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Introduction to Velmans, M (2018) Consciousness (Critical Concepts in Psychology), Volume 2: Cognitive and Neuropsychological Approaches to the Study of Consciousness Part 1, Major Works Series, London: Routledge

The emergence of cognitive psychology in the late 1950s led to a detailed exploration of the nature of mind, viewed as an information processing system, and with that, a renewed interest in tracing the exact relations of mind to consciousness. Examples of empirical investigation included:

1. The investigation of functional differences between preconscious, unconscious, and conscious processing, for example, in studies of non-attended versus attended stimuli in perception, learning, and memory.

2. Examination of the timing of conscious experience. When in the course of human information processing does a conscious experience arise, for example, in input analysis of visual and auditory stimuli?

3. The determination of functional conditions that suffice to make a stimulus conscious. For example, does material that enters consciousness first have to be selected, attended to and entered into a "working memory" or a "global workspace"?

There was also a growing interest in how all these functions and functional differences were implemented in the dynamic activities of the brain, a form of *cognitive neuroscience* that was energised from the 1990s onwards by the emergence of functional magnetic resonance imaging (fMRI), positron emission tomography (PET), more sophisticated forms of electroencephalography (EEG), magnetoencephalography (MEG) and transcranial magnetic stimulation (TMS).

Such methods also allowed the examination of other, related questions about how states of consciousness relate to processing in the brain, including:

1. The search for the neural causes and correlates of major changes in normal, global conscious states such as deep sleep, dreaming in rapid eye movement (REM) sleep, the awake state, anaesthesia and global disorders of consciousness such as coma and vegetative states.

2. The search for added neural conditions that support variations in conscious experience within normal, awake states, such as visual, auditory and other sensory experiences, experiences of cognitive functioning (such as the phonemic and other imagery accompanying thinking and metacognition) and affective experience (motivational states, emotions and so on).

3. The search for neural conditions that support altered states of consciousness in psychopathology and in non-pathological altered states, such as the hypnotic state, some drug-induced states, meditation, and mystical states.

Much of this endeavour over the last 25 years or so involved a period of 'normal science' in which many studies attempted to find minimal contrasts in mental processes that either were or were not accompanied by consciousness, or accompanied by significant changes in consciousness, in order to isolate the precise functional and/or neural changes that might cause or correlate with those transitions. There was also continued interest in developing more precise first-person methods to accompany the development of more precise third-person methods. However, over this period, deeper philosophical questions about the nature and function of consciousness in "conscious processes" did not disappear.

In Volume 2 we focus more on cognitive approaches, in Volume 3, more on neural approaches and the first-person methods that can, in principle, support them, and in Volume 4, more on altered and transformed states of consciousness, along with enduring philosophical questions about the relation of consciousness to the material world. However, no clear separation between these is possible and each volume contains a mixture of all three.

Unconscious, Preconscious and Conscious Processing

In the study of how conscious experiences relate to mental processing, the investigation of functional differences between unconscious, preconscious, and conscious processing provide a natural place to start. As noted in Volume 1, the acceptance of unconscious mind and/or mental processing was already apparent from the late 19th Century onwards, for example in the work of Helmholz, Meyers, James, Freud, Jung and many others. However it was only with the arrival of cognitive psychology, when it became possible to view the mind as a complex system, along with more advanced methods of studying its component processes and their interactions, that it became possible to specify the relationship of conscious experiences to their associated processes in finer detail.

In their examination of the "psychological unconscious" Howard Shevrin and Scott Dickman (1980—R24) provide an excellent review of studies of unconscious vs. conscious processing from the late 1950s to the late 1970s, including studies of selective attention, subliminal perception, retinal image stabilization, binocular rivalry and backward masking, along with the main findings and explanatory theories. They also made some interesting suggestions about how the experimental evidence might have a bearing on psychodynamic theories.

John Kihlstrom (1987—R25) reviews additional research that reveals the impact of nonconscious mental structures and processes on the individual's conscious experience, thought, and action. As he notes, research on perceptual-cognitive and motoric skills indicates that they are automatized through experience, and thus rendered unconscious. In addition, research on subliminal perception, implicit memory, and hypnosis indicates that events can affect mental functions even though they cannot be consciously perceived or remembered. These findings suggest a tripartite division of the cognitive unconscious into truly *unconscious* mental processes operating on knowledge structures that may themselves be *preconscious* or *subconscious*. Given the experimental evidence, he also concludes that,

"One thing is now clear: consciousness is not to be identified with any particular perceptual-cognitive functions such as discriminative response to stimulation, perception, memory, or the higher mental processes involved in judgment or problem-solving. All of these functions can take place outside of phenomenal awareness. Rather, consciousness is an experiential quality that may accompany any of these functions. The fact of conscious awareness may have particular consequences for psychological function—it seems necessary for voluntary control, for example, as well as for communicating one's mental states to others. But it is not necessary for complex psychological functioning." (p. 1450)

In Velmans (1991a—R26), a target article in the *Behavioral and Brain Sciences* (followed by 36 commentaries and a response) I develop this analysis further, citing evidence that, in every phase of human information processing (from input to output) processing can, in principle, take place either with or without accompanying consciousness. Furthermore, as a general rule, in cases where processing *is* accompanied by phenomenal consciousness that phenomenology arises *too late* to *enter into* the processing with which it is most closely associated. This requires re-examination of what is meant by a "conscious process". Processes can be conscious (a) in the sense that one is conscious *of* them (introspectively), (b) in the sense that they *result in* a conscious experience, and (c) in the sense that consciousness *enters into* that process. Many (and arguably all) claims in the literature of type (c) are based on confounds with types (a) and (b). However, contrary to what one might expect from this analysis, I reject "epiphenomenalism" in favour of a form of dual-aspect monism that makes sense of the apparent causal efficacy of consciousness in mental life.[1]

The remaining readings in this section provide examples of how the relationship of conscious to preconscious and unconscious processing have been studied in great detail in four areas, reviewed by authors who are leading researchers in those areas. Lawrence Weiskrantz (1991—R27) provides a very informative review of spared mental functioning in the absence of its normally accompanying conscious experience in neurological patients with blindsight (where patients can make accurate guesses about the nature of visual stimuli that they cannot consciously see)—an area in which he did pioneering research—and also in aphasia, amnesia, and agnosia. He then goes on to discuss some of the practical and theoretical implications of such findings.

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[1] Although arrived at independently, this analysis is strikingly similar to that developed by Romanes (1885—R21) in response to Huxley's epiphenomenalism. For details see Velmans (2009—R64).

Merikle, Smilek, and Eastwood (2001—R28) provide an excellent review of the experimental evidence for perception of stimuli without awareness of those stimuli, including the effects of such nonconscious perception both on action and conscious awareness of subsequent stimuli. They also given a thoughtful evaluation of "subjective" versus "objective" measures of awareness, and, therefore, of the value of first-person measures that supplement more traditional third-person ones.

Melvin Goodale (2017—R29) provides an up-to-date review of evidence for the existence of two visual pathways in the cerebral cortex, a ventral stream that supports conscious visual experience, and a dorsal stream that supports the control of action—suggesting a surprising dissociation of visual experience from control of action. Goodale suggests that only ventrally supplied conscious representations of the visual world can enter working memory, and thereby (potentially) become part of our (off-line) long-term knowledge of the world. But largely unconscious dorsally supplied visual information is more effective for visual (on-line) control of motor acts in real-time. This theme is further developed by Mark Jeannerod (2007—R30) in his review of innovative research on the complex ways in which consciousness of action relates to the control of action in voluntary and involuntary actions, and the consequences of these relations for differences between the embodied self that actually controls the motor acts and the "narrative self" (the self as consciously described).

Attention and Consciousness

The intimate links of attention to consciousness were first clearly spelt out by William James (1890—R31) including the need for attention to make a selection of what is of greatest interest and importance, and the suppression and inhibition of the rest from the wealth of available information. However, a detailed examination of the processes that enable selection only started in the 1950s with the work of Colin Cherry (1953) and Donald Broadbent (1958). Much of the research focused on the depth of preconscious analysis required to select the most important stimuli, along with research on how deeply non-selected messages were analysed. As Broadbent noted there was an "information processing bottleneck" in human information processing (a limited capacity to focus attention on and analyse stimuli in parallel) so, for efficiency, it is important to select stimuli as early as possible, and, according to Broadbent, this could be done on the basis of their physical properties. On the other hand, as Anne Treisman and other researchers noted, one might need to analyse aspects of the meaning of input in order to decide on its importance—and Treisman (1969—R32) provided a classical review of this early theory and research.

These early models assumed that, prior to selection, information processing was automatic, pre-attentive, and limited. For example, pre-attentive analyses of verbal stimuli were thought to be limited to the simple meanings of individual words. For phrases and sentences one required more elaborate, flexible, focal-attentive processing that could deal with novelty and complexity. They also assumed that pre-attentive processing was "preconscious", while focal-attentive processing was “conscious”. As noted in the General Introduction (see Volume 1), towards the late 1960s models of selective attention and memory combined (in ways anticipated by William James). For example, in the model proposed by Donald Norman (1969—R33), once the most “pertinent” of the input stimuli are selected for further processing by a limited capacity attention system they enter into primary memory and become conscious. Once in primary memory, they may be subjected to more sophisticated, focal-attentive processing. For example, they may be rehearsed and stored in secondary memory, enter into problem solving, form the basis of some overt response, and so on. Non-selected Information remains unconscious and is eventually lost from the system.

How attention operates and contributes to conscious experience became, and continues to be a major area of psychological research with increasingly sophisticated focus on the detailed operations involved. The visual features of input stimuli are coded by topographically distinct regions of the visual system (Zeki and Bartels, 1999) which leads one to ask how the activities of these feature analysers are bound together to form the coherently whole objects and events that we experience (the “binding problem”). Drawing on cognitive research combined with neurological findings Treisman (1998)[2] provided an excellent review of how focal attention to a given spatial location contributes to the binding of the features analysed to be at that location. And Engel, et al. (1999—R34) reviewed extensive evidence that the temporal synchrony of neural firing patterns associated with attention to a given object or event (in the 30-80Hz gamma range) may contribute to, or even be the binding mechanism. However such synchronous firing can also occur without associated consciousness (for example in well-practiced tasks), so they warn that binding might be *necessary, but not sufficient* for consciousness.

This raises a deeper question. In Velmans (1991a—R26) I also distinguished focal-attention from phenomenal consciousness, arguing that (in normally functioning human minds/brains) attention is necessary but not sufficient for consciousness—in which case it is important not to confound the functions of focal-attentive processing with the functions of consciousness, which is implicit, for example, in the assumption that “focal attentive processing is conscious”. However, at that time, researchers interested in the relation of attention to consciousness typically adopted a form of functionalist reductionism in which the functions of focal-attentive processing and the functions of consciousness were viewed as one and the same. Miller (1962) for example had suggested that, “… the selective function of consciousness and the limited span of attention are complementary ways of talking about one and the same thing” (Ibid. p. 65). And, in his commentary on my target article, Baars (1991) argued that awareness and focal attention "covary so perfectly, we routinely infer in our everyday life that they reflect a single underlying reality." (p. 669) [3]

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[2] Unfortunately, permission was not granted for reprint of this paper but it is available online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1692340/

[3] For a full discussion of the varying ways attention was thought to be related to consciousness in the early 1990s see Velmans (1991a, section 5).

The issue remains topical. For example, Shiffrin (1997) provided a thoughtful review that explicitly dissociated the "automatic" (pre-attentive) processing versus "focal-attentive" processing distinction, from the "unconscious" versus "conscious" distinction on a range of cognitive measures. Koch and Tsuchiya (2006—R35) also summarize more recent psychophysical evidence of a double dissociation between attention and consciousness, arguing that events or objects can be attended to without being consciously perceived, while an event or object can be consciously perceived in the near absence of top-down attentional processing. Much depends on what is meant by "near absence" however. Cohen et al. (2012—R36) in an extensive review of the same evidence along with much additional evidence drawn from a range of attention research paradigms, conclude once again that attention is dissociable from consciousness, necessary for consciousness, but not sufficient for consciousness.

From the 1990s there was also a surge of interest in *inattentional blindness*, the finding that unless one is attending to them, objects and events may not be noticed even if they are directly in one's visual field in the same location as objects and events one does notice. Similarly, with *change blindness*, unless one happens to attend to them, one may not notice major changes in major features of object and events that are directly in one's visual field. Given the important, practical consequences of this work we include an authoritative review of it from the laboratory of Dan Simons, covering many innovative experiments that pioneered the investigation of such phenomena (Jensen et al., 2011—R37).

In his book *A Cognitive Theory of Consciousness* Baars (1988) attempted to integrate many of the earlier theories about how input analysis, attention, memory and consciousness relate to each other by positioning consciousness within a "Global Workspace" (GW) architecture of the brain—and, with colleagues, he continued to develop this model over subsequent years. Consequently we close this section with McGovern and Baars (2007—R38), which provides a useful review of subsequent developments, the relation of GW to other cognitive theories, and the supporting evidence.[4] As they note, the brain has hundreds of different types of *unconscious specialised processors* such as feature detectors for colours, line orientation and faces, which can act independently or in coalition with one another, thereby bypassing the limited capacity of consciousness. These processors are extremely efficient, but restricted to their dedicated tasks. The processors can also receive global messages and transmit them by 'posting' messages to a limited-capacity, *global workspace* whose architecture enables system-wide integration and dissemination of such information. Such communications allow new links to be formed between the processors, and the formation of novel expert 'coalitions' able to work on new or difficult problems.

In later work, Baars and his colleagues no longer *identified* consciousness with attention, arguing instead that attention is the "gateway to consciousness", and that "*information in the global workspace corresponds to conscious contents*" (Baars &

[4] See also Baars, Franklin and Ramsoy (2013), which provides a sophisticated update of the neural conditions that might underly the global workspace.

McGovern, 1996, p. 89)—still a form of reductive functionalism, although this identifies consciousness with a later stage of information processing. Accordingly, they give consciousness a central role in the economy of mind that corresponds to the *functions of the global workspace*, which are essential for organising novel or complex activities.[5] In one form or another (see also Dehaene and Changeux, 2011—R51), the GW model remains the most popular, current model of these relationships in the field.

Learning, Memory and Consciousness

As noted above, attention has been linked to learning, memory and consciousness in cognitive accounts from the time of William James. However, from the late 19th Century onwards, studies of learning and studies of memory remained, in part, distinct fields. Consequently, with the emergence of cognitive psychology, research into how learning and memory respectively relate to consciousness focused on somewhat different questions. For example, from the mid 1960s, Arthur Reber initiated a seminal research program that investigated the extent to which learning of rule-governed patterns in stimulus environments is tacit (consequent on simply being exposed to material rather than consciously intending to learn it), and the resulting knowledge implicit (as opposed to consciously explicit), for example in the way that children naturally acquire the rules of language grammar. In Reber (1989—R39) he reviews the differences between implicit versus explicit learning and knowledge, as well as the broader uses of implicit learning, demonstrating ways in which complex knowledge can be acquired, held and used to control behavior *in preconscious fashion*. Given the evidence, he considers implicit learning to be a general, modality free Ur-process, a fundamental operation whereby critical co-variations in the stimulus environment are picked up, and considers how this might function to ground what is commonly thought of as intuitive knowledge.

Endel Tulving (1985—R40), a leading memory researcher, introduced ways of relating different varieties of consciousness to different types of memory, commonly referred to as episodic, semantic, and procedural memory (memory of personally experienced events, symbolically represented meanings, and acquisition of skills). According to Tulving episodic memory is associated with autonoetic consciousness (consciousness associated with memories of one's own past existence), semantic memory with noetic consciousness (associated with remembered meanings), and procedural memory with anoetic consciousness (acquired skills which may not require explicit conscious knowledge of those skills or how they are acquired, as in the acquisition of grammar described above). These memory systems and associated experiences can be dissociated experimentally, developmentally (in children), and clinically (in neurological patients). For example, some amnesics lose the ability to update their episodic memory and consequently live in a "permanent present" although much of their semantic and procedural memory remains intact. The

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[5] Note however that the claim that information in the global workspace *correlates* with, or is *associated* with conscious contents, does not warrant the conclusion that these are *ontologically identical*, or that consciousness *carries out the functions* of the global workspace. See R23 and the detailed discussion of this issue in Velmans (2014).

experiences associated with different kinds of memory can also be measured in different ways, for example by asking subjects whether they “remember” items as having occurred before (autonoetic) or whether they “know” them (noetic).

Mental Imagery Research

The behaviourist John Watson denied that visual imagery exists, and even now there are respected philosophers of mind such as Dennett (1994), who deny the existence of conscious “qualia”—in which case these cannot be subject to serious scientific study. Given this, is rather ironic that with the emergence of cognitive psychology, studies of mental imagery flourished. Allan Paivio’s 1979 book *Imagery and Verbal Processes* (R41) provided a major review of visual imagery research in the earlier period, including its applicability to the understanding of meaning and other symbolic processes, as well as perception, learning and memory. In this, its impact was seminal, normalizing imagery research in a way similar to the way Ulric Neisser’s *Cognitive Psychology* (1967) normalized cognitive psychology.

The second review in this section (Moulton and Kosslyn, 2009—R42) comes from the lab of Steven Kosslyn, a leading imagery researcher. In this, they bring aspects of mental imagery research up to date, but also move beyond questions such as ‘what is imagery?’, ‘can imagery enhance memory?’ and ‘how is imagery encoded in the brain?’, to ask ‘what is the primary psychological function of imagery?’. They go on to argue that mental imagery allows us to simulate reality at will, thereby allowing us to predict what we would experience in a specific situation or after we perform a specific action.

Some additional, distinct fields of consciousness research

Volume 2 concludes with influential papers from three distinct fields of consciousness research, each of which have substantial literatures that are too voluminous and complex to fully represent in this collection.

Sleep, Dreaming, and Consciousness

The earliest theory of sleep dates back to the Ancient Greek physician Alcmaeon in 450 BCE[6], and the topic has been of psychological interest from the time of Wilhelm Wundt (1874—R9). In 1899, Freud published his *Interpretation of Dreams*, in 1925 Nathaniel Kleitman created the first sleep laboratory at the University of Chicago, and in 1939 he published *Sleep and Wakefulness*, which became a standard text for the developing field. Aserinsky and Kleitman (1953) discovered and named rapid eye movement (REM) sleep when dreaming takes place, and in 1954 William Dement demonstrated that sleep cycles through different stages, repeated four or five times per night.

In 1977, J. Allan Hobson and Robert McCarley (R43) proposed an *Activation-Synthesis* model of dreaming, a seminal theory of the neural systems that govern

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[6] http://www.howsleepworks.com/research.html provides an instructive timeline

dreaming that dominated the field for subsequent decades. While not denying the possible psychological relevance of dream *content*, it argues that the primary motivating force for dreaming is not psychological as argued by Freud but physiological since the time of occurrence and duration of dreaming sleep are quite constant, suggesting a preprogrammed, neurally determined genesis. In their model the dreaming state is characterized by: activation of the brain; relative exclusion of external input; generation of some internal input, which the activated forebrain then processes as information; and blocking of motor output, except for the oculomotor pathway. They then develop a physiological model of dream state activation involving interactions between the bulbar (BRF), pontine (PRF), and midbrain (MRF) divisions of the reticular formation (initially explored in cats). They propose that the activated forebrain synthesizes dreams by fitting experiential data to information endogenously and automatically generated by reticular, vestibular, and oculomotor neurons in the pontine brain stem. A specific physiological and mathematical model of the pontine generator (based upon single cell recording studies in cats) is described which posits reciprocal interaction between inhibitory aminergic (level-setting) and excitatory cholinergic (generator) neurons.

Over subsequent years research in this area continued to develop[7], and for the purposes of this collection we include a paper by Llinás, and Paré (1991—R44), which relates dreaming research specifically to research on consciousness, comparing the thalamocortical activity in paradoxical (REM) sleep and dreaming to that in the waking state, along with the role of 40 Hz synchronous oscillations (found in both states) that underpin integrated forms of consciousness. They conclude that, with respect to these measures, REM sleep and the awake state are functionally equivalent although the handling of sensory information and cortical inhibition is different in the two states. That is, paradoxical sleep and wakefulness are seen as almost identical intrinsic functional states in which subjective awareness is generated.

The Development of Consciousness in Human Infants

Many aspects of research into infant development have a direct or indirect bearing on the development of infant consciousness. In Trevarthen and Reddy (2017—R45), two leading researchers in this area, summarise a wealth of relevant findings, integrating them into a coherent stage-by-stage model of this early development and how to foster it. They propose that infants can be aware both of their own active selves as agents, and of another person's moving presence perceived as a separate consciousness. Adult knowledge and reasoning grows both from a need to engage with the environment physically, and from a need to respond in sympathy, or 'attunement', with other persons. Newborn babies can move to choose experiences, imitate expressions, and are led, by age-related developments to learn conventional

[7] For example, Hobson developed his early work into a general model of waking, sleeping and dreaming involving the interactions of three factors, activation level (A), input-output gating (I), and neuromodulation ratio (M)—see Hobson (2009). Unfortunately, the reprint cost of this paper was too expensive to include in this collection, but it is available online at http://www.nature.com/nrn/journal/v10/n11/abs/nrn2716.html

meanings in a community of self-other-aware actors. Through the first two years, a baby shows age-related advances with growth of motor powers used in intersubjective play and development of object awareness. These developments are adapted for lifetime learning of how to identify and share meaningful conventions of a culture, and the description of experiences in words of a living language. The teaching of infants is stimulated and assimilated by the affections, playful humor and imaginative curiosity of the child interacting with people they know well.

Consciousness in Non-human Animals

According to Descartes' *Discourse on The Method* (1637) only humans are conscious, while other animals (which he refers to as "brutes") are just non-conscious machines —and this view persisted even in modern times for example in the writings of Eccles (in Popper and Eccles, 1976), Humphrey (1983), and philosophers of mind such as Carruthers (1998). However, from ancient times, this view was also opposed, for example by the panpsychists (see R3) and, from the late 19th century onwards, on the grounds of evolutionary continuity, for example by Darwin (1871), Huxley (1874—R20) and Romanes (1882, 1885—R21). Given the accumulating evidence of intelligence in non-human animals, the weight of opinion has shifted the default position to the view that many (and perhaps all) animals are conscious in ways specific to their biology, although the degrees and forms of such consciousness remain a much-debated area of research. Given the importance of this question to the humane treatment of other animals, debate about these issues was also energized in 2016 by the founding of *Animal Sentience*, a new online journal devoted to these issues.

In this bourgeoning field, the work of Jaak Panskepp on *Affective Neuroscience* (Panksepp, 1998) is of particular importance, directly challenging the behaviourist prejudice that there is no rigorous way of studying the emotional states of non-human animals. In Panksepp (2015—R46) he summarises the arguments, pointing out for example that cross-species studies of the effects of deep brain microelectrode stimulation of specific subcortical sites evoke the same, distinct emotional behaviour patterns associated with rewarding states (associated with neural systems that govern SEEKING, LUST, CARE, and PLAY) or punishing states (associated with neural systems that govern RAGE, FEAR, and PANIC/GRIEF) in animals, and desirable or aversive ones in humans—suggesting that primal emotional feelings in humans and other animals arise from the same subcortical circuits, and have similar evolutionary origins.[8] Many of the desirable and aversive effects of drugs also arise from the same neurochemical systems in all mammals (as demonstrated by conditioned place-preference and operant reward paradigms). As he notes, humans have neither rewards nor punishments that they do not experience affectively, and there are no lines of evidence indicating that it is otherwise in animals. He goes on to discuss the shared mammalian evolution of such systems, for example in the way that deep subcortical primary, instinctual processes

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[8] See also Damasio and Carvalho (2013) for an alternative, accessible review of the evolutionary origins of affective states, available online at https://www.ncbi.nlm.nih.gov/pubmed/23329161.

and secondary, higher limbic emotional-action networks (critical for stimulus-response learning and instrumental memory consolidation), interact with tertiary cortical functions that govern thinking and decision-making and the control of refined/complex actions based on external information processing. He goes on to demonstrate how a more precise understanding of how these systems operate and interact in all mammals can lead to novel understanding and treatment of affective disorders in humans such as depression.

In the final reading for this Volume, Colin Allen and Marc Bekoff (2007—R47) provide a broad analysis of the philosophy and empirical research on animal consciousness and the debates surrounding the ethics of animal experiments. They first briefly survey developments in *comparative psychology* and *cognitive ethology*—the comparative, evolutionary, and ecological study of nonhuman animal minds, including thought processes, beliefs, rationality, information processing, intentionality, and consciousness. They go on to evaluate the many arguments over whether non-human animals suffer, how this can be assessed, and the consequent ethics of their humane treatment. Overall, they produce a useful map of this complex territory that can inform the science, philosophy, and many practical disciplines concerned with the nature and welfare of non-human animals.

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R38. Melinda S. Jensen, Richard Yao, Whitney N. Street and Daniel J. Simons (2011) ‘Change blindness and inattentional blindness’, *WIREs Cognitive Science*, 2, 529–546.

R39. Katherine McGovern and Bernard J. Baars (2007) ‘Cognitive theories of consciousness’, in P.D. Zelazo, M. Moscovitch, and E. Thompson (eds.), *The Cambridge Handbook of Consciousness*, Cambridge: Cambridge University Press, pp. 177-205.

Learning, Memory and Consciousness

R40. Arthur Reber (1989) ‘Implicit learning and tacit knowledge’, *Journal of Experimental Psychology: General*, 118, 219-235.

R41. Endel Tulving (1985) ‘Memory and consciousness’, *Canadian Psychology*, 26, 1-12.

Visual Imagery Research

R42. Allan Paivio (1979) ‘Introduction’, in *Imagery and Verbal Processes*, New York: Psychology Press, pp. 1-10.

R43. Samuel T. Moulton and Stephen M. Kosslyn, ‘Imagining predictions: mental imagery as mental emulation’, *Phil. Trans. R. Soc. B*, 2009, 364,1273-1280.

Sleep, Dreaming, and Consciousness

R44. J. Allan Hobson and Robert W. McCarley (1977) ‘The brain as a dream state generator: An activation-synthesis hypothesis of the dream process’, *The American Journal of Psychiatry*, 134, 1335-1348.

R45. Rodolpho, R. Llinás, and Denis Paré (1991) ‘Commentary: Of dreaming and wakefulness’, *Neuroscience*, 44, 512-535.

The Development of Consciousness in Human Infants

R46. Colwyn Trevarthen and Vasudevi Reddy (2017) ‘Consciousness in infants’, in S. Schneider and M. Velmans (eds.), *The Blackwell Companion to Consciousness Second Edition*, Chichester: Wiley-Blackwell, pp. 45-62.

Consciousness in Non-human Animals

R47. Jaak Panksepp (2015) ‘Affective preclinical modeling of psychiatric disorders: taking imbalanced primal emotional feelings of animals seriously in our search for novel antidepressants’, *Dialogues in Clinical Neuroscience*, 17, 363-379.

R48. Colin Allen, and Marc Bekoff (2007) ‘Animal minds, cognitive ethology, and ethics’, *The Journal of Ethics*, 11, 299–317.

ADDITIONAL REFERENCES

Aserinsky, E. and Kleitman, N. (1953) Regularly Occurring Periods of Eye Motility, and Concomitant Phenomena, during Sleep. *Science, New Series*, 118, 273-274

Baars, B.J. (1988) *A Cognitive Theory of Consciousness*, New York: Cambridge University Press.

Baars, B.J. and McGovern, K. (1996) Cognitive views of consciousness: What are the facts? How can we explain them?, in M. Velmans (ed.) *The Science of Consciousness: Psychological, Neuropsychological, and Clinical Reviews*, London: Routledge.

Baars B. J, Franklin S, and Ramsoy, T. Z. (2013) Global workspace dynamics: cortical "binding and propagation" enables conscious contents. *Fronteers of Psychology*. 2013 May 28; 4:200. doi: 10.3389/fpsyg.2013.00200.

Broadbent, D.E. (1958) *Perception and Communication*, New York: Pergamon Press.

Carruthers, P. (1998) Natural theories of consciousness, *European Journal of Philosophy*, 6(2), 203-222.

Cherry, C. (1953) Some experiments on the reception of speech with one and with two ears, *Journal of the Acoustical Society of America* 25, 975-979.

Damasio, A. and Carvalho G.B. (2013) The nature of feelings: evolutionary and neurobiological origins. *Nat. Rev. Neurosci.*, 14(2), 143-152.

Darwin, C. (1871) *The Descent of Man and Selection in Relation to Sex*, New York: D. Appleton and Company.

Dennett, D.C. (1994) ‘Instead of qualia’, in A. Revonsuo and M. Kampinnen (eds) *Consciousness in Philosophy and Cognitive Neuroscience*, Hillsdale, NJ: Lawrence Erlbaum Associates.

Hobson, J. Allan (2009) REM sleep and dreaming: Towards a theory of protoconsciousness, *Nature Reviews Neuroscience*, 10 (11), pp. 803–813.

Humphrey, N. (1983) *Consciousness Regained*, Oxford: Oxford University Press.

Kleitman, N. (1939) *Sleep and Wakefulness.* Chicago: University of Chicago Press.

Neisser, U. (1967*) Cognitive Psychology*, Englewood Cliffs, N.J.: Prentice-Hall.

Panksepp J. (1998) *Affective Neuroscience: The Foundations of Human and Animal Emotions*. New York, NY: Oxford University Press.

Popper, K.R. and Eccles, J.C. (1993[1976]) *The Self and its Brain*, London: Routledge.

Romanes, G. (1882) *Animal Intelligence*, London: Routledge & Kegan Paul.

Shiffrin, R. (1997) Attention, automatism, and consciousness, in J.D. Cohen and J.W. Schooler (eds.) *Scientific Approaches to Consciousness*, Hillsdale, N.J.: Lawrence Erlbaum Associates.

Treisman, A. M. (1998) Feature binding attention, and object perception, *Phil.Trans. R. Soc. Lond. B*, 353, pp. 1295-1306.

Velmans, M. (1991b) Consciousness from a first-person perspective, *Behavioral and Brain Sciences* 14(4): 702-726.

Velmans, M. (2014) Review of Stanislas Dehaene. *Consciousness and the Brain: Deciphering how the Brain Codes our Thoughts*. *Journal of Consciousness Studies*, 21(11-12), 178-195.

Wundt, W. (1874) *Grundzüge der Physiologischen Psychologie*, Leipzig: Engelmann.

Zeki, S. and Bartels, A. (1999) Towards a theory of visual consciousness, *Consciousness and Cognition*, 8, 225-259.