He believed that 'in psychosis there is no lasting or complete insight' (Jaspers, 1913). After all, how can one be deluded, that is, hold incorrigibly to a belief in the face of evidence to the contrary and yet also hold a belief that the other belief is false? Of course, not all deluded people do have insight, yet this paradoxical situation is seen in many patients with delusions when questioned at length. Garety & Hemsley (1987) have studied delusions along various dimensions and have shown that such variables as 'conviction' and 'plausibility' correlate weakly at best. Strauss (1969) not only interviewed deluded patients at length but, significantly, over time. He reported a state of 'double awareness', particularly during recovering from psychosis in which belief and nonbelief seemed to coincide (see also Stanton & David, 2000). It is perhaps easier to accept that a person may doubt his or her delusions and oscillate between total and partial conviction. If so, one only has to accept that such oscillations could be so frequent as to amount to dual awareness.

Such paradoxical situations are hard to grasp but we can begin to approach this from the point of view of a common experience such as being engrossed in a book or movie. Imagine watching a well-made film about aliens from outer space, such as 'ET: the extra-terrestrial'. The plight of ET as he is being chased or as he lies dying inside an oxygen tent is genuinely moving. This does not necessarily imply that we 'believe' in ET or confuse fantasy (or film) with reality. Further, our response to the story is both intellectual and emotional, not merely conditioned by the dramatic tension, music and images manipulated by a skilful director like Steven Spielberg – although that certainly helps. It appears as if we believe in the characters of the film, yet a moment's reflection would leave no doubt that we know that it is 'just a film'. Indeed, such an act of reflection would be provoked by the mere posing of the question: is this real? It appears, though, that in the absence of such an interruption, we are in a state of double awareness.

Is lack of insight a cognitive deficit?

If self-awareness is to some extent a natural cognitive function or skill, is lack of self-awareness, or specifically, lack of awareness of the self as mentally ill, a cognitive deficit? The pathophysiological basis of poor insight, or the analogy with anosognosia or 'frontal lobe deficits' of neurological patients has, as noted above, some attractions as a framework (David, 1990). The first formal test of this was by Young et al. (1993), who found a correlation between insight as assessed from a semistructured interview (Amador et al., 1993) and measures obtained from the

Wisconsin Card Sorting Test, a traditional executive or 'frontal lobe' test. However, several attempts to replicate this have been unsuccessful. In fact, the bulk of the results go against this idea (Cuesta & Peralta, 1994; Cuesta et al., 1995; David et al., 1995; Collins et al., 1997; Dickerson et al., 1997; but see Lysaker et al., 1998; Mohamed et al., 1999; Smith et al., 2000). Another way of showing that lack of insight cannot be equated with a global cognitive deficit or even a deficit in 'mental illness detection' is the work employing case vignettes. The procedure is to ask psychotic patients to read a description of a person with delusions or hallucinations and behavioural disorder and to ask whether they would regard such a person as suffering from a mental illness. Such responses can then be correlated with an insight score from some rating scale or, more specifically, the patient's own psychopathology can be rated in the same way. The aim of the task is to test the individual's awareness of the 'self as a mentally ill person'. This approach has shown that psychotic patients have a very similar model of mental illness (Chung et al., 1997), including the need for medical treatment, as do mental health professionals, but this is entirely separate from their own illness awareness (Swanson et al., 1995; Startup, 1997). The problem is that such patients (like the rest of us) tend to think that mental illness is something that happens to other people. That self-perception is protected from objective scrutiny – presumably in order to preserve self-esteem (see chapter 14). In other words: 'They are mad; he is mentally ill; I am under stress/misunderstood/a loveable eccentric'.

Conclusions

In this chapter we have introduced a new model of the self based on concepts of philosophy, the cognitive and neurosciences as well as the normal and the abnormal. The scientific study of this topic is just emerging, but we have tried to give an overview of the current positions. Sources of data and theory come from experimental studies of normal volunteers, functional neuroimaging and clinical studies of patients with focal brain damage and psychiatric disorders, particularly schizophrenia. Just as in any other young field of research, established definitions and concepts do not yet exist and an all-encompassing view must remain somewhat speculative. More data must be accumulated and, along this course, new and refined models will emerge. We believe self-consciousness, and, in particular, the 'feeling of selfhood' (self-qualia) is a valid construct and its neurocognitive–emotional basis will be understood in the near future.

Acknowledgements

The authors would like to thank Henner Giedke, Dirk Leube and Thomas Hünefeld for their helpful comments.

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